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U.S. Marine Corps

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FOREWORD

Marine Corps Reference Publication 3-35.1C, *Mountain Leader's Guide to Mountain Warfare Operations*, is a reference for trained summer mountain leaders to use during operations in complex, compartmentalized, mountainous, high altitude, alpine, and glaciated terrain. This manual is not exhaustive and must be used together with the mountain warfare operations doctrinal series, as duplication of material is being avoided and target audiences vary.

This publication covers terrain; weather; rope skills; rope systems; climbing; fixed ropes; rappelling; casualty evacuation; planning considerations across all six warfighting functions; chemical, biological, radiological, and nuclear considerations; glacier operations; and processes used to guide units through mountainous/alpine terrain. It focuses on a standard method of instruction and stresses only the skills necessary for Marines to go into combat.

Because of rapid turnover in personnel, the many units that train annually, the multitude of training commitments, and the short season, the Marine Corps Mountain Warfare Training Center cannot train all personnel or units. In combat, Marines may receive instruction from their unit's qualified summer mountain leaders. This publication specifically supports the mountain leader's ability to provide that instruction.

Reviewed and approved this date.

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MOUNTAIN LEADER'S GUIDE TO MOUNTAIN WARFARE OPERATIONS

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CHAPTER 1
INTELLIGENCE IN MOUNTAINOUS TERRAIN

Intelligence Planning Considerations

In order to fight in the complex terrain of mountainous regions, commanders and staffs must analyze the area of operations to become familiar with the challenges found in the mountains, which are distinct from those encountered in less rugged environments. They must also understand how these characteristics affect personnel, equipment, and the enemy when planning for reconnaissance, surveillance, and intelligence preparation of the battlespace (IPB).

Mountainous Terrain

The principal mountain ranges of the world lie along broad belts called *cordilleras*, the Spanish word for ropes. They encircle the Pacific basin and then lead westward across Eurasia into North Africa. Secondary and less rugged mountain chains lie along the Atlantic margins of the Americas and Europe. See figure 1-1.

While current mountain operations are focused on Afghanistan and the mountains of central Asia, it is important to remember that mountains are found on every continent and most are relatively near the coast.

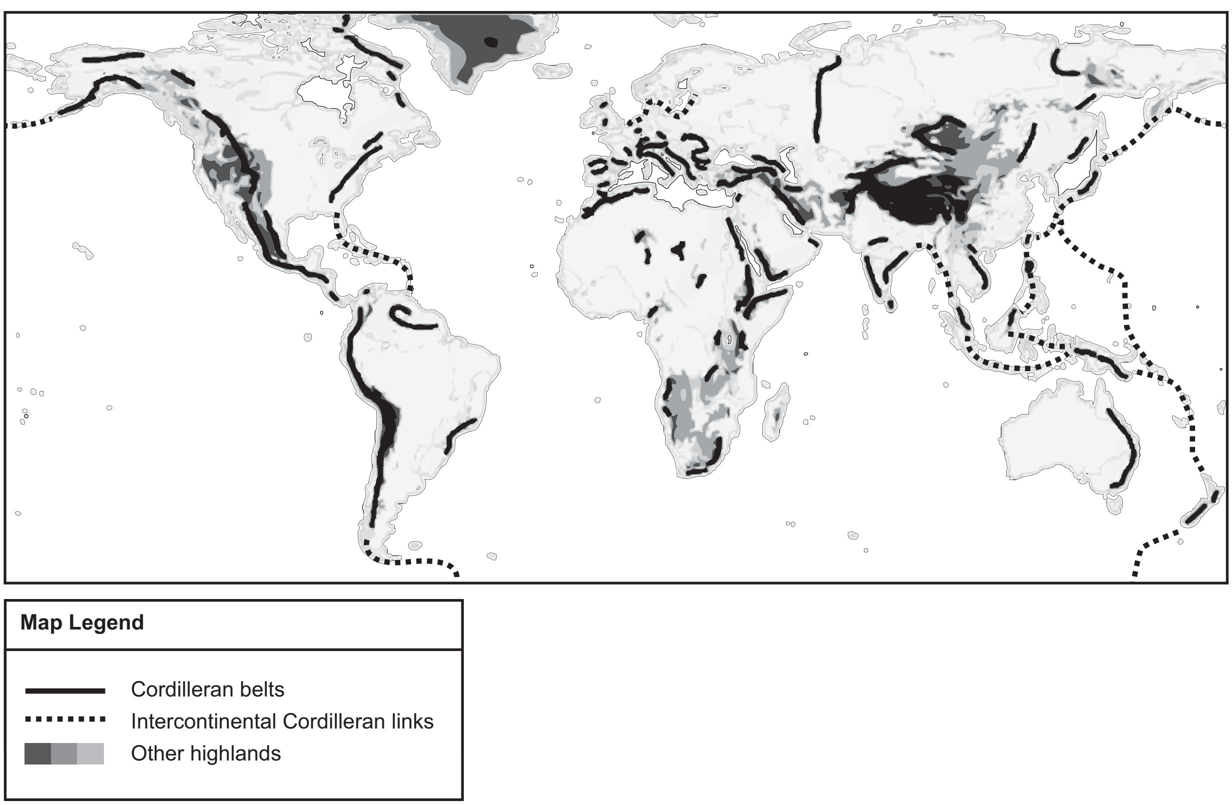


Figure 1-1. Mountain Belts.

Intelligence Process

Little has changed in sixty-plus years since the World War II *gebirgs jäger* (German mountain troops) conducted a thorough IPB. It was the key to their success and IPB will also be the key to Marine operational success in complex, compartmented terrain. Commanders should make every effort to understand the intelligence process and requirements in this environment; however, the intelligence process and cycle do not change based on it (see fig. 1-2). What does change is the data gathered and entered into the process. The planning based upon that data and the commander's direction will be adjusted accordingly.

Operations in mountainous terrain and cold weather require commanders and staffs to make adjustments to the conventional way they operate. These environments drastically shape operations, logistics, and command and control and will demand that Marines change how they approach intelligence development. Intelligence products must be produced for the right consumer.

The results of the IPB process help the commander selectively apply and maximize combat power at critical points in time and space on the battlefield by determining the enemy's likely course of action. It also describes the environment in which a unit is operating and the effects of that environment on it.

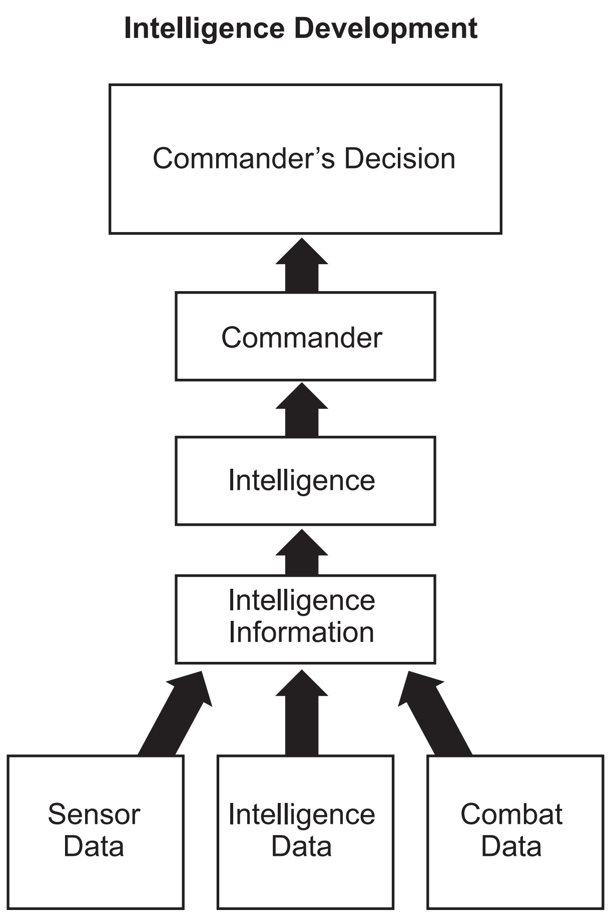


Figure 1-2. Intelligence Development and Intelligence Cycle.

"Conventional" IPB is a continuous four-step process that Marines perform each time they conduct IPB—

- Define the battlefield environment.
- Describe the battlefield's effects.
- Evaluate the threat.
- Determine threat courses of action.

Intelligence should not be understood as a commodity; rather, it is a shared appreciation of the battlespace that is developed by the entire staff. The intelligence officer (S-2) should be viewed as the coordinator and not simply as the producer of intelligence products.

A complex terrain environment, especially if it is also a cold weather environment, requires high fidelity in the development of intelligence and in intelligence products. Nontraditional sources may become central to the full intelligence picture. Beyond the staff, consumers of these products may include small unit leaders.

Mountain Weather

In general, mountain climates tend to be cooler, wetter versions of the climates of the surrounding lowlands. Most mountainous regions exhibit at least two different climatic zones—one at low elevations and another at elevations nearer the summit regions. In some areas, an almost endless variety of local climates may exist within a given mountainous region.

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

Mountain weather can be erratic, varying from strong winds to calm and from extreme cold to relative warmth within a short time or a minor shift in locality. The severity and variance of the weather require Marines to be prepared for alternating periods of heat and cold as well as conditions ranging from dry to extremely wet (see table 1-1 on page 1-4). At higher elevations, noticeable temperature differences may exist between sunny and shady areas or between areas exposed to wind and those protected from it, which greatly increases every Marine's clothing load and a unit's overall logistical requirements.

Temperature

Temperature changes and variations in the mountains can be both severe and unexpected. Normally, temperature drops 4 °F per 300-meter (1,000-foot) gain in elevation. In an atmosphere containing considerable water vapor, the temperature drops about 1 °F for every 100-meter (300-foot) increase, while in very dry air, it drops about 1 °F for every 50 m (150 feet). (At higher elevations, air is considerably dryer than air at sea level. Due to this increased dryness, Marines must increase their normal fluid intake by approximately one-third.) At high elevations, there may be differences of 40 to 50 °F between the temperature in the sun and that in the shade.

Clear air at high altitudes also results in rapid cooling at night. Consequently, temperatures rise swiftly after sunrise and drop quickly after sunset. Much of the chilled air drains downward so that the differences between day and night temperatures are greater in valleys than on slopes.

Wind

In high mountains, the ridges and passes are seldom calm. By contrast, strong winds in protected valleys are rare. Normally, wind velocity increases with altitude, is intensified by mountainous terrain, and may blow with great force on an exposed mountainside or summit. As wind speed doubles, its force on an object nearly quadruples.

In the mountains, wind causes rapid temperature changes and may result in blowing snow, sand, or debris that can impair movement and observation. Commanders should routinely consider the combined cooling effect of ambient temperature and wind (wind chill) experienced by their Marines. Wind chill charts, as in table 1-2 on page 1-5,

Table 1-1. Terrain Effects.

Weather Condition	Flat to Moderate Terrain Effects	Added Mountain Effects
Sunshine	Sunburn Snow blindness Temperature differences between sun and shade	Increased risk of sunburn and snow blindness Severe, unexpected temperature variations between sun and shade Avalanches
Wind	Wind chill	Increased risk and severity of wind chill Blowing debris or driven snow, causing reduced visibility Avalanches
Rain	Reduced visibility Cooler temperatures	Landslides Flash floods Avalanches
Snow	Cold weather injuries Reduced mobility and visibility Snow blindness Blowing snow	Increased risk and severity of common effects Avalanches
Storms	Rain/snow Reduced visibility Lightning	Extended duration and intensity greatly affecting visibility and mobility Extremely high winds Avalanches
Fog	Reduced mobility/visibility	Increased frequency and duration
Cloudiness	Reduced visibility	Greatly decreased visibility at higher elevations

provide an easy-to-read format to determine the perceived drop in temperature based upon the recorded wind speed.

Precipitation

Precipitation increases with elevation and occurs more often on the windward than on the leeward side of ranges. Both rain and snow are common in mountainous regions. Rain presents the same challenges as at lower elevations, but snow has a more significant influence on all operations. Snow creates additional considerations, including decreased movement speeds, degraded cross country mobility based on snow depth, and possible restriction of movement to roads or cleared routes. Due to the strain placed on personnel and equipment by snow, logistical requirements and timelines will need to be increased.

Thunderstorms usually last only a short time, but can negatively impact operations. In alpine zones, driving snow and sudden wind squalls often accompany thunderstorms. Ridges and peaks become focal points for lightning strikes.

Figure 1-3 provides an overview of some factors that need to be considered when planning for unit movement during snow conditions. This information is just for ground travel over snow-covered terrain. Slope, weather, and fitness of personnel and vehicles must also be considered.

Physical Terrain

The physical terrain of the mountains impacts operations, logistics, and command and control much more so than flat land does. Mission success or failure depends on the interaction between humans and the physical terrain.

Table 1-2. Wind Chill.

Wind Speed		Cooling Power of Wind Expressed As Equivalent Chill Temperature																				
Knots	MPH	Temperature (°F)																				
Calm	Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45	-50	-55	-60
		Equivalent Chill Temperature																				
3-6	5	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45	-50	-55	-60	-70
7-10	10	30	20	15	10	5	0	-10	-15	-20	-25	-35	-40	-45	-50	-60	-65	-70	-75	-80	-90	-95
11-15	15	25	15	10	0	-5	-10	-20	-25	-30	-40	-45	-50	-60	-65	-70	-80	-85	-90	-100	-105	-110
16-19	20	20	10	5	0	-10	-15	-25	-30	-35	-45	-50	-60	-65	-75	-80	-85	-95	-100	-110	-115	-120
20-23	25	15	10	0	-5	-15	-20	-30	-35	-45	-50	-60	-65	-75	-80	-90	-95	-105	-110	-120	-125	-135
24-28	30	10	5	0	-10	-20	-25	-30	-40	-50	-55	-65	-70	-80	-85	-95	-100	-110	-115	-125	-130	-140
29-32	35	10	5	-5	-10	-20	-30	-35	-40	-50	-60	-65	-75	-80	-90	-100	-105	-115	-120	-130	-135	-145
33-36	40	10	0	-5	-15	-20	-30	-35	-45	-55	-60	-70	-75	-85	-95	-100	-110	-115	-125	-130	-140	-150
Winds above 40 have little additional effect		Little danger			Increasing danger (flesh may freeze within 1 minute)						Great danger (flesh may freeze within 30 seconds)											

March Rates in Extreme Cold

Infantry in:

- Snow less than 30 cm deep - 3 to 4 km/h
- Snow over 30 cm deep - 1 to 2 km/h
- Soldier on skies - 6 to 8 km/h
- Subunit on skies - 3 to 6 km/h

Vehicles

- Tracked vehicles - 18/24 km/h

Tanks and APCs in:

- Snow less than 50 cm - employed as usual
- Snow 50 to 75 cm - (short moves) 10 km/h
- Snow more than 75 cm - restricted to roads or cleared routes

Maximum Snow Depths

Wet Snow:

- Personnel - 12 to 18 in
- Wheeled vehicles (with chains) - 18 in
- Tracked vehicles - 30 in

Dry Snow:

- Personnel - 18 to 24 in
- Wheeled vehicles (with chains) - 24 in
- Tracked vehicles - 48 in

Distance Covered in One Day's March

- Infantry - 12 to 24 km
- Ski unit - 32 to 40 km
- Tracked vehicles - 96 to 112 km

Thickness of Ice Required for Passage

- Infantry - 10 cm
- Medium tanks - 70 cm

LEGEND

APC armored personnel carrier

Figure 1-3. Rates of March.

Mountainous terrain, especially during cold weather, can be defined as complex and compartmentalized. More simply put, it is terrain that is characterized by steep slopes, great variations in local relief, natural obstacles, and a lack of accessible routes. This terrain restricts mobility, drastically increases movement times, limits the effectiveness of some weapons, and complicates supply operations.

The weather in the mountains can change greatly with the season and even the time of day. Combined with the terrain, these changes can affect mobility and tactical operations. Even under nonviolent conditions when not faced with an enemy, operations in a mountainous environment may pose significant risks and dangers.

The mountain environment demands much greater fidelity of geographic analysis. Tools used in the development of a conventional modified combined obstacle overlay (MCOO) prove very effective for macro analysis; however, it may be incomplete for a mountain terrain micro-trafficability assessment, which is essential but more difficult to develop. Commanders must not forget to include human intelligence in the geographic analysis process when working to determine how the locals and the enemy use the terrain.

Mountain Terrain

The terrain found in the mountain environment varies greatly. Most slopes generally vary between 15 and 45 degrees, but some cliffs and other rocky precipices may be near vertical or even overhanging. Aside from obvious rock formations and other local vegetation characteristics, slope surfaces tend to be some type of relatively firm earth or grass.

Grassy slopes may include grassy clumps known as *tussocks*, short alpine grasses, or *tundra*, which is more common at higher elevations and latitudes. Many slopes will be scattered with rocky debris deposited from the higher peaks and ridges. Extensive rock or boulder fields are known as *talus*. Slopes covered with smaller rocks, usually fist-sized or smaller, are called *scree* fields. All of these surfaces, when added to the degree of slope, can contribute to mobility challenges.

In winter and at higher elevations throughout the year, snow may blanket slopes, creating an environment with its own distinct characteristics. Some snow conditions can aid travel by covering rough terrain with a consistent surface. Deep snow, however, greatly impedes movement and requires Marines to be well-trained in using snowshoes, skis, and over-the-snow vehicles.

Snow can pose a serious threat to Marines not properly trained and equipped for movement under such conditions. Steep, snow-covered terrain presents the risk of avalanches as well. Avalanches have taken the lives of more Military personnel engaged in mountain warfare than all other terrain hazards combined.

Operational Terrain Levels

Mountain operations are generally carried out at three different operational terrain levels. Each of the following levels in the operational area should be considered when forming the course of action scenarios:

- *Level I.* Level I terrain is located at the bottom of valleys and along the main lines of communications. At this level, heavy forces can operate, but maneuver space is often restricted. Light and heavy forces are normally combined, since vital lines of communication usually follow the valley highways, roads, and trails.
- *Level II.* Level II terrain lies between valleys and shoulders of mountains. Generally, narrow roads and trails, which serve as secondary lines of communication, cross this ridge system. Ground mobility is difficult and light forces will expend great effort on these ridges, since they can easily influence operations at Level I. Similarly, enemy positions at the next level can threaten operations on these ridges.

- *Level III*. Level III includes the dominant terrain of summit regions. Although summit regions may contain relatively gentle terrain, mobility in Level III is usually the most difficult to achieve and maintain. Level III terrain can provide opportunities for well-trained units to attack the enemy from the flanks and rear. At this terrain level, acclimatized Marines with advanced mountaineering training can infiltrate to attack lines of communication, logistic bases, air defense sites, and command infrastructures (see table 1-3 and figure 1-4).

Table 1-3: Operational Terrain Levels.

Level	Description
I	The bottoms of valleys and main lines of communications
II	The ridges, slopes, and passes that overlook valleys
III	The dominant terrain of the summit region

Classes of Terrain

Mountainous terrain is categorized into five classes (see table 1-4 on page 1-8) based upon the type of individual movement skill required. Operations conducted in classes 1 and 2 terrain require little to no mountaineering skills, while operations conducted in classes 3, 4, and 5 terrain require a greater degree of mountaineering skills for safe and effective movement. Planning and preparation for mountain operations depend upon terrain analysis and terrain class determination.

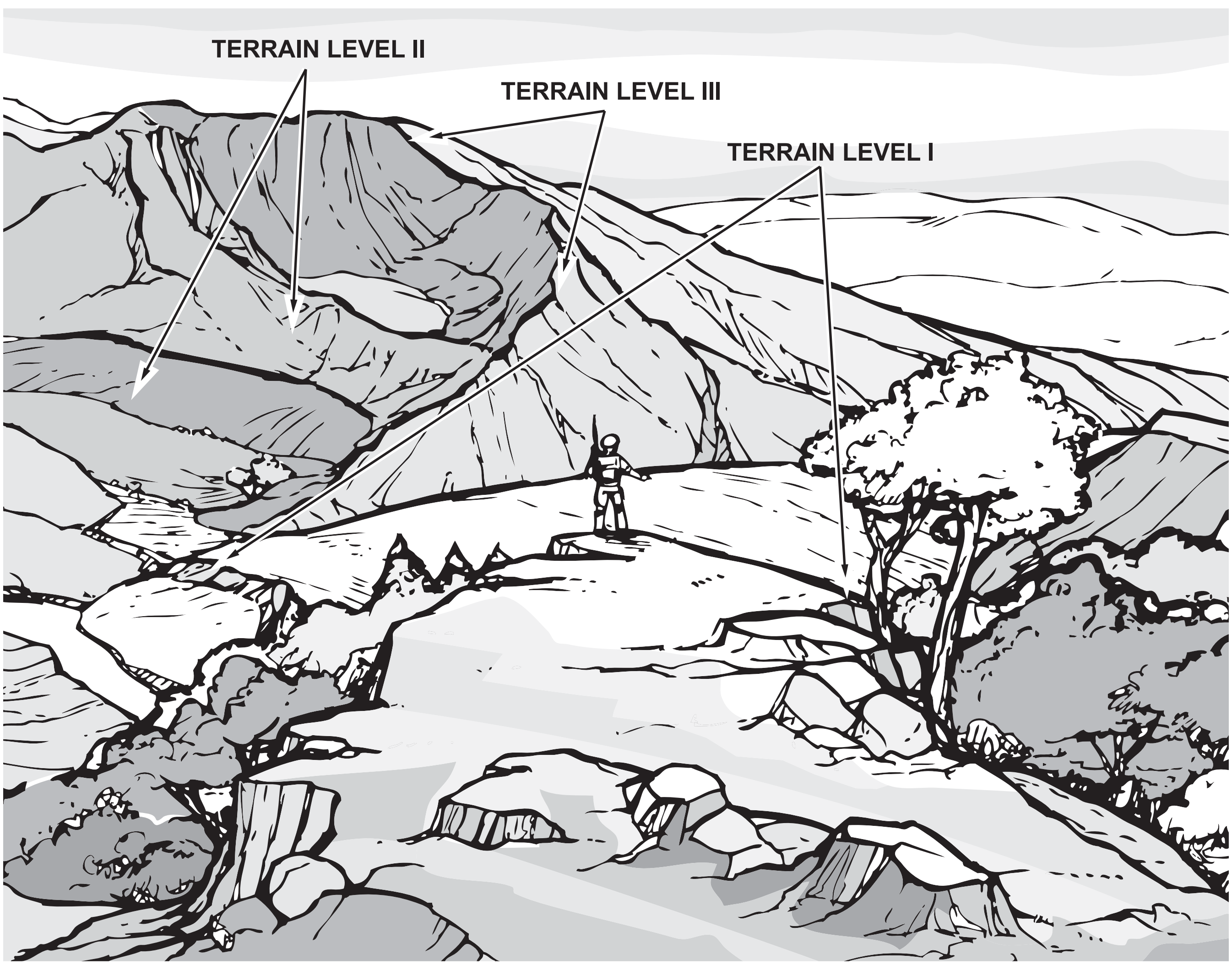


Figure 1-4. Terrain Levels.

Table 1-4. Terrain Classes.

Class	Terrain	Mobility Requirements	Skill Level Required
1	Gentler slopes/trails	Walking techniques	Unskilled (with some assistance) and basic mountaineers
2	Steeper/rugged terrain	Some use of hands	
3	Easy climbing	Fixed ropes where exposed	Basic mountaineers (with assistance from assault climbers)
4	Steep/exposed climbing	Fixed ropes required	
5	Near vertical	Technical climbing required	Assault climbers

Additional Terrain Considerations

The complex, compartmentalized terrain of the mountains presents some additional specific planning considerations—

- Mobility is canalized by terrain.
- Marines and enemy forces tend to rely upon known, cleared routes for movement.
- Speed of movement and logistical response times are decreased due to terrain challenges.
- When adapting to the terrain, units typically put less distance between their elements.
- Commanders constantly evaluate communications, personnel, and vehicle capabilities.
- S-2 must keep MCOO up to date.
- Key terrain is fluid and relative.
- Weather can determine what defines key terrain. Commanders consider the impact of weather on line of sight (LOS) (visibility and communications) and on both friendly and enemy operations and objectives. Such considerations are critical when determining observation post/listening post and reconnaissance and surveillance locations.
- S-2 must constantly re-evaluate key terrain to assist in the continuous planning process.
- LOS (visibility and communications).
- Slope and elevation—
  - Limits communications capabilities (especially very high frequency [VHF]).
  - Can negatively impact resupply and material drops. For example, when targeting, a 5-meter horizontal error could result in a 1500-meter error on a mountainside.
- Vegetation can impact cross-country mobility.

Detailed terrain analysis will aid in determining the Marine's ability to observe, the enemy's ability to observe, as well as how much cover and concealment might be available.

Modified Combined Obstacle Overlay

The MCOO is the standard product developed to understand terrain considerations. However, in complex environments, additional products might be required, such as human environment (enemy or friendly village and disposition), avalanche danger areas, flash flood areas, accessibility (slope), and water access.

Enemy Mobility

Enemy mobility is different than that of friendly forces and Marines should learn how to see the terrain as the enemy does. Local combatants most often take the unpublished "shortcuts" and stay off the main roads. The enemy knows where the chokepoints are and uses vegetation to conceal their movement and achieve surprise. The enemy will always have a preplanned escape route, so a well planned response is essential (see fig. 1-5).

Marines must always consider terrain from the enemy's perspective when looking for delays, bottlenecks, and coordination difficulties. The entire staff must understand that physical terrain impacts all elements of combat power, including supporting fires, casualty evacuation (CASEVAC), and quick reaction force response.

Environmental Effects on Personnel

Marines conducting operations anywhere, even under the best conditions, become cold, thirsty,

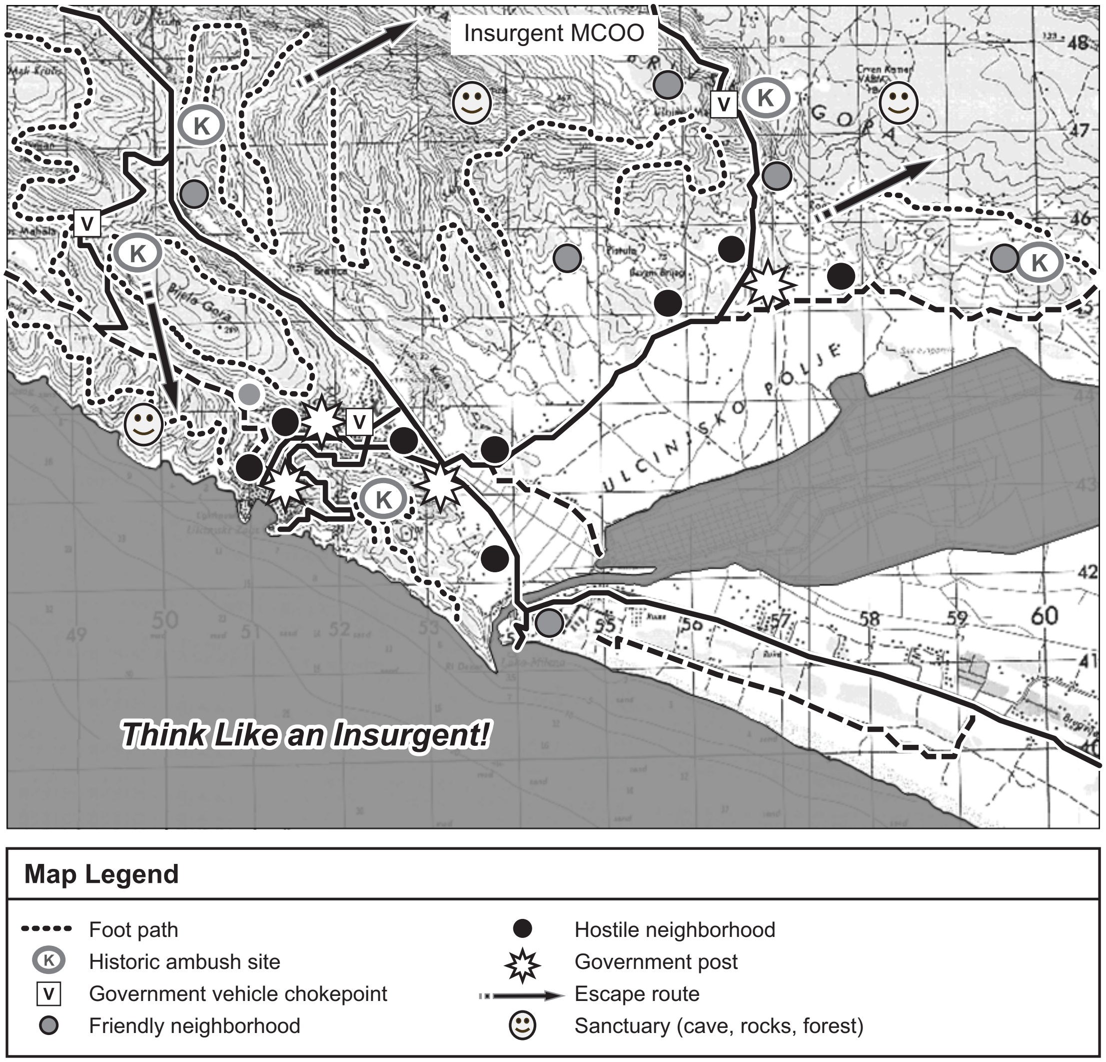


Figure 1-5. Insurgent Modified Combined Obstacle Overlay.

tired, and energy-depleted. In the mountains, however, they may become paralyzed by cold and thirst and incapacitated due to utter exhaustion.

Conditions, such as high elevations, rough terrain, and extremely unpredictable weather, require leaders and Marines who understand and can deal with environmental threats. A variety of individual personnel characteristics and environmental conditions influence the type, prevalence, and severity of mountain illnesses and injuries (see fig. 1-6 on page 1-10). Due to combinations of these characteristics and conditions, Marines often succumb to more than one illness or injury at a time, increasing the danger to life and limb. Three of the most common, cumulative, and subtle factors affecting a Marine’s ability under these variable conditions are nutrition (to include water intake), decreased oxygen due to high altitude, and cold.

In addition to temperature, wind velocity, and precipitation, poor nutrition is a significant contributor to illness or injury, decreased performance, poor morale, susceptibility to cold injuries, and unsuccessful military operations. High altitudes influence nutrition because they can cause a dulled taste sensation (making food undesirable), nausea, and lack of energy or motivation to prepare or eat meals.

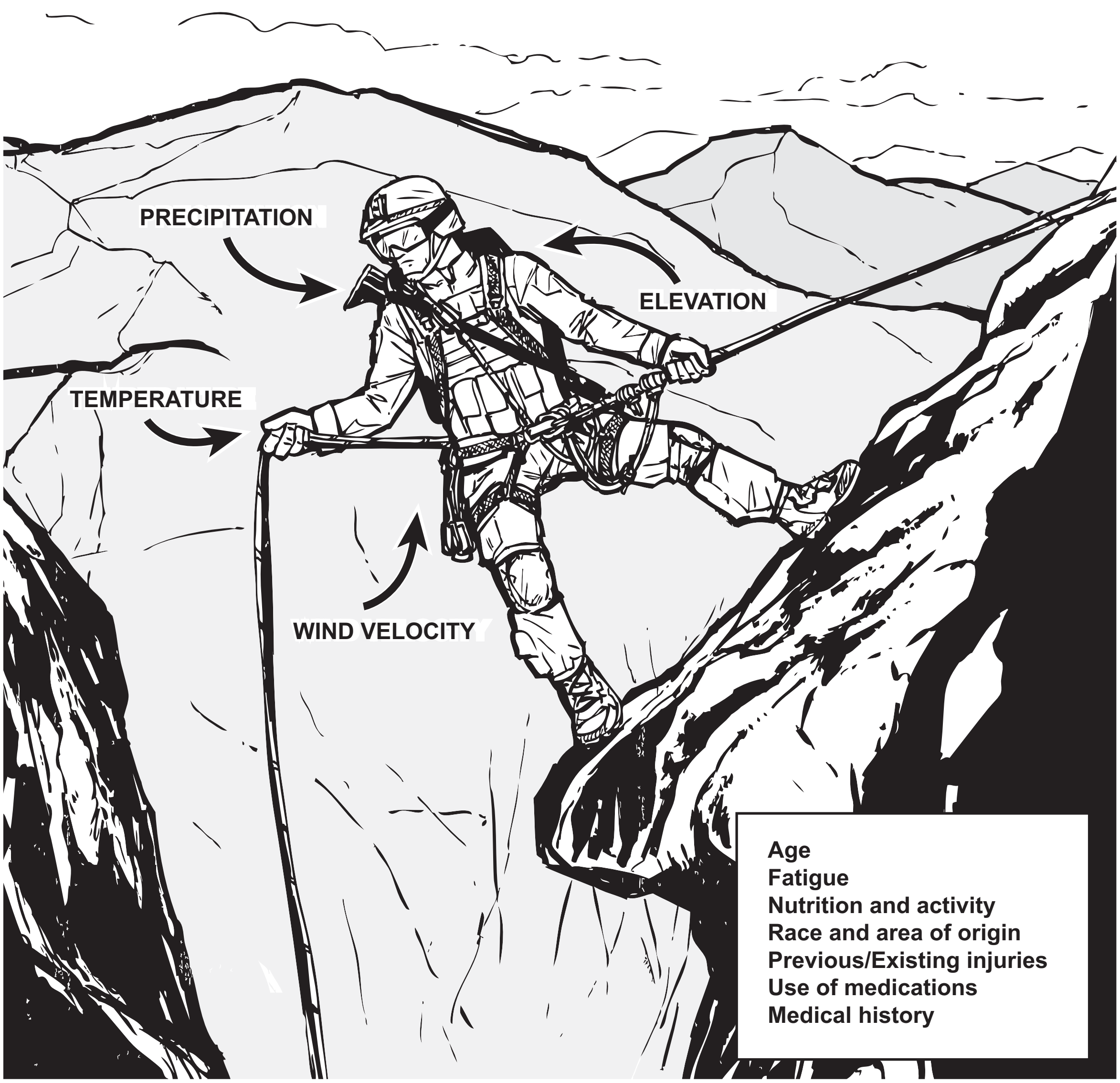


Figure 1-6. Personnel Effects Factors.

Caloric requirements increase in the mountains due to the altitude and the cold. A diet high in fat and carbohydrates is important in helping the body fight the effects of these conditions. Fats provide long-term, slow caloric release, but are often unpalatable to Marines operating at higher altitudes. Snacking on high-carbohydrate foods is often the best way to maintain the calories necessary to function.

Altitude Effects on Personnel

The proportion of oxygen in the air decreases with altitude. Without proper acclimatization, this decrease in oxygen can cause altitude sickness and reduce physical and mental performance (see table 1-5). Marines cannot maintain the same physical performance at high altitude that they can at low altitude, regardless of their fitness level.

Table 1-5. Physiological Effects of Altitude.

Altitude	Meters	Feet	Effects
Low	Sea level–1,500	Sea level–5,000	None
Moderate	1,500–2,400	5,000–8,000	Mild, temporary altitude sickness may occur
High	2,400–4,200	8,000–14,000	Altitude sickness and decreased performance is increasingly common
Very high	4,200–5,400	14,000–18,000	Altitude sickness and decreased performance is the rule
Extreme	5,400–higher	18,000–higher	With acclimatization, personnel can function for short periods of time

Altitude acclimatization involves physiological changes that permit the body to adapt to the effects of low oxygen saturation in the air. It allows Marines to achieve the maximum physical work performance possible for the altitude to which they are acclimatized. The four factors that affect acclimatization are altitude, rate of ascent, duration of stay, and level of exertion.

Acclimatization is maintained as long as the Marine remains at that altitude, but it is lost upon returning to lower elevations. Acclimatization to one altitude does not prevent altitude illnesses from occurring if ascent to higher altitudes is too rapid.

For most Marines, 70 to 80 percent of the respiratory component of acclimatization occurs in 7 to 10 days at high to very high altitudes, 80 to 90 percent of overall acclimatization is generally accomplished by 21 to 30 days, and maximum acclimatization may take several months to years. The mental effects most noticeable at high altitudes include decreased perception, memory, judgment, and attention.

Highly fit, motivated individuals may go too high too fast and become victims of mountain sicknesses. Slow and easy climbing, limited activity, and long rest periods are critical to altitude acclimatization.

Exposure to altitudes of over 10,000 feet may also result in changes in senses, mood, and personality. Within hours of ascent, many Marines may experience euphoria, joy, and excitement that are likely to be accompanied by errors in judgment, mistakes, and accidents. After a period of about 6 to 12 hours, euphoria decreases, often changing to varying degrees of depression. Marines may become irritable or appear listless.

Vision is generally the sense most affected by altitude exposure and can influence military operations at higher elevations. Night vision is significantly reduced, affecting Marines at or above 8,000 feet. To compensate for loss of functional abilities, commanders should make use of tactics, techniques, and procedures (TTP) that trade speed for increased accuracy. By allowing extra time to accomplish tasks, commanders can minimize errors and injuries.

The most important factor to consider is the combined effects of the environment on the Marine and the subsequent ability to operate and maintain his/her weapons and equipment. Increasingly sophisticated equipment requires Marines that are mentally alert and physically capable. Failure to consider this important factor often results in severe injury, lowered weapons and equipment performance, and mission failure.

Hypoxia-Related Illnesses

Hypoxia is a deficiency in the amount of oxygen reaching the tissues of the body and has been the cause of many mountain illnesses, injuries, and deaths. The three most significant hypoxia-related illnesses are acute mountain sickness (AMS), high altitude pulmonary edema (HAPE), and high altitude cerebral edema (HACE). These illnesses are discussed in greater detail in chapter 13.

Effects of Cold Temperatures

After altitude-related illnesses, cold weather injuries (both freezing and nonfreezing) are generally the greatest threat. The four most common cold weather injuries are frostbite (freezing), hypothermia (nonfreezing), trench/immersion foot (nonfreezing), and snow blindness (nonfreezing).

Environmental Effects on Equipment

The following factors are some of the influences that impact weapons and equipment in a mountainous environment:

- Operator/maintenance personnel.
- LOS (surveillance and communications).
- Range estimation.
- Thermal contrast.
- Ballistics and trajectory.
- Target detection and acquisition.
- First round hit capability.
- Camouflage and concealment/noise.
- Mobility.
- Wear and maintenance.
- Aerodynamics and lift.
- Functioning and reliability.
- Positioning/site selection.

Environmental Effects on Weapons

In a mountainous environment, the speed and occurrence of wind generally increase with elevation as do the effects of wind and weather with range. Consequently, Marines must be taught the effects of wind on ballistics and how to compensate for them.

In cold weather, firing weapons often creates ice fog trails. Ice fog trails obscure vision while allowing the enemy to more easily discern the location of primary positions and the overall structure of a unit's defense. This situation increases the importance of alternate and supplementary firing positions.

Range estimation in mountainous terrain is difficult. Depending upon the type of terrain in the mountains, Marines may either overestimate or underestimate range. In rocky, mountainous terrain, the effectiveness of small arms fire increases by the splintering and ricocheting that occurs when a bullet strikes a rock. This effect works both ways—for and against friendly forces.

As elevation increases, air pressure and air density decrease. At higher elevations, a round is more efficient due to reduced drag. This effect does not significantly influence the marksmanship performance of most Marines; however, designated marksmen and snipers should rezero their weapons after ascending to higher elevations.

Human Environment

The human environment is likely the reason for the mission in the first place. While important due to its impact on operations, the physical terrain should not be the only focal point.

Regardless of where in the world they live, mountain people, due to necessity of location, environment, and need, tend to be tough, self-reliant problem-solvers. They can be geographically isolated, suspicious, and distrustful of outsiders. Rumors or intelligence spread by word of mouth are frequently their primary source of information, often due to their relatively poor literacy and education standards and a lack of technology connecting them with the outside world or even the next valley.

These compartmentalized societies may differ socially as well as physically and Marines may find that language dialects, perspectives, and customs may vary dramatically within a small area. Family, ethnic, and extremist feuds and disputes can last for generations. Mountain people also tend to make their livings by either growing or producing drugs, mining and selling gems or precious metals, or harvesting timber.

Power Structures

Mountain people tend to work and live within a tribal/ethnic leadership structure, which may be further fragmented or compartmentalized. The "flatland" government is generally viewed as adding little value to daily lives and its intrusion breeds resentment. If the government is involved in their lives and is either unable or unwilling to assist when trouble comes, mountain people will revert to or be forced to deal with the power of the moment and they are vulnerable to local dominance in the form of mobsters, imams, doctors, or hereditary leaders.

The Enemy (Generalized: NOT Theater-Specific)

When Marines are working to understand an indigenous mountain enemy or an enemy that has taken refuge in the mountains, it is important to know that the enemy is or was unable to force power in the urban areas, and is now constrained to the mountains. Marines must also realize that he/she has nearly 100 percent situational awareness of Marine activities, rules of engagement (ROE), and allies. The enemy can choose when/where to fight, often operating with impunity among the populace. He/She needs to maintain credibility as a threat and maintain a position in the minds of the locals. The enemy also requires support and logistics just like Marines do.

The enemy tactics are those of the weak. The ambush is the preferred method of engagement and is usually against high-profile targets. It inflicts maximum damage and can be conducted at short-range with a rapid, planned withdraw; from long-range with an intervening terrain feature to limit pursuit; or in the form of an improvised explosive device (IED).

The enemy has a keen understanding of chokepoints and restricted terrain and is clever in the application of simple technologies. He/She will also use carefully coordinated mass attacks against isolated outposts, fire bases, and patrol bases. The enemy will conceal their massing of troops and then attack and withdraw prior to the arrival of support.

Reconnaissance and Surveillance Considerations

In mountainous environments, the importance of reconnaissance is arguably greater due to the challenges of terrain.

Ground Reconnaissance and Surveillance

Ground reconnaissance and surveillance elements must focus on the performance of their standard or traditional missions, vice their kinetic missions. These missions in mountainous and winter environments are especially important due to limited routes, complex terrain, and rapidly changing weather, which significantly increase the importance of reconnaissance operations to focus fires and maneuver.

Commanders must also consider the slower movement rate of ground reconnaissance and surveillance elements in complex terrain and will need to determine its impact on the entire reconnaissance and collection process. They must develop plans that account for this slower rate and initiate reconnaissance as early as possible to provide additional time for movement. Some specific considerations for ground reconnaissance and surveillance that are critical in the mountains include:

- Insertion/extraction.
- Travel distances.
- Elevation/slope of infiltration routes.
- Hide and observation locations.
- Observation methods.
- LOS (communications and observation).
- Sustainability.
- Weather.
- Vegetation.
- Terrain.

Surveillance will be accomplished primarily through well positioned observation posts.

Commanders must plan not only their insertion, but also support and extraction. Surveillance limits the enemy's ability to use the environment to their advantage, conduct decentralized operations, use terrain found in Levels II and III, employ obstacles or barriers to restrict maneuverability, conduct limited-visibility operations, and sustain maneuver elements.

The following list highlights some of the taskings that will be levied upon reconnaissance and surveillance elements. These units truly become the eyes of the commander while working in compartmented terrain over larger distances and with greater unit separation. They—

- Locate the enemy's primary and alternate lines of communication.
- Determine locations and directions from which the enemy can attack or counterattack.
- Identify heights that allow the enemy to observe the various sectors of terrain.
- Locate suitable observation posts for forward observers.
- Highlight portions of the route that provide covert movement.
- Determine the level of mountaineering skill required to negotiate routes (dismounted mobility classification) and sections of the route that require mountaineering installations.
- Determine suitability of routes for sustained logistics combat element operations.
- Identify trails, routes, and bridges that can support or can be improved by engineers in order to move mechanized elements into areas previously thought to be impassable.
- Determine where bypass routes are located.
- Pinpoint potential airborne and air assault drop/pick-up zones and aircraft landing areas.

Unattended Ground Sensors

The mountain environment is a perfect, target-rich environment for unattended ground sensors. Due to predictable movement patterns, key chokepoints, and known or reported trails, unattended ground sensors enable commanders to cover a greater area than with the limited amount of traditional ground reconnaissance usually available. The intelligence battalion's ground sensor platoon may be employed to place unattended ground sensors.

Airborne Sensors

Due to the challenges found in ground reconnaissance, aerial reconnaissance can become increasingly important, especially in the early stages of planning, but also throughout the conduct of operations. During all but the most adverse weather conditions, aerial or overhead reconnaissance may be the best means to gather information and cover large areas that are difficult for ground units to traverse or observe.

Flight paths and weather challenges unique to mountain and cold weather need to be considered when planning for aerial reconnaissance support. Weather, such as wind (especially on unmanned aerial vehicles), visibility, and icing, can impact plans to use airborne sensors.

Some additional limitations for aerial reconnaissance include visual sensor limitations, safe altitude limits and approach vectors over enemy-controlled territory, limited cover and concealment in rugged terrain, and limited LOS.

Marines should remember that while their surveillance limits the enemy's abilities, the enemy will also be using their own surveillance plan to observe and limit Marine operations. Countersurveillance could become a primary mission for reconnaissance and surveillance elements.

Geology

Geology is the study of the earth. Mountain leaders are concerned only with rock types, surface features, and near surface features.

Rock Types

In general, a rock is a coherent aggregate (a whole made up of parts) of mineral particles. Although the number of minerals making up most of the rocks of the lithosphere is limited, they are combined in so many different ways that the variety of rock types is enormous. Nevertheless, there are three basic types of rock classifications—igneous, sedimentary, and metamorphic.

Igneous

These are “fire-formed” rocks made from magma—molten matter beneath the earth’s crust—that has cooled and solidified. Examples are granite, basalt, and obsidian, as seen in figure 1-7.

Igneous rocks rise from a depth in the earth as a molten magma. If the magma cools and solidifies before reaching the surface, the igneous rocks are

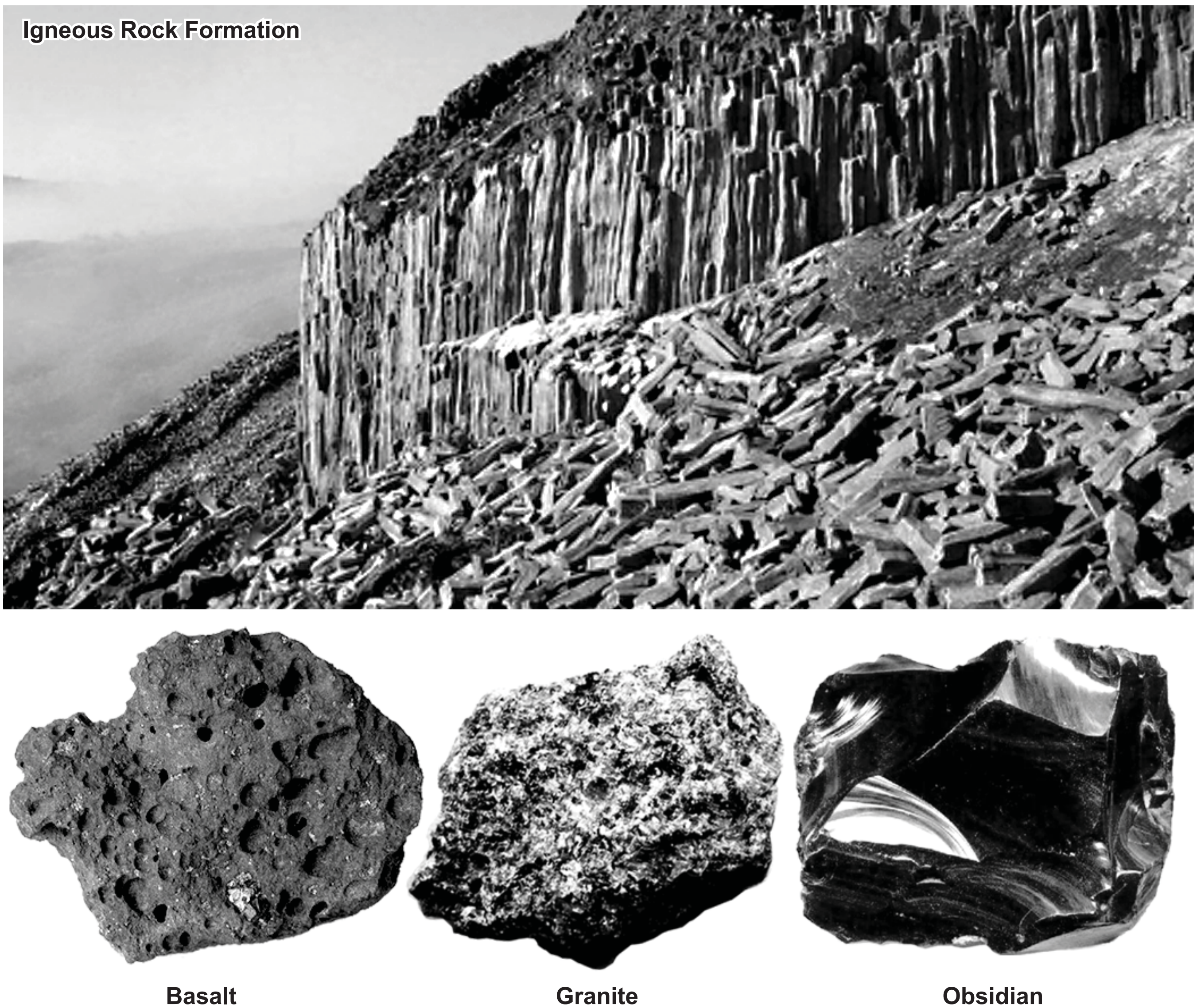


Figure 1-7. Igneous Rocks.

termed intrusive. Intrusive rocks, such as granite, cool slowly and result in a tightly inter-grown fabric of crystals, which form a tough and hard rock that is generally excellent for climbing. Intrusive rocks normally have a great many small cracks (joints) and fissures, which may be used for hand and foot holds.

The cores of most volcanic mountain ranges in the world are granite. In general, the older the mountain, the more granite has been exposed at the surface and the better it is for climbing. When an eruption occurs, the magma comes out as either a liquid or a solid. If it is liquid, it flows out and cools. When magma is ejected in an eruption, it cools off in the form of ash. These igneous rocks are called extrusive and, as they cool, they solidify in the atmosphere. Extrusive rocks that are ejected by volcanic action have very little strength or cohesion and are very difficult to climb. Extrusive rocks that cool more slowly, such as basalt, can be almost as good for climbing as granite; however, such rocks rarely make up the major portion of a mountain range.

Sedimentary

Sedimentary rock (see fig. 1-8) is deposited by the action of water, wind, or ice or is chemically precipitated from water. Sandstone, shale, and

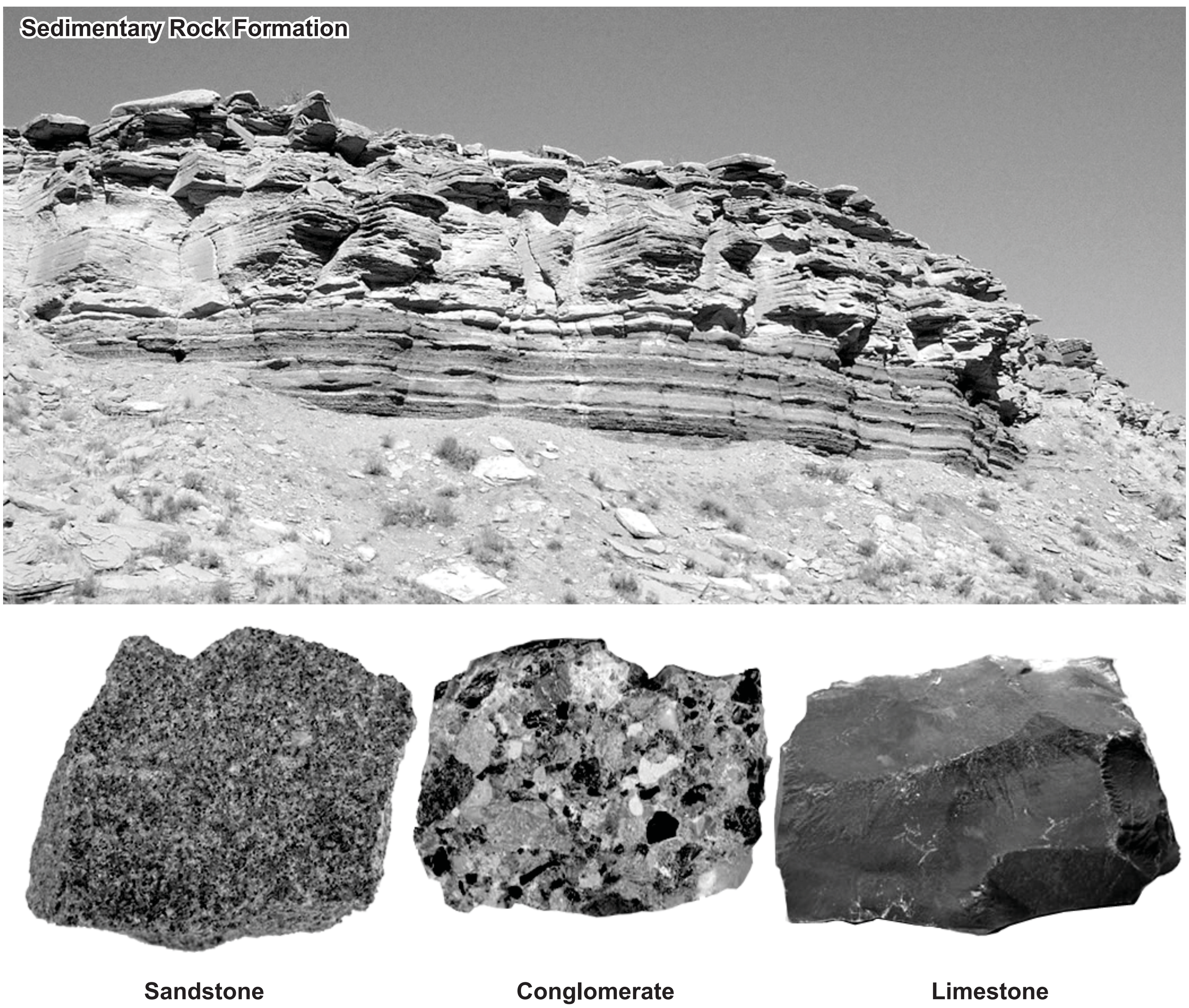


Figure 1-8. Sedimentary Rocks

coal are sedimentary rocks usually deposited by rivers and oceans; whereas, limestone is precipitated from seawater because of organic action.

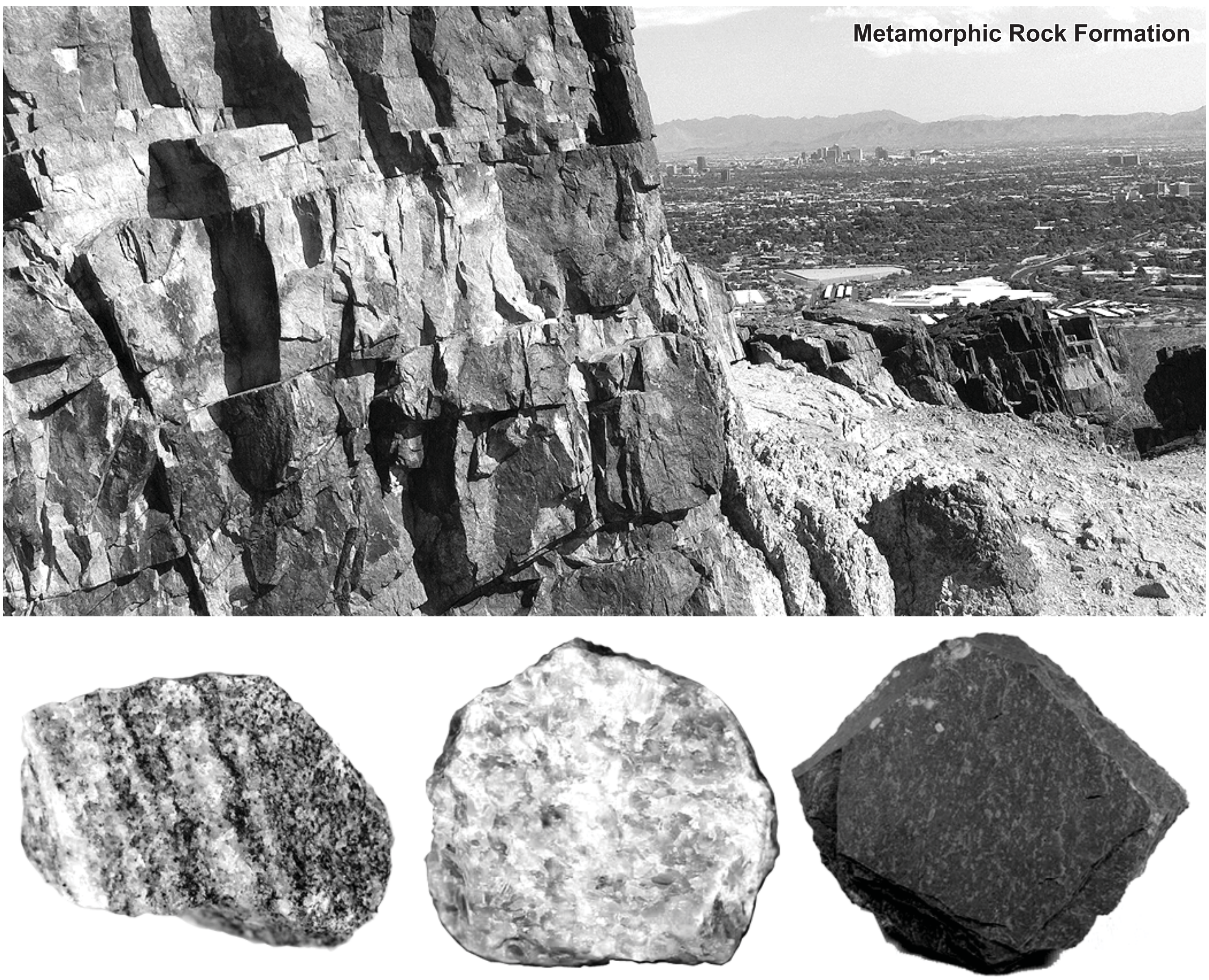
Metamorphic

These "changed" rocks were originally igneous or sedimentary rocks that, due to temperature and pressure within the earth, have been altered physically or chemically. Examples of metamorphic rocks are slate from shale, marble from limestone, and gneiss from granite. See figure 1-9 for examples of metamorphic rocks.

Generally, sedimentary and metamorphic rocks are more difficult to climb than igneous rocks as they tend to be much more friable (breakable or "rotten"). Often, sedimentary and metamorphic rocks contain high concentrations of clay-like minerals that may be very soft and slippery when wet; however, there are types of sandstone in very dry regions where there is little water to weaken the rocks' cementing agents.

Formation Mechanics of Mountains

Most mountain ranges are the result of compressive stresses in the earth's interior. In order to



Gneiss Marble Slate

Figure 1-9. Metamorphic Rocks.

relieve these stresses, thick sections of the crust slowly bend (fold) or fault (break). The resultant surface relief caused by folding, the processes of erosion, often magnify faulting or volcanism (see app. A).

Basin and Range Mountains

Basin and range mountains are bounded on one or more sides by faults, forming in areas of crustal extension, as in figure 1-10. The Tetons and the Sierra Nevadas of western United States are some examples.

Folded and Faulted Mountains

Folded mountains, such as the Appalachians, have numerous faults, but the principal structures are large-scale folds, which are again modified by erosion, as in figure 1-11. Some examples are the Himalayas, Urals, and Hindu-Kush.

Domal Mountains

Domal mountains are usually the result of the upward movement of magma and the subsequent folding of the rock layers overhead. They are shallow and intrusive. Erosion may strip away the overlying layers, exposing the central igneous core, as in figure 1-12. Some examples are Stone Mountain in Georgia and the Ozark Mountains.

Volcanic Mountains

Volcanic mountains are formed by repeated extrusions (see fig. 1-13 on page 1-20). They tend to occur in long chains. The mountains of the Hawaiian Islands and Japan are examples of volcanoes.

Plains/Plateaus

In semi-arid regions, extreme erosion of flat-lying rock layers can produce typical badlands topography. Compartmented environments can be very complex, impassable to vehicles, and may require mountaineering techniques to maneuver (see fig. 1-14 on page 1-20). Examples of this type of topography are the Grand Canyon area and the Black Hills and Badlands of the Dakotas.

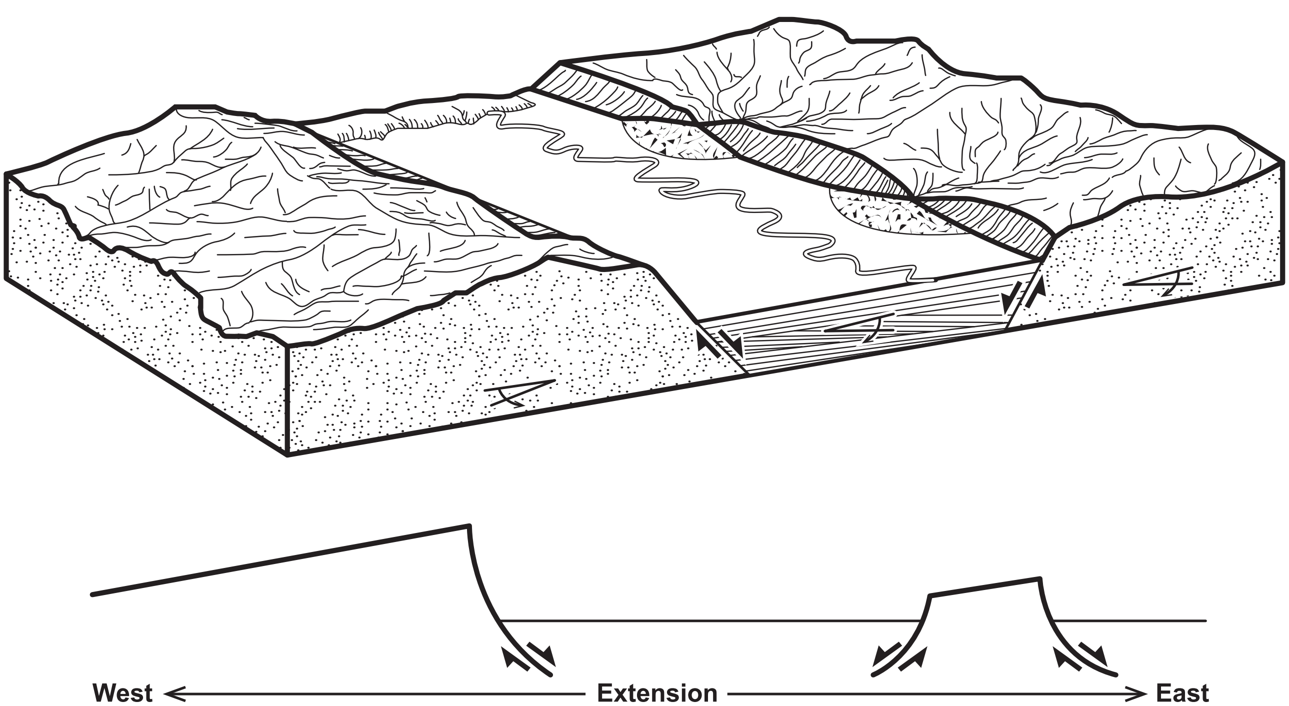


Figure 1-10. Basin and Range Mountains.

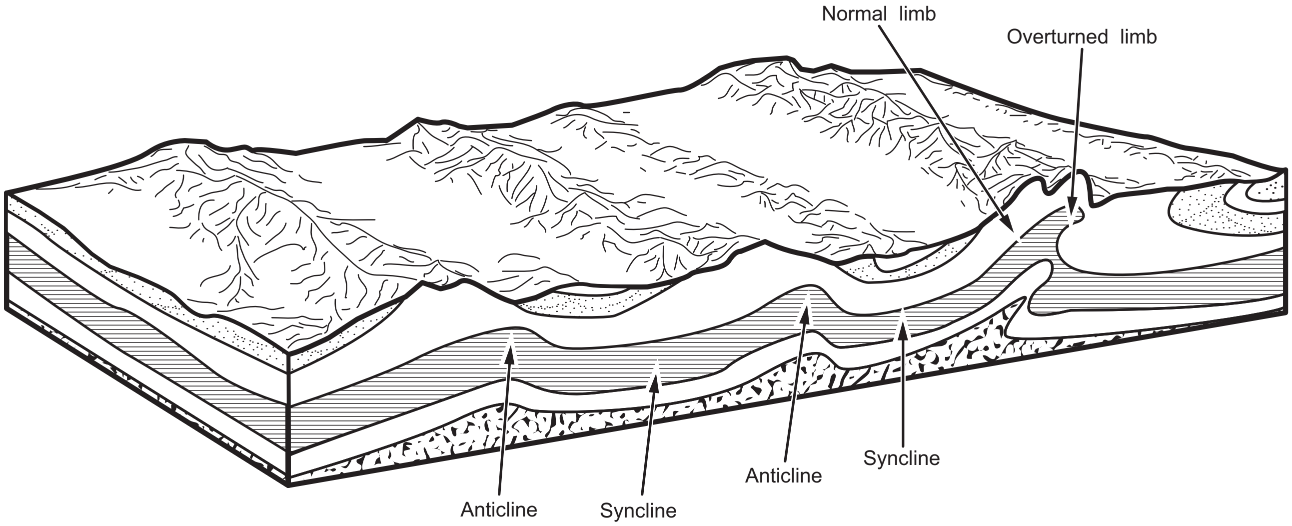


Figure 1-11. Folded and Faulted Mountains.

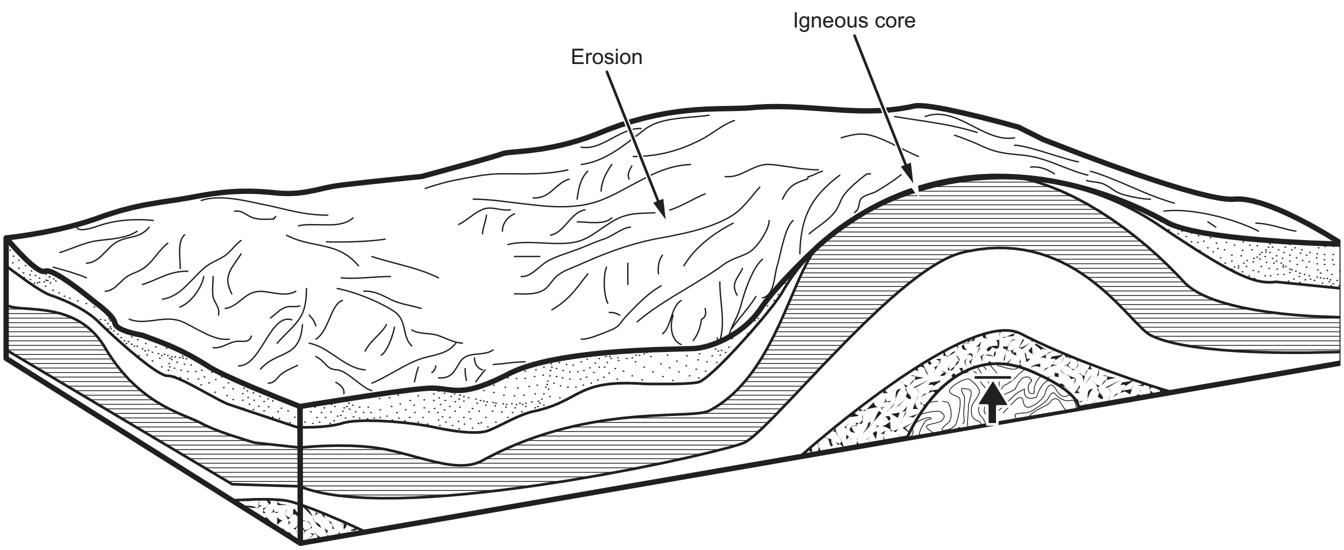


Figure 1-12. Domal Mountain.

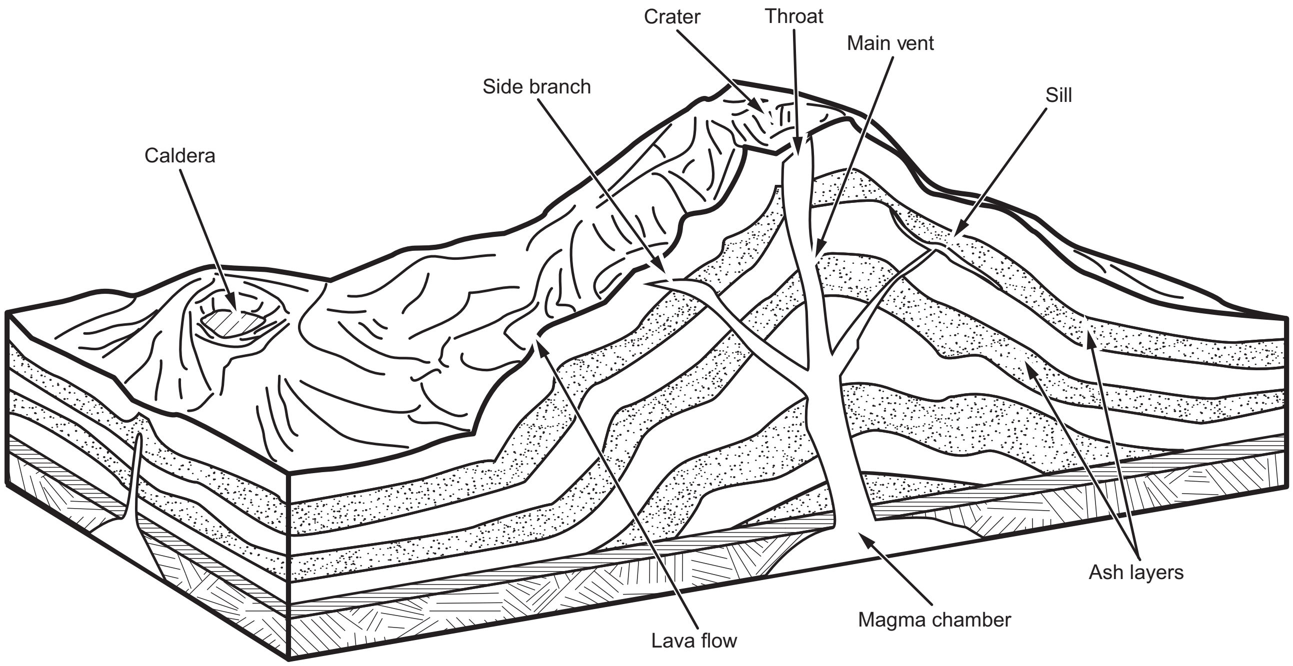


Figure 1-13. Volcanic Mountains.

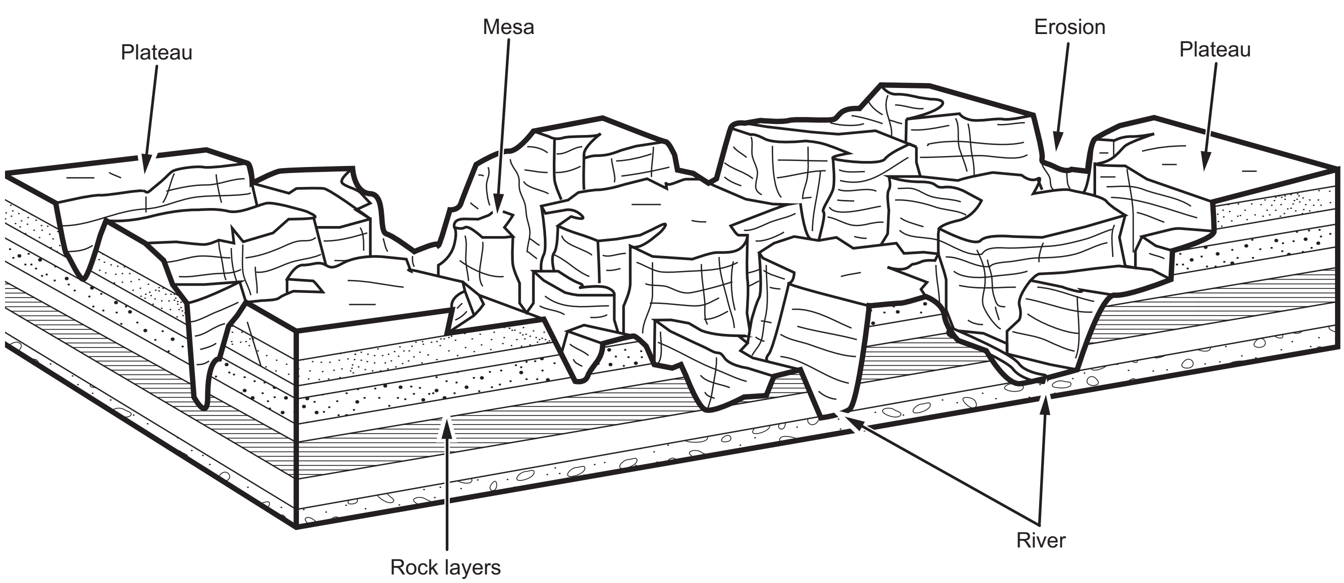


Figure 1-14. Compartmented Plains/Plateaus.

Cave Formation

Caves form naturally from rainwater in limestone and dolomite rock formations. Limestone is calcium carbonate and dolomite is magnesium carbonate. Both are easily eroded by water. Since rainwater forms the cave, potable water is also naturally available in the cave complex as underground lakes and rivers/streams. The S-2 can provide geological maps, which have been prepared by oil companies worldwide, to help determine if the area of operations has cave-bearing rock. These maps will show general rock formation trends. Color aerial photos and the assistance of a geologist who can identify limestone will also help.

Cave entrances can be either vertical or horizontal; even a small entrance can lead into a huge underground complex. Cave formation can be predicted along the line of a fault, which produces big caves. Bisecting the fracture line will also indicate lines of cave formation, which can produce large or small caves (where the main water runoff lines flow). Uplifting will lead to exposure of horizontal entries and provide protection from air delivered munitions (see fig. 1-15). Some examples are Mammoth Cave, Carlsbad Caverns, and Tora Bora.

Lava Tubes

Lava tubes can form naturally underground and run for miles from a volcanic cone mountain. They are horizontal, shallow lava flows that formed tunnels/caves during consolidation. Pluto's Cave at Mt. Shasta is an example, as in figure 1-16 on page 1-22.

Manmade

Tunnels, mines (old and current), underground aqueducts, subways, sewage pipes, and military caves—such as the tunnels dug under the demilitarized zone in Korea and the qanat aqueduct system in Afghanistan—are all examples of manmade underground structures that need to be identified for military purposes. Shallow tunnels and lava tubes can be identified by sonar as they were in Korea on the demilitarized zone.

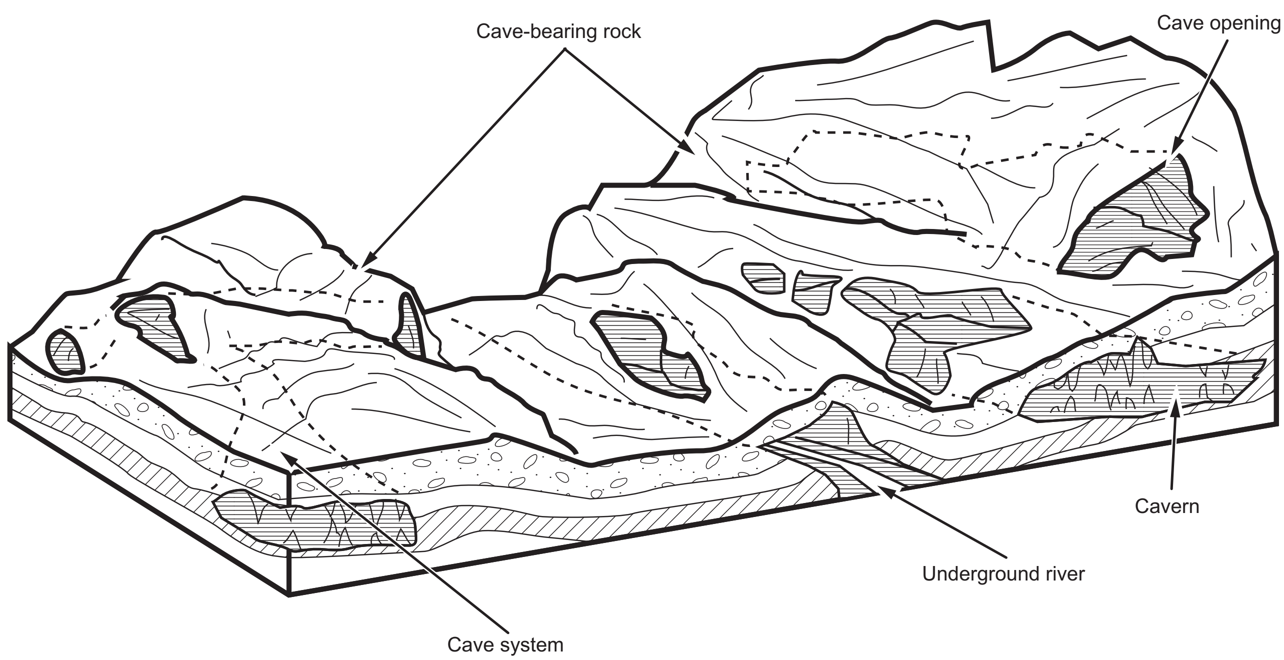


Figure 1-15. Cave-Bearing Rock.

