# Chapter 2

# **Command and Control**



In the mountains, major axes of advance are limited to accessible valleys and often separated by restrictive terrain. The compartmented nature of the terrain makes it difficult to switch the effort from one axis to another or to offer mutual support between axes. The battle to control the major lines of communications of Level I develops on the ridges and heights of Level II. In turn, the occupation of the dominating heights in Level II may leave a force assailable from the restrictive terrain of Level operational III. Each terrain level influences the application of tactics. techniques, and procedures necessary for successful operations.

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In mountainous terrain, it is usually difficult to conduct a coordinated battle. Engagements tend to be isolated, march columns of even small elements extremely long, and mutual support difficult to accomplish. Command and control of all available assets is best achieved if command posts are well forward. However, the mountainous environment decreases the commander's mobility. Therefore, commanders must be able to develop a clear vision of how the battle will unfold, correctly anticipate the decisive points on the battlefield, and position themselves at these critical points.

The success of a unit conducting mountain operations depends on how well leaders control their units. Control is limited largely to a wellthought-out plan and thorough preparation. Boundaries require careful planning in mountain operations. Heights overlooking valleys should be included in the boundaries of units capable of exerting the most influence over them. These boundaries may be difficult to determine initially and may require subsequent adjustment.

During execution, leaders must be able to control direction and speed of movement, maintain proper intervals, and rapidly start, stop, or shift fire. In the mountains, soldiers focus mainly on negotiating difficult terrain. Leaders, however, must ensure that their soldiers remain alert for, understand, and follow signals and orders. Although in most instances audio, visual, wire, physical signals, and messengers are used to maintain control, operations may be controlled by time as a secondary means. However, realistic timetables must be based on thorough reconnaissance and sound practical knowledge of the mountain battlefield.

Commanders must devote careful consideration to the substantial effect the mountain environment may have on systems that affect their ability to collect, process, store, and disseminate information. Computers, communications, and other sophisticated electronic equipment are usually susceptible to jars, shocks, and rough handling associated with the rugged mountain environment. They are also extremely sensitive to the severe cold often associated with higher elevations. Increased precipitation and moisture may damage electronic components, and heavy amounts of rain and snow, combined with strong surface winds, may generate background electronic interference that can reduce the efficiency of intercept/direction finding antennas and ground surveillance radars. Localized storms with low sustained cloud cover reduce the effectiveness of most imagery intelligence (IMINT) platforms, to include unmanned aerial vehicles (UAVs). The collective effect of mountain weather and terrain diminishes a commander's ability to achieve shared situational understanding among his subordinates. However, increased use of human intelligence (HUMINT), clear orders and intents, and leaders capable of exercising initiative, allow commanders to dominate the harsh environment of a mountain area of operations.

As in any environment, mountain operations pose both tactical and accident risks. However, since most units do not routinely train for or operate in the mountains, the level of uncertainty, ambiguity, and friction is often higher than in less rugged environments. Commanders must be able to identify and assess hazards that may be encountered in executing their missions, develop and implement control measures to eliminate unnecessary risk, and continuously supervise and assess to ensure measures are properly executed and remain appropriate as the situation changes. Although risk decisions are the commanders' business, staffs, subordinate leaders, and individual soldiers must also understand the risk management process and must continuously look for hazards at their level or within their area of expertise. Any risks identified (with recommended risk reduction measures) must be quickly elevated to the chain of command (see FM 3-100.14).

# SECTION I – ASSESSMENT OF THE SITUATION

2-1. Although higher-elevation terrain is not always key, the structure of a mountain area of operations (AO) often forms a stairway of key terrain features. Identification and control of dominant terrain at each operational terrain level form the basis for successful mountain maneuver. Key terrain features at higher elevations often take on added significance due to their inaccessibility and ease of defense. To maintain freedom of maneuver, commanders must apply combat power so that the terrain at Levels II and III can be exploited in the conduct of operations. Successful application of this concept requires commanders to think, plan, and maneuver vertically as well as horizontally.

2-2. Mountain operations usually focus on lines of communication, choke points, and dominating heights. Maneuver generally attempts to avoid strengths, envelop the enemy, and limit his ability to effectively use the high ground. Major difficulties are establishing boundaries, establishing and maintaining communications, providing logistics, and evacuating wounded. Throughout the plan, prepare, and execute cycle, commanders must continuously assess the vertical impact on the mission, enemy, terrain and weather, troops and support available, time available, civil considerations (METT-TC).

# HISTORICAL PERSPECTIVE

# Importance of Controlling Key Terrain:

# Mustafa Kemal at Gallipoli (April 1915)

On 25 April 1915, the Allies launched their Gallipoli campaign. However, LTC Mustafa Kemal's understanding of the decisive importance of the hilly terrain, his grasp of the enemy's overall intent, and his own resolute leadership preserved the Ottoman defenses. His troops seized the initiative from superior forces and pushed the Allied invasion force back to its bridgehead. The result was nine months of trench warfare, followed by the Allies' withdrawal from Gallipoli.

German Fifth Army Commander General von Sanders expected a major Allied landing in the north, at Bulair. The British, however, were conducting a feint there; two ANZAC divisions were already landing in the south at Ari Burnu (now known as "ANZAC cove") as the main effort. The landing beaches here were hemmed by precipitous cliffs culminating in the high ground of the Sari Bair ridge, a fact of great importance to the defense. Only one Ottoman infantry company was guarding the area. Although prewar plans had established contingencies for using 19<sup>th</sup> ID, Kemal, the division commander, had received no word from his superiors regarding the developing scenario. Nevertheless, understanding that a major Allied landing could easily split the peninsula, he decided that time was critical and set off for Ari Burnu without waiting for his senior commander's approval. In his march toward Ari Burnu that morning, he recognized that the hilly terrain in general and the Sari Bair ridge in particular were of vital strategic importance: if the enemy captured this high ground they would be in an excellent position to cut the peninsula in half.

Kemal now engaged the enemy. He impressed upon his men the importance of controlling the hilltops at all costs, issuing his famous order: "I am not ordering you to attack. I am ordering you to die. In the time it takes us to die, other forces and commanders can come and take our place." Despite being outnumbered three-to-one, the Turkish counterattack stabilized their position and prevented the Allies from capturing the Sari Bair ridge. Nightfall brought about a lull in the fighting. There was some sniping and a few local encounters on 26 April, and on 27 April Kemal finally received major reinforcements. The front stabilized and the opposing armies settled down into trench warfare. On 16 January 1926, the Allies admitted defeat and withdrew.

The 19<sup>th</sup> ID's counterattack, which prevented the ANZAC from establishing themselves on the Sari Bair ridge, may well have decided the outcome of the entire Gallipoli campaign. Despite his lack of situational knowledge, Kemal instinctively understood the enemy's intent and, recognizing the importance of controlling the hilltops and ridgelines, was committed to concentrating his combat power to seize and hold this key terrain.

Compiled from "The Rock of Gallipoli," Studies of Battle Command, George W. Gawrych

# MISSION

2-3. Mission analysis must include the spatial and vertical characteristics of the AO. Although defeating the enemy continues to be the basic objective of tactical operations, the task of controlling specific operational terrain levels will be paramount. At brigade level and below, major tactical objectives are normally translated into tasks pertaining to seizing, retaining, or controlling specific dominating heights at either Level II or Level III. Therefore, it is imperative to identify the tasks and assets necessary to access each operational terrain level.

2-4. At any operational terrain level, defending and delaying are easier at defiles, while attacking is more difficult. Due to the compartmented terrain, units usually execute offensive missions by conducting several simultaneous

smaller-scale attacks, utilizing the full height, width, and depth of their area of operations. Consequently, commanders must always consider the impact of decentralization on security.

2-5. One method of maintaining freedom of action is to seize or hold key terrain. In the mountains, key terrain is frequently identified as terrain that is higher than that held by the enemy. Seizing this terrain often depends on long and difficult envelopments or turning movements. Therefore, the specified and implied tasks associated with mobility and sustainment, as well as command and control, must be considered in terms of their vertical difficulty.

### ENEMY

2-6. An enemy will normally position forces in depth and height along likely avenues of approach. Mountain terrain facilitates wide dispersal, allowing relatively small units to hold dominant terrain in a connected system of strong points. To prevent bypassing and envelopment attempts, the enemy may adopt a many-

- Utilize the environment to his advantage
- Conduct air operations
- Conduct decentralized operations
- Utilize the terrain in Levels II and III
- Employ obstacles or barriers to restrict maneuverability
- Conduct limited-visibility operations
- Sustain his maneuver elements

#### Figure 2-1. Factors Affecting Assessment of the Enemy Situation

tiered, perimeter defense. Aside from the relative size of forces, the type of enemy units and their equipment must be compared with those of friendly forces, to include a comparison of the suitability of forces, tactics, and training. When considering the enemy's ability to operate in mountainous terrain, commanders should consider how well the enemy can accomplish the tasks and actions listed in Figure 2-1. Again, in analyzing both enemy and friendly factors during mountain operations, the vertical, as well as the horizontal, perspective should be fully integrated into all aspects of the assessment.