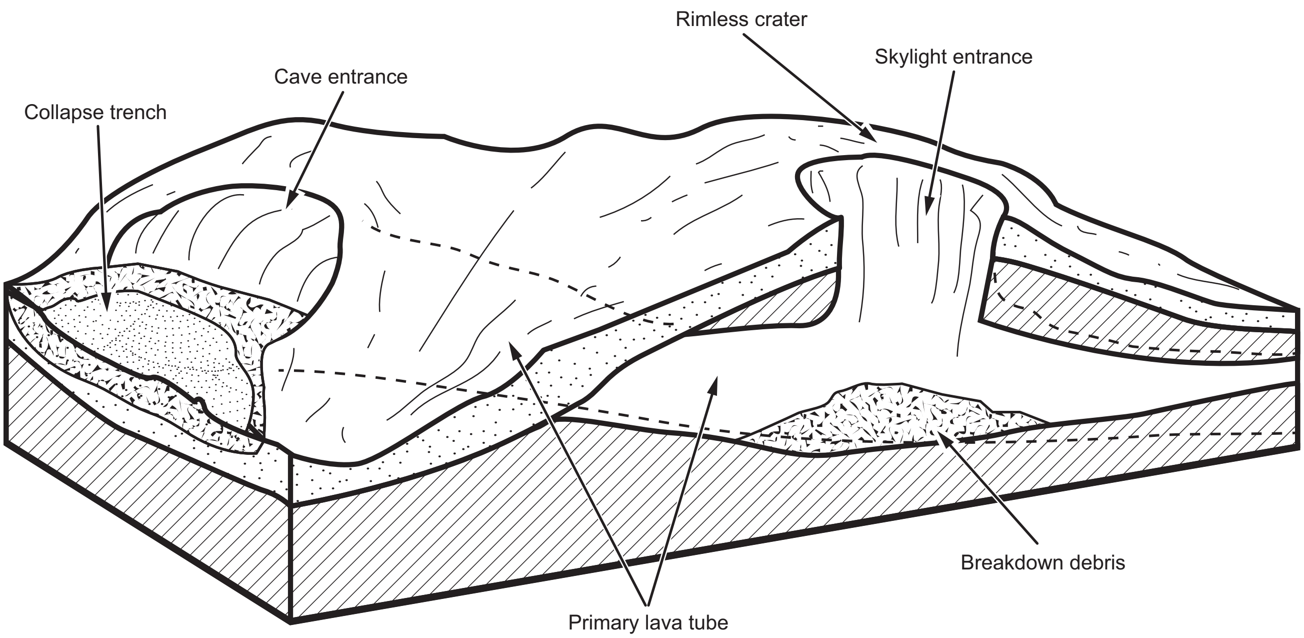


Figure 1-16. Lava Tube.

Weathering and Erosion

Once mountains have been formed, the forces of nature begin a relentless task of tearing them down. Weathering, both mechanical and chemical, breaks the rocks into smaller pieces without moving the pieces very far. Erosion then transports the pieces to another location by gravity, wind, water, or ice. The most important type of weathering in mountainous regions is called frost wedging, which is the result of moisture in the rocks and crevices freezing and thawing repeatedly. The resulting expansion and contraction wedges off angular flakes and blocks of rock that fall down the slope and are accumulated as talus and scree. Scree and talus resulting from wedging action are generally poor for climbing due to their instability, although scree may be descended rapidly using the plunge step technique.

Glaciology

Glaciers are the world's greatest earthmovers. They are rivers of ice flowing under the influence of gravity, constantly restructuring the mountains around them. They often provide the best route in otherwise impassable terrain. Glaciers can be very small or large enough to cover an entire continent, as in Antarctica (see app. B). They may move from several inches to several hundred feet a year. When the snowmelt rate exceeds the rate of snowfall, a glacier can actually retreat up the valley. Movement is usually caused by gravity, by basal slippage over the bedrock, or by internal flow in the ice.

Formation of Glacial Ice

Glaciers can occur in any mountainous terrain where the annual snowfall exceeds snowmelt and the terrain permits deep deposits of snow. Once the snow depths exceed 10 feet, the weight of the underlying snow is compacted into firm (neve) snow (10 feet of snow makes 1 foot of firm snow). This firm snow is recrystallized into firm ice and then into glacial ice. The region of the glacier where the annual snow accumulation exceeds the melt is called the accumulation zone. Further down the glacier, where melt exceeds accumulation, is an area called the ablation zone. The imaginary line between the two zones is known as the firm line.

Glacier Classifications

There are two classifications of glaciers: alpine and ice sheet or ice cap. Alpine glaciers form in high mountain bowls by the year-round accumulation of snow over a long period. Ice sheet or ice cap glaciers are larger and a far more significant formation than the alpine glacier. These glaciers usually cover hundreds of thousands of square miles. Though uncommon today, at one time they covered as much as 30 percent of the land on earth. They still blanket Greenland and Antarctica and smaller ice caps are still present in many highlands.

Types of Glaciers

The following are the four types of glaciers:

- *Cirque glacier*. These glaciers do not advance beyond the bowl in which they are formed.
- *Hanging glacier*. A hanging glacier is forced out of its area of origin and over a cliff or precipice. It breaks off at the snout and tumbles down as an ice avalanche.
- *Valley glacier*. Valley glaciers advance down a valley. Glaciers form U-shaped valleys while rivers form V-shaped valleys.
- *Piedmont glacier*. These glaciers move out of their valley origins onto an open plain or into the sea, forming a fan-like pattern.

Glacial Features that Impede Travel

Glaciers are treacherous places with many of the following features that can impede travel upon them (see figs. 1-17, on page 1-24, and 1-18, on page 1-25):

- *Moraines*. The most common features of a glacier are moraines, which are piles of rock and other debris that have either fallen onto the glacier or been pried loose by the glacier as it moves along. There are four basic types:
  - Lateral Moraine—the rock debris along the valley wall.
  - Medial Moraine—formed when two glaciers come together and the lateral moraines are forced out into the middle of the glacier.
  - Terminal Moraine—the rock debris at the snout of the glacier, which is being dredged up and pushed down the valley. A glacial stream often flows out from under the terminal moraine.
  - Ground Moraine—the rocks and debris under the glacier that can be exposed if the glacier stops and then begins to move again. Generally, the outside of a moraine wall is stable, but the side facing the glacier can be steep and loose and should be avoided. A moraine may be the only path, but it can be awkward and tiring due to the jumbled rocks.
- *Crevasses*. Crevasses are the result of irregularities in the bedrock under the glacier or stresses in the ice. They are called transverse, longitudinal, or lateral, depending on their orientation to the direction of the glacier's movement. Crevasses can be 200 feet deep, but are normally 40 to 100 feet deep. Crevasses are hindrances to traveling across glaciers because they may have to be bypassed. They can be hazardous when blowing snow conceals them by forming a snow bridge across the top. This type of bridge must be tested before crossing. It can give way without warning. In summer, the ice is less covered with snow and most crevasses are exposed, but they can still be hazardous at night or during reduced visibility.
- *Bergschrund*. The Bergschrund is a giant crevasse found at the upper limit of glacier movement and is formed where the moving glacier breaks away from the ice cap or snowfield above. (Technically, the point at which this crevasse separates the glacier from a rock wall is not a Bergschrund, but a moat.) The Bergschrund can be very high and even overhanging and can create a serious obstacle to movement when attempting to move from the valley floor onto the mountainsides.

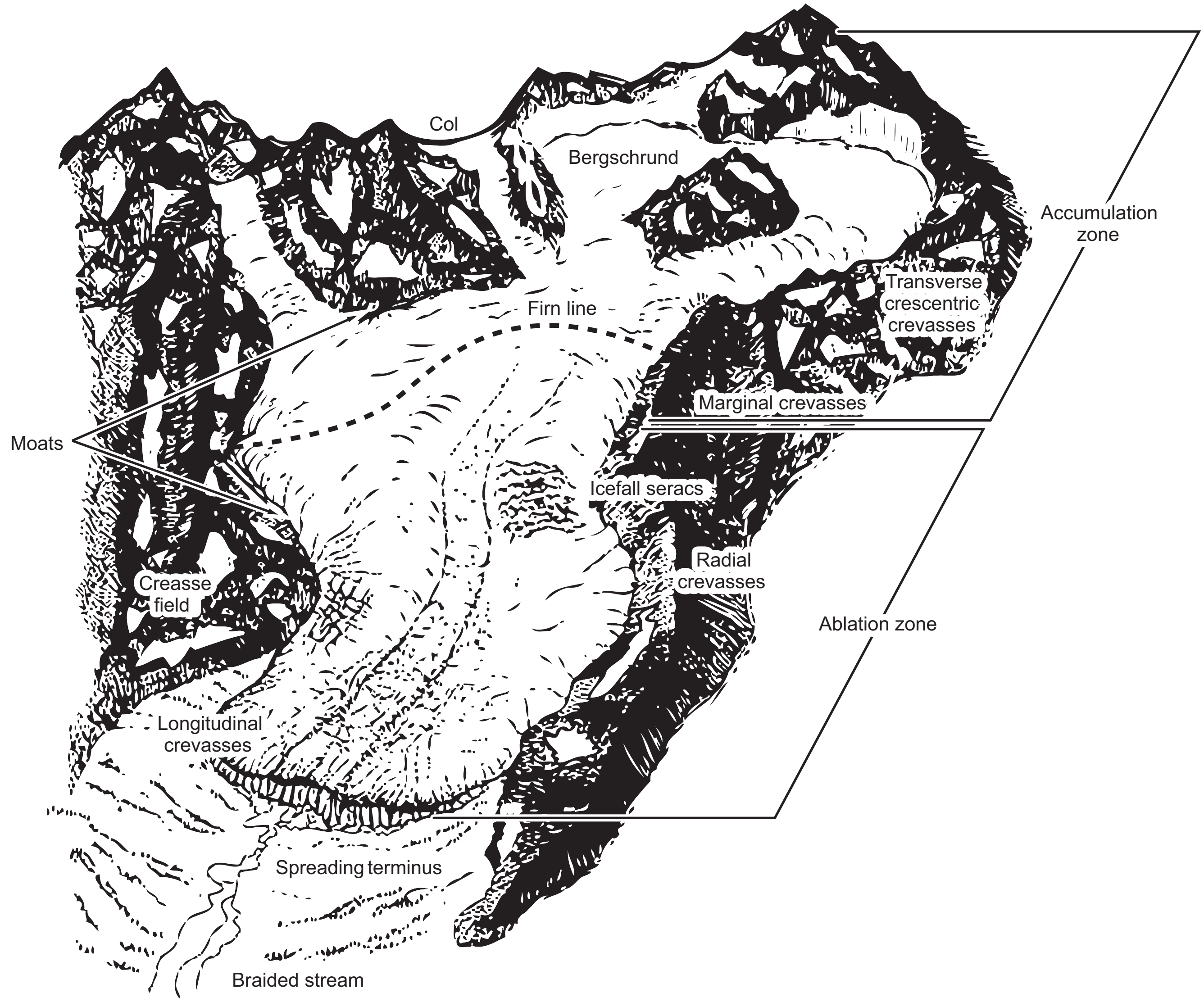


Figure 1-17. Glacier Features, Example 1.

- *Serac*. These ice walls and towers have been forced upward due to pressure within the glacier. They are unstable and can fall unexpectedly. It is another hazard and route planning should give them a wide berth when possible.
- *Icefalls*. Icefalls result from the flow of the glacier down a steep ridge. The ridge forces the ice up into a jumbled mass as the glacier flows over the rock. These present formidable obstacles and should be avoided when moving troops.
- *Nunatak*. This bedrock protrudes up through the glacier, creating an obstacle to glacial movement. It can create pressure in the ice and help to bring about crevasses, seracs, and icefalls.
- *Rock and Ice Avalanches*. Avalanches can occur when seracs or blocks of ice come loose and cascade onto the glacier. Avalanches are potential dangers when traveling near the valley walls or under a hanging glacier; therefore, these areas should be avoided when possible.

- *Water hazards*. Streams that run on the surface and then disappear into a hole are called moulins. Moulins form when melt-water from the glacier finds a crevasse and moves to the ground below the ice; they cause a dangerous obstacle. The glacial streams above this point must also be treated with respect. They are very cold, can be deep, and create a hazard for a heavily laden individual. In summer, glacial thaw water can form in troughs, freeze at night, and form glacial swamps. These should also be approached with care.

Figure 1-18. Glacier Features, Example 2.

Cliff Reconnaissance

Conducting a cliff assault is a dangerous undertaking. Without extensive reconnaissance of the intended site, the operation will almost be doomed to fail. The more information that is available to the raid force commander (RFC), the better the chances of success. The following units are capable of conducting cliff site reconnaissance and will normally have organic assault climbers or M7A-qualified mountain leaders:

- Force reconnaissance company.
- Reconnaissance battalion (division).
- Scout sniper platoon.
- Qualified small boat company scout swimmers. They are trained to conduct cliff reconnaissance as the boat company often has the primary mission of conducting an amphibious cliff assault.
- Others. Additional units involved may consist of ranger pathfinder platoons and special forces "A" teams.

Cliff Reconnaissance Procedures

The assault force and its climbers must be prepared to overcome the cliff by whatever means necessary. There are many factors that drive the reconnaissance effort in support of special operations. This mission can be assigned to any one of the aforementioned cliff assault units at the MEU commander's discretion. The following are general considerations for the conduct of a cliff reconnaissance and are not meant to dictate current unit standard operating procedures (SOPs):

- Determine mission feasibility at the mission planning stages (mission, enemy, terrain and weather, troops and support available-time available [METT-T]). Take terrain analysis (key terrain, obstacles, cover and concealment, observation and fields of fire, and avenues of approach [KOCOA]), enemy likely course of actions (defend, reinforce, attack, withdraw, or delay [DRAW-D]), enemy weapons, and enemy reports (size, activity, location, unit, time, equipment [SALUTE]) into account.
- Determine equipment requirements and the assault force's current capabilities. Pretraining or sustainment training is required before mission execution.
- Request an aerial reconnaissance of the area.
- At a minimum, conduct a detailed map reconnaissance. Request to use current reconnaissance assets if available.
- The unit conducting the reconnaissance should be thoroughly familiar with assault climber operations and the assaulting unit's capabilities.
- If the unit conducting the reconnaissance does not have a qualified mountain leader or an assault climber, it should bring one with them.
- Ideally, a summer mountain leader (M7A) or assault climber (YAK) from the unit that intends to do the cliff assault should lead the effort. If an outside element is conducting the reconnaissance, then the mountain leader or assault climber should accompany it. He/She will provide on-site expertise to give a clear picture of the obstacle to be crossed, identify possible climbing points and equipment requirements, and offer a tentative time estimate.

Gather Essential Data

If personnel conducting the reconnaissance are not familiar with this type of mission, they must be thoroughly briefed on the specific information required by the assault climbers. A face-to-face coordination with the reconnaissance team leader is recommended.

The reconnaissance preparation should include sketches, photographs, or any other items of significance. Uncommon sources of information, such as tourist maps or photos from submarines, are very good for planning and navigation. The information must be reported in a timely manner in order to prepare the assault force.

On-Site Observations

The following information should be gathered on site:

- Top and bottom anchor points.
- Top and bottom rally points.
- Probable lanes for climbing and establishing rope installations.
- Weakness in the cliff face, such as chimneys, overhangs, and rotten rock.
- Natural animal habitats, such as dens, caves, and nests. Startling the animals may warn the enemy of a disturbance on the cliff face.
- Possible rock slide/avalanche sites.
- Feasibility of fire support.

Operational Security

Operational security is of utmost importance and the following points should be considered:

- The reconnaissance element should not climb the intended cliff breach points. Doing so could compromise the plan, causing a disastrous loss of surprise for the assaulting unit.
- If the reconnaissance unit is to remain in place, surveillance of the breach points and likely avenues of approach should be established.
- The unit should facilitate the arrival of the assault force and be prepared to assist in any way possible.

Cliff Sketch

A cliff sketch is a pictorial representation of the cliff in elevation and perspective as seen from one point of observation. It will contain a horizon line and intervening features. Rapidly made and easily read and understood, a proper cliff sketch will have great value to the RFC and assault climbers.

Equipment

The following equipment will assist in constructing the cliff sketch:

- Compass.
- Binoculars equipped with a mil scale.
- Sketchpad.
- Soft pencil.
- Ruler.
- Digital camera.

Marginal Information

The following information is placed on the sketch paper in the margin after indicating the reference line and before conducting the sketch:

- Sketcher's name, rank, and unit.
- Date of sketch.
- Sketcher's location (8-digit grid at a minimum).
- Direction of view (in degrees magnetic).
- Magnetic north arrow.
- Scale (if used/known).

Construction

Cliff sketch construction procedures follow:

- Study the landscape to distinguish prominent terrain features in relation to each other in conjunction with a military map.
- Select a permanent and conspicuous reference point. The features of the sketch will be drawn from this base.
- Establish a scale. The cliff sketch is a panoramic or bird's eye view of the cliff. To maintain a correct relationship between objects and features, a proportion must be established. One method of scale is the 15-inch method:
  - Attach a 15-inch piece of cord to a ruler and hold one end of the cord in your teeth.
  - Hold the ruler at eye level; each three-quarter inch increment is equal to 50 mils in width.
  - Using a scale will increase the accuracy of the sketch.

Basic Symbols

There are seven basic symbols used on the cliff sketch. Each defines an important characteristic to the assault climber (see figs. 1-19 and 1-20).

Note: Ramp, slab, and chute can be written on the sketch; include the dimensions (width, depth, height) in order to know the number of lanes possible.

Only details that are of military importance should be added. Details should not be added simply to fill up space or improve the appearance of the sketch.

Cliff Report

The cliff report contains thirteen lines, Alpha through Mike. Each of the lines provides information about a specific aspect of the cliff and the surrounding area. The following information on each line is provided in the event that a reconnaissance team is reporting directly to the assaulting unit and not their reconnaissance operations center:

- *Line Alpha*: Line Alpha (see table 1-6) indicates the units of measure used in the sketch.
- *Line Bravo*: Date/time report completed.
- *Line Charlie*: Cliff location. Given at cliff center and expressed as a minimum 8-digit grid over a secure net or encrypted.
- *Line Delta*: Width of the cliff head, expressed in the units of measure stated in line alpha.
- *Line Echo*: Cliff height, expressed in the units of measure stated in line alpha.
- *Line Foxtrot*: Obstacles at the base of the cliff (see table 1-7). This line can use multiple codes.
- *Line Golf*: Rock type, if known (see table 1-8).

Table 1-6. Line Alpha Information.

Unit of Measure	Number Code
Meters	1
Yards	2
Feet	3

- *Line Hotel*: Military classification of climbs, if determined (see table 1-9 on page 1-30, and app. C for more information on climbing rating systems).
- *Line India*: This line (see table 1-10 on page 1-30) will identify hazards on the cliff face.

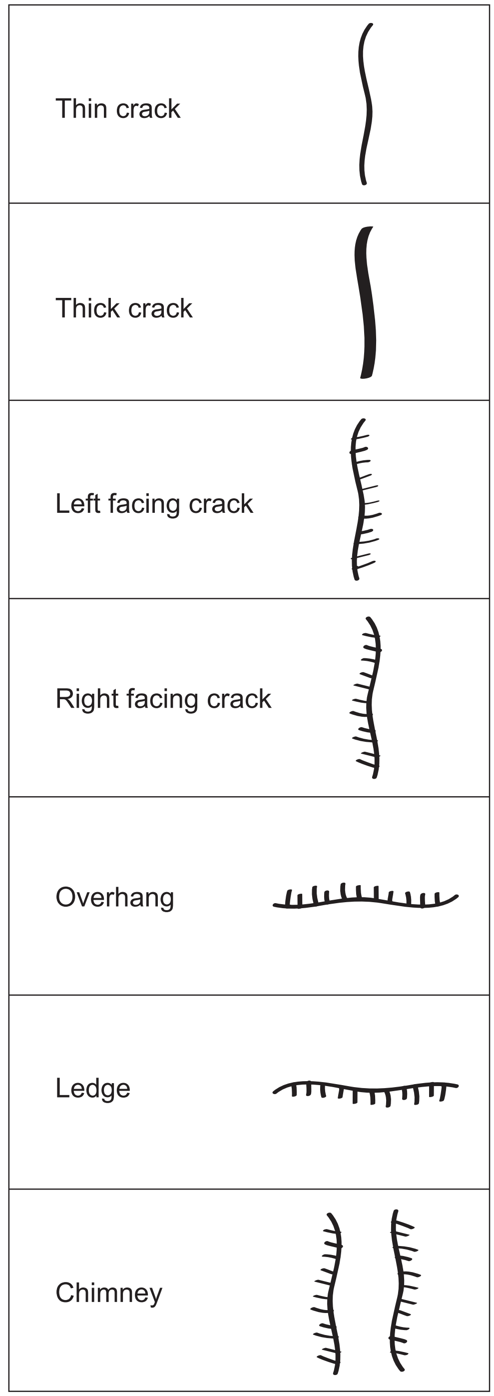


Figure 1-19. Cliff Sketch Symbols.

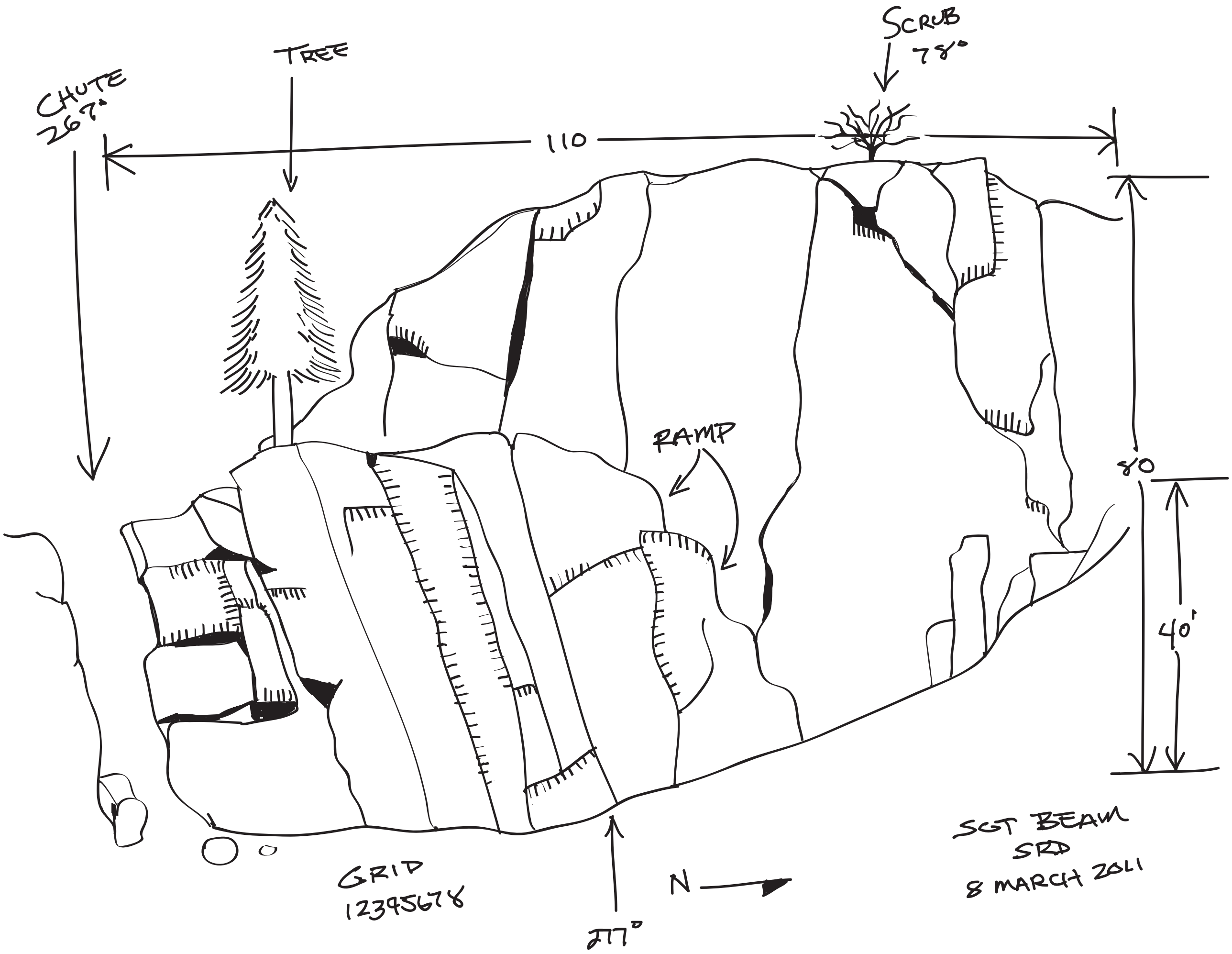


Figure 1-20. Cliff Sketch.

Table 1-7. Line Foxtrot Information.

Obstacle	Letter Code	Number Code	Type
Natural	A	1	Rocks
		2	Stream/river
		3	Trees/vegetation
		4	Ditches
		5	Snow/ice
Manmade	B	1	Buildings
		2	Fences
		3	Pylons/wires
		4	Poles/masts
		5	Others

Table 1-8. Line Golf Information.

Type	Number Code
Granite	1
Basalt	2
Lava	3
Sandstone	4
Steep earth	5
Unknown	6

- *Line Juliet*: This line (see table 1-11) will identify the number and types of tactical lanes that can be constructed. This line may contain more than one code as applicable.
- *Line Kilo*: Is an A-frame needed? *YES* or *NO*
- *Line Lima*: Enemy situation. Given in the SALUTE report format for any current enemy reports that may affect the cliff assault or are pertinent.
- *Line Mike*: Remarks/comments. Identifies any data that is essential, but not covered in the other lines.

Table 1-9. Line Hotel Information.

Code	Description
Easy	Class III to class IV
Moderate	Hard class IV to class V (5.0–5.4)
Difficult	Hard class V (5.5–5.8)
Severe	Climb ratings exceeding 5.8

Table 1-10. Line India Information.

Hazard	Number Code
Rock fall	1
Water	2
Snow/ice	3
Vegetation	4
Other	5

Table 1-11. Line Juliet Information.

Lane Type	Letter Code
Simple fixed	A
Fixed	B
Top rope	C
Cable ladder	D
Vertical hauling line	E
Suspension traverse	F

Tables 1-12 and 1-13 are an example of a cliff report and a cliff report cheat sheet. The cliff report is based on North Atlantic Treaty Organization (NATO) report formats used by reconnaissance units. The advantages to this style of report are the encryption of the pertinent information and the ability to rapidly transmit the data by radio communications. The disadvantage to this style is that the receiver of the report must understand how to decipher the information.

Table 1-12 describes a cliff in feet that was reconnoitered at 0800 on 18 Jan 2000. The cliff is located at grid MG67890898 and is 250 feet wide at the base. The cliff is 40 feet high and has a ditch, stream, and fence in the area surrounding the base. It is made of granite and is a moderate climb. There is vegetation on the cliff face with six top rope lanes, three ladder lanes, and one suspension traverse site. An A-frame is needed to bring up equipment and no enemy activity was noted.

Table 1-12. Example Reconnaissance Team Cliff Report.

Reconnaissance Team: *KILO ONE TANGO THIS IS GOLF SEVEN DELTA. STAND BY FOR CLIFF REPORT, OVER.*	
Line Alpha	3
Line Bravo	180800ZJAN00
Line Charlie	MG67890898
Line Delta	250
Line Echo	40
Line Foxtrot	2,4 A; 2 B
Line Golf	1
Line Hotel	Moderate
Line India	4
Line Juliet	6 C, 3 D, 1 F
Line Kilo	Yes
Line Lima	None
Line Mike	None

Table 1-13. Cliff Report Cheat Sheet.

ALPHA: Unit of Measure Meters = 1 / Yards = 2 / Feet = 3
BRAVO: Date/time
CHARLIE: Location
DELTA: Width
ECHO: Height
FOXTROT: Obstacles NAT (A): Rocks = 1 Stream/water = 2 Trees/vegetation = 3 Ditches = 4 Snow/ice = 5 MAN (B): Buildings = 1 Fences = 2 Pylons/wires = 3 Poles/masts = 4
GOLF: Rock type Granite = 1 Basalt = 2 Lava = 3 Sandstone = 4 Steep earth = 5 Unknown = 6
HOTEL: Class of climbs Easy = class III/IV Moderate = hard class IV/V (5.0–5.4) Difficult = hard class V (5.5–5.8) Severe = climb ratings exceeding 5.8
INDIA: Hazards Rock fall = 1 Water = 2 Snow/ice = 3 Vegetation = 4
JULIET: Tactical lanes Simple fixed = A Fixed = B Top rope = C Cable ladder = D Vertical haul lines = E Suspension traverse = F
KILO: A-frame needed: YES or NO
LIMA: Enemy situation (SALUTE)
MIKE: Remarks or comments

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CHAPTER 2
COMMAND, CONTROL, AND COMMUNICATIONS PLANNING IN A MOUNTAINOUS ENVIRONMENT

Command and Control Planning Considerations

Roles of Command and Control Nodes

Command posts, company FOBs, and jump command posts comprise the command and control nodes and require meticulous planning, especially when deploying to a mountainous environment.

The Command Post

The command post manages the fight for the battalion and all of its subordinate units, to include all attachments; however, the mountains act as barriers, so if a battalion is assigned an area of operations and the mountains further divide that area of operations into smaller regions, it may not be practical or efficient for a single command post to manage the fight. A battalion command post located in one part of the area of operations may not always have a timely, realistic picture of what is going on in a distant, remote part of the area of operations.

Consequently, it becomes essential for the unit to disaggregate its forces during some missions, such as stability and security operations. The principle of economy of force requires that a unit disperses its forces throughout the battlespace in order to remain engaged; however, it is also imperative that units have the ability to re-aggregate their forces in order to meet any threat that arises. During disaggregated operations, it is vital that all of a unit's forces are able to keep the unit commander aware of what is occurring in the battlespace.

One solution to mitigating the effects of the mountain barriers may be to organize the battalion into a multi-command post configuration, such as alpha/bravo (A/B). Units have done this with success in Operation Enduring Freedom (OEF) in the past. In such a configuration, each command post needs to be able to operate independently and carry out all the functions of a battalion command post, such as clearing fires or coordinating CASEVACs. This configuration allows the battalion to maintain a more accurate awareness of the battlespace. Staffs must also recognize that there are limitations to operating in this type of configuration, particularly in terms of personnel and sustainment.

Company Forward Operating Bases

Subordinate units operate more independently during disaggregated operations than in a traditional operational environment. The battalion and higher headquarters still needs to be aware of what is going on and direct the fight as required, but the company will be performing roles that were previously associated with higher echelons of command. For example, company level intelligence cells may be responsible for collecting, processing, and disseminating intelligence gained from biometrics, human exploitation teams, and other sources. Additionally, a company level operations cell may be responsible for clearing fires within that company's area of operations and other functions normally associated with the battalion.

The Jump Command Post

The principal factors distinguishing the operation of a jump command post in complex terrain from operating a jump command post in a more traditional environment are the distances and times required for transit between the various command posts and forward operating bases (FOBs). It is not uncommon for a jump command post to require 6 or 7 days to visit all of a unit's sites. Planners must consider that the jump command post may have additional requirements, particularly in terms of sustainment and force protection. In addition, planners will need to install and configure any systems to which the commander will need access within the jump command post. While planning for communications with the jump command post, planners must consider which methods are best suited for on-the-move communications, such as satellite communications (SATCOM) and high frequency, and allocate resources accordingly.

Required Functionality of Each Command and Control Node

During the planning process, the unit commander and staff determine what functions each node must perform. These needs drive resource and personnel allocation. Some functions to consider are—

- *Fires*. The unit must answer the following questions in order to resource equipment and personnel appropriately:
  - Which nodes should be capable of clearing their own fires?
  - Given the unit's Advanced Field Artillery Tactical Data System assets, how many nodes could potentially clear their own fires?
- *Reporting*. In today's coalition operational environment, a unit typically files reports on several different networks, including the Secure Internet Protocol Router Network, Central Command Regional Intelligence Exchange System, Battlefield Intelligence Collection and Evaluation System (known as US BICES), and Joint Worldwide Intelligence Communications System. Units must determine which nodes should have access to these networks. In an A/B configuration, both command posts probably do; however, all networks may not need to be pushed down to all of the companies.
- *Intelligence, surveillance, and reconnaissance*. Since companies will probably be performing some of the intelligence functions typically associated with the battalion, units need to determine which functions their companies will be required to perform. Functions may include biometrics, unmanned aircraft systems (UASs), or signals intelligence. Deciding which nodes will perform these functions will determine how the staff distributes the assets required to support them.

Required Systems

Once the required functions of each node have been determined, the unit must decide which command and control systems and applications will be required for a particular node. Each application has a specific purpose and requires specific resources. For instance, a company FOB may only have a requirement to monitor a multi-user internet relay chat room via a PRC-117 SATCOM connection, while a regimental command post may be required to continually monitor and update C2PC [Command and Control Personal Computer], Command Post of the Future, MarineLink, StrikeLink, Battle Command and Support Sustainment System, and a host of others through multiple satellite systems.

Required Equipment

Once the functions and systems of a node have been determined, the staff must assign the equipment assets required in order to support those functions and systems. At this point, the staff will have to weigh the requirements of each node against the constraints of the equipment available. For instance, if there is only one Secure Mobile Anti-jam Reliable Tactical Terminal satellite terminal available, it will likely end up at the unit headquarters since headquarters is required to support data and telephone communications. In addition, due to the disaggregated nature of operating in the mountains, units often request additional assets, such as support wide area network (SWAN) terminals, in order to support their requirements.

Required Personnel

The staff must allocate personnel to support the equipment, systems, and functions that the various elements within the node are performing. Such support will, like equipment, be a significant constraint. In complex terrain, personnel must be pushed to lower levels. Because the elements of a unit are disaggregated and it may not be practical to regularly transport personnel and equipment between the various elements, it can be much more effective to permanently attach support personnel to lower levels than to keep them at the headquarters. For example, a battalion electronics maintenance section might normally stay together in the shop at the battalion headquarters; however, when operating in a disaggregated environment, there may not be the logistical support assets available for every company to send its electronics to the battalion for maintenance. In such a situation, the maintenance section may be able to provide better support if it is split up into smaller teams that are attached to a company FOB or another node. The principle can apply to many of the Marines that typically reside within the unit headquarters.

Information Exchange Requirements

Information exchange requirements (IERs) determine what events the staff reports to what entities and by what method. In some cases, this information will be obvious. A squad in a troops-in-contact (TIC) situation will report it and any requests for support to its platoon. The platoon may then be required to report the TIC further up the chain to the company, and so forth. In another case, if a company needs to request an air CASEVAC, the company will most likely report it to the battalion, which will then report the request to its higher command and/or the assigned supporting air agency. Higher headquarters will direct some IERs, indicating what it wants reported and by what means. For instance, if a platoon is running low on batteries, they might put in a request for batteries to the company on the assigned company radio net. The company may then translate the request into a standardized rapid request format and use e-mail to send it to the battalion S-4 chief. For events that do not need to be reported outside of the unit, the unit will determine how those events are reported. The IERs determine how the staff will quickly process an event through multiple echelons of command in order to ensure a timely and sufficient response by supporting units and organizations.

Priority for Reporting

Priority is granted either by event or network. The IERs will clarify what events take precedence when multiple events occur simultaneously; furthermore, they should clarify which reports the staff makes first. For instance, if a squad is engaged in a TIC, any reports requesting a quick reaction force or CASEVAC will be made first by radio. Subsequently, the battalion may be required to report on events, such as enemy or civilian casualties or collateral damage, in a written report. Finally, the company or battalion may then file the event in MarineLink so that future planners can see that a TIC took place in that particular location; IERs should clarify the timelines required with each report.

In the coalition environment with many networks operating, the staff may need to file similar reports on disparate networks. The IERs should clarify which reports go on which networks and the priorities associated with each. For instance, the staff may first be required to report on IED detonation on Secure Internet Protocol Router Network with a later report being required on NATO Mission Secret. Because the reports are on separate networks and cross-contamination cannot occur, the same report may have to be manually entered multiple times.

Convoy Reporting Tactics, Techniques, and Procedures

Reporting TTP for convoys deserves special attention, particularly for the sustainment or logistics combat element planner. Convoy reporting is particularly difficult due to the distances involved (often more than 100 kilometers) and due to the employment of electronic countermeasures (ECM). Because of the distances over which a convoy must report, SATCOM is the most reliable method of communications; however, most ECM devices currently in use operate in the same frequency range as SATCOM, which means that the convoy cannot employ SATCOM while the ECM is in use. Therefore, unit convoy operators must develop special TTP for the convoy in order to make reports. Some of the TTP currently in use are security halts and ECM spacing.

Displacement Requirements

As in a traditional operating environment, command posts in complex terrain must be capable of displacing throughout the battlespace; however, displacement becomes much more difficult due to the terrain and low route availability. When planning for displacement, unit staff must consider the optimal method of deployment—vehicle, air, animal-packed, or even human-packed. Planners also need to develop protocols and procedures for transferring authority to an alternate command post, such as a forward or A/B command post, while they are displacing.

Communications Systems

A communications architecture in complex terrain is likely to look significantly different from that in a traditional operational environment. The planning process for putting together a communications plan does not change, but the inputs into that process are significantly different. Specifically, many of the LOS or near LOS systems will not be as effective. Therefore, the outputs of the planning process are likely to lead planners to a significantly different communications architecture.

Radio Systems

There are a number of considerations for radio systems and components in mountain warfare.

Vehicle Mounted Radios

In complex terrain, Marines cannot rely heavily on vehicle mounted radios, since vehicles are typically restricted to roads and roads are typically not in locations ideal for radio wave propagation (along the sides of a valley wall, rather than along the top of the ridge). Vehicle mounted radios may still be useful in a FOB or command post, since the power amplifiers in the vehicles will make the radios more powerful, but they are not as useful during maneuver.

Battery Considerations

Batteries lose their power much faster in cold weather. Lithium-ion rechargeable batteries are the most effective in cold weather; however, in temperatures below freezing, they will only last for about 80 percent of their normal life. Alkaline and nonrechargeable lithium batteries will only last for about 30 percent of their rated life. Rechargeable batteries should be returned to a warmer environment once they are drained. Prolonged exposure of a drained battery to the cold could cause permanent damage to the gas gauge inside of the battery.

High Frequency

High frequency and SATCOM will be the workhorse of mountain communications. The primary piece of gear that the Marine Corps currently uses for high frequency is the AN/PRC-150.

High frequency and SATCOM are both capable of long-haul communications. If the atmospheric conditions are suitable and the operators are proficient, it is possible to talk several hundred miles on a packed radio. The principal advantage of high frequency over SATCOM is that it is easier to obtain frequencies for high frequency. In addition, Marines can program multiple frequencies for a single net and the radio will select the best frequency. High frequency waves are low enough that they can reflect off of different levels of the atmosphere, so that Marines can talk "over" the mountains.

Executing high frequency communications is difficult because high frequency wave propagation may be inconsistent—what worked yesterday may not work today. Personnel must be intelligent enough and have the required training to incorporate all of the following planning factors, including systems planning, engineering, and evaluation device software to assist in the planning process:

- *Ionization of the atmosphere*. "Sunspots" will determine at what layer of the atmosphere the radio waves will bounce back down to Earth.
- *Time of the day*. The atmosphere is more ionized during the day, which allows the radio waves to more easily bounce back to Earth. Higher frequencies penetrate the atmosphere more easily, so higher frequencies work better during the day and lower frequencies at night. Marines do not have to switch between day and night frequencies because 3G/ALE will pick the best out of a set.
- *Take-off angle*. The distance over which Marines are attempting to communicate will determine how many "hops" they are going to use, bouncing the waves from the atmosphere to the Earth and back. The hops, in turn, will determine the ideal angle at which the radio waves should propagate.
- *Antenna type*. There is a wide variety of antennas that operators can employ with high frequency. Some can be several hundred feet long and take a while to build; others can be setup and deployed very quickly. The type of antenna the radio operator uses will depend on the take-off angle, frequency being used, direction being broadcast, and resources available.

Data

The PRC-150 is also capable of conducting data communications, which can be an extremely useful feature in a disaggregated operating environment in complex terrain. Marines can connect a laptop to a PRC-150 and chat with users at other PRC-150 tactical chat terminals. Marines can also use ViaSat cards with a laptop and PRC-150 to transmit photos and other files over a high frequency net, which is useful for reconnaissance and other patrols. Because high frequency uses low frequencies, the data rate will typically be low. The PRC-150 is capable of up to 9.6 kbps [kilobytes per second], but the signal between radios is usually not strong enough to support that. Commercial broadband antennas can help ensure that the maximum data rate is available.

Very High Frequency

Traditionally, VHF has been the range of the frequency spectrum most used for battalion tactical, battalion intelligence, and conduct of fire nets. However, because VHF waves are unable to penetrate or go over mountains, it is unlikely that a single VHF net could cover the area of operations. Therefore, units operating in complex terrain are being forced to use SATCOM and high frequency for battalion nets. This usage tremendously impacts the redundancy within the communications architecture, so the commander must develop measures to mitigate the limited communications assets and the ineffectiveness of VHF assets. Nets that do not need to be used over much distance, such as convoy nets and FOB security nets, can still use VHF.

Units can still use retransmission (RTX) sites for VHF nets, but their effectiveness will be limited for the following reasons:

- *Terrain Limitations*. Even if the RTX site is on top of a terrain feature, it is likely that there are other complex terrain features nearby that will hinder the effectiveness of the RTX site. Therefore, the RTX site may cover the valleys below it, but not the next valley over only 2 miles away.

- *Deployment*. It is unlikely that there will be roads up to the ideal locations for RTX sites. Therefore, most RTX teams will have to be human- or animal-packed, which is likely to impose limitations on what the RTX team is able to use, such as power amplifiers that require an external power source and heavy mast-mounted antenna systems.
- *Sustainment*. Operating RTX sites in complex terrain will take considerably more sustainment support, because the sites will be located in positions not easily accessible. Planners should consider using pack animals or foot mobile transportation to support sustainment requirements of RTX sites, such as fuel, chow, or water.
- *Security*. As in any operating environment, security teams will be required for RTX sites. However, because a unit's forces are already disaggregated through the area of operations, it may be particularly difficult to source a security team.

Ultra High Frequency

Ultra high frequency (UHF), in any environment, is an LOS system—both radios must be able to "see" each other. Therefore, there may be particular challenges in complex terrain for UHF when trying to talk ground-to-air. If Marines are in a valley, they probably will not be able to get in contact with the aircraft on a UHF net until it comes over the ridge. It may be more effective to use a VHF net for contacting the aircraft in such a situation. Alternatively, it may be necessary to move up the sides of the valley, potentially to the top of the ridge, in order to contact the aircraft.

Satellite Communications

There are advantages and disadvantages to consider for SATCOM in the mountains. As long as there are no obstructions between the antenna and the satellite, SATCOM allows reliable voice and data communications. The footprint that a satellite services will be significantly larger than the area of operations assigned to a unit, which avoids range limitations. The primary radio the Marine Corps uses is the PRC-117.

The SATCOM nets use channels assigned to the unit by the Defense Information Systems Agency (DISA), which can assign these channels as either dedicated (all of the bandwidth on that channel is available for the unit's use) or demand assigned multiple access (DAMA). If a DAMA channel is assigned, other units may be using the same portion of the bandwidth available through the satellite. If multiple units are trying to use the channels simultaneously, then the full amount of bandwidth will not be available.

Because there are limited channels available through a satellite, a unit will usually not be allocated as many as they request. In addition, DISA may assign channels requested to be dedicated as DAMA. It will probably not be realistic to replace all of a unit's VHF nets with SATCOM nets. For instance, a brigade and its subordinate battalions may be forced to share two SATCOM channels or even only one.

Protocols

Since VHF nets will probably not be available in complex terrain, the functions previously performed on those nets will need to take place on a high frequency or SATCOM net. Typically, Marines are not as proficient on high frequency and have a difficult time establishing long-haul high frequency communications, which results in many users trying to send their traffic on a limited number of channels—a crowded net. Without effective protocols for whom is authorized to talk on the net, at what time, and to send what information, the net will be cluttered with chatter, making it difficult to execute command and control. The operations and communications sections need to work closely together to develop such protocols to ensure that they are using other means, such as high frequency, and that the communications architecture is meeting all requirements.

Satellite Systems

Blue Force Tracker (BFT), also referred to as Force XXI Battlefield Command Brigade and Below, is a system used to monitor the locations of friendly forces. It consists of a computerized display, global positioning system (GPS) receiver, and a satellite terminal. All of the BFT terminals continuously transmit their locations via the GPS system, which combat operation centers and higher headquarters can monitor. In addition, personnel can use BFT to send text messages and small data files, making it particularly valuable in complex terrain, but they should expect delayed transmission times in complex, compartmentalized terrain.

Satellite communications can also be extremely useful for data communications. It is possible to connect a laptop to a PRC-117 with a ViaSat card (or some other data personal computer manufacturer interface adaptor card) and transmit data over the PRC-117 at rates that are usually much faster than over high frequency, which uses the PRC-117's capability for higher performance waveform. A good option for reconnaissance and surveillance teams that need to send imagery back to the combat operations center, SATCOM is also being used as a primary method of data communications with some company FOBs. There are typically not enough satellite terminals for every FOB, so data communications over SATCOM serves as an alternative.

Satellite Terminal Systems

Given the required functions at the company FOBs and the other disaggregated elements throughout the unit, satellite systems serve as the best method of long-haul data and telephone communications in complex terrain. Some of the smaller systems, such as the SWAN, are capable of deploying rapidly and being set up by a couple of skilled individuals.

A unit will typically not have enough organic equipment to supply all of its elements with satellite systems. The staff will need to submit requests for equipment augmentation for deficiencies. Generally, the architecture will have a Secure Mobile Anti-jam Reliable Tactical Terminal or TSC-93D or TSC-85 satellite terminal at the headquarters of the battalion level and higher. Company FOBs generally have a SWAN that connects back to another SWAN at the battalion headquarters.

Telephone Systems

Telephone systems that should be considered are the voice over Internet protocol and Iridium. Traditional telephone services are available through the large satellite terminal systems mentioned earlier. However, the SWAN terminals that provide connectivity to the FOBs are principally designed for data and not traditional telephones. Therefore, voice over Internet protocol phones provide an ideal method of supplying telephone services to the FOBs. Each telephone is a small computer to which planners assign an internet protocol address. The phone can make calls over the network as long as higher headquarters operates a call manager. In addition, because it operates over the network, voice over Internet protocol can be classified SECRET if the phones are installed on a SECRET network.

Iridium uses a system of 66 satellites constantly orbiting the earth, providing coverage almost everywhere. They can be extremely useful in complex terrain where other phones and even radios do not work. Iridium phones must be procured through DISA and can be ordered with cryptographic "sleeves" that enable the phone to be encrypted for SECRET communication. The principal drawback of Iridium phones is that if one of the satellites is not currently in view, due to their constant orbiting/potential terrain obstructions, Marines will be unable to make a call until a satellite comes into view. They may wait a few minutes, so operating units should not depend on Iridium phones for anything that would require an instant response.

External Connectivity

In almost any operational environment, it is imperative for the unit to have external connectivity. Without it, the unit will only be able to operate data and telephone services within its own elements. It will not be able to access external Web sites, send e-mail to personnel in other units, or receive telephone calls from other units. Traditionally, units at the regimental level and below receive external connectivity from their higher headquarters. The higher headquarters then establishes connections with nodes of the Department of Defense's global information grid, which enables connectivity and is probably the easiest method of external connectivity to plan and execute.

In general, it is simpler for a regimental communications officer to coordinate with a division G-6 than it would be to coordinate with DISA or a joint task force communications officer. In addition, both nodes of the connection are likely to have the same information assurance policies and other protocols. Should a change in the connection be required, both sides can make the change relatively easily without having to go through many "bureaucratic" steps. In the operating environment today, however, a Marine unit's higher headquarters may not always be in the same theater, so this sort of connection may not exist.

Joint Connections

In the joint operating environment, a Marine unit may fall under the operational/tactical control of an Army unit or joint task force, which can pose problems because it is not the way that most Marines, to include communications Marines, are accustomed to operating. The individuals at the different node sites often speak a different technical language and geographical differences often make it harder to plan. Information assurance policies between the services can also differ, so a unit may have to modify its policies in order to receive services from its higher headquarters in theater.

Connections with a Standard Tactical Entry Point Site

Units may also have a connection with a standard tactical entry point (STEP) site, either as a primary or redundant circuit. These sites are the gateways between the tactical networks and the global information grid. They have tremendous resources and are extremely reliable. The likelihood of a STEP site going down is much less than that of a Marine higher headquarters site or a joint task force site; however, establishing a connection with a STEP site can be a very bureaucratic process.

Satellite access requests for satellite usage must be submitted to DISA for almost any sort of satellite connection, but, for STEP site connections, ground access requests must be submitted as well, specifying exactly what services will be requested. These requests are usually required long in advance of the unit's need for the services and before there is a finalized concept of operations. If there is a change later on to the services that the unit is requesting, it is not simply a matter of making a phone call to the STEP site. Typically, the unit must submit at least an official modification to the ground access request and, depending on the change, an entirely new ground access request may be required. This process is time consuming for DISA.

CHAPTER 3
MANEUVER PLANNING CONSIDERATIONS

> *I was surprised by the terrain, which is the roughest and most restrictive that I have ever seen. The difficulties that we face due to the terrain were shocking early on. For example, terrain severely limits our ability to maneuver mounted, forcing mostly dismounted maneuver. Dismounted ops in this terrain, with extremely heavy loads, means you will have injuries—especially knees. Alternate methods such as ATVs were restricted due to force protection issues [IED threat]. The same conditions that limit maneuver also make extracting casualties a serious challenge, which means combat lifesaver/medical training for soldiers is all-the-more important. Standard methods of resupply usually don't work, causing us to rely on alternate means such as donkeys and local nationals. Finally, the extreme terrain is hard on vehicles, and when a vehicle breaks down, recovery becomes difficult as well.*
>
> —Commander in Afghanistan OEF-7,
> Marine Corps Center for Lessons
> Learned (MCCLL) after action report

Small Unit Considerations

There are a variety of considerations for moving in mountainous terrain. Using a mountain time-distance formula should be routine: 3 kilometers per hour, plus 1 hour for every 1,000 feet of elevation gained/2,000 feet of elevation loss. See table 3-1 for a general formula, but the following points should also be considered:

Table 3-1. Time-Distance Formulas and Rates of March for Individual Movement.

Movement Mode	Unbroken Trail	Broken Trail
On foot, no ski or snowshoe Less than 1 foot of snow	1.5 to 3 kph	2 to 3 kph
On foot, no ski or snowshoe More than 1 foot of snow	.5 to 1 kph	2 to 3 kph
Snowshoe	1.5 to 3 kph	3 to 4 kph
Skiing	1.5 to 5 kph	5 to 6 kph
Skijoring	NA	8 to 24 kph (for safety, 15 kph is the highest recommended speed)
Note: Add 1 hour for every 300 m of ascent and 1 hour for every 600 m of descent.		
Legend NA—not applicable kph—kilometers per hour		

- Contouring reduces the slope angle.
- Altitude has an effect. How much time has the unit had to acclimatize? Two to four weeks are needed to acclimatize to 10,000 feet with staged ascents thereafter. See appendix D for metric conversions.
- Equipment and supplies carried by individual Marines must be scrutinized down to the lowest level of leadership. The duration of operations will be significantly shorter in this environment unless there is meticulous planning and an efficient execution of resupply by a variety of means.
- The unit's ability must be considered when determining mission feasibility, such as cold weather and night operations experience and physical conditioning.
- Available assault support, considering weather and altitude limitations.
- Periods of darkness or reduced visibility will limit medical evacuation capabilities and movement in general.

- Baiting the enemy by using the terrain to an advantage will give Marines the upper hand when the enemy is expecting Marines to conduct operations revolving around the lunar cycle.
- Preplanned assault support will be easily thwarted by the presence of foul weather. A back-up plan for extraction, sustainment, and relief of disaggregated units, regardless of what the immediate weather forecast predicts, should be prepared. See appendix E for temperature conversions.

Sustainment

Sustainment of the maneuver element must rely on multiple capabilities. The availability of ground-based or aerial resupply must be determined and relayed to the supported unit. Ground-based resupply can be bolstered by leveraging pack animals and the local population. The accessibility of aerial resupply depends on weather, drop zone locations, and the allocation of aviation assets.

Maneuver units can use previously identified local food sources. Each unit that leaves the defensive position must procure food and water through various means (see chap. 15), such as Commander's Emergency Response Program funding, known hydrological features, or the presence of goats/chickens.

Force Protection

Force protection presents considerable challenges for smaller, disaggregated units, including—

- Economy of force and minimum staffing requirements can be mitigated with the integration of indigenous forces when available.
- Determination of which level of command has the ability to authorize flak jackets versus plate carriers. See appendix F for warfighting load requirements.
- The ability to transport, install, and reinforce physical security measures is significantly reduced.
- Engineer detachments may need to be attached.
- Regional (joint task force) graduated standards may or may not be feasible.

Fires

During maneuver, the following impact on fires must be considered:

- What assets are available while on the move? Organic, small unit fire support assets are significantly affected by sustainment considerations.
- How are multiple, disaggregated units supported by fires? How are those fires coordinated or deconflicted?

Command and Control

During maneuver, the impact on command and control must be considered:

- Is the unit sourced with the appropriate equipment in order to conduct disaggregated operations?
- Is there a creative solution for covering all aspects of maneuver with uninterrupted communications? If a squad or platoon is on patrol with limited satellite or high frequency communications assets, will the unit be able to leverage VHF assets and still maintain a fire support umbrella or reinforcing capabilities?

> *The squadron positioned re-trans stations throughout our AO to ensure FM comms were maintained; however, the terrain created pockets of dead space. The HF radio proved too difficult to use for our Soldiers who had limited experience and no ability to trouble shoot. TACSAT comms were most effective but only two channels were available in both RC east and RC south. Routine traffic often tied the net up.*
>
> —Commander in Afghanistan OEF-7,
> MCCLL after action report

Mounted Operations

There are obvious road/trail limitations in the mountains. Very often the unit is only able to travel in one direction for significant distances, which makes traffic control relatively simple; however, maneuvering vehicles out of kill zones becomes quite challenging. Foot patrols could be placed above chokepoints where ambushes or IED placement is likely. Random foot patrols are better than none if sustained foot patrolling is not feasible to protect main supply routes.

Frequently, the terrain will dictate that only certain types of vehicles are able to travel on the narrow and restrictive roads. Additionally, annual precipitation, whether in rain or snow, will hamper vehicular movement. Trafficable roads in elevations closer to rivers have a tendency to flood during the spring thaw, during melt-off of snow at higher elevations, and/or during monsoon season.

The ability to recover vehicular assets must always be considered when planning convoys. Each vehicle should be rigged to conduct a hasty tow and each convoy should bring a minimum of one tow bar for every two vehicles. Also, to facilitate vehicle recovery it is important that the convoy bump plan is practiced and enforced. The complexity of the terrain surrounding navigable roads coupled with the enemy's ability to defeat counter-IEDs can have devastating effects and ECM are severely affected. The following considerations should also be made:

- Route clearance assets must be able to cover the entire spectrum of IED defeat mechanisms.
- A very conscientious assessment of the road must take place in order to determine the risk associated with dismounting the vehicles in IED-prone areas.
- If dismounted operations are conducted, "dismounted" counter radio-controlled IED electronic warfare systems must be employed to counter/defeat radio-controlled IEDs through jamming.
- Maintenance and parts block resupply for vehicles will affect the ability to employ them.

> *Having a Motor-T background myself, we have broken things on motor transport equipment that I have never seen break before.*
>
> —Initial Afghanistan Observations (U) training-CDR-4146

Traverse and elevation settings on pintle- or turret-mounted weapons may render those weapons useless at close range. If engaged from slopes above 20 degrees, free gun will be necessary as the traverse and elevation is limited to 20 degrees (high marking a tire on micro terrain by an experienced driver can be done, conditions permitting). The Army has developed "super-elevating" mounts and scissor mounts that increase the gun's ability to elevate. Gunners must be trained to switch to their secondary weapon in terrain that exceeds the limits of their mounted gun.

Inexperienced drivers will have a steep learning curve. Roll-over battle drills must be rehearsed as roads tend to have very steep drop-offs. Only the most experienced drivers should be used when driving in high-rollover-producing terrain. Every effort should be made to provide drivers with additional rough terrain driver training prior to a deployment to a mountainous environment.

There can be a substantial lag-time in BFT transmissions. Significant terrain features in close proximity to the road can also limit on-the-move SATCOM equipment.

Battalion-Level Maneuver

Effectively synchronizing the warfighting functions in order to reaggregate throughout the battlespace takes a considerable amount of planning and preparation. The following points should be considered:

- Offensive operations in complex and compartmentalized terrain vary depending on the degree of restrictive terrain. Ridgelines and crests can often provide a tactical advantage to the unit that controls them. Their control may allow for the rapid movement from one terrain compartment to another and afford excellent observation onto lower elevations.
- Because maneuver space is limited or confined and restricts the number of avenues of approach for larger units, deception plays an important role. Commanders should plan systematic measures of deception to mislead the enemy regarding friendly intentions, capabilities, and objectives.
- The restrictive terrain also affords increased opportunities to conduct raids and ambushes. These operations should take advantage of limited visibility and terrain that the enemy may consider impassable.
- The locations of a quick reaction force and reserve forces should be carefully thought out. Considering the limitations of assault support, the ability to efficiently relieve an attacking unit can have significant implications for preventing exhaustion, fatigue, and cold weather injuries.
- Leveraging all available intelligence, surveillance, and reconnaissance (ISR) assets can increase the ability to seize key terrain. These assets play an increased role in this environment due to restrictive terrain features that result in greater dead space.
- With limited ingress and egress options for narrow valleys and draws, blocking positions in conjunction with helicopter-borne assaults can have a devastating effect on the enemy's freedom of movement. However, the same considerations apply for friendly units.
- Mountain pickets play an invaluable role in mitigating enemy ambushes on friendly units. In order to effectively use mountain pickets, a unit must have a physically fit, well trained group of Marines (up to one-third of the unit) who are capable of negotiating difficult terrain with relative ease. This group will require meticulous planning for sustainment, even more so than a conventional unit.
- Limited fire support assets must be prepositioned with caution. Response times for displacing artillery and mortar units must be carefully planned and the use of dismounted counter-ambush forces can reduce the likelihood of attack.
- Determination of logistical packaging of container delivery systems (CDS) may be affected if Marines are supporting host-nation security forces.
- Medical evacuation plan must consider aviation limitations, weather conditions, and available locations for trauma or life supporting facilities.
- Prioritizing communications paths is of paramount importance. Operational control from main/forward/jump command posts must be rehearsed. The difficulties of communicating in a complex, compartmentalized environment will require a flawless execution of transferring authority from one command element to another.

> *Yeah, there's a possibility that you're going to have to sustain that guy for at least 24 to 72 hours depending on weather. Temperature, terrain, altitude all play a role in it, with altitudes that helicopters can fly [to accomplish the mission].*
>
> —Medical Support of Operations in a High Altitude, Mountainous Environment Lessons and Observations from OEF

Cold Weather Considerations

Commanders should consider the following points regarding operations in cold weather—

- Equipment and clothing shortfalls must be identified early, which will mitigate foreseeable delays in the supply chain, such as being issued cold weather boots during the summer and the follow-on unit being issued warm weather boots while deployed during the winter months. Units must ensure that all Marines understand how to properly wear and use the Marine Corps mountain/cold weather clothing system.
- Regardless of how cold the ambient air temperature gets, Marines will still be susceptible to dehydration from strenuous movements. Dehydration can subsequently lead to hypothermia, frostbite, and altitude-related illnesses.
- In deep snow and during temperatures of extreme cold, units will require shelter. The 2-person tent was primarily designed as a 3-season tent. When transitioning to winter and deep snow cover, the 4-person extreme cold weather tent will perform better under heavy snow loads and high winds. The extreme cold weather tent is a 4-season tent.
- Over-the-snow mobility techniques and equipment will increase a unit's ability to maneuver at a faster tempo than the enemy.

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CHAPTER 4
ROPE MANAGEMENT, KNOTS, AND ANCHORS

Knowing how to handle ropes, tie knots, and construct anchors is fundamental to all mountaineering systems. The following are common terms used in rope management:

- *Bight*. A simple bend in the rope in which the rope does not cross itself, as in figure 4-1.
- *Loop*. A simple bend in the rope in which the rope does cross itself, as in figure 4-2.
- *Half hitch*. A loop that runs around an object in such a manner as to bind on itself, as in figure 4-3.
- *Standing end*. The part of the rope that is anchored and cannot be used, also called the static end, as in figure 4-4 on page 4-2.
- *Running end*. The free end of the rope that can be used, as in figure 4-4 on page 4-2.
- *Lay*. The same as the twist of the rope. Applies only to hawser laid ropes, such as manila.
- *Pigtail*. The short length left at the end of a rope after tying a knot or coiling a rope. It may or may not be tied off with a secondary knot depending on the circumstance, as in figure 4-5 on page 4-2.
- *Stacking (or flaking)*. Taking off one wrap at a time from a coil and letting it fall naturally to the ground.
- *Dressing the knot*. Orienting all knot parts so they are properly aligned, straightened, or bundled. Not dressing the knot can result in an additional 50 percent reduction in knot strength, as in figure 4-6 on page 4-2.

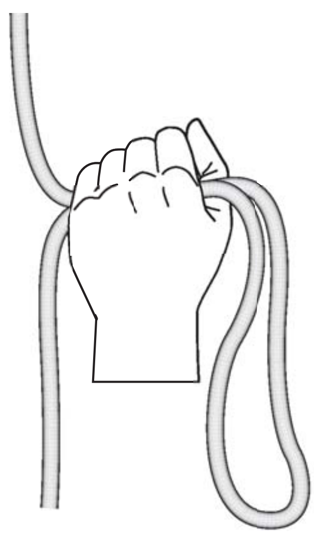

Figure 4-1. Bight of Rope.

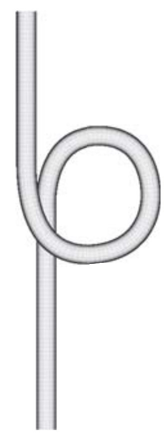

Figure 4-2. Loop.

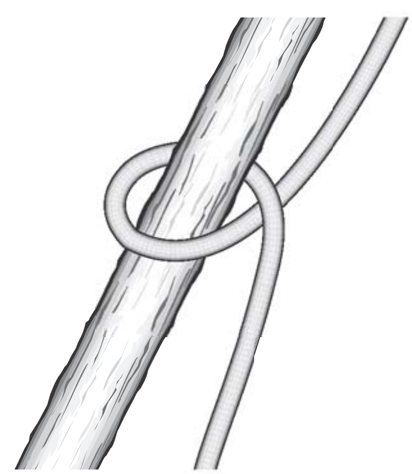

Figure 4-3. Half Hitch.

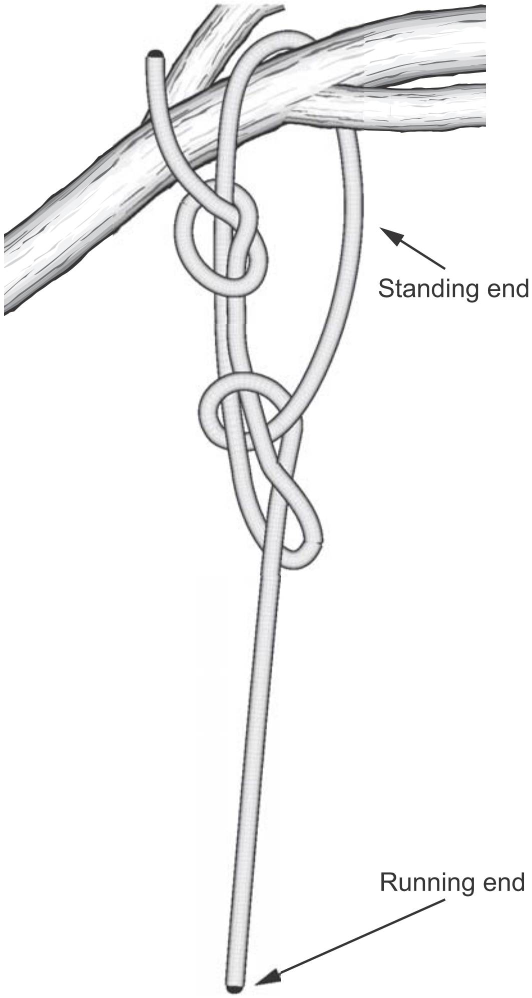

Figure 4-4. Standing/Running Ends.

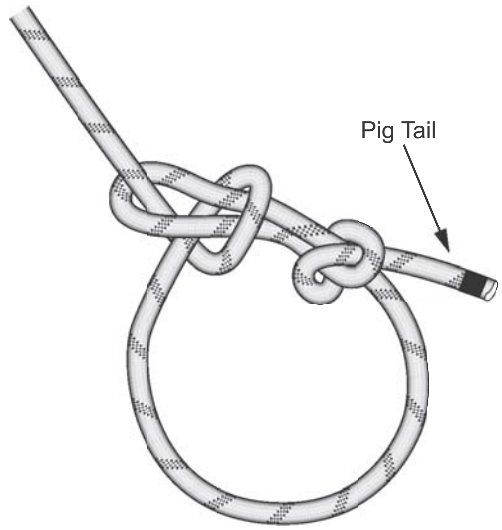

Figure 4-5. Pigtail.

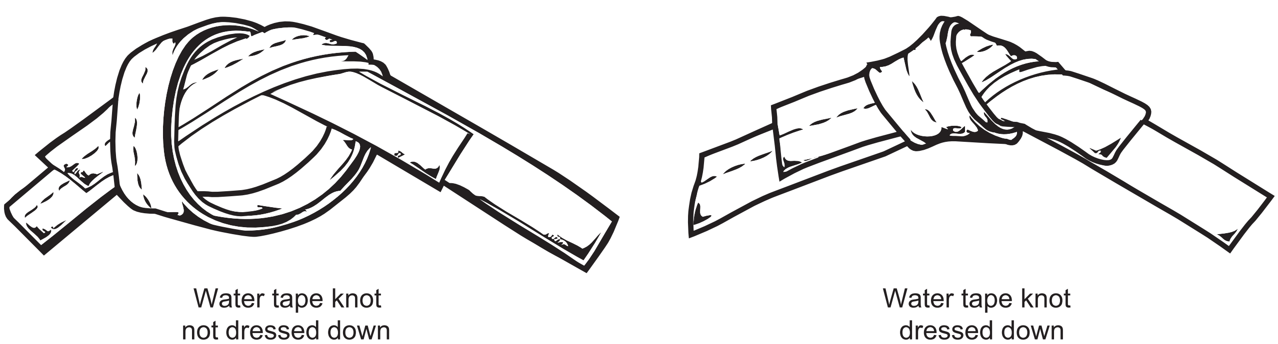

Figure 4-6. Dressing the Knot.

- *Setting the knot.* Tightening all parts of the knot so that all parts bind upon other parts of the knot. This renders the knot operational. A loosely tied knot can easily deform under strain and change character, as in figure 4-7.

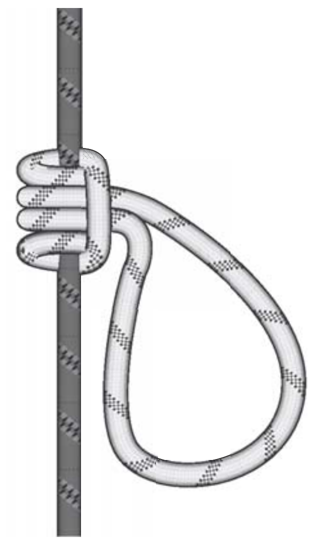

Figure 4-7. Fully Set Knot.

Rope Care Considerations

Rope care considerations are as follows:

- The rope should not be stepped on or dragged on the ground unnecessarily. Small particles of dirt will get into and through the sheath causing unnecessary wear to the rope core.
- The rope should never be exposed to sharp edges. Nylon rope is easily cut, particularly when under tension. If a rope must be used around a sharp edge, then that edge must be padded or buffed with fire hose, several small sticks, clothing, or an isopor mat.
- The rope should be kept as dry as possible. If it should become wet, it should be hung in large loops above the ground and allowed to dry. A rope should never be dried out by an open flame, or be hung to dry on metal pegs, as rust will get in the rope rendering it unserviceable.
- A rope should never be left knotted or tightly stretched longer than necessary.
- When using rope installations, one rope should never rub continually against another. With manila ropes, this will cause the rope to fray; whereas, nylon ropes can melt under the friction that this causes.
- The rope should be inspected for frayed or cut spots, mildew, rot, or defects in construction before each use.
- All ropes should be marked at their midpoints. Such marking allows quick location of the midpoint for a procedure requiring it, such as rappelling. The rope should be marked with a bright colored adhesive tape (see fig. 4-8). Rope marking pens are not recommended.
- The rope should not be exposed to oils, paints, or any petroleum products. They will weaken the rope.
- A climbing rope should never be used for any other purpose other than mountaineering.
- Rope ends should be cut using a rope cutter and marked with a serial number (see fig. 4-9 on page 4-4). This pertains to the ends of a new rope or the end caused by a cut in the rope.

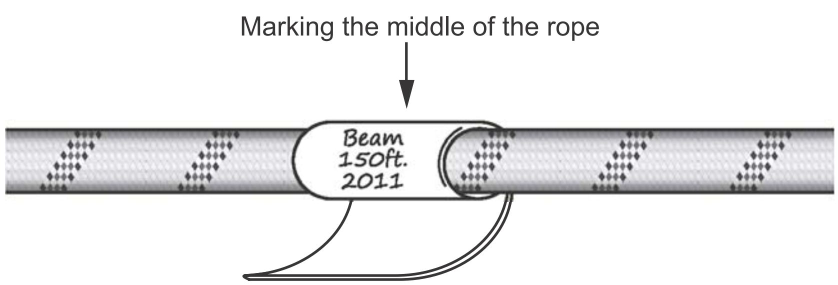

Figure 4-8. Rope Marking.

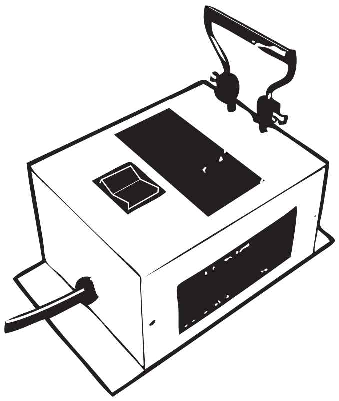

Figure 4-9. Rope Cutter.

- The rope should never be subjected to high heat or flame, which can significantly weaken the rope.
- Ropes should be cleaned with mild soap and rinsed thoroughly with water. A rope washer can be used to clean or rinse the rope, as in figure 4-10.

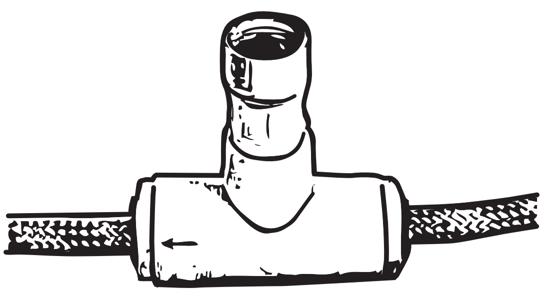

Figure 4-10. Rope Washer.

- Ropes should be coiled and hung on wooden pegs rather than nails or metal objects and stored in a cool place out of direct sun.
- When in areas of loose rock, the rope must be inspected frequently for cuts and abrasions.
- Accurate rope logs must be maintained.
- Ropes 300 to 600 feet long should be mountain coiled.

Inspection of Rope

All ropes have to be inspected before, during, and after all operations. Kernmantle ropes are harder to inspect than a laid rope because the sheath covers up the core. The assault climber must know what to look and feel for when inspecting a rope. Most new dynamic ropes are marked at each end of their pigtails with UIAA [*Union Internationale des Associations d'Alpinisme*] rating and size. Dynamic ropes measuring between 9 and 12 mm have a rating of "1," indicating that the rope is UIAA approved for single rope lead climbing. Dynamic ropes measuring between 8 and 9 mm have a rating of "1/2," indicating that this rope should never be used alone for lead climbing. Static ropes are only marked at each end of their pigtails with the size. Any of the following deficiencies can indicate unserviceability and warrant the retirement of the rope:

- Excessive fraying indicates broken sheath bundles or core damage, as in figure 4-11.
- Exposed core fibers indicate severe sheath damage.
- Glossy marks signify heat fusion damage and are also called boogers.

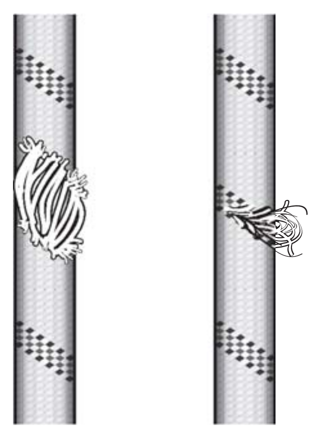

Figure 4-11. Damaged Rope.

- Ununiformity of diameter may indicate core damage, noted by an obvious hourglass depression or exposure of white core fibers protruding from the sheath.
- Discoloration, a drastic change from the rope's original color, may indicate chemical change or damage.
- Stiffness or soft spots could signify core damage.

Rope Log

The purpose of the rope log is to maintain an accurate record of the use of each rope contained within the Marine assault climbers kit (MACK). Due to the turnover of personnel, the rope log is used to ensure the safe use, serviceability, and accountability of each rope.

Serial Number

By assigning each rope a serial number, responsible units can determine information about a rope. As soon as the ropes are cut to the desired length for their intended purpose, each rope will be assigned a serial number by the responsible unit. Both ends of that rope should be labeled with that serial number and shrink heat laminated. A rope serial number has the following five parts:

- Type of rope (S for static or D for dynamic).
- Last two digits of the year of manufacture. (Each rope has a shelf life of five years and a service life of two years. After that, it must not be used for any mountaineering purpose.)
- Four-digit numbers for that individual rope. (These numbers are assigned by the responsible unit sequentially as new ropes are issued.)
- The length and diameter of the rope. (The length is recorded in feet or meters and the diameter in millimeters.)
- Responsible unit code.

An example serial number is S-96-0001-150/11mm-F2/8. This rope is a 150-foot, 11 mm, static rope, manufactured in 1996. It is the first rope issued by Fox Company 2/8.

Recording Information in a Rope Log

Once a new rope has been serialized, the rope log for that rope should be started. At a minimum, it should contain the following information:

- The rope serial number.
- Manufacturer. (Depending on the manufacturer, ropes of the same type and diameter may vary in tensile strength, stretch factor, and durability.)
- Date of manufacture. (Five years from this date, ropes are considered to have reached their normal expiration date and should be destroyed.)
- Date in service. (This date is to be recorded for tracking purposes to establish how long a rope is in service. Two years is considered maximum rope life in service.)
- Use. (Each time a rope is used, the using unit is responsible to record [see table 4-1 on page 4-6] how that rope was used and how much use the rope received.)

Additionally, before checking out a rope and before turning it back in, the rope must be inspected by qualified personnel and initialed in the "Inspected By" block of the rope log. Any time a dynamic rope is subject to a fall factor of two (fall factors are discussed in chap. 6), the rope should not be used for mountaineering.

Coiling a Rope

There are two types of rope coils used—the mountain coil and the butterfly coil.

Mountain Coil

The mountain coil is useful for carrying the rope over a pack or over a climber's shoulder. To tie the mountain coil—

- Sit down with one leg bent at a 90-degree angle, heel on the deck. Starting at one end, loop the rope around the leg, going over the knee and under the boot sole until the entire rope is coiled.
- When coiling a 150-foot rope, use only one leg. When coiling a 300-foot rope, use two legs and keep them together.
- Once the rope is coiled, form a 12-inch bight on the top of the coils using the starting end of the rope.
- Uncoil the last two coiled loops and make four to six wraps over the closed end of the 12-inch bight ensuring the wraps cross over the first wrap.
- Run the end of the rope being wrapped through the closed end of the bight.
- Pull the running end of the bight snugly to secure the coil.
- To prevent the coil from unraveling, tie the two pigtails together with a square knot without overhands, as in figure 4-12.

Table 4-1. Rope Log.

DYNAMIC					
SERIAL #					
MANUFACTURER					
DATE OF MANUFACTURE					
DATE IN SERVICE					
INDICATE THE DATE AND NUMBER OF EACH SPECIFIC USE					
CLIMBS	FALLS (FACTOR)	TOP ROPES	RAPPELS	REMARKS	INSPECTED BY

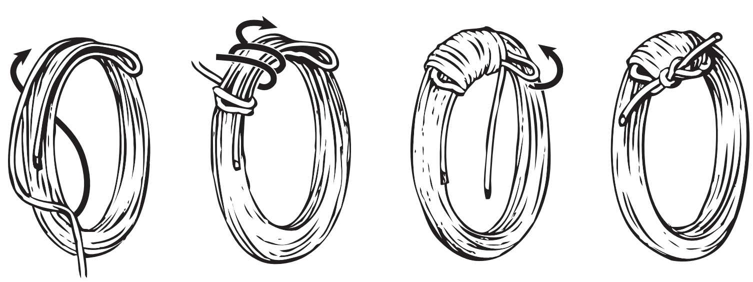

Figure 4-12. Mountain Coil.

Butterfly Coil

The butterfly coil method is used for carrying a rope when individuals need to have maximum use of their upper bodies without being encumbered by a large rope coil hanging across the chest. To tie the butterfly coil—

- Find the middle of the rope, then form a bight by laying both ropes in the upraised palm two feet back from the top of the bight.
- Form another two-foot bight with the running end. Place the rope at the two-foot bight alongside and on top of the original bight, ensuring the running end is on the same side as the original bight.
- Continue making two-foot bights, laying them alternately into the palm until there are only six to eight feet of rope remaining, as in figure 4-13.
- Wrap the two pigtails horizontally four to six times from bottom to top around the midpoint of the bights.

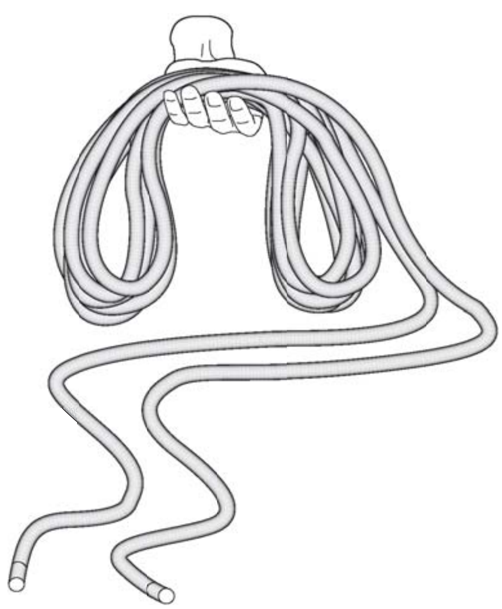

Figure 4-13. Forming Butterfly Coil.

- After completing the wraps, form a bight with the remaining pigtail and then thread it underneath the palm and upward above the coiled rope, as in figure 4-14 on page 4-8.
- Thread the remaining pigtail through this bight.

To carry the coil, place the coil in the center of the back of the carrier and run the two pigtails over the carrier's shoulders forming shoulder straps. Run the pigtails under the arms, cross them in the back over the coil, bring them around the body, and tie them off in the front with a square knot without overhands.

Deploying the Rope

To ensure that the rope will not be tangled when deployed, conduct the following steps:

- With a stacked rope, anchor off the standing end.
- With the running end of the rope, make six to eight coils and place them in the stronger arm. These wraps will serve as a throwing weight.
- 10 to 15 feet back from the strong arm's coils create a second set of 6 to 8 wraps and place them in the other arm.
- From the edge of the cliff, sound off with the command STAND BY FOR ROPE. Without hesitating, release the weak arm's coils and sound off with the command ROPE.
- Quickly take aim and throw the strong arm's coils overhand or sidearm, hard enough to hit the intended target.

If the throw is misdirected due to wind, a tree, or something else, pull the rope back up, restack, and redeploy the rope.

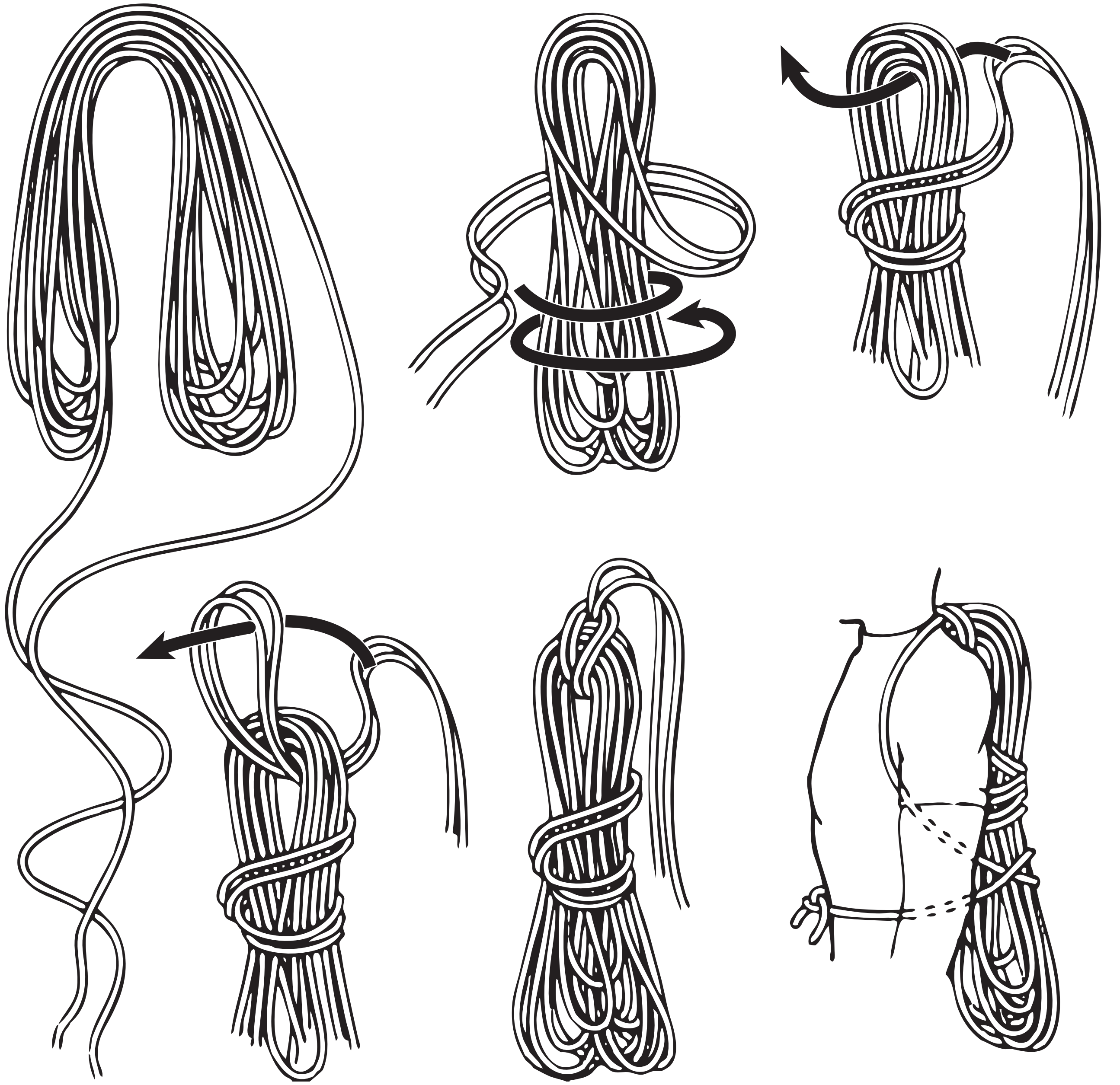

Figure 4-14. Butterfly Coil Tie Off.

Mountaineering Knots

There are four classes of knots.

Class I—End-of-the-Rope Knots

Square Knot

The square knot is used to tie ends of two ropes of equal diameter together. It should be secured by overhand knots on both sides of the square knot. It can be untied after it has been heavily loaded. It can also be untied under a load. See figure 4-15.

Double Fisherman's Knot

Also known as the grapevine knot, the double fisherman's knot is a self-locking knot used for tying two ropes of equal diameter together. It is difficult to untie after it has been heavily loaded. See figure 4-16 on page 4-10.

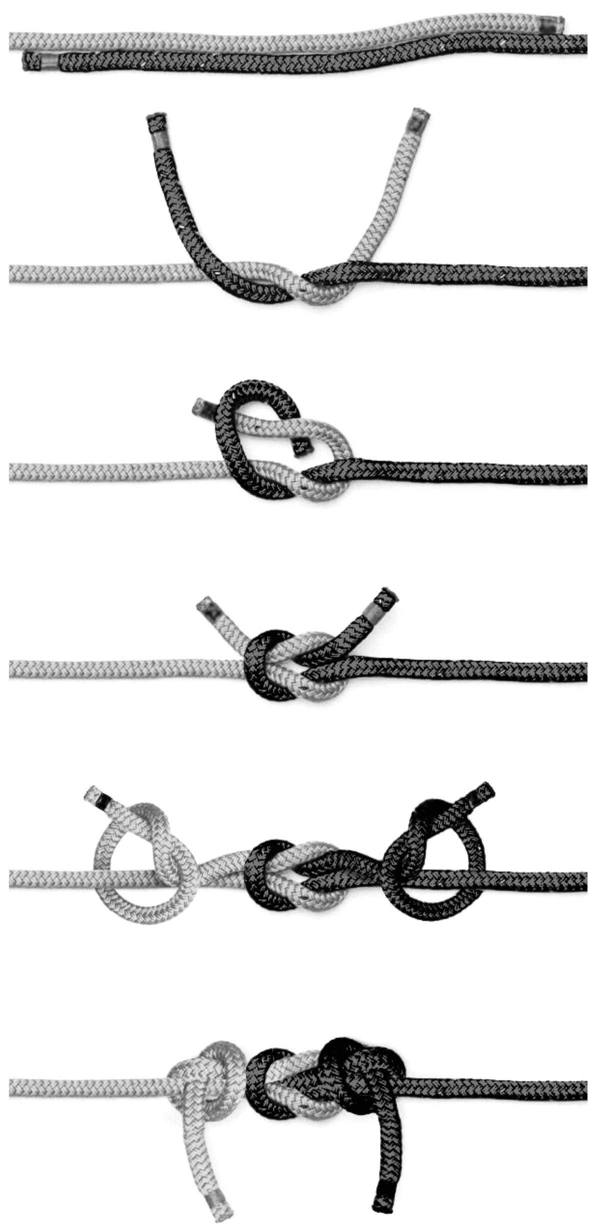

Figure 4-15. Square Knot.

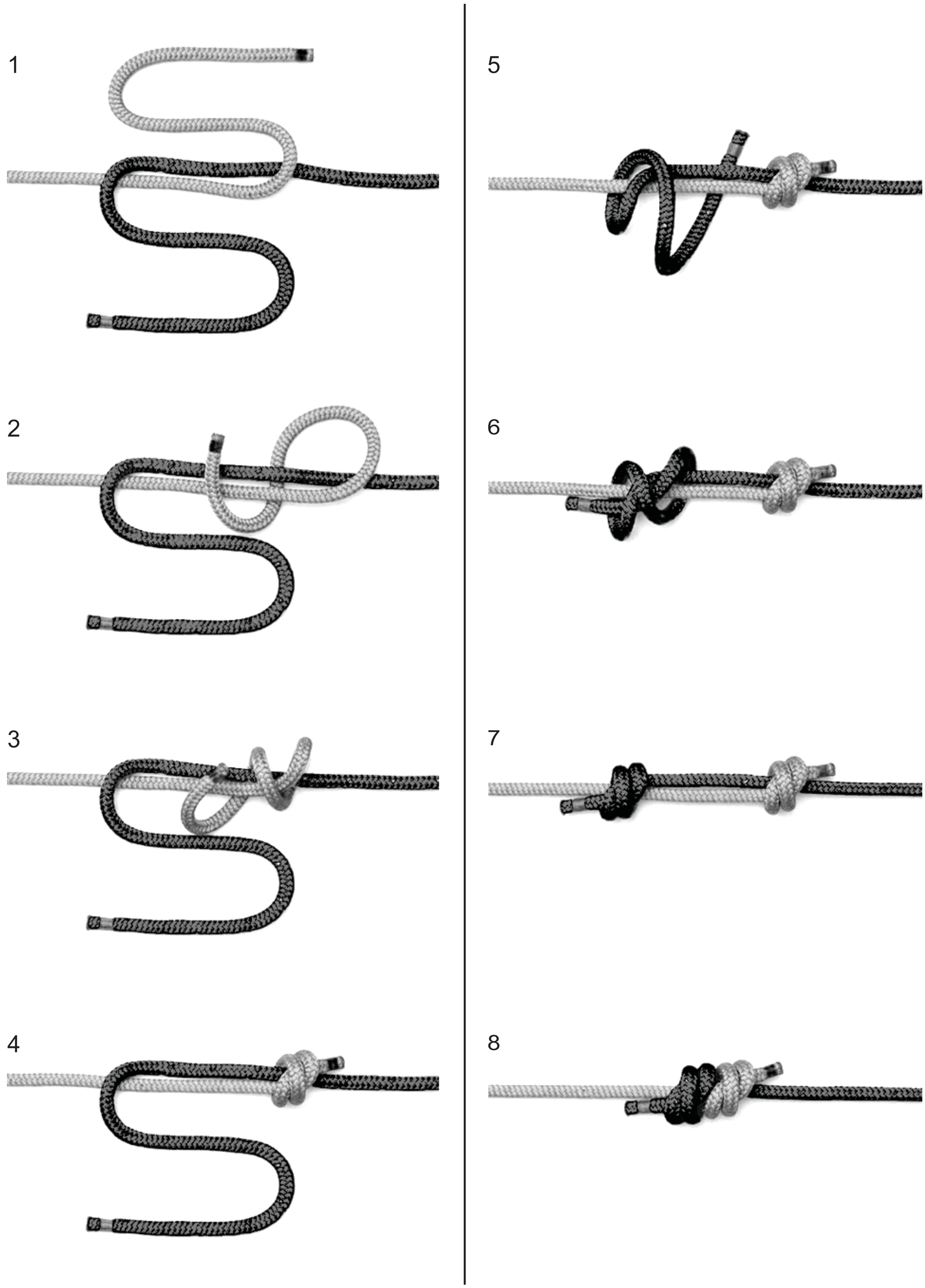

Figure 4-16. Double Fisherman's Knot.

Tape Knot

Known as the ring bend, the tape knot is used to secure the ends of webbing or tape runners together. It should be checked periodically because it can work loose over time. See figure 4-17.

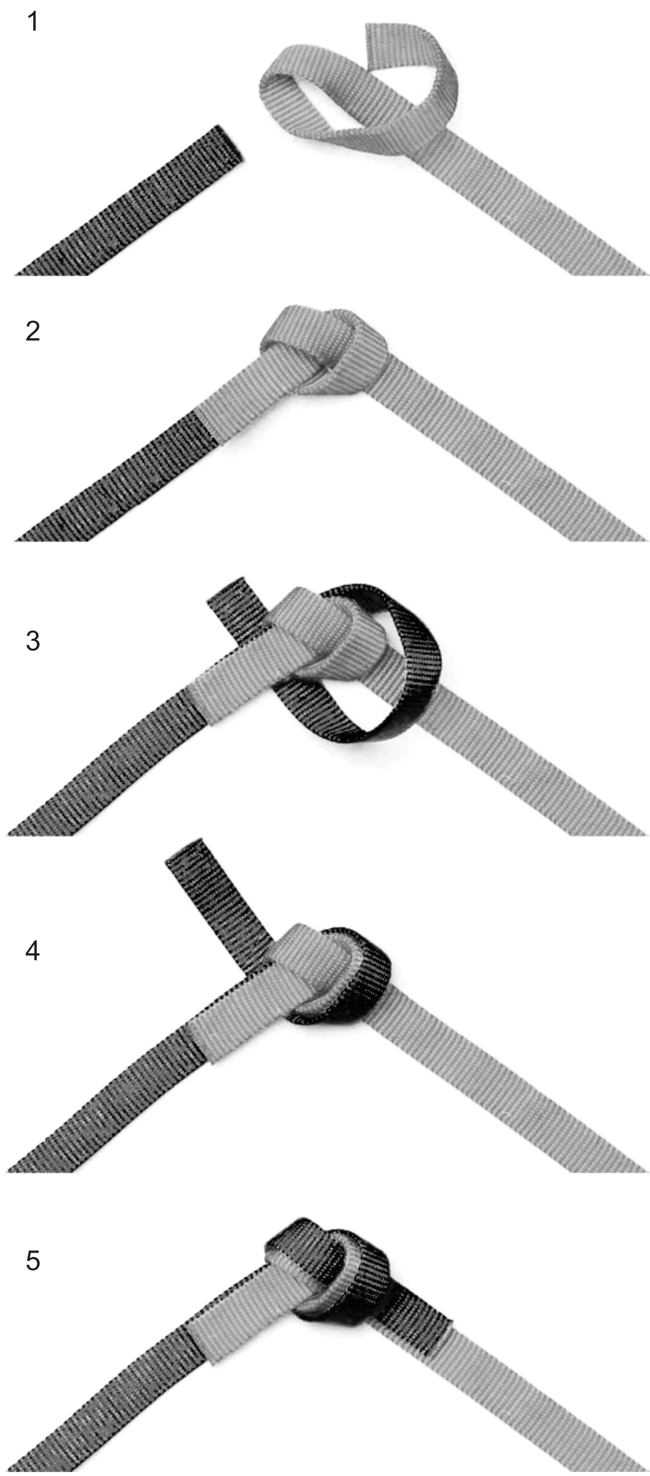

Figure 4-17. Tape Knot.

Double Sheet Bend

The double sheet bend is used to tie the ends of two or more ropes of equal or unequal diameter together. See figure 4-18.

Class II—Anchor Knots

Bowline

The bowline is used to tie a fixed loop in the end of a rope. This knot is always tied with the pigtail on the inside and secured with an overhand knot. Having the pigtail on the outside significantly weakens the knot. See figure 4-19.

Round Turn with Two Half Hitches or a Bowline

This knot anchors the rope, providing 360-degree contact with the anchor. It can be secured with two half hitches or a bowline. Using two half hitches allows the user to pull slack out of the system while securing the rope. See figure 4-20 on page 4-14.

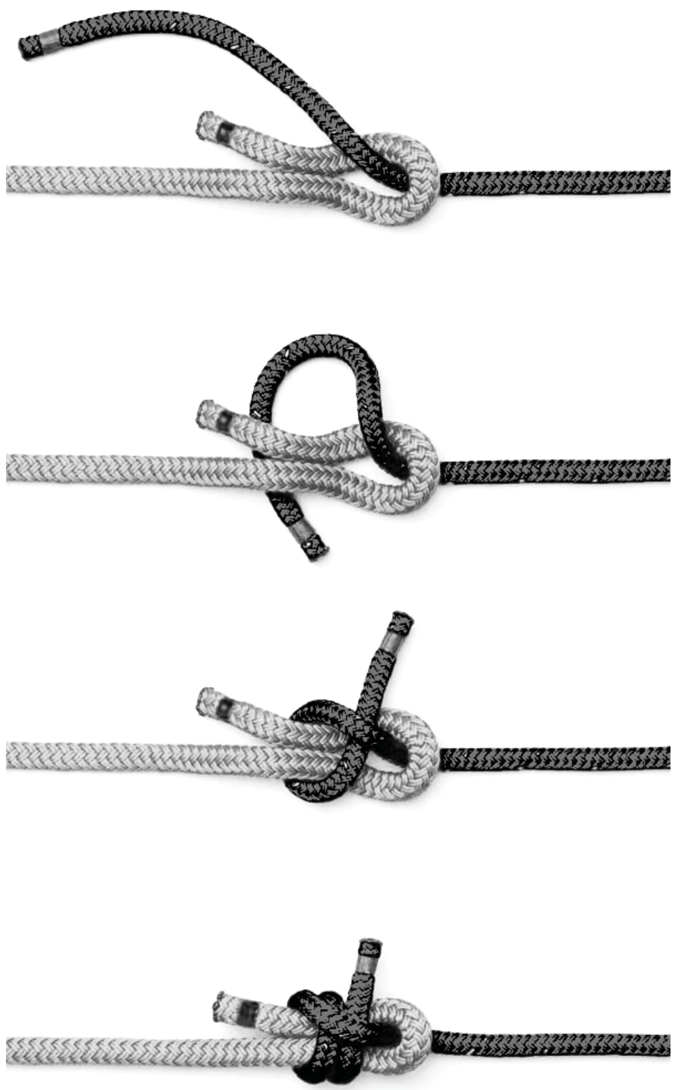

Figure 4-18. Sheet Bend.

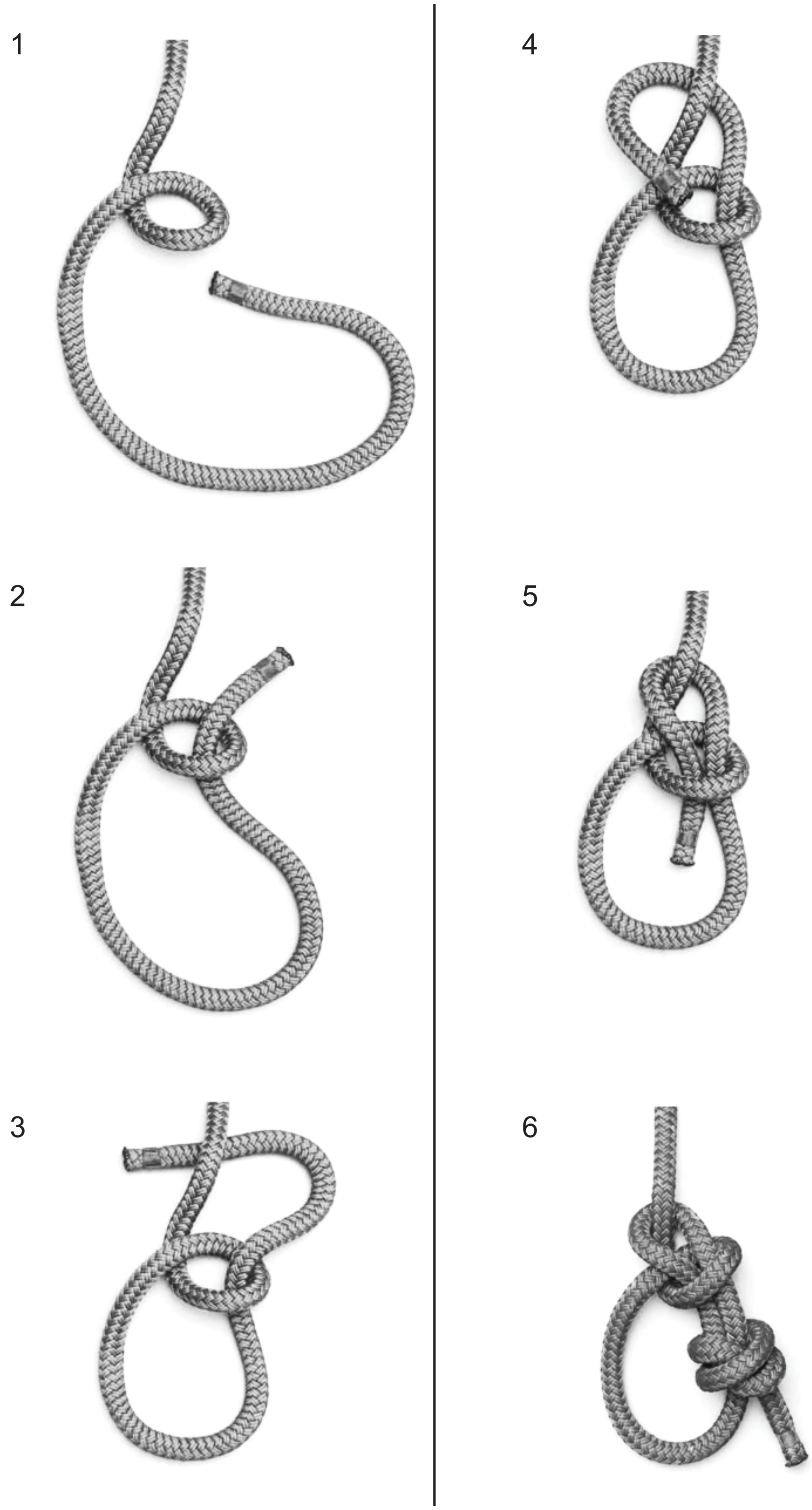

Figure 4-19. Bowline.

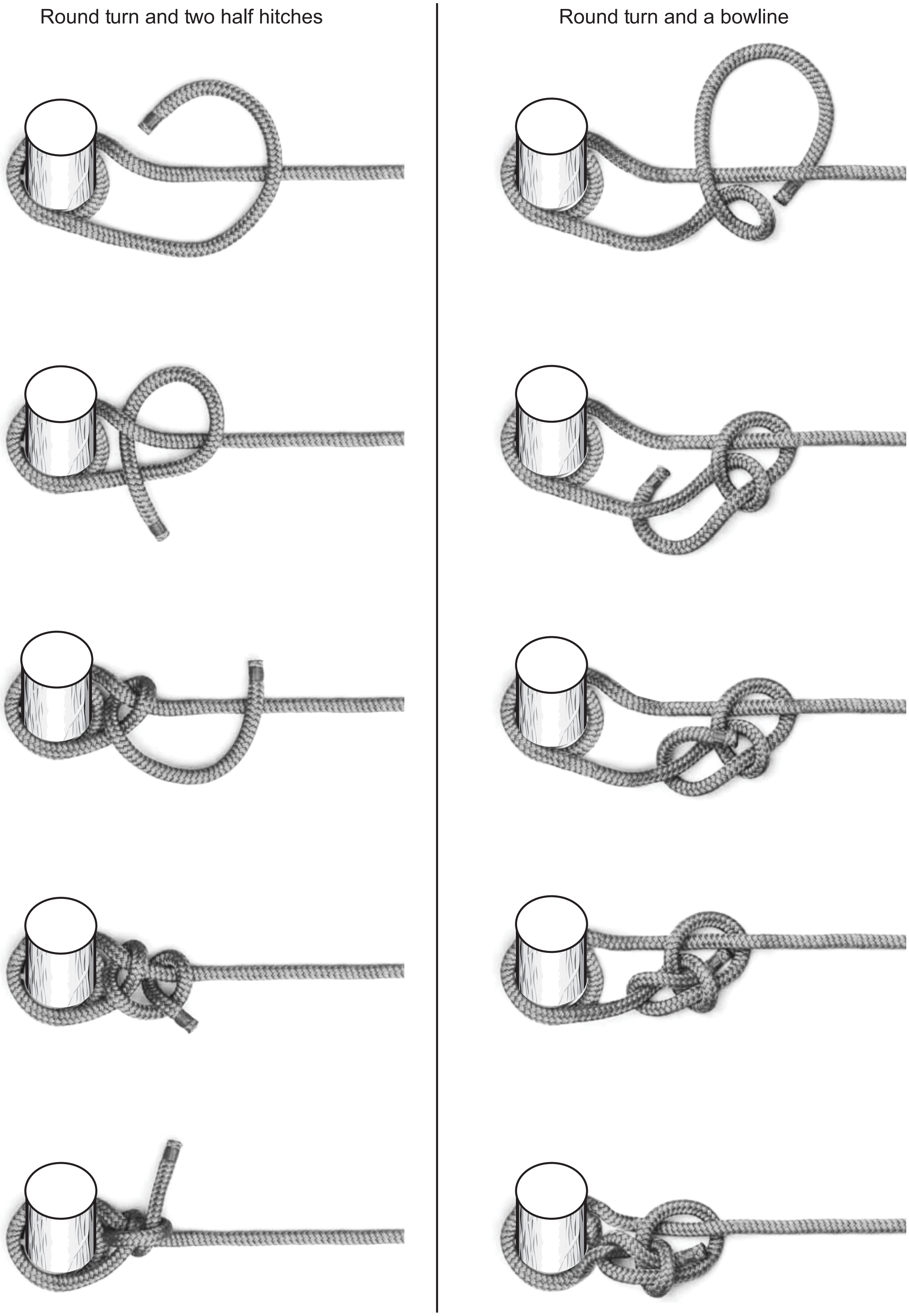

Figure 4-20. Round Turn and Two Half Hitches and Round Turn and a Bowline.

Clove Hitch

The clove hitch can be adjusted while tied on an anchor. It can be tied in the middle of the rope or at the end of the rope when used in conjunction with a bowline or two half hitches.

Around-the-Object Clove Hitch

This knot is tied around an anchor. See figure 4-21.

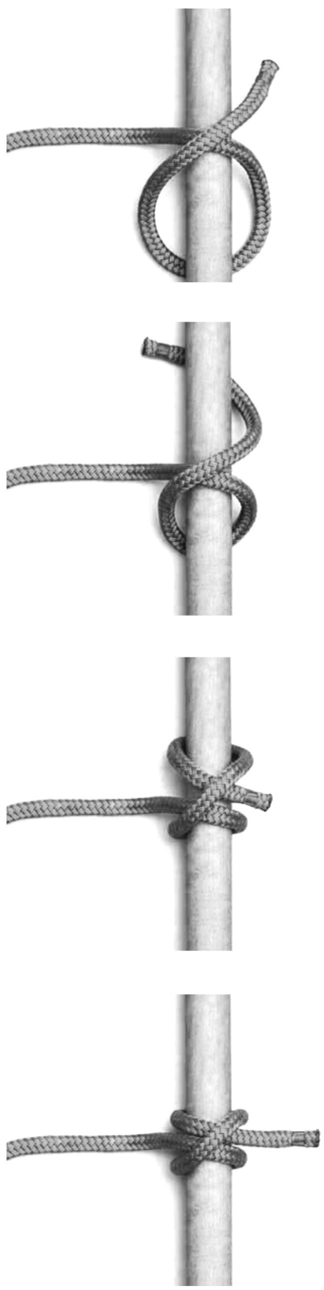

Figure 4-21. Around-the-Object Clove Hitch.

Over-the-Object Clove Hitch

This knot is tied and placed over an anchor. When tied using the middle of the rope, the knot can be tied without having to pull the rest of the rope through it. See figure 4-22.

Class III—Middle-of-the-Rope Knots

Figure-8 Loop

Also known as figure-8 on a bight, the figure-8 loop is a strong knot that can be readily untied after being under a load. It can be tied in the middle or at the end of the rope. See figure 4-23.

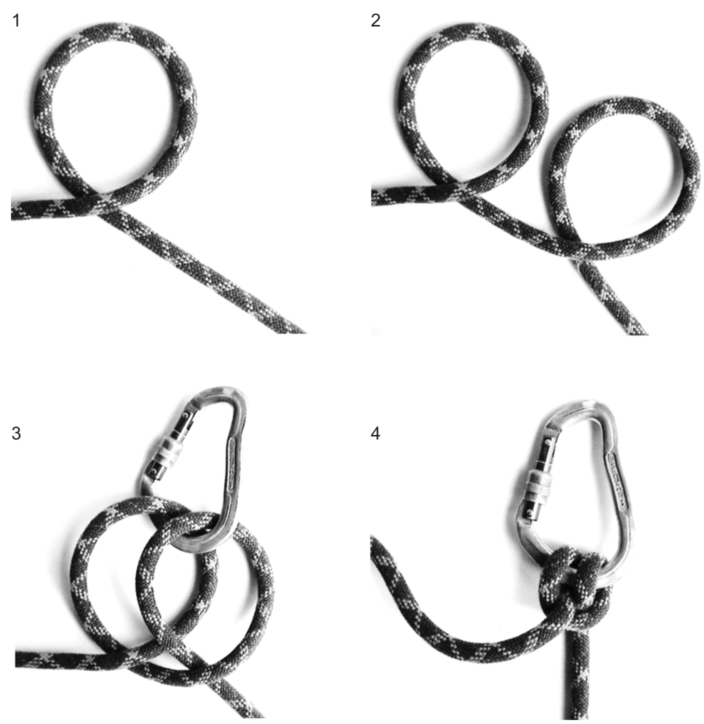

Figure 4-22. Over-the-Object Clove Hitch.

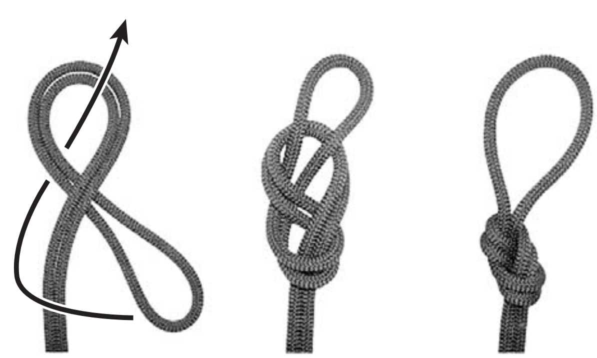

Figure 4-23. Figure-8 Loop.

Double Figure-8 Loop

This knot is strong and the double loop reduces the wear and strength loss from the rope bending around the carabiner by splitting the load between the two loops. See figure 4-24.

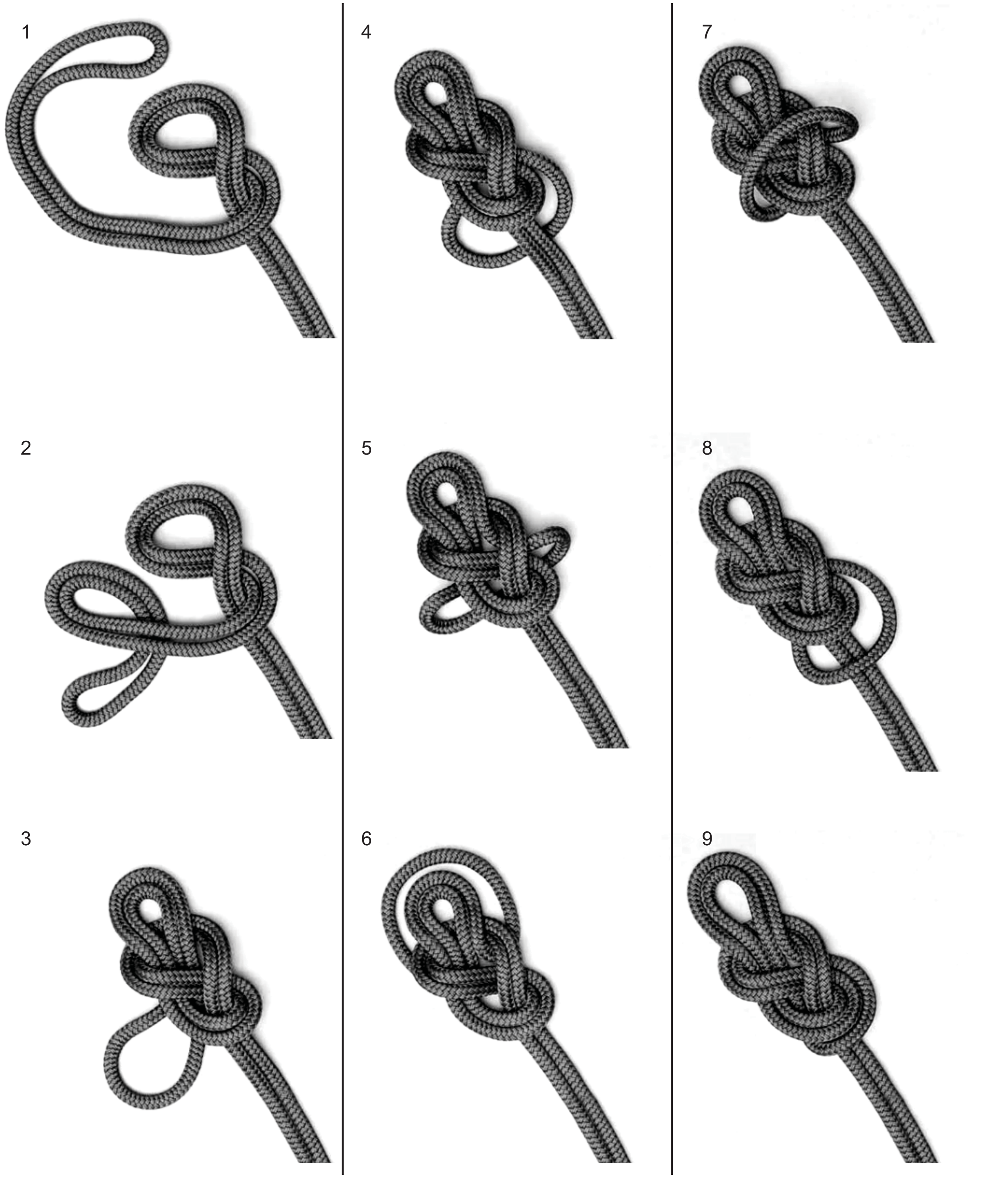

Figure 4-24. Double Figure-8 Loop.

Three Loop Bowline

This knot can be used to construct a three point self-equalizing belay or to tie the middle person in to the middle of the rope when using a three-person rope team. When connecting to a harness the third loop should be secured with an overhand knot or a carabiner. See figure 4-25.

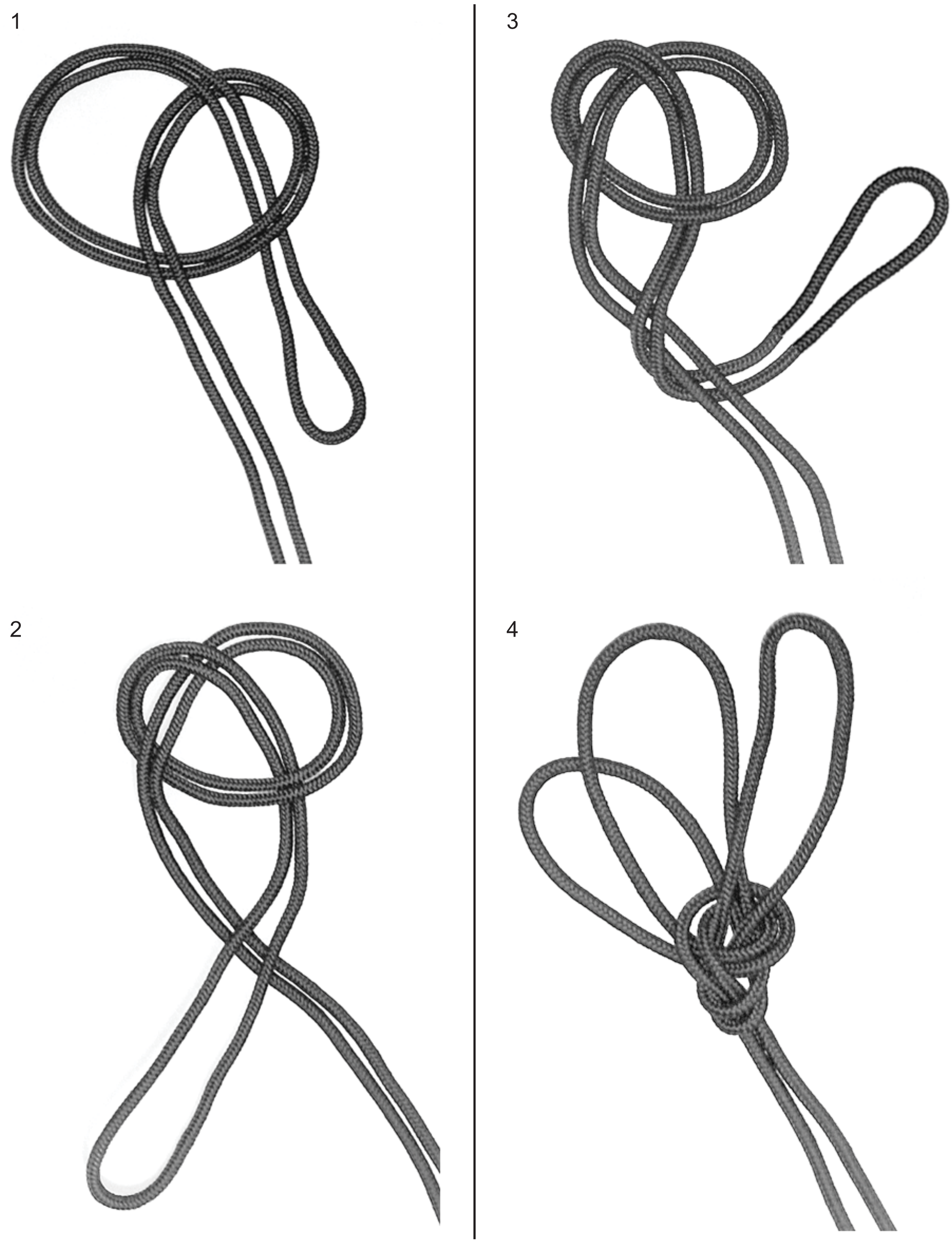

Figure 4-25. Three Loop Bowline.

Class IV—Special Knots

Prusik Knot

This knot functions by friction that can be alternately set and released. For best results, tie the knot with a smaller diameter cord on a larger diameter cord having at least 3 mm in diameter difference. If slippage occurs, make more wraps. Do not use tape when tying this knot.

Middle-of-the-Rope Prusik

This knot is tied using a closed loop. Ensure that the knot connecting the two ends of the loop is not encompassed inside the wraps. See figure 4-26.

End-of-the-Rope Prusik

This knot is tied using one end of the cordage. The pigtail of this knot is secured with a bowline. See figure 4-27.

French Prusik

This knot is tied using a closed loop and a carabiner. The knot connecting the two ends of the loop must not be encompassed inside the wraps. See figure 4-28.

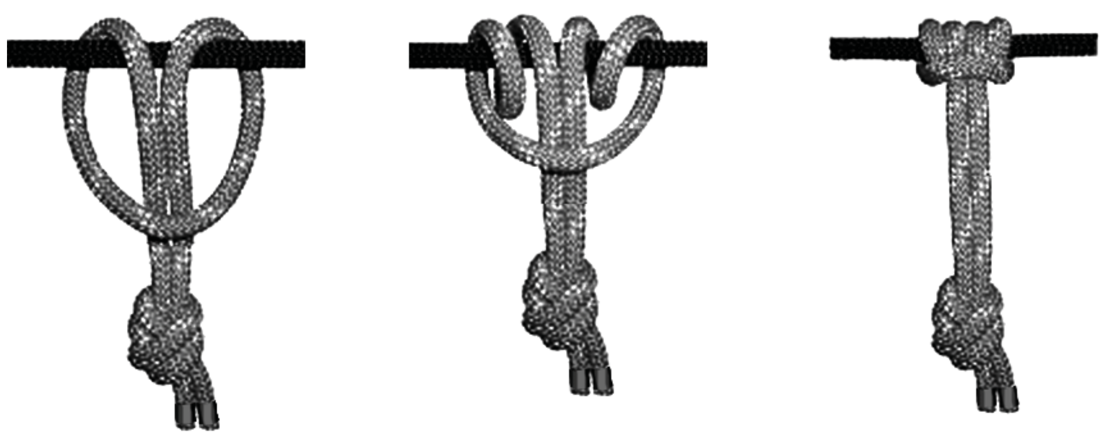

Figure 4-26. Middle-of-the-Rope Prusik.

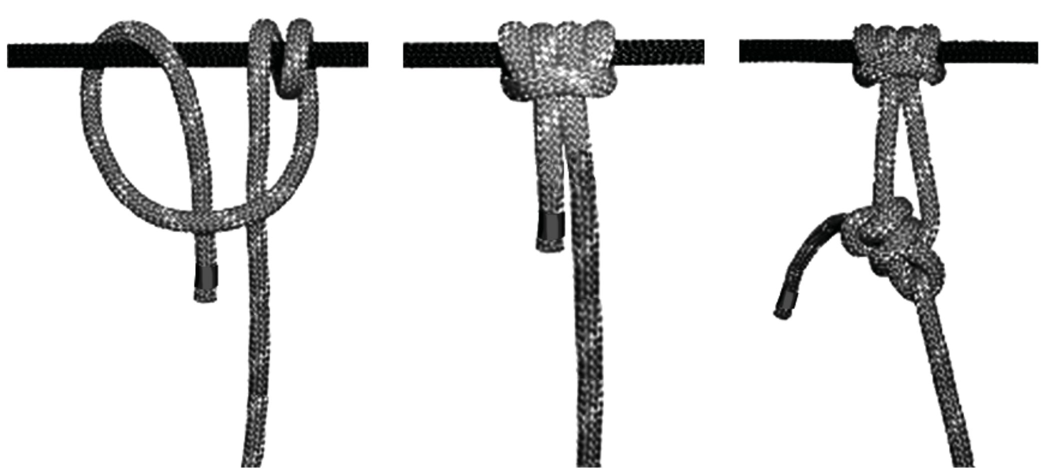

Figure 4-27. End-of-the-Rope Prusik.

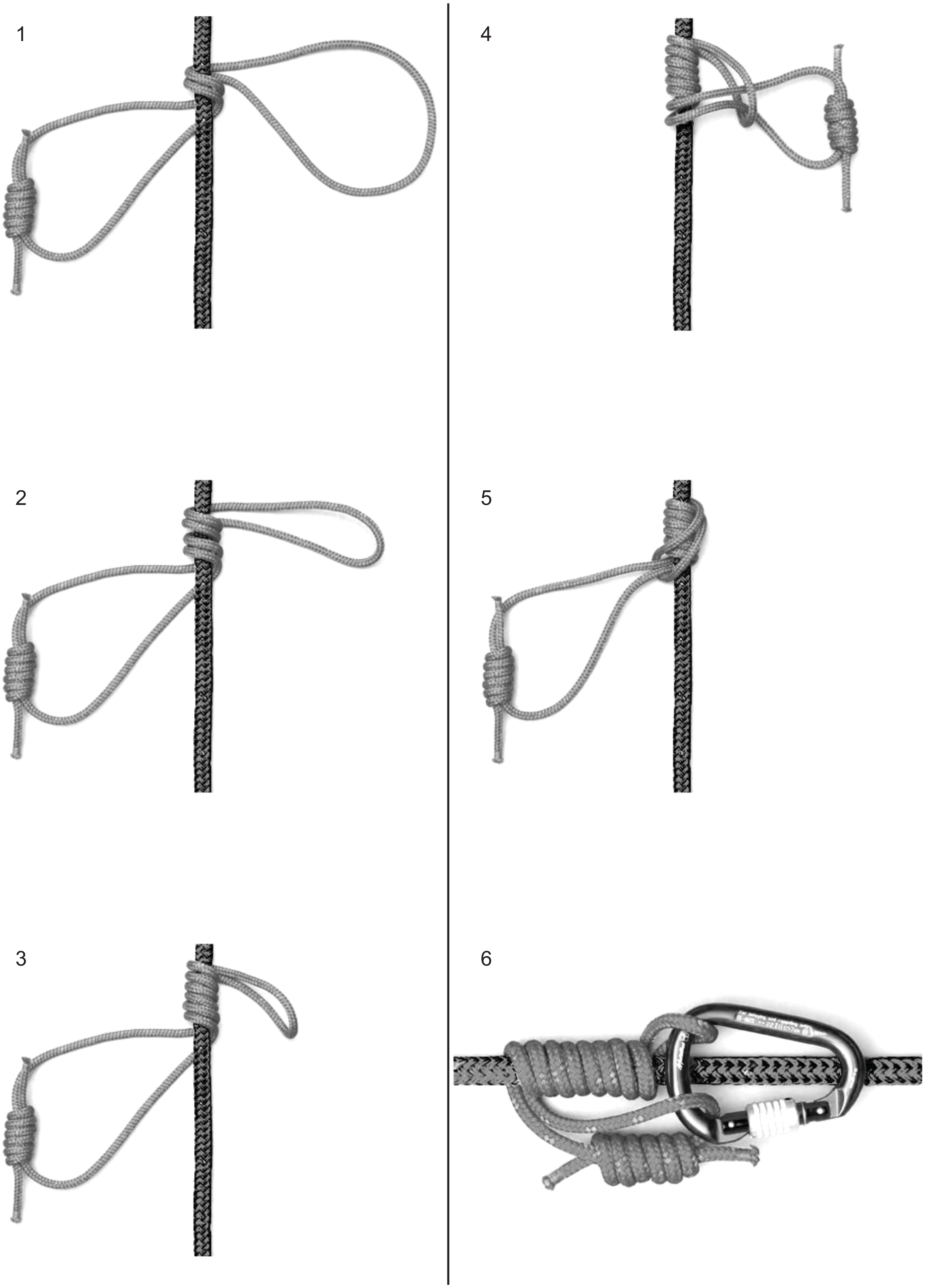

Figure 4-28. French Prusik.

Retraced Figure-8

This knot is used to tie the end of the climbing rope into a harness or swami wrap. The pigtail may be secured with an overhand or a single fisherman. See figure 4-29.

Directional Figure-8

When tied and tension is applied to both ends of the rope, the knot will not pull apart. The loop will point toward the direction of pull. See figure 4-30.

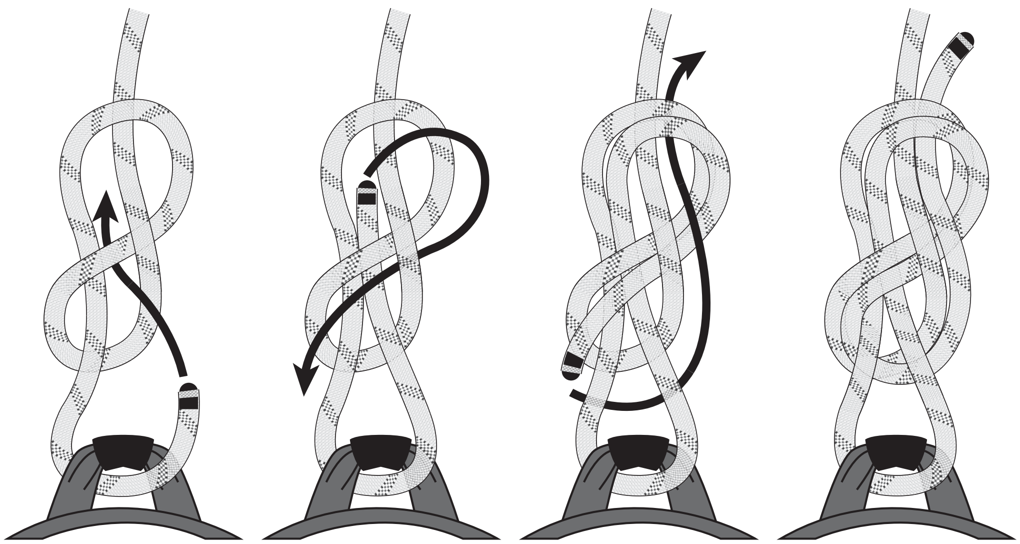

Figure 4-29. Retraced Figure-8 in Harness.

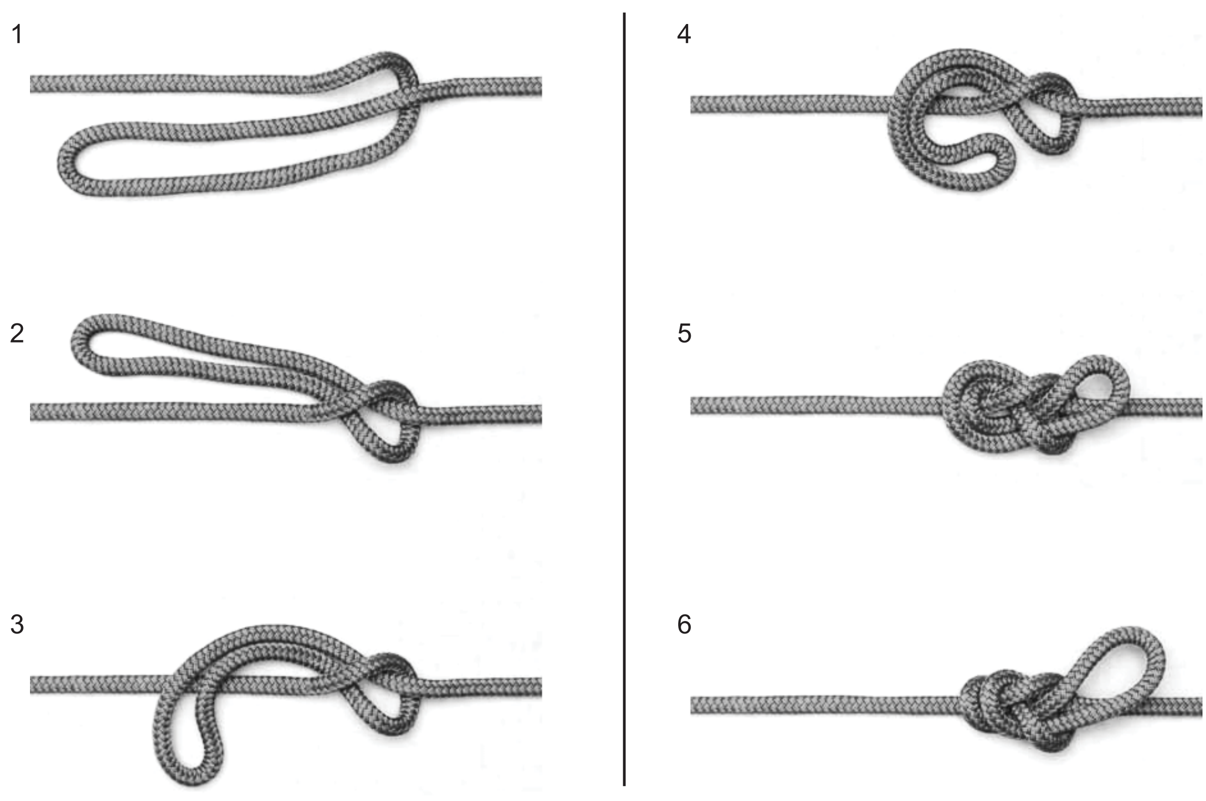

Figure 4-30. Directional Figure-8.

Slip Figure-8

This knot is used for retrievable anchors and fixed rope installations for the ease of untying the knot. The slip overhand is a variation of this knot. See figure 4-31.

Kliemheist

This friction knot can be tied with all types of cordage including tape. See figure 4-32.

Bachman Knot

The bachman knot is used for the same purpose as the prusik knot. Because it is tied around a carabiner, it is much easier to loosen and slide. It is almost considered a self-tending knot when the rope slides through it. See figure 4-33 on page 4-22.

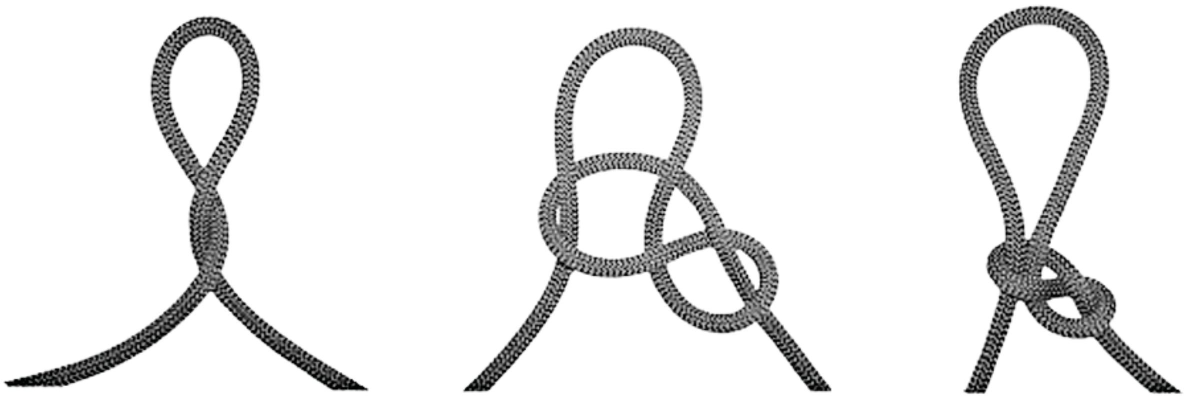

Figure 4-31. Slip Figure-8.

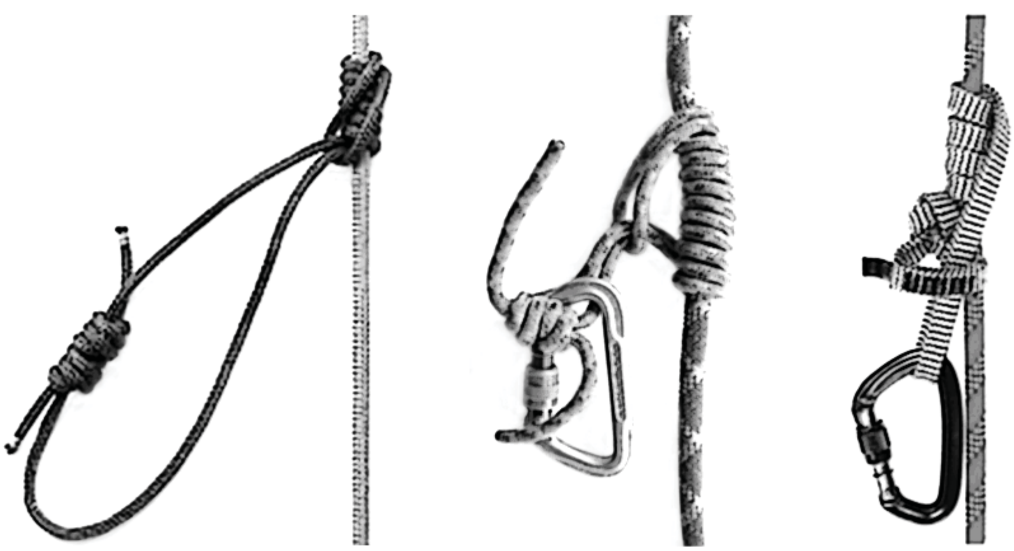

Figure 4-32. Kliemheist.

Overhand Knot

The overhand knot is generally used to secure primary knots. A double overhand knot is often tied to secure the loose ends of a double-rope rappel. See figure 4-34.

Munter Hitch

The munter hitch is used for belaying. See figure 4-35.

Munter Mule

The munter mule is a finishing knot used to secure a munter hitch. It uses the brake rope tie, an overhand slipknot over the load rope, and an overhand on a bight. See figure 4-36 on page 4-24.

Timber Hitch

A timber hitch is used to fix a rope to a pole or equivalent for hoisting or towing purposes. See figure 4-37 on page 4-25.

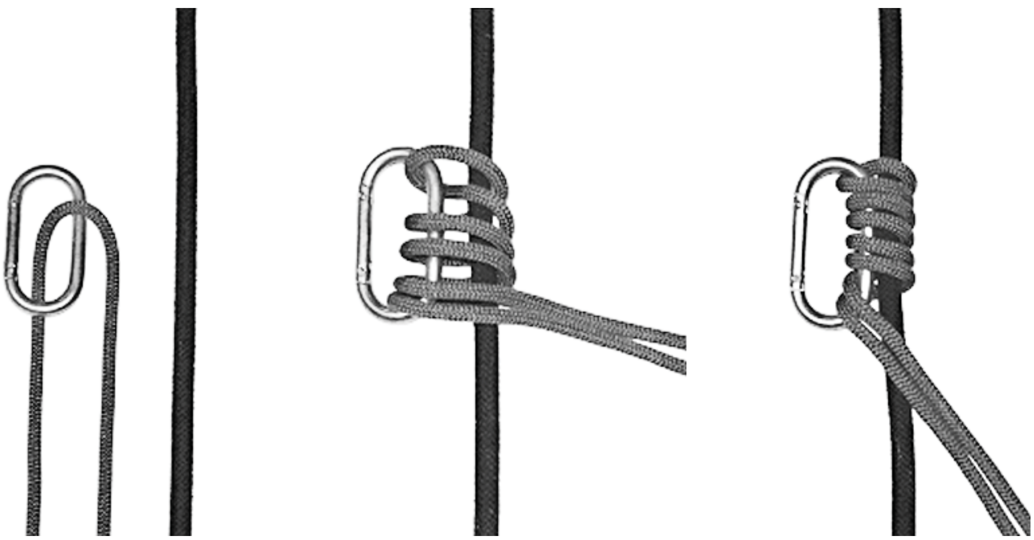

Figure 4-33. Bachman Knot.

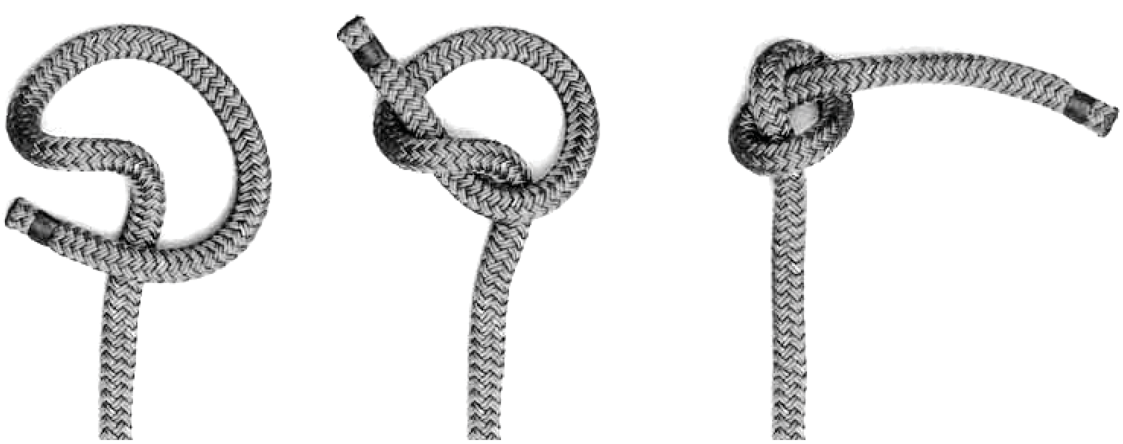

Figure 4-34. Overhand.

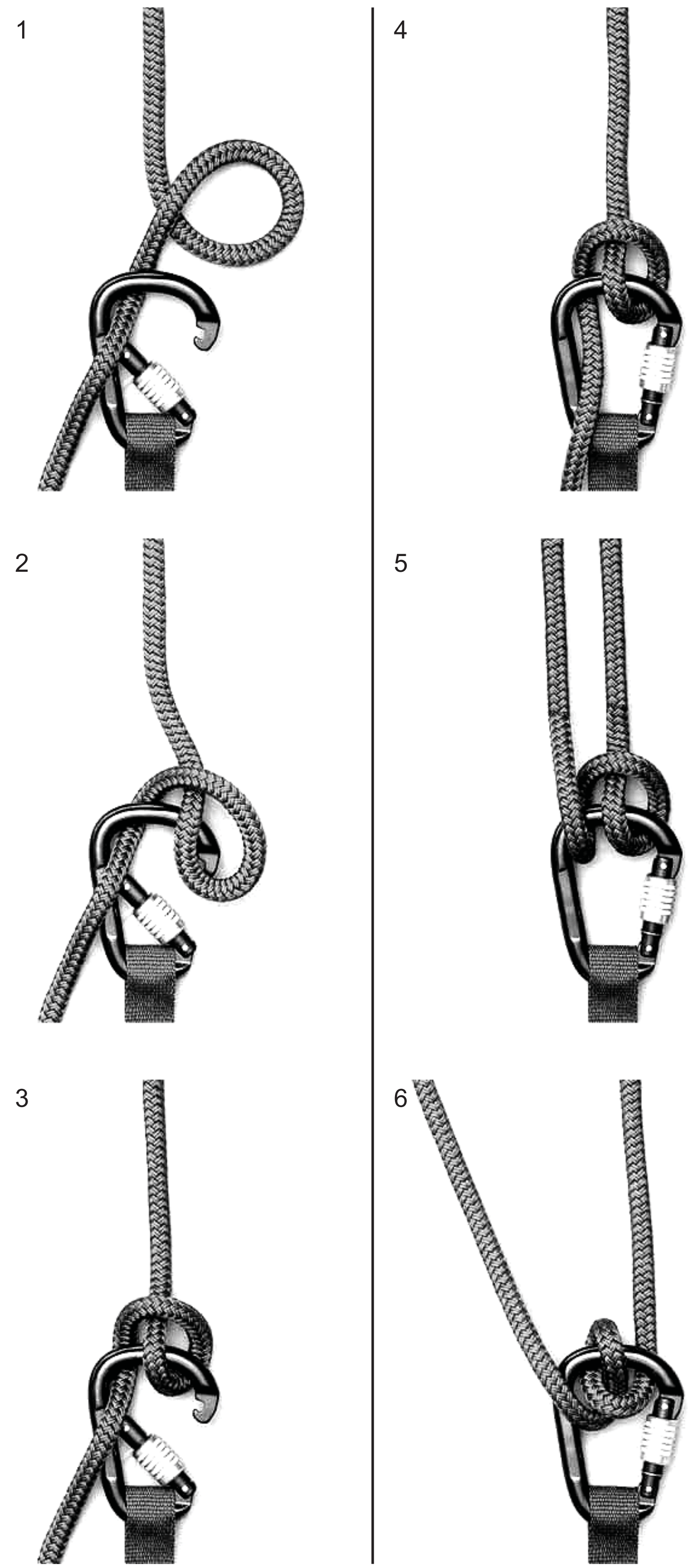

Figure 4-35. Munter Hitch.

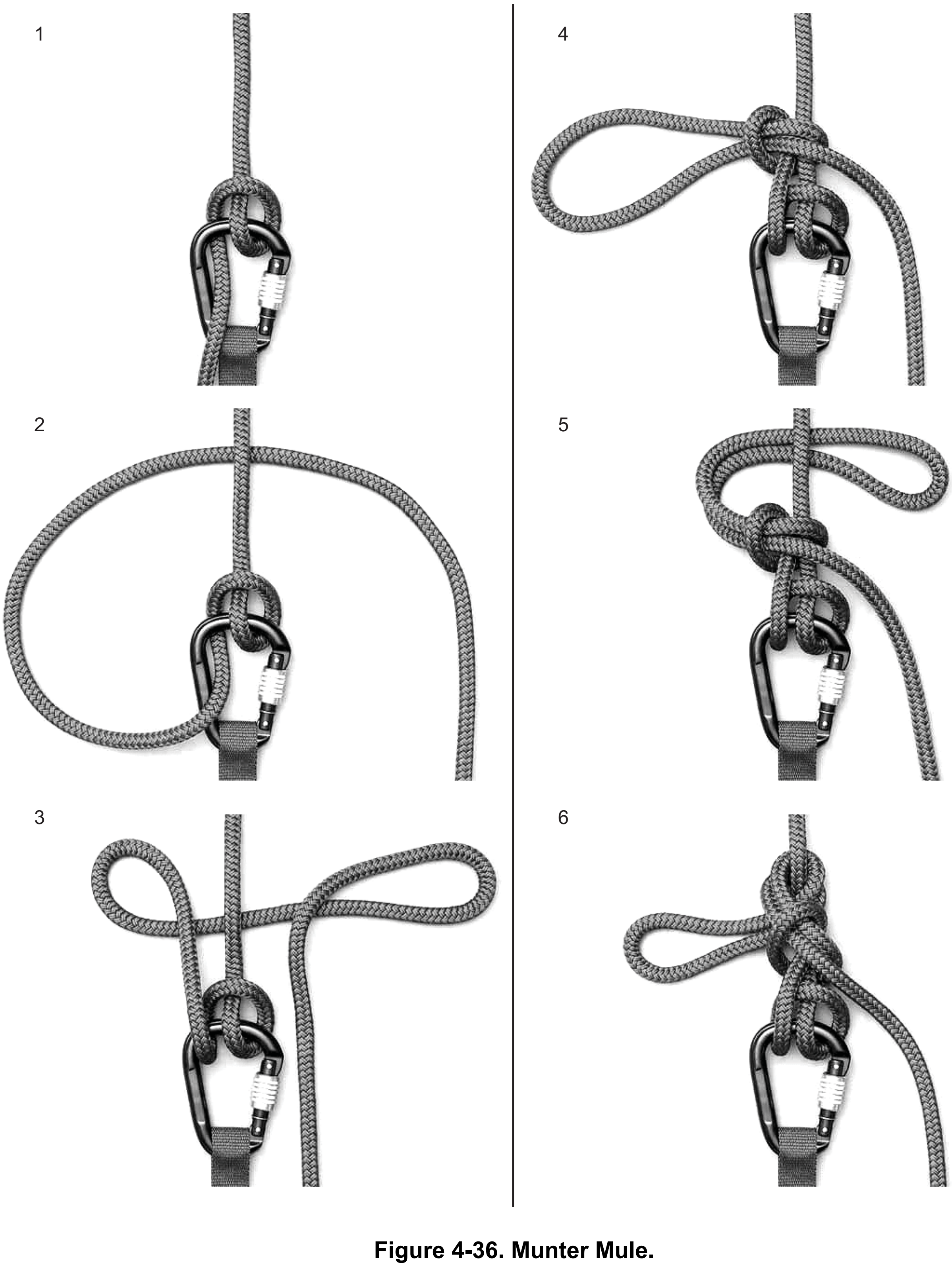

Figure 4-36. Munter Mule.

Mariner's Hitch

This knot can be untied under a load as shown in figure 4-38.

Kragur Knot

This friction knot is used when using ropes of equal diameter and a friction knot is needed. See figure 4-39 on page 4-26.

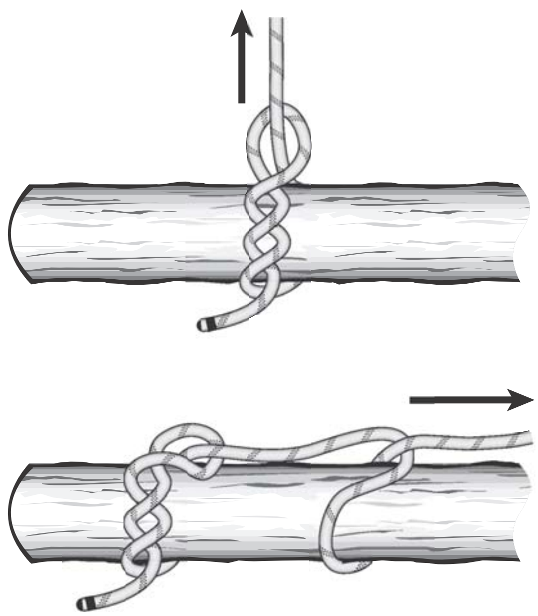

Figure 4-37. Timber Hitch.

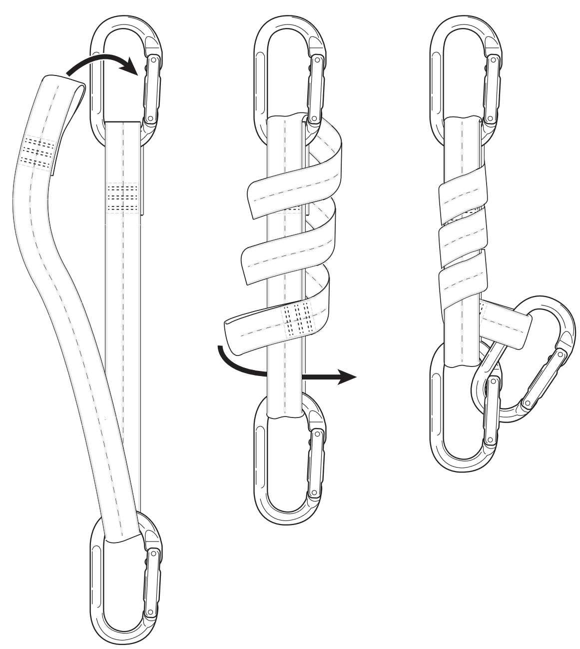

Figure 4-38. Mariner's Hitch.

Rappel Seat

A rappel seat is used as an expedient harness. To construct the rappel seat, conduct the following steps:

- Find the middle of the sling rope and place it on the left hip.
- Wrap the sling rope around the waist and tie two wraps in the front. See figure 4-40.
- Bring the running ends down through the legs, up over the buttocks, over the original waist wrap, down between the waist wrap and the waist, and over itself, forming a half hitch on each side. See figure 4-41.
- Cinch the half hitches tightly by squatting several times while pulling on the pigtails. See figure 4-42.

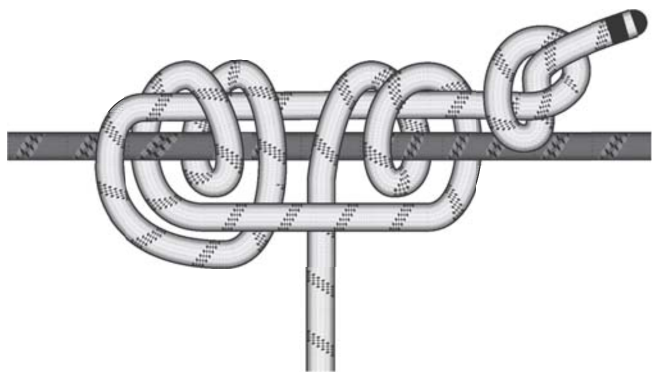

Figure 4-39. Kragur Knot.

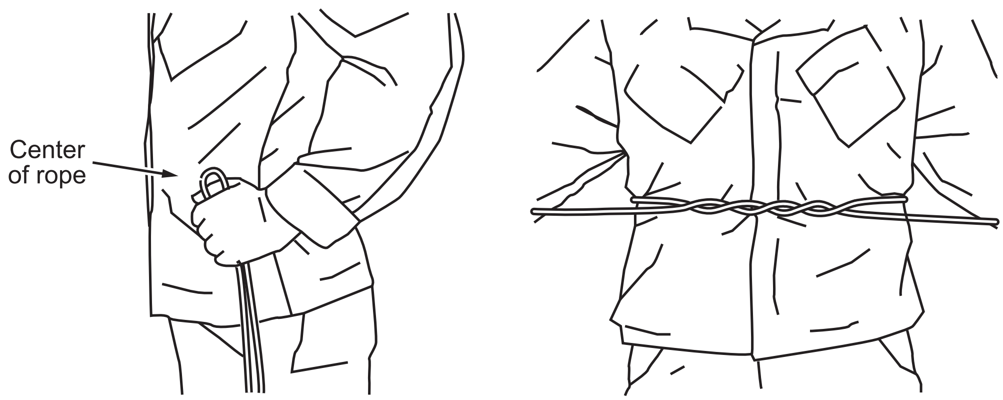

Figure 4-40. Rappel Seat 1.