# TERRAIN AND WEATHER

2-7. As in all military operations, terrain analysis involves observation and fields of fire, cover and concealment, obstacles, key terrain, and avenues of approach (OCOKA). Terrain often influences the conduct of operations more in the mountains than on flatter terrain. The mountains form the nonlinear and vertical structure of the battlefield, and the influences of geography and climate dictate the extent to which commanders modify tactics. Examples of these difficulties are often encountered in the concentration of forces, as well as in the maintenance of command and control.

2-8. In the mountains, as elsewhere, surprise is easier to achieve for the force that knows the terrain better and has the skills and equipment necessary to achieve greater mobility. The appropriate use of vertical terrain improves the element of surprise if the terrain has been analyzed properly to determine the best means to counter the enemy's reactions. Once the commander decides on a preliminary course of action, he should immediately initiate a detailed terrain reconnaissance.

2-9. In a mountainous environment, the terrain normally favors the defender and necessitates the conduct of limited visibility operations. Highly trained units can achieve significant tactical gains and decisive victories by exploiting limited visibility. However, limited visibility operations in mountainous terrain require precise planning, careful daylight reconnaissance, exceptionally good command and control, and a high degree of training. Imaginative and bold limited visibility operations can minimize the advantage of terrain for the defender and shift the balance of combat power to the side that can best cope with or exploit limited visibility.

# **OBSERVATION AND FIELDS OF FIRE**

2-10. Although mountainous terrain generally permits excellent longrange observation and fields of fire, steep slopes and rugged terrain affect a soldier's ability to accurately estimate range and frequently cause

- 1. The ability to observe and identify targets in conditions of bright sunlight
- 2. The ability to estimate range in clear air
- 3. The ability to apply wind corrections
- 4. The ability to shoot accurately up and
- down vertical slopes

Figure 2-2. Factors Affecting Observation and Fields of Fire

large areas to be hidden from observation. The existence of sharp relief and dead space facilitates covert approaches, making surveillance difficult despite such long-range observation. Four factors that influence what can be seen and hit in mountainous terrain are listed in Figure 2-2.

### COVER AND CONCEALMENT

2-11. The identification and proper use of the cover and concealment provided by mountainous terrain are fundamental to all aspects of mountain operations. The ridge systems found in Level II may provide covert approaches through many areas that are hidden from observation by the vegetation and relief. The difficulties a force encounters in finding available cover and concealment along ridges are fewer than those on the peaks, especially above the timberline. Uncovered portions of an approach leave a force exposed to observation and fire for long periods. The enemy can easily detect movement in this region, leaving commanders with three primary options to improve cover and concealment:

- 1. Identify and exploit avenues of approach the enemy would consider unlikely, due to their difficult ascent or descent.
- 2. Negotiate routes during periods of limited visibility.
- 3. Provide overwhelming route security.

# OBSTACLES

2-12. Obvious natural obstacles include deep defiles, cliffs, rivers, landslides, avalanches, crevices, and scree slopes, as well as the physical terrain of the mountains themselves. Obstacles vary in their effect on different forces. Commanders must evaluate the terrain from both the enemy and friendly

force perspective. They must look specifically at the degree to which obstacles restrict operations, and at the ability of each force to exploit the tactical opportunities that exist when obstacles are employed. Man-made obstacles used in conjunction with restrictive terrain are extremely effective in the mountains; however, their construction is very costly in terms of time, materiel, transportation assets, and labor. Commanders must know the location, extent, and strength of obstacles so that they can be incorporated into their scheme of maneuver.

#### KEY TERRAIN

2-13. Key terrain generally increases in importance with an increase in elevation and a decrease in accessibility. In the mountains, however, terrain that is higher than that held by the opposing force is often key, but only if the force is capable of fighting there. A well-prepared force capable of maneuver in rugged terrain can gain an even greater advantage over an ill-prepared enemy at higher elevation levels.

2-14. The vast majority of operations in the mountains requires that the commander designate decisive terrain in his concept of operations to communicate its importance to his staff and subordinate commanders. In operations over mountainous terrain, the analysis of key and decisive terrain is based on the identification of these features at each of the three operational terrain levels. There are few truly impassable areas in the mountains. The commander must recognize that what may be key terrain to one force may be an obstacle to another force. He must also recognize that properly trained combatants can use high obstructing terrain as a means to achieve decisive victories with comparatively small-sized combat elements.

### AVENUES OF APPROACH

2-15. In mountainous terrain, there are few easily accessible avenues of approach, and they usually run along valleys, defiles, or the crests and spurs of ridges. This type of geography allows the defender to economize in difficult terrain and to concentrate on dangerous avenues of approach. A typical offensive tactic is to conduct a coordinated assault with the main effort along accessible avenues of approach, and supporting efforts by one or more maneuver elements on difficult and unexpected avenues of approach. Normally, high rates of advance and heavy concentration of forces are difficult or impossible to achieve along mountainous avenues of approach. Relief features may create large areas of dead space that facilitate covert movement. Units may use difficult and unlikely avenues of approach to achieve surprise; however, these are extremely high-risk operations and are prone to failure unless forces are well trained and experienced in mountaineering techniques. In mountainous terrain, the analysis of avenues of approach should be based on a thorough reconnaissance and evaluated in terms of the factors listed in Figure 2-3 on page 2-8.

#### WEATHER

2-16. As discussed in Chapter 1, weather and visibility conditions in the mountainous regions of the world may create unprecedented advantages and disadvantages for combatants. To fight effectively, commanders must acquire

accurate weather information about their AO. Terrain has a dominant effect on local climate and weather patterns in the mountains. Mountainous areas are subject to frequent and rapid changes of including weather, fog, strong winds, extreme heat and cold, and heavy rain or snow. Thus, many forecasts that describe weather over large areas of terrain are inherently inaccurate. Commanders must be able to develop local, terrain-

- Ability to achieve surprise
- Vulnerability to attack from surrounding heights
- Ability to provide mutual support to forces on other avenues of approach
- Effect on rates of advance
- Effect on command and control
- Potential to accommodate deception operations
- Ability to support necessary CS and CSS operations
- Access to secure rest and halt sites
- Potential to fix the enemy and reduce the possibility of retreat

# Figure 2-3. Factors Affecting Analysis of Avenues of Approach

based forecasts by combining available forecasts with field observations (local temperature, wind, precipitation, cloud patterns, barometric pressure, and surrounding terrain). Forecasting mountain weather from the field improves accuracy and enhances the ability to exploit opportunities offered by the weather, while minimizing its adverse effects (see Appendix B).

# TROOPS AND SUPPORT AVAILABLE

2-17. Commanders must assess the operational and tactical implications of the restrictive environment on mobility, protection, firepower, and logistics. The complex task of arranging activities in time, space, and purpose requires commanders to fully understand the impact of elevation, weather, and visibility on the capabilities of his subordinate elements and relative combat power. Mountainous terrain and weather can greatly enhance the relative combat power of defending forces and, conversely, it can drastically reduce those of the attacking forces. For example, an infantry battalion may be inadequate to defeat a defending infantry company in the mountains. Instead, an infantry battalion may only be capable of defeating a well-positioned infantry platoon. However, commanders must carefully consider each unique situation and weigh all tangible and intangible aspects of combat power (maneuver, firepower, leadership, protection, and information) when comparing strengths and determining the forces necessary to accomplish the mission.

2-18. Commanders must also assess the proper mix of heavy and light forces that capitalizes on the unique strengths that each type of force can bring to mountain operations while minimizing their limitations. While generally complicating command and control, an appropriate mix allows commanders more flexibility in the synchronization of their operations. Additionally, the difficulty providing combat support and combat service support for mountain operations must be evaluated to determine if the proportion of support troops to combat troops is sufficient.

2-19. Prior to and throughout an operation, commanders must continually assess the effect that the rugged mountain environment and sustained combat operations has on the ability of their soldiers to accomplish the mission.

Commanders may need to slow the pace of their operation, transition to the defense for short periods, or rotate units to ensure that their soldiers are physically capable of striking effectively at decisive times and locations. Too often, commanders consider only the operational readiness (OR) rate of equipment and logistics levels when determining their overall ability to continue offensive actions. Failure to consider this intangible human aspect may result in increased loss of lives and mission failure.

2-20. Vertical operations are an integral part of mountain operations and are one means to improve the success of decisive engagements. Commanders must review the state of training of their units to ensure they are adequately prepared to maneuver and fight at various elevations. Increased requirements for aviation support require aviation units to be capable of operating in the specific mountain environment. Units must also have sufficient numbers of pathfinders and trained air assault personnel to select and mark landing zones (LZs) and prepare sling loads.

### TIME AVAILABLE

2-21. In the mountains, proper timing is fundamental to creating opportunities to fight the enemy on favorable terms. Restrictive terrain, weather, the accumulation of chance errors, unexpected difficulties, and the confusion of battle increase the time necessary to assemble, deploy, move, converge, and mass combat power, effectively decreasing the amount of time available to plan and prepare. To optimize the time available, commanders must continuously evaluate the impact of reduced mobility caused by the weather and ter-

- Adaptability of plans to the terrain and varying weather
- Increased time needed to conduct reconnaissance, execute movements, and synchronize events on the battlefield
- Significant variance in the number of hours of visibility with season and elevation

### Figure 2-4. Factors Affecting Time Available

rain. At times, commanders may need to conduct a tactical pause to facilitate the concentration of combat power at a decisive point. However, they must consider time with respect to the enemy as time available is always related to the enemy's ability to execute his own plan, prepare, and execute cycle. Figure 2-4 summarizes the time considerations that are different from or greater than those encountered on flatter terrain.

# CIVIL CONSIDERATIONS

2-22. Generally, civilian population centers will be located at the lower elevations of Level I close to sources of water and along major lines of communications. Refugees and displaced civilians may increase congestion on the already limited road and trail networks normally found in mountainous environments, further complicating maneuver and sustaining operations.

2-23. Commanders must also consider the impact of operations on the oftenlimited civilian resources available in the mountains. The wisdom of using local resources to lighten in-theater supply requirements must be balanced against the impact on civilians and their local economy. While the purchase of goods and services from the local economy is generally welcomed, it may serve to inflate prices and make it impossible for local civilians to purchase their own scarce and needed supplies.

2-24. In mountainous regions, commanders often encounter a populace of diverse political and ethnic orientation that may support, oppose, or be ambivalent to US operations or the presence of US forces. Depending on friendly force objectives, commanders may conduct public relations, civil affairs, humanitarian assistance, and psychological operations (PSYOP) to influence perceptions and attitudes of neutral or uncommitted parties. Even if commanders choose not to commit resources to enlist civilian sympathy and support, they must still adjust their operations to minimize damage and loss of life to innocent civilians.

# SECTION II – LEADERSHIP

2-25. To help ease their anxiety in combat, soldiers must have confidence in their leaders. This confidence may diminish rapidly unless leaders demonstrate the ability to lead over formidable terrain and under the most difficult weather conditions. Superficial knowledge of mountain warfare and ignorance or underestimation of mountain hazards and environmental effects may result in mission failure and the unnecessary loss of soldiers' lives.

2-26. Effective leadership in mountain operations combines sound judgment with a thorough understanding of the characteristics of the mountain environment. Commanders must first develop flexible and adaptable leadership throughout the chain of command. They must then be able to understand and exploit the operational and tactical implications of the mountain environment, as well as its effects on personnel, equipment, and weapons. The keys to meeting this challenge are proper training and operational experience in the mountains. To fight effectively, leaders creatively exploit the opportunities offered by the mountain environment while minimizing the adverse effects it can have on their operations.

2-27. Leadership rapidly becomes the primary element of combat power on the mountain battlefield. Commanders must recognize the distinctive effects created by decentralization of command, develop a depth of leadership that forms the vital link to unity of effort, and organize and direct operations that require minimum intervention. While specific situations require different leadership styles and techniques, the nature of mountain warfare generally necessitates that commanders embrace the philosophy of command and control known as *mission command* (see FM 6-0). This type of command and control requires subordinates to make decisions rapidly within the framework of the commander's concept and intent. Commanders must be able to accept some measure of uncertainty, delegate, and trust and encourage subordinate leaders at all levels to use initiative and act alone to achieve the desired results, particularly when the situation changes and they lose contact with higher headquarters.

# SECTION III – COMMUNICATIONS

2-28. The communications means available to support operations in mountainous regions are the same as those to support operations in other regions of the world. However, rapid and reliable communications are especially difficult to achieve and maintain in mountainous areas. The mountainous environment requires electronic equipment that is light, rugged, portable and able to exploit the advantages of higher terrain. The combined effects of irregular terrain patterns, magnetic and ionospheric disturbances, cold, ice, and dampness on communications equipment increase operating, maintenance, and supply problems and require precise planning and extensive coordination.

# COMBAT NET RADIO

#### SINGLE-CHANNEL GROUND AND AIRBORNE RADIO SYSTEMS (SINCGARS)

2-29. The Single-channel Ground and Airborne Radio System (SINCGARS) family of frequency modulation (FM) radios is good for the control of battalion and smaller-sized units operating in a mountainous environment (see FM 6-02.32 and FM 6-02.18). If available, hands-free radios, such as helmetmounted radios, are an excellent means of communication for small unit tactics and close-in distances, particularly while negotiating rugged terrain. In colder environments, shortened battery life greatly reduces the reliability of manpacked systems that rely on constant voltage input to maintain maximum accuracy.

2-30. Since even a small unit may be spread over a large area, retransmission sites may be needed to maintain communications and increase range. These sites require extensive preparation and support to ensure the survival of personnel and the continued maintenance of equipment. Retransmission systems are often placed on the highest accessible terrain to afford them the best lineof-sight; however, through simple analysis, these locations are often predictable and make them more vulnerable to enemy interdiction. The importance and difficulty of maintaining adequate communications in mountainous terrain requires commanders to devote additional resources for the protection of these limited assets and operators skilled in the proper use of cover and concealment, noise and light discipline, and other operations security (OPSEC) measures.

2-31. Physical range limitations, difficulties in establishing line-of-sight paths due to intervening terrain, and limited retransmission capabilities often make it difficult to establish a brigade and larger-sized radio net. However, commanders can, if within range, enter subordinate nets and establish a temporary net for various contingencies. In the mountains or if the mobile subscriber equipment network is not yet fully developed, commanders should consider the increased need for the improved high frequency radio (IHFR) family of amplitude modulation (AM) radios and single-channel tactical satellite communications terminals for extended distances.

### SATELLITE COMMUNICATIONS (SATCOM)

2-32. Satellite communications (SATCOM) terminals are light, small, portable ground terminals that are able to communicate in spite of rugged terrain. During operations in mountainous areas having little or no infrastructure to support command and control, satellite

- Greater freedom from siting restrictions
- Extended range, capacity, and coverage
- Mobility and rapid employment
- Extremely high circuit reliability

#### Figure 2-5. SATCOM Advantages

communications become the primary means of communications. Single channel SATCOM are currently transmitted over the ultrahigh frequency (UHF) band and readily support forces operating in the mountains, while providing worldwide tactical communications, in-theater communications, combat net radio (CNR) range extension, and linkage between elements of long-range surveillance units (LRSUs) and Army special operations forces (ARSOF). SATCOM can network with multiple users, communicate while enroute, penetrate foliage while on the ground, and has several other advantages making it an ideal system for mountain communications (see Figure 2-5). However, limitations include restricted access, low-rate data communications, and lack of antijam capability. Commanders should review FM 6-02.11 for further information on the employment of SATCOM.

#### COMMAND AND CONTROL (C<sup>2</sup>) AIRCRAFT

2-33. Using C<sup>2</sup> aircraft can assist the commander in overcoming ground mobility restrictions and may improve communications that would otherwise limit his ability to direct the battle. In the mountains, terrain masking, while making flight routing more difficult, may provide the degree of protection needed to allow an increased use of aircraft. To avoid radar or visual acquisition and to survive, C<sup>2</sup> aircraft must use the same terrain flight techniques employed by other tactical aviation units. This flight method often degrades FM communications and reinforces the requirement for radio relay or retransmission sites.

### ANTENNAS AND GROUNDS

2-34. Directional antennas, both bidirectional and unidirectional, may be needed to increase range and maintain radio communications. Although easy to fabricate, directional antennas are less flexible and more time-consuming to set up. Positioning of all antennas is also crucial in the mountains because moving an antenna even a small distance can significantly affect reception.

2-35. Antenna icing, a common occurrence at high elevations, significantly degrades communications. Ice may also make it difficult to extend or lower antennas, and the weight of ice buildup, combined with increased brittleness, may cause them to break. Antennas should have extra guy wires, supports, and anchor stakes to strengthen them to withstand heavy ice and wind loading. All large horizontal antennas should be equipped with a system of counterweights arranged to slacken before wire or poles break from the excess pressures of ice or wind. Soldiers may be able to remove wet snow and sleet that freezes to antennas by jarring their supports, or by attaching a hose to

the exhaust pipe of a vehicle and directing the hot air on the ice until it melts. However, soldiers must exercise great care to ensure that the antenna is not damaged in their attempts to dislodge the ice.

2-36. Ground rods and guy wires are often difficult to drive into rocky and frozen earth. Mountain pitons are excellent anchors for antenna guys in this type of soil. In extreme cold, ropes can be frozen to the ground and guys tied to these anchor ropes. Adequate grounding is also difficult to obtain on frozen or rocky surfaces due to high electrical resistance. Where it is possible to install a grounding rod, it should be driven into the earth as deep as possible or through the ice on frozen lakes or rivers. Grounding in rocky soil may be improved by adding salt solutions to improve electrical flow.

# MOBILE SUBSCRIBER EQUIPMENT

2-37. Like FM, mobile subscriber equipment (MSE) requires a line-of-sight transmission path and a tactical satellite or several relay sites to overcome mountainous terrain and maintain MSE connectivity (FM 6-02.55 contains in-depth information concerning the deployment and employment of MSE).

# WIRE AND FIELD PHONES

2-38. Wire is normally one of the most reliable means of communication. Unfortunately, in rugged mountains and particularly during the winter months, wire is more difficult and time consuming to install, maintain, and protect. Wire may be dispensed in mountain areas by tracked or wheeled vehicle, foot, skis, snowshoes, or oversnow vehicles. As in any environment, units must periodically patrol their wire lines to ensure that they have remained camouflaged and that the enemy has not tapped into them.