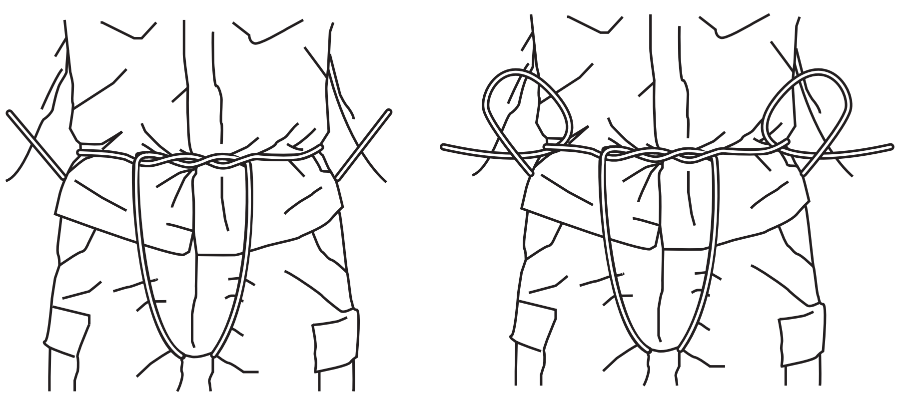

Figure 4-41. Rappel Seat 2.

- Bring the pigtails to the left hip and secure the two ends with a square knot and two overhand knots, ensuring that the overhand knots encompass all the wraps. See figure 4-43.
- Tuck any excess rope into a pocket.

Bowline on a Coil

This knot is used to tie into the end of a rope. It distributes the force of a fall over a larger area of a climber's waist and is preferable over a single bowline around the waist. The bowline on a coil can also be used to take up excess rope. The bowline on a coil should have 4 to 6 wraps around the waist and the bowline is secured with an overhand. See figure 4-44 on page 4-28.

Swami Wrap (Swami Belt)

A swami wrap tied with four to six wraps of cordage or nylon webbing can be tied around the waist as a means of securing a person to the end of a rope. It is preferred over the bowline on the coil because it saves rope and it is more time efficient.

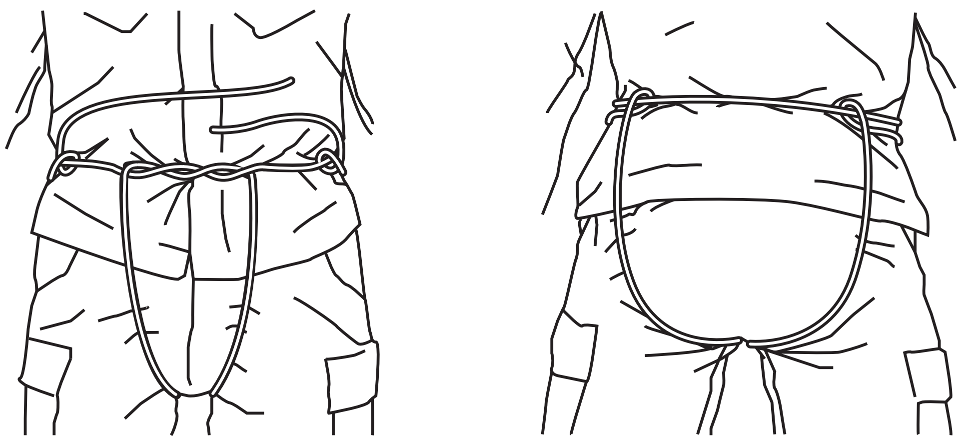

Figure 4-42. Rappel Seat 3.

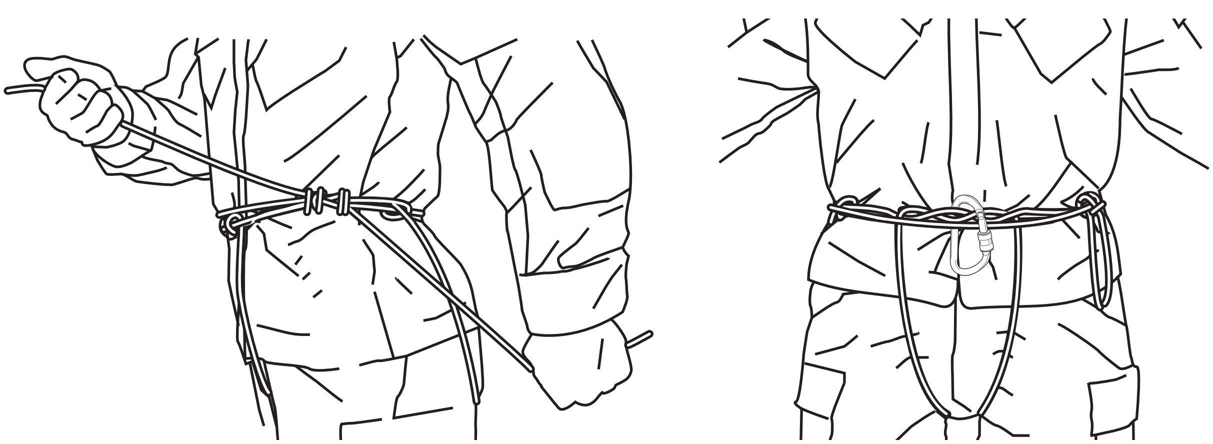

Figure 4-43. Rappel Seat 4.

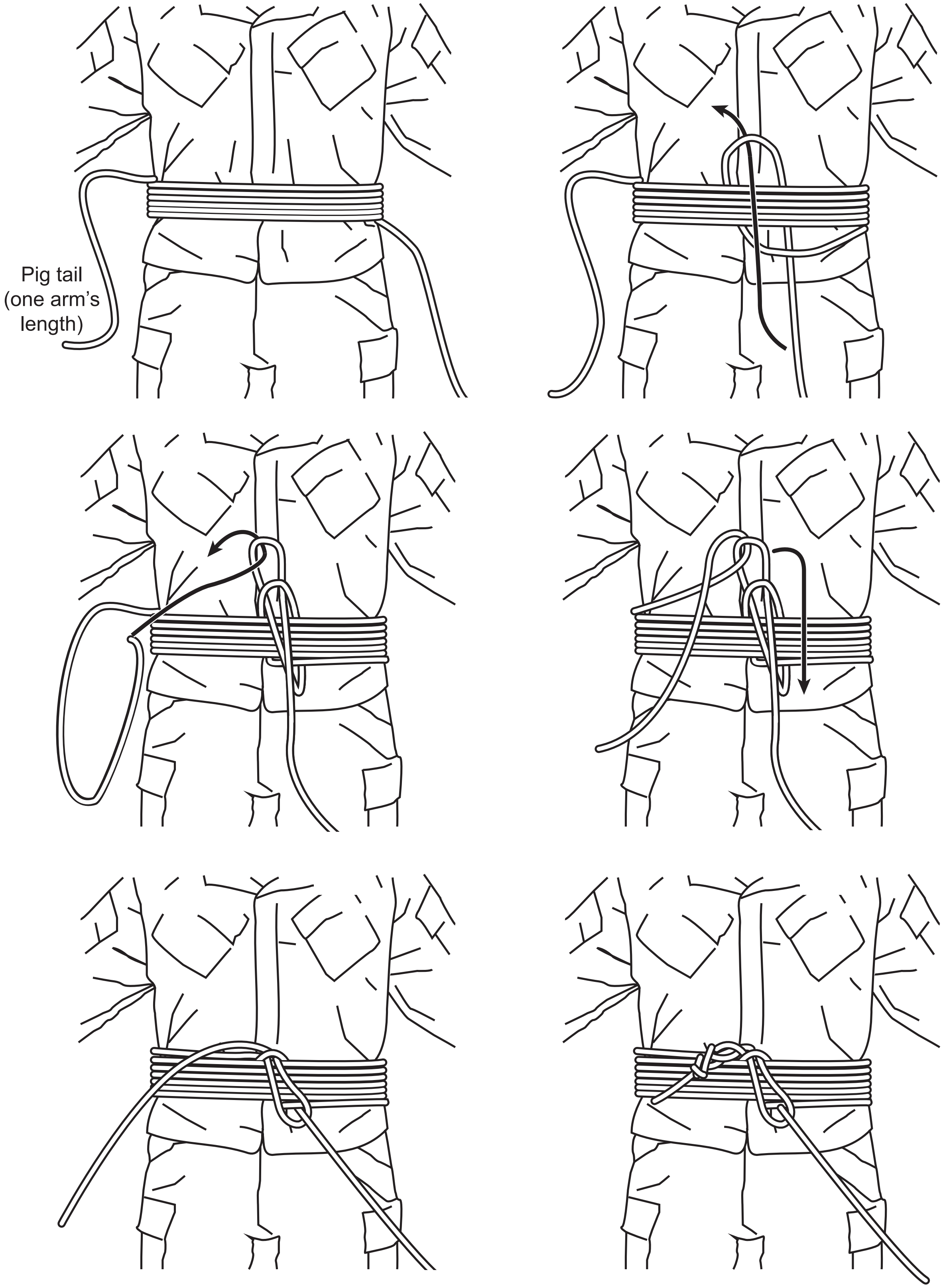

Figure 4-44. Bowline on a Coil.

Multiple individuals can prerig the swami wrap before connecting to the rope. See figure 4-45.

Knot Strength

Rope, cordage, and webbing are strongest when loaded in a straight line. When bending a rope or web to create a knot, the strength of the rope is reduced. All knots should be dressed properly for maximum effective use. Table 4-2 lists the relative strengths of each knot as a percentage of the strength of the material used to tie it. Remember a static rope's average strength is more than 6,000 pounds.

Knot Testing Standards

Table 4-3, on page 4-30, presents knot-tying times that must be met by summer mountain leaders and assault climbers while blindfolded or at night without lighting.

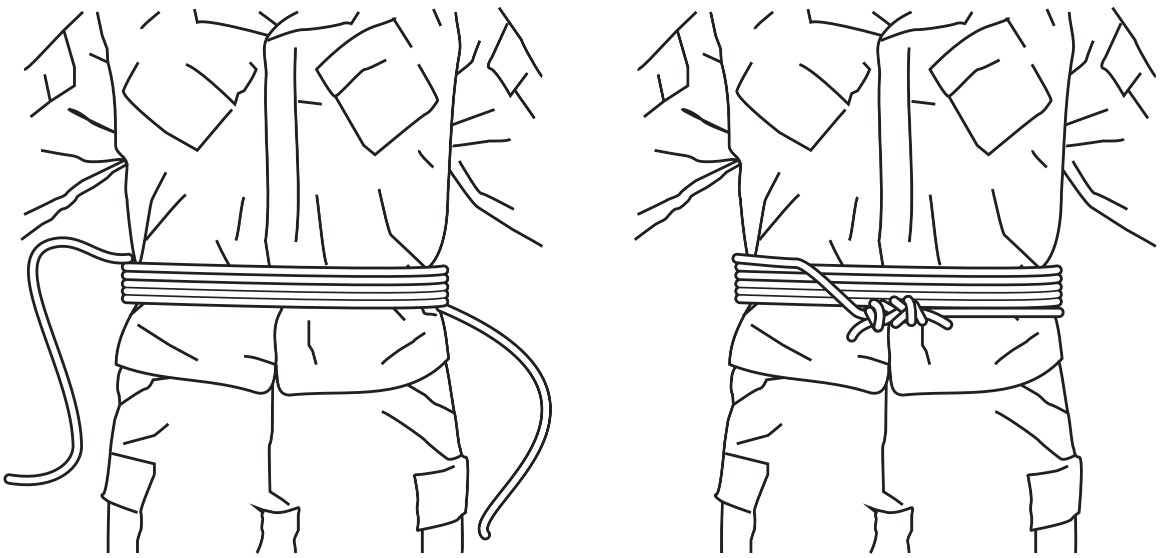

Figure 4-45. Swami Wraps.

Table 4-2. Knot Strength.

Knot	Relative Strength of Knot
No Knot	100%
Figure-8	75-80%
Bowline	70-75%
Double bowline	70-75%
Double fisherman	65-70%
Water (tape) knot	60-70%
Clove hitch	60-65%
Overhand knot	60-65%
Square knot	45%

Table 4-3. Knot Testing Standards.

Knot	Summer Mountain Leader, Assault Climber Time Limit
Square knot	30 seconds
Double fisherman's knot	30 seconds
Water (tape) knot	30 seconds
Middle-of-the-rope prusik	30 seconds
Round turn and a bowline	30 seconds
Round turn and two half hitches	30 seconds
Clove hitch (around the object)	30 seconds
Munter hitch	30 seconds
Munter mule	30 seconds
Slip figure-8	30 seconds
Figure-8 loop	30 seconds
Directional figure-8	30 seconds
End-of-the-line prusik	45 seconds
Retrace figure-8	45 seconds
Rappel (Swiss) seat	90 seconds

Types of Anchors

There are several types of anchors—natural, artificial, unidirectional, and multidirectional.

Natural Anchors

Natural anchors are furnished by the terrain and include plants and rocks. Trees, shrubs, protruding roots, and large bushes provide the most obvious anchors. The following considerations should be made when choosing a plant for an anchor:

- Favor plants that have a healthy trunk, live branches, and solid root system.
- Do not trust plants that are poorly rooted, or appear weak, loose, rotten, dead, or brittle.
- Carefully evaluate plants near or on cliff faces and growing out of rocky terrain. They generally have shallow root systems and may not be as solid as they appear.
- The strongest part of plants is generally closest to the ground. Securing the rope higher up on the trunk or stem or on a branch or limb places more leverage on the plant and increases the danger of it being uprooted. See figure 4-46.
- Test stability of plants and roots by pushing and pulling on them.
- Be cautious of using a bush as an anchor. Consider backing it up with another anchor.
- Be aware that during cold weather plants may become brittle.

Rock horns, spikes, knobs, chicken heads, flakes, columns, rock tunnels, chockstones, and large and flat-bottom boulders are commonly used as anchors. See figure 4-47 on page 4-32.

It is easy to overestimate the stability of large boulders, but larger boulders are generally more stable. Flat-bottom boulders that are wider than higher are generally harder to tip over. The shape of the socket the boulder is sitting on should be considered. Boulders in a depression are harder to move than boulders resting on a dip in the ground. Likewise, boulders on flat terrain or lower angle slopes are generally better than boulders resting

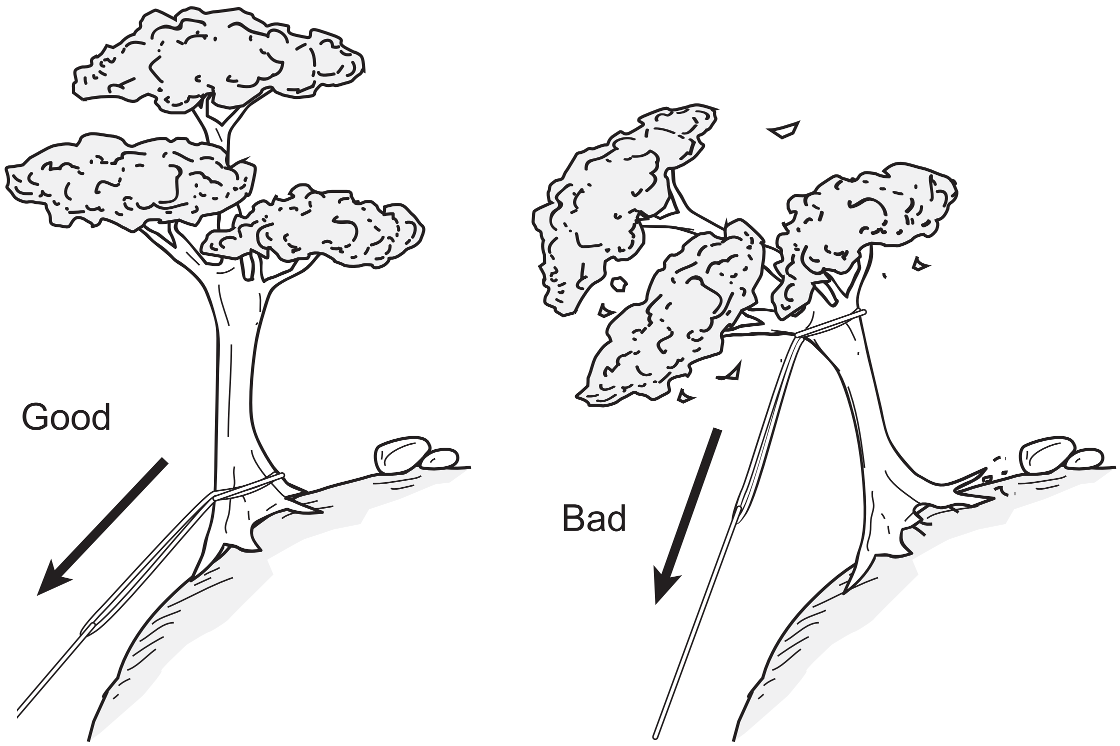

Figure 4-46. Good and Bad Plants As Anchors.

on steeper slopes and boulders underneath other large boulders are generally quite solid. Marines can test boulders by pushing against them gradually. When evaluating a rock feature, its relative hardness and stability should be considered as well as the following precautions:

- Be wary of weathered, friable, and broken up rock common in alpine areas.
- Chockstones should have maximum surface contact and be well tapered with the surrounding rock.
- Check for fracture lines that may separate it from the rock around it.
- Whack it a few times with your hand and fist. Movement, hollow sounds, and brittleness are signs of unstable rock.
- Gradually push and pull on it, being careful not to dislodge it and pull it loose on someone else.

Artificial Anchors

Artificial anchors are manmade, either manufactured or improvised and include picket hold fast and deadmen. A picket hold fast is an anchor system that uses stakes driven into the ground as anchor points. Engineer stakes work well. A deadman is an anchor system that uses a buried natural or artificial object as an anchor point. Other artificial protection includes chocks, spring-loaded camming devices (SLCDs), pitons, and bolts. For more information, see chapter 6.

Unidirectional Anchors

Unidirectional anchors can only withstand a load from one general direction. An example of a unidirectional anchor would be a rock horn slung during a climb. It is generally only good for downward pull.

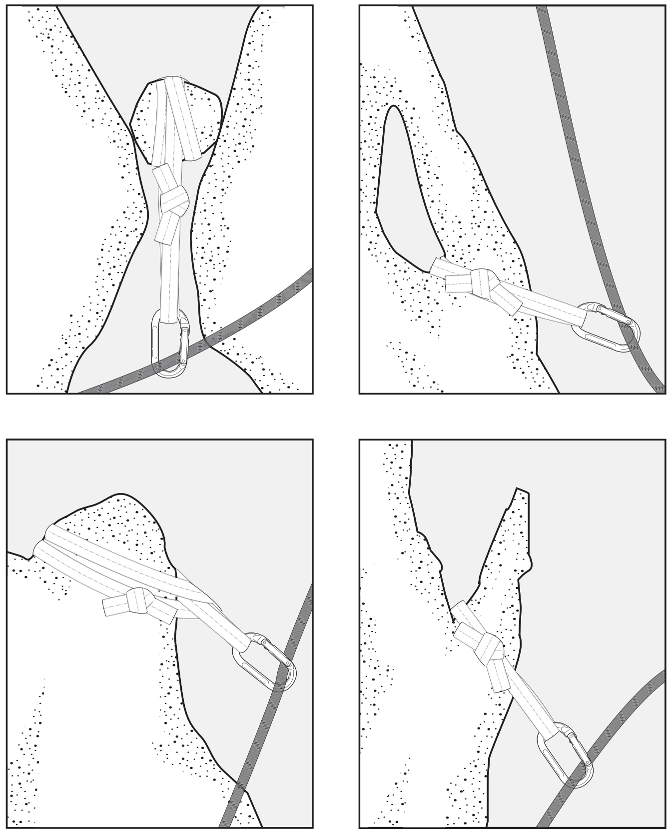

Figure 4-47. Rock As Protection Point.

Multidirectional Anchors

Multidirectional anchors can withstand a load from any direction. An example of a multidirectional anchor would be a large healthy tree.

Establishing Anchor Systems

Selection of proper anchor points is a skill that requires a great deal of practice. General considerations for establishing anchors are:

- Anchor points must be suitable for the load. The load is based on the amount of force placed on the system. Rope installations are generally divided into two main categories based on the forces they can withstand—high- and low-tension systems. Any load more than body weight is considered a high load. An example of a high-tension system is a one-rope bridge tied using mechanical advantage or an anchor to belay a climber climbing on fifth-class terrain. A rappel lane set up for a large unit carrying heavy loads can also be considered a high-tension system.
- Anchor points must be oriented in the direction of pull. Unidirectional anchors should be evaluated for their orientation. Multidirectional anchors are always good.
- The angle between anchor points should not exceed 90 degrees. The smaller the angle between the anchor points, the less force each anchor point has placed on it. Selecting anchors that are sufficiently close together will make this possible. If the only available anchors are far apart, they can be extended with other cordage or slings to reduce the angle. See table 4-4 and figure 4-48 on page 4-34.

Table 4-4. Force on Each of the Equalized Anchors.

Angle	Forces on Each Anchor
0°	50%
60°	58%
90°	71%
120°	100%
150°	193%
180°	573%

Single-Point Construction

A single-point anchor system consists of one single anchor point, natural or artificial, such as a large healthy tree. A single-point anchor system is used—

- In a low-tension system.
- When the strength and security of anchor point is carefully evaluated.
- To back up a braced belay.
- When a bombproof anchor point is present. A bombproof anchor is stronger than any load that could be placed on it. An anchor that is stronger than the rope is considered bombproof.

Multi-Point Construction

A multi-point anchor system is always preferable to a single-point. They connect two or more natural or artificial anchor points together, which provides redundancy in case one or more anchor points fail. If the anchor system is constructed correctly, it will also distribute the load across the anchor points such that the force applied to any single point is less than the total force applied on the system. A multi-point anchor is the norm and always used in a high-tension system or when a bombproof anchor point is not present.

Protecting the Equipment

Any sharp edges that may come in contact with the rope or cordage should be padded to help prevent it from being damaged or severed. A loaded rope can cut easily when placed against a sharp edge. Equipment should also be protected when using sap-producing plants as anchor points.

Using the Rope

This method requires less equipment, but also sacrifices some rope length to tie the system. The amount of rope used will depend on the knots and the size of the anchor point. Round turns can be implemented in some knots to keep the rope in position on the anchor point.

Anchor Knots

Any appropriate anchor knots can be used to connect the rope directly to one or more anchor points. When using most anchor knots, the angle created by the rope coming around the anchor point toward the knot should always measure less than 90 degrees. Four types of anchor situations are discussed in the following subparagraphs.

Figure-8 Anchor

The figure-8 anchor method is quick and efficient, but it cannot be released while loaded. It is constructed by tying a figure-8 loop on the standing end of the rope and wrapping the rope around the anchor point. The user attaches a locking carabiner through the loop, clips it onto the running end of the rope, and locks the carabiner. See figure 4-49 on page 4-35. Before tensioning the system, he/she adjusts the tree wrap so that the running end of the rope runs smoothly through the carabiner toward the direction of pull, which prevents any lateral tension.

Tree Wrap

As long as the tree is suitable, the tree wrap, also known as a tensionless anchor, is able to support high-tension systems, such as one that has been tensioned using mechanical advantage, and can be released while loaded. To construct a tree wrap, tie a figure-8 loop on the standing end of the rope and wrap the rope around an anchor

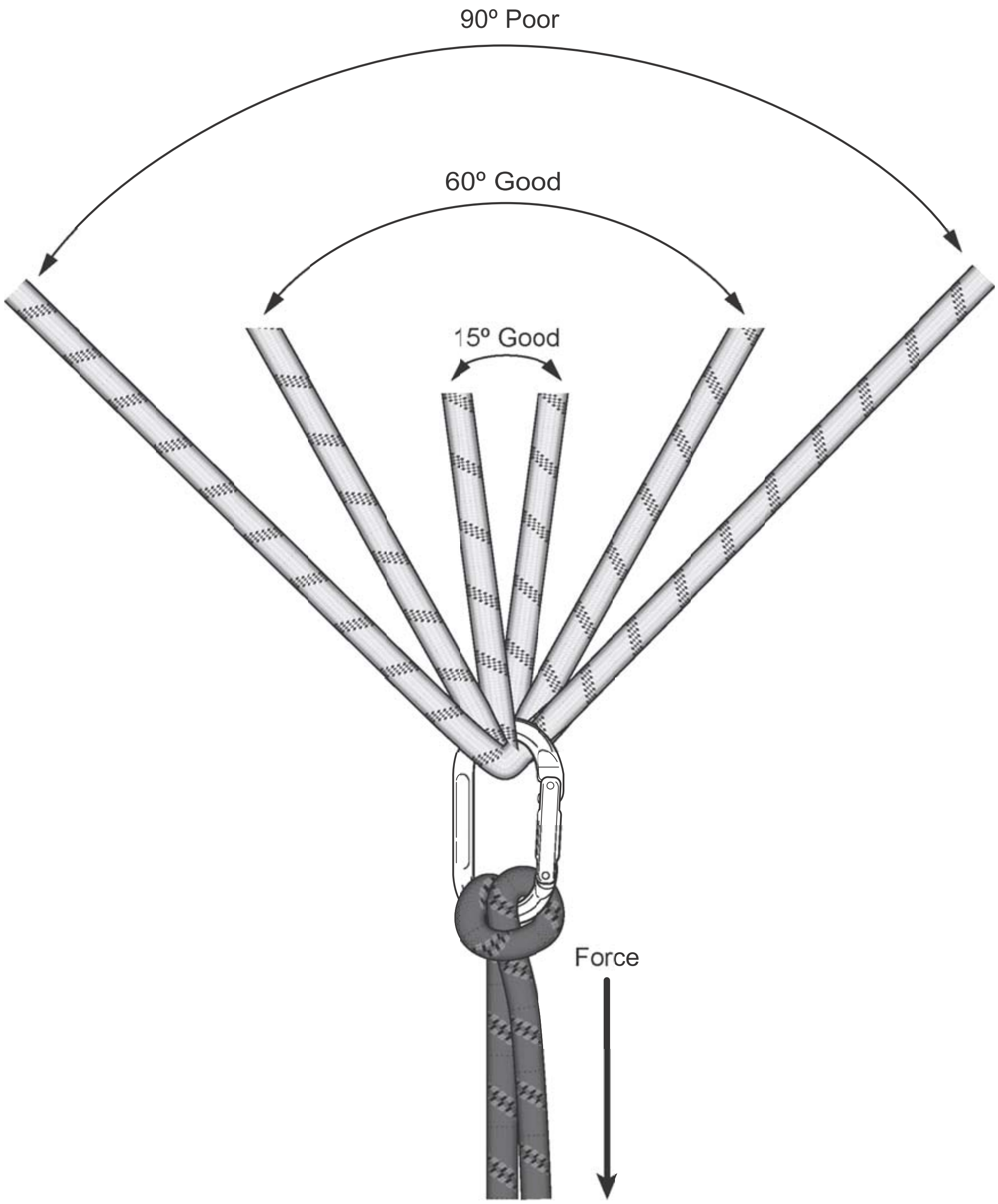

Figure 4-48. Good and Bad Angles.

point a minimum of four complete times. A locking carabiner is attached through the knot's loop, clipped onto the running end of the rope, and locked down, ensuring there is no excess slack on the last wrap (there should be just enough to allow the carabiner to be disconnected from the system). See figure 4-50. The wraps will absorb the tension placed on the rope, allowing the figure-8 knot to remain tensionless. A smooth-textured anchor may require several more wraps to prevent the system from sliding when loaded, placing the figure-8 knot under tension.

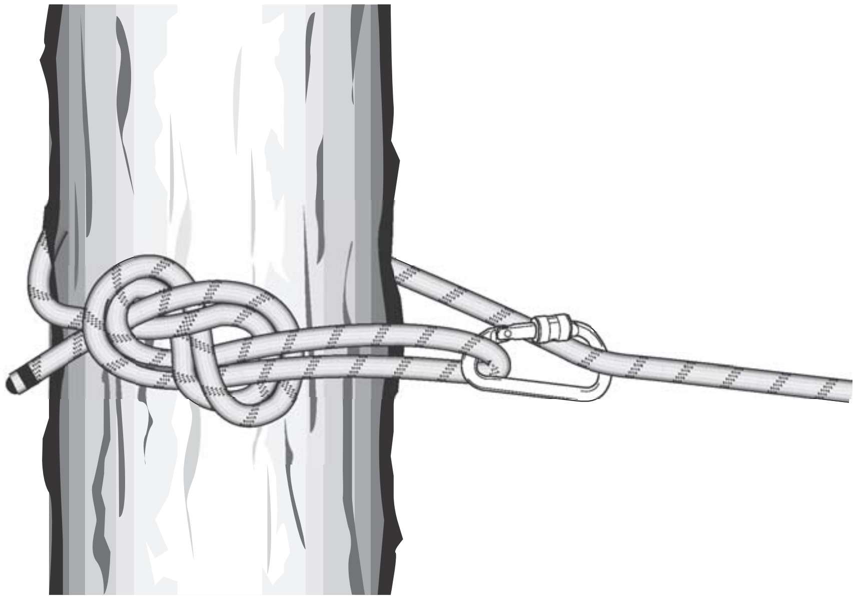

Figure 4-49. Figure-8 Anchor.

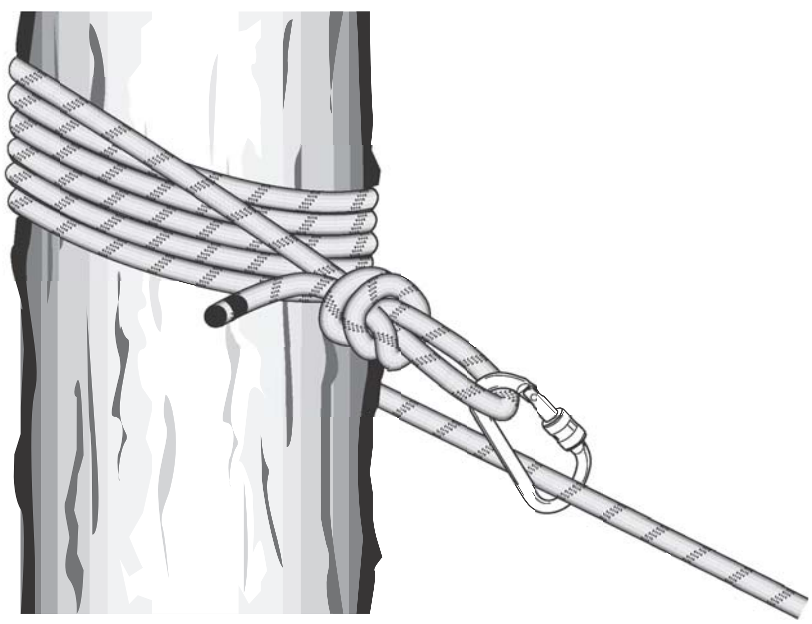

Figure 4-50. Tree Wrap.

Swami Wrap

This method can support high-tension systems, such as one tensioned using mechanical advantage, and can be released while loaded. Using one or more sling ropes or other available cordage, the user makes two or more wraps around the anchor point. The cordage used for the wraps should be joined together with an appropriate end-of-the-line knot. A square knot with two overhands works well because it can be untied while loaded.

Before securing the last two pigtails, the joining knot must be kept on the side of the anchor and close to the attachment point, which ensures that the joining knot can be untied while loaded. Also, there must be enough space left between the wraps and the anchor to allow a carabiner to be clipped to the wraps. The angle created by the wraps coming around the anchor point should measure less than 90 degrees. The carabiner is connected to the swami wrap, encompassing as many wraps as possible. This will serve as the attachment point.

Multiple Anchors

The rope can be secured to multiple anchor points using the in-line method described later in this chapter.

Using Slings

Slings can be used as anchors in the following five ways:

- *Drape*. Drape the sling over the anchor or untie it, route it around the anchor, and then retie it. Be aware of the angle created by the sling as it comes around the anchor. Select a sling long enough that allows the angle to remain less than 90 degrees. See figure 4-51.
- *Wrap*. Loop a sling around the anchor and connect the two ends together with a carabiner. Be aware of the angle created by the sling as it comes around the anchor. Select a sling long enough that allows the angle to remain less than 90 degrees. See figure 4-52.

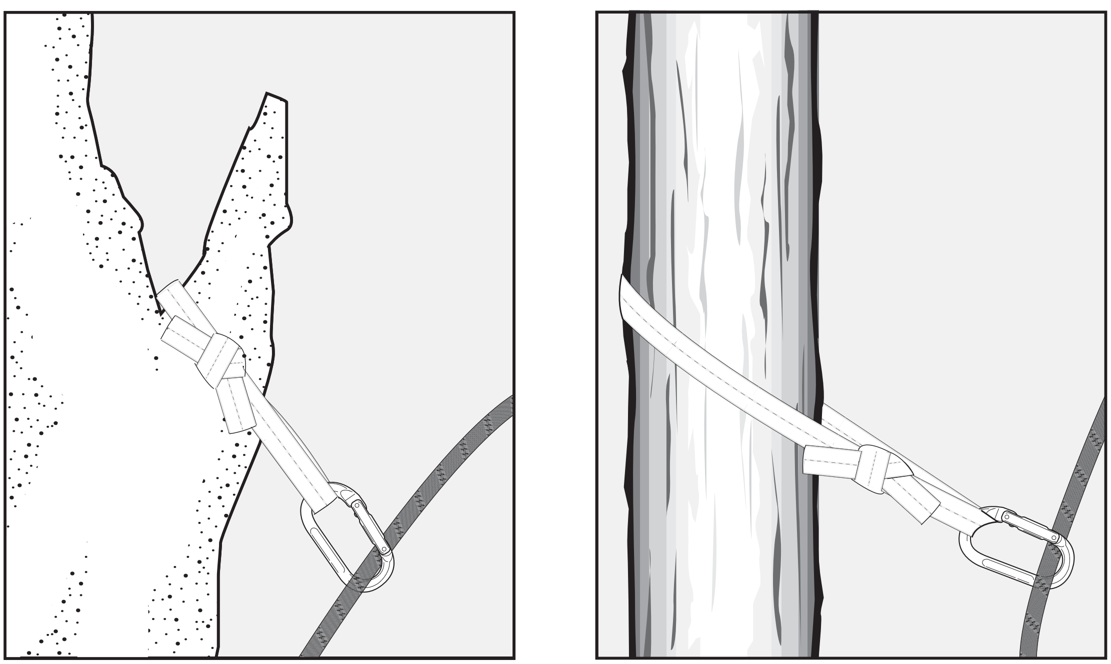

Figure 4-51. Draped and Tied Sling.

- *Girth*. Tie a girth hitch around the anchor with the sling. Although it reduces the strength of the sling, it creates friction against the anchor that helps prevent the sling from sliding around and possibly slipping off the anchor. See figure 4-53.
- *Clove hitch*. Tie a clove hitch around the anchor so that the locking bar is pointing in the direction of pull. Just like the girth hitch, the clove hitch reduces the strength of the sling, while creating friction against the anchor that helps prevent the sling from

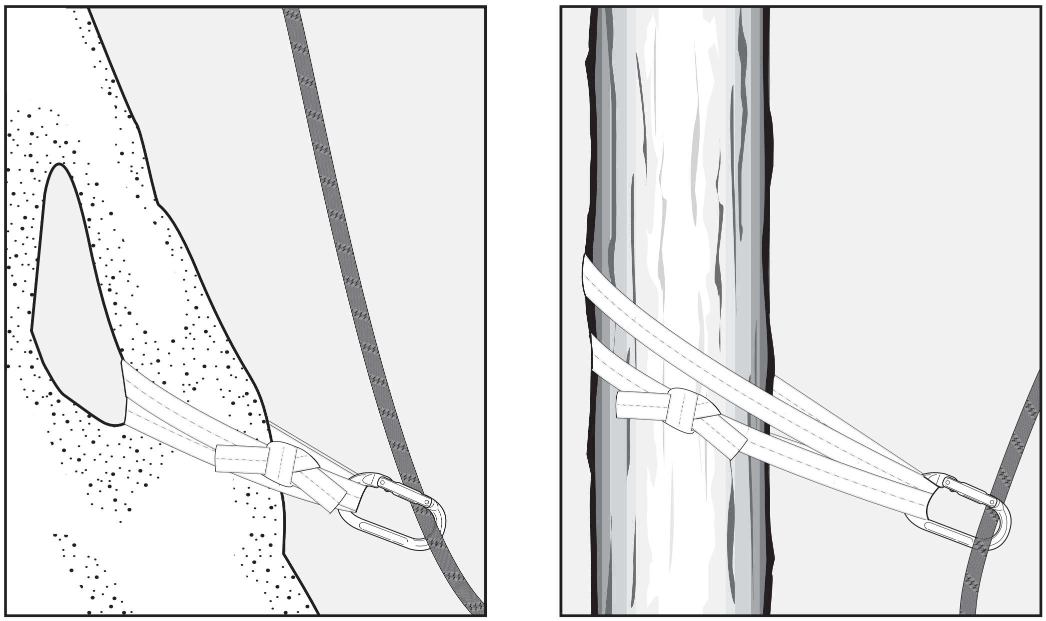

Figure 4-52. Wrapped Sling.

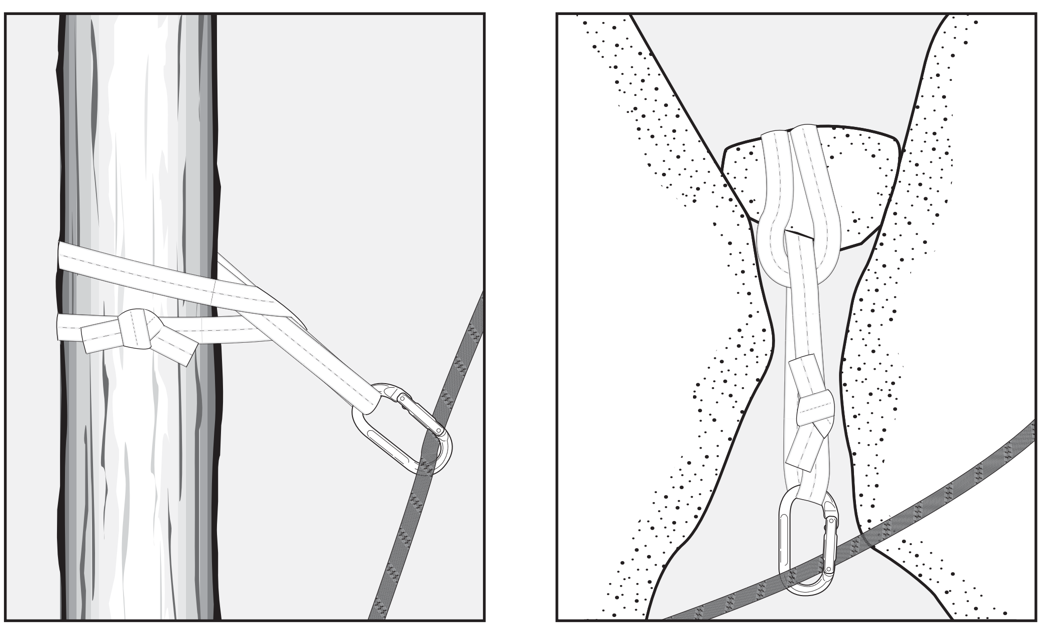

Figure 4-53. Girth Hitched Sling.

sliding around and possibly slipping off the anchor. See figure 4-54.

- *Slipknot*. Tie a slip overhand loop around the anchor. Just like the girth hitch and clove hitch, the slipknot reduces the strength of the sling, while creating friction against the anchor that helps prevent the sling from sliding around and possibly slipping off the anchor. This method uses less sling material, which allows the use of a shorter sling. See figure 4-55.

Carabiners

When using a single anchor point, the attachment point for the system should consist of one locking carabiner or two nonlocking carabiners with the gates opposite and opposed. When correctly opposed, gates should open on opposite sides and form an "X." See figure 4-56.

When using multiple anchor points, nonlocking carabiners will suffice on all but the main

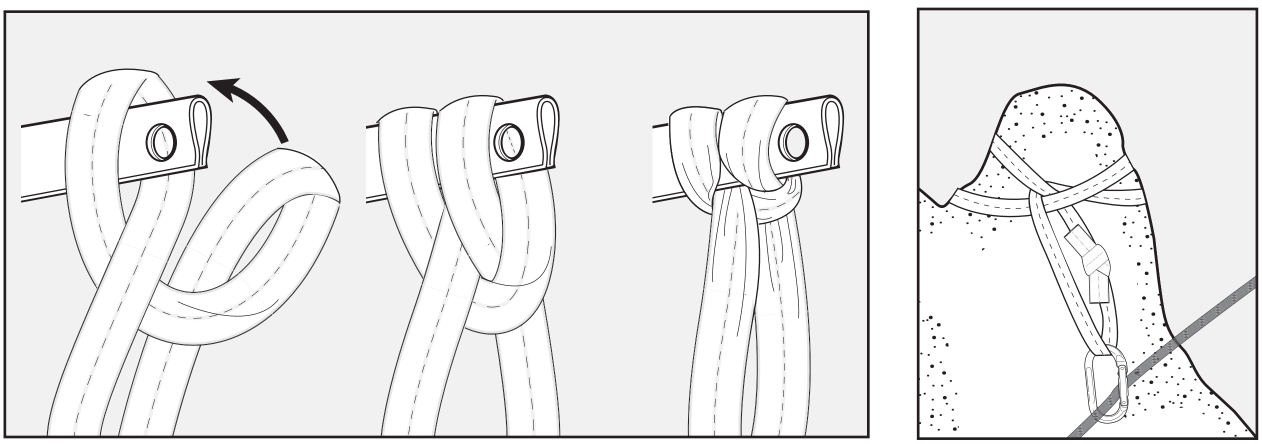

Figure 4-54. Clove Hitched Sling.

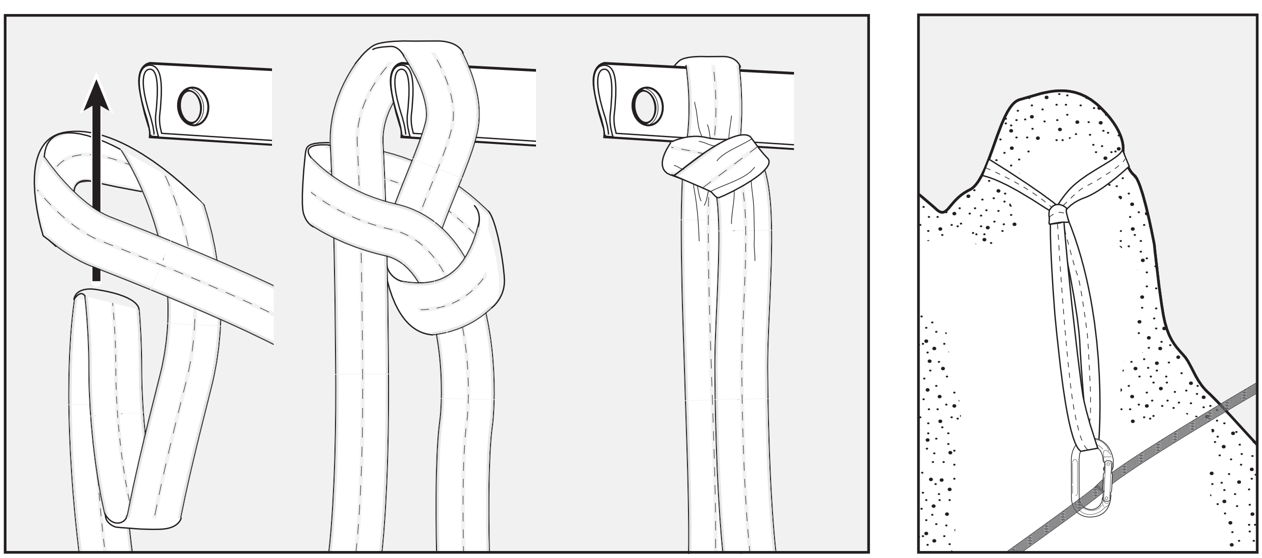

Figure 4-55. Slipknot Sling.

attachment point. There, one locking carabiner or two nonlocking carabiners with the gates opposite and opposed are required. Carabiners should not be clipped in succession. They can twist, which weakens them and can cause the gates to open. Once the system is loaded, the carabiner must not be cross-loaded against an edge.

Connecting the Rope

When connecting the rope to a single anchor, use any suitable anchor knot and clip it into the carabiner. When connecting to multiple anchors, the rope should be secured using one of the three equalization methods described later in the chapter. Equalization helps distribute the load among the different anchor points such that the force applied to any single point is less than the total force applied on the system.

In-Line Two-Point Anchor System

The two anchor points should be in line with the direction of pull. See figure 4-57. The primary anchor point is the one nearest the running end, while the secondary anchor point is directly behind the primary.

The primary anchor knot should be an around-the-object clove hitch for ease of untying the system after tension has been placed on the rope. If a round turn and two half hitches are tied on the secondary anchor, then Marines must ensure it and the clove hitch on the primary anchor are on the same side of the anchors. The secondary knot is tied around a suitable anchor point, ensuring that the rope is taut between the two anchor points. All knots should be near the ground to reduce leverage.

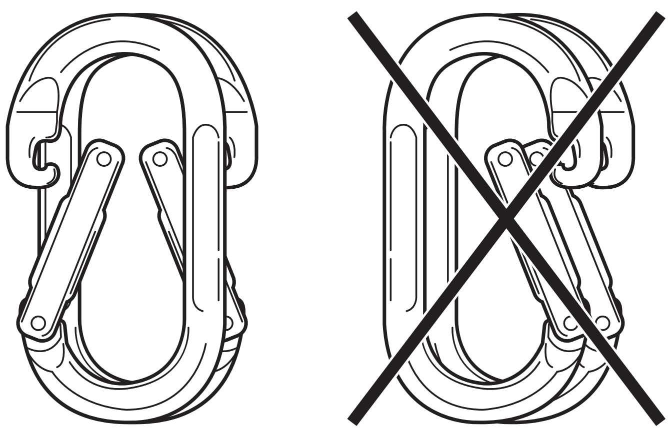

Figure 4-56. Opposed Carabiners.

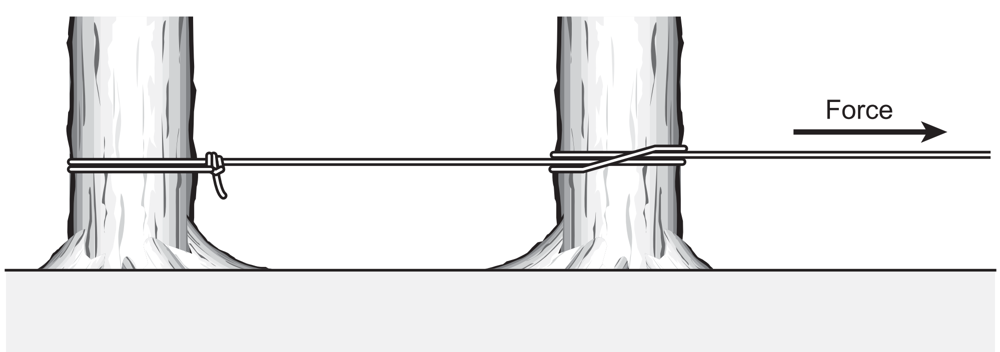

Figure 4-57. In-Line Anchor System.

Picket Hold Fast

The picket hold fast is generally easier and faster to construct than a deadman and can be used almost anywhere. It uses the same principle of the in-line anchor system. The strength of this system depends on the relative strength of the stakes and ground composition. The principle is the same whether using snow pickets or engineer stakes and whether permanent or temporary.

To place the stakes, drive two or three stakes into the ground, stakes should be in line with the direction of pull. On flat to gentle slopes, stakes should be first placed perpendicular to the slope and angled 10 to 30 degrees back from the direction of pull. The distance between the pickets can be anywhere from 3 to 12 feet apart, depending on the terrain and ground composition. Padding or buffing should be placed around the base of the pickets.

The rope is connected to the base of the furthest picket away from the direction of pull, using a round turn and two half hitches. With the running end of the rope, an over-the-object clove hitch is tied to the base of the middle picket, if applicable. Then, another over-the-object clove hitch is tied to the base of the closest picket. There should be tension on the rope in between each picket.

The pickets are tied off to themselves by connecting one end of a sling rope to the base of the furthest picket using a round turn and two half hitches. The other end connects to the top of the middle picket using a round turn and two half hitches. A second sling rope connects one end to the base of the middle picket using a round turn and two half hitches. The other end of the second rope connects to the top of the closest picket using a round turn and two half hitches. This step should be skipped if using two stakes. All knots should be kept on the same side of the pickets to allow for rapid check of the system and as close to the ground as possible to reduce leverage. See figure 4-58.

Note: If using two stakes, eliminate the right stake pictured in figure 4-58.

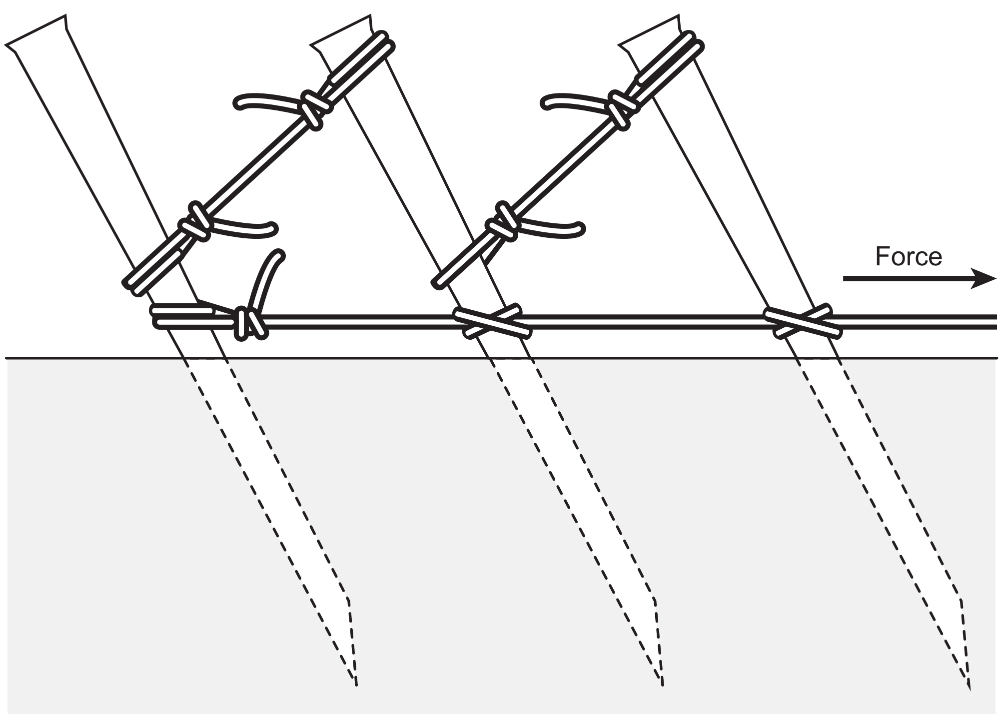

Figure 4-58. Picket Hold Fast.

Deadman

The deadman, also known as T-trench anchor, is any solid object, natural or artificial, that can be buried into the ground and used as an anchor point. This system is built in the ground, and, depending on size of buried anchor and ground consistency, may require considerable time and effort to construct. Construct a deadman using the following steps:

- Dig a trench perpendicular to the direction of pull—the main trench. It should be big enough to allow the anchor to be buried and it should be undercut on the load side.
- Dig another trench perpendicular to the main trench. It should intersect the main trench at its middle and should point directly toward the direction of pull. Ensure this trench is dug deep enough so that it joins the bottom of the main trench.
- Connect the rope to the anchor point by either using an anchor knot incorporating a round turn or by girthing a sling around it, which helps prevent the attachment point from sliding off the anchor.
- Place the anchor in the trench and cover it with dirt, ensuring that the point where the two trenches intersect remains uncovered, which allows the attachment point to remain under observation.
- To improve stability especially when in soft soil, stakes can be driven into the ground on the load side, against the deadman. See figure 4-59.

Equalized Rope Anchor

This system is secured to two or more natural or artificial anchor points using the standing end of the rope. An equalized anchor is constructed using the following steps:

- Connect a carabiner to each of the anchor points using any of the methods described earlier in this chapter.
- Tie a figure-8 loop in the standing end of the rope and clip it into the carabiner of one of the outside anchor points. Clip the rope into the remaining carabiners. See figure 4-60 on page 4-42.

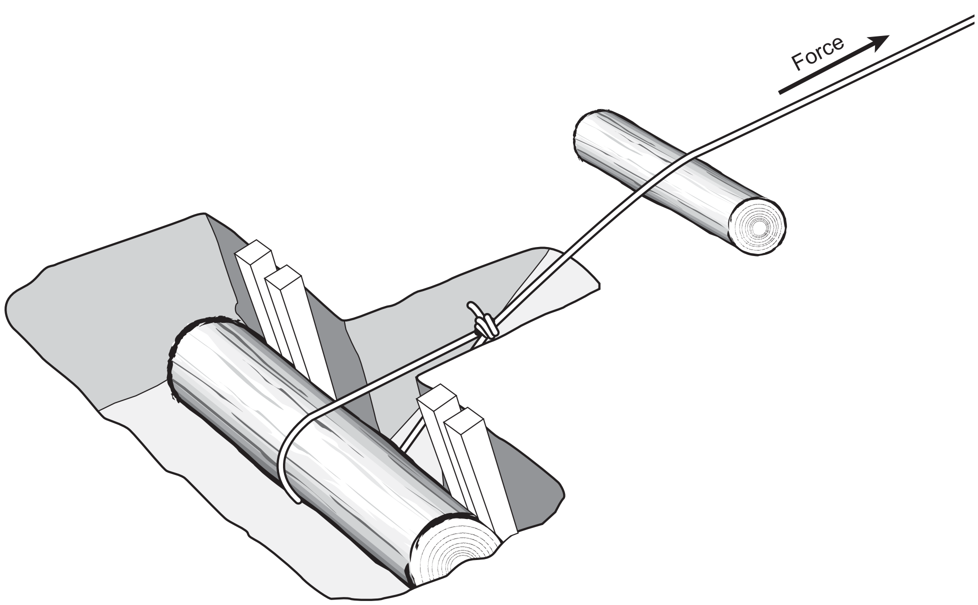

Figure 4-59. Deadman Anchor.

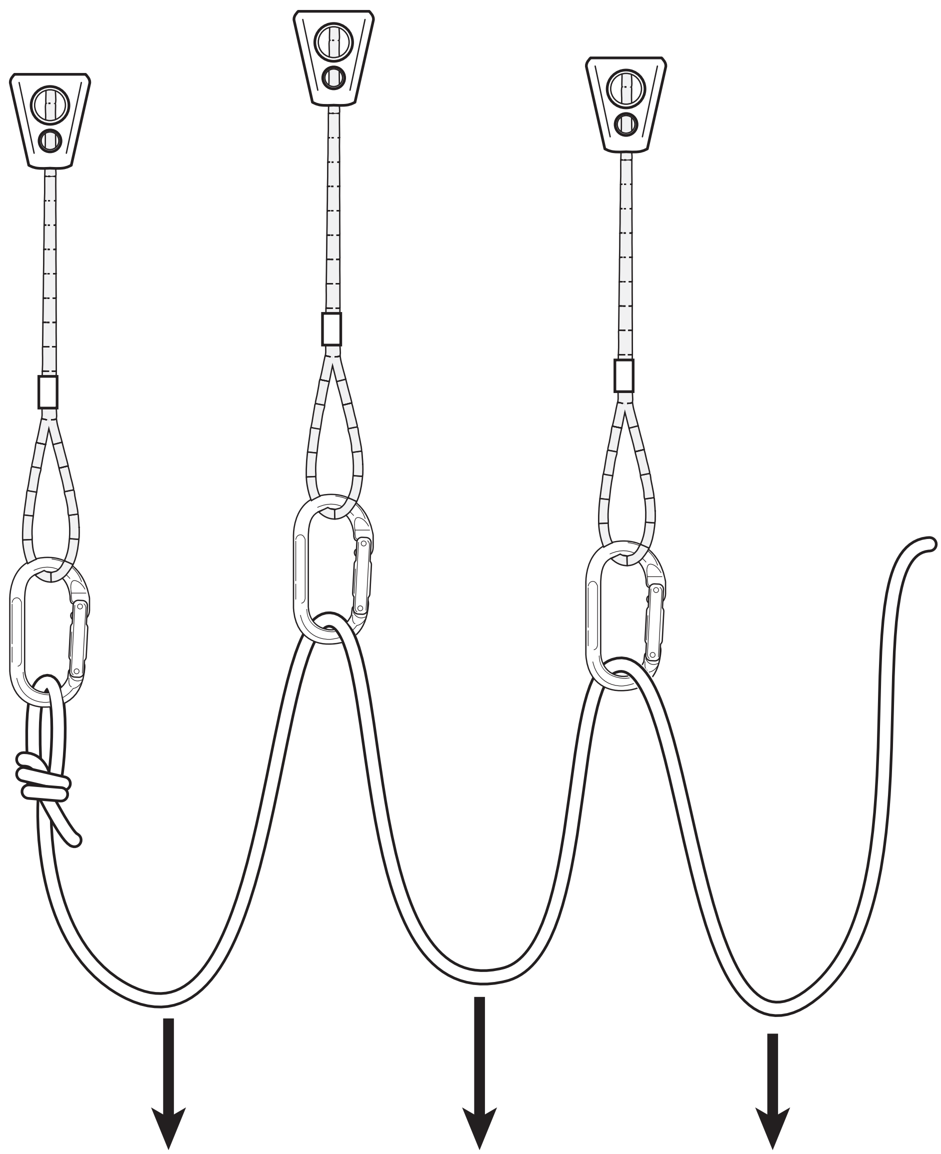

Figure 4-60. Clip Rope and Form Bights.

- Pull a bight of rope between each anchor point in the anticipated direction of pull.
- With all the bights, tie an overhand or figure-8 knot around itself to include the running end of the rope. See figure 4-61. The overhand knot requires less cord, but it will be much harder to untie if heavily loaded. The loops coming out of the front of this knot provide the main attachment point or master point of the anchor.
- With the running end of the rope coming out of the back of the knot, tie a figure-8 loop and connect it to the loops coming out of the front of the knot with a locking carabiner. See figure 4-62 on page 4-44.

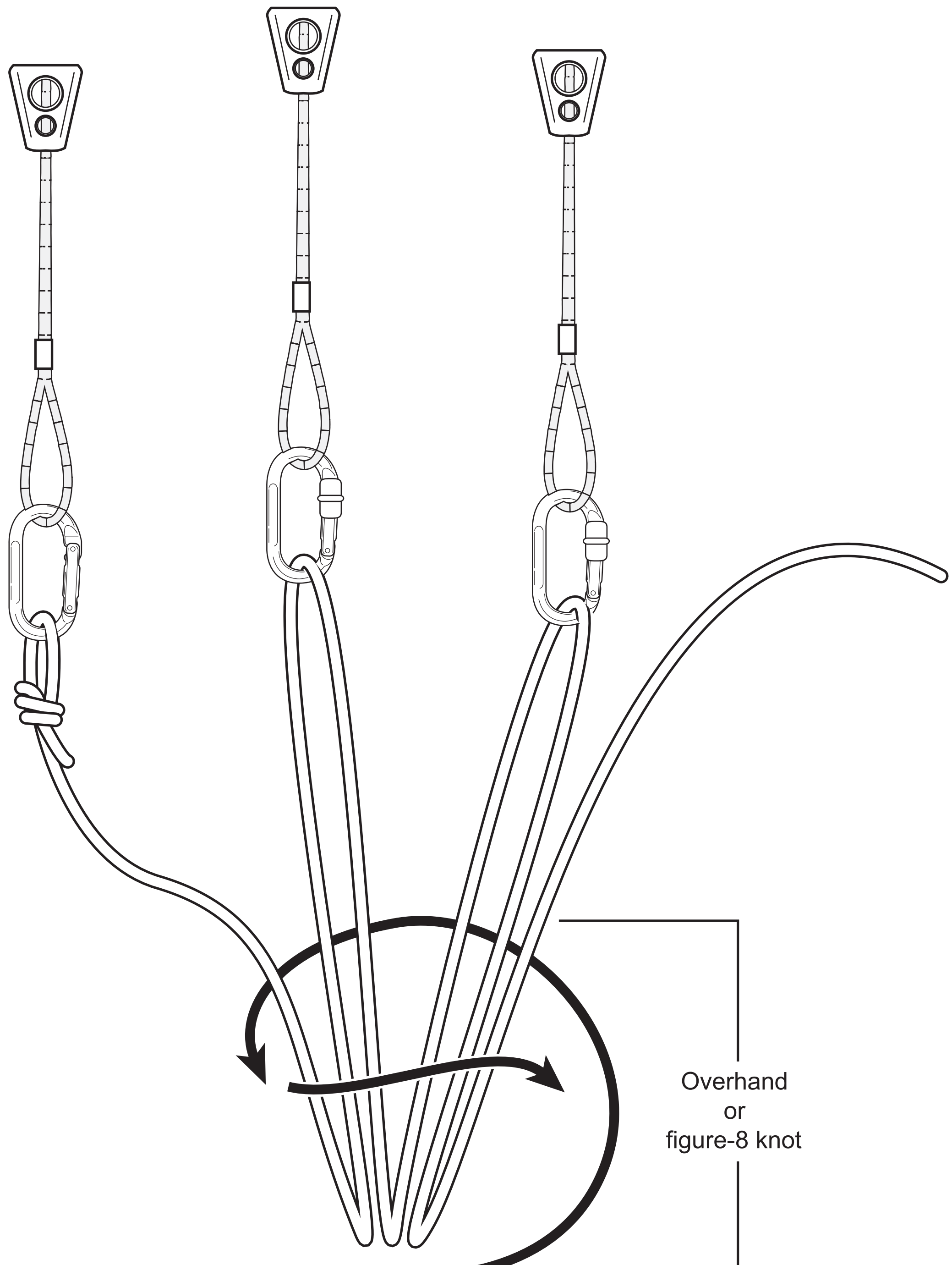

Figure 4-61. Overhand.

- Dead rope should remain on the rope between the overhand and the carabiner to ensure that the entire load is applied to the carabiner and not to the overhand knot.

In the event that one or more anchor points fail, the system will not extend. However, the direction of pull must be exact. The system will not adjust for changes in the direction of pull.

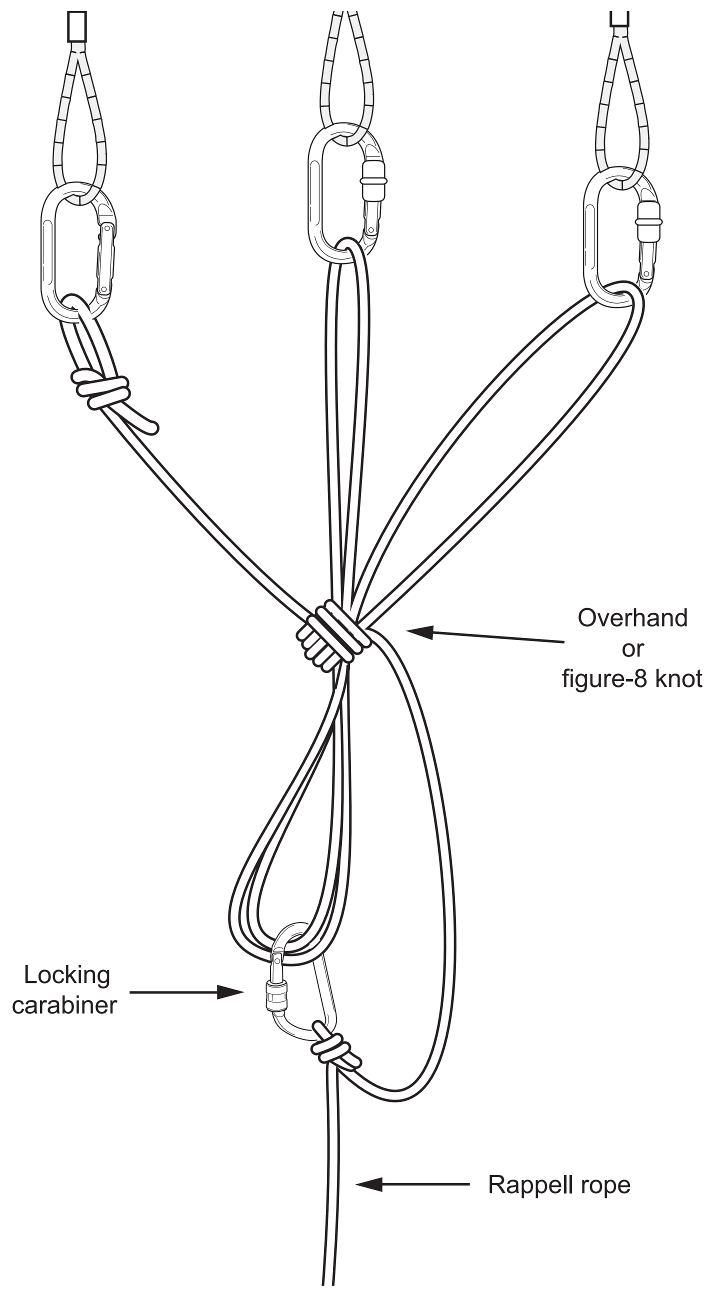

Figure 4-62. Equalized Rope Anchor.

Equalized Cordelette Anchor

Also known as a pre-equalized anchor, the equalized cordelette anchor method uses an 18-foot piece of 7 to 8 mm perlon cord connected at the ends with a suitable knot to create a closed loop. Webbing and other cordage may be used. The length of the cordage used depends on the distance between the anchor points. The system is secured to two or more natural or artificial anchor points. To construct, use the following steps:

- Connect a carabiner to each of the anchor points, using any of the methods described previously.
- Clip the cordelette into each of the carabiners.
- Pull a bight of rope down between each carabiner into the intended direction of pull. See figure 4-63.

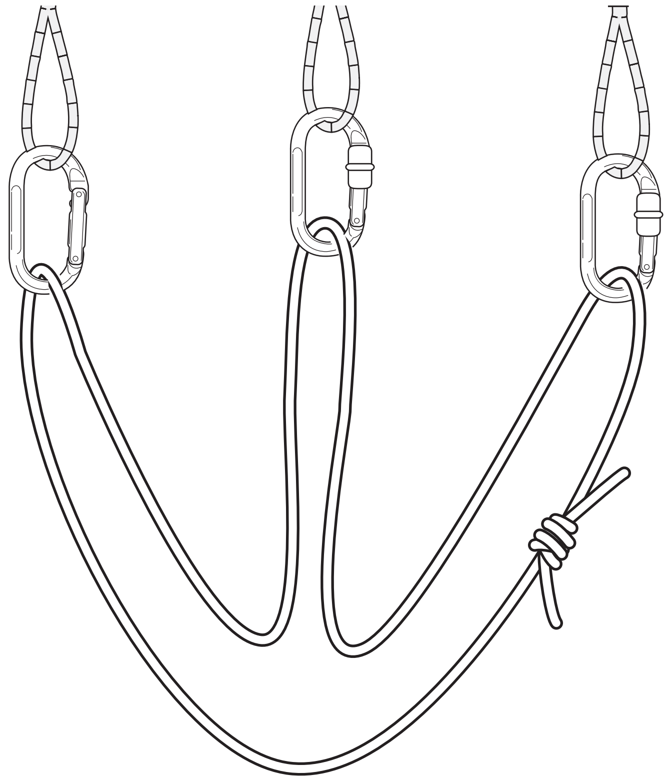

Figure 4-63. Cordelette Anchor Clip In.

- Tie an overhand or figure-8 knot on itself using all the bights. The overhand knot requires less cord, but it will be much harder to untie if heavily loaded. See figure 4-64 on page 4-46.
- Place a locking carabiner into the resulting end loop, which serves as the main attachment point or master point of the anchor system.

This system has the same advantages and disadvantages as the rope method. However, it can also be used to create a stronger anchor point by equalizing two less than ideal anchor points.

Web-o-lette Method

An alternate method uses webbing or spectra with presewn loops at each end. Fixed loops can be tied at the end of standard perlon cordage or webbing to create an improvised web-o-lette; however, this is not the preferred method. The cordage used for a web-o-lette is shorter and lighter than the one used for a cordelette, but not as versatile. To construct—

- Connect a carabiner to each of the anchor points, using any of the methods described previously.
- Clip the two fixed loops of the web-o-lette into the respective carabiners of the outer anchor points.
- Take the middle of the web-o-lette and clip it in the remaining carabiners.
- Pull a bight of rope down between each carabiner into the intended direction of pull.
- With all of the bights, tie an overhand or figure-8 knot on itself.
- Place a locking carabiner into the resulting end loop.

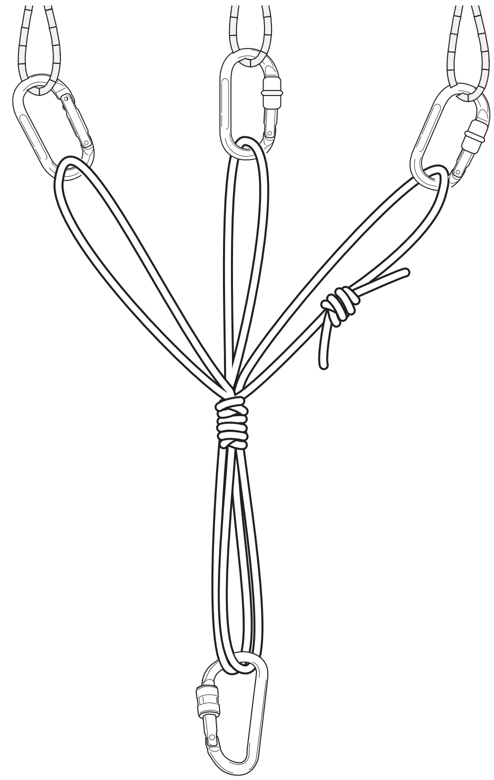

Figure 4-

American Triangle

HAZARD: Beware of using this system because it is not properly equalized. The sling is simply clipped into two anchors and the carabiner of the master point forms a triangle between the three carabiners. With this system, forces on the anchors are dangerously multiplied and may be many times more than the actual load.

Self-Equalizing Cordelette Anchor

This method uses the same materials and anchor points as the equalized cordelette anchor system. To construct—

- Connect a carabiner to each of the anchor points, using any of the methods described previously.
- Clip the cordelette into each of the carabiners.
- Grasp the intermediate sections of cordelette between each carabiner and place a half twist in each section to create loops.
- Connect these loops and the outer part of the cordelette with a locking carabiner. This connection serves as the main attachment point or master point of the anchor system. It is essential that the half twists are placed on the intermediate sections, which prevents the system from completely slipping through the carabiners and leaving the rope unanchored should one anchor fail. See figure 4-65.

Advantages of this system are—

- Knowing the exact direction of pull is not required.
- The system will adjust for changes in the direction of pull.
- The system can also be used as a means of creating a stronger anchor point by equalizing two less than ideal anchor points.

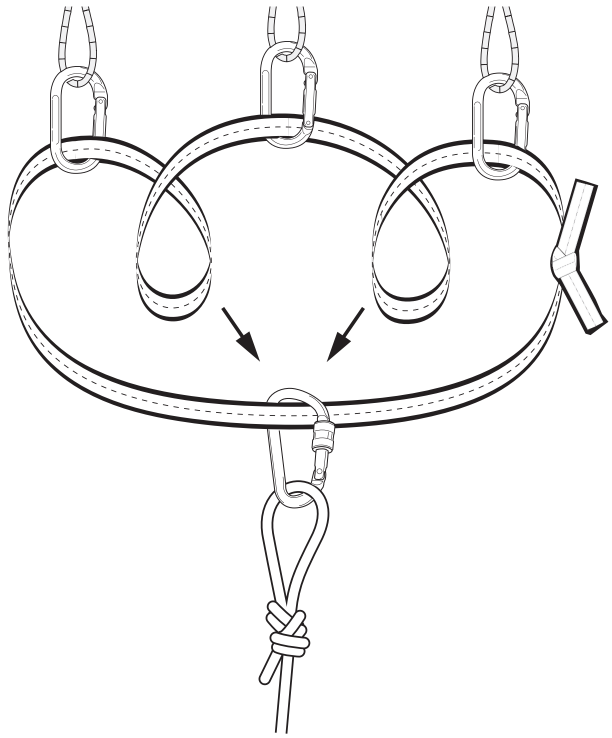

Figure 4-65. Self-Equalizing Cordelette Anchor.

Disadvantages of this system are—

- Under severe loading, the system can lock and concentrate the load only on a single anchor.
- This method also violates the "No Extension" principle of evaluating an anchor system.
- In the event that one or more anchor points fail, the system will extend. This shock loads the remaining anchor points with a dangerously high impact that can cause them to fail. A limiting knot can be tied on the loop of cordelette connected to the furthest or suspect anchor to minimize the extension, which minimizes the self-equalizing range of the system.

Principles for Evaluating an Anchor System

The principles for evaluating an anchor system are remembered by SRENE:

- *Solid*. Each individual component and the system as a whole should be solid without question.
- *Redundant*. Redundancy should exist throughout the entire system. All components, to include anchors, slings, and carabiners, should be backed up. Two solid anchors are considered a minimum in most cases. Three or more, however, are preferable. One really bombproof anchor is sometimes acceptable. An example would be a large healthy tree used for a retrievable system. When in doubt, add another equalized anchor or two.
- *Equalized*. An equalized system distributes the load equally between the various anchor points, increasing the overall strength of the system and reducing the chance of a single anchor point pulling out under stress.
- *No extension*. No extensions eliminate the possibility of the anchor system extending in the event that one of the anchor points fails. Sudden extension in the system from failure of one or more anchor points shock loads the remaining anchor points with a dangerously high impact and can cause them to fail.

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CHAPTER 5
SYSTEMS FOR LIFTING AND CROSSING

Mechanical Advantage Systems

Mechanical advantage systems use pulleys to transmit force, such as lifting an object or tightening a rope. Specifically, it is the advantage of the ratio of the force that performs the system's work to the force applied to it. The use of mechanical advantage enables one or two Marines to have the strength of many.

For example, there is a heavy block suspended from two ropes in figure 5-1. The upward force on the block is the tension in the ropes and the sum of the two tensions must equal the weight of the block. If the whole system is symmetrical, each of the two ropes is under tension equal to half the weight of the block (equivalent to a 2:1 ratio). If there was one rope holding the block, it would hold the full weight and there would be no advantage.

In figure 5-2 the block has been attached to a pulley. There is now only one rope, which passes through the pulley. The tension in the rope is the same throughout; if it were different on one side than on the other, the pulley would turn until the tension on the two sides equalized. The tension in the rope is still only half the weight of the block.

Work is an activity in which strength or faculties are exerted to do or perform something. It is a sustained physical or mental effort to overcome obstacles and achieve an objective or result.

While pulleys are useful, they do not give something for nothing. Ignoring the problem of friction (force which opposes the movement of one surface sliding or rolling over another with which it is in contact), the input and output forces are in inverse ratio to the respective distance. The solution is the following formula:

$$\frac{\text{Effort}}{\text{Load}} = \frac{\text{Load distance}}{\text{Effort distance}}$$

EXAMPLE: If a Marine has a log that weighs 100 pounds. To lift it two feet, using a 2:1 ratio system, the formula is—

$$\frac{50}{100} = \frac{2\text{ feet}}{4\text{ feet}}$$

The frictionless pulley does not alter the product of force and distance. There is another limitation on the definition of work. Only the force in the

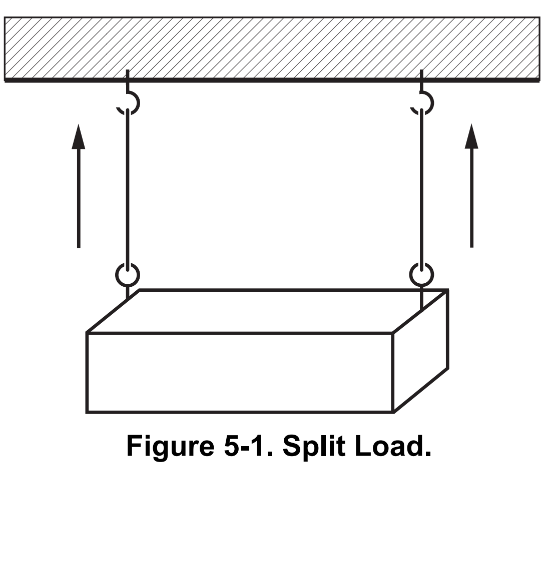

Figure 5-1. Split Load.