2-39. Snow-covered cables and wire can cause the loss of many man-days in recovering or maintaining circuits. This can be avoided by pulling the cable from under the snow after each snowfall and letting it rest just below the surface of the snow. Trees or poles can be used to support wire. Allowances must be made for drifting snow when determining the height above ground at which to support the lines. However, when crossing roads, it is preferable to run the wire through culverts and under bridges rather than bury or raise wire overhead. In addition to ease, this technique reduces maintenance requirements associated with vehicles severing lines, particularly with higher volumes of traffic on limited road networks. If long-distance wire communications are required, the integration of radio relay systems must be considered.

2-40. Great care must be taken in handling wire and cables in extreme cold weather. Condensation and ice on connectors make connecting cables difficult and can degrade the signal path. When rubber jackets become hard, the cables must be protected from stretching and bending to prevent short circuits caused by breaks in the covering. Therefore, all tactical cable and wire should be stored in heated areas or warmed prior to installation. TC 24-20 provides more detailed information on the installation and maintenance of wire and cable.

2-41. Field phones are useful in a stationary position, such as a mountain patrol base or an ambush site, although leaders must consider the weight and

difficulties encountered in laying and maintaining wire in these sites of limited duration. The batteries that are used to operate field telephones and switchboards are subject to the same temperature limitations as those used to power tactical radio sets.

2-42. When used with a hands-free phone, commercially available rope with a communication wire in it is ideally suited for mountain operations. This system is lightweight and easy to manage, and provides an added measure of security during limited visibility operations. In addition to the standard uses, since it functions as both a rope and a wire, it can be used to control movement on all types of installations, and it can serve as a primary means of communication for climbing teams.

# AUDIO, VISUAL, AND PHYSICAL SIGNALS

2-43. Leaders can use simple audio signals, such as voice or whistles, to locally alert and warn. Sound travels farther in mountain air. Although 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.

2-44. Like audio signals, 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 sand or snow, haze, fog, and other atmospheric conditions may periodically affect range and reliability.

2-45. Units should use hand and arm signals instead of the radio or voice whenever possible, especially when close to the enemy. 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.

2-46. 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. Soldiers can pass signals quietly and quickly between positions by pulling on the tug line in a prearranged code.

### MESSENGER

2-47. 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 the winter, advanced skiing skills may also be required. Messengers should always be dispatched in pairs. Air messenger service should be scheduled between units and integrated with the aerial resupply missions. Vehicles may also be employed to maintain messenger communications when conditions of time, terrain, and distance permit.

# **SECTION IV – TRAINING**

2-48. Because US forces do not routinely train in a mountain environment, they must make extensive preparations to ensure individual and unit effectiveness. Ultimate success in the mountains depends largely on developing cohesive, combat-ready teams consisting of well-trained soldiers. To be successful, commanders must understand the stratification of mountain warfare, recognize the unique aspects of leadership required, and implement training programs that prepare soldiers for the rigors of mountain fighting.

2-49. In the mountains, commanders face the challenge of maintaining their units' combat effectiveness and efficiency. To meet this challenge, commanders conduct training that provides soldiers with the mountaineering skills necessary to apply combat power in a rugged mountain environment, and they develop leaders capable of applying doctrine to the distinct characteristics of mountain warfare.

- Mountaineering skills
- Air assault and air movement operations
- Deception
- Stealth and infiltration
- Limited visibility operations
- Patrolling
- Reconnaissance
- Communications
- CS and CSS operations

#### Figure 2-6. Training Areas of Emphasis

2-50. The ability to apply doctrine and tactics in mountainous environments is not as easy to develop as technical proficiency. Training, study, and garrison experimentation may provide the basis for competence. However, only through experience gained by practical application in the mountains will leaders become skilled in mountain warfare. Proficiency in the areas listed in Figure 2-6 will provide commanders with a degree of flexibility in the application of doctrine to a mountain area of operations.

2-51. The best combat and combat support plans cannot ensure victory unless commanders concentrate on developing a leadership climate that is derived from the human dimension of mountain warfare. The complexities of mountain combat make it extremely important to establish training programs that modify the traditional application of tactics so that units can reach their full potential. Training must simulate the tempo, scope, and uncertainty of mountain combat to create the versatility required to capitalize on the harsh environment as a force multiplier.

2-52. Competent units operate effectively in mountains and focus on the battle. Unprepared units, however, may become distracted by the environment and end up expending as much effort fighting the environment as they do fighting the enemy. Soldiers cannot be fully effective unless they have the proper clothing and equipment, and are trained to protect themselves against the effects of terrain and frequent and sudden changes in weather.

# INITIAL TRAINING ASSESSMENT

2-53. In addition to the questions applicable to every mission, commanders must consider the following when preparing for operations in a mountainous environment:

- What kind of mountains will the unit be operating in?
  - What elevations will the unit be operating at?
  - What are the climatic and terrain conditions of the AO?
  - Are at least two years of accurate weather reports available (see Appendix B)?
- When must the unit be ready to move?
- What training resources are needed and available?
- Are local training areas and ranges available?
  - If not, what alternative arrangements can be made?
  - What available training areas most closely resemble the AO?
- What special equipment does the unit require?
- What training assistance is available?
  - Does the unit have former mountain warfare instructors, military mountaineers, or others with experience in a mountainous environment?
  - Are instructors available from outside the unit?
- What special maintenance is required for weapons and equipment?
- What is the level of physical fitness?
- What additional combat, combat support, and combat service support units are necessary to accomplish the operational missions?
  - Can specific units be identified for possible coordinated training?
- Will allied and multinational troops participate?

2-54. As commanders get answers to these and other questions, they must develop training programs to bring their units to a level where they will be fully capable of operating successfully in mountainous conditions. To do this, they must establish priorities for training. The training requirements listed in Figure 2-7 are only a guide. Commanders should add, delete, and modify the tasks as necessary, depending on the specific AO, the state of readiness of their units when they begin preparations for mountain operations, and the time and facilities available (see FM 7-10).

# PHYSICAL CONDITIONING

2-55. Soldiers who have lived and trained mostly at lower elevations tend to develop a sense of insecurity and fear about higher elevations – many are simply afraid of heights in general. With this in mind, leaders must plan training that accustoms soldiers to the effects of the mountain environment. Physical conditioning must be strictly enforced, since "new muscle" strain associated with balance and prolonged ascents/descents quickly exhausts even the most physically fit soldiers. Even breathing becomes strenuous, given the

TRAINING REQUIREMENTS	ALL	STAFF AND LEADERS	TEAMS AND CREW MEMEBERS	SPECIALISTS
Physical Conditioning and Acclimatization	~	~	~	~
Mountain Illnesses and Injuries	~	<b>v</b>	V	$\checkmark$
Mountain Living and Survival	~	~	~	~
Mountain Navigation Techniques	~	<b>v</b>	<b>v</b>	<b>v</b>
Mounted and Dismounted March Planning	~	<b>v</b>	<b>v</b>	<ul> <li></li> </ul>
<b>Communications Techniques</b>	~	~	<b>v</b>	$\checkmark$
Weapons/Equipment Training	~	~	~	<b>v</b>
Additional Maintenance Requirements	~	<b>v</b>	<b>v</b>	~
Camouflage and Concealment	~	~	~	<b>v</b>
Obstacles		<b>v</b>	<b>v</b>	
Above-ground Fortifications	~	~	~	<b>v</b>
Level 1 Mountaineering	~	~	~	~
Level 2 and 3 Mountaineering				~
Driver and Pilot Training				~
Air Assault/Air Movement Operations	~	<b>v</b>	~	<b>v</b>
NBC Operations	~	~	~	~

#### Figure 2-7. Mountain Preparatory Training

thinner atmosphere at higher altitudes. Therefore, training must emphasize exercises designed to strengthen leg muscles and build cardiovascular (aerobic) endurance (see FM 3-25.20). Frequent marches and climbs with normal equipment loads enhance conditioning and familiarize soldiers with mountain walking techniques.

# MOUNTAIN LIVING

2-56. Successful mountain living requires that personnel adjust to special conditions, particularly terrain and weather. To develop confidence, soldiers should train in conditions that closely resemble those they will face. Lengthy exercises test support facilities and expose soldiers to the isolation common to mountain operations. The mountain area of operations can be harsh, and training should develop soldiers who possess the necessary field craft and psychological edge to operate effectively under mountainous conditions. Although FM 4-25.10 and FM 3-25.76 do not specifically address mountain environments, much of their information applies. Regardless of the level of technical mountaineering training required, all soldiers deploying to a mountainous region should be trained in the areas listed in Figure 2-8 on page 2-18.

# NAVIGATION

2-57. Navigation in the mountains is made more difficult because of inaccurate mapping, magnetic attraction that affects compass accuracy, and the irregular pace of the soldiers. It is easy to mistake large terrain features that are very far away for features that are much closer. The increased necessity for limited-visibility operations restricts the use of terrain techniques as the primary means of

- Temperature extremes and clothing requirements
- Bivouac techniques and shelter construction
- Elevation and rarified air effects
- Hygiene, sanitation, and health hazards
- Locating and purifying water
- Food-gathering techniques

Figure 2-8. Mountain Living Training

determining and maintaining direction. Individuals must train to use a variety of equipment, such as a compass, an altimeter, global positioning system devices, and maps, as well as learn techniques pertaining to terrestrial navigation, terrain association, dead reckoning, resectioning, and artillery marking (see FM 3-25.26).

# WEAPONS AND EQUIPMENT

2-58. Nearly every weapon or piece of equipment familiar to the soldier is affected to some degree by the mountain environment. In addition to honing skills, training must focus on the specific operational area and ways to overcome anticipated environmental impacts when using weapons and equipment.

2-59. Individual marksmanship training must emphasize the effect of wind and include practical training in wind measurement techniques and adjusted aiming points (holdoff). Practical training in range estimation techniques, combined with using laser range finders, M19 binoculars, target reference points, and range cards, helps to overcome difficulties in range estimation.

2-60. In the conduct of their preparations, commanders should strive to increase the number of qualified snipers within their units, as they are ideal in the mountains and can be used to adversely affect enemy mobility by delivering long range precision rifle fire on selected targets. They can inflict casualties, slow enemy movement, lower morale, and add confusion to enemy operations. A single sniper team in well-concealed positions, such as mountain passes, can severely impede enemy movement (see FM 3-21.20 and FM 3-91.2 for further information on sniper employment).

# CAMOUFLAGE AND CONCEALMENT

2-61. The basic principles of camouflage and concealment also apply in mountain operations (see FM 3-24.3). However, certain elements must be adjusted for snow. With snow on the ground, standard camouflage nets and paint patterns are unsuitable. In areas where snow cover is above 15 percent of the background, winter camouflage nets should take the place of standard nets and temporary white paint should be used over the green portions of vehicles. In terrain with more than 85 percent snow cover, the vehicles and equipment should be solid white. However, with less than 15 percent snow cover, standard patterns should be maintained.

2-62. Snow provides excellent conditions for threat thermal and ultraviolet sensor detection. To counter these types of sensors, soldiers must be trained to utilize the terrain to mask themselves and their weapons and equipment from enemy detection. The mountainous terrain often limits the access routes to and from selected positions. Commanders must take appropriate measures to conceal vehicle tracks and limit movement times to periods of limited visibility. Snow presents a significant problem, making movement discipline an absolute requirement. When moving, leaders should be trained to follow the shadows along windswept drift lines as much as possible. Drivers should learn to avoid sharp turns, which are easily recognizable in the snow, and follow existing track marks where possible.

# FORTIFICATIONS

2-63. Fighting and protective positions in the mountains do not differ significantly from other environments, except in areas of snow and rock (see FM 3-34.112 for more information on common survivability positions and FM 3-97.11 for positions created in snow). Digging positions in rocky ground is difficult and often impossible. If demolitions, pneumatic drills, and jackhammers are available, positions may be blasted or drilled in the rock to afford some degree of protection. More often, it will be necessary to build aboveground positions by stacking boulders, stones, and gabions. If possible, existing rock formations should be used as structural wall components.

2-64. If above-ground positions are to be used, considerable care should be taken to avoid siting them in view of any likely enemy avenues of approach. Even a two-man position is difficult to conceal if it is above the timberline. Camouflage nets and the use of background rocks are necessary to break up the outline of the position and hide straight edges.

2-65. Positions should be built of the largest rocks available, wedged securely together. Extreme care should be taken that the walls are stable and not leaning or sloping downhill. An unstable wall is more of a liability than an asset, as the first impact may cause it to collapse onto the defenders. Rocks and gabions should be stacked to systematically overlap each joint or seam to help ensure stable construction. Larger rocks or stones can be used to help bond layers of rock beneath. If possible, a layer of sandbags should be placed on the top of and around the inside of the wall. Substantial overhead cover is normally required in rocky areas. The effects of artillery bursts within and above a protective position are greatly enhanced by rock and gravel displacement or avalanche. Figure 2-9 on page 2-20 shows simple examples of the right and wrong way to build these positions.

# MILITARY MOUNTAINEERING

2-66. The skills required for movement are often difficult to learn and usually very perishable. Commanders must understand the application and mechanics of technical mountaineering systems needed for mobility and movement of soldiers and equipment. In the mountains, a unit may be ineffective unless it has the prerequisite technical training. However, some mountains may feature terrain that is relatively benign, requiring minimal specialized techniques. Other areas will mandate the need for more advanced mountaineering skills. One key to quickly determining the type and extent of training required is to analyze and classify the level of individual movement required according to the dismounted mobility classification table introduced in Chapter 1. Once commanders have determined the specific level and tasks required, TC 90-6-1 will provide them with detailed information on specific mountaineering techniques and equipment (described below).

2-67. Military mountaineering training provides tactical mobility in mountainous terrain that would otherwise be inaccessible. Soldiers with specialized training who are skilled in using mountain climbequipment ing and techniques can overcome the difficulties of obstructing terrain. Highly motivated soldiers who are in superior physical condition should be selected for more advanced military mountaineering training (Levels 2 and 3) conducted at appropriate facilities. Soldiers who have completed advanced mountaineering training should be used as trainers, guides, and lead climbers during collective training. They may also serve as su-

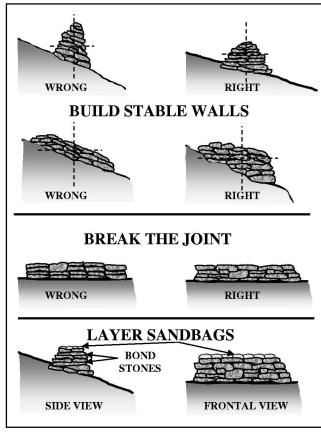


Figure 2-9. Fortifications in Rocky Soil

pervisors of installation teams (see Chapter 4) and evacuation teams (see Chapter 5). Properly used, these soldiers can drastically improve mobility and have a positive impact disproportionate to their numbers. Units anticipating mountain operations should strive to achieve approximately ten percent of their force with advanced mountaineering skills.

#### LEVEL 1: BASIC MOUNTAINEER

2-68. The basic mountaineer, a graduate of a basic mountaineering course, should be trained in the fundamental travel and climbing skills necessary to move safely and efficiently in mountainous terrain. These soldiers should be comfortable functioning in this environment and, under the supervision of qualified mountain leaders or assault climbers, can assist in the rigging and use of all basic rope installations. On technically difficult terrain, the basic mountaineer should be capable of performing duties as the "follower" or "second" on a roped climbing team, and should be well trained in using all basic rope systems. These soldiers may provide limited assistance to soldiers unskilled in mountaineering techniques. Particularly adept soldiers may be selected as members of special purpose teams led and supervised by advanced mountaineers. Figure 2-10 lists the minimum knowledge and skills required of basic mountaineers.

•	Characteristics of the mountain	٠	Rope management and knots
	environment (summer and winter)	•	Natural anchors
٠	Mountaineering safety	•	Familiarization with artificial
•	Use, care, and packing of		anchors
	individual cold weather clothing	•	Belay and rappel techniques
	and equipment	•	Use of fixed ropes (lines)
٠	Care and use of basic	•	Rock climbing fundamentals
	mountaineering equipment	•	Rope bridges and lowering
•	Mountain bivouac techniques		systems
٠	Mountain communications	•	Individual movement on snow and
•	Mountain travel and walking		ice
	techniques	•	Mountain stream crossings (to
	Hazard recognition and route		include water survival techniques)
	selection	•	First aid for mountain illnesses
•	Mountain navigation		and injuries
٠	Basic medical evacuation		-

### Figure 2-10. Level 1: Basic Mountaineer Tasks

2-69. In a unit training program, level 1 qualified soldiers should be identified and prepared to serve as assistant instructors to train unqualified soldiers in basic mountaineering skills. All high-risk training, however, must be conducted under the supervision of qualified level 2 or 3 personnel.

#### LEVEL 2: ASSAULT CLIMBER

2-70. Assault climbers are responsible for the rigging, inspection, use, and operation of all basic rope systems. They are trained in additional rope management skills, knot tying, belay and rappel techniques, as well as using specialized mountaineering equipment. Assault climbers are capable of rigging complex, multipoint anchors and high-angle raising/lowering systems. Level 2 qualification is required to supervise all high-risk training associated with Level 1. At a minimum, assault climbers should possess the additional knowledge and skills shown in Figure 2-11 on page 2-22.

#### LEVEL 3: MOUNTAIN LEADER

2-71. Mountain leaders possess all the skills of the assault climber and have extensive practical experience in a variety of mountain environments in both winter and summer conditions. Level 3 mountaineers should have well-developed hazard evaluation and safe route finding skills over all types of mountainous terrain. Mountain leaders are best qualified to advise commanders on all aspects of mountain operations, particularly the preparation and leadership required to move units over technically difficult, hazardous, or

٠	Use specialized mountaineering equipment	<ul> <li>Movement on moderate angle snow and ice</li> </ul>
•	Perform multipitch climbing: - Free climbing and aid climbing - Leading on class 4 and 5 terrain	<ul> <li>Establish evacuation systems and perform high angle rescue</li> <li>Perform avalanche hazard evaluation and rescue</li> </ul>
٠	Conduct multipitch rappelling	techniques
٠	Establish and operate hauling systems	<ul> <li>Familiarization with movement on glaciers</li> </ul>
٠	Establish fixed ropes with intermediate anchors	

### Figure 2-11. Level 2: Assault Climber Tasks

exposed terrain. The mountain leader is the highest level of qualification and is the principle trainer for conducting mountain operations. Instructor experience at a military mountaineering training center or as a member of a special operations forces (SOF) mountain team is critical to acquiring Level 3 qualification. Figure 2-12 outlines the additional knowledge and skills expected of mountain leaders. Depending on the specific AO, mountain leaders may need additional skills such as snowshoeing and all-terrain skiing.