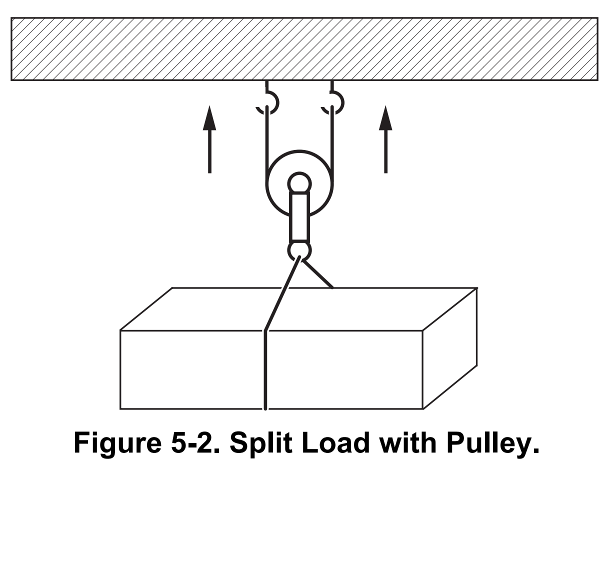

Figure 5-2. Split Load with Pulley.

direction of motion counts, so the angle on which the Marine directs the pull of the system will determine the actual advantage that it will receive. See figure 5-3.

There are various mechanical advantage systems named by the ratio of its mechanical advantage, such as 1:1, 2:1, 3:1, and 9:1. These systems are discussed in the following subparagraphs.

Constructing the 1:1 Ratio System

To construct—

- Attach the pulley to a suitable anchor point.
- Anchor one end of the rope to the load.
- Run the other end of the rope through the pulley.
- To equalize the load, pull the rope until there is tension on the system. If the load weighs 100 pounds, theoretically it should only take 100 pounds of force to lift the load, but, due to friction, it may require 110 pounds of force to equalize the load. To lift the load one foot, the Marine will have to pull the rope one foot.

This method is referred to as a directional pulley or redirect and gives no mechanical advantage at all. See figure 5-4.

Constructing the 2:1 Ratio System

A 2:1 system is known as a "C." To construct—

- Attach one end of the rope to a suitable anchor.
- Attach a pulley to the load.
- Run the other end of the rope through the pulley.

Now, a Marine can raise the load with the amount of force that is equal to half of its weight. See figure 5-5.

To lift the load two feet with this system, a Marine must pull four feet of rope through the pulley. When each rope is equalized, divide by two. So if the load weighs 100 pounds, each line has 50 pounds of supported weight.

Constructing the 3:1 Ratio System

A 3:1 system is known as a "Z." To construct—

- Anchor one end of the rope to a suitable far anchor using the tree wrap method.
- Tie a swami wrap around the near anchor and clip a locking carabiner with the gate up and large axis facing the far anchor. This carabiner is referred to as the main anchor carabiner (MAC).

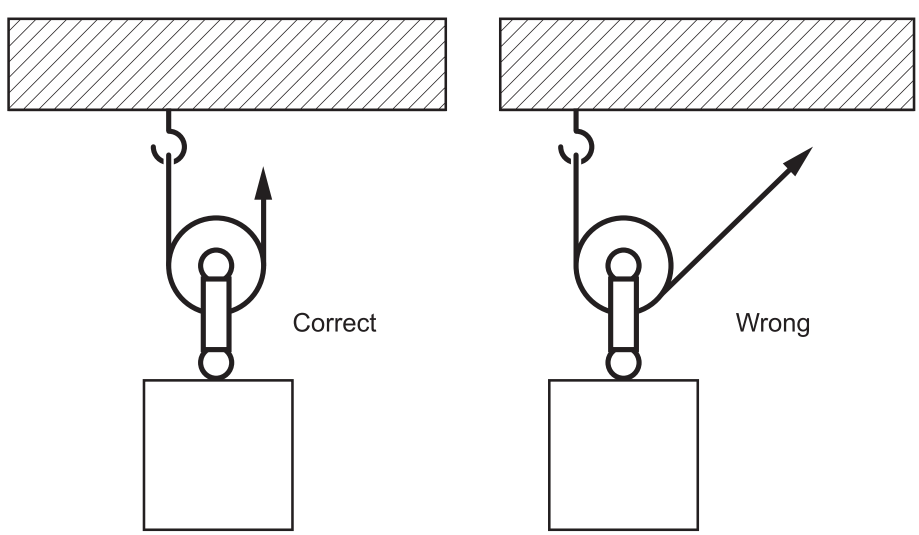

Figure 5-3. Pulling Angles.

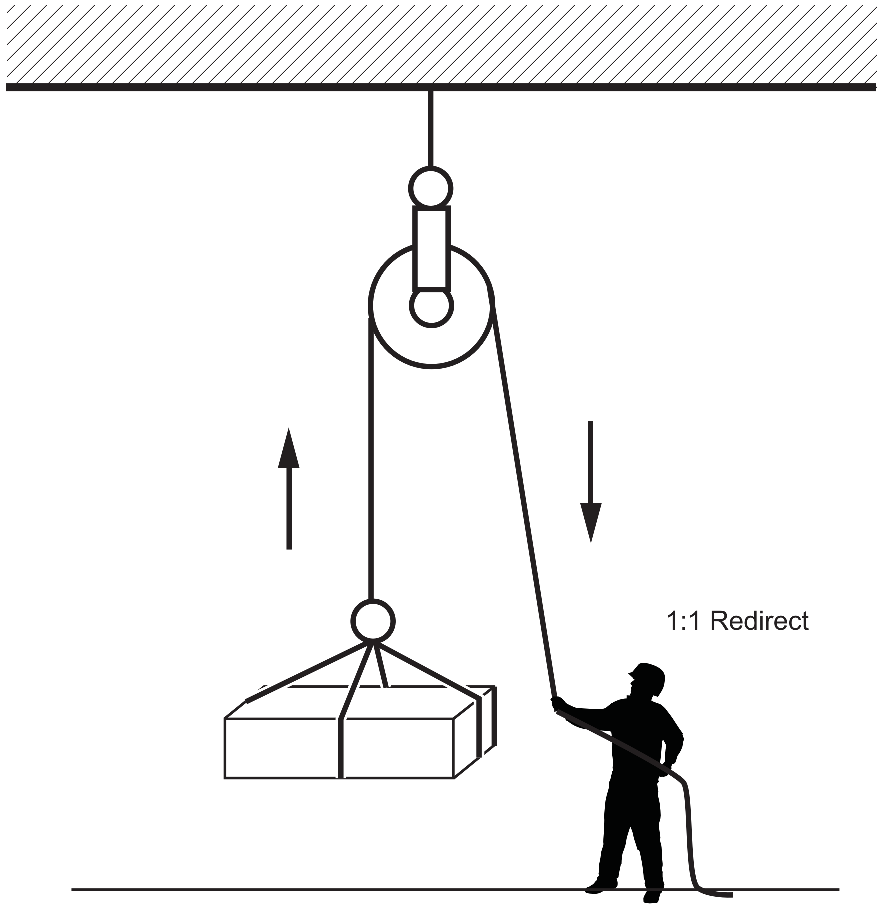

Figure 5-4. Redirect–No Advantage.

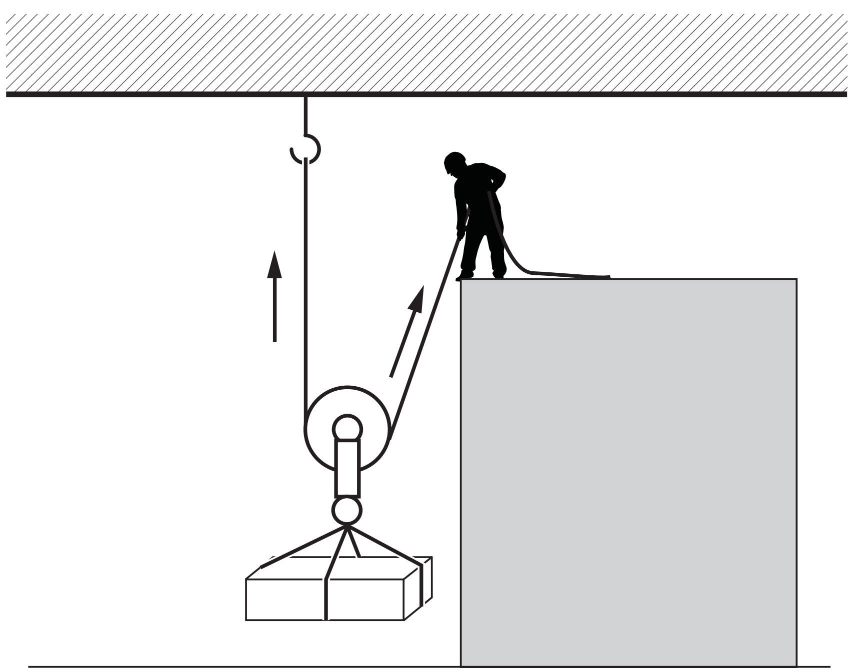

Figure 5-5. 2:1 Mechanical Advantage (C).

- Take the running end of the rope from the far anchor and clip it into the MAC. Tie a stopper knot (auto block) with a short prusik on the rope, attach it back into the MAC, and lock it down. See figure 5-6.
- Using another short prusik, come out from the swami wrap a few feet and tie a stopper knot (French prusik) on the rope and clip a locking carabiner into it with the direction of pull toward the near anchor. Clip the running end of the rope from the auto block into the carabiner and lock it down.
- Pull the running end of the rope to tighten the rope installation. See figure 5-7.

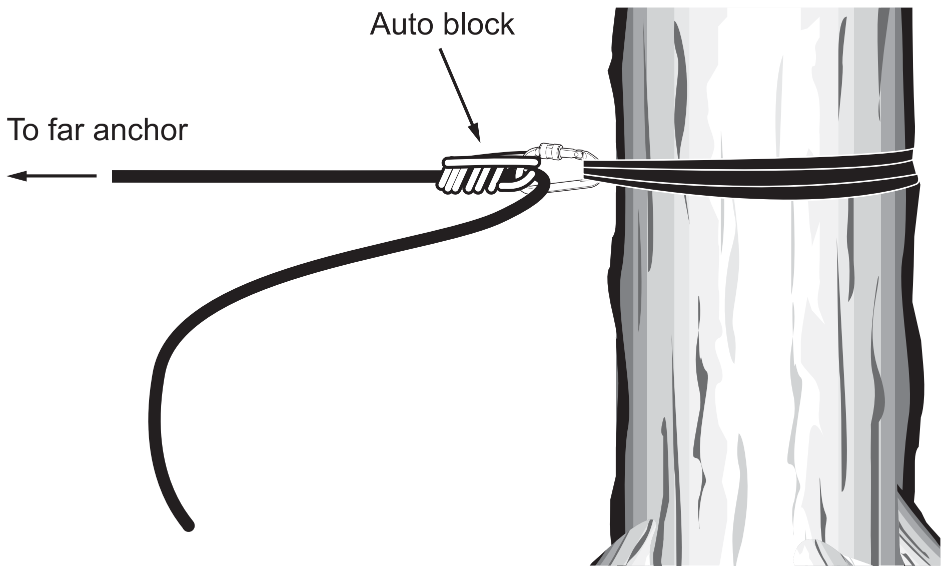

Figure 5-6. Auto Block.

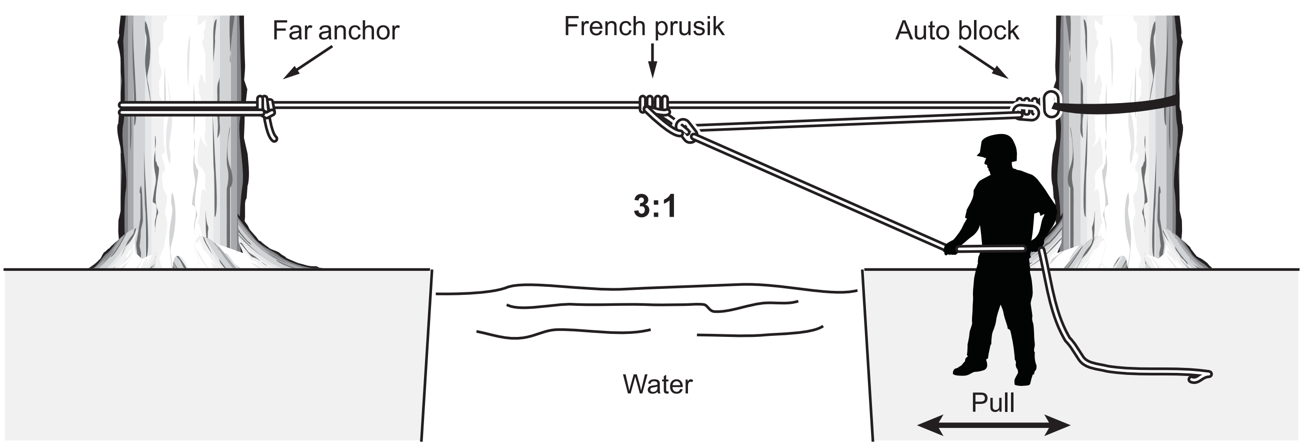

Figure 5-7. Tightening a 3:1 Mechanical Advantage (Z).

WARNING

Do not use a mechanical ascender in place of the auto block or French prusik.

Constructing the 9:1 Ratio System

A 9:1 system is known as a "Z-Z." To construct—

- Anchor one end of the rope to a suitable far anchor using the tree wrap method.
- Tie a swami wrap around the near anchor and clip a MAC through all the wraps with the gate up and large axis facing the far anchor.
- Take the running end of the rope from the far anchor and clip it into the MAC. Tie a stopper knot (auto block) with a short prusik on the rope, attach it back into the MAC, and lock it down.
- Using another short prusik, come out from the swami wrap a few feet and tie a stopper knot (French prusik) on the rope. Clip a locking carabiner into it with the direction of pull toward the near anchor. Clip the running end of the rope from the auto block into the carabiner and lock it down.
- Take the running end of the rope back to the swami wrap. Attach another locking carabiner into the MAC with the large axis facing down and out to the far anchor. Clip the rope into this carabiner and lock it down. See figure 5-8 on.
- Holding the rope that runs between the second stopper knot and the carabiner hanging from the MAC, go back to a few inches before the French prusik and tie a third stopper knot (French prusik) on that line of rope with a locking carabiner attached to it. Clip the running end of the rope into the carabiner and lock it down. See figure 5-9 on page 5-6.
- Pull the running end of the rope to tighten the rope installation. See figure 5-10 on page 5-6.

Note: Care must be taken when increasing the ratio system. Breakage and damage to the ropes, carabiners, and pulleys is very possible if the force end of the rope is greater than the load end of the rope. No more than two individuals will tension the installation at any time.

One-Rope Bridge

A one-rope bridge can be used to cross various gaps, such as rivers and gorges.

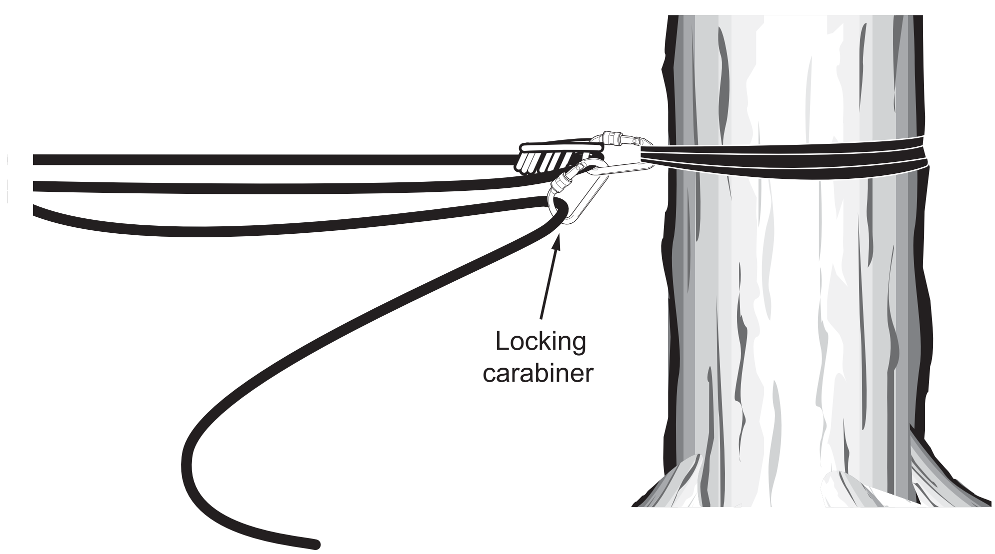

Figure 5-8. Carabiner into the Main Anchor Carabiner.

Site Selection

An ideal site for a one-rope bridge must have suitable anchors on both sides of the stream that offer good loading and unloading platforms. The site chosen for the initial crossing does not have to be at the location for the construction of the bridge, just as long as the rope can be taken to the selected site for the crossing.

The site chosen for the lead swimmer to cross should be as free as possible from obstacles, such as large boulders, stumps, or logs, in the water and should allow clear fields of fire to cover the scout swimmer once he/she is on the far side, if needed.

The anchors must be close enough for the rope to reach the near and far sides. It will take approximately one-third of the rope for tightening and anchoring of the bridge.

Distance Estimation

The azimuth method and the unit average method can be used to determine the distance across the gap between the anchor points. To employ the

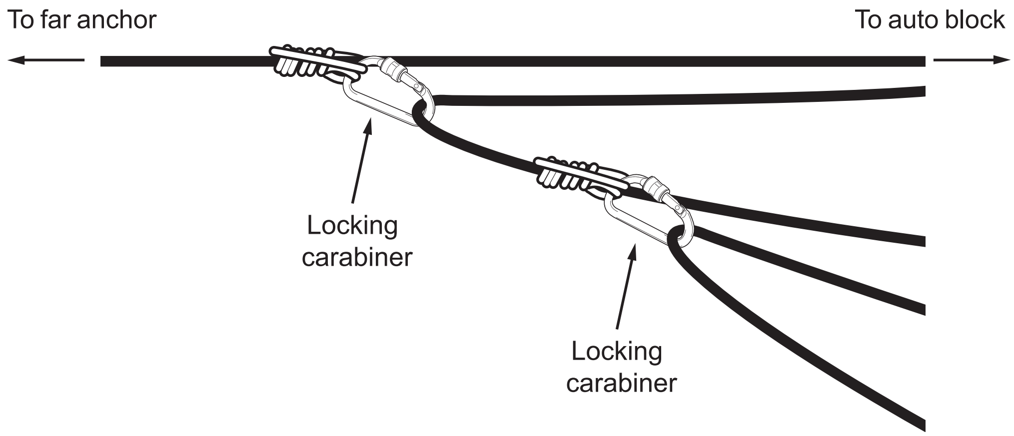

Figure 5-9. Clipping into the Prusiks.

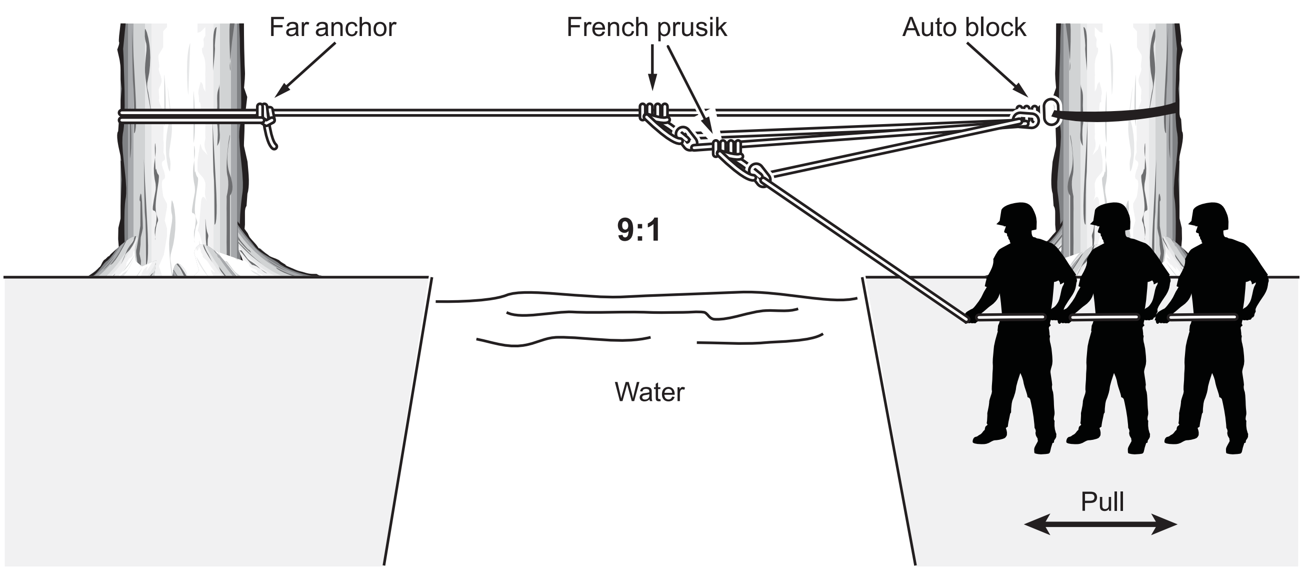

Figure 5-10. Tightening a 9:1 Mechanical Advantage.

azimuth method, shoot an azimuth to a point on the far side of the intended obstacle to cross; then, move left or right (perpendicular to the azimuth) until a 15-degree offset is achieved from the azimuth. Next, measure the distance in feet by pacing from the first azimuth to the second azimuth and multiply that distance by three. This total will give the approximate distance across the obstacle in feet.

The unit average method takes the average of three Marines' best guesses of the distance across the intended obstacle. To do this, add all three distances together and divide by three. The quotient is an estimation of the distance across the obstacle.

Example:	Marine 1 -	240 feet	
	Marine 2 -	230 feet	
	Marine 3 -	250 feet	
		720 feet	720 divided by 3 = 240 feet

Organization

The organization of constructing a one-rope bridge is broken down into the following three groups:

- The nearside team, consisting of the bridge noncommissioned officer (NCO) and another Marine.
- The farside team, consisting of the lead swimmer and his/her belay person.
- The security team, consisting of the rest of the party.

Construction

The one-rope bridge is ideal for squad- and platoon-sized units because of its quick construction and minimal amount of required equipment.

Occupying the Site

Once the bridge NCO has designated the site for the bridge, two teams will prepare the site for construction. On the near side, the bridging team will tie a simple figure-8 anchor. Once the anchor is secure, they flake out the bridging line in order to send it across. On the far side, their first step is to flake out the rope. The lead swimmer will tie a figure-8 loop at the end of the rope that will be going to the far side, ensuring the knot has an 18- to 24-inch loop. The swimmer will place his/her neck and one arm through the loop. The loop must be large enough for him/her to slide out, if necessary. The other person will belay the swimmer.

Securing the Bridging Line

Once the two teams are on either side of the stream, they may begin constructing the bridge. On the near side, the belay person will move to the near side anchor as close to the water's edge as possible. Next, he/she will attach the bridging line to the safety line (middle-of-the-line figure-8 loop on the safety line connected with a carabiner to an end-of-the-line figure-8 loop on the bridging line). As the bridging line is being pulled across the stream, he/she must attempt to keep it out of the water.

The lead swimmer, once across, will move to the far side anchor and establish a diaper wrap anchor using 1 or 2 sling ropes joined with square knots. He/She attaches a locking carabiner with the auto block and pulls the safety line across with the end of the bridging line attached, keeping the bridging line dry. Once the bridging line is across, the swimmer's belay person will pull back the slack in the safety line in case the swimmer comes under attack and must evade back to the nearside with the help of his/her belay person and safety line. Once he/she pulls all the bridging line across, he/she will attach it to the auto block/locking carabiner and construct the 9:1. He/She will take the line downstream (there must be a 45-degree angle between anchor points) and properly secure it to a good anchor. See figures 5-11 and 5-12 on page 5-8.

Note: If a fall from a rope bridge would result in death or serious injury, then a second bridging line should be used as with a suspension traverse (tightened with a 3:1). The Marine crossing will clip into both ropes prior to crossing.

Constructing the Mechanical Advantage and Finishing the One-Rope Bridge

The swimmer will need four locking carabiners and three 3-foot prusiks to build the mechanical advantage. The 9:1 will be constructed in the same manner as was previously described.

Tensioning the Bridge

Now that the bridge is built, the bridge NCO can call up the mule team to tension the bridge. The swimmer will set the brake knot, make a bight out of the running end, and bring it around the tree while keeping tension.

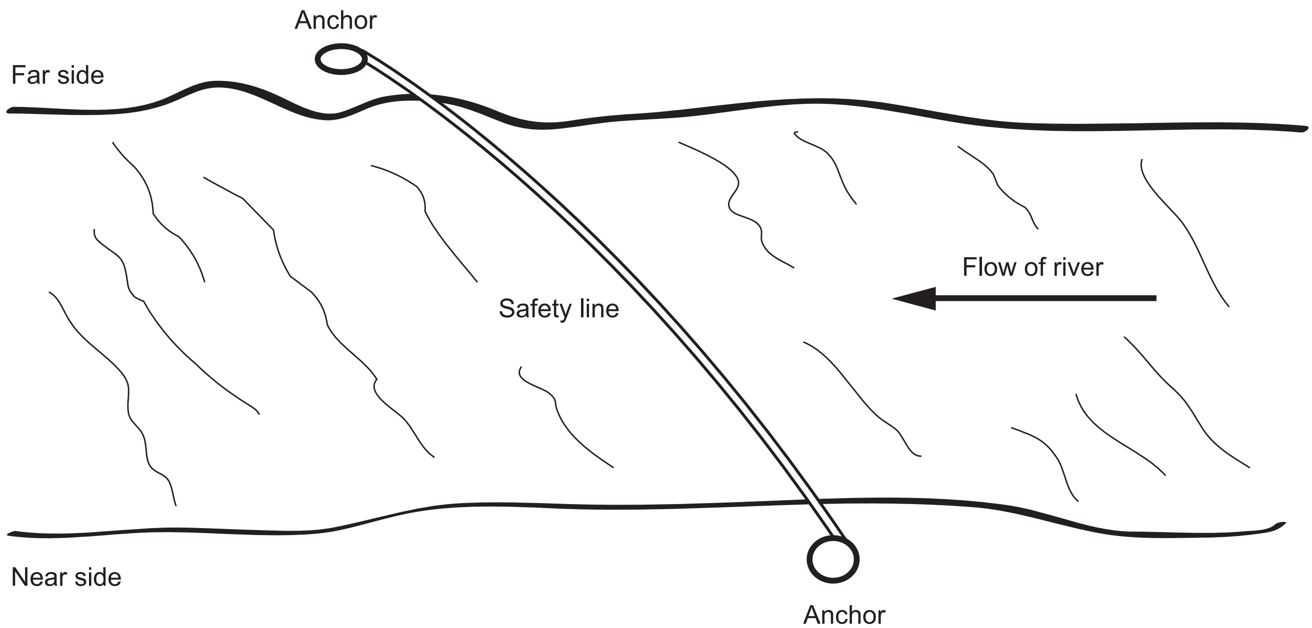

Figure 5-11. Safety Line and Anchor Points.

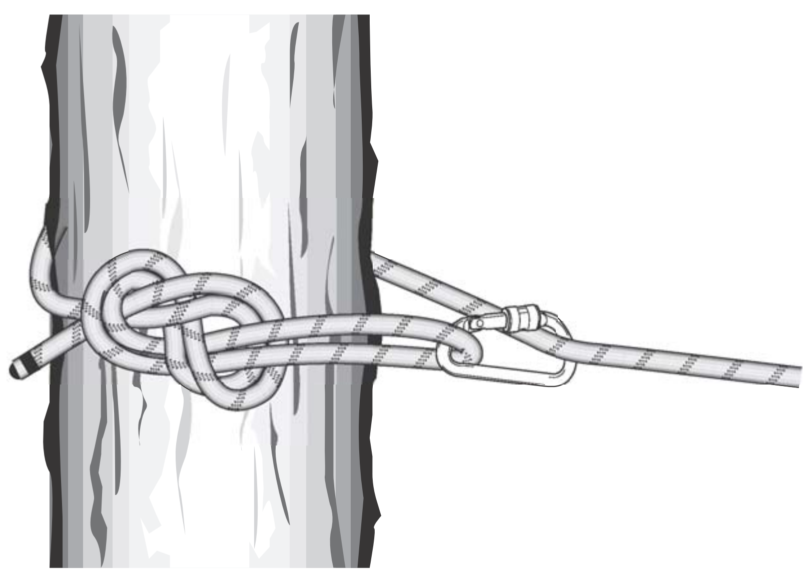

Figure 5-12. Nearside Anchor.

With the bight, he/she makes a complete round turn on the body of the carabiner and two half hitches, encompassing all the ropes just behind the anchor. See figure 5-13. Then, he/she signals to the bridging NCO to send across the first person. If necessary, the swimmer and the first person across will untie the tie-off and retighten the bridge. The last thing the swimmer will do is secure the safety line downstream at a 45-degree angle (ferry angle). The safety line should be semi-taut just above the surface of the water.

At this stage, the bridge is tight and secured, the bridge NCO will now call up the remainder of the squad/platoon to cross. The bridge NCO will monitor the crossing of all Marines and will be the last one to cross.

Crossing

The method used to cross is known as a tyrolean traverse. This traverse can be accomplished using the rappel (Swiss) seat method or the pulley method.

Rappel (Swiss) Seat Method

This method is the safest and preferred. The Marine ties themself into a rappel (Swiss) seat and inserts a locking carabiner with the gate facing down and away. He/She faces the bridge with his/her right hand toward the near anchor to snap into the bridge. Once the carabiner is locked onto the bridge rope, a helper flips the carabiner over so that the locking nut screws down. See figure 5-14 on page 5-10. Marines may need assistance reaching the bridging line. An improvised step can be made with sling ropes or tubular nylon and tied with a girth hitch.

The Marine hangs below the bridge from his/her rappel seat with his/her head pointing in the direction of the far anchor and allows his/her legs to hang free. He/She pulls with his/her arms to make progress.

If the Marine must take a pack across, it may be worn with the waistband secured; however, the preferred method is to have another carabiner (nonlocking is sufficient) attached to the pack frame at the top (with three points of contact on the pack). It is attached to the bridge behind the Marine. He/She puts his/her legs through the shoulder straps and pulls the pack across with him/her.

One person at a time will cross, although one can load and another can unload concurrently. Weapons will be worn across the shoulder; muzzle down with a tight sling securely attached to the weapon. The weapon may be worn underneath the load bearing equipment to ensure it cannot fall off.

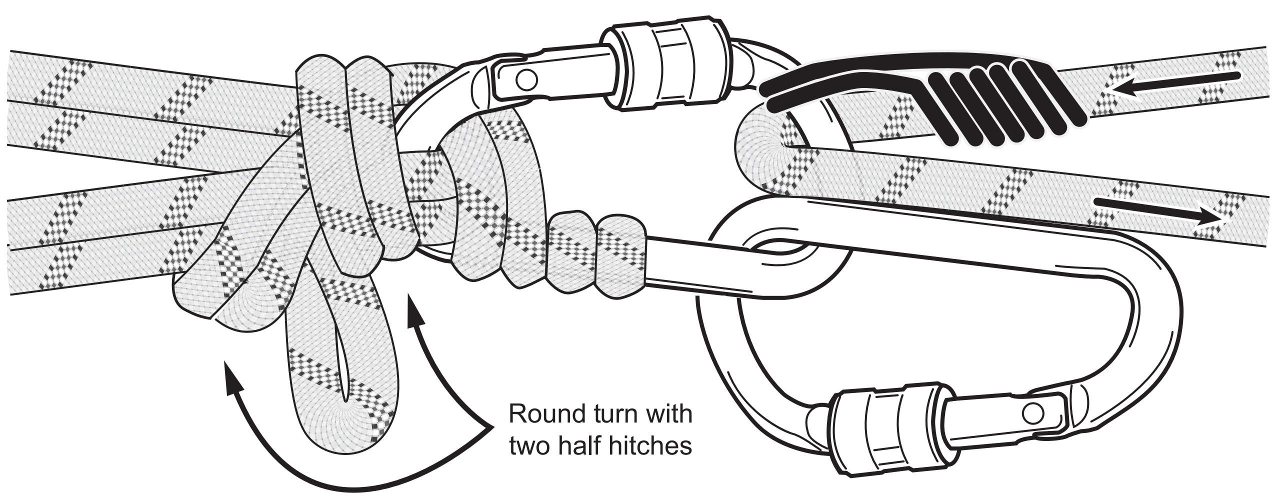

Figure 5-13. Tie Off.

Pulley Method

This method is used when the one-rope bridge is long, uphill, or when speed is vital and the Marines crossing it have a lot of heavy personal equipment, machine guns, and radios. This method requires one pulley, four locking carabiners, and a hauling line twice the length of the obstacle. This system is set up by attaching a pulley to the one-rope bridge. One carabiner is attached to the pulley, gate down, and a second carabiner is attached to it with the gate facing the near side bank. Into this second carabiner, the hauling rope is attached with a figure-8 loop. The figure-8 is placed halfway along the hauling rope and attached to the carabiner, which is then locked. Four feet down the line another figure-8 on a bight is placed into the second suspension point. See figure 5-15.

The Marine clips his/her locking carabiner into the lower carabiner; his/her equipment is

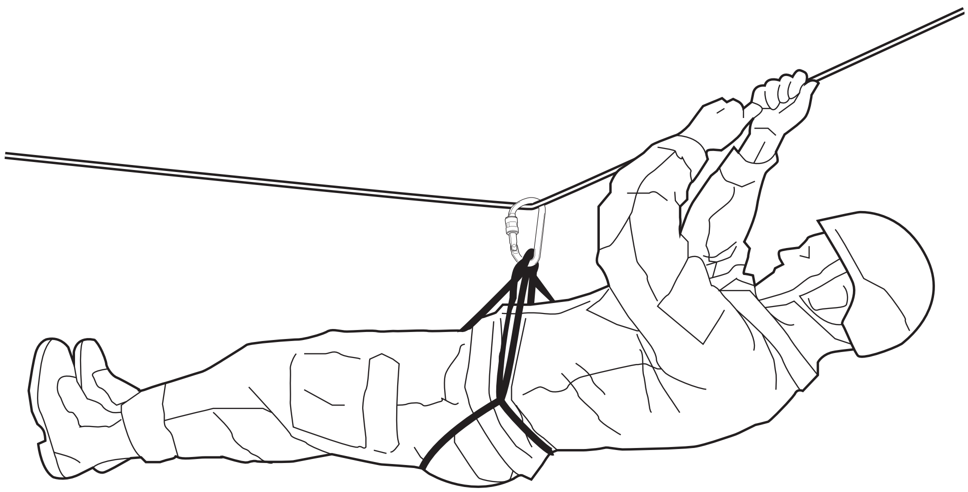

Figure 5-14. Crossing a One-Rope Bridge.

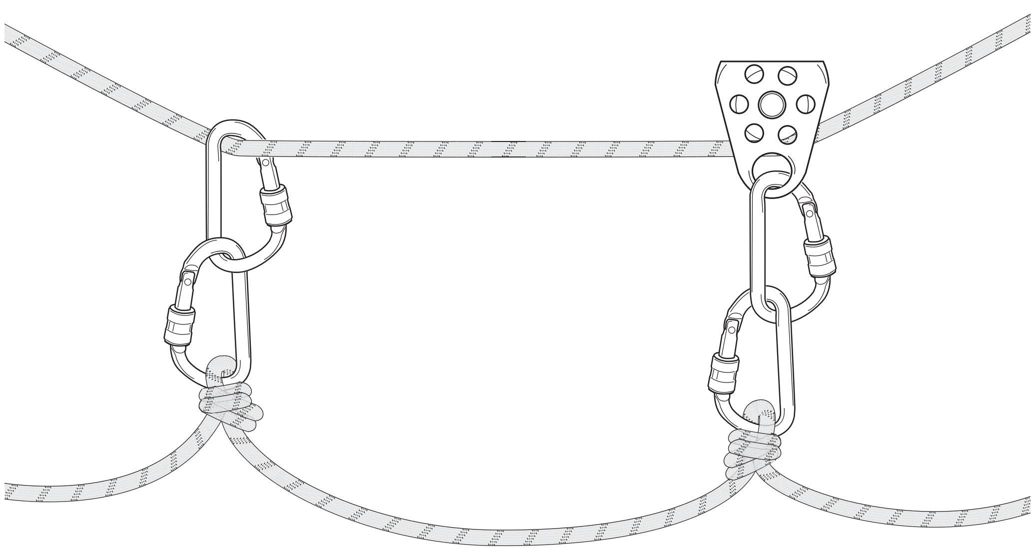

Figure 5-15. Pulley Method.

clipped into the second carabiner. Then the mule team starts to pull.

Note: There are additional methods of crossing a one-rope bridge, such as the commando crawl, monkey crawl, and hand-over-hand techniques. The person crossing is not attached to the rope when using these methods, which is a safety concern.

Rescue Techniques

If an individual is unable to complete the crossing (because of exhaustion, for example), a rescue will have to be made in the following manner:

- *Reach*. First try to reach the victim by using an object, such as a pole or your hand, if the victim is close enough.
- *Throw*. If reaching the victim is impossible, try throwing a rope and have the victim attach the rope to themself, preferably his/her seat, and pull him/her back to the desired side of the installation.
- *Tow*. If the victim is unable to catch or reach a rope being thrown to him/her or the victim is unconscious, tie a figure-8 loop into the middle of the safety line and then connect the rope to the rope bridge with a locking carabiner. The mule team will pull the carabiner up against the victim's seat and begin towing him/her to the desired side of the installation. The rope used to tow the victim should be twice the length of the span of the rope bridge. If necessary, ropes can be tied together to accommodate the span. This rope length will allow towing from either side without having to throw or have a Marine carry the safety line back across the bridge each time a towing rescue is performed.
- *Go*. The last option will be to go after the victim. The rescuer will move out onto the rope bridge with a safety line attached to him/her at approximately eight feet from the end of the safety line. In the end of the safety line, he/she ties a figure-8 loop and inserts a locking carabiner in the end of it. Once the rescuer has made contact with the victim, he/she will attach the locking carabiner to either the victim's seat (preferably the victim's carabiner that is attached to the rope bridge) or to the bridge itself, ensuring that the carabiner is placed so that it pulls against the victim's carabiner. The mule team now starts to pull both the victim and the rescuer to the desired side of the installation.
- *Cut*. If, while crossing the rope over water, the individual goes underwater and no other rescue technique can be employed, the rope will be cut. Ensure personnel are safely out of the way of possible rope whip.

Retrieving the One-Rope Bridge

Before the bridge NCO sends the last Marine to cross, the NCO must make the bridge retrievable. The bridge NCO unties the safety line and attaches it to the end of the bridging line with an overhand knot (see fig. 5-16 on page 5-12).

The bridge NCO crosses the bridge and the safety line is brought up from downstream. The 9:1 is then disassembled and, once the diaper wrap is off, all knots and carabiners are taken out. The safety line is then pulled and the bridge is retrieved.

Gaining Height in Rope Installations

Gaining height in a rope installation, if necessary, can be accomplished by one of three ways: natural, quad-pod, or A-frame.

Natural

Gaining height by natural means is the easiest and fastest way to do it. Natural objects, such as trees, bushes, and boulders, can be used to gain height in a rope installation by running the rope over a branch and making a loading point by anchoring a sling rope to the branch and tying a prusik onto the rope with the other end of the sling rope.

When using a tree to gain height in a suspension traverse rope installation, the following points should be considered:

- Select a branch that is not rotten or has not been chopped or burned.
- The branch must be at least 6 inches in diameter or of suitable thickness to support the intended load.
- The branch should be at a sufficient height to offer adequate clearance for the load.
- A suitable anchor point must be located behind the intended branch and in relation to the direction of pull of the load (see figure 5-17).

To secure the rope in place over the branch, use a sling rope and tie a clove hitch around the branch. Secure the pigtail of the sling rope to the rope installation by tying an end-of-the-line prusik, which prevents the rope from rubbing from side to side and functions as the third leg.

Quad-Pod

A quad-pod is an artificial device used to gain height in a rope installation. A quad-pod can be used with various types of rope installations—most commonly, in conjunction with a vertical hauling line (VHL) or suspension traverse. The materials required for construction are a quad-pod, complete and at least 5 prusik cords (each 18 feet long) or a chain. Quad-pods consist of the following components:

- Apex: the apex is the point at the top of the quad-pod where the four legs connect.
- Legs: There are 4 legs on the quad-pod that can be adjusted to the desired height.

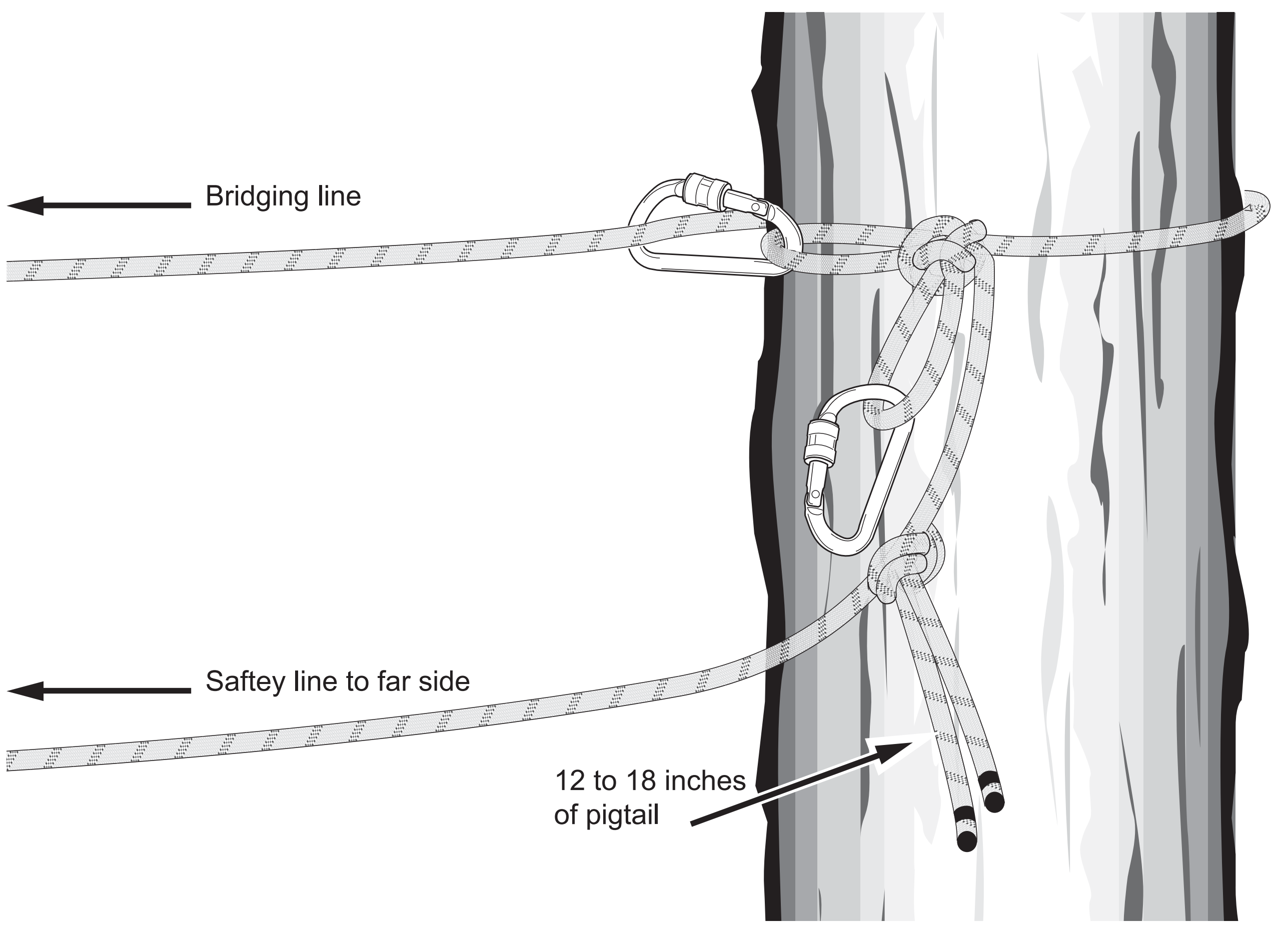

Figure 5-16. Recovery.

- Load bearing eyelets: the eyelets are located at the top of the quad-pod on the apex.
- Leg pads: The leg pads are at the end of each leg and are used as a stable platform for the quad-pod to sit on.

The quad-pod is constructed in the following manner:

- Place the quad-pod on a sturdy platform and extend the legs to the desired level of height gain.
- Secure the legs with one piece of prusik cord or the chain to the bottom of the legs using the eyelets.
- If using the prusik cord, leave 20 inches of pigtail. The pigtail goes through each eyelet. Tie a clove hitch, ensuring that the prusik cord is taut.
- With the extra pigtail left on the running end of the prusik cord, tie a square knot secured by two overhands with the standing end of the rope.
- If using the chain, run the chain through the eyelets then secure the chain to the desired length with the master link that is already on the chain.
- Take the other four pieces of prusik cord and secure the quad-pod for more stability to ensure it does not fall off the cliff, causing injury to the rescuer.
- Find a good anchor or make one out of artificial protection.
- Tie off the prusik cord to the anchor and run it back to the legs of the quad-pod. Tie it off with the appropriate knot and manage the excess rope.
- If using the quad-pod in conjunction with VHLs, ensure that there are two locking carabiners on the bottom eyelet of the apex with opposing gates.

A-Frame

An A-frame is an artificial device used to gain height in a rope installation. Although an A-frame can be used with various types of rope installations, its most common use is in conjunction with a VHL. An A-frame requires two poles that are approximately 8 feet long and not less than 3 inches

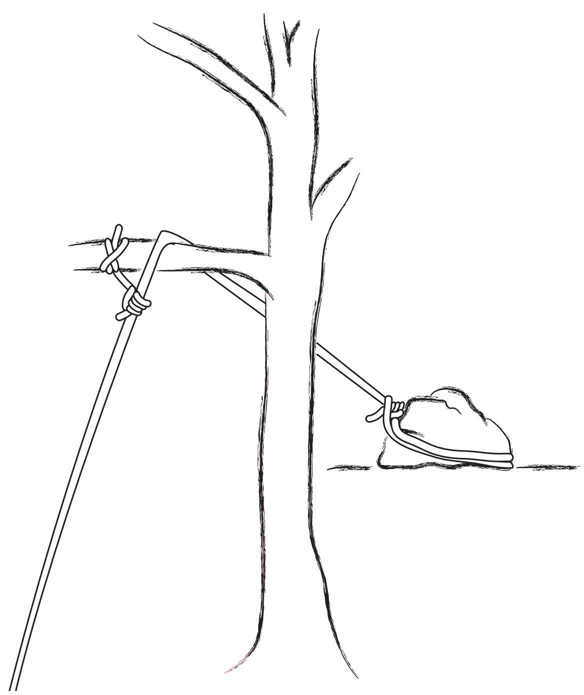

Figure 5-17. Using a Tree to Gain Height.

in diameter. The actual size of the poles will depend on the type of load—a very heavy item would require a stout pole and a taller item would require a longer pole to provide sufficient clearance for the load. Four to six ropes are required to construct an A-frame. The number of ropes may vary, depending on the diameter of the poles and the length of the sling ropes being used.

An A-frame is made up of the apex and the butt ends. The apex is the point near the top of the A-frame where the poles cross each other. The butt ends are the bottom ends of the poles used to construct the A-frame. The butt end is larger in diameter than the end at the apex.

To construct an A-frame, use the following steps:

- Place two sturdy poles of approximately the same length side by side, ensuring that the butt ends are flush together.
- Take a sling rope and come down 18 inches from the top of the shortest pole, leaving an 18-inch pigtail extended. Next, tie a clove hitch, ensuring that the 18-inch pigtail is toward the top of the pole and the locking bars of the clove hitch are to the outside.
- Wrap the sling rope six to eight times horizontally around both poles; hitch down toward the butt ends.
- Using the starting sling rope, join it with another sling rope with a square knot finished with two overhand knots.
- The joining of the sling ropes must be done on the horizontal wraps and the square knot must be on the side of one of the poles so it will not interfere with the vertical wraps.
- Wrap four to six times vertically between the poles and around the horizontal wraps (see fig. 5-18).
- Tie off the sling with a square knot by using the 18-inch pigtail that extends from the clove hitch. The square knot should be so tight that the overhands will be tied on the pigtails themselves. The square knot should not be tied on the inside of the apex (see figure 5-19).
- Tie a sling rope or ropes between the poles at the bottom of the A-frame with a clove hitch with locking bar facing out and two half hitches on both butt ends, also called the spreader bar.
- If more than one sling rope is needed, join the sling ropes with a square knot finished with two overhand knots. Make sure the ropes are joined in the middle of the A-frame.
- Adjustments can be made to either side when needed.

To construct the A-frame quicker and more efficiently, separate tasks can be assigned to different individuals. The following tasks should be assigned:

- One individual will tie the sling ropes around the poles to form the apex.
- While the apex is being tied, another individual should construct the anchor. After the spreader bar is completed, this individual will anchor down the A-frame.
- Once the poles are spread, a third Marine should tie the spreader bar. Ensure the spreader bar is not tied over the anchor line.

Vertical Hauling System

The purpose of a vertical hauling system is to move equipment and personnel over vertical terrain, either up or down.

Site Selection

Selecting the proper site is critical to the safe and efficient operation of a VHL. The site must meet the following four criteria:

- It must have a suitable top anchor.
- It must have a good loading and unloading platform on both the top and bottom.
- There must be sufficient clearance for the load at all points.
- If using an A-frame, Marines must be able to anchor the butt ends of the A-frame.

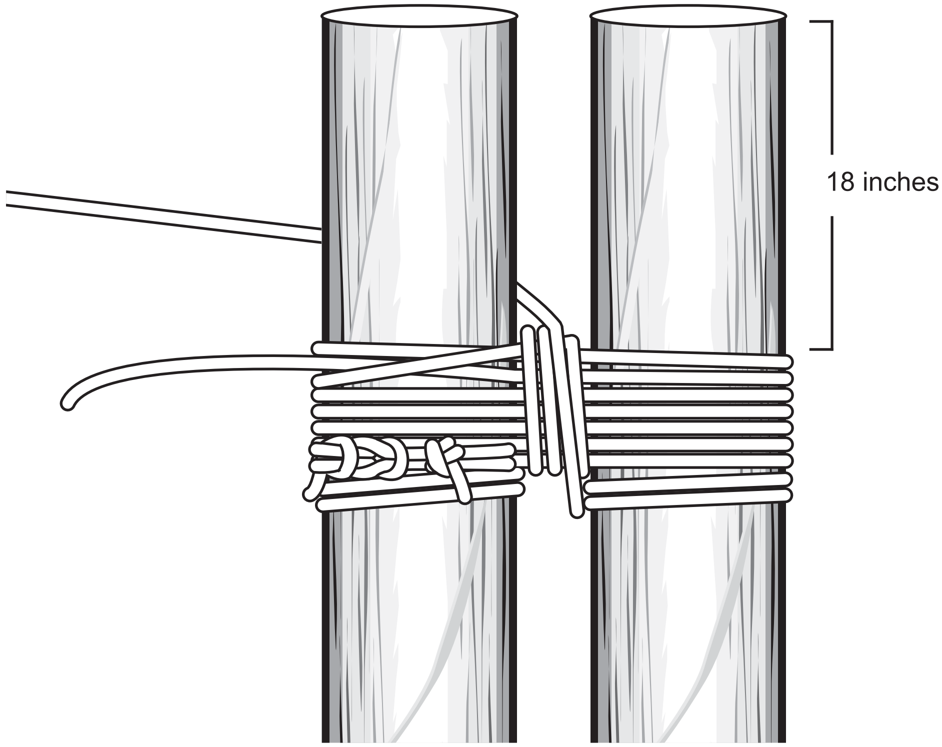

Figure 5-18. A-Frame Apex.

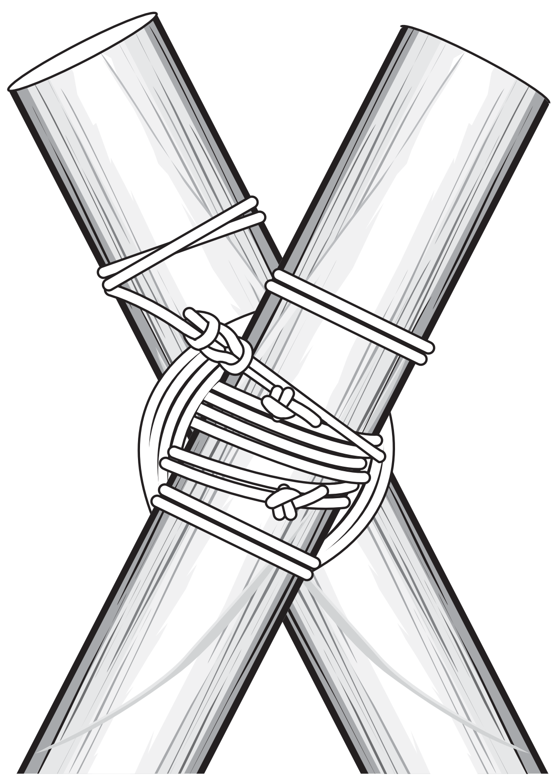

Figure 5-19. A-Frame Tie Off.

Construction

The materials needed to construct a vertical hauling system are—

- Two static ropes (an additional rope is required if using a knotted hand line).
- A minimum of six sling ropes.
- Four locking carabiners.
- An appropriate belay device.
- Two rescue pulleys are preferred, but locking carabiners may be used.
- A device to gain height, such as an A-frame, quad-pod, or tree.

Anchoring to the A-Frame

The A-frame is anchored by securing the butt ends or bottom of the A-frame, which is accomplished by placing the butt ends of the A-frame poles into natural or manmade pockets. Use natural or artificial anchors to prevent the butt ends from moving. In order to keep the butt ends in place, additional anchors may be necessary along the A-frame at the middle and bottom. The A-frame can be kept stationary with sling ropes. Tie a clove hitch and two half hitches or a round turn and two half hitches to the A-frame and normal anchor knots on the anchors.

To secure the apex or top of the A-frame, find the middle of a static rope and lay it over the apex of the A-frame, leaving an 18-inch bight, also known as the anchor bight. Tie over-the-object clove hitches above the lashing on each side of the apex, ensuring that the locking bars are facing each other and are next to the lashing. The 18-inch bight is left dangling from the top of the apex.

Secure the A-frame by tying off the static rope using a round turn and two half hitches. Next, angle the A-frame out 30 degrees from vertical and secure it into position by retying the rope. The rest of the rope is then coiled neatly and placed out of the way.

Construct a second 18-inch bight from the top of the apex using a sling rope, also known as the safety bight. Attach the sling rope to each side of the apex of the A-frame above the first clove hitches in the same manner as the anchor bight except with the locking bars to the outside. Adjust the spacing between the anchor bight and safety bight to 1 to 3 inches (2 to 4 fingers). Secure the pigtails of the sling rope with a square knot and two overhands at the rear of the apex of the A-frame, as in figure 5-20. Insert two locking carabiners with the gates opposite and opposed to each other into both bights hanging down from the apex.

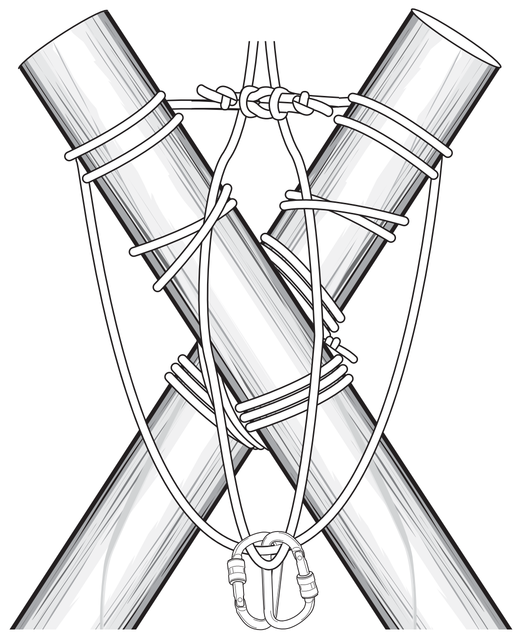

Figure 5-20. Safety Bight.

Anchoring to the Quad-Pod

The quad-pod can be anchored for stability, if necessary, using standard natural or artificial anchors.

Anchoring to a Tree

Anchoring to a tree has been discussed previously in this chapter. See the subparagraph on gaining height in rope installations.

Using the Endless Loop

For lowering and raising heavy loads and personnel, the end of the rope is used. This method is less efficient, but much safer than the endless rope. Construct the endless loop by running one end of the rope through the carabiners/pulleys on the safety/anchor bight and tying an end-of-the-line figure-8 knot, which is then attached to the load with a locking carabiner. The other end is tied off with an appropriate anchor knot. If the hauling line is to be controlled from the bottom of the obstacle, it is converted into an endless rope by tying the two ends together using a square knot. Next, two directional figure-8 knots are then tied—one is tied approximately an arm's length from the square knot and the second is tied approximately an arm's length from the other end of the endless rope, as seen in figure 5-21.

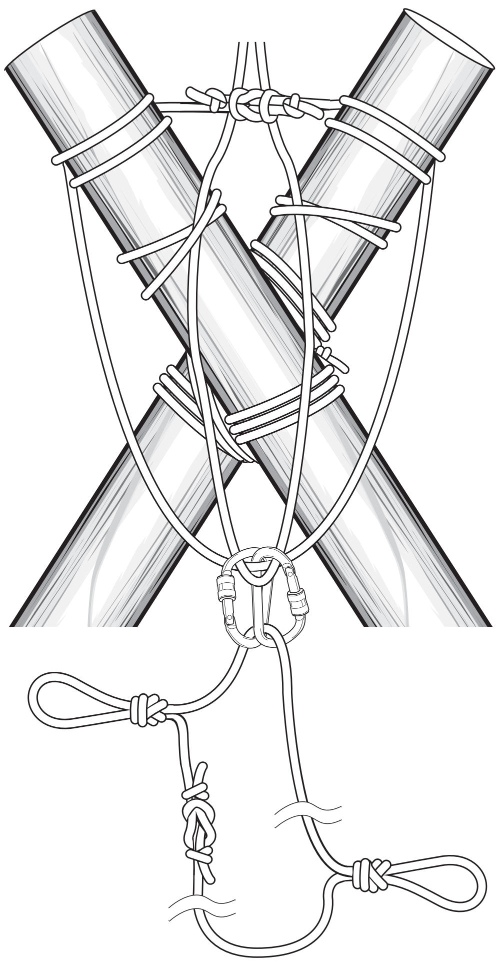

Figure 5-21. Endless Loop.

After completing the hauling line, personnel at the base of the obstacle pull on the line to test the system's functionality. Additional instructions are to—

- Eliminate excessive friction. Use pulleys when possible.
- Anchor the endless rope at the bottom of the obstacle to keep the line taut and the load from banging into the obstacle. Tie a swami wrap on a tree with a locking carabiner and a pulley on it. Run the endless rope through the pulley and tighten the joining knot on the endless rope, as in figure 5-22 (on page 5-18) to minimize the mule team size and make it easier to move the loads up and down.
- Station two people at the unloading platform to operate the A-frame during use. These operators are tied in with safety lines.
- Use multiple anchors when establishing an A-frame/VHL to prevent total system failure should one anchor fail.
- A knotted hand line may be used to aid individuals up a VHL and is constructed by placing overhand knots in a static rope every 10 to 12 inches apart with the exception of the last 20 feet, which will be used to anchor the rope. Directly behind the A-frame, tie the rope off with an appropriate anchor knot. Then, throw the knotted hand line over the apex of the A-frame. This line is then used as a simple fixed rope by any personnel ascending the VHL, as in figure 5-23 on page 5-19.

Using the Vertical Hauling Line

Personnel or equipment are secured to the hauling line and raised or lowered by a team pulling on the rope or belaying it down. If equipment and personnel are only being lowered, the hauling line can be used from the top with the same belay that is covered in the next subparagraph on suspension traverse. If equipment is being raised from the bottom, an endless rope is the most efficient hauling line. Personnel and equipment being raised or lowered will load and unload through the center of the A-frame, not to the sides.

If equipment and personnel are to be raised from the top of the obstacle, they must use a mule team. To establish a mule team, the hauling line is run through a pulley or locking carabiner (preferably a pulley) at the anchor point behind the system. The line is then led away at about a 90-degree angle to a cleared area. A safety knot is tied to the rope to act as a backup, which would prevent the load from falling to the ground should the mule team accidentally drop the hauling line. The appropriate friction knot, such as a prusik, is directly attached to an anchor.

A group of six Marines (mule team) assembles on the side of the rope away from the obstacle or outside the bight of the rope if on the bottom. They will haul personnel and supplies up the obstacle by grasping the rope and simply walking away with it. One Marine monitors the safety knot to ensure it does not run through the carabiner (gloves will not be worn). If the mule team loses control of the line, the safety person will simply let go of the safety knot, stopping the load. The mule team responds to a single commander by using verbal/hand and arm signals.

Suspension Traverse

A suspension traverse is a high-tension rope installation established at a suitable angle (not less than 30 degrees and not more than 65 degrees, approximately) that allows a suspended load (a limit of 250 pounds is recommended) to be moved over cliffs, ravines, and rivers.

Note: The limit of 250 pounds is recommended not because the suspension traverse would fail, but because 250 pounds is the limit that can be safely manhandled next to a cliff edge. Several loads weighing less than 250 pounds each can be attached in series.

Site Selection

The three considerations for site selection for a suspension traverse are that the site has:

- Suitable upper and lower anchors.
- Good loading and unloading platforms.
- Sufficient clearance for the load.

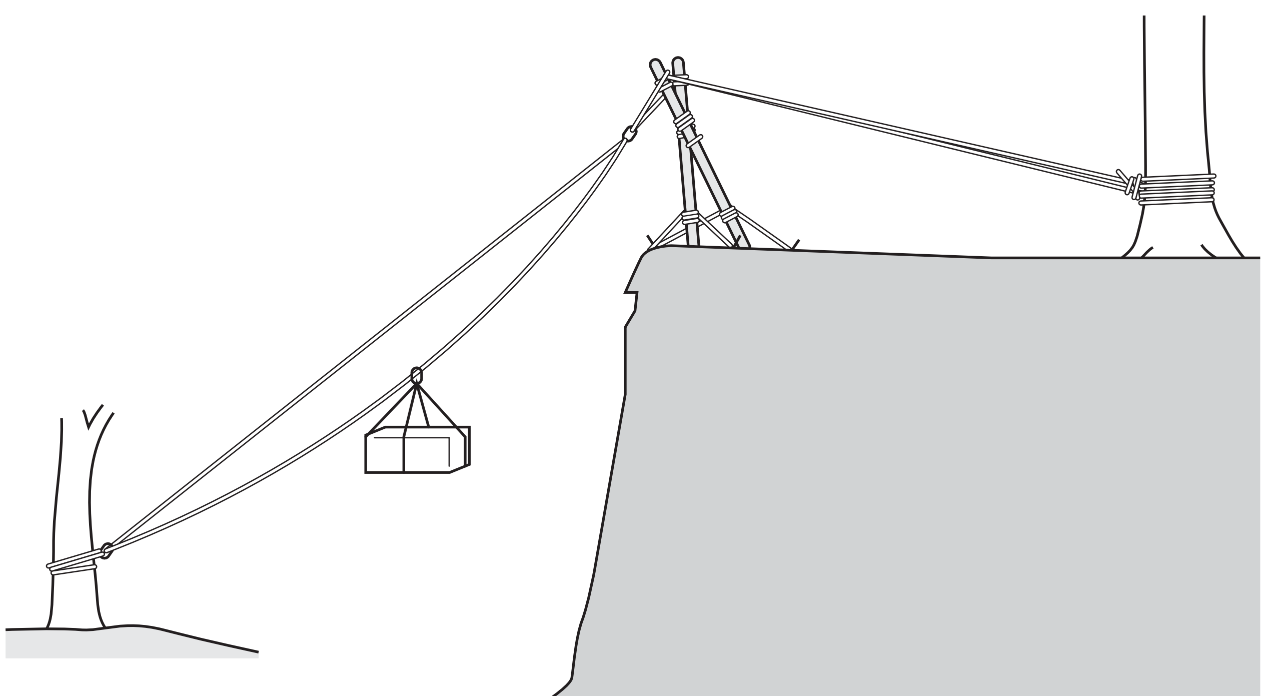

Figure 5-22. Endless Rope Anchored at Bottom.

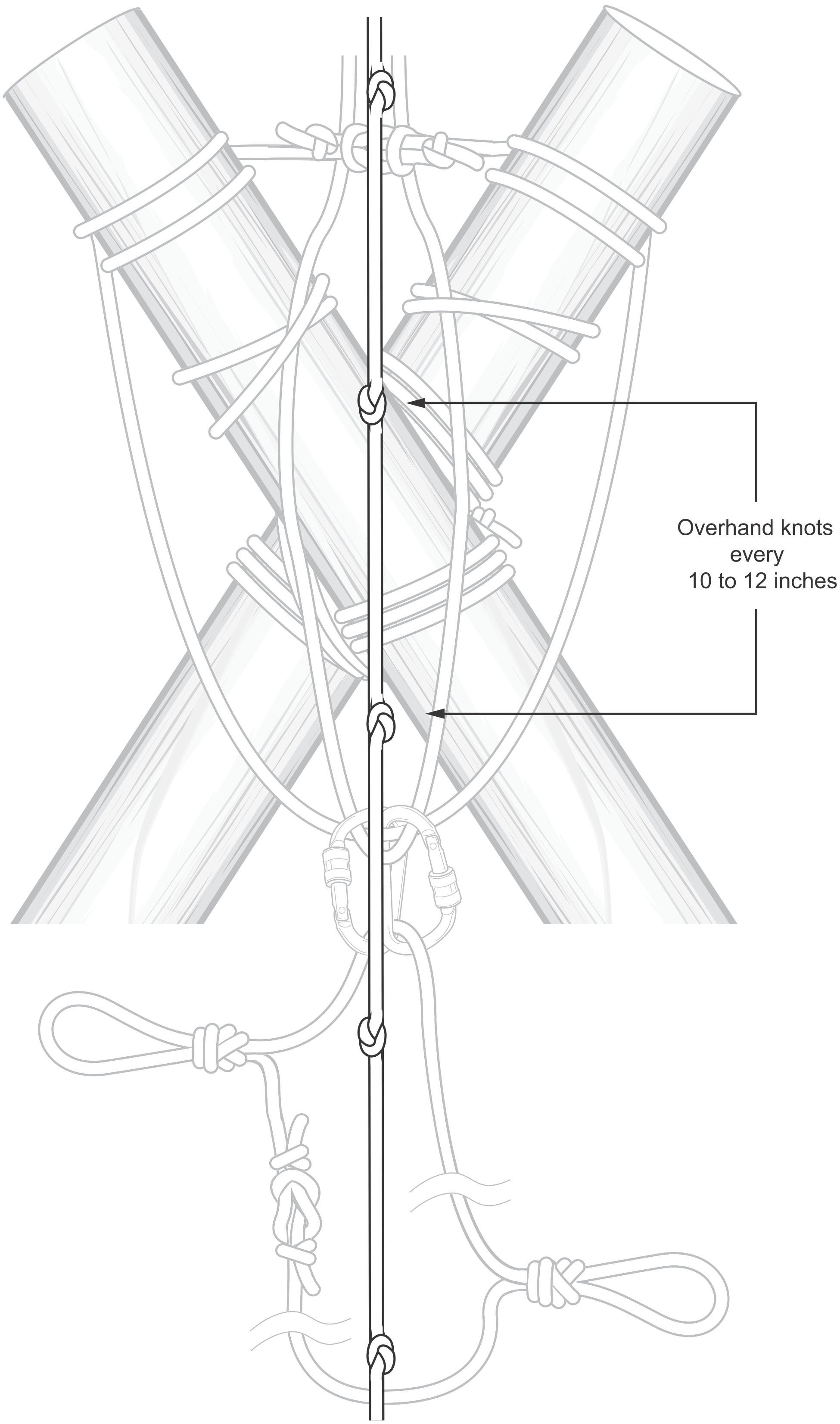

Figure 5-23. Vertical Hauling Line.

Construction

A suspension traverse can be constructed from top to bottom or from bottom to top.

Top to Bottom

When constructing the suspension traverse from top to bottom, a suitable high-tension anchor system will be placed around the top anchor point. The rope will be deployed and the construction/mule team will rappel down in order to construct the bottom anchor. A suitable bottom anchor point is selected and a suitable high-tension anchor system constructed. The rope is pulled to the bottom anchor and clipped through the anchor system's MAC and a 9:1 one-rope bridge is constructed. The suspension traverse is tensioned and tied off as previously described in the paragraphs on constructing the one-rope bridge.

Note: If pulleys are available, place them in the locking carabiner on the friction knot.

> **SAFETY NOTE**
>
> No more than two individuals will tension the installation at any time. When two ropes are used, take care to anchor the lines as close together as possible in such a manner that the ropes do not cross each other. Tensioning of the second rope can be done separately with a 3:1 ratio system.

Bottom to Top

When constructing a suspension traverse from bottom to top, the lead climber will attach the traverse's ropes to the back of his/her harness. Once the lead climber reaches the top safely, the traverse's ropes will be anchored using a suitable high-tension anchor system. The lead climber will then bring up the number 2 climber. The installation is constructed and tightened from the bottom.

Using an A-Frame

If Marines have to gain artificial height at the top and there is no suitable tree branch/rock, then the A-frame logs, sling ropes, and carabiners need to be moved to the top of the cliff. Such a move can be accomplished by tying the A-frame logs to the ropes using the timber hitch and clipping the extra sling ropes and carabiners into the rope. The climbers will haul the logs to the top and construct their portion of the installation.

Note: The A-frame is constructed as described previously in this chapter in the subparagraphs on gaining height in rope installations. The suspension traverse rope is located in the upper V (apex) of the A-frame. The A-frame can be placed under the static rope before or after the rope is tensioned. The latter way is better on a long suspension traverse as it helps tension the rope further.

To secure the A-frame, an over-the-object clove hitch is tied in the middle of a sling rope and placed over one pole at the apex. A prusik is tied around the suspension traverse lines with the ends of the sling rope on both sides of the A-frame *before* erecting the A-frame. The butt ends must be anchored using appropriate anchoring material, such as cordage, rope, or runners. The ropes should be buffed wherever necessary.

As figure 5-24 shows, the A-frame should be inclined forward on the edge of the cliff face to offset the strain on the A-frame and to stop it from collapsing forward or backward. The approximate angle is between 45 and 60 degrees.

Using a Tree

Using a tree to gain height has been discussed previously in this chapter. See the subparagraph on gaining height in rope installations.

Using the Quad-Pod

When using a quad-pod, Marines should—

- Pick a suitable platform to set up the quad-pod.
- Ensure the quad-pod is properly constructed and anchored.

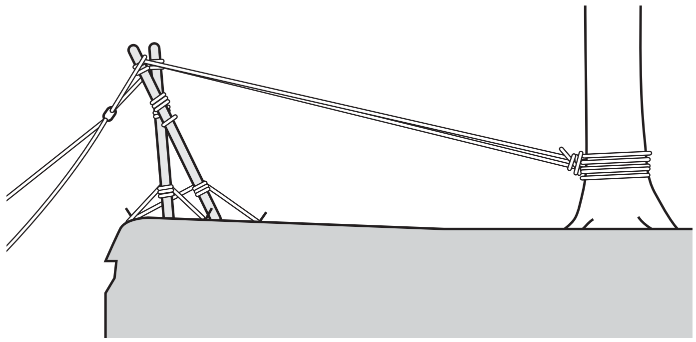

Figure 5-24. Securing the A-Frame.

- Run the suspension traverse lines through the eyelet on the top of the device to the anchor if using the newer version of the quad-pod.
- Run the suspension traverse lines under the plate ring then across the top of the plate and back down under the plate ring to the anchor if using the older version, which has just a plate on top of the device instead of an eyelet.
- Using a long prusik, tie a clove hitch onto the top eyelet or plate ring.
- Tie a four- or six-finger prusik to the suspension traverse lines.
- Tie another four- or six-finger prusik to the suspension traverse lines in the opposite direction of the first one tied, creating the third leg for the quad-pod.
- Attach two locking carabiners opposite and opposed to the eyelet on the underside of the quad-pod. The belay line will run through these carabiners.

Using Suspension Traverse When Unable to Gain Height

If there is no reasonable object available to gain height, personnel may have to manhandle the equipment over the edge. The following factors are to be considered:

- The edge of the obstacle must be buffed to prevent unnecessary abrasion to the ropes.
- The weight of the load must not exceed 100 pounds.
- The personnel handling the load must be secured to the cliff with a safety line.

Construction of the Belay Line

The belay rope is used to attach personnel and equipment to the bridging line and belay system. The belay line must be established at the top of the bridge with an adequate anchor, braking system (when lowering heavy loads or live loads, a braking system must be used), and a safety prusik, which will have its own anchor, if available. To construct the belay line—

- Tie a figure-8 loop at the end of the belay line and attach it with a carabiner to the load.
- Less than 18 inches from the end of the belay line tie another figure-8 loop and attach this loop to the bridging line with a carabiner. The closer these knots are, the better.
- Using web runners and nonlocking carabiners, girth hitch the web runners to the belay line and clip into the bridging line at intervals of approximately 15 feet to ensure that the belay line does not sag excessively and tangle in trees or on rocks. See figure 5-25 on page 5-22.

Operation

A suspension traverse is used for the transportation of personnel and equipment up and down a vertical obstacle. The operating procedure is discussed in the following subparagraphs.

Point Noncommissioned Officer

The point NCO has overall responsibility for the operation of the suspension traverse. The point NCO's duties include—

- Supervising the construction of the installation.
- Controlling the load being lowered and raised.
- Deploying web runners on the belay line.
- Ensuring that the belay/brakes are employed properly.
- Leading the mule team.

Lowering

Whenever a load is lowered down a suspension traverse, a belayer and a belay line are used to control the load. Ideally, the belayer should observe the load being lowered. If this is not possible, the point NCO will give commands to the belayer. Some common brake/belay techniques are—

- *Munter hitch*. The munter hitch is an excellent brake/belay and requires minimal equipment. When used with heavy loads, it should be backed up with a safety prusik. See figure 5-26.
- *Mechanical belay devices*. The mechanical belay device is user-friendly and offers quick attachment and removal. Unlike some other belay techniques, it has no rope-on-rope friction. This system can be used for all load sizes. See figure 5-27.