### Figure 2-12. Level 3: Mountain Leader Tasks

# DRIVER TRAINING

2-72. Driving in mountains is extremely difficult. To be successful, drivers must know their equipment's limitations and capabilities. Training should center on practical exercises in mountainous terrain that gradually introduce drivers to more complex terrain and weather conditions. The exact nature of the mountainous terrain determines the training (see Figure 2-13).

- Identification and recognition of potential dangers
- Movement along steep grades combined with:
  - Narrow roads and sharp curves
  - Loose rock and gravel
  - Ice and snow (to include using tire chains for wheeled vehicles)
     Towed loads
- Increased cold weather maintenance requirements

Figure 2-13. Driver Training

# ARMY AVIATION

2-73. The mountainous environment, particularly its severe and rapidly changing weather, affects aircraft performance capabilities, accelerates crew fatigue, and influences basic flight techniques. These techniques can be acquired only through a specific training program for the particular type of mountainous terrain. Additionally, limited visibility operations in the mountains are extremely hazardous and require extensive training for those aviation units involved. Common problems associated with mountain operations become much more complex at night, even when using night vision devices. Few Army aviation units regularly train for mountain operations, so it is critical to alert them as soon as possible to facilitate the required training to ensure safe and successful mission execution.

# RECONNAISSANCE AND SURVEILLANCE

2-74. Training in reconnaissance and surveillance should focus on trafficability (route, mobility, and bridge classification), potential drop zones or landing areas, likely defensive positions, and potential infiltration routes. Infiltration and exfiltration are relatively easy in mountainous terrain and constitute a significant threat to the maneuver elements and their support units.

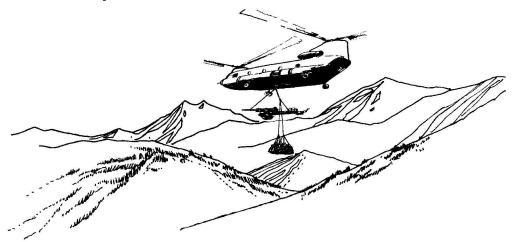
# TEAM DEVELOPMENT

2-75. The decentralized nature of mountain combat and the need for the exercise of a mission command philosophy of command and control involve assigning missions to independently operating small teams that may be isolated from their higher headquarters. The disruptive influences of the environment and sustained physical stress further increase the perception of isolation (see FM 4-02.22). The most important factor that sustains a soldier in combat is the powerful psychological support that he receives from his primary group, such as a buddy team, squad, or platoon. He is less likely to feel the stress of loneliness under the isolated conditions of mountain warfare if his primary group maintains its integrity.

2-76. The soldier's ability to survive and operate in the mountains is the basis for the self-confidence needed to feel accepted by the team. Leaders must develop small-unit cohesion down to the buddy team. Each soldier must have a buddy to share both responsibilities and rewards. The leader must not simply assign two soldiers as a buddy team, but pair soldiers whose skills and attributes complement each other. Each soldier can then learn his buddy's specialized skills adding depth to the unit if one soldier becomes disabled. Soldiers work with their buddies, as well as function as part of the larger squad team. The combined strengths of buddies enhance both unit effectiveness and combat power. FM 6-22 has more information on team development.

# **Chapter 3**

# **Firepower and Protection of the Force**



Employing fire support systems, which are an integral part of maneuver, is included in this chapter. This arrangement, however, does not suggest any change in the close doctrinal relationship between fires and maneuver during mountain operations.

# **SECTION I – FIREPOWER**

### FIELD ARTILLERY

3-1. The basic tactical principles for artillery remain valid in mountains, subject to the limitations imposed by terrain and weather.

### MOVEMENT AND POSITIONING

3-2. 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. Self-propelled artillery is often limited to

traveling on the existing road and trail networks and positioning in their immediate vicinity. Towed field artillery is usually more maneuverable; it can be brought into position with the aid of trucks, tractors, and fixed or rotary-winged aircraft. Therefore, gun crews should be

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proficient in 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 often necessitates substantial engineer support.

3-3. Light field artillery may require forward displacement of gun sections by helicopter to provide forward troops the necessary support. Medium field artillery may give the longer range required, but may be limited by highterrain crest clearance. Normally, field artillery is employed far enough to the rear to take advantage of increased angles of fall. Flat areas, such as dry riverbeds, villages and towns, and farmland, can usually accommodate firing units, however, these positions present particular problems in the mountains 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 but they are relatively scarce and often targeted by the enemy.
- Farmland is often difficult to negotiate from spring to fall. In the winter, if the ground is frozen, farmland may provide good firing positions; however, frozen ground may cause difficulty emplacing spades, base plates, and trails.

3-4. Good artillery positions, selected for cover, flash defilade, and accessibility to road nets and landing zones (LZs), are difficult to find, and their relative scarcity makes it easier for the enemy to target probable locations. In some instances, it may be necessary to by-pass the best position for one less suitable to reduce the enemy's counterfire effects. 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.

3-5. Some weapons may be moved 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. In the mountains, commanders must often employ field artillery in a decentralized manner because of the limited space for gun positions.

#### ACQUISITION AND OBSERVATION

3-6. Because of high angle fire requirements, radar can be effective against enemy indirect fire systems. In many instances, terrain masking and diminished line-of-sight may degrade its effectiveness. Sites should be selected on prominent terrain to obtain the lowest possible screening crest. However, it is often difficult to obtain a low and consistent screening crest in mountainous terrain. Too low a screening crest drives the search beam into the ground. Too high a screening crest allows the enemy to fire under the beam and avoid detection. When positioning weapons locating radars, commanders should also consider the following:

- Although time-consuming, visibility diagrams are extremely useful in determining the probability of acquiring targets within the sectors of search of the radar.
- 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 survey by use of the Position Azimuth Determining System (PADS). If possible, digital radar maps may be used to minimize the time required for height correction of the weapon system. Digital maps allow the Firefinder systems to initially locate weapon systems to within 250 meters. This allows the radar operator to make only two to three visual elevation adjustments to accurately locate the weapon system.
- Impact predict is computed at the radar's elevation, therefore, excessive errors in the impact predict can be expected.
- Firefinder radars in the same area must not face one another and radiate at the same time. This causes interference and emissions burnout, resulting in equipment failure. If radars need to face one another to accomplish the mission, commanders must coordinate 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 FM 3-09.12 for computations).
- Units will use more shelling reports (SHELREPs) to determine enemy firing locations.

3-7. The majority of all field artillery fires in mountains will be observed, especially close support and defensive fires. Unobserved fires are frequently unreliable because of poor maps and rapidly changing meteorological conditions that cause registration corrections for high angle fire to be valid for only short periods of time.

3-8. Generally, field artillery observation posts should be emplaced on the highest available ground to increase observation. Low clouds or fog may require moving them to preplanned emplacements at lower elevations. Observers must be prepared to perform assault climbing to reach the most advantageous observation site. Commanders may use aerial observers or unmanned aerial vehicles (UAVs) to detect long-range targets and complement forward observers by adjusting fires beyond terrain masks, in deep defilade, and on reverse slopes. However, in extremely high mountains aerial observers may be confined to valleys and lower altitudes due to altitude limitations on different types of aircraft.

3-9. Laser weapons demand increased emphasis on observation techniques. Laser target ranging and designation systems help to overcome difficulties in range estimation by providing accurate directional distance and vertical angle information for use in locating enemy targets. However, when positioning with a laser designator, an observer should consider line-of-sight with the target, as well as cloud height. Cloud ceilings that are too low will not allow laser guided munitions enough time to lock on and maneuver to the target.

### TARGETING

3-10. Because of the decentralized nature of mountain operations, targets warranting massed fires may present themselves less often than in open terrain. However, narrow defiles 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 are also good targets, because they can be converted into highly destructive rockslides and avalanches that may deny the enemy the use of roads and trails, and may 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. Commanders and their staffs should carefully review FM 3-60. A clear understanding of the targeting methodology combined with the knowledge of the capabilities and limitations of target acquisition and attack systems in a mountain environment is crucial to the synchronization of all available combat power.

3-11. To provide accurate and timely delivery of artillery fires in mountainous terrain, commanders must take into account the following:

- High angles of elevation and increased time of flight for rounds to impact.
- Targets on reverse slopes, which are more difficult to engage than targets on flat ground or rising slopes, requiring more ammunition for the same coverage.
- Increased amounts of dead space that cannot be hit by artillery fires.
- Intervening crests that require detailed map analysis.

• When the five requirements for accurate predicted fire (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 FM 3-09.40 for more detailed information).

#### MUNITIONS

3-12. Terrain and weather also affect the use of field artillery munitions. Considerations for munitions employment in the mountains are discussed below.

- Impact fuze, high explosives (HE) shells and dual-purpose improved conventional munitions (DPICMs) are very effective on rocky ground, scattering stones and splintering rocks, which themselves become missiles. However, deep snow reduces their bursting radius, making them approximately 40 percent less effective. The rugged nature of the terrain may afford added protection for defending forces; therefore, large quantities of HE may be required to achieve the desired effects against enemy defensive positions.
- Variable time (VT) or time fuzes should be used in deep snow conditions and are particularly effective against troops on reverse slopes. There are some older fuzes that may prematurely detonate when fired during heavy precipitation (M557 and M572 impact fuzes and M564 and M548 time fuzes).
- Smoke, DPICM, and illuminating fires are hard to adjust and maintain due to swirling, variable winds and steep mountain slopes. Smoke (a base-ejecting round) may not dispense properly if the canisters become buried in deep snow. In forested mountains, DPICMs may get hung up in the trees. These types of munitions are generally more effective along valley floors.
- Using the artillery family of scatterable mines (FASCAM) and Copperhead is enhanced when fired into narrow defiles, valleys, and roads. FASCAM may lose their effectiveness on steep terrain and in deep snow. Melting and shifting snow may cause the anti-handling devices to detonate prematurely the munitions, however, very little settling normally occurs at temperatures lower than 5 degrees Fahrenheit. Remote antiarmor mine system (RAAMS) and area denial artillery munitions (ADAM) must come to rest and stabilize within 30 seconds of impact or the submunitions will not arm, and very uneven terrain may keep the ADAM trip wires from deploying properly.

## MORTARS

3-13. Mortars are essential during mountain operations. Their high angle of fire and high rate of fire is suited to supporting dispersed forces. They can deliver fires on reverse slopes, into dead space, and over intermediate crests, and, like field artillery, rock fragments caused by the impact of mortar rounds may cause additional casualties or damage.

3-14. The 60 mmmortar is an ideal supporting weapon for mountain combat because of its portability, ease of concealment, and lightweight ammunition. The 81mm mortar provides longer range and delivers more explosives than the 60mm mortar. However, it is heavier and fewer rounds (usually no more than two per soldier) can be man-packed. The 120mm mortar may be more desirable in some situations, since they can fire either white phosphorous (WP) or HE at greater ranges than lighter mortars and have a significantly better illumination capability.



However, because of the weight of these mortars and their ammunition, it may be necessary to transport fewer of them into mountainous terrain and use the remaining gun crews as ammunition bearers, or position them close to a trail network in a valley or at lower elevations. The second technique may be satisfactory if the movement of the unit can be covered and sufficient firing positions exist.

### AIR SUPPORT

3-15. Air interdiction and close air support operations can be particularly effective in mountains, since enemy mobility, like ours, is restricted by terrain. Airborne forward air controllers and close air support pilots can be used as valuable sources of information and can find and designate targets that may be masked from direct ground observation. Vehicles and personnel are particularly vulnerable to effective air attack when moving along narrow mountain roads. Precision-guided munitions, such as laser-guided bombs, can quickly destroy bridges and tunnels and, under proper conditions, cause landslides and avalanches to close routes or collapse on both stationary and advancing enemy forces. Moreover, air-delivered mines and long-delay bombs can be employed to seriously impede the enemy's ability to make critical route repairs. Precision-guided munitions, as well as fuel air explosives, can also destroy or neutralize well-protected point targets, such as cave entrances and enemy forces in defilade.

3-16. Low ceilings, fog, and storms common to mountain regions may degrade air support operations. Although, global positioning system (GPS) capable aircraft and air delivered weapons can negate many of the previous limitations caused by weather. Terrain canalizes low altitude air avenues of approach, limiting ingress and egress routes and available attack options, and increasing aircraft vulnerability to enemy air defense systems. Potential targets can hide in the crevices of cliffs and the niches of mountain slopes, and on gorge floors. Hence, pilots may be able to detect the enemy only at short distances, requiring them to swing around for a second run on the target and giving the enemy more time to disperse and seek better cover. Additionally, accuracy may be degraded due to the need for pilots to divert more of their attention to flying while simultaneously executing their attack.

# ELECTRONIC WARFARE

3-17. The ability to use electromagnetic energy to deceive the enemy, locate his units and facilities, intercept his communications, and disrupt his command, control, and target acquisition systems remains as important in the mountains as elsewhere. The effects of terrain and weather on electronic warfare (EW) systems are often a result of the effects on the components of those systems (particularly soldiers, communications, and aviation). Although a number of the effects are discussed in more detail elsewhere in this manual (and in applicable FMs and TMs), for ease some of the more common degrading effects of the mountainous environment on the components of electronic warfare systems are described in Figure 3-1 on page 3-8.

### SECTION II – PROTECTION OF THE FORCE

# AIR DEFENSE ARTILLERY

3-18. The severe mountain environment requires some modification of air defense employment techniques. Suitable positions are scarce and access roads are limited. In some instances, supporting air defense weapons may not be able to deploy to the most desirable locations. Consequently, the manportable air defense systems (MANPADS) may be the only air defense weapon capable of providing close-in protection to maneuver elements.

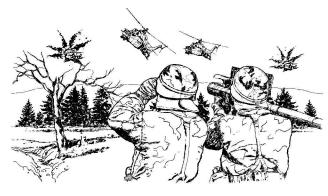
3-19. Mountain terrain tends to degrade the electronic target acquisition capabilities of air defense systems. This degradation makes it more difficult for the air defense planner to locate and select position to provide adequate coverage for the force, and increases the importance of combined arms for air defense (CAFAD) and passive air defense measures (see FM 3-01.8). Individual and crew-served weapons can mass their fires against air threats. The massed use of guns in local air defense causes enemy air to increase their standoff range for surveillance and weapons delivery, and increase altitude in transiting to and from targets. These reactions may make the enemy air more vulnerable to air defense artillery (ADA).

3-20. Enemy aircraft will probably use defiles and valleys in mountainous terrain for low-altitude approaches to take advantage of terrain masking of radar. Congested roads and trails, and their junctions, may become lucrative targets for enemy air strikes. Enemy pilots may avoid early detection by using terrain-clearance or terrain-following techniques to approach a target. Rugged mountain terrain degrades air defense detection, but, at the same time, mountain ridges and peaks tend to canalize enemy aircraft. Detailed terrain analysis, coupled with predictive analysis to identify probable enemy air avenues of approach, aids in effective site selection.

ENVIRONMENTAL FACTORS								
EW COMPONENT	C L O U D S	њОG	RAIN	s n n s n s n s n s n s n s n s n s n s	V I Z D	ΤΕMΡ	T U R R A I N	REMARKS
Soldiers <sup>1</sup>	ゝ	>	ゝ	~	ゝ	ゝ	ゝ	<ul> <li>Clouds, fog, precipitation, and terrain affect visibility and observation.</li> <li>Precipitation, temperature, and the rugged terrain affect soldier performance and ability to operate systems.</li> </ul>
Electronics and- wire/cables <sup>2</sup>		>	>	~		~	~	<ul> <li>Extreme cold, combined with rugged terrain, increases fragility and breakage.</li> <li>Precipitation and humidity affect electronic com- ponents.</li> </ul>
Antennas <sup>2</sup>			ゝ	~	2		2	<ul> <li>Strong winds damage or prevent erection.</li> <li>Precipitation and cold create ice, causing breakage (increased load and wind resistance) and reduce effectiveness.</li> <li>Terrain affects masking and line-of-sight restrictions.</li> </ul>
Aircraft <sup>3</sup>	ゝ	ン	ゝ	ゝ	>	ゝ	>	<ul> <li>Clouds, fog, and precipitation degrade visibility and may prevent aircraft from flying under visual flight rules (VFR), precluding missions requiring aircraft landing at unimproved mountain LZs.</li> <li>Cold and precipitation lead to icing, which im- pedes lift.</li> <li>Compartmented terrain affects flight routes and target acquisition.</li> </ul>
Vehicles			く	~		~	>	<ul> <li>Rain, snow, and rugged terrain decrease mobility.</li> </ul>
Radars/ Sensors		~	~	~	~		~	<ul> <li>Wind increases background noise, reducing efficiency.</li> <li>Terrain affects masking and line-of-sight restrictions.</li> <li>Fog and precipitation decrease infrared and electro-optical systems effectiveness.</li> </ul>
Batteries						~		<ul> <li>Terrain reduces effectiveness and battery life – some systems may not even work under reduced power.</li> </ul>
<ol> <li>See Chapter 1 (Effects on Personnel)</li> <li>See Chapter 2 (Communications)</li> <li>See Chapter 4 (Helicopters) and the Previous Section (Air Support)</li> </ol>								

#### Figure 3-1. Effects of the Mountainous Environment on EW Systems

3-21. Movement to and occupation of positions in mountainous terrain require additional time. Planners must consider slope (pitch and roll), site preparation, and access route improvement prior to movement. Bradley Stinger fighting vehicle (BSFV) units often are unable to accompany small, lightly equipped maneuver elements, and may be restricted to supporting elements in more accessible areas of the battlefield. Avenger fire units can be sling-loaded by heavy lift aircraft and MANPADS airlifted into otherwise inaccessible positions. However, equipment emplaced by helicopters resupplied and is repositioned by the When same means. moving dismounted, MANPAD teams are limited to one missile per soldier, unless other members of the unit are tasked to carry additional missiles.