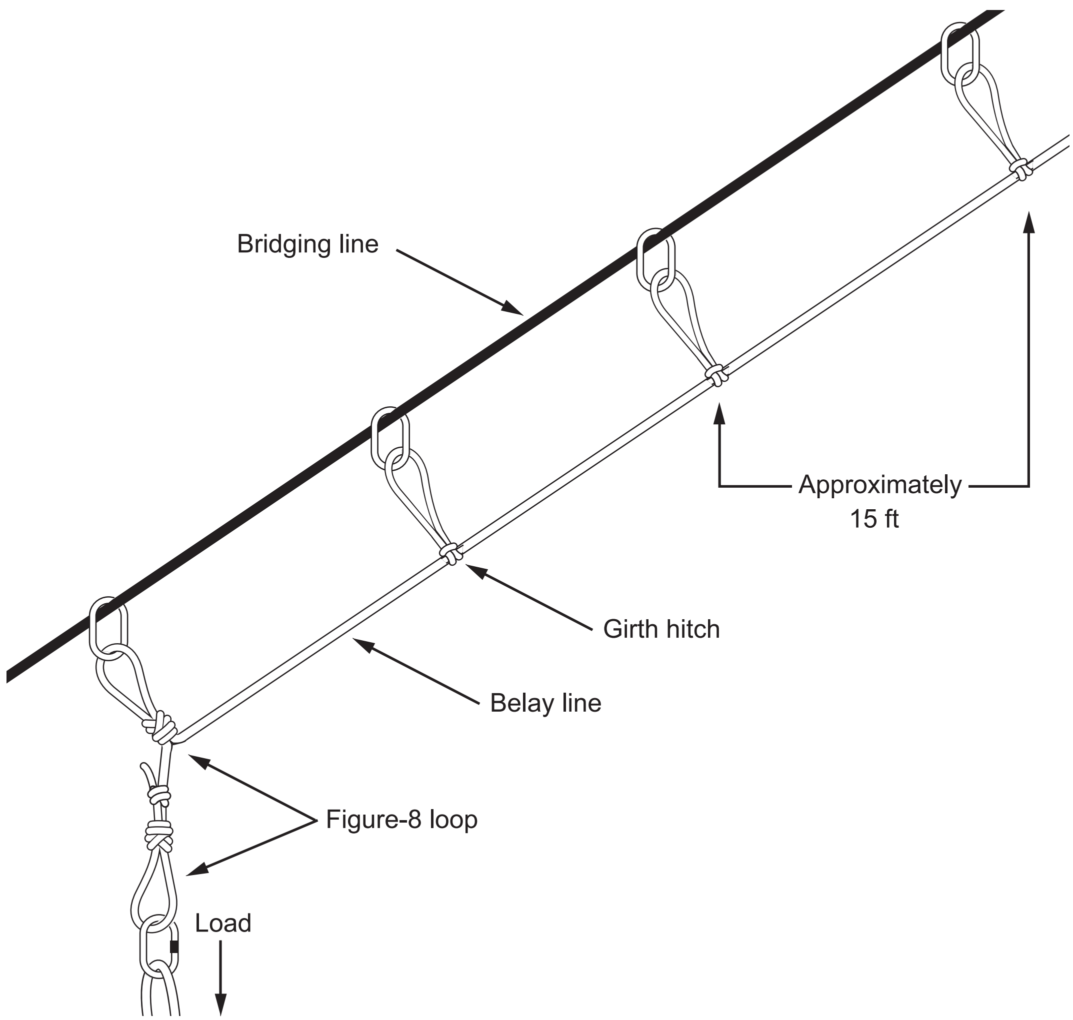

Figure 5-25. Suspension Traverse Belay Line.

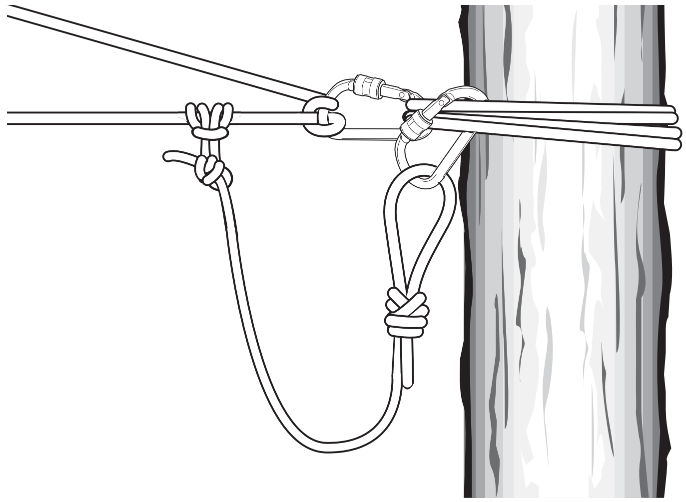

Figure 5-26. Munter Hitch.

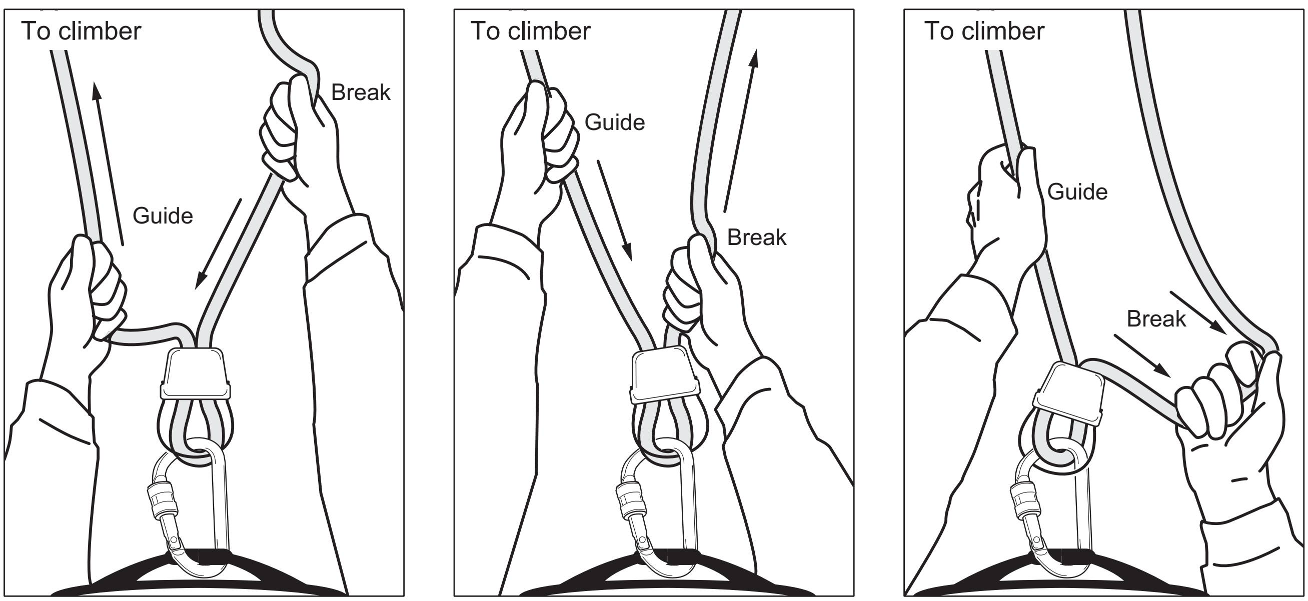

Figure 5-27. Belay Device.

- *Figure-8/Rescue-8*. This device is the easiest method for belaying a load. Use the following procedures in rappel mode (large hole) for most loads or belay mode (small hole) for very heavy loads:
  - Thread a bight of the belay line through the large O-ring and pull it over the small O-ring.
  - Clip a locking carabiner through the small O-ring and attach it to an anchor point, as in figure 5-28 on page 5-24.
- *Carabiner brake*. Use the crab brake method when no locking carabiners are available. To make the single carabiner brake, hook two small carabiners to the anchor point, opposite and opposed. Two more carabiners are locked, gates to the right, to the first set. The last sets of carabiners are placed across the body of the second set, gates down. The carabiner brake is a good method for lowering a load due to high friction and good control. If the loads require more or less friction, add or take away the carabiners, which are placed across the body.

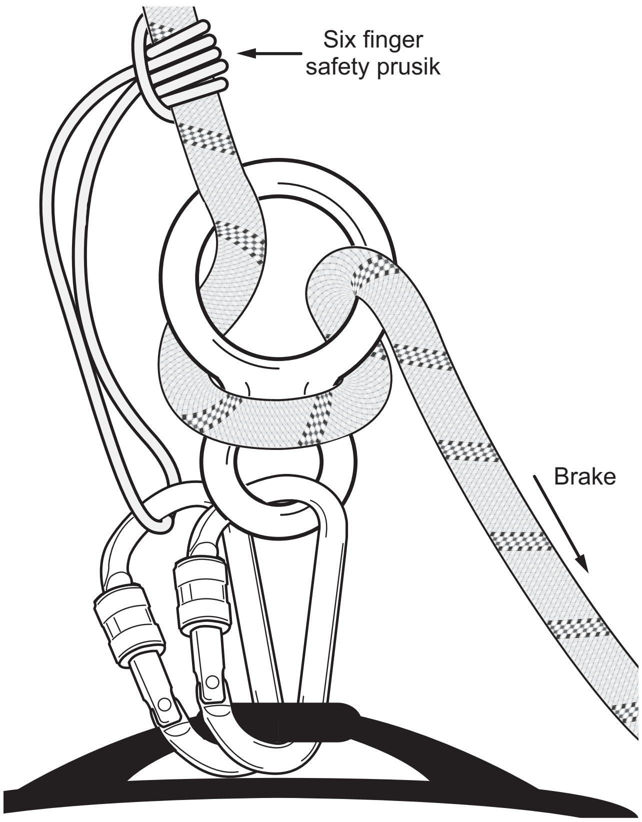

Figure 5-28. Operation of the Figure-8.

Safety Brake

For added security, an end-of-the-line friction knot is attached to the belay line in the front of the braking device. The safety brake will have its own anchor point. One Marine is tasked with the operation of the safety brake.

Raising the Load

If a large amount of heavy weapons, ammunition, or other logistical equipment is to be moved over an obstacle, a suspension traverse is the most expedient method because part of the weight of the supplies to be lifted will be carried by the static line. The opposite is true in a VHL—all the weight is suspended vertically.

The main method of raising supplies is by using a mule team—a group of six or more Marines—to do the lifting/pulling. To establish a mule team, the belay/haul line is run through a pulley or a locking carabiner at the top of the system, just as for lowering.

If the cliff head does not afford an open area for the mule team to operate directly back, the haul/belay line can be redirected. The line is then led away at an angle to a cleared area. Six or more Marines assemble on the rope on the side away from the cliff. They will haul supplies and personnel up the cliff by grasping the rope and simply walking with it, using the leg muscles. In this way, they can maintain the effort for a long time. The mule team uses the verbal/hand and arm signals in table 5-1.

Table 5-1. Mule Team Verbal and Hand and Arm Signals.

Command	Meaning	Signal
PICK UP THE ROPE[1]	Mule team picks up the rope	None
TAKE THE STRAIN	Take up the slack in the rope	Arm up, palm out
WALK AWAY	Walk away with the rope lifting the load	Arm motion away from the installation
CHECK	Stop in place, holding the load	Arm up, fist clinched
WALK BACK	Walk toward the installation holding the load	Arm motion toward the installation

[1] The rope should be held unless specifically ordered to lay it down. In addition, the use of the prusik braking system on the belay rope is necessary in the event that the mule team loses control of the rope. As with all installations requiring commands, some form of tactical commands need to be established by unit SOP.

General Load Considerations

The type of equipment that needs to be lowered or raised will vary, ranging from weapons to ammunition and personnel to litters. Each needs to be handled differently.

Weapons

Normally the types of weapons that would have to be raised or lowered are the crew-served weapons organic to a rifle battalion, such as 81-mm mortar and .50-caliber machine gun. The basic method of securing these weapons is accomplished by using two sling ropes and tying a clove hitch to the front and rear of the weapon. A figure-8 is then tied into the ends and attached to the suspension traverse. The belay line is now attached to the load.

Ammunition/Equipment

The articles to be moved are to be secured through bundling or banding them together. A rope is tied around the equipment in a package wrap fashion. The rope is wrapped one time around the bundle, then, when the rope is brought back together, the ends are crossed and wrapped around the remainder of the bundle (90 degrees to the previous wrap). This wrap is secured by using a square knot with two overhands and attached to the carrier rope by a locking carabiner.

Litters

The two standard litter types used are the collapsible litter and the stokes litter. These litters are to be rigged for CASEVAC and attached to the suspension traverse as follows:

- To attach the belay line to the litter, tie a figure-8 loop at the end of the belay line and attach it to the lower body prerigs. Then, tie a second figure-8 loop approximately 4 to 5 feet from the first figure-8 loop and attach it to the upper body prerigs.

  Note: Ensure that this takes place 10 feet or more from the edge of the cliff edge and the brakeman is on belay.

- At this stage, it is worth checking and adjusting the length of the prerigs, to ensure that the casualty's head is higher than his/her feet.
- The belay line is then made taut and the litter is attached to the suspension traverse. The lower body carabiner is attached first, followed by the upper body carabiner. This is awkward to do. The helpers must have a safety line on while moving around at the cliff head.
- Before lowering, a last minute safety check is essential to ensure that carabiners are locked, the knots are secure, the casualty is secure, the brakeman is on the brake, and the safety person is at the prusik.

Personnel

Personnel will wear a rappel seat clipped into the belay line.

Stream Crossing

Mountain streams and rivers are military obstacles and are considered danger areas for units crossing them. In order to reduce the time in the danger area, a reconnaissance team should precede the main body and select the best crossing site.

Site Selection

The site selection for a stream crossing should include the following eight considerations:

- Look for logjams, rocks, or fallen trees that will provide a dry crossing, if possible.
- If a dry crossing is not possible, select a crossing point at a wide and shallow point where the current is slower.
- Avoid sharp bends. They can be deep with a strong current on the outside of the bend.
- Look for a firm, smooth bottom. Large rocks provide poor footing and cause a great deal of turbulence in the water.
- It may be easier to cross several small channels of water rather than one large one.
- Do not cross just above rapids, falls, or logjams. Taking a fall or slipping could have serious consequences.
- Cross in the early morning. The water level will be lower since there has been less daylight for the snow to melt; on sunny days, crossing in the morning will give Marines more time to dry clothing and equipment.
- There should be a suitable spot downstream for safety swimmers.

Safety Precautions

There are safety precautions for both training and combat.

Training

In a training environment, extra safety precautions are required to minimize the training hazard. There must be strong swimmers positioned downstream to serve as safety swimmers. The safety swimmers will save anyone who is swept downstream using a throw bag. As a last resort, safety swimmers will enter the water to attempt a rescue. In swift moving water, safety swimmers will not swim to a victim without a belay line. In a training scenario, the swimmers will wear life jackets.

There must be a downstream safety line at a minimum of a 45-degree angle downstream and skimming across the top of the water. Anyone who slips and is swept downstream will grab the line and pull themself to shore. If the victim is unconscious and is caught on the line, the safety swimmer will enter the water and pull the victim to safety.

Note: The safety line and any other lines that must be taken across the stream will be taken across using the lead swimmer method.

Combat

Combat safety precautions may differ from training safety precautions. Combat safety is just as important as training safety, but it requires balancing speed, security, and the enemy threat.

Swimmers may be used when crossing a stream where the Marines' feet can touch the bottom. They will also be used if someone trips and begins rolling downstream toward a hazard (rock jam or waterfall). Safety swimmers can make a field-expedient throw bag with 550 cord and a half-empty canteen.

If the stream current is strong or Marines cannot touch the bottom of the stream, a safety line may be used. Marines attach themselves to the line, known as a ferry line, and slide across the stream.

Individual Crossing Preparations and Methods

Before crossing a stream, each Marine should make the following six preparations:

- Wear pack with shoulder straps fastened snugly. Waterproof the pack for buoyancy, if possible.
- Sling weapons diagonally over the shoulder between the pack and the individual's back.
- Button all pockets and remove blousing garters to prevent the water from flowing into open pockets and creating added drag.
- Wear boots to protect the feet, but remove socks and insoles to keep them dry.
- Wear the minimum amount of clothing to reduce the amount of clothing that must be dried after the crossing.
- Do not wear helmets in swift moving currents; the current could force the helmet/head under water.

The staff method, swimming, and the ferry line method are used by individuals to cross bodies of water.

Staff Method

A strong staff or pole that extends at least 1 foot above the Marine's head is used as a crossing aid. It should be strong enough to support his/her weight and trimmed clean of any branches. Placing both hands on the pole, the Marine places the staff upstream of his/her intended path. The staff is used as the third leg of a tripod and moves only one leg or the staff at a time. He/She should face upstream using the staff to retain balance. He/She also uses the staff to probe the bottom to discover any irregularities that could trip him/her. He/She should drag his/her feet instead of picking them up.

Swimming

Swimming is an obvious method if the unit is good at swimming, such as a reconnaissance unit, but, since this is not normally the case, this method is not preferred. In fast, shallow water, the swimmer should cross on his/her back with his/her feet downstream and head up. He/She will move at an angle across the stream, moving with the water; using his/her hands to tread water and feet to fend off obstructions. In fast, deep water, the swimmer should angle across the stream on his/her stomach with his/her head upstream, to establish a proper ferry angle.

Ferry Line Method

In chest deep water or a strong current, a rope can assist greatly. A rope is secured from bank to bank, with the far anchor downstream from the near anchor. The rope will be anchored off so that it lays at a minimum of 45 degrees. The Marine attaches to the rope by using a sling rope and tying a bowline around his/her chest and a figure-8 loop with a nonlocking carabiner inserted. The figure-8 loop must be within an arm's length. The Marine attaches his/her pack and then themself to the line. He/She grasps the pack and crosses, using the current to assist him/her.

Team Crossing Methods

The line abreast, line astern, and huddle methods are used by teams to cross bodies of water.

Line Abreast Method

Small units (squad to platoon) can cross in moderate currents up to chest deep, by linking arms in a line abreast or chain method. The largest person of the chain is placed on the upstream side of the group. The group will enter the stream parallel to the flow of the stream. The middle person of the chain will control the group's movement and give the command to step. See figure 5-29.

Line Astern Method

Three or more Marines can line up facing the current. The upstream person, who should be the largest in the group, breaks the current while the downstream Marine hold him/her steady. The upstream person may use a staff, similar to the

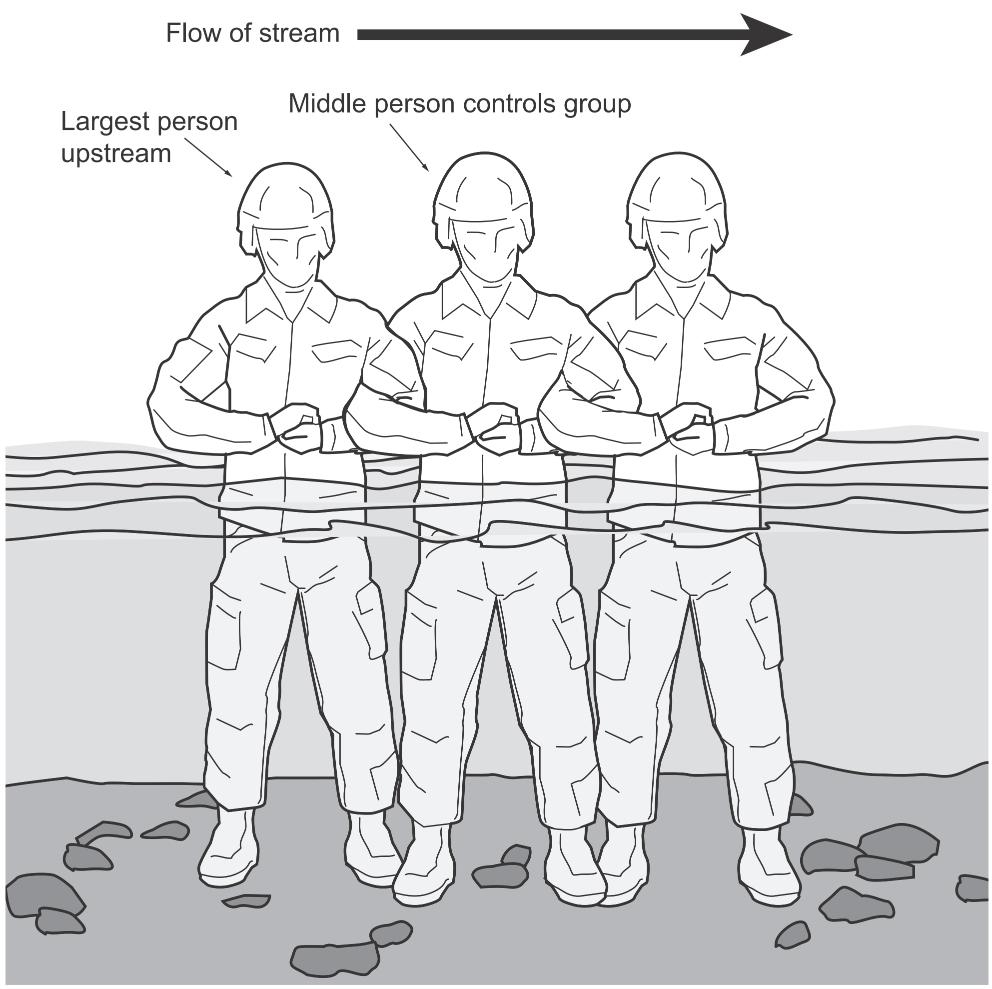

Figure 5-29. Line Abreast Method.

individual staff method, to steady themself. All Marines side step at the same time with one Marine calling the cadence. See figure 5-30.

Huddle Method

Between three and eight Marines can face inboard as in a football huddle (see a top view of the huddle method in fig. 5-31). They will wrap their arms around each other's shoulders and cross the stream in this formation. The upstream person changes position as they cross because the entire formation will rotate, which prevents one person from becoming exhausted in the upstream position.

Tactical Stream Crossing

Any standard method for crossing a linear danger area can be modified to work at a stream. Figure 5-32, on page 5-30, shows an example tactical SOP.

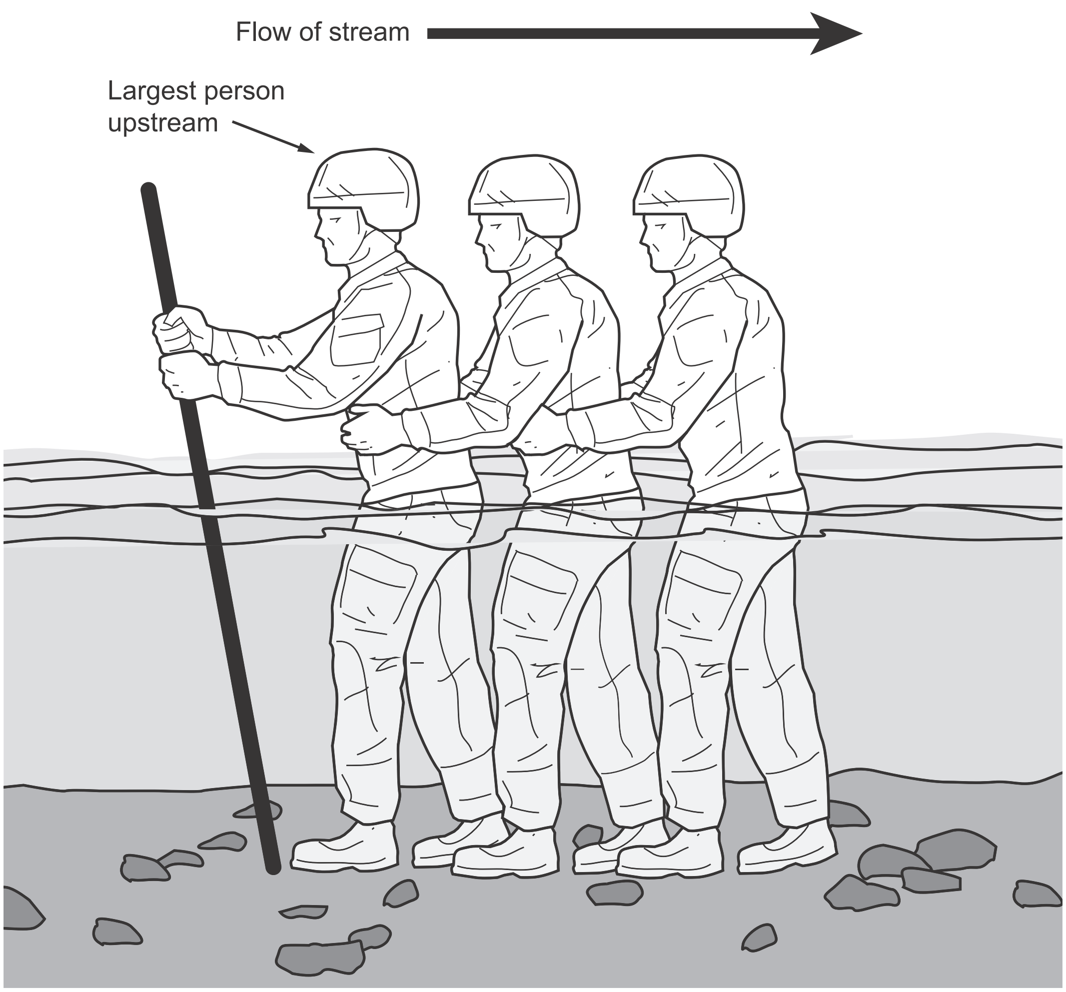

Figure 5-30. Line Astern Method.

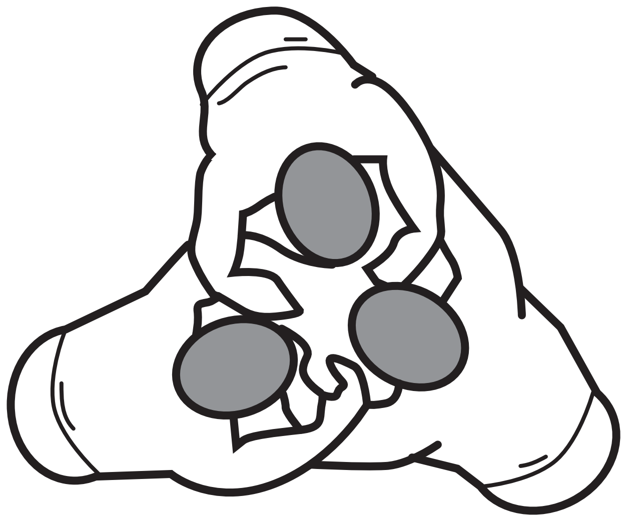

Figure 5-31. Huddle Method.

<u>Team 1:</u>
Actions upon reaching the stream:
1. Conduct reconnaissance of crossing site.
2. Establish near side security.
3. Determine whether a snow bridge will have to be constructed (winter).
4. Provide guide to bring remainder of the unit forward.

Actions during crossing the stream:
1. Maintain security during the crossing.
2. Will be the last team to cross the stream.

Actions after crossing the stream:
1. Establish security as directed.
2. Wait for the order to move out.

<u>Team 2:</u>
Actions upon reaching the stream:
1. Set up rally point with team 3.
2. If necessary, move forward to construct a snow bridge for the crossing.
3. Team 1 will guide team 2 to the site.

Actions during the crossing:
1. First team to cross the steam.
2. Maintain accountability of all Marines crossing the stream.

Actions after crossing:
1. Reconnoiter the far side of crossing site.
2. Establish 360-degree security on the far side.
3. Give signal for rest of unit to cross.
4. Place other teams in 360 as they cross.
5. Wait for order to move out.

<u>Team 3:</u>
Actions upon reaching the crossing site:
1. Establish 360 with team 3.
2. Wait for guide from team 1.

Actions during the crossing:
1. Second team to cross.

Actions after crossing:
1. Establish security as directed by team 2.
2. Wait for order to move out.

<u>Actions if compromised:</u>
If compromised prior to the crossing, team leader will make the decision to attack or attempt the crossing, depending on the size of the enemy. This will be situationally dependent.

If compromised during the crossing, team leader will make the decision to either cross the remainder of the unit or bring the Marines on the far side back across to engage the enemy. This will be situationally dependent.

If compromised after the crossing, team leader will make the decision to engage the enemy or withdraw—possibly, back across the stream. This is situationally dependent.

Figure 5-32. Example Tactical Stream Crossing Standard Operating Procedure.

CHAPTER 6
RAPPELLING AND CLIMBING

Rappelling

Rappelling is inherently dangerous because rappellers rely totally on their equipment. During training, two ropes are used for additional safety and to reduce rope wear; however, rappelling can be completed with a single rope if the combat situation requires it. If using a one-rope system with the carabiner wrap, the rope will be attached to the carabiner with two wraps instead of one. The munter hitch may also be used to rappel.

Site Selection

When selecting a rappel site, consider the following three factors:

- There must be a good anchor; natural anchors are preferred.
- The rappel route down should be as free from obstacles, such as vegetation or debris, as possible.
- There must be suitable loading and unloading platforms.

Note: Sites should be re-evaluated by a mountain leader, assault climber, or helicopter rope suspension training master.

Duties of the Rappel Point Noncommissioned Officer

Once a rappelling site has been selected, one Marine will be appointed to each rappel lane as a rappel point NCO. These individuals should be trained to be point NCO by a mountain leader or assault climber. The rappel point NCO has the following ten duties and responsibilities:

- Ensure that the anchor points are sound and that the knots are properly tied.
- Ensure that loose rock and debris are cleared from the loading platform.
- Allow only one person on the loading platform at a time and ensure that the rappel point is run in an orderly manner.
- Ensure that each individual is properly prepared for the particular rappel—gloves on, sleeves down, helmet secured, and rappel seat tied correctly and secured properly.
- Attach the rappeller to the rope and ensure the rappeller knows the proper braking position for that particular rappel.
- Ensure that the proper commands or signals are used.
- Dispatch each person down the rope.
- Ensure the last person is down the rope.
- Ensure that the ropes are inspected after every 50 rappels.
- Maintain a rope log.

Types of Rappels

The three types of rappels are the hasty rappel, the seat-shoulder rappel, and the seat-hip rappel. The hasty rappel is used when carrying loads down moderate slopes. The seat-shoulder rappel is used for heavily laden troops over vertical to near vertical terrain or cliff faces. The seat-hip rappel is used when carrying loads over vertical to near vertical terrain or cliff faces.

Hasty Rappel

The hasty rappel is the easiest type of rappel for which to prepare. It requires no equipment other than a rope and gloves. It is conducted in the following manner:

- Roll sleeves down and put gloves on.
- Face slightly sideways.
- Place the rappel rope across your back, grasping it with both hands, palms forward, and arms extended.
- The hand nearest the anchor is the guide hand. The hand farthest from the anchor is the brake hand.
- Lean out at a moderate angle to the slope.
- Descend down the hill facing half sideways, taking small steps and continually looking downhill while leading with the brake hand.
- Feet should not cross and the downhill foot should lead at all times. See figure 6-1.

The steps for braking during a hasty rappel are to bring the lower (brake) hand across the front of the chest to brake and, at the same time, turn to face up toward the anchor point.

Seat-Shoulder Rappel

The seat-shoulder rappel relies on friction as the main effort of controlling the descent. It is very efficient for Marines with heavy packs because it provides support for heavy loads on the back. A seat-shoulder rappel is conducted in the following manner:

- Put on the rappel-seat, roll sleeves down, and put gloves on.

  Note: To avoid injury, the rappel seat should be constructed at the rear of the rappel site loading platform. If the rappel seat is worn for too long, the rappel seat could loosen up enough to cause the Marine to slip out of his/her seat while rappelling.

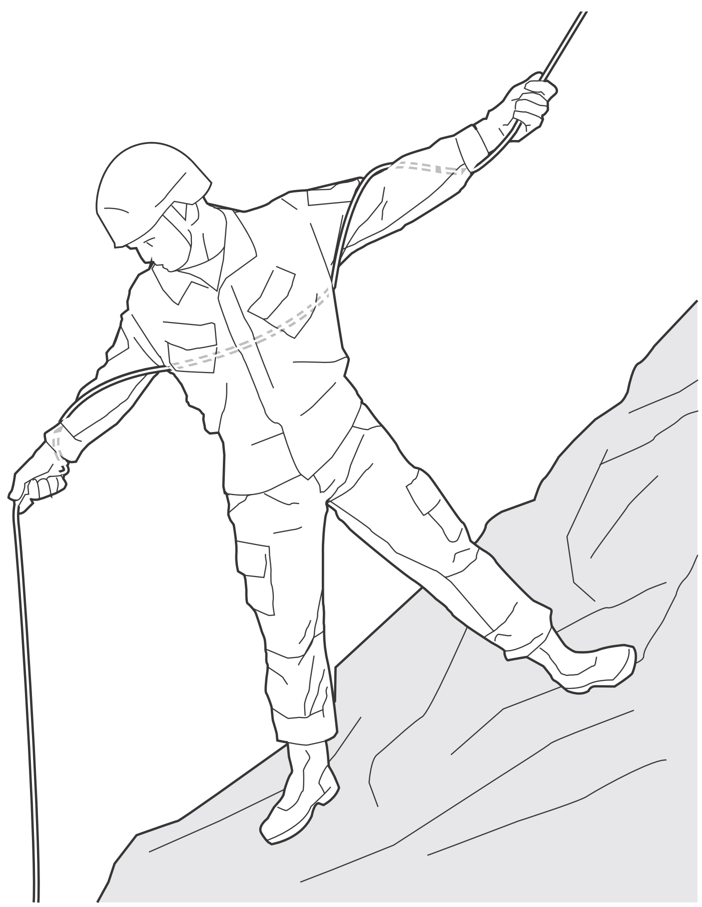

Figure 6-1. Hasty Rappel.

- Place the locking carabiner on the rappel-seat so that the gate opens down and away to prevent the gate from opening once the wraps are placed into the carabiner.
- Step up to the rope with the rappeller's left shoulder facing the anchor. The rappel rope is attached to the rappeller's hard point carabiner as follows:
  - Snap the rope into the locking carabiner.
  - Take slack from the standing (anchor) end of the rope and make one wrap with the rope around the body of the carabiner and back through the gate.
  - Ensure that the locking nut of the carabiner is fastened to lock the carabiner closed.

  Note: If Marines are using only one rope to rappel due to the tactical situation or equipment availability, the procedures are the same, EXCEPT the Marine will make two wraps around the body of the carabiner instead of one or use a munter hitch.

- Take the rope across the Marine's chest, over the left shoulder, diagonally across the pack and down to the right (brake) hand.
- Descend by walking down the cliff using the braking procedure to control the rate of descent. Look under the brake arm for possible obstacles to avoid.

The steps for braking during a seat-shoulder rappel are to lean back and face directly uphill while bringing the brake hand across the chest.

Seat-Hip Rappel

The seat-hip rappel is the most commonly used rappel and is conducted in the following manner:

- Construct the rappel seat, roll down sleeves, and put gloves on.
- Place the locking carabiner on the rappel-seat so that the gate opens up and away.
- Step up to the rope with your left shoulder facing the anchor. The rappel rope is snapped into the carabiner as follows:
  - Snap the rope into the locking carabiner.
  - Take slack from the standing (anchor) end of the rope and make one wrap with the rope around the body of the carabiner and through the gate again, as in figure 6-2 on page 6-4.
  - Ensure that the locking nut of the carabiner is closed.

  Note: If Marines are using only one rope to rappel due to the tactical situation or equipment availability, the procedures are the same, EXCEPT the individual will make two wraps around the body of the carabiner instead of one or use a munter hitch.

- The rappeller will grasp the running end of the rope with the brake (right) hand, palm down and turned slightly inboard, near the hip, as in figure 6-3 on page 6-5.

The steps in braking for a seat-hip rappel are to grasp the rope tightly with the brake hand and place it in the small of the back. This move creates enough friction to stop all momentum.

Note: At no time should a Marine bound or jump while descending because it places undue stress on the anchors. "Walk" down the cliff face, using the proper braking procedure to control the rate of descent.

Safety of the First Person Down

To ensure the safety of the first person down, the rappeller will:

- Tie an overhand knot or figure-8 18 to 24 inches from the end of each rope before deploying the ropes.
- Tie a friction knot on the standing end of the rappel rope with a prusik cord, as seen in figure 6-4 on page 6-5.
- Attach the rappel ropes to the harness's hard point with a locking carabiner.
- Attach the prusik cord to the harness's hard point with a locking carabiner. This cord is also called a safety prusik. See figure 6-5 on page 6-6.

Note: If the safety prusik is too short, it can be extended with a web runner.

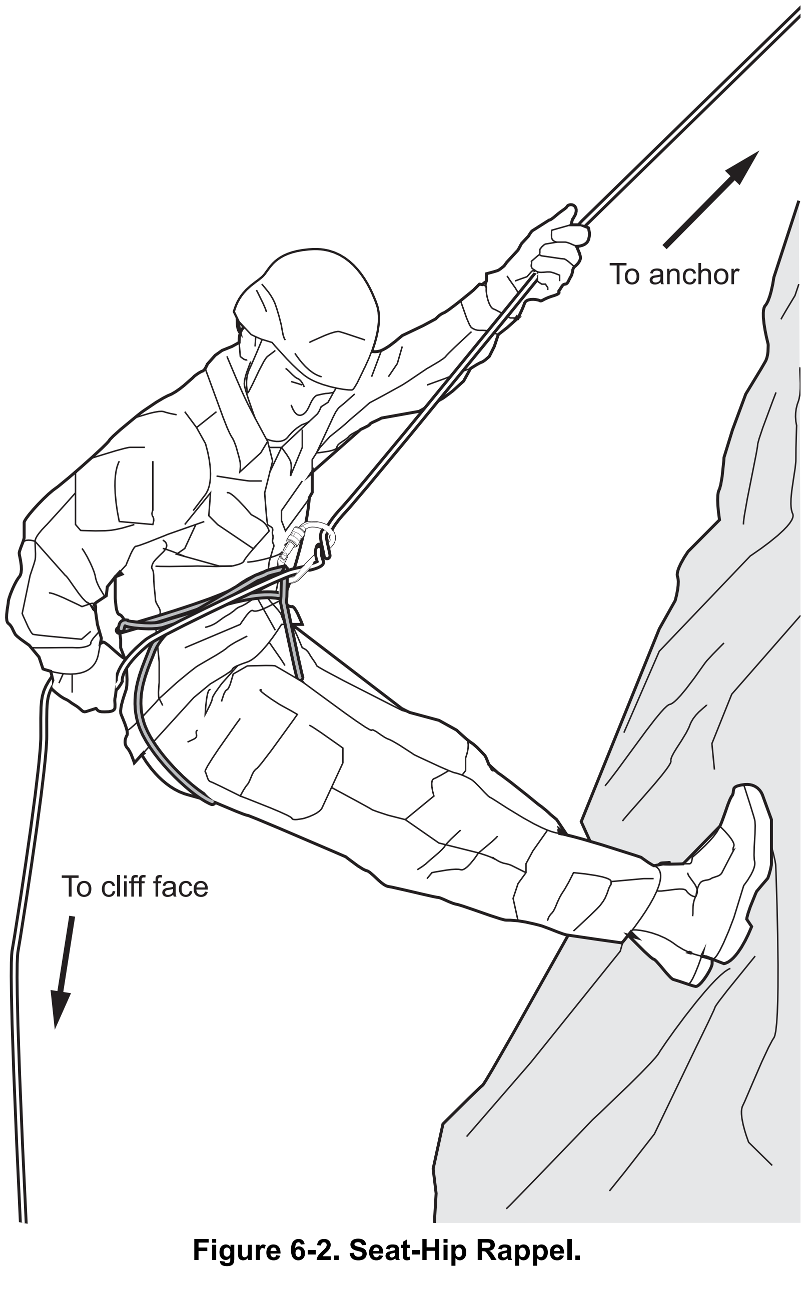

Figure 6-2. Seat-Hip Rappel.

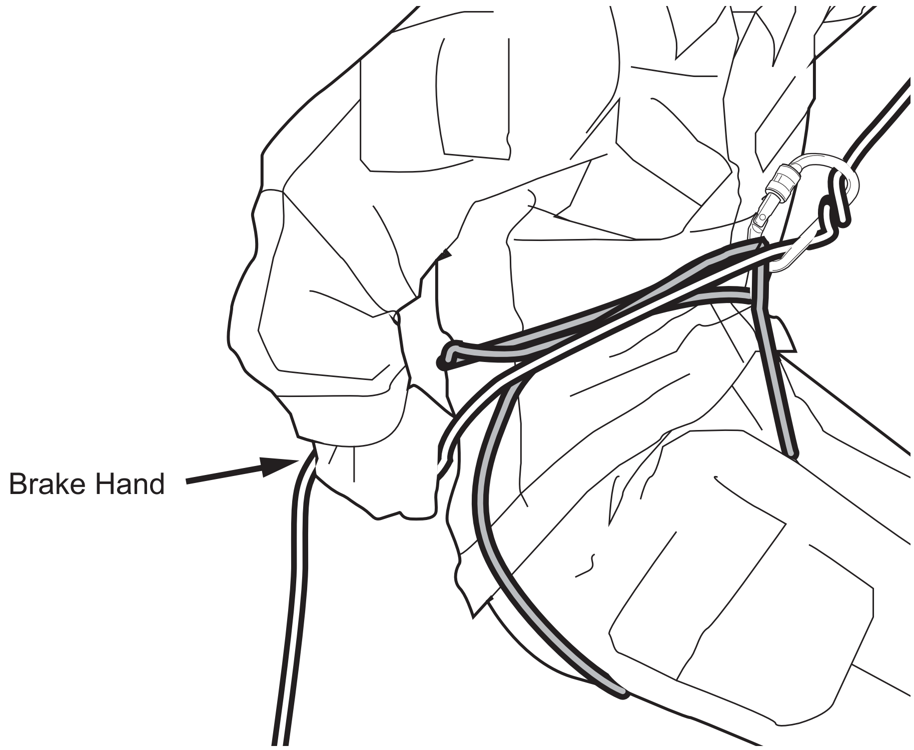

Figure 6-3. Rappeller with Brake Hand on Rope.

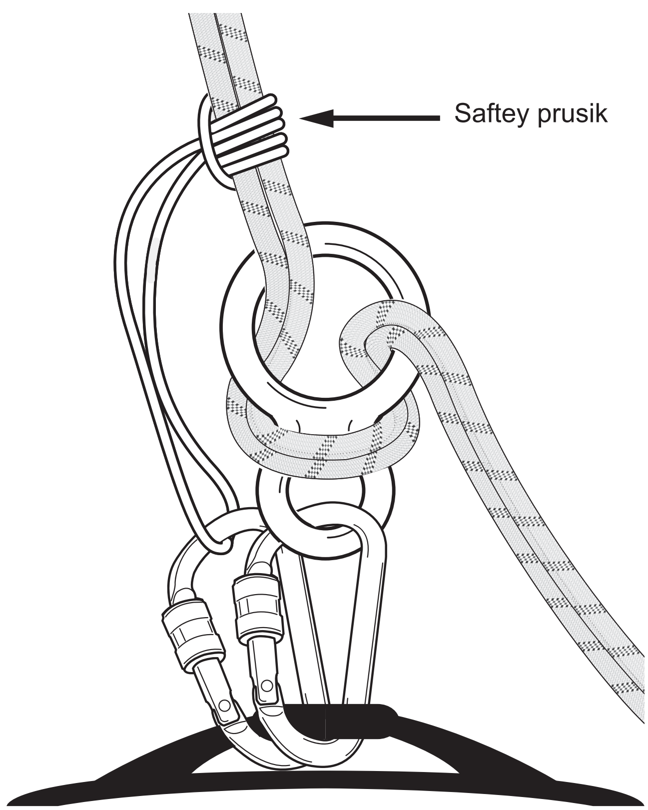

Figure 6-4. Safety Prusik.

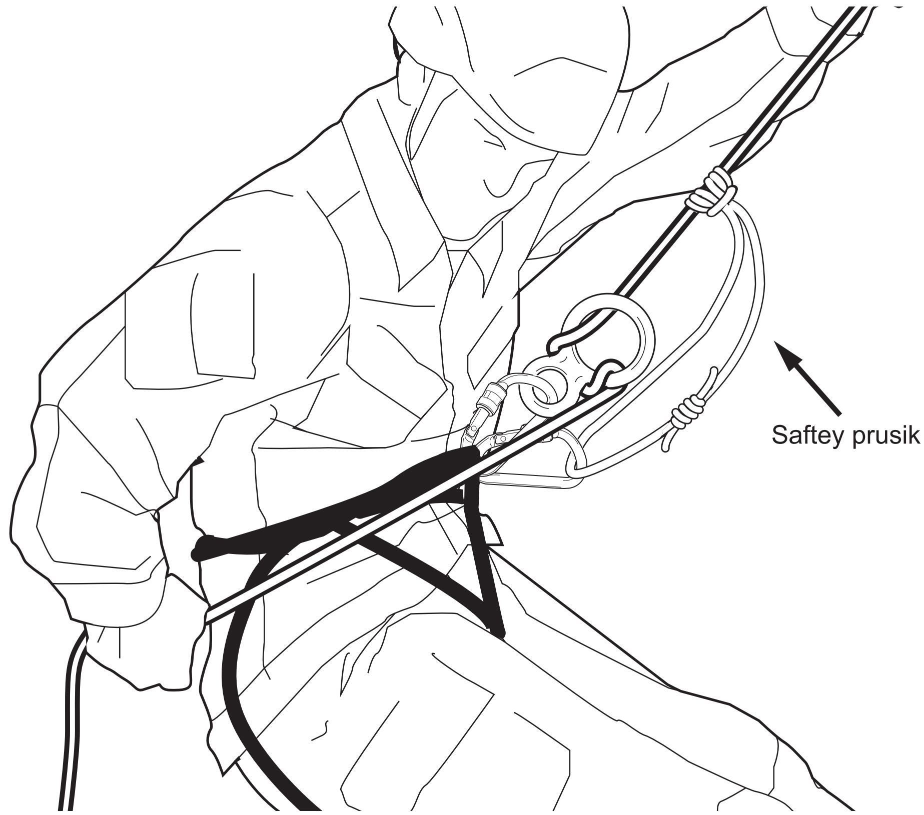

Figure 6-5. Rappeller with Safety Prusik.

The safety prusik can also be attached to the leg loop and placed under the rappel device, as in figure 6-6. This placement allows the guide hand to be free because the prusik is operated with the brake hand, which is useful when dealing with a casualty. Having the safety prusik below the rappel device is also preferable because it is less likely to catch on overhangs and obstacles. It is also less likely to lock up and, if it does, it is easier to loosen.

Duties of the First Person Down

The first person down the rope has the following specific duties:

- Selects a smooth route down for the ropes.
- Clears the route of loose rocks and debris.
- Unties the knots and straightens out the ropes once he/she reaches the bottom.

The first person down belays the next individual down the rope. There are two methods of belaying the next person down—the confined and open unloading platform belay. Method selection is based upon the restriction of the unloading platform.

Confined Unloading Platform Belay

The belay person will stand facing the cliff face, arms up with palms facing upward and overlapping. The rope will pass through the opening of the overlapping hand's thumb and index fingers. See figure 6-7 on page 6-8.

To stop a fallen rappeller, the belay person will grab the rope with closed fists and pull straight down, as in figure 6-8 on page 6-9.

Open Unloading Platform Belay

The belay person should stand facing the cliff with the ropes under both arms and behind his/her back.

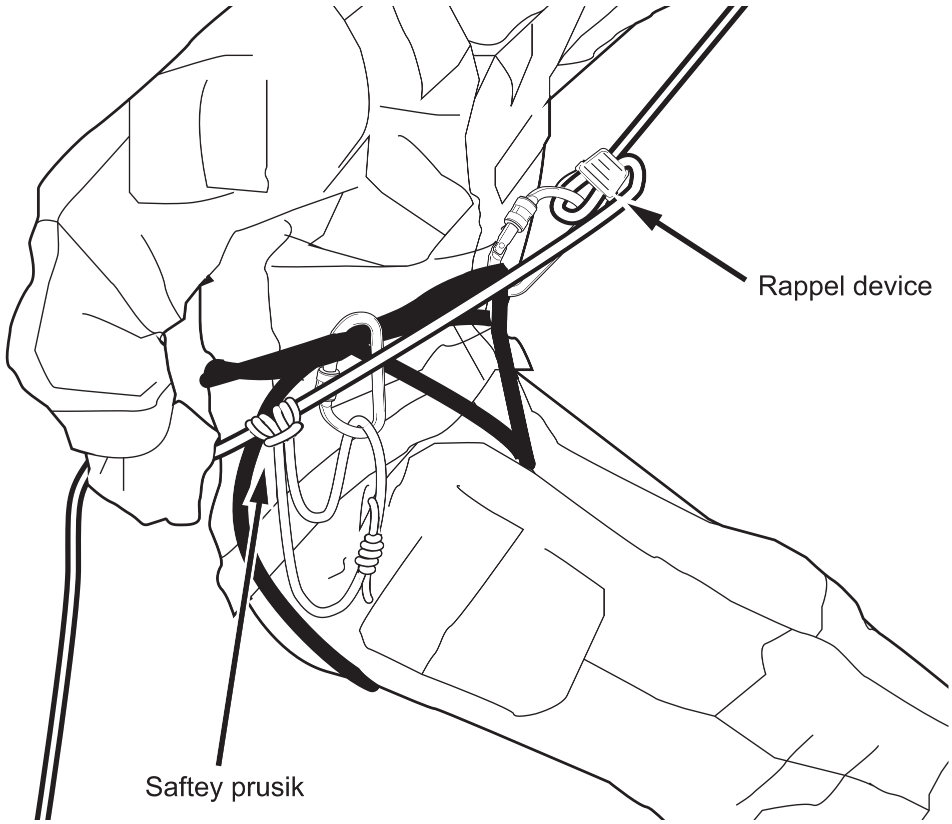

Figure 6-6. First Person Down.

To stop a fallen rappeller, the belay person will move away from the cliff face while holding the ropes firmly as in a standing hip belay. He/She takes charge of personnel as they arrive at the bottom to include appointing a belay person and setting in the security.

Rappelling Commands

In order to conduct rappelling operations safely, it is essential that everyone understands the sequence of events. The voice commands or rope tugs in table 6-1 are used.

Tying Off

Occasionally, it may be necessary to stop during a rappel before reaching the bottom of a cliff (see table 6-2 on page 6-10).

Table 6-1. Rappelling Voice Commands and Rope Tugs.

Voice Commands	Given By	Meaning
LANE NUMBER ON RAPPEL	Rappeller	Ready to begin rappelling
LANE NUMBER ON BELAY	Belayer	Ready to belay, safe to begin rappel
LANE NUMBER OFF RAPPEL	Rappeller	Completed the rappel and off the rope
LANE NUMBER OFF BELAY	Belayer	Completed the belaying of the rappeller

Rope Tugs	Given By	Meaning
Three tugs	Rappel point NCOIC	The rappeller is ready to begin rappelling
Three tugs	Belayer	Belayer is on belay, rappeller can rappel
Three tugs	Belayer	The rappeller is off the rappel rope
Legend NCOIC noncommissioned officer in charge		

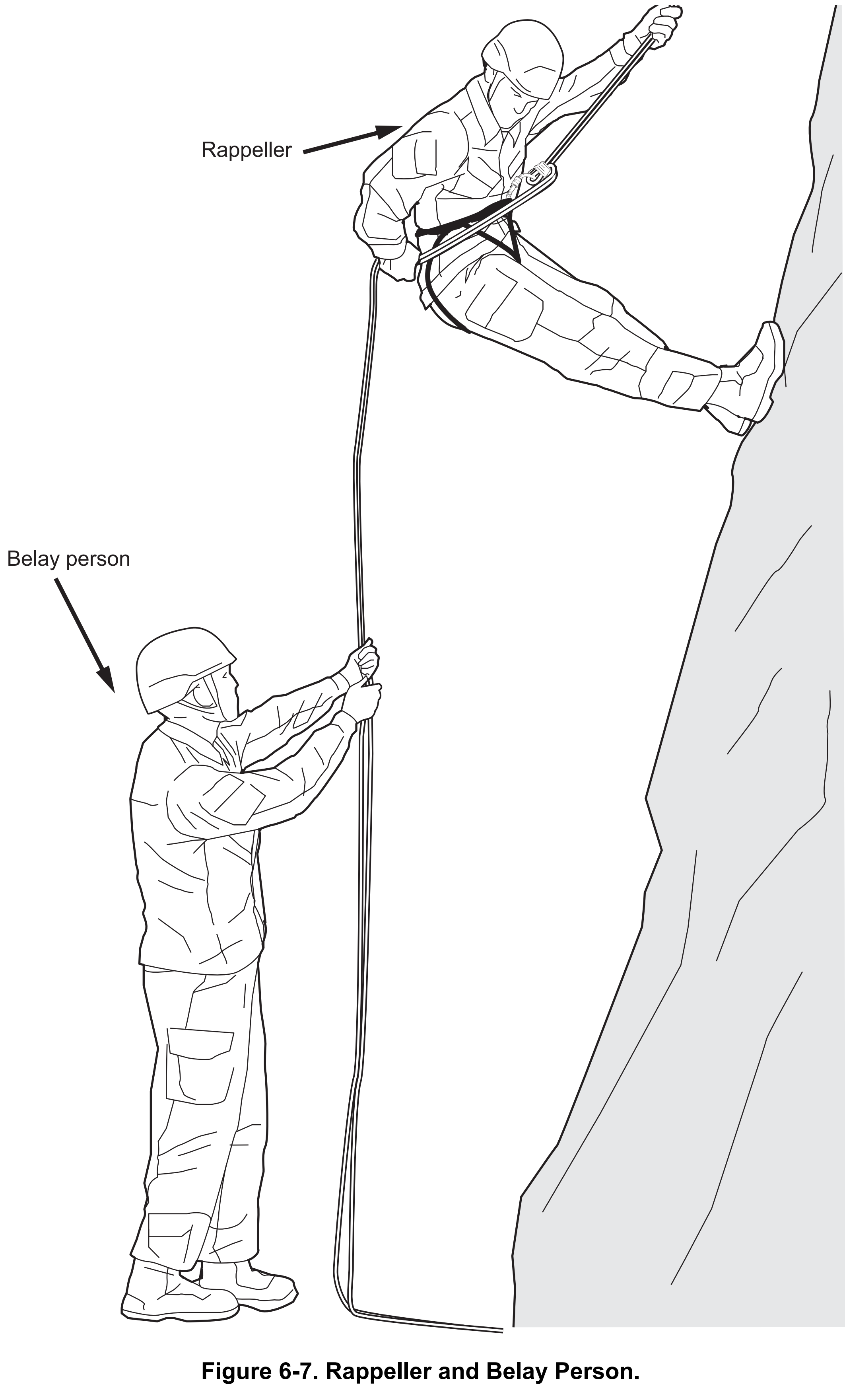

Figure 6-7. Rappeller and Belay Person.

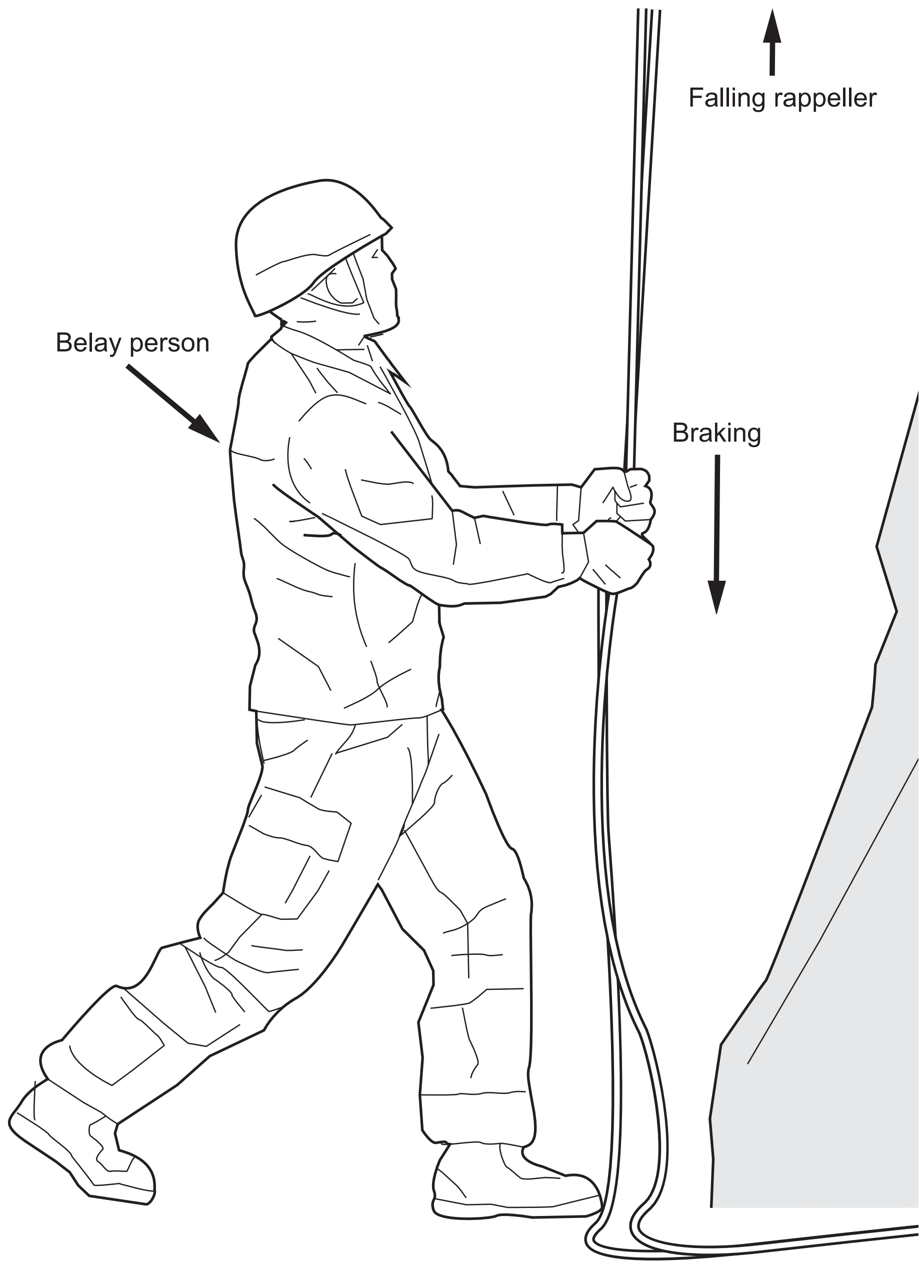

Figure 6-8. Belay Person Braking.

Table 6-2. Commands Used in Tying-Off.

Command	Given By	Meaning
LANE NUMBER TYING-OFF	Rappeller	Ready to tie-off, give some slack
LANE NUMBER TYING-OFF	Belayer	Enough slack given, tie-off
LANE NUMBER ON RAPPEL	Rappeller	Completed tying-off, ready to resume rappelling
LANE NUMBER ON BELAY	Belayer	On belay, resume rappel

The procedure used when tying-off is as follows:

- The rappeller gives the command, LANE NUMBER TYING-OFF.
- The belayer gives the rappeller slack and gives the command, LANE NUMBER TYING-OFF. He/She continues to hold the rope in the belay position, remaining alert and watching the rappeller.
- The rappeller quickly brings his/her brake hand to the twelve o'clock position so that the running end and standing end are parallel.
- The rappeller grasps all ropes with his/her guide hand as close to the carabiner as possible.
- The rappeller steps over the rope so that the running end is going between his/her legs.
- The rappeller releases the rope with his/her brake hand and then reaches under the running end over the standing end. He/She then takes up a bight from the running end about two feet long and pulls it over the standing end and under the running end, forming a half hitch.
- He/She pulls the half hitch tightly against the guide hand.
- He/She works the half hitch down snugly against the carabiner while maintaining contact with the guide hand as long as possible.

  Note: A loose half hitch could bind into the carabiner, causing difficulties in clearing the knot out. Make sure that the first half hitch is dressed down tightly before moving it against the carabiner.

- Place another half hitch above the one already tied.

To untie, reverse the steps:

- Remove the safety half hitch, then shrink the first half hitch down to a small loop by grabbing the running end of both ropes and pulling them straight out to the left.
- Place the right hand in the middle of the two bights until they are snug on all four fingers.
- Remove one finger and make the bights snug on three fingers.
- Repeat this process until it is down to one finger and both the bights are equal.
- Grasp the running end with both hands and smartly jerk the running end of the ropes upward to pop the small loop out from the first half hitch.
- From this position, keep the guide hand around both of the ropes next to the carabiner; step back over the rope so that the running end is on the right side.
- Grab just the running end with the brake hand and quickly set the brake behind the small of the back, then readjust the guide hand onto the standing end. This is the seat-hip rappel position.

  Note: The wraps may bind up some after untying where no further movement down is possible. To alleviate this, keep the brake on and force the body weight down to pop the wraps in the carabiner back to their intended position and then continue with the rappel.

- The rappeller gives the command, LANE NUMBER ON RAPPEL
- The belayer takes up the slack and gives the command, LANE NUMBER ON BELAY.
- The rappeller resumes rappelling down.

Rescue Techniques

When conducting rappelling operations, the possibility of a rappeller getting caught on the rope due to either clothing or equipment can occur. The following subparagraphs discuss types of rescues that can be performed to free the rappeller.

The Self-Rescue Technique

To perform the self-rescue technique, the rappeller, after realizing that he/she is caught up on the rope, must do the following:

- Check with the belay person to ensure that he/she has the brake set.
- Using a safety prusik, tie a friction knot on to the rappel rope approximately an arm's length above the area that is fouled. Anchor the other end of the safety prusik to the rappel seat's hard point. This technique is the same as used for first person down procedures.
- Work the friction knot up until there is no tension on the rappel device, which will give the necessary slack to free the malfunction.
- Once the problem is corrected, continue to rappel down using the first person down method.

The Buddy Rescue Technique

The buddy rescue technique is used when the rappeller is unable to correct the problem by themself:

- The rescuer will rappel down on another rope to the disabled rappeller and tie off.
- The rescuer will then establish a safety prusik onto the victim as in the self-rescue technique.
- After clearing the malfunction, rappelling operations are continued.

Rappelling Casualty Rescue

There are three different methods in which to get an injured rappeller to the bottom. The first method is to allow the belay person to lower the casualty by slowly releasing the tension on the rappel rope.

The second method is used for critical injuries or when the belay person cannot properly control the casualty's descent. The rescuer will rappel down using another rope. Once the rescuer gets to the casualty, the rescuer will have his/her belay person set the brake, enabling the rescuer to use both hands. If necessary, the rescuer will perform the basic first aid needed. Once the casualty is ready to be lowered, the rescuer will call down to both of the belay people to simultaneously lower both individuals. The rescuer will hold onto the casualty the entire way down so that he/she doesn't bounce off the rock face.

The third method is called a tandem rappel. It is used to rescue a casualty who has sustained an injury serious enough that he/she cannot operate the rappel device themself and requires the assistance of a second rappeller. This type of rescue can be conducted from the top of the cliff face or while on rappel, depending on where the injury occurred. If the injury occurs while on top of the cliff face, the following steps should be taken:

- Take either a long sling rope or prusik cord and tie a figure-8 knot offset so that one length of the cord is longer than the other.
- Tie a figure-8 knot at each end.
- Attach a rappel device to the offset figure-8 loop with a carabiner and attach it to the rappel rope.
- Attach the casualty's hard point to the short end of the sling rope/prusik cord and the rescuer to the other end.
- Use a safety prusik in the same method as the first person down technique, except that the friction knot will be tied below the rappelling device and controlled with the brake hand.
- Maneuver under the casualty to provide assistance and support. At this point the rescuer is ready to rappel both themself and casualty at the same time.

  Note: The rappel device should be far enough in front so that the casualty will not be able to reach it.

If the injury occurs during the rappel, the following steps are taken:

- The rescuer will preset the same system on a separate rappel rope and rappel down to the casualty.
- The rescuer then takes the short end of the sling rope and attaches it to the casualty's hard point.

- With a knife, the rescuer will cut the casualty's rappel rope away.
- Both rappel down to the bottom of the cliff face.

Note: This is the only time that a knife will be used during a rappel. Extreme caution should be used. It is not to be done in training, but only during an actual rescue as a last resort.

Retrievable Rappels

Once a unit has rappelled down a vertical obstacle, it may be necessary to retrieve the rope(s). Depending on the height of the obstacle, either one or two ropes will be used to construct the rappel lane.

One-Rope Retrievable Rappel

The one-rope retrievable rappel procedures are as follows:

- Find the middle of the rope and place it directly behind a suitable anchor point.
- Join the pigtails of the rope with an overhand/ figure-8 knot and deploy the rope down the obstacle.
- On one side of the rope in front of the anchor point, tie an over-the-object clove hitch onto a locking carabiner.
- On the other side of the rope, tie a figure-8 loop and attach it to the same carabiner.
- The first person down will use a safety prusik and untie the overhand knot after he/she reaches the bottom.
- All others conduct proper rappel procedures.
- The last person down will disconnect the carabiner from the rope, ensuring that the middle of the rope is directly behind the anchor point. He/She then rappels down the rope.
- The rope is then retrieved by pulling on either end of the rope.

Two-Rope Retrievable Rappel

The two-rope retrievable rappel system is identical to the one-rope retrievable rappel except for the following considerations:

- The reason for using two ropes is the height of the rappel requiring it.
- When two ropes are used they should be joined together using a square knot. This knot will be placed out of the system when securing the carabiner to the ropes and will prevent total failure of the system if the knot should fail.

All else remains the same as the one-rope retrievable rappel except:

- The last person down will disconnect the carabiner from the rope and will move the joining knot as close to the vertical obstacle's edge as possible, which will prevent the knot from getting caught up while retrieving.
- The last person down will then place a carabiner on the rope below the knot, which will enable him/her to know which line to pull for retrieval.

Equipment

Equipment should be worn in accordance with the unit's SOP. The unit has the responsibility to determine which methods it feels are most beneficial to the mission. Weapons should be worn across shoulder with the muzzle down and away from the brake hand and with a tight sling securely attached to the weapon. Weapons should be dummy corded to the Marine.

Balance Climbing

Balance climbing comprises the foundational climbing techniques used to move through all fixed rope systems or when climbing without ropes.

Individual Preparations

Before beginning a balance climb, there are seven things that the climber must do to prepare:

- Wear a helmet with a serviceable chinstrap.
- Roll sleeves down to give hand and arm freedom of movement. Tuck blouse into trousers, so, in case of a fall, it does not catch on a rock and cause the climber to flip over sideways.
- Remove all watches, rings, and jewelry before climbing.
- Do not wear gloves, as they can slip and give a false feel for the rock.
- Unblouse trousers if they restrict movement.
- Ensure the boot soles are clean and dry.
- Select a route where vegetation is minimal. Never use vegetation for hand or foot holds.

Duties of the Spotter

The spotter is the balance climber's partner who, rather than climbing themself, acts as the safety person for the climber during the climb. The five duties of the spotter are to—

- Position himself/herself directly behind the climber before the climb starts.
- Maintain his/her position facing the cliff, directly below the climber and approximately 3 to 4 feet away from the base of the cliff, for the duration of the climb. He/She will move diagonally as necessary to remain below the climber.
- Stand with his/her feet shoulder-width apart and arms ready to stop the climber if he/she falls.
- Prevent the climber from falling further down the hill should he/she begin to fall. The spotter will not "catch" him/her; rather, he/she pushes the climber toward the base of the cliff, preventing him/her from tumbling backwards.
- Never allow anyone to come between themself and the face of the cliff while a balance climb is taking place. He/She will require anyone who wants to pass by his/her position to go behind him/her.

Spotting and Climbing Commands

Table 6-3 shows the commands used by both the spotter and climber.

Table 6-3. Spotting and Climbing Commands.

Command	Given By	Meaning
LAST NAME, CLIMBING	Climber	I am ready to climb
CLIMB, CLIMBER	Spotter	I am ready to spot you
LAST NAME, OFF CLIMB	Climber	I am off the climb
ROCK	Climber or spotter	A rock has been knocked off the rock face and is falling
FALLING	Climber	I am falling

If the command ROCK is given, all personnel in the vicinity will take the following action:

- If close to the cliff face, put your face against it and your hands between your body and the cliff face.
- If not close to the cliff face, look up to locate the rock and avoid it.

Actions if Falling

If, while making a balance climb, the climber feels themself slipping and beginning to fall, he/she will take the following action:

- Sound the command, FALLING.
- Push themself away from the rock face.

The falling climber should maintain proper body position as follows:

- Head up.
- Hands held out toward the rock.
- Body relaxed.
- Feet kept below the body, slightly apart.
- Face the cliff face in a fall.

Types of Holds

The five basic holds that are used in balance climbing are push holds, pull holds, foot holds, friction holds, and jam holds.

Push Holds

Push holds are most effective when the hands are kept low and are often used in combination with a pull hold. See figure 6-9.

Pull Holds

Pull holds are the easiest hold to use and, consequently, are often overused. They can be effective on small projections. See figure 6-10.

Foot Holds

The following should be considered when using foot holds:

- Feet should be positioned with the inside of the foot to the rock.
- Use full sole contact as much as possible.
- Avoid crossing the feet. If a Marine must cross his/her feet, he/she should use a change step. A change step is a method of substituting one foot for the other foot on the same foothold.
- Climbing with the feet is an effective means of conserving body strength since leg muscles are stronger. Make maximum use of foot holds. See figure 6-11.

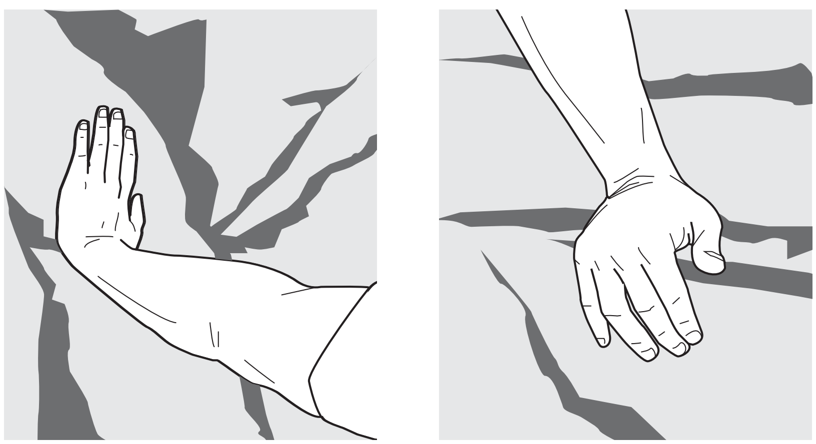

Figure 6-9. Types of Push Holds.

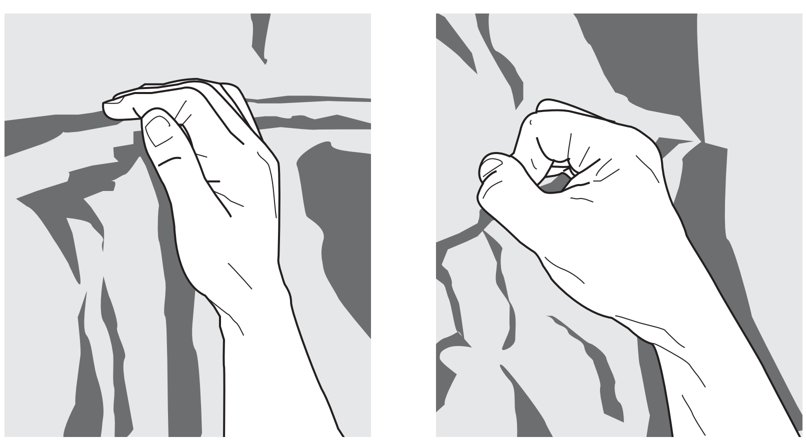

Figure 6-10. Types of Pull Holds.

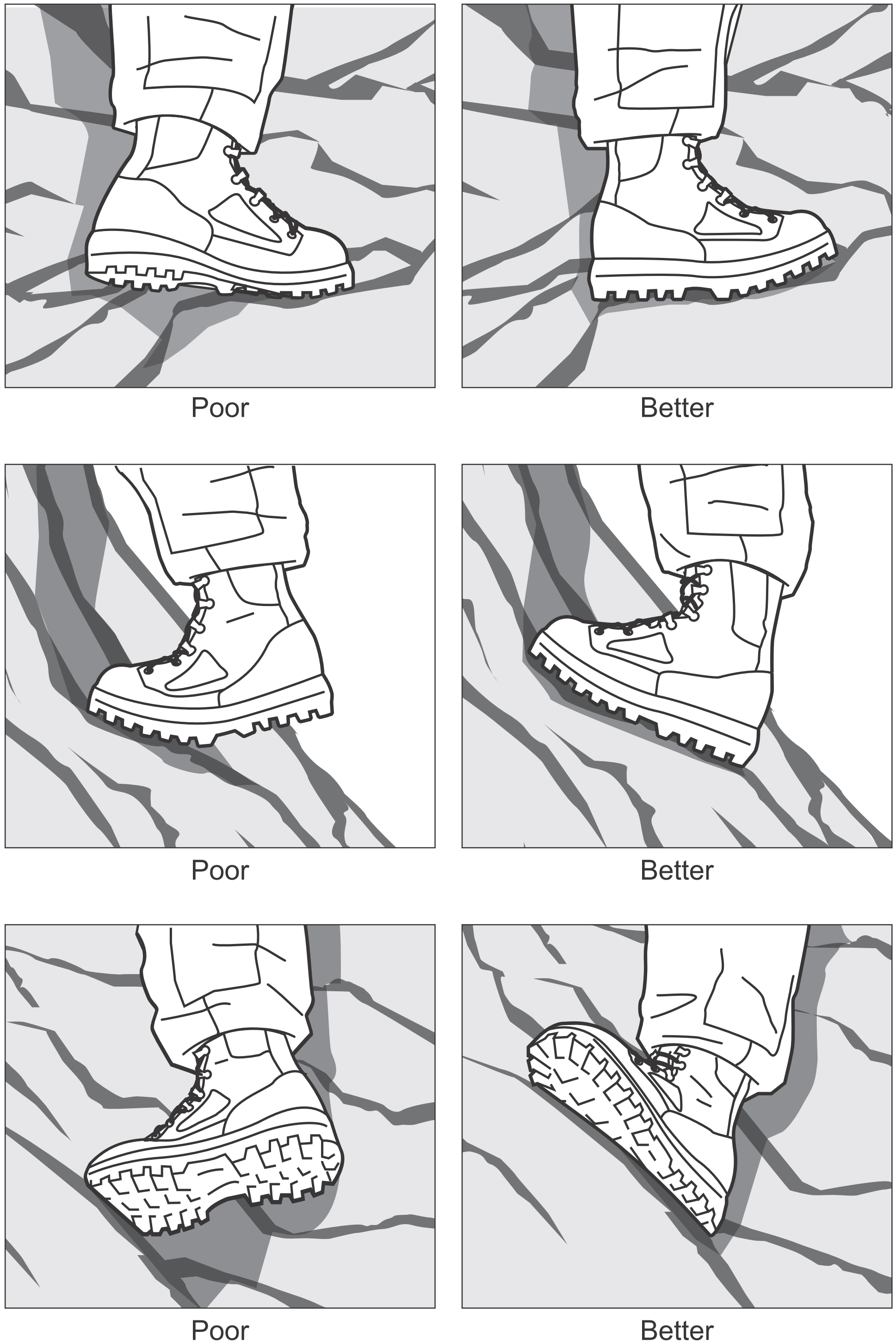

Figure 6-11. Use of Foot Holds.

Friction Holds

A friction hold is used any time a climber relies on the friction of the foot or hand against the face of the rock for traction, rather than pushing/pulling against a projection on the face of the rock. See figure 6-12. It is a type of hold that feels very insecure to an inexperienced climber. The effectiveness of this type of hold depends on the type, condition, and angle of the rock face; type of boot soles the climber is wearing; and his/her confidence.

Figure 6-12. Friction Hold.

Jam Holds

This type of hold involves jamming/wedging any part of the body or the entire body into a crack/opening in the rock. The climber must not jam so hard that he/she cannot free that portion of his/her body after completing the move, which will be from a different angle than when inserted. See figure 6-13.

Figure 6-13. Finger, Hand, and Fist Jams.

Combination Holds

The five types of holds just discussed are not only used individually. The following subparagraphs offer examples of how the holds are most often used in combination with each other.

Chimney Climbing

Chimney climbing is when a climber inserts his/her entire body into a crack in the rock, using both sides of the opening, and possibly all five types of basic holds to move up the crack, as in figure 6-14.

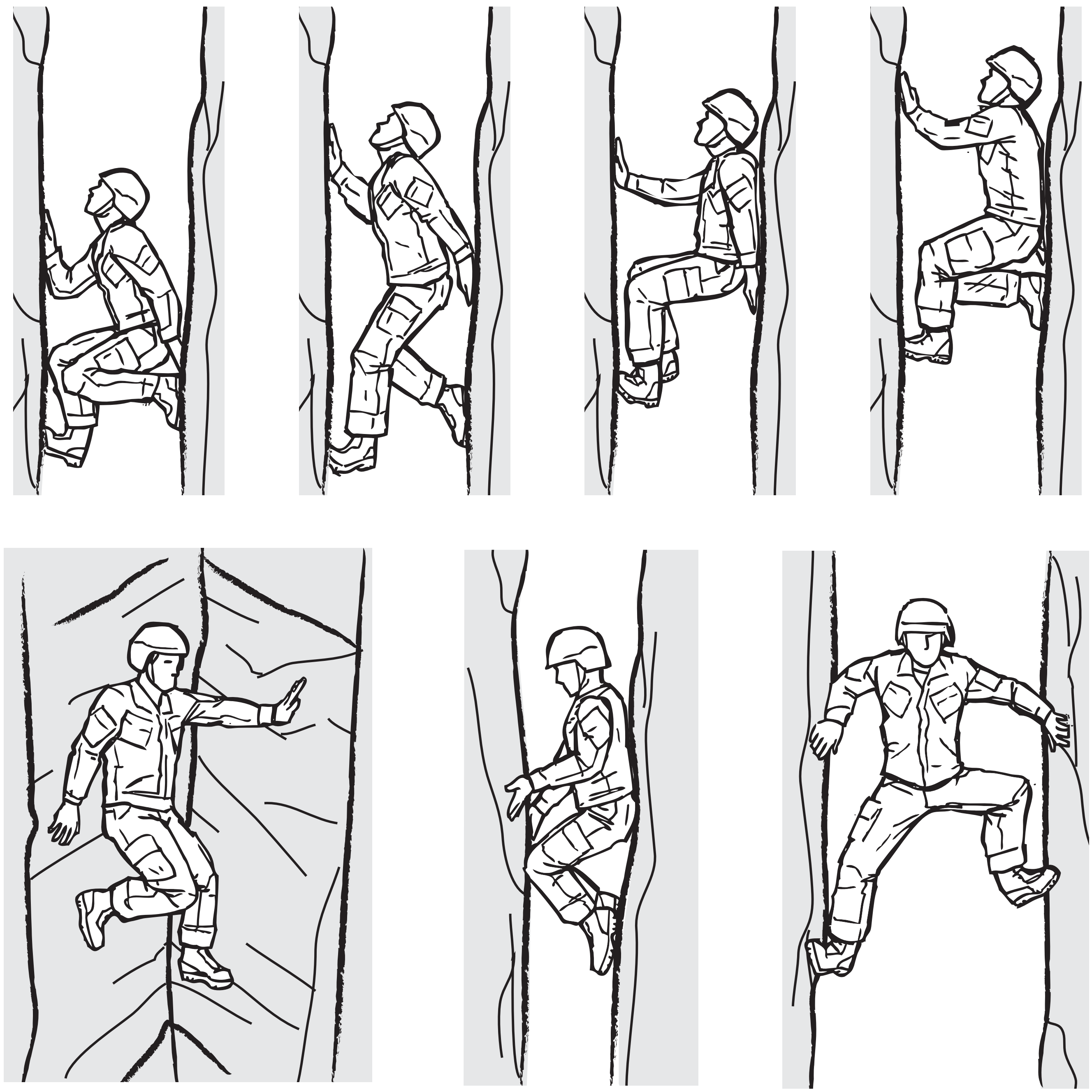

Figure 6-14. Chimney Climbing Techniques.

Lie-Back

The lie-back is a combination of pull holds with hands and friction holds with feet, as in figure 6-15.

Push-Pull

The push-pull is a push hold and a pull hold together, as in figure 6-16.

Mantling

In this technique, the climber continues to climb without moving his/her hands off a projection. He/She pulls up until his/her hands are at chest level and then inverts his/her hands and pushes on the same projection, as seen in figure 6-17.

Cross-Pressure in Cracks

Cross-pressure in cracks is the technique of putting both hands in the same crack and pulling apart, as in figure 6-18.

Inverted

Inverted techniques can be either pull or push, as in figure 6-19.

Pinch

The pinch is a grip used on small projections, as in figure 6-20.

Stemming

Stemming is the wide spreading of arms or legs to maintain a proper body position (usually used in a book or chimney), as in figure 6-21 on page 6-20.

General Use of Holds

How a climber uses holds depends on his/her experience level and imagination. General guidelines are—

- Most handholds can next be used as foot holds.
- Use all holds possible in order to conserve energy.
- Even small projections may be used as holds.
- Do not use knees or elbows because a slip could occur if pressure is exerted on them. Knees and elbows may be used with the extension of a limb jam.

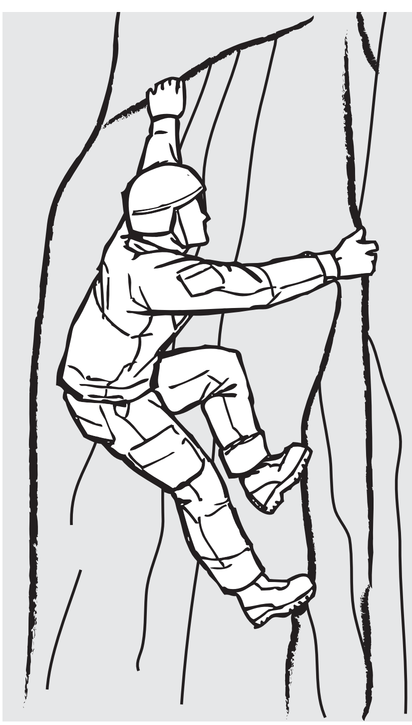

Figure 6-15. Lie Back.

Figure 6-16. Push-Pull.

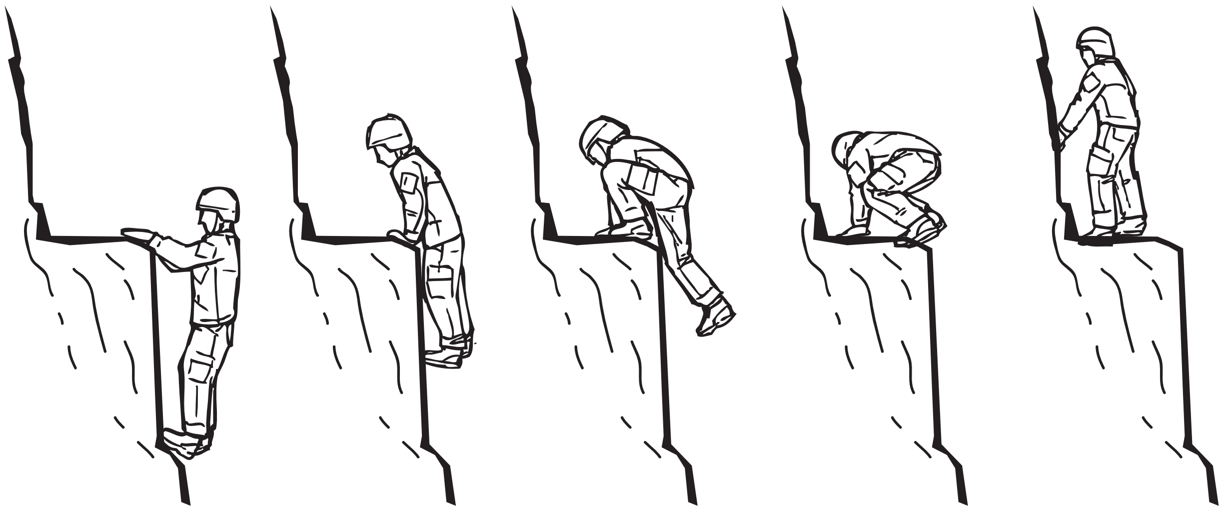

Figure 6-17. Mantling.

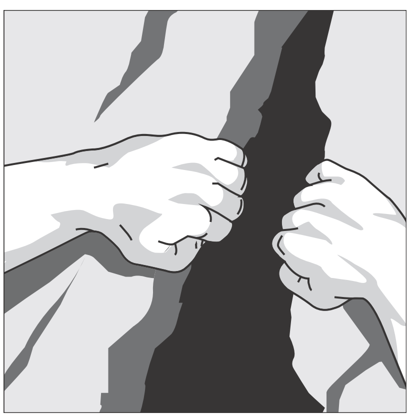

Figure 6-18. Cross-Pressure Method.

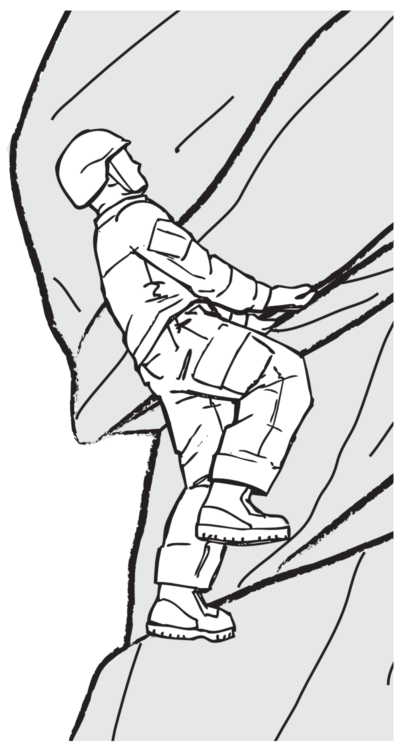

Figure 6-19. Inverted Techniques.

Figure 6-20. Pinch.

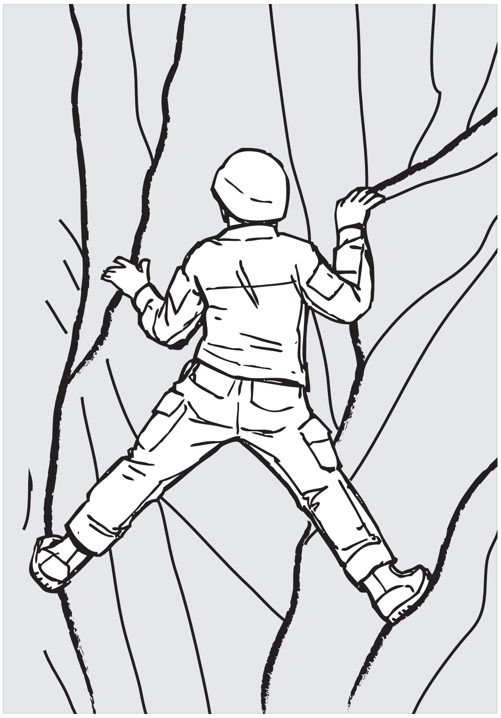

Figure 6-21. Stemming.

Movement on Slab

Movement on a slab is based on friction holds and climbers should make the following considerations:

- Use any irregularities in the slope to gain additional friction.
- Traversing requires both hands and feet.
- Descending a steep slab may require turning inboard to face the slab and backing down.
- The biggest mistake in slab climbing is leaning into the rock. Maintain maximum friction by keeping weight centered.

Body Position

The climber should climb with his/her body in balance, keeping his/her weight centered over and between his/her feet and not hugging the rock or overextending into a "spread-eagle" position. While climbing, climbers should remember "CASHWORTH" for proper body position and movement:

C—Conserve energy.
A—Always test holds.
S—Stand upright on flexed joints.
H—Hands kept low; handholds should be waist to shoulder high.

W—Watch your feet.
O—On three points of contact.
R—Rhythmic movement.
T—Think ahead.
H—Heels kept lower than the toes.

Top Roping

Top roping is a method of ascending a vertical obstacle. It is safe, but very time consuming because only one person can be on the rope at a time.

Establishing a Belay Stance from the Top

The belay person will establish a sitting belay stance on the cliff head by—

- Constructing a suitable anchor with the standing end of the rope.
- Tying a directional figure-8 loop with the direction of pull away from the anchor near enough to the cliff's edge so that the climber can be observed, if possible.
- Tying a swami wrap around the waist and clipping a locking carabiner through the front of the wraps and a locking carabiner through all of the rear wraps.
- Securing the rear locking carabiner into the directional figure-8 loop.
- Securing the running end of the rope to the rear locking carabiner using a suitable belay, such as a munter hitch or mechanical belay device.

Note: Gloves will not be worn while belaying a climber during a top rope.

Securing the Climber to the Rope

The climber will tie into the end of the top rope using the following three steps:

- Construct a swami wrap around his/her chest.
- Tie a retrace figure-8 loop through all swami wraps.
- Tie a figure-8 loop clipped into a locking carabiner and secured through all the swami wraps.

Alternative methods are a bowline on a coil or a sit harness.

Establishing a Belay Stance from the Bottom

The belay stance from the bottom is commonly referred to as a "yo-yo" or "sling shot" belay. This system can be constructed for either a direct or an indirect belay. A suitable top anchor is constructed, using either a pulley, one locking, or two nonlocking carabiners as the attachment point for the anchor. The rope will travel up from the bottom and pass through the attachment point then return to the bottom. The climber will be secured to one end of the rope and the belayer to the other end, as in figure 6-22.

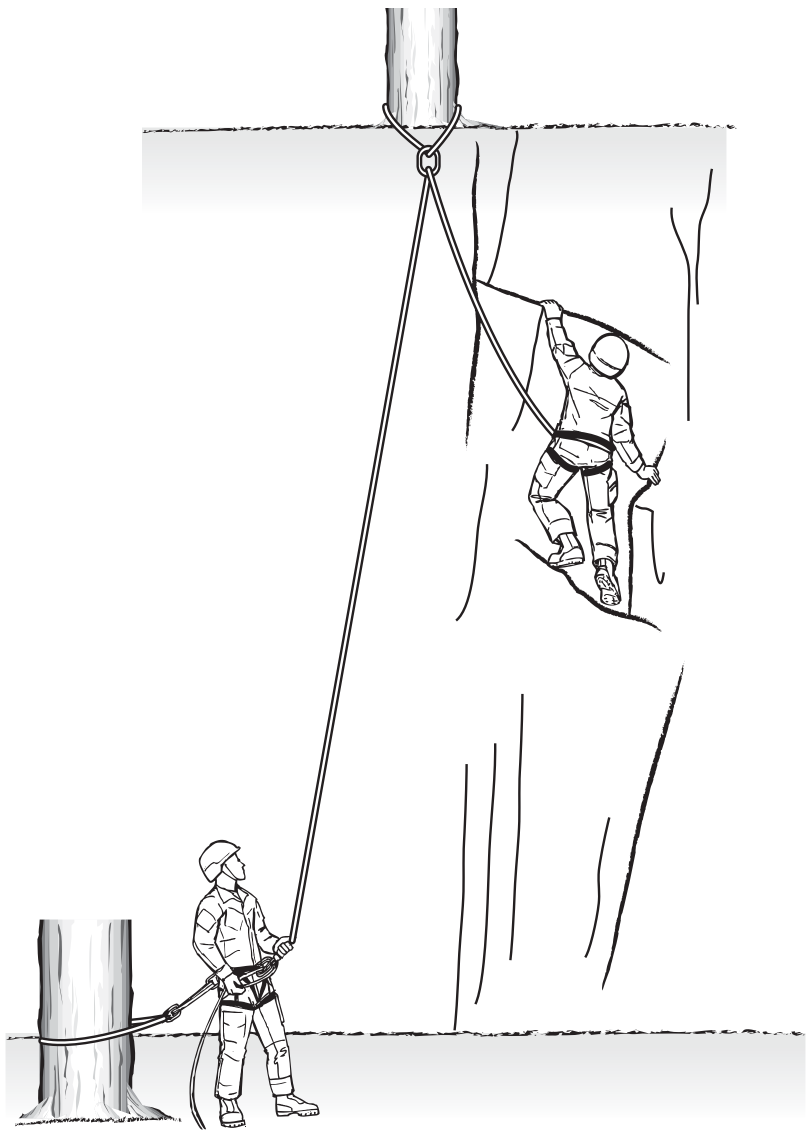

Figure 6-22. Belay Stance from the Bottom.

Climber Responsibilities

The climber's responsibilities are to—

- Ensure that the belayer is anchored and on belay by use of commands or prearranged signals before beginning the climb.
- Keep the same pace as the belayer; out climbing him/her will cause slack in the rope between the belayer and the climber.
- Avoid placing excess pressure/weight on belay person.
- Wear weapon across the shoulder with the muzzle down and to the left and with a tight sling securely attached (dummy cording recommended).

Climbing Commands and Signals

In order to conduct top rope operations safely, it is essential that everyone understand the sequence of events. The voice commands or rope tugs in table 6-4 will be used.

Table 6-4. Voice Commands and Rope Tugs Used in Top Rope Operations.

Voice Commands	Given By	Meaning
LANE NUMBER, UP ROPE	Climber	Belayer needs to take in the slack
THAT'S ME	Climber	Excess slack has been taken up
LANE NUMBER, ON BELAY	Belayer	On belay
LANE NUMBER, ON CLIMB	Climber	Ready to climb
CLIMB CLIMBER	Belayer	Begin to climb
LANE NUMBER, SLACK!	Climber	Pay out rope
LANE NUMBER, GIVING SLACK	Belayer	Paying out rope
LANE NUMBER, TENSION!	Climber	Take in rope
LANE NUMBER, TAKING TENSION	Belayer	Taking in rope

Rope Tugs	Given By	Meaning
Three tugs	Climber	Belayer needs to take in the slack
Three tugs	Belayer	Slack taken in; begin to climb
Three tugs	Climber	Climbing

Placing Protection

There are two general types of protection—natural and artificial.

Using Natural Protection

Natural protection is furnished by the terrain. It includes rock features and plants and can be used as intermediate protection during a climb or as anchors at belay points. During a climb, when testing the stability of natural protection, climbers must be especially careful not to dislodge it and pull it off on someone else. Be aware that rope drag may cause slings to slide off of carelessly slung natural features.

Placing Artificial Protection

Artificial protection, also known as protection, is climbing hardware placed in the rock by the climber. It can be removable or fixed. It can also be constructed with moving parts (active) or without moving parts (passive). It includes chocks, SLCDs, pitons, and bolts.

Placing good protection depends directly on the experience and knowledge of the climber placing it. Knowing how the tool works is critical to achieving its greatest performance. Acquiring this knowledge requires a great deal of practice, but a climber who has such knowledge makes an informed placement of his/her gear.

To hold a fall, protection must be placed properly in good, solid rock. Often climbers place mediocre protection that could be made better with just a minor adjustment. Practice in placing protection should start long before the first lead. Placement should begin with both feet firmly on the ground where there is no danger of a fall and under the supervision of an experienced climber.

For environmental reasons, placing chocks and cams is preferred over pitons in most established climbing areas. Piton placements should be practiced on rock outcroppings not frequented by climbers.

Chocks

Chocks are metal wedges of various size and design, strung with cable or cordage, which fit into constrictions or bottlenecks in cracks and cavities for a specific direction of pull. They evolved from slinging natural chockstones and later from threading machine nuts placed in the rock. Chocks are both removable and passive and include nuts and hexes.

Nuts. Nuts, also known as stoppers, wedges, and tapers, follow a basic wedge-shaped design with some variations based on the manufacture. They have a wide side and a narrow side and they are narrower at the base than at the top, where they widen on all sides. The design allows them to slip down into constrictions. Curved and offset nuts have virtually replaced straight nuts in the medium to large range, because they are easier to place and remove.

Note: Beware of the smaller nuts. They have a low tensile strength and are usually not strong enough to hold a hard fall. Their straight design and small surface area often causes them to rip out of the rock.

Originally, all but the smallest nuts were strung with nylon rope. Today, swaged cable has replaced the rope. Aside from being stronger, the cable also facilitates placement. When held straight up, a wired nut will not drop like one strung with rope. See figure 6-23.

Nuts can be placed in both vertical and horizontal cracks. Bottlenecks and constrictions in the crack make the best placements, as in figure 6-24 on page 6-24. Placements in flared or shallow cracks are tricky and it may take some work to find a good placement, if any. The rock should be checked for relative hardness and stability. Soft rock and crumbly rock makes for questionable placements and one side of a crack may actually be a detachable block or flake. To test it—

- Whack the rock a few times with the hand or fist while listening for hollow sounds.
- Gradually push or pull on the crack, being careful not to dislodge it and pull it loose.
- Remember that the crack has to widen only slightly for passive protection to pull out once loaded.

Figure 6-23. Example Nuts.

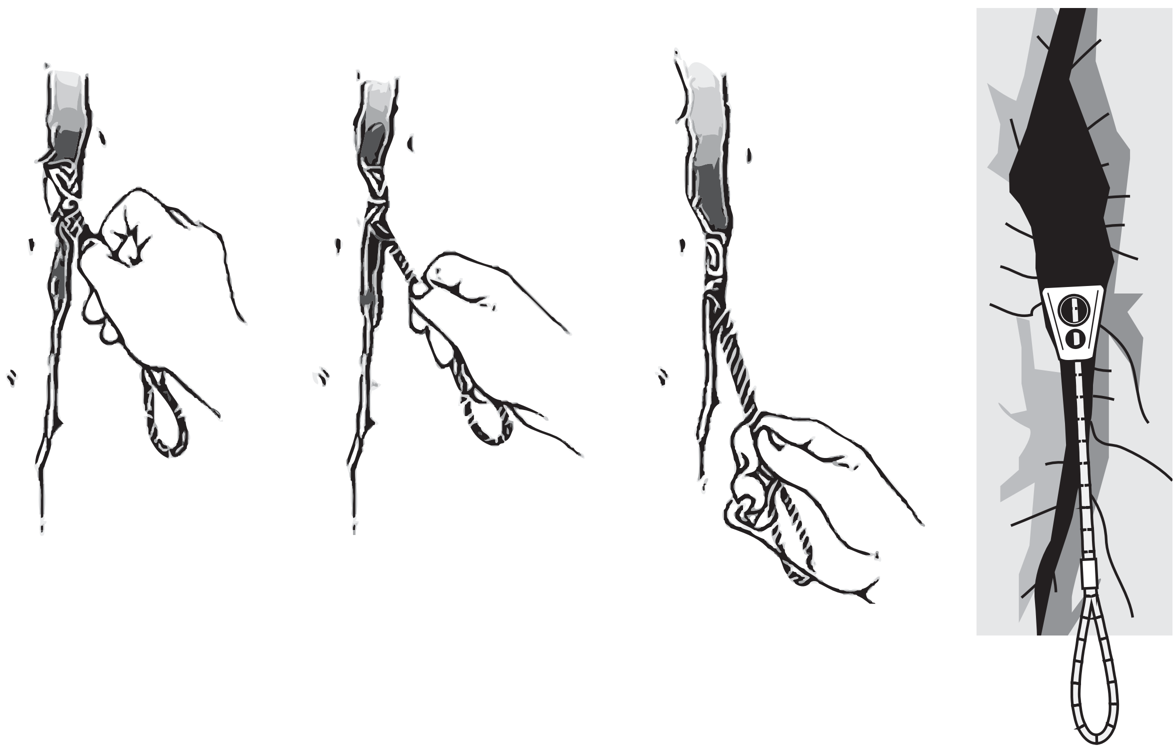

Figure 6-24. Nut Placement.

On remote virgin routes, Marines may have to clear dirt, moss, or grass from the crack before placing protection. They should select the nut that best fits the crack, always looking for the nut that will best fit the placement, not for the placement that will best match the nut. Most manufactures color-code their nuts by size to facilitate selection.

All but the smallest nuts can also be effectively placed sideways. This placement is generally weaker because the narrow side is used, reducing the surface area in contact with the rock. The nut is placed in the crack no deeper than necessary (a nut placed too deep makes removal difficult) and slid toward the constriction. The wire should point in the specific direction of pull.

Greater contact between the nut and the rock means a more secure placement. A nut resting on a small crystal or point of rock is likely to be unsafe. A bigger nut is generally more secure than a small one because it has a larger surface area; however, when the larger nut does not completely seat inside the crack, a smaller size should be selected. Sometimes a loose nut placed deep in a crack against a solid bottleneck may also offer a strong placement.

The nut is set by grasping the carabiner connected to the wire and giving it a few good tugs. This is enough. Applying any excess force just makes removal more difficult. The nut should seat solidly in the crack.

Check placement by gently pulling the wire against the intended direction of pull. If the nut comes loose, attempt to place it again. If the nut is still loose, climbers should consider selecting a different size or finding a new placement in a different section of the rock.

During a climb, connect wire protection to the rope using runners. Using the right length runner reduces rope drag and the possibility of the nut dislodging and coming loose or falling out of the placement. Always use a carabiner to connect the runner to wire protection, which prevents the wire from cutting the runner.

When constructing an anchor, using only a carabiner to connect to the nut is enough. Once loaded, carabiners should not be cross-loaded against an edge.

Nut placements are often unidirectional. An opposing nut can be placed to hold the first one in position. For more information, see the party climbing paragraphs later in this chapter.

To remove the nut, inspect its placement to determine the direction from which the nut was placed and work it in that direction. Grab hold of the cable or sling and moderately jerk on it toward the direction of placement. This alone will often work; however, if a nut is buried deep in a crack, the climber may have to pull harder, which can bend and damage the cable. Careless jerking or working the protection in the wrong direction may also cause it to become stuck. A nut that sustained a hard fall and became lodged often requires a nut tool to remove it.

Hexes. Hexes or hexentrics take their name from their six-sided, tube-shaped design. Each pair of opposing sides is a different distance apart, giving each piece four different placement options. Hexes are especially useful in wide cracks, horizontal cracks, and bottlenecks. Many hexes in the medium to large range are still strung with cordage. Using cordage over cable allows an unrestricted camming action of the hex. For such action, nylon rope has been replaced by 5.5 mm Spectra or Gemini cord, which has proven to be stiffer and much stronger. Hexes not preslung with cable or cordage from the manufacturer come with holes drilled to accept this type of cordage. The holes should have smooth rounded edges to avoid damaging the material. The stiff and slippery texture of Spectra and Gemini should be secured using a triple fisherman knot.

The cordage should be cut to 28 to 32 inches long, which will give an 8- to 10-inch sling and allow for 1-inch long pigtails. The knot is kept near the carabiner end of the sling to avoid interference with the placement. Among climbers, SLCDs have almost entirely replaced hexes; however, because they are cheaper and lighter, some prefer hexes to SLCDs. See figure 6-25.

Figure 6-25

. Example Hexes.

When placing hexes, follow the same criteria as for nuts with the following considerations (see fig. 6-26):

- In all but the sideways placements, the cable or wire, when loaded, creates a torquing or camming action that strengthens the placement.
- In vertical cracks, hexes should be placed to allow the camming action to pull the piece tighter against any irregularities of the rock.
- In horizontal cracks, hexes should be placed so they create a maximum camming action when loaded. When placed for a downward direction of pull, the sling should leave the hex closer to the roof of the crack.
- Hexes slung with cordage do not require a runner to connect them to the rope, only a nonlocking carabiner. In most cases, the cordage alone will minimize rope drag.

Removal of hexes follows the same principles as for nuts.

Spring-Loaded Camming Devices

Also called cams, SLCDs are active, removable protection that expands to take the shape of the crack, hollow, cavity, or pocket in which it is placed. Unlike nuts or chocks, they do not require a constriction in the crack. In fact, they work best in parallel-sided cracks where chocks fail to work. Cams can be placed and removed easily and quickly with just one hand.

In the basic design, four blades or lobes rotate from an axle connected to a trigger mechanism on a stem. When the trigger is pulled, the lobes retract, narrowing the cam's profile for the placement. When the trigger is released, the lobes open up against the sides of the crack. The lobes move independently of each other, permitting each to rotate to the point needed for maximum contact with the rock.

As the stem is loaded, the camming action of the lobes increases and generates high pressure against the rock. This pressure creates friction, which opposes the downward pull. Because of the potential force generated by the loaded camming unit, the rock surrounding the placement needs to be solid. The expansion range will compensate for small shifts in the rock; however, this force can easily dislodge a loose block or flake.

Many variations of the basic design exist:

- Units with two or three lobes for narrower placements.
- Units with fatter lobes for softer rock or offset lobes flaring placements.
- Units with two axles or two stems for passive placements and larger expansion range.

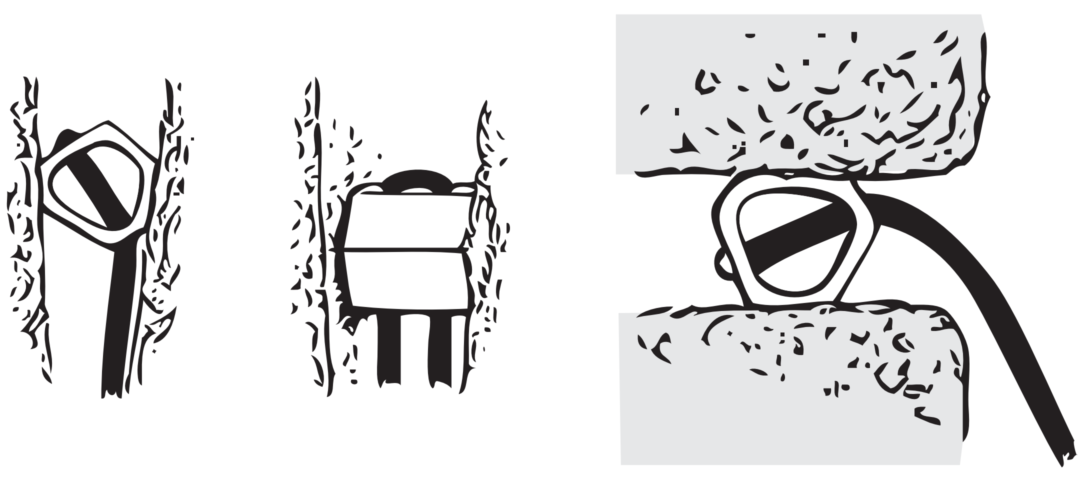

Figure 6-26. Example Hex Placements.

- Units with a flexible stem instead of a rigid one for horizontal placements.
- Units with a different trigger design that is specialized for flaring placements, for softer rock, and to fit in very tiny to very large cracks.

Each manufacturer produces a line of cams in a wide size range. All modern camming devices have a presewn sling threaded through the stem to clip a carabiner through it. See figure 6-27.

SLCD Placement. Flexible-stem cams can be placed in both vertical and horizontal cracks, even if this placement causes the stem to be loaded against an edge. The stem of a rigid-stem cam should NEVER be loaded against an edge because the load could bend or break the unit. Marines should also—

- Look for parallel-sided cracks, pockets, and cavities, since they make the best placements. Place cams in flared cracks, if appropriate.
- Avoid bottoming cracks; they can make removal difficult.
- Check surrounding rock for relative hardness and stability. Cams placed in soft rock, such as sandstone or limestone, can be pulled out by a hard fall even if properly placed.

On remote virgin routes, Marines may have to clear dirt, moss, lichen, or grass from the crack before placing protection. Debris in the crack will adversely affect the camming action of the unit by reducing the friction between the lobes and the rock.

Like hexes and nuts, climbers should select the cam that best fits the crack and always look for the cam that will best fit the placement, not for the placement that will best match the cam. Most manufacturers color-code their cams by size to facilitate selection. The following are some additional tips for SLCD use:

- Align the stem to point in the intended direction of pull. Such alignment is strongest and helps keep the cam from being pulled out of position once loaded.
- Align lobes evenly. When lobes are not equally cammed or offset, they have less holding power.
- Ensure the camming unit is completely seated in the crack and lobes are in full contact with the rock.
- Avoid shallow and deep placements. In shallow placements, cams (especially smaller cams) can sometimes rip out once loaded. In deep placements, a cam may be difficult to remove.

Figure 6-27. Example Cams.

- Avoid a tipped (or under-cammed) placement, in which the lobes are wide open and rocking on their tips. In such placement, lobes have little room for expanding and little holding power and stability. In ideal placements, lobes are 20 to 50 percent cammed. Below 10 percent, the cam may become stuck; above 60 percent, the cam becomes unstable. See figure 6-28.
- Avoid over-cammed placements. When a cam is pushed or forced into an undersized placement, the lobes become fully cammed, or over-cammed, making removal difficult or impossible. Before creating an over-cammed placement, try to find a different placement or select a smaller size camming unit.
- Know that smaller cams have limited expansion range, so there is little room for error when setting them.
- Know that certain camming units can be placed passively like a chock, with the lobes fully opened in an umbrella configuration; check the manufacturer specifications to be sure.
- Beware of walking and flagging. During a climb, consider using a runner when connecting cams to the rope, which reduces rope drag and the possibility of the cam walking or flagging. Walking occurs when a cam moves deep into a crack (becoming over-cammed) or when a cam falls out of the placement. Flagging occurs when the stem orients away from the intended direction of pull. In both cases, the stability of the placement is jeopardized.

Some old cams do not come with a pre-sewn length of sling. When a climber places such units during a climb, he/she should always connect them to the rope using a runner to minimize rope drag and always use a carabiner to connect the runner to the wire.

When constructing an anchor, using only a carabiner to connect to the cam is enough. Once loaded, carabiners must not be cross-loaded against an edge.

SLCD Removal. To remove a cam, the climber squeezes the trigger to disengage the lobes and pulls the cam out. Overcammed placements may require a little more work. Pushing and wiggling the stem while squeezing the trigger may help, but the cam must not be worked in too deep for retrieval. When a cam has walked too deep for the climber to reach the trigger, a nut tool may have to be used to remove it.

Pitons

Pitons, also known as pins or pegs, are hardened steel devices that are usually spike-shaped. They are hammered into cracks or cavities in the rock. They come in many different shapes and sizes, but every modern piton has an eye through which a carabiner is clipped. Originally, they were made of malleable soft iron that could conform to the crack in which they were placed. Even one placement would maul their shape and they were usually left fixed in the rock since removal could ruin them.

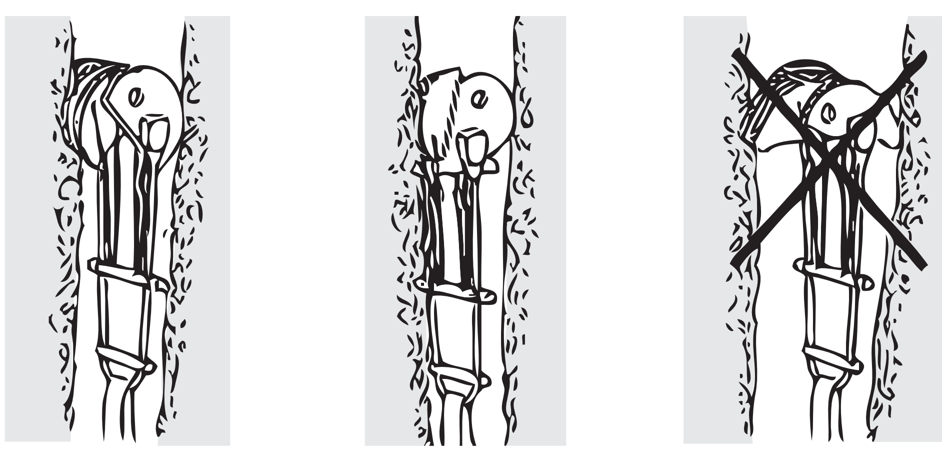

Figure 6-28. Cam Placements.

New pitons are made from hardened chromium-molybdenum steel (see fig. 6-29). They are removable, but their repeated placement and removal scars the rock. Because they scar the rock, are heavy, and require a hammer, pitons have been replaced by chocks and cams in all but the most difficult aid routes.

The distinct sound created from placing and removing pitons is also a tactical disadvantage during military operations. Cloth placed over the pitons while hammering can help muffle the sound. Pitons still have a variety of uses in military application, such as for fixed ropes in a situation where noise discipline is not a factor, with poor rock quality, in very thin cracks, or in alpine areas or winter conditions when cracks may be filled with snow and ice.

The following are types of pitons:

- *Angles and bongs*. Bongs are the larger version of angles. They both follow a channel or V-shaped design, giving three points of contact with the rock—the back or spine and the two edges of the channel. They are the strongest and most secure type of piton.
- *Leeper Zs*. Leeper Zs follow a Z-shaped design, which gives an added bite in vertical cracks. Their short length also makes them useful in bottoming cracks.
- *Lost arrow*. Lost arrows follow a hefty blade design with one eye, which is centered and set perpendicular to the end of the blade. They are very good in horizontal cracks.
- *Knifeblades and bugaboos*. Bugaboos are the larger version of knifeblades. They both follow a thin blade design and have two eyes—one at the end of the blade and a second in the offset or right-angled portion of the piton. The offset eye allows for placements in corners. Their streamlined design allows them to be placed in thin cracks where even the smallest chocks will not fit.

Figure 6-29. Example Pitons.

Some type of hammer is required to place and remove pitons. Piton hammers are specifically designed for this purpose. They have a forged steel head attached to a wooden handle, which absorbs vibration better than a metal handle. The head has a flat striking surface for cleaning and driving pitons and a blunt pick for prying out protection, cleaning dirty cracks, and placing malleable aid-climbing protection. The head also comes with a carabiner hole, which can be used when cleaning pitons. The hammer's shaft should be long enough to forcefully drive pitons in, but short enough to fit in a belt holster. Attaching a sling to the end of the shaft allows full arm extension when using the hammer and allows the hammer to be dropped without being lost. Most piton hammers weigh about 24 ounces.

Pitons can be placed in both vertical and horizontal cracks. Placements in cracks that run perpendicular to the direction of pull are generally stronger because rotation is reduced or eliminated. See figure 6-30 on page 6-30. The following are tips regarding pitons and their placement:

- Just as with chocks, look for bottlenecks in the crack. If the crack widens above or below the piton, a load could cause the piton to rotate and rip out of the rock.
- Check surrounding rock for relative hardness and stability. Tap it with the hammer, listening

for hollow sounds. Beware of cracks or flakes that may expand while a piton is hammered.

- Find a stable and secure stance, because placing pitons requires two hands.
- Choose the piton type that best corresponds to the shape of the crack.
- Select the piton size that best fits the crack. Always look for the piton that will best fit the placement, not for the placement that will best match the piton.
- In vertical cracks, use the longest piton that will fit.
- Place angles with the three points of the V always in contact with the rock.
- Place lost arrows in horizontal cracks with the eye facing the intended direction of pull.
- Place knifeblades in vertical cracks with the offset eye pointing toward the intended direction of pull.
- Insert the piton by hand. A properly sized piton should enter the crack about 50 to 75 percent of its length before hammering.
- Start hammering. As it is hammered, the piton makes a ringing sound, rising in pitch until the eye comes in contact with the rock. If the pitch does not rise, then the placement has not achieved maximum strength. If the pitch rises then stops, the piton has reached the limit of its strength in that placement. If the ringing stops and is replaced by a duller sound, the piton has likely hit the bottom of the crack.
- Test the piton for rotation either by using a hammer or a sling. With a hammer, gently tap the piton along the axis of the crack. Connect the sling to the piton and jerk on it in all directions. In either case if the piton moves it is not biting the rock and it should be replaced with a larger one.
- If the crack expands while the piton is being hammered, remove it and find a different placement.
- During a climb, use a runner to connect a piton to the rope, which reduces rope drag.

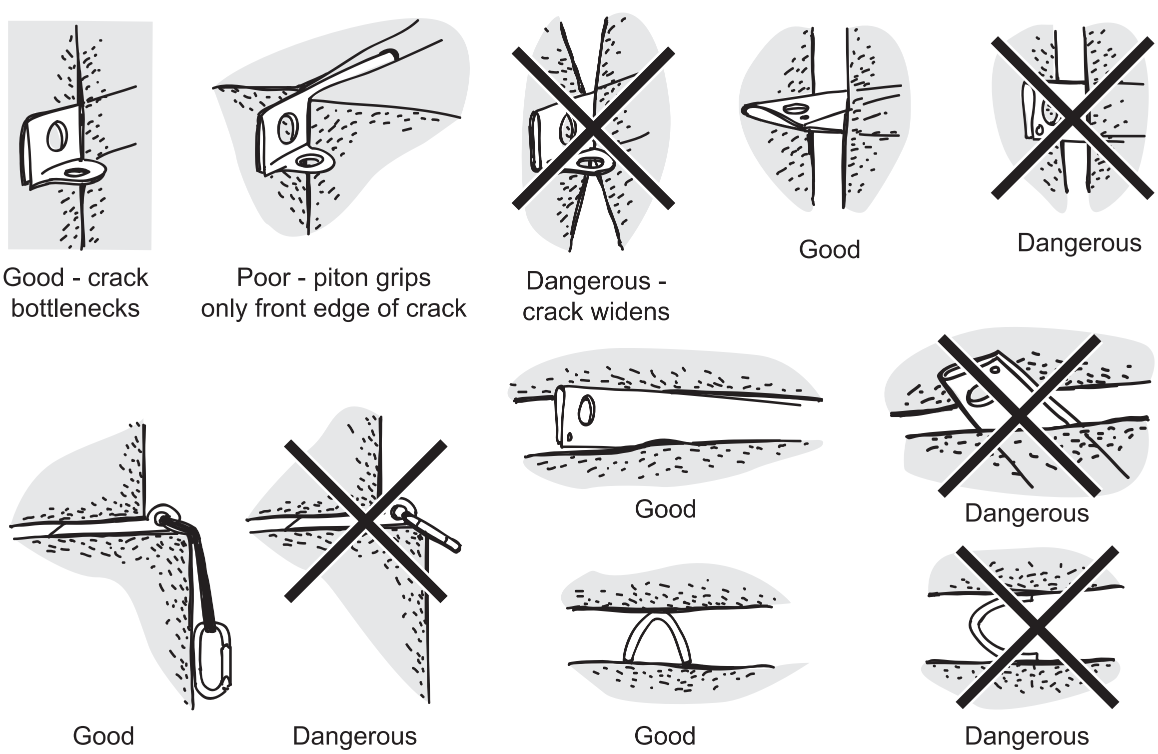

Figure 6-30. Good/Bad Piton Placements.

- When constructing an anchor, using only a carabiner to connect to the piton is enough. Ensure that, once loaded, carabiners will not be cross-loaded against an edge.
- If the position of the piton causes the connecting carabiner to be cross-loaded against an edge, tie a hero loop through the eye of the piton.
- Test pitons for rotation and tie them off if they bottom out before the eye encounters the rock. To test a piton—
  - Take a runner and tie a hero loop around the shaft of the piton where it emerges from the rock, using a girth hitch or a clove hitch.
  - Connect a carabiner on the other end of the runner to the rope or anchor system. This tie-off reduces the advantage on the piton once it becomes loaded.
  - Thoroughly inspect the setup, especially noting whether the piton has sharp edges that could cut the runner.
  - Take a longer runner and connect the eye of the piton to the hero loop. This connection creates a keeper sling, which does not bear weight, but will catch the piton in case it pops out. See figure 6-31. This setup should only be used as a last resort.

Removing a piton requires a hammer and normally a sling connected to a carabiner no longer used for climbing, also known as a cleaner biner. Red paint or tape is often used to mark and distinguish a cleaner biner from other carabiners. The following steps are taken to remove a piton:

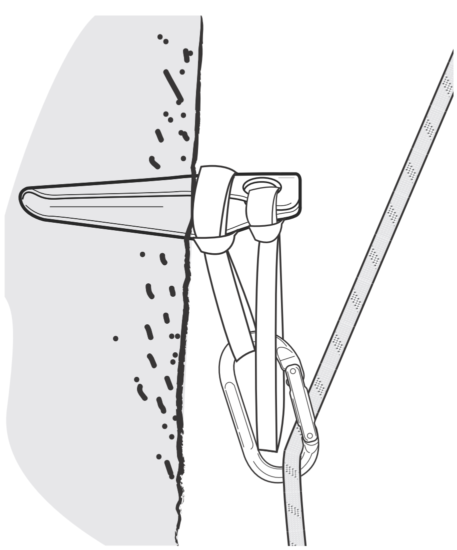

Figure 6-31. Hero Loop on Piton.

- Find a stable, secure stance. During removal, pitons may pop out unexpectedly.
- Connect a sling to the piton using a cleaner biner, which helps retain the piton once it pops out.
- Pull out on the sling while pounding on the piton with the hammer along the axis of the crack.
- On a vertical crack, pound the piton upward as far as it will go and then downward back to its original position.
- In a horizontal crack, pound from side to side.
- Continue this process until the piton pops out.
- When dealing with a stubborn piton, connect the sling to the eye of the hammer with a second carabiner and repeatedly swing the hammer away from the rock until the piton pops out.

In the absence of a cleaner biner, pound on the piton until it is loose enough to be moved easily back and forth. Pry out the loose piton using the pick of the hammer through the piton's eye. Take care not to break the hammer.

Bolts

Bolts are permanent or fixed protection placed in rock barren of natural features and cracks. First, a hole is drilled into the rock using a hand drill or electric drill. Then, a bolt connected to a bolt hanger is inserted into the hole. The rod assembly of the bolt is designed to either expand or contract when driven into the hole.

Some of the best bolts are held in place entirely by glue, a special epoxy that can be significantly stronger than the surrounding rock. Regardless of design, all bolt hangers have an eye or a ring through which a carabiner is clipped. Rope or cordage is never threaded directly through standard bolt hangers because doing so could seriously damage or sever the rope once it becomes loaded.

Note: Placing bolts is the job of mountain warfare instructors, not mountain leaders, as only they have a training application for safety and not a tactical application. Mountain leaders and assault climbers should focus on distinguishing between the different types of bolts and assessing their integrity, rather than the mechanics of placing a bolt.

Assessing Fixed Protection

When climbing on established routes, a climber may encounter fixed protection. It is imperative that before using fixed protection—bolts, pitons, chocks and SLCDs, and cordage—the climber evaluates its integrity.

Bolts

A well-placed bolt will last for years, but age and weather can compromise it. Bolts should be inspected thoroughly before using them as protection and the following precautions should be taken:

- Check quality of the rock. Beware that bolts placed in soft rock have lower pull out strength.
- Check bolts and bolt hangers for weathering and weaknesses. Look for damage, cracks, excessive corrosion, rust, or brittleness. A rust streak on the rock below the bolt indicates metal wear.
- Check the quality of the hole. It should be perpendicular to the rock face and should not have chipped or broken edges.
- Check for hammer marks on the bolt. They often indicate a compression bolt. These bolts have a lower pull out strength.
- Test whether the bolt is securely anchored into the rock by connecting a runner to the hanger and jerking in all directions. Never use a hammer to test the integrity of a bolt as doing so will only weaken it.
- Beware of spinners—the bolt hanger spins around—which indicate that the hole was drilled too shallow for the bolt. Consider these bolts unsafe.
- Inspect threads of screw-head bolts. If the threads are stripped, the nut holding the hanger in place could pop off under surprisingly low force.
- Do not trust old sheet metal style bolt hangers.
- Beware of homemade bolt hangers. Most are fashioned from inferior materials and are prone to failure.
- Check bolt size. Regardless of type, one-quarter-inch bolts indicate an older bolt and should be treated as suspect because they have low pull out strength. Bolts measuring three-eighths to one-half inch in diameter are standard. Newer bolts and are much stronger.
- Always use a carabiner when connecting rope or slings to a bolt hanger. Cordage threaded through a hanger can become severed once loaded.
- Wire nuts can be used as a last resort on bolts that are missing a bolt hanger. Slide the nut down its wire and then slip the upper wire around the bolt stud. Snug the nut up tight against the stud to secure it, as in figure 6-32. Clip a runner on the nut as normal to connect it to the rope.

Pitons

Even if rarely used today, pitons were commonly used up through the 1980s. Many pitons remain as fixed placements on various routes. Pitons, even more than bolts, are vulnerable to weathering. If a climber encounters a piton, he/she should—

- Check for signs of corrosion or weaknesses. Heavy use, failed attempts at removal, and falls on a piton can lead to cracks in the metal around the eye or other damage.
- Examine the crack around the piton for any sign of deterioration.
- Ensure the piton was driven in all the way, with the eye close to the rock and the piton perpendicular to the direction of pull.
- Do not trust ring-angle pitons. They follow a channel design with a welded ring. They are very old and the ring design may fail under relatively low loads.
- Beware of melt-freeze cycles, which widen cracks and loosen pitons.

- Test for rotation with a hammer or sling as during placement.
- If the piton seems strong, secure, and in good condition, then use it as normal.
- If the piton is only partially driven in but otherwise secure, tie it off with a hero loop around the shaft of the piton where it emerges from the rock using a girth hitch, as in figure 6-33.

Chocks and Spring-Loaded Camming Devices

Removable protection becomes fixed when someone was unable to remove it. Examine them carefully before deciding to use them:

- Study the condition of the rock around them.
- Ensure they are securely and properly placed.
- Ensure they are oriented in the desired direction of pull.
- Examine wires and cordage for damage, weathering, and weaknesses.
- Because of their questionable integrity, they should only be used as backup protection.

Cordage

On popular climbs, established rappel anchors have slings left behind from prior rappels. Slings are also commonly found around natural anchors on alpine routes where a climbing party used a rappel to retreat. Beware of the American triangle discussed in chapter 4. Climbers should check slings for discolorations, possible ultraviolet damage, adverse effects of weathering, or weaknesses. They should also check the sling for a rappel ring or a carabiner, also known as a leaver biner. If slings are not equipped with a leaver biner, they may no longer be safe. Ropes must have been pulled through them during retrieval, which generates friction and weakens the slings' material.

Most established rappel anchors can be adorned by a multitude of slings. In this case, failure of the whole system is unlikely. It is common practice, however, to cut off some of the older slings and replace them with new ones before conducting the rappel. The slings should be of equal length to distribute the load evenly among them.

Using the Nut Tool

A nut tool, also known as cleaning tool or nut pick, is a thin metal tool designed to help extract pieces of protection that have become lodged in a crack.

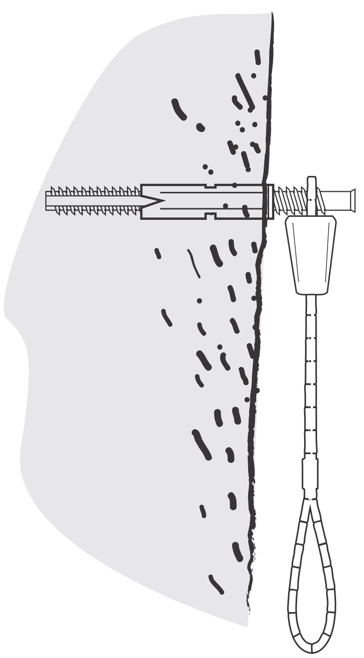

Figure 6-32. Nut on Bolt Rod.

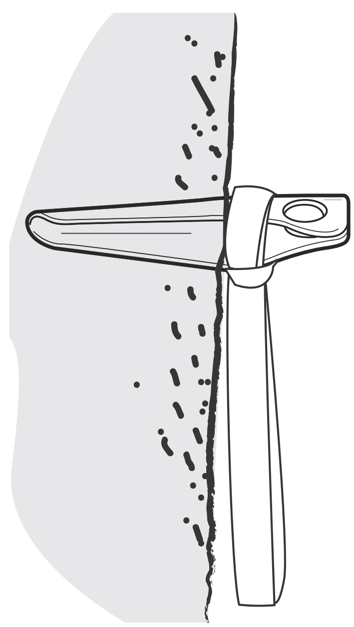

Figure 6-33. Basic Hero Loop.

It can also be used to clear cracks of debris and vegetation, a process known as gardening.

Carrying the Nut Tool

To carry the nut tool—

- Attach the keeper sling to the nut tool using a 2- to 4-foot section of accessory cord.
- Connect one end of the sling to the pen hole above the left breast pocket of the utility uniform.
- Wrap the sling around the nut tool and slide it in the pen slot. The nut tool can also be slung cross-body, carried on the gear sling, or attached to the harness.
- Beware that a fall may somehow result in a puncture from a nut tool carried in such a fashion.

Removing Chocks

The head of the nut tool is placed against the bottom part of the chock and its base is tapped with a small rock, large nut or hex, or steel carabiner until the chock becomes loose or dislodged.

Removing Spring-Loaded Camming Devices

A cam that has walked deep into a crack may place the trigger out of reach. The nut tool can be used to hook the trigger while the stem is skillfully wiggled.

Racking Climbing Equipment

The collection of gear used by climbers for protection is called the rack. The size of the rack depends on the difficulty, type and length of a climb, and the climbers' ability level. Overall, equipment choices warrant careful planning and considerations. A large, heavy rack may impede the climbing. With a small rack or the wrong pieces, lead climbers may have to make dangerous run-outs or build skimpy belay anchors. While some experts can get by with a meager assortment of gear, less experienced climbers need to carry a fuller rack. Selecting the right rack takes experience, research, and creativity to make equipment work with what is available.

Gathering route information helps climbers make a more educated decision on what gear to bring. When climbing in a popular area, a climber can consult different guidebooks and topographical publications or talk to other climbers who have climbed the route. In remote locations, not as much information may be available. Aerial photographs taken from different angles and scoping a route from a distance can be a valuable source of information. From a distance, cracks will appear smaller than they really are. A long, thin crack will take small, wired chocks and some small cams, while a wide crack will take larger pieces. On a straight-up climb, a small number of mainly short runners may be enough. On a route that meanders or zigzags, a larger number of runners (many of which long) are needed to keep the rope running in a straight line.

A standard rack used on class 5 terrain includes a selection of protection, carabiners, and runners. The following equipment comprises the basic requirements for such a rack:

- Camming devices, ranging progressively from one-half inch to 3 inches and each on a carabiner, connected to a gear sling and arranged by size.
- A selection of 3 to 5 of the smaller wired chocks on one carabiner connected to either the gear sling or one of the gear loops on the front of the harness.
- A selection of 3 to 5 of the larger wired chocks on one carabiner connected either to the gear sling or one of the gear loops on the front of the harness, but on the opposite side from the small chocks.
- 8 to 12 runners of various lengths and enough nonlocking carabiners for the protection and the cordage.

Climbers may double up on certain sizes of protection, tailor the rack toward small or large placements, and vary the number and sizes of runners. A rack used on class 4 terrain has fewer pieces of protection grouped on individual carabiners and a larger number of longer runners used to sling natural protection. Regardless of terrain, a climber will also carry a basic kit on the climbing harness, which includes a belay device, 2 to 4 locking carabiners, a nut tool, a pocket knife, a short loop of perlon cord to tie friction hitches, and one or more cordelettes used for anchor and rescue systems.

The ideal racking method permits the leader to place protection efficiently and to climb without awkwardness despite carrying the gear. It allows easy gear transfers between climbers for changing or swinging leads and helps keep the hardware away from the rock so that it stays readily available. Whatever method used, gear should be racked in a systematic order based on priority of need. The most necessary equipment, such as the protection for the upcoming section of the route, should be placed in the front for quick and easy access; the less necessary equipment, such as a belay device and anchoring material, should be placed in the rear where it is out of the way. Experienced climbers tailor the racking method to their personal style and the demands of the route. No racking method is perfect, but several are commonly used.

Typically, most protection is racked on a gear sling, which is slung over one shoulder and under the opposite arm. A padded gear sling can be purchased and may be more comfortable. A shoulder-length runner can also be used for the job. Having the rack on a sling allows the climber to switch the sling between shoulders during awkward moves and positions, leaving the ability to reach the protection with either hand. Organizing the protection by size will make for easier selection, as in figure 6-34.

One option is to place each piece of protection on its own carabiner. This method can be very efficient for placing protection as long as the climber selects the correct size protection for the crack. He/She simply places the piece of protection in the rock and connects it to the rope with a runner; however, if he/she chooses the wrong size piece, time and energy are wasted in returning to the rack to find the right one. Using this method with every piece of protection can make the rack bulky, cumbersome, and heavy and can significantly reduce the number of free carabiners.

Another option is to combine 3 to 5 pieces of protection of similar size on one carabiner, which reduces the number of carabiners used and makes the rack lighter and less bulky. To choose the best placement—

- Unclip the carabiner of protection for the specific size range and hold the whole batch up to the placement, eyeing each piece of protection for fit.
- Place the desired piece.
- Return the carabiner with the rest of the protection to the rack.
- Connect the placed piece to the rope using a runner. When using this method, beware of the increased risk of dropping gear.

On class 5 routes, most climbers will use a hybrid of these two systems, placing camming devices on individual carabiners while keeping groups of

Figure 6-34. Racked Gear Sling.

3 to 5 chocks of similar size on one carabiner. The expansion range of cams makes them easier to place. On class 3 and class 4 routes, when carrying a smaller rack, climbers will generally rack all the protection using the second option.

On some occasions, climbers will rack protection entirely on the gear loops of the climbing harness, which works well with a small rack, such as one used on class 3 and class 4 routes. However, it can be awkward with a large rack, such as ones used on class 5 routes. It makes gear exchange more troublesome and there are times when a climber may not be able to reach a specific piece of protection with the free hand. Typically, gear loops are used to rack runners and other equipment, such as a belay device and anchoring material. Whatever gear is carried on the gear loops must be rigged in such a way not to interfere with footwork. See figure 6-35.

Quick draws and runners are typically carried on the harness. Longer runners can be doubled or tripled, which makes them streamlined and efficient because they can be easily extended with just one hand. To triple a runner—

- Connect two carabiners to the runner.
- Pass one of the carabiners through the other.
- Clip the carabiner onto the newly formed set of loops.

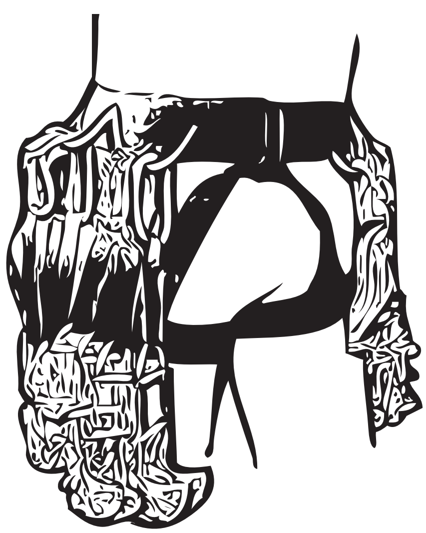

Figure 6-35. Racked Harness.

To extend the runner—

- Unclip one of the carabiners.
- Fan out the loops.
- Clip the carabiner back onto the extended single loop.

Single and double-length runners can also be carried over one shoulder, but, if many are carried, it can become difficult to retrieve just one from the tangle. Long sections of tape used for anchoring are daisy chained and clipped to the back of the harness. To daisy chain cordage—

- Create a slip overhand on one end.
- Pull a loop of cordage through the loop created by the slipknot.
- Repeat this process until the entire section is chained and connect the two ends to a carabiner, which will prevent the chain from unraveling.

To extend the sections of tape, unclip the carabiner and allow the cordage to unravel. Cordelettes used for anchoring or rescue systems can be coiled using several methods and are clipped to the back of the harness.

Free nonlocking carabiners are racked in groups of three with two hanging off a third and are carried on either the gear sling or the harness. All carabiners clipped to the rack, whether on the gear sling or gear loops, should have the same orientation so that each unclips in exactly the same way.

When climbing with a pack, the rack should either be worn on the climbing harness or over the pack. Climbing partners should agree on using one racking technique; otherwise, much time may be lost in reracking gear when swinging leads.

Belaying for Party Climbing

Belay is a method to stop a fall by applying friction to the rope and by resisting the forward pull of the fall. The belayer, also known as the number 2 climber, manages the rope that is tied to the lead climber, who is known as the number 1. The following procedures take place during the belay sequence of a climb:

- The belayer establishes an anchor system (a safe, secure, strong attachment point to the mountain) and takes a stance (bracing against the terrain to resist a hard pull on the rope).
- Rope is paid out as the climber advances, keeping a minimum of slack between the roped team so that any fall will be stopped as short as possible.
- If the climber falls, the belayer will apply the brake with the use of a belay device.
- Upon reaching the top, the lead climber will establish a belay stance to top rope up the number 2.

Note: Alertness and appreciation for the importance of the belayer's role is critical.

Types of Belay Anchors

There are two types of belay—indirect and direct. In indirect belay, the belayer's position is between the anchor point and the climber, so he/she absorbs some of the impact force in the event of a fall. The force of the fall goes indirectly to the belay anchor point through the belayer. The direct belay exerts the impact force of a falling climber directly to the belay anchor point. The belayer is not in the system, but still remains in control of the belay device. See figure 6-36.

Elements of a Belay Chain

There are three principle elements of a belay chain used in climbing—the anchor, the belayer, and the climber.

The Anchor

The anchor is a safe, secure attachment point to the mountain, hillside, or cliff face. It must be a high tension anchor. The belayer attaches themself (with the rope or additional equipment) to the anchor so that he/she cannot be pulled off his/her belay stance. The anchor can be either an indirect or a direct belay using natural and/or artificial points.

When using natural anchors during climbing operations, at least two natural anchor points are required; at least three are required for artificial anchor points. If constructing an anchor system in which only one natural anchor can be located for use, it must also have two pieces of artificial protection as part of the system.

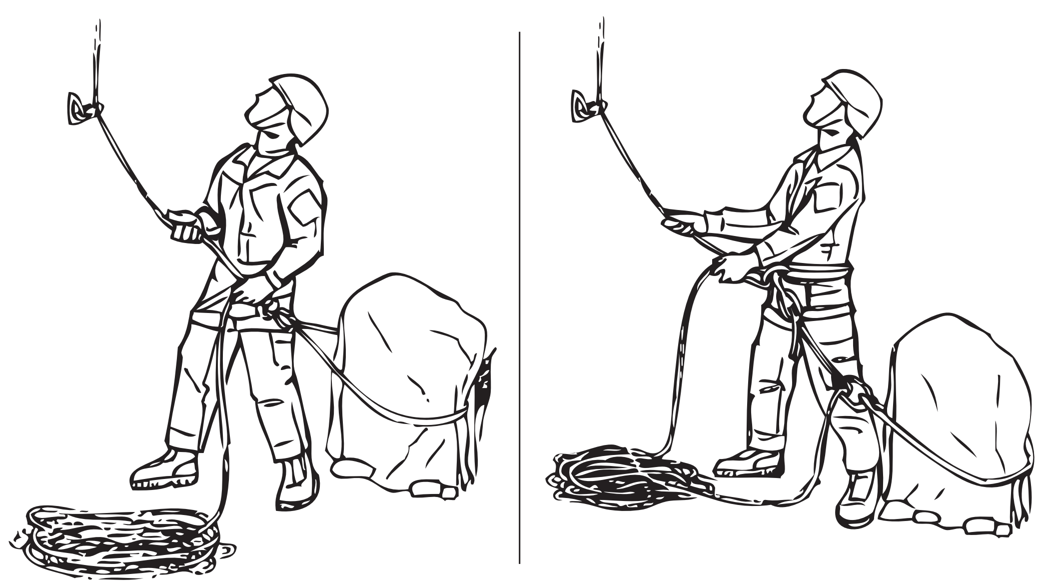

Figure 6-36. Direct and Indirect Belays.

Anchors on the bottom should normally be behind the belay person and at or below his/her waist, terrain permitting. Anchors on the top should be at waist height or above, terrain permitting.

The Belayer

The term belayer is used to describe the static climber's mission of providing security with a rope to the lead climber in case of a fall. The belayer should position themself as near to the climbing route as possible, but not directly under the climbers' intended route. This positioning decreases the chance of the climber or objects that he/she dislodges hitting the belayer. It also helps to prevent the "zipper effect," covered later in this chapter.

When using the indirect belay stance, the belayer should secure themself snugly between the anchor and the climber in a straight line (an anchor-belayer-climber, or ABC, chain) on the intended route. This positioning will allow the belayer to absorb some of the impact force and to prevent him/her from being knocked over or dragged across the ground, which could cause him/her to release the brake hand on the rope.

When belaying from above, the belayer should try to establish a sitting belay stance. When belaying from below, he/she should always stand.

The Climber

Besides climbing the route, the climber must place protection into the rock through which the rope is passed so that, in case of a fall, the length of the fall is reduced. He/She also establishes the top anchor belay to bring up the number 2 climber.

Belayer's Responsibilities

Before establishing a belay stance, the belayer must—

- Ensure that the anchors are sound and set in the correct direction of pull.
- Locate the exact position in which he/she will belay the lead climber—the belay stance. When possible, the belay stance should be slightly offset from the lead climber's intended route to avoid possible hazards, such as falling rocks or equipment.
- Ensure that the climbing rope is back stacked near the belay stance.
- Tie a retrace figure-8 into the harness with his/her end of the climbing rope.

Establishing the Belay

A properly designed and secured belay stance is essential if the risk of a serious injury is to be minimized while conducting climbing operations. The use of natural or artificial anchor points will determine the design of the belay stance.

Using the Rope

Establish a natural anchor belay stance using the rope. This method is desired when the anchor points are nearby. A minimal amount of equipment is necessary to build this system, but it may require the use of a lot of rope. To construct a belay using rope—

- Tie a figure-8 loop approximately three feet from the retrace figure-8 loop on the harness.
- Attach a locking carabiner onto the retrace figure-8, which is referred to as the MAC.
- Clip the figure-8 loop into the MAC, which is referred to as the remote. The remote allows the belayer to escape the anchor system if necessary (see chap. 7).
- From the remote, take a bight of rope and place it around the furthest natural anchor point then back to the belay stance.
- Ensuring that the rope is taut, tie an over-the-object clove hitch with the bight of rope and clip it into the MAC.
- From the clove hitch on the MAC, place a bight of rope around the second natural anchor point then back to the belay stance.
- Ensuring that the rope is taut, tie an over-the-object clove hitch, clip it into the MAC, and lock down the carabiner. The climber is now in

a secure belay stance. He/She will sound off with the command OFF CLIMB. He/She clips another locking carabiner into the MAC to serve as the belaying carabiner to which the belaying device is attached.

- With the live rope near the lead climber’s retrace figure-8, attach the rope to the belay device, ensuring that the belaying carabiner is locked down when complete. The number 2 is now ready to belay the lead climber.

Using Slings or Runners

Using slings/runners will shorten the distance to the anchor points. More equipment will be necessary to build this system, but it may require less rope to construct. To establish a natural anchor belay stance—

- Place a sling/runner around the furthest natural anchor point with a nonlocking carabiner.
- Attach a MAC onto the retrace figure-8.
- With the rope from the retrace figure-8 loop on the harness, attach it to the furthest natural anchor point, ensuring that there will be slack in the rope to enable the climber to escape the system, if needed.
- With the rope from the natural anchor point, return to the designated belay stance.
- Ensuring that the rope is taut, tie an over-the-object clove hitch and clip it into the MAC.
- From the clove hitch on the MAC, clip the rope straight through the second natural anchor point and return to the belay stance.
- Ensuring that the rope is taut, tie an over-the-object clove hitch, clip it into the MAC, and lock down the carabiner. The climber is now in a secure belay stance and will sound off with the command OFF CLIMB. He/She clips another locking carabiner into the MAC to serve as the belaying carabiner to which the belaying device is attached.
- With the live rope near the lead climber’s retrace figure-8, attach the rope to the belay device, ensuring that the belaying carabiner is locked down when complete. The number 2 is now ready to belay the lead climber. See figure 6-37.

Using an Artificial Anchor

When no natural anchor points are available, the number 2 climber will establish the belay stance, using at least three pieces of artificial protection. All three pieces of protection will be placed in the direction of pull. To establish an artificial anchor—

- Place the three pieces of artificial protection into the rock, keeping in mind the anticipated direction of pull if the lead climber should fall. Ideally, the number 2 would place the three pieces behind him/her below the waist and spaced out evenly.
- Attach a MAC onto the retrace figure-8.
- Attach the rope from the retrace figure-8 loop on the harness to the furthest artificial anchor point with an over-the-object clove hitch, ensuring that there will be slack in the rope that returns to the climber. This slack will enable him/her to escape the system, if needed.

Note: Runners and slings are not required but can be used for extension purposes.

- With the rope from the artificial anchor point, return to the designated belay stance.
- Ensuring that the rope is taut, tie an over-the-object clove hitch and clip it into the MAC.
- From the clove hitch on the MAC, clip the rope straight through the second artificial anchor point, and return to the belay stance.

Figure 6-37. Belaying with Two Natural Anchors Using Slings and Runners.

- Ensuring that the rope is taut, tie an over-the-object clove hitch, clip it into the MAC, and lock down the carabiner.
- Attach a nonlocking carabiner into the MAC.
- From the second clove hitch on the MAC, take the rope straight through the third piece of artificial protection and attach it to the non-locking carabiner on the MAC with an over-the-object clove hitch. The climber is now in a secure belay stance. He/She will sound off with the command OFF CLIMB. He/She clips another locking carabiner into the MAC to serve as the belaying carabiner to which the belaying device is attached.
- With the live rope near the lead climber's retrace figure-8, attach the rope to the belay device ensuring that the belaying carabiner is locked down when complete. The number 2 is now ready to belay the lead climber.

Establishing an Anchor Belay Stance Using Natural and Artificial Anchors

If constructing an anchor system in which only one natural anchor can be located for use, it must also have two pieces of artificial protection incorporated into the belay system. The method of constructing this system will be the same as constructing an artificial anchor belay stance.

Methods of Belaying a Fall

There are two methods of belay—static and dynamic. A static belay is a method that does not allow the rope to run through the belay device and stops the falling climber quickly. The belayer brakes immediately after the fall occurs, preventing any unnecessary slack developing between themself and the climber. This technique is used when the belay anchor points and the running belays are sound. It is also used to stop a falling climber from hitting any projection below, such as a ledge or rock outcrop. Static belay is the most common belay used on rock.

A dynamic belay is a method that deliberately allows some of the rope to run through the belay device. This method slowly brings the falling climber to a halt. The belayer will gradually apply braking pressure to the rope to reduce the impact force on the belay anchor points and the running belays. This technique is used when the belay anchor points and the intermediate points of protection are not very sound. It is mostly used when ice climbing, although the technique is widely used when climbing unstable rock.

Disassembly of the Belay Stance

Upon hearing the command OFF CLIMB from the lead climber, the number 2 will—

- Sound off with OFF BELAY. He/She will then remove the belay device.
- Sound off with UP ROPE if the number 1 person, who is now the belayer, is not bringing in the excess slack already.
- Once the rope is taut between the number 1 and number 2, sound off THAT'S ME to inform the lead climber to secure the rope to his/her belay device.
- After securing the climbing rope to his/her belay device, the lead climber will give the command ON BELAY.

The number 2 will now disassemble the belay stance in reverse order of the way it was constructed, ensuring that lead climber continues to take the slack out of the rope after each anchor removed. After all the anchors have been removed, the number 2 will ensure that all the gear is stowed properly and that the nut pick is readily available. The number 2 then gives the command CLIMBING.

The lead climber will answer back with the command CLIMB, CLIMBER and the number 2 will begin to climb. At this time, the roles are switched. The belayer will become the climber and the lead climber will become the belayer.

Note: As military climbers, Marines will ***always*** *be on belay or tied into an anchor.*

Establishing a Hanging Belay Stance

Multipitch climbs require the climber to establish a belay stance at one or more locations throughout the climb. Since it takes approximately 15 feet of rope to construct a hanging belay, constant awareness of the amount of rope used during the climb must be acknowledged. This awareness can occur through communications between the climber and the belayer. Constructing the hanging belay stance is basically the same as an artificial anchor belay stance with the following considerations:

- When the belayer has approximately 25 feet of rope left to pay out to the climber, he/she will sound off TWENTY-FIVE FEET to inform the climber to begin looking for a suitable position to establish the hanging belay.

  Note: Lead climber may also establish a hanging belay because he/she is low on protection or fatigued.

- The climber will locate a suitable position, understanding that he/she will use approximately 10 to 15 feet of rope to construct the belay. If possible, he/she will select a ledge big enough to stand on and then identify suitable placements for artificial protection or suitable natural anchors.

  Note: A hanging belay should never be established before a hard move or a roof that may increase the chances of a leader fall with a higher fall factor (fall factors are discussed later in this chapter).

- The climber must also plan for his/her belay stance. The belay stance should be somewhat comfortable, due to the length of time that could be spent there. It must also be suitable to belay the number two climber to the hanging belay and up through the next pitch. Lastly, it must accommodate the number 2 climber for the exchange of gear.
- Once a position and stance have been selected, the climber sounds off with the command BUILDING AN ANCHOR to inform the belayer to set the brake with the belay device because the climber will be stationary for some time during the construction process.
- The belayer will repeat the command BUILDING AN ANCHOR to assure the climber that he/she has set the brake and that he/she is aware of the climber's actions.
- The climber begins to construct his/her belay stance by placing a piece of protection in the downward direction of pull at approximately chest level to the climber or higher within arm's reach.
- With the rope from the retrace figure-8 loop on the harness, attach it to the piece of protection with an over-the-object clove hitch, ensuring that just enough slack rope is left to escape the system.
- The climber will attach a MAC into the retrace figure-8 loop. He/She ensures that the rope is taut from the piece of protection, ties an over-the-object clove hitch, and clips it into the MAC.
- The climber places a second and third piece of protection in the downward direction of pull at approximately chest level to the climber or higher within arm's reach. Avoid placing these pieces in the same crack as the first piece. If unavoidable, camming devices are recommended.

  Note: Before selecting which protection to use, the climber should attempt to evaluate the protection that may be needed to complete the next pitch and avoid using the needed protection for the anchor.

- From the clove hitch on the MAC, the climber will clip the rope straight through the furthest piece of protection and ensure that the rope is taut, attach it on to his/her MAC with an over-the-object clove hitch, and lock down the carabiner.

  Note: If two suitable natural anchors are present after cloving the MAC from the second piece, the climber can skip the third artificial piece of protection.

- The climber will now attach a nonlocking carabiner into the MAC.
- From the second clove hitch on the MAC, the climber will clip the rope to the third piece of protection.
- The climber ensures that the rope is taut and attaches it to the nonlocking carabiner on the MAC with an over-the-object clove hitch.
- The climber then places his/her fourth piece of protection in the upward direction of pull below waist level, but within arm's reach. When the number 2 climber passes the belay stance and becomes the lead climber, this fourth piece of protection will prevent the belayer from being pulled upward if the leader falls.
- From the clove hitch on the nonlocking carabiner, the climber attaches the rope to the fourth piece of protection with an over-the-object clove hitch within arm's reach.

  Note: If the climber cannot find a suitable placement for upward direction of pull, he/she can skip the last step, ensuring, however, that the number 2 places this piece before he/she leaves the hanging belay for the next lead.

- The climber is now in a secure belay stance. He/She will sound off with the command OFF CLIMB.
- He/She clips another locking carabiner into the MAC to serve as the belaying carabiner to which the belaying device is attached.

The climber will pull up and stack the rope. The rope can be stacked in different ways, depending on the situation and the gear available. If the ledge is big enough, the rope is simply stacked on the ledge. If not, the climber has a few options. He/She can stack the rope over the MAC, creating loops on either side as in making a butterfly coil. The rope must be stacked carefully to prevent unnecessary entanglement. The beginning loops need to be the largest with the subsequent loops increasingly smaller. Using the same method, the rope can also be stacked over the climber's lap or legs, but this method will restrict the climber's freedom of movement when he/she assumes the belay. The last and most preferred method is to stack the rope in the same fashion over a runner clipped between the doughnut and the anchor. This method will allow the climber to move the rope out of the way.

Once the climber receives the command THAT'S ME, he/she will attach the rope to the belay device, ensuring that the belaying carabiner is locked down when complete. The climber is now ready to belay his/her partner and will sound off with the command ON BELAY.

At this point, as in two-party climbing, the number 2 person brakes down the anchor and begins climbing. The same commands and procedures are used. The number 2 person may have to climb slower to allow the number 1 climber the opportunity to stack the rope neatly.

When the number 2 person reaches the hanging belay, he/she will place a piece for upward pull if the number 1 climber has not already placed one. In this situation, the piece may be out of reach of the number 1 climber. To get it within reach, the number 2 person extends the piece with a runner and, grabbing the rope from the clove hitch on the nonlocking carabiner in the MAC, he/she attaches it to the fourth piece of protection with an over-the-object clove hitch.

The number 2 person will then climb to the location previously planned by the number 1 climber for the exchange of gear. He/She clips a cow's tail (a long runner girthed through the doughnut) to the number 1 climber's doughnut with a nonlocking carabiner. The number 1 climber then brakes him/her off and ties off the belay device by feeding a bight through the belay carabiner and tying a round turn and two half hitches that encompasses both ropes. He/She then sounds off with the command OFF BELAY.

Because the most efficient method of multipitch climbing is for a pair of climbers to alternate leading pitches, the climbers will now have to change over and reorganize the gear for the next pitch. To speed up the exchange, the number 2 climber should begin racking the gear for the next pitch as he/she cleans the route. To prevent gear from falling due to carelessness, climbers should never exchange gear from one climber's hand to another climber's hand. The climbers will exchange gear in one of the following manners:

- The number 1 climber unclips gear from themself and places it on the number 2 climber.
- The number 2 climber unclips gear from the number 1 climber and clips it to himself/herself.
- The number 1 climber unclips gear from themself and clips it to the cow's tail. The number 2 climber then unclips it from the cow's tail and clips it to himself/herself.

If a gear sling is used, the number 1 climber clips the sling to the cow's tail before taking it off his/her shoulder. The number 2 will then place it over his/her shoulder before unclipping it from the cow's tail. Another method to change over a gear sling is for the number 1 and number 2 person to both grab the gear sling. Together they will both remove the sling from the number 1 shoulder and place it over the number 2 shoulder. At that point, they can both let go.

Once all gear has been exchanged and organized, the roles are reversed and the number 2 now becomes the number 1. The belay person unties the belay device and sounds off ON BELAY.

The number 1 climber takes out the cow's tail and gets ready to climb. Before he/she leaves the hanging belay, he/she must emplace a piece of protection. If one cannot be placed, he/she must clip the highest piece of the anchor with a second carabiner to help prevent a possible factor two fall by the leader.

The number 1 person will then finish the climb as in two-party climbing. Because of the way the rope is stacked, it often becomes tangled, forcing the climber to climb slower. Effective communication must be maintained between the climber and the belay person so that the climber is not halted in the middle of a move.

After the climber tops off and assumes the belay, the number 2 climber brakes down the hanging belay in reverse order. Before he/she leaves the ledge, he/she will down climb or lower themself to retrieve it if a piece for upward direction of pull was placed out of reach.

Note: Multipitch climbing takes place on cliffs of considerable height, so communication techniques must be considered. Due to wind or the traversing nature of some routes, voice commands may not be effective. In such situations, a system of rope tugs should be used.

Special Considerations for a Belay Stance

To safeguard the belayer at the bottom of a cliff from sea waves during amphibious assaults, the belayer will make a variation of the hanging belay stance detailed above. He/She will create a regular three-piece artificial anchor (with an upward direction of pull) when belaying from the bottom of the sea cliff, which will hold him/her in place if the lead climber falls. He/She will also place one more piece above him/her with the direction of pull down. This piece will keep him/her on his/her stance should a wave cover his/her belay stance.

Alternate Belays

Besides the use of traditional devices in belaying operations, other techniques can be used. Interlinked carabiners, figure-8 descenders, and even pitons can be used as expedient belay devices. The following subparagraphs discuss five expedient methods of belaying.

Body Belay Method

The body belay is used as a convenient and quick belay when ascending and descending moderate terrain with experienced troops. Since friction burns are a real danger, the arms must be covered and gloves should be worn. This method can be used when either standing or sitting. The belayer performs the following techniques for the body belay:

- He/She positions themself so that his/her legs are braced straight into the direction of pull.
- He/She places the rope around his/her back so that the rope rests on top of his/her hips while he/she grasps the rope tightly with both hands.
- To pay out rope, he/she slides the running end of the rope (nearest the climber) forward with a guide hand and clasps both strands of the rope above the brake hand.
- He/She allows the brake hand to slide back down to its original position and repeats the process.
- To brake the climber, his/her brake hand wraps the rope around the waist. A twist of rope can be taken around the brake arm to increase friction.

Carabiner Brake Method

Also known as the “crab” brake, this method is somewhat complex to set up, but it has the advantage of not requiring any special equipment. To set up the crab brake—

- Attach one locking or two nonlocking opposite and opposed carabiners to the hard point on a harness. See figure 6-38.
- Clip another pair of nonlocking carabiners to the other carabiners already attached to the hard point.
- Run a bight of the rope through the outer pair of carabiners.
- Clip another carabiner across the outer pair of carabiners beneath the bight of the rope.

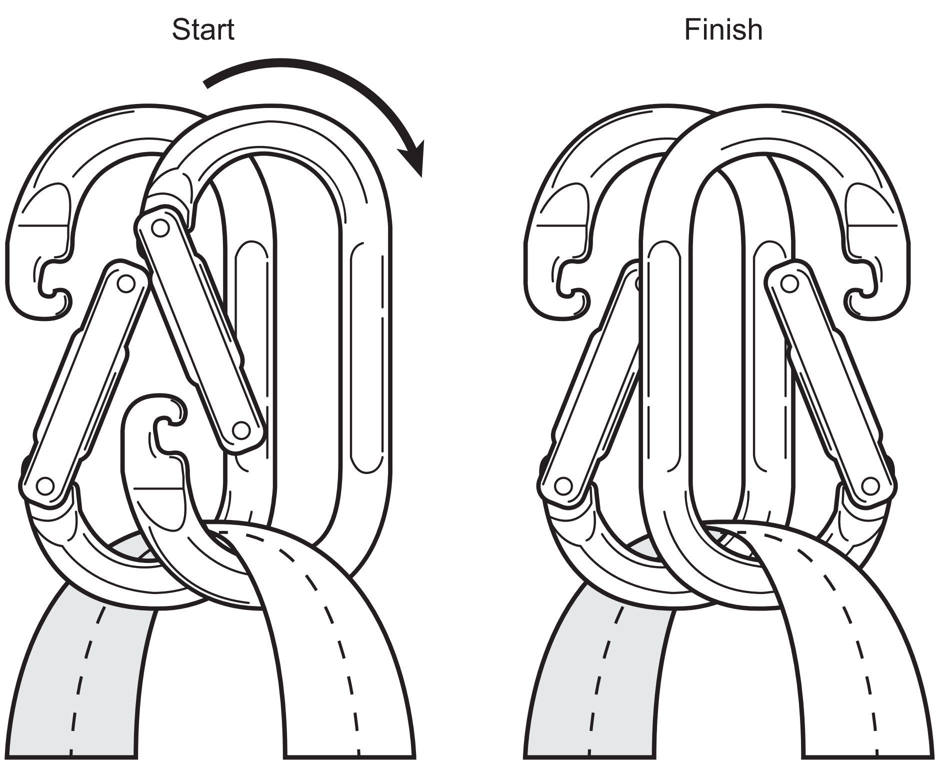

Figure 6-38. Opposite and Opposed Carabiners.

- Run the rope across the outer edge of this final carabiner, forming the carabiner or crab brake, as in figure 6-39.
- To brake, pull the rope forward, causing a bight around the rope and the carabiner.

Figure-8 Method

There are three ways to use the figure-8 as a belay device, as seen in figure 6-40:

- Use the figure-8 in the normal manner as in rappelling.
- Pull a bight of the rope through the small hole of the figure-8 and clip a carabiner through the bight. Belay in the same manner as with a mechanical belay device.
- Place the figure-8 on a carabiner in the normal fashion. Pull a bight through the large hole of the figure-8 and clip it through the carabiner.

Specialized Belay Device (Grigri Method)

The grigri is an example of a specialized belay device that does not require any stopping force at all from the belayer's hand. It works on the same principal as the safety belts in a car. With slow steady movements the rope feeds through freely. When there is a shock load (as in a fall), the grigri locks, jamming the rope with a cam. There is

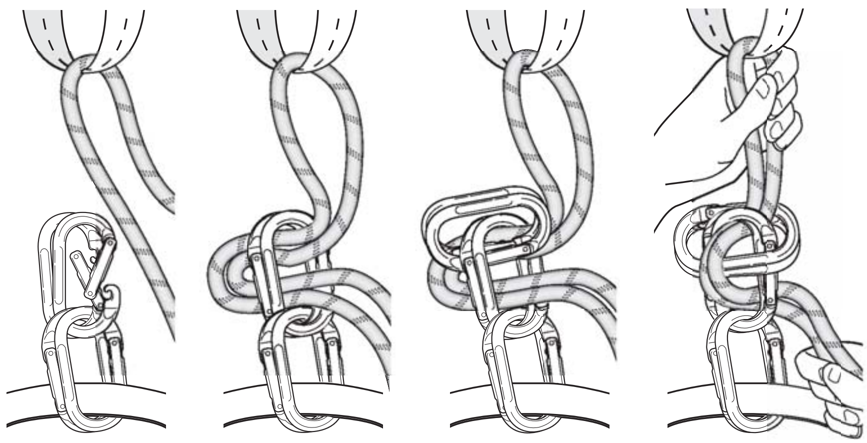

Figure 6-39. Carabiner/Crab Brake.

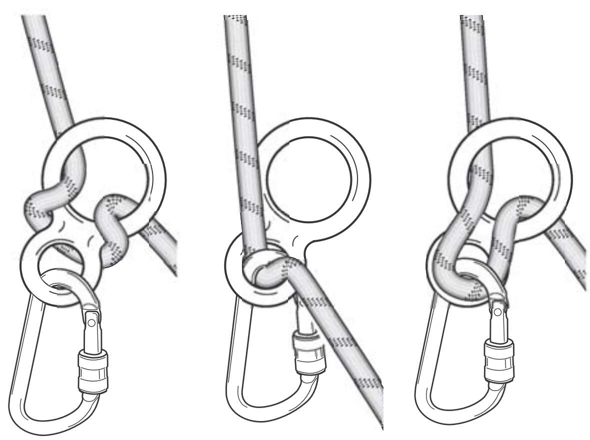

Figure 6-40. Normal Figure-8; Using the Small Hole; Using the Carabiner.

some tendency for the grigri to lock up when the leader makes a sudden move up. It also works badly or not at all on wet or icy ropes, which, together with its weight and bulk, makes it largely unsuitable for tactical mountaineering, but quite useful for safety in training. To set up a grigri—

- Open the grigri and run the rope around the cam. Pay attention to the routing and ensure the load (leader) is on the end of the cam closest to the carabiner hole.
- Close the grigri and hook the carabiner from the MAC through the hole in the bottom of the grigri. See figure 6-41.
- Check the diagram on the device and ensure the rope is run the correct way.
- Perform a function check by feeding the rope through the grigri with both hands. Then, take the load rope (rope from the climber's harness) and tug it. The grigri should lock and stop all movement.

The left hand is the guide and the right controls the slack. Should a climber take a fall and the belayer need to release the load or lower the climber, the left hand operates the load release lever. Belayers must maintain control of the slack rope with the right hand to help control the speed of the descent.

Piton Carabiner Method

Not all pitons can be used for this technique due to some pitons being designed with sharp edges. Shallow angle pitons work the best. To establish the piton carabiner method—

- Place a locking carabiner into the hard point on a harness.
- Clip another carabiner with a piton attached through its eyelet to the other carabiner already attached to the hard point.
- Run a bight of the rope through the outer carabiner.
- Place the piton beneath the bight so its pointed end rests on the opposite side of the carabiner to which it is attached.
- Run the rope across the top of the piton.
- To brake, pull the rope forward causing a bight around the rope and the piton.

Party Climbing

Party climbing is a method used by two Marines who are using a rope and protection for safety to climb a vertical to near vertical obstacle.

Climbing Classification

There are several systems of classification. The Yosemite Decimal System (YDS), previously known as the American Rating System, describes climbing using five classifications—1 to 5 (class 1 to class 4 terrain is discussed ater in this chapter). Class 5 climbing involves movement over vertical to near vertical terrain. This system

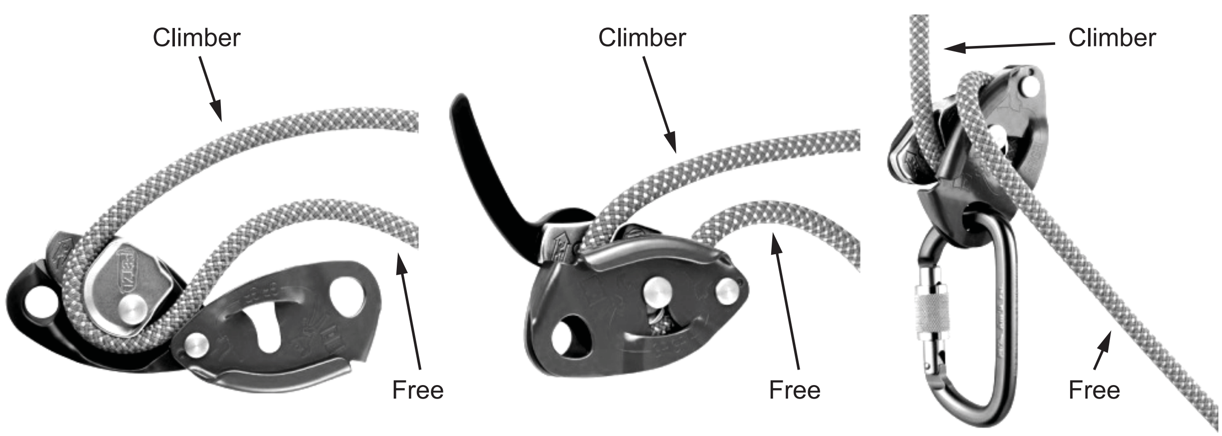

Figure 6-41. Loading the Grigri.

categorizes terrain according to the techniques and equipment required to climb that terrain in the following manner:

- 5.0 to 5.4: A physically fit person can usually climb at this level with little or no climbing skills and using only natural ability.
- 5.4 to 5.7: Requires use of rock-climbing techniques, such as hand jamming/strength.
- 5.7 to 5.9: Rock-climbing shoes, good skills, and some strength are usually required at this level.
- 5.10 and above: Excellent skill and strength are necessary. This level requires training for climbing techniques and a commitment of time to maintain that level.

Note: The limit of difficulty for military climbs is 5.7 because, with minimal training, the average Marine in good condition can climb this terrain. Above 5.7 is too technical for tactical purposes, but 5.8 to 5.10 terrain serves well for improving the technical proficiency of certified summer mountain leaders, assault climbers, and senior/master mountain warfare instructors.

Although the YDS is common in the US, other countries have developed their own rating systems and scales. Table 6-5, on page 6-48, will help determine the difficulty of a climb regardless of the type of rating system. Refer to appendix C for more information on climbing rating systems.

Climbing Route Site Selection

When selecting a route for lead climbing, the most common danger is overestimating one's own ability. It is also important to avoid the following hazards:

- *Wet or icy rock.* These impediments can make an otherwise easy route almost impassable.
- *Rocks overgrown with moss, lichen, or grass.* These areas can be very treacherous when wet or dry.
- *Tufts of grass and small bushes growing from loosely packed soil.* These normally appear firm, but can give way suddenly when they are pulled or stepped on.
- *Gullies that are subject to rockfall.* If Marines have to use a gully that has evidence of rockfall in it, then they should try to stay to the sides.

Responsibilities of the Lead Climber

Before starting a climb, the lead climber must—

- Preselect probable route.
- Ensure he/she has the proper equipment to complete the route.
- Ensure that the climber and the number 2 are tied into their respective ends of the rope.
- Ensure that the number 2 has established a proper anchor for the belay anchor system.
- Ensure that all members of the climbing party are properly tied into the system.

The lead climber may have to construct a gear rack to carry his/her equipment. He/She can construct this rack by tying the ends of a length of one-inch tubular nylon webbing together using a water/tape knot so it forms a loop that fits over the climber's head and shoulder and runs diagonally across his/her chest. If tubular nylon webbing is not available, one of the runners or a sling rope can be used if the route will permit.

Rules for Placing Protection

Placing protection was covered earlier in this chapter, but it is also important to remember the following rules for placing protection:

- Before leaving the ground, a good piece of protection should be placed as high as possible. If that is not attainable, climber should begin his/her climb and place protection as soon as possible.
- Protection is placed every 6 to 8 feet to prevent the possibility of taking a long fall. On a longer route, protection can be spread out from 10 to 15 feet as long as it is within the climber's ability and experience level.

Table 6-5. Ratings of Climbing Difficulty.

UIAA	FRANCE	YDS (US)	UK	AUS
I	1	5.2	moderate	
II	2	5.3	difficult	11
III	3	5.4	very difficult	12
IV	4	5.5 5.6	4a	13
V-	5-		4b	
V	5	5.7	4c	14
V+				15
VI-	5+	5.8	5a	16 17
VI	6a	5.9	5b	18
VI+	6a+	5.10a		19
VII-	6b	5.10b		20
VII	6b+	5.10c 5.10d	5c	21
VII+	6c 6c+	5.11a 5.11b		22
VIII-	7a	5.11c	6a	23 24
VIII	7a+	5.11d		25
VIII+	7b	5.12a	6b	
IX-	7b+	5.12b 5.12c		26
IX	7c 7c+	5.12d 5.13a	6c	27 28
IX+	8a	5.13b		29
X-	8a+	5.13c	7a	30 31
X	8b 8b+	5.13d		32
X+	8c	5.14a	7b	33

- A leader should place protection before and after a hard move (crux) because a fall is more likely. See figure 6-42.
- A climber should place protection whenever he/she feels he/she should.
- Climbers should follow the first runner rule, if practical. See the four pictured scenarios in figure 6-43 on page 6-50. The first picture shows a climber with no protection until 10 feet. Risk of injury is minimal at that height. The second picture shows what would happen if a climber were to fall at 15 feet with one piece of protection placed at 10 feet. The climber would fall to at least 5 feet from the ground. The third picture shows a climber at 23 feet with two pieces of protection on the rope. If the climber falls at that height, he/she would fall to 7 feet off the ground. The last picture shows a climber at 33 feet with three pieces of protection on the rope. If the climber falls at 33 feet he/she would fall to at least 13 feet off the ground. Rope stretch and belayer reaction time should also be considered.

Attaching the Rope to the Protection

Carabiners and runners are the tools climbers use to connect the climbing rope to the protection. The carabiner should almost always be used in the down-and-out position: the gate should point down and away from the rock surface. This position lessens the chance of accidentally opening the gate during a fall. The rope itself should be clipped so it runs freely through the gate in the direction of travel. See figure 6-44 on page 6-51.

Preventing Rope Drag

Rope drag causes various problems. It can hold a climber back, throw him/her off balance, pull his/her protection out, and make it hard for the leader to pull enough rope up to clip the next piece of protection. Also, rope drag can affect how well a belayer responds to a fall by reducing the ability to provide a dynamic belay. Keeping the rope in a straight line from the belayer to the climber is the best way to reduce rope drag (see fig. 6-45 on page 6-51).

Protection should be placed so that the rope follows as straight a line as possible. If the protection placements do not follow a straight line up the pitch and the rope is clipped directly to these placements, it will zigzag up the cliff and cause severe rope drag. If the protection cannot be placed in a direct line, runners or quick draws can be used to extend the protection, as in figure 6-46 on page 6-52, to allow the rope to hang straight and run more freely through the protection system.

Using an extra long runner can create another problem. The extension may keep the rope in a straight line, but it may also add dangerous extra feet to the length of a fall. In such a case, it is sometimes better to accept some rope drag in order to get better security in case of a fall.

If the protection placements happen to be in a straight line, the rope will run straight and there will be less rope drag even if it is clipped directly to the protection; however, rope movement can jiggle a piece of protection out of position. To reduce this risk, a quick draw can be used to isolate the protection from rope movement.

A quick draw or runner should always be placed on protection with wire or without pre-sewn runners. There is no requirement to place quick draws on wire runners used for a belay stance, unless some extension is needed. See figure 6-47 on page 6-52.

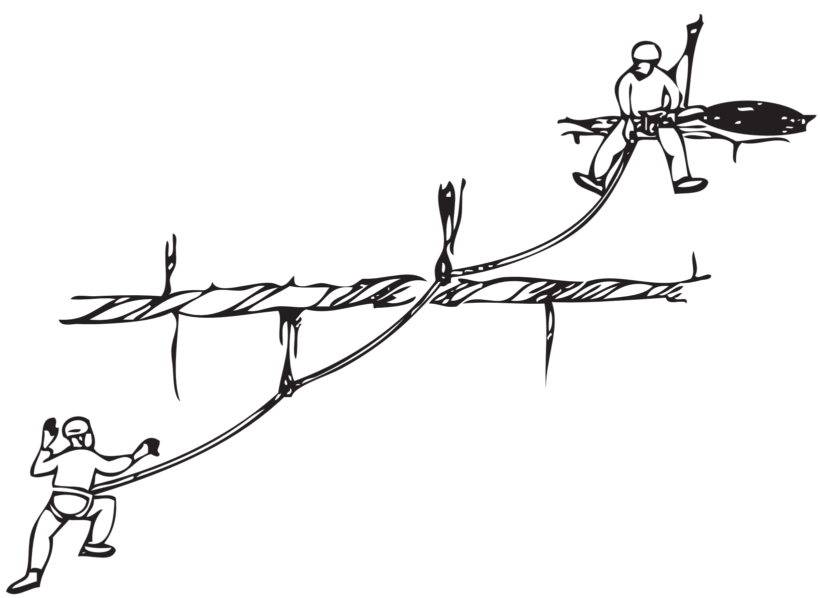

Figure 6-42. Placing Protection Before and After Hard Move.

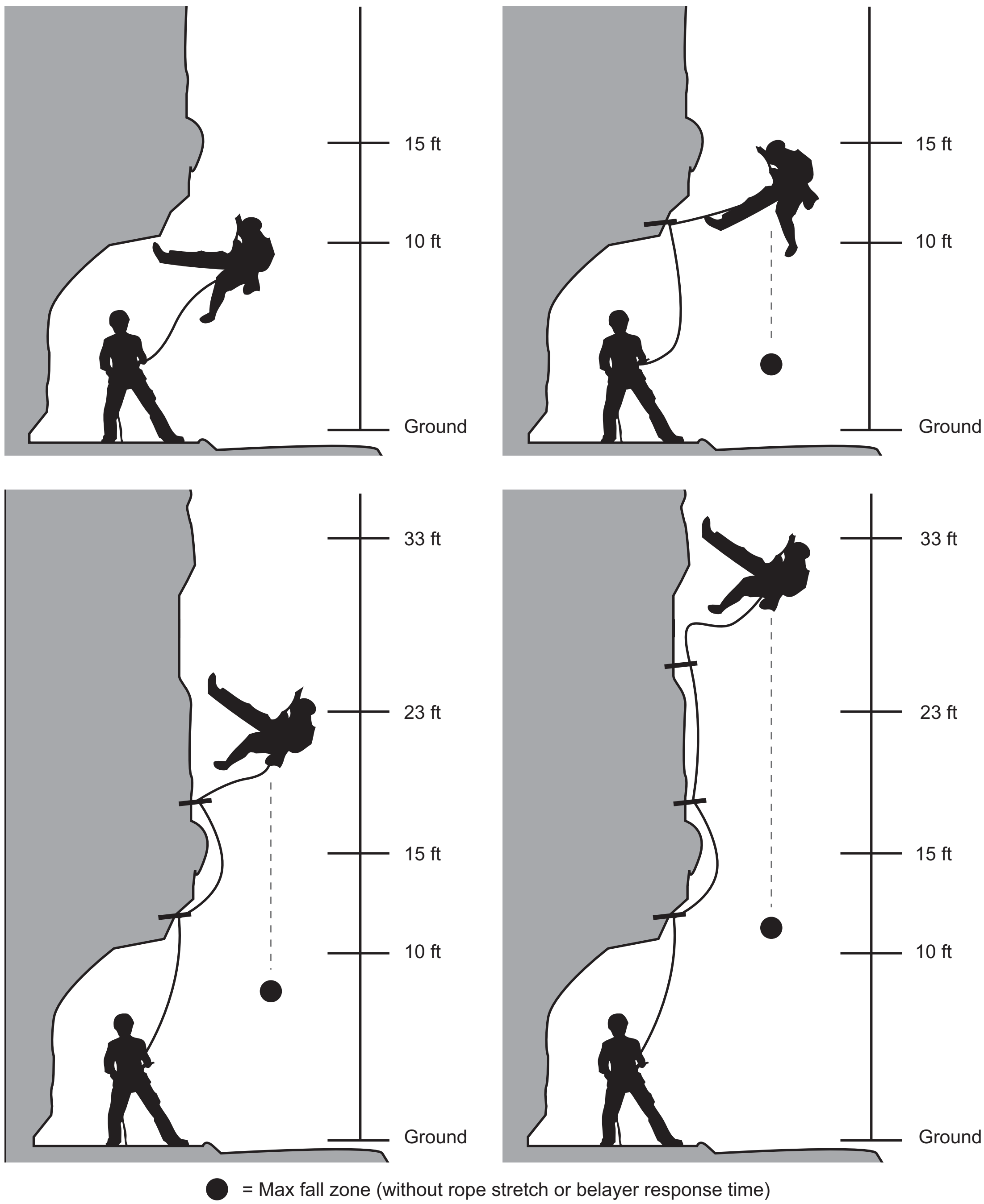

Figure 6-43. First Runner Rule.

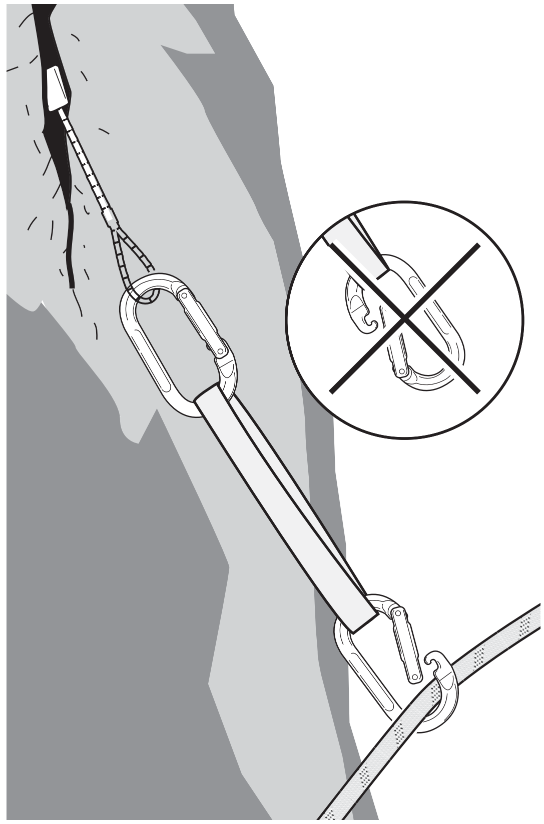

Figure 6-44. Attaching Rope to Protection.

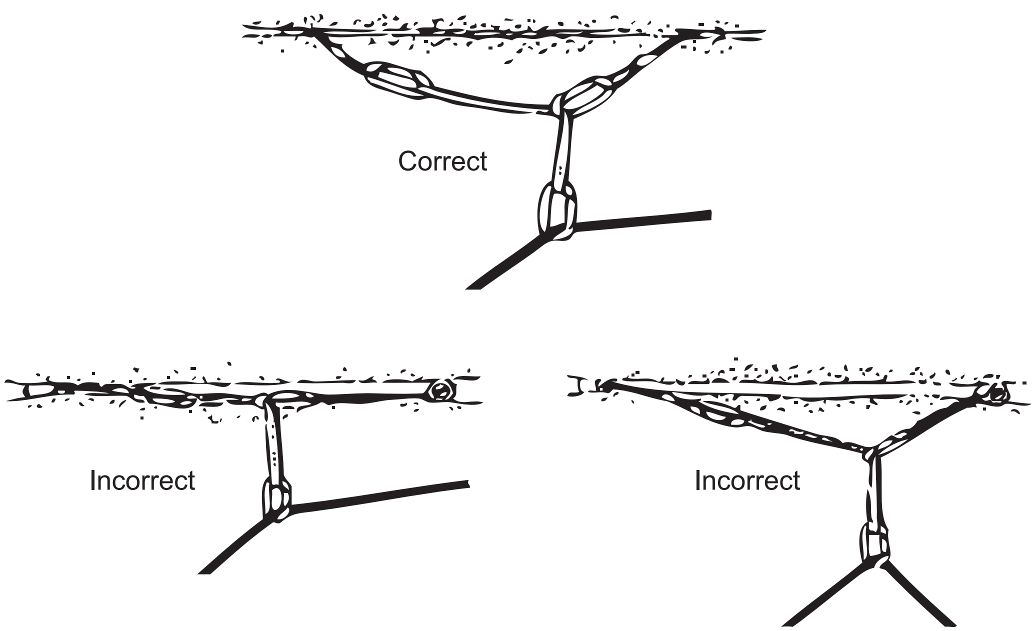

Figure 6-45. Placement of Protection in Party Climbing.

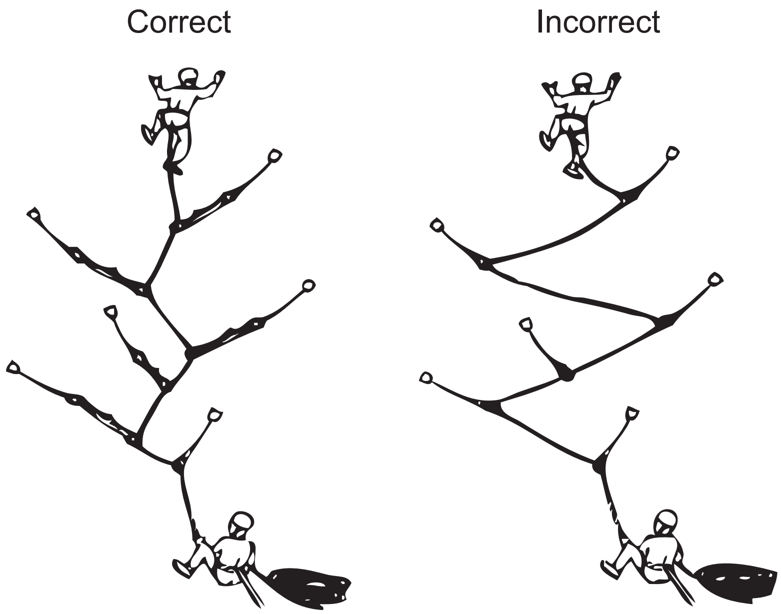

Figure 6-46. Use of Runners to Prevent Rope Zigzag.

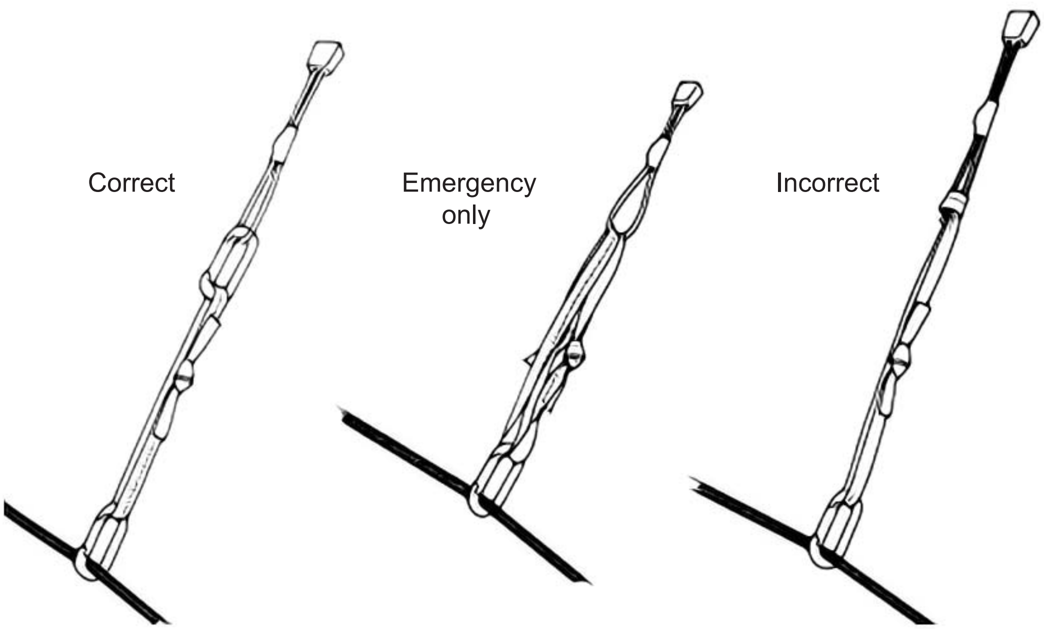

Figure 6-47. Quick Draw on a Piece of Wire Protection.

The runner must be the proper length to clear overhangs. See figures 6-48 and 6-49.

Preventing the Zipper Effect (Redirect)

When belays are established away from the base of a climb, the rope runs at a low angle from the belayer to the first piece of protection on the rock. From there, the rope changes direction and goes abruptly upward. If the leader should fall, the rope tightens and tries to run in a straight line from the belayer to the top piece of protection. This effect puts great strain on the bottom piece of protection.

If it pulls out, the line of protection could come out one after another from the bottom up—known as the zipper effect. The zipper effect can be prevented by moving the belay stance within 10 feet of the base of the climb or by creating opposition protection. To create opposition protection—

- Set in two pieces of protection (opposite and in the direction of pull).
- Clip a sling to one of the nuts.
- Pass the sling through the carabiner of the other nut and back between its own strands.
- Pass it once more around the carabiner and cinch it tight, as seen in figure 6-50.
- Clip the end loop into the rope.

Climbing Commands

During a climb, the climber often cannot see the belayer, which, accompanied by the effects of wind, weather conditions, or the distance between each other, makes communication very difficult. As a result, a strict set of commands is used in order to communicate with as little confusion as possible. See tables 6-6 and 6-7, on page 6-54, for verbal commands.

When undertaking a tactical cliff assault the use of verbal climbing commands may not be practical. In this circumstance, the climbing pair can use a method of sharp tugs on the rope (see table 6-8 on page 6-54) to communicate with each other.

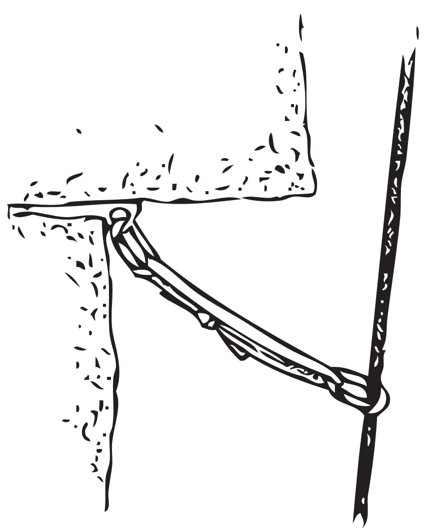

Figure 6-48. Proper Runner Length.

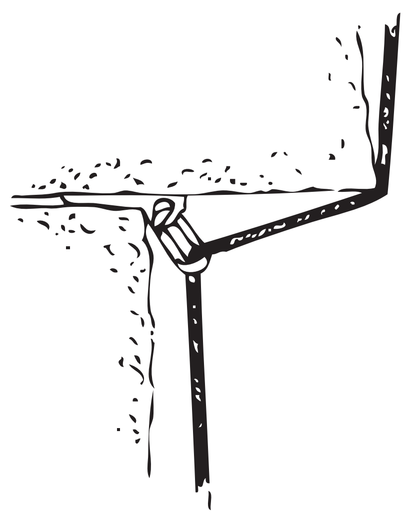

Figure 6-49. Improper Runner Length.

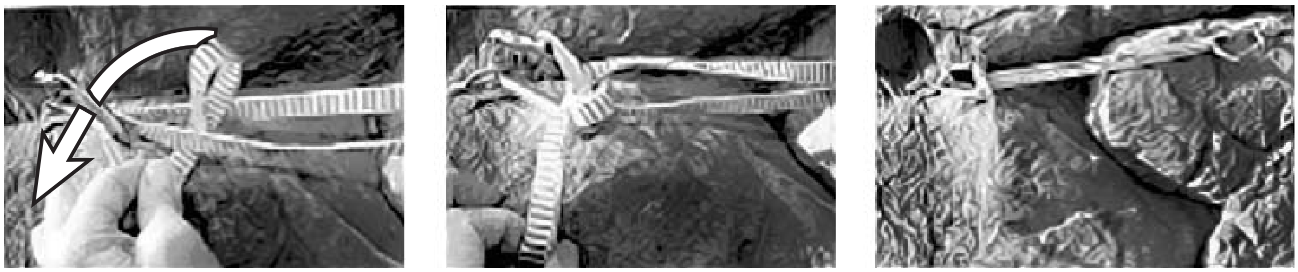

Figure 6-50. Redirects.

Table 6-6. Verbal Commands.

Command	Given By	Meaning
ON BELAY	Belayer	Anchored and ready to belay
CLIMBING	Climber	Ready to begin the climb
CLIMB	Belayer	Start climbing
POINT	Climber	Placing protection, watch
POINT	Belayer	Watching, giving or taking rope as needed
25 FEET	Belayer	The climber has 25 feet of rope left and must find a belay stance soon
FALLING	Climber	The climber is about to fall
SLACK	Climber	Pay out some rope
SLACK	Belayer	Allows climber to take rope as needed
TENSION	Climber	Tells belayer to take up excess rope
TENSION	Belayer	Belayer is taking up excess rope
OFF CLIMB	Climber	Climber is safely anchored, end belay
OFF BELAY	Belayer	Untied and off the belay

Note: At this point, the belayer becomes the number 2 climber and the lead climber is the belay person.

Table 6-7. Verbal Commands When Belayer Becomes Number Two Climber.

Command	Given By	Meaning
UP ROPE	Number 2 (climber)	Take up excess rope between us
THAT'S ME	Number 2 (climber)	The climber is ready to be put on belay and the rope is taut on the climber and not snagged
ON BELAY	Number 1 (belayer)	Belayer is in the belay stance and ready for climber to climb

Note: From this point on the commands are the same as before.

Table 6-8. Nonverbal Commands.

Command	Meaning
1 tug	Give slack
2 tugs	Give tension
3 long tugs	Secured on the belay/the rope is secure

Note: Practice of the tug commands is essential. During the normal course of a climb, the rope will move around in the belayer's hand and can deceive the belay person.

Lead Climber's Actions On Top

The lead climber will sound off with TOPPED OFF, MAX SLACK to indicate to the belayer that he/she is on top and no longer climbing. He/She is looking for anchors to create a belay. The belayer will remain alert and give or take in slack as required.

The lead climber will construct a top anchor. When possible, he/she uses natural anchors for protection. Once his/her anchor is properly built and his/her MAC is locked down, he/she will sound off OFF CLIMB to inform the belayer that he/she is safe and no longer requires a belay. The belayer will sound off with OFF BELAY and removes his/her belay device. The belayer will then sound off UP ROPE. The number 1 climber will then pull up all the slack rope to his/her position.

Once the rope is taut between the lead climber and the belayer, the belayer will sound off THAT'S ME, which informs the lead climber to secure the rope to his/her belay device. After the lead climber places the climbing rope in his/her belay device, he/she will give the command ON BELAY. The belayer breaks down and retrieves his/her anchor/belay system. Once finished, he/she will sound off CLIMBING, informing the lead climber (now in his/her belay stance) that he/she is beginning his/her climb.

Retrieving the Protection

While the number 2 is climbing, he/she will retrieve all the pieces of protection along the route, also performing the following actions:

- When he/she reaches a piece of protection, he/she will sound off POINT, informing the belayer to set the brake with the belay device.
- The belayer will answer back POINT, informing the climber that he/she has set the brake.
- The number 2 will remove the protection and stow it on his/her rack. If the piece of protection becomes difficult to remove, he/she uses the nut pick.
- After stowing the protection, he/she will sound off with the command CLIMBING, which informs the belayer that he/she has removed the protection and is beginning to climb again.
- The belayer will answer back CLIMB, CLIMBER, informing the climber that he/she is ready to begin belaying procedures.
- The number 2 will repeat these actions until he/she tops off or reaches the established belay stance.
- When the number 2 reaches the belay position or tops off, he/she does one of the following:
    - Makes himself/herself secure by moving 10 feet back from the edge of the climb or attaches themself to an anchor point.
    - Stops and exchanges/reorganizes climbing gear with the lead climber for the next pitch and then continues climbing.

Fall Forces

In the event of a fall by a lead climber, an enormous amount of force is applied on the rope. As the rope stretches, part of the energy is converted into heat due to the friction between the rope fibers. There are two parts in determining the force of a fall—impact force and fall factor.

Impact force, also called shock force, is the amount of force the belay person has to exert on a falling climber through the rope, anchor, and belay device to stop his/her fall. See figure 6-51. The amount of impact force needed to stop his/her fall is determined by the fall factor.

The fall factor is the amount of force generated by a leader fall onto the rope. A fall factor is a

Figure 6-51. Impact (Shock) Force.

mathematical equation is expressed as its numeric result ranging between 0 at the lowest and 2 at the greatest (while lead climbing). Fall factor is simply the length of the fall divided by the rope run out (see fig. 6-52). The equation is:

$$\text{Fall factor} = \frac{\text{Length of fall}}{\text{Rope run out}}$$

EXAMPLE 1:
10 meters of rope out above a belay on a rock face results in a 20-meter fall (10 x 2). A 10-meter drop to the anchor and 10 meters past the anchor until the rope catches. The 20-meter fall divided by 10 meters of rope out of the anchor equals two—also called a factor 2 fall.

$$\frac{20}{10} = \text{Factor 2 fall (highest fall factor)}$$

EXAMPLE 2:

10-meter run out above a belay on a rock face, but with a piece of protection placed at 5 meters results in a 10-meter fall.

$$\frac{10}{10} = \text{Factor 1 fall}$$

EXAMPLE 3:

10-meter run out above a belay on a rock face, but with a piece of protection placed at 7.5 meters results in a 5-meter fall.

$$\frac{5}{10} = \text{Factor 0.5 fall}$$

Table 6-9 shows the relationship of fall factor and impact force for a 180-pound climber.

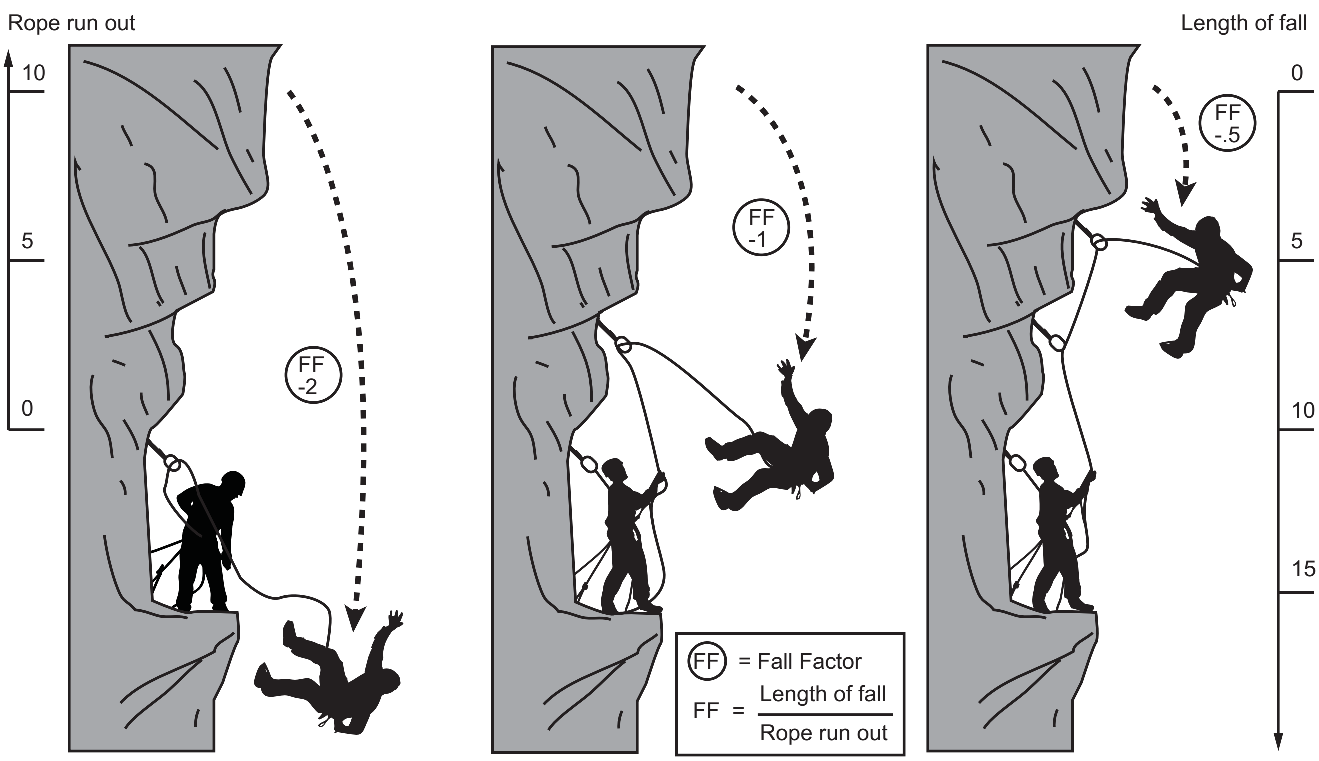

Figure 6-52. Fall Factor Examples.

Table 6-9. Fall Factor and Impact of Force.

Fall Factor	Impact Force	Fall Factor	Impact Force
0.0	360 pounds	1.0	1,676 pounds
0.1	683 pounds	1.2	1,817 pounds
0.2	868 pounds	1.4	1,947 pounds
0.4	1,137 pounds	1.6	2,067 pounds
0.6	1,347 pounds	1.8	2,181 pounds
0.8	1,521 pounds	2.0	2,288 pounds

Note: The less a climber weighs, the less impact force the belay has to sustain. The more the climber weighs, the more force is exerted.

The following points should be considered during a climb to minimize the seriousness of a fall:

- The belayer must always be in a position to withstand a fall.
- It is better to belay after a series of cruxes than before them. Belays after cruxes minimize fall factors in potentially dangerous situations.
- A direct belay from the anchor will place all force from the fall on the anchors. To minimize the stress on the anchors, an indirect belay from the belayer's harness will allow the belayer to absorb some of the force through the belay stance.
- Any factor 1 fall or greater should be regarded as serious and the rope should be retired from lead climbing duties.

Night Climbing and Silencing Gear

A visual reconnaissance of the cliff and a cliff sketch should be completed before nightfall in order to study the terrain and probable route. Otherwise, all considerations for party climbing apply at night as do the following:

- Apply nonverbal commands.
- Use the munter hitch for belaying to eliminate metal belay devices that can create noise.
- Place tape around carabiners to reduce noise. The tape must not interfere with gate operation.
- Attach 550 cord to the nut pick to allow the climber to extend it from his/her chest pocket and prevent losing it, if dropped.

Three-Person Climbing Team Techniques

In most situations, a pair of climbers is quicker that a team of three; however, there are situations during which a team of three can be quicker or necessary. The caterpillar or simul-belay techniques may be used to negotiate a cliff with three climbers. When using the caterpillar technique, the lead climber leads on one rope, then the second climber follows on that rope and trails a second rope for the third climber. The second climber unclips his/her rope from the protection and then clips the trailing rope into it, which protects the third climber from a swinging fall if the pitch traverses. When the second climber arrives at the belay, the third climber climbs up and removes (cleans) the protection.

When using the simul-belay technique, the leader will climb up with both ropes and then belay both partners up one at a time. It is wise to clip both ropes into each piece of protection so climbers do not create a pendulum fall if the pitch traverses. See figure 6-53 on page 6-58.

Class 1 Through Class 4 Climbing

Class 5 climbing (discussed earlier in this chapter) involves movement over vertical to near vertical terrain and can be very slow and tedious; however, in many tactical situations, Marines will be required to move over steep, dangerous terrain that is not vertical or near vertical. These terrain types are categorized as class 1 through class 4 terrain.

Class 1

Class 1 terrain is generally defined as climbing or mountaineering during which no specific

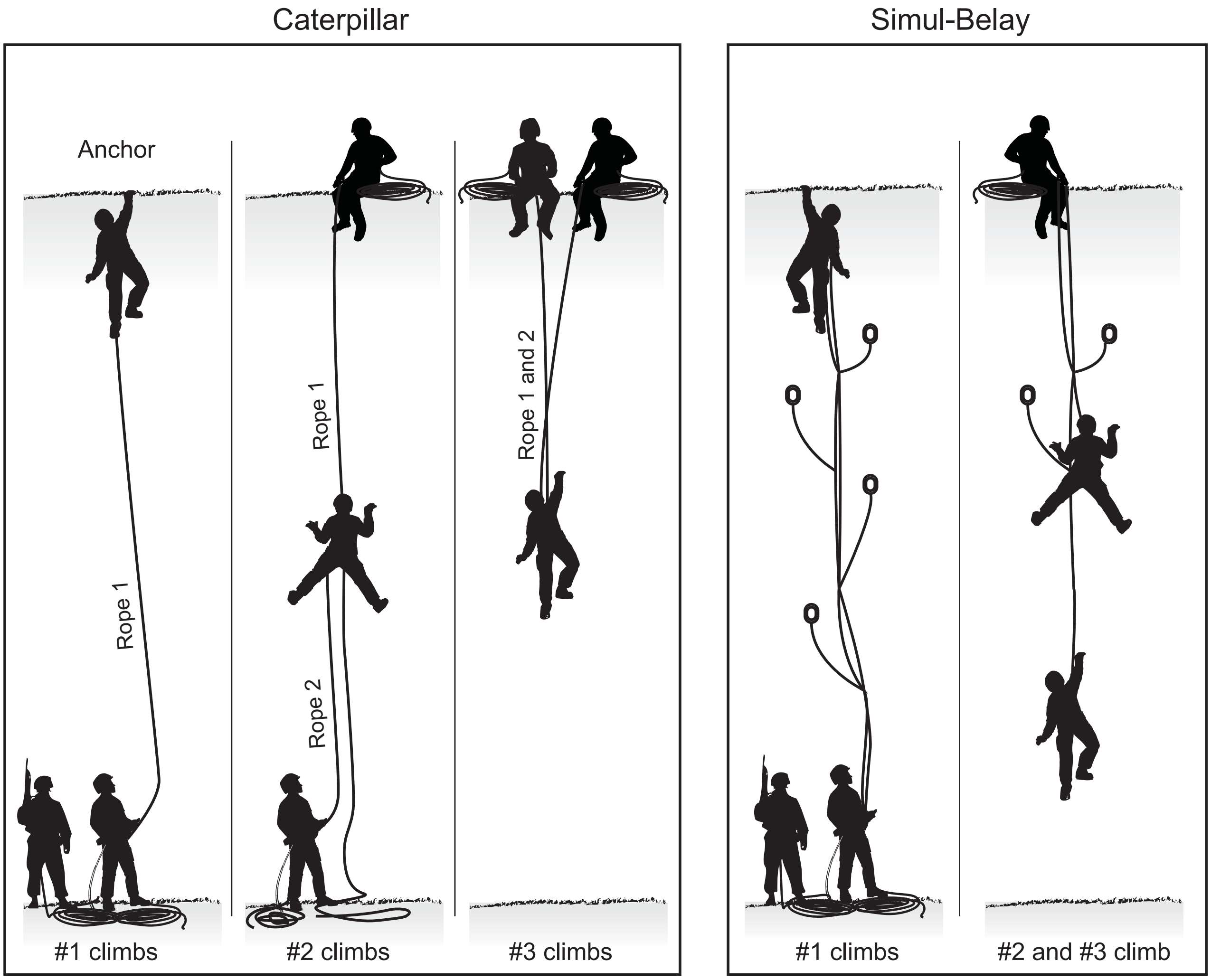

Figure 6-53. Caterpillar and Simul-Belay.

footwear is required. Some examples would be a hard packed trail or a grassy slope. There are no specific travel considerations on this type of terrain. Only general navigation and mountain movement techniques are required. More information on traveling through class 1 terrain can be found in Marine Corps Reference Publication (MCRP) 3-35.1A, *Small Unit Leader's Guide to Mountain Warfare Operations*.

Class 2

Class 2 terrain is generally defined as climbing or mountaineering that requires specific mountaineering boots, because the terrain is broken and can be difficult to maneuver. Some examples of this terrain are a talus field or a steep scree field. The travel techniques in this type of terrain are basic and no specific mountaineering equipment is necessary. Most difficulties will come from injuries and the most common injuries are rollovers and short distance falls, which result in small musculoskeletal injuries. More information can be found in MCRP 3-35.1A.

Class 3

Class 3 climbing is generally defined as scrambling (on all fours) with exposure that may require climbers to move roped together or with a rope. In this type of climbing, Marines begin to use technical skills. An unroped fall on class 3 terrain can be fatal. Many different techniques can be used and the one chosen is based on the number of people in the climbing team. Small teams consist of 2 to 4 climbers on one rope. The method of attaching to the rope is similar to the techniques used in glacier travel, except that a safety prusik is not necessary. Climbers move from one “island of safety” to another—one climber can be in a position of instability or in an exposed section if another climber is in a solid, braced position. Experienced climbers may be able to move together simultaneously through this terrain; whereas, inexperienced climbers may have to set up hasty belay points throughout their route. Specific travel techniques can be found in MCRP 3-35.1A.

Ideally, large units use fixed ropes to move over this type of terrain. It may take a considerable amount of time to set up fixed ropes, but the unit may save time and energy in the long run. See the discussion on fixed ropes in chapter 8.

Class 4

Class 4 terrain is defined as simple climbing, often with exposure. A rope is often used for inexperienced or heavily laden Marines. A fall on class 4 could be fatal. Typically, natural protection can be easily found. Many different techniques can be used based on the unit’s size and experience. Small teams will need to move roped together as in class 3 climbing and glacier movement. Class 4 climbing is more technical and may require better climbing skills. Often, climbers will move from one belayed position to another. These belay positions may be hasty positions with no artificial or natural protection. It is possible for the belayer to use terrain to belay other climbers. This type of terrain can be extremely dangerous and only experienced climbers should attempt to move inexperienced troops over it. The possibility of injury due to guiding mistakes is high. Ideally, large units use fixed ropes to move over this type of terrain as with class 3.

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CHAPTER 7
RESCUE CLIMBING

Rescues for Party Climbing

A party climb rescue can become time consuming, yet minutes matter when dealing with injuries.

Assessing the Situation

Whenever an injury occurs while climbing, whether it involves the number 1 or number 2 climber, rescuers must first assess the situation and determine the following:

- Is the climber conscious or unconscious?
- How severe is the injury?
- What is the location of the injured climber?
- Is there enough gear to conduct the rescue?
- Can other climbing teams assist in the rescue?
- How familiar are the climbers with rescue techniques?

Rescuing an Injured Lead Climber

There are several methods that can be used to rescue an injured lead climber, depending on the amount of rope available and the extent of the injury. If *less than half the rope* has been used, the casualty can be lowered to the ground or to the belay stance. If the casualty is *conscious*, he/she will back up the lowering point with another piece and equalize it, clipping the rope into it.

If *more than half the rope* has been used and the climber is *conscious*, he/she will conduct the same actions as above plus the following:

- Clean the route on the way down.
- Descend past the halfway mark, then locate a feasible stance to tie off to the rock using an equalized anchor system.
- Pull slack up from the bottom and tie it off to a hard point.
- Untie the retrace figure-8 from his/her harness and pull the rope through the lowering point.
- Attach the end of the rope back into his/her harness with a retrace figure-8 once the rope has cleared the lowering point.
- Untie the slack rope from the hard point and have the belayer take in all the slack.
- Clip in into the equalized anchor system, taking a bight from his/her retrace figure-8.
- Detach himself/herself from the anchor, ensuring the belayer has taken in all the slack and the brake is applied. The belayer will now lower the casualty.

If *more than half the rope* has been used and the climber is *unconscious*, then rescuers should try to obtain help from climbing teams in the area and conduct a tandem rappel rescue.

Escaping from the system is a phrase used to describe the technique of the belayer releasing themself from the belay, while ensuring that the climber is safe and secure. The reasons for escaping the belay are varied, such as to perform first aid and get help. Once the reason to escape has been established, rescuers must work logically, safely, and as simply as possible.

If aid comes from a second climbing team, that team rappels to the casualty and conducts a tandem rappel. If the second team cannot rappel, it will two-party climb up to the casualty and lower him/her.

Rescuing an Injured Number 2 Climber

To rescue an injured number 2 climber, Marines may use one of five methods, depending on whether the victim is conscious and the availability of rope.

Modified 2:1

A modified 2:1 can be constructed as follows:

- Tie off the number 2 using a mule knot.
- Tie a friction knot to the load rope with a carabiner attached.
- Clip the running end of the rope into the carabiner.
- Untie the mule knot keeping the munter on.
- Pull on the running end until the friction knot cycles up.
- Holding the brake on, cycle the friction knot back down.
- Repeat as necessary.

3:1

A 3:1 rescue can be constructed as follows:

- Tie off the number 2 using a mule knot.
- Tie a friction knot onto the load rope and attach it to the shelf as the backup brake.
- Tie a friction knot to the load rope with a carabiner attached.
- Clip the running end of the rope into the carabiner.
- Take off the munter without taking the rope completely off the MAC.
- Bring up the number 2.
- Repeat as necessary.
- Put the munter back onto the MAC and assume the belay.

9:1

More mechanical advantage may be added to the 9:1 system; however, there must be a strong anchor able to withstand the pressure from the system. It can be constructed as follows:

- Tie off the number 2 using a mule knot.
- Tie a friction knot onto the load rope and attach it to the shelf as the backup brake.
- Tie a friction knot to the load rope with a carabiner attached.
- Clip the running end of the rope into the carabiner.
- Take off the munter without taking the rope completely off the MAC.
- Clip a carabiner onto the MAC.
- Clip the running end of the rope into that carabiner.
- Tie a friction hitch with a carabiner onto the rope that is running through the carabiner on the shelf.
- Clip the running end of the rope into the friction hitch. The lead climber now has a 9:1 mechanical advantage. The casualty will have to remove the protection as he/she is being raised.

Unconscious Number 2

If the number 2 is unconscious, the following steps should be performed:

- Tie off the climber.
- From the munter mule knot and with the unloaded rope, tie a fixed knot (clove hitch, figure-8) on a separate anchor. Ensure there is slack between the knot just tied and the munter mule knot.
- Tie in for rappel with the rope coming out of the knot on the new anchor. This rope will be used to rappel.
- Untie retrace figure-8 from the harness and deploy that rope down the cliff.
- Ensure there is enough rope to reach all protection.
- Rappel down and clean the route.
- "Batman" (self-belay) back up the route.
- Build a mechanical advantage (as described previously) and haul up the casualty.

Not Enough Rope

If there is not enough rope to reach all the protection, the following steps should be performed:

- Tie a friction knot onto the loaded strand and clip it into the hard point.
- Untie retrace figure-8 and manage it on the belay stance.

- Descend on the loaded strand and clean the route.
- Once the route is clear of all protection, ascend back to belay stance.
- Build mechanical advantage and haul up the casualty.

Military Aid Climbing

Free climbing is the use of the rock alone to climb and the equipment used while free climbing is only for safety. Equipment is not used to ascend the rock directly. Direct aid climbing is using equipment alone to ascend a full pitch, which is too technical and has no military application. However, military aid climbing is the occasional use of a piece of protection to rest or use as a hand or foot hold to get through a hard move and/or to reach the next hold. There is no such thing as an illegal move in military climbing—Marines should do whatever it takes to get up the rock face.

Reasons to Use Military Aid

Marines may use military aid techniques for any of the following reasons:

- The terrain is above climber's ability. After conducting the cliff reconnaissance and picking a route which appeared to be within the climber's ability, the lead climber gets stuck part way up.
- The climber is fatigued or injured. The route may be a simple 5.6, but, due to it being a sustained 5.6 for the entire pitch and not just one move, the lead climber transitions to aid due to fatigue or he/she takes a lead fall on the second pitch and injures an arm or leg. As long as the lead climber has one good arm and leg, he/she can continue on by using military aid techniques.
- The weather turns inhospitable. It begins to rain or snow. Aid can be accomplished with gloves on and even while wearing ski or ice boots.
- Climbers need to save energy for mission or rescues. As an assault climber, conducting a cliff assault is just a means of crossing an obstacle en route to the objective. Once the unit is up the cliff, energy is still needed to continue on with the mission. In the event of a tactical recovery of aircraft and personnel (TRAP) mission or high angle rescue, the real work begins once the casualty is down off the cliff and must be carried to the extract zone.

Gear for Military Aid Climbing

Usually, only standard gear is used; however, some specialized gear may be required for military aid climbing, such as an etrier or daisy chain. This gear can be constructed from the equipment a climbing team already possesses.

Etrier

Also known as aiders, etriers are ladder-like slings that allow climbers to step up from one placement to the next when they are clipped into a piece of protection. Etriers become hand and foot holds on otherwise unclimbable rock. They can be constructed from an 18-foot tape or 21-foot prusik cord that has been tied in a loop with a square knot by performing the following steps:

- At the top of the web/cord, tie a two-inch loop with an overhand knot.
- 10 to 12 inches down from the overhand, pinch the two strands of web/cord together and pull up one side until it is offset enough for a comfortable step.
- Tie another overhand knot and repeat the process for the entire length of the web/cord. It is important to alternate which side is offset so that all the steps are not on one side. An 18-foot tape should provide 6 or 7 steps. See figure 7-1 on page 7-4.

Daisy Chain

A daisy chain is made of a length of webbing or cordage with clip-in loops along its entire length

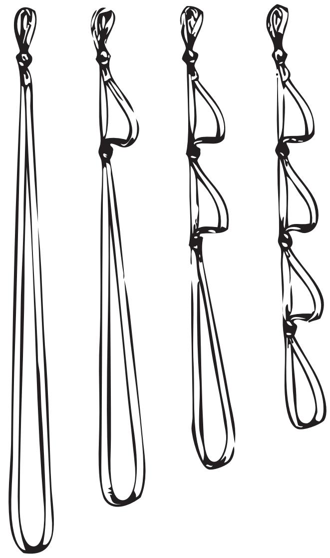

Figure 7-1. Etrier

that are used to connect a climber to a piece of protection from his/her harness. This construction allows the climber to rest his/her arms or use two hands. A daisy chain can be made from a 48-inch web runner. It is constructed in a similar manner as an etrier; however, all the loops should be 3 to 6 inches apart and not offset. The daisy chain should not extend beyond arm's reach when measured from the harness. See figure 7-2.

Aid Techniques

Hang dogging and the French free are military aid climbing techniques. Hang dogging involves the following steps:

- Clipping into a piece of protection.
- Having the belayer take in all the slack.
- Locking the belay device off so the climber can rest or use two hands. A climber may also tell the belayer to take up the slack between the climber and his/her last piece of protection and lock him/her off.

The French free uses protection as a means to pull up or to stand up. The most basic method is using aid for one move, as in figure 7-3. To use a French free—

- Set in a piece of protection and clip an etrier into it.
- Step into the etrier and slowly transfer weight onto it in order to test the solidity of the piece of protection.
- If it holds, conduct a bounce test with one foot in the etrier.
- Step up higher in the etrier and bypass the difficult move.
- If the problem is lack of a handhold, clip a short web runner into the protection and use it as a handle.

Figure 7-3. French Free.

Figure 7-2. Daisy Chain.

CHAPTER 8
STEEP CLIMBING

This chapter's discussion of steep climbing includes steep earth, urban, and tree climbing. This chapter also describes the use of fixed ropes and cliff assaults.

Steep Earth Climbing

Climbing steep earth uses techniques and equipment similar to ice climbing or glacier travel because rock protection is ineffective on steep earth. Each climber will need the following equipment:

- Climbing harness.
- Mountain boots with a half or full shank, if possible.
- Helmet.
- Gloves.
- One 50-meter climbing rope per team.
- One short ice axe.
- One alpine hammer or ice hammer.
- Five-finger/point grip fast (fabricated or open purchase).
- Twelve-point crampons.
- Sling rope.
- Snow stakes.
- Rebar (1-, 2-, and 3-foot lengths).

The number 2 climber will have a five-point hand grapnel with at least 20 feet of knotted 7 mm cord and a 50-meter knotted climbing rope. The short ice axe can be used to cut steps or hand holds, while the pick can be used to gain holds in earth or rock. It should be "dummy-corded" to the climber.

Climbing Procedures

Climbing on steep earth requires many of the procedures previously discussed and includes route reconnaissance, belay, foothold and anchor, changing lead, cleaning the route, and continuing procedures. The route is visually inspected for steepness, soil composition, rock outcroppings, ice and snow patches, and availability of anchors. Based on this reconnaissance, the climbers construct a climbing rack best suited to the proposed climbing route.

Normal belay procedures are used for climbing steep earth. The belayer establishes the bottom of the climb using available anchors. Natural anchors are preferred, but, if no natural anchors are available, artificial anchors can be used. If a 5-point grip fast is used, the belay person will tie into the end of the rope and into the grip fast.

Once the belay is established, the lead climber ties in and begins his/her climb. The climber will cut steps with the adze of his/her earth axe for foot holds. As soon as possible after beginning the climb, the lead attempts to place an intermediate anchor. Depending on the composition of the face being climbed, this anchor may be an ice or rock piton, a chock, camming device, or a specialized steep earth anchor. The climber must remember that any protection placed in steep earth has questionable holding strength. The climber uses his/her axe for a handhold, free hand for balance, or an alpine hammer or ice hammer for his/her second hand tool.

The lead climber digs a belay platform at the end of his/her rope, if required. He/She then plants his/her grip fast, ties into it, and sits on it for additional security. If possible, he/she establishes an anchor using pitons, chocks, camming devices, rebar, or whatever is available. The lead climber then belays up the number 2 climber.

The number 2 climber climbs toward the belay stance, collecting all unused protection. This procedure continues until one climber reaches the top, establishes a belay stance with an appropriate anchor, and top ropes his/her companion up.

Using the Grapnel

A five-point grapnel can be useful when steep earth climbing. With its 20 feet of knotted cord, it provides handholds where there may otherwise be none. Short, sheer faces and overhangs have fewer holds, providing ideal situations for grapnel use.

To use the grapnel, the climber unwinds his/her grapnel line, secures it to themself, and then throws it over a ledge, cliff edge, or other near-horizontal feature. It must be thrown to one side so that, if it does not hold, it will not fall on the climber or his/her belayer. After the grapnel has landed, the climber pulls it slowly until it is securely caught.

The climber then climbs up the difficult section, assisted by the grapnel line and keeping the pull steadily down. Changing to a palms-down grip at the top will help to keep the grapnel in place.

Once at the top, the climber checks the security of the grapnel and changes its position, if needed. He/She establishes a belay and belays the second climber up, who also uses the grapnel line as necessary.

Bottom Duties

Personnel at the bottom perform security and safety duties. They set up a 180-degree perimeter and ensure that no personnel at the bottom are directly under the climbing site because of the loose rock and dirt that could fall on them and cause injury. These bottom duties also include ensuring that the area is swept for any evidence that the unit was there before everyone moves to the top if the tactical situation permits.

Duties Once on Top

Personnel on top also have specific duties, including providing security and ensuring order. The first person up makes a hasty reconnaissance of the area before belaying the other climber. Once that reconnaissance is complete, he/she sets up the knotted hand line at a suitable climbing site for a fixed rope while the number 2 climber provides security. The site selected for each climbing lane should have—

- Good natural anchors, which may have to be multiple small shrubs or bushes.
- Artificial anchors, such as grip fast, pickets, deadmen, and chocks.
- A height such that the rope reaches the bottom.
- Minimum of loose rocks and dirt.

Climbers should also prepare a lane rope. A hand line should be preknotted to save time and brought up by the number 2 climber. He/She can also bring up multiple ropes for multiple lanes. The assault leader and an automatic weapon are the first to ascend in the order of movement. As personnel reach the top, they set up 180-degree security. The assistant leader and an automatic weapon are the last to come up as the 180-degree security on the bottom gets smaller. After all personnel are on top, ensure—

- The ropes are pulled up and coiled.
- All evidence, such as anchors, indentations, or rope marks on the edge of the dirt, is removed.
- Area is policed of any other evidence.

Urban Climbing

Many climbing and anchoring skills are transferable between mountain and urban climbing. On roof tops, anchors can be established for rappelling or raising/lowering systems using structure points available. Judgment must be used to determine if two or three anchor points is sufficient. Ladders, poles, or grappling hooks may be used when climbing walls for window entries up to three floors high. Marines can train for urban climbing by using structures made of wood, brick, concrete (wall materials), and metal poles/girders/beams (bridge, oil rig, tower materials). Intermediate protection is normally not possible in urban climbing. For this reason, the risk of death when climbing more than 20 feet must be considered.

A tall urban climb is very dangerous. The climber must practice on the material he/she will actually climb and be comfortable climbing unprotected to the target height required. Military operations in urban terrain complexes and fire stations often have rated structural climbing facilities for training.

Tree Climbing

The TRAP is an aviation combat element mission similar to combat search and recovery. The main difference is the recovery of aircraft and the possible use of ground forces. As such, the TRAP force is responsible for expeditiously providing recovery and repatriation of friendly aircrews and personnel from a wide range of political environments and threat levels. Additionally, equipment will be recovered or destroyed, depending on the threat and the condition of the downed aircraft. For an assault climber, the TRAP mission may require a lead climber to climb a tree and retrieve a pilot/victim who is unconscious/disabled. To accomplish the mission, excellent rope system skills will be necessary. The amount and variety of the equipment needed is situational. As a general rule, the following equipment is sufficient for most missions:

- Harness or sling rope.
- Static rope 165 to 300 feet long.
- Ten aluminum nonlocking carabiners.
- Six locking carabiners.
- Fifteen assorted runners (the longer the better).

Optional equipment includes—

- One pair of mechanical ascenders.
- Two pulleys.
- One set of gaffs and strap.
- One line launcher.
- Pitons with a hammer.

Ascending Techniques

Before executing a TRAP, a method of retrieval should be tentatively planned. There are four tree-climbing techniques, which depend on the situation and equipment available, discussed in the following subparagraphs. All require both the number 1 and the number 2 climbers to tie into the end of the rope. The number 2 will establish an anchor and belay system.

Gaffs and Strap/Crampons Method

Using gaffs and strap/crampons is the fastest and easiest means of ascending a tree. By using the strap, the climber eliminates the need to place protection. The use of gaffs/crampons provides quick and easy footholds for ascending even the tallest of trees.

> *Note: Marines must be "pole climber" certified by the field wireman's course to use gaffs and strap.*

Girth Hitch Method

The girth hitch method is tiring and slow, but very safe. The steps to perform it are—

- Girth hitch two runners around a tree. These runners should be long enough to create about a 3- to 4-foot loop for one boot.
- Attach the top runner to the climber's harness with a locking carabiner.
- Grip the tree and stand up in the loop of the bottom girth hitch.

- Slide the top girth hitch up as high as possible and hang from it.
- Grab the bottom girth hitch and move it as high as possible.
- Insert your foot and stand up again.
- Repeat this process until the desired height is gained.
- Bypass branches encountered along the way by having a third runner to attach above the tree limb.
- Place a girth hitch with the third runner and attach it to the harness.
- Slide the bottom runner up as far as possible and then stand in order to slide the top runner up and bypass the tree limb.

Monkey Method

The monkey method depends on the size and type of tree being climbed. Smaller diameter trees with many branches are optimal. The lead climber free climbs the tree using branches and shimmying up the trunk.

Party Climb Method

The party climb method is similar to that of the monkey method with the exception that the lead climber will place pitons in the tree or girth hitch runners around branches for protection. The climber will clip into these pieces of protection as discussed in chapter 6.

Jumar Climbing Techniques

In order to jumar or "rope walk" to the pilot, it is necessary to first establish a rope above the pilot. The use of a line launcher or 550 cord around a canteen will aid in getting the rope up the tree (Marines will most likely use 550 cord). To construct the jumar—

- Attach the 550 cord to a half-full canteen or heavy carabiners.
- Throw it over the desired branch to loop it around.
- Tie the climbing rope to the 550 cord and pull the other end of the 550 cord up and around the tree branch until both ends are on the ground.

There are four methods that can be used to jumar up the rope to the pilot—body thrusting, foot locking, kick, and haul.

Body Thrusting

This method is very tiresome, but requires little gear. It is constructed using the following steps:

- Tie a retrace figure-8 to the harness.
- Tie a friction knot (Bachman or prusik) with the running end onto that line.
- Attach the friction knot to the retrace figure-8.
- Ascend the tree by pulling down on the free rope. With a free hand move the friction knot up the rope (to prevent a long fall).

Foot Locking

This method, though also tiresome, requires little gear. The climber will attach a prusik knot to the two ropes hanging down from the tree and attach it to his/her harness. Then, hand-over-hand, he/she makes his/her way up using his/her feet to bend and lock the rope in place to aid in ascending the rope. To get down, the climber will follow the aforementioned steps in reverse or rappel.

Jumar/Texas Kick

This method is the easiest, but requires the most gear. The climber attaches one end of the rope to his/her harness using a figure-8 with a carabiner clipped into hard point. Next, the climber will attach a foot jumar and a chest jumar or a waist prusik and foot stirrup (as discussed in chapter 11) to the opposite rope into which the climber is tied. The climber will then slide the top jumar (waist prusik) as high as possible and then slide the foot jumar up and stand, unweighting the top jumar so it can be moved up higher. This process will repeat until the climber has reached the desired height. Military aid climbing is further discussed in chapter 7.

Haul System

The haul system is the most desired method and requires very little gear. Once the rope is looped around a tree limb, the climber ties into one end of it and a mule team hoists him/her up to the desired height.

Note: Since all of these techniques require the rope to run in the crotch of a tree branch and the trunk of the tree, rope wear should be considered because of the friction that occurs when ascending.

Lowering Techniques

There are many methods to lower a victim from a tree. An experienced mountain leader should be able to use his/her rope skills to adapt to any situation. Two recommended methods for lowering a pilot from a tree are the single and double tree methods.

Single Tree Method

The single tree method should be used if the pilot is found within arm's reach of the trunk of the tree. Once the climber has ascended the tree to the appropriate height, he/she must then anchor themself slightly above the pilot. Quad hitching or girth hitching a runner to the tree and hanging from it is sufficient. The climber must then construct a secondary anchor to lower the pilot, which can be accomplished in the same manner with girth hitches.

He/She then does one of two things: if no second rope is available, he/she will untie from his/her rope (making sure that he/she is safely tied off first) and run it through the anchor for lowering the pilot; if a second rope is available, he/she stays tied in for safety and uses a separate rope for the pilot. Once the rope is fed through the anchor for lowering, a figure-8 is tied into one end and a locking carabiner will be attached. If the pilot is conscious, the climber lowers the carabiner. The pilot connects it to the D-rings located on the front of his/her harness. In the event the pilot is unconscious, the climber lowers themself to the pilot and attaches the rope to him/her. If the D-rings cannot be accessed, then the climber must quad hitch a runner through the shoulder portion of the pilot's harness and attach to the rope with a locking carabiner. At this point, all is ready to release the pilot from his/her parachute.

The climber then double checks his/her system, ensuring all slack is out of the system and a belay is on. It is critical to ensure that the pilot is safe before releasing his/her parachute. After double-checking everything, the climber reaches down to the pilot and pulls the cable-loop type canopy releases located on the shoulder portion of the pilot's harness. The climber should be ready for the slight shock load onto the rope caused by the release. After the pilot is free, the climber and belay person slowly lower him/her to the ground.

Double Tree Method

The double tree method is used if the pilot is suspended between two trees out of reach from the tree trunk. One climber is needed for each of the trees between which the pilot is suspended.

Once the climbers have ascended their trees, they need to position themselves at equal height above the pilot. Climber A creates an anchor knot with a static rope. Climber B creates a swami wrap with practice coils or sling ropes. Climber A will throw the running end of the static rope to Climber B, who then pulls out all of the slack and attaches the rope to the tree with a munter hitch.

With Climber B on belay, Climber A attaches a carabiner to the rope and then to his/her hard point. At this point, Climber A will slide out until he/she is above the pilot. Climber B lowers Climber A until he/she is suspended level with the pilot. Climber A attaches a prusik knot in between himself/herself and Climber B on the rope. Climber A then attaches the pilot to the end of the prusik knot. At this point, Climber A must double check the system, ensuring the pilot is securely attached to the static rope and that Climber B is on belay and ready to lower them both.

Climber A reaches down to the pilot and pulls the canopy releases located on the shoulder portion of the pilot