3-22. Because of terrain masking of radars and the difficulty in establishing line-of-sight communications with the Sentinel or light and special division interim sensor (LSDIS) radar, early warning for short-range air defense (SHORAD) systems may be limited. Soldiers must maintain continuous visual observation, particularly along likely low-level air avenues of approach. Therefore, when possible, Sentinel or LSDIS radars should be emplaced on the highest accessible terrain that provides the best air picture for target detection and early warning, not necessarily peaks and summits.

### ENGINEER OPERATIONS

3-23. Engineer combat support requirements increase in mountainous terrain because of the lack of adequate cover, the requirement for construction of field fortifications and obstacles, and the need to breech or reduce enemy obstacles. With such an enormous multitude of tasks, effective command and control of engineer assets is essential for the optimal utilization of these relatively scarce resources (see also the discussion of engineer augmentation and employment in the mobility section of Chapter 4).

3-24. Digging fighting positions and creating temporary fortifications above the timberline is generally difficult because of thin soil with underlying bedrock. As described in Chapter 2, boulders and loose rocks may be used to build hasty, aboveground fortifications. Well-assembled positions constructed in rock are strong and offer good protection, but they require considerable time and equipment to prepare.

3-25. Engineers assist maneuver units with light equipment and tools carried in or brought into position by ground vehicles or helicopters. Bulldozers, armored combat earthmovers (ACEs), and small emplacement excavators (SEEs) can be used in some situations to help prepare positions for command bunkers and crew-served weapons. They can also be used to prepare positions off existing roads for tanks, artillery, and air defense weapons. Conventional equipment and tools are often inadequate in rocky terrain, and extensive use of demolitions may be required. In the mountains, a greater number of engineer assets will be devoted to maintaining mobility and maneuver and unit commanders should assume that available engineer support will be limited to assist them with their survivability efforts. To enhance survivability and mobility a minimum of two soldiers per maneuver platoon should be capable of using standard demolitions.

# NBC PROTECTION

3-26. Terrain and weather dictate a requirement for a high degree of nuclear, biological, and chemical (NBC) defense preparedness in mountainous areas. Due to limited mobility, viable tactical positions, and limited communication abilities, friendly units must be self-sufficient in protecting themselves against NBC weapon system effects.

3-27. Wearing mission-oriented protective posture (MOPP) gear at high elevations, when possibly combined with altitude sickness, increased dehydration, and increased physical exertion, degrades performance and increases the likelihood of heat casualties. Commanders should make every effort to keep soldiers out of MOPP gear until intelligence indicators reveal that an NBC attack is imminent or it is confirmed that a hazard actually exists (see FM 3-11.4 for a discussion on vulnerability analysis). When precautions must be taken against hazards, commanders must make decisions early and allow extra time for tactical tasks. Commanders should also refer to TC 3-10 for greater detail on tactics, techniques, and procedures necessary to operate under NBC conditions.

#### NUCLEAR

3-28. A mountainous environment can amplify or reduce the effects of and distort the normal circular pattern associated with nuclear blasts. The irregular patterns reduce the accuracy of collateral damage prediction, damage estimation, and vulnerability analysis.

3-29. Air blast effects are amplified on the burst side of mountains (see Figure 3-2). Mountain walls reflect blast waves that can reinforce each other, as well as the shock front. Therefore, it is possible that both overpressure and dynamic pressure, and their duration will increase. An added danger is the creation of rockslides or avalanches. A small yield nuclear weapon detonated 30 kilometers or more from the friendly positions may still cause rockslides and avalanches, and easily close narrow roads and canalized passes. On the other hand, there may be little or no blast effects on the side of the mountain away from the burst.

3-30. Hills and mountains block thermal radiation, and trees and other foliage reduce it. Low clouds, fog, and falling rain or snow can absorb or scatter up to 90 percent of a burst's thermal energy. During colder weather, the heavy clothing worn by soldiers in the mountains provides additional protection. However, the reflection from snow and the thin atmosphere of higher elevations may increase the effects of thermal radiation. Snow and ice melted by thermal radiation can result in flash flooding.

3-31. Frozen and rocky ground may make it difficult to construct shelters for protection from the effects of nuclear weapons. However, natural shelters

such as caves, ravines, and cliffs provide some protection from nuclear effects and contamination. In some instances, improvised shelters built of snow, ice, or rocks may be the only protection available. The clear mountain air extends the range of casualty-producing thermal effects. Within this range, however, the soldiers' added clothing reduces casualties from these effects.

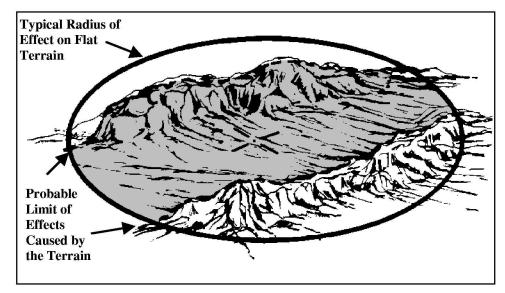


Figure 3-2. Effects of Mountains on Radiation and Blast

3-32. In mountainous regions, the deposit of radiological contamination is very erratic in speed and direction because of variable winds. Hot spots may occur far from the point of detonation, and low-intensity areas may occur very near it. Limited mobility makes radiological surveys on the ground difficult, and the difficulty of maintaining a constant flight altitude makes air surveys highly inaccurate. Additionally, melting snow contributes to the residual radiation pattern. After a nuclear detonation, streams should be checked for radiation contamination before using them for drinking or bathing. As with the other effects, the pattern of initial and induced nuclear radiation may be modified by topography and the height of the burst.

#### BIOLOGICAL

3-33. Most biological pathogens and some toxins are killed or destroyed by the ultraviolet rays in sunlight. Above the timberline, there is little protection from the sun; thus, the effectiveness of a biological attack may be reduced. Downwind coverage may be greater because of the frequent occurrence of high winds over mountain peaks and ridges. Additionally, inversion conditions favor the downwind travel of biological agents through mountain valleys. Typically, winds flow down terrain slopes and valleys at night and up valleys and sunny slopes during the day. The effects of mountainous terrain and rapidly changing wind conditions on the ability to predict and provide surveys of contamination for biological agents are similar to that for nuclear radiation.

3-34. Temperatures and humidity also affect the survivability of biological agents. Generally, cool temperatures favor survival, and higher humidity increases the effectiveness of the agents. Extreme cold weather and snow deposited over a biologically contaminated area can lengthen the effective period of the hazard by allowing the agent to remain alive but dormant until it is disturbed or the temperature rises. If the use of biological agents is known or suspected, commanders should ensure that soldiers pay added attention to personal hygiene and consume only purified/treated water.

#### CHEMICAL

3-35. Wind and terrain can also cause the effectiveness of chemical agents to vary considerably. Depending on conditions, effects can be significantly enhanced or almost ineffective. High winds and rugged terrain cause chemical agent clouds to act in a manner similar to radioactive fallout. Inversions in mountain valleys may also effectively cap an area, slowing the dissipation rate. Because of terrain and winds, accurate prediction of the downwind travel of toxic agent clouds is difficult.

3-36. In mountain warfare, chemical munitions are likely to be delivered by air. The generally cooler daytime temperatures in mountainous terrain slow the evaporation process, thus allowing a potential contamination hazard to remain active longer. Midday temperatures favor using persistent or blistertype agents, since nonpersistent agents dissipate too rapidly to cause any effect and unsupervised personnel are more likely to remove protective clothing for comfort.

3-37. The actions to protect against chemical agents in the mountains are not significantly different than from the requirements in less mountainous terrain. However, in extreme cold weather, survey and monitoring is often limited to the individual team mission, the FOX system may be limited to roads and trails, and the detection of vapor hazards is limited when the temperature falls below 32 degrees Fahrenheit. Decontamination may be more difficult due to freezing conditions, and the virulency period of contamination hazard for persistent agents may increase.

#### SMOKE AND OBSCURANTS

3-38. Smoke operations in mountainous areas are characterized by difficulties encountered due to terrain and wind. Inadequate roads enhance the military value of existing roads, mountain valleys, and passes and add importance to the high ground that dominates the other terrain. Planners can use smoke and flame systems to deny the enemy observation of friendly positions, supply routes, and entrenchments, and degrade their ability to cross through tight, high passes and engage friendly forces with direct and indirect fires.

3-39. Thermally induced slope winds that occur throughout the day and night increase the difficulty of establishing and maintaining smoke operations, except in large and medium sized valleys. Wind currents, eddies, and turbulence in mountainous terrain must be continuously studied and observed, and their skillful exploitation may greatly enhance smoke operations rather than deter them. Smoke screens may be of limited use, due to enemy aerial observation, to include UAVs, and observation by enemy forces located on high ground. Smoke units may be required to operate for extended periods with limited resupply unless petroleum, oils, and lubricants (POL) supplies are emplaced in hide positions with easy access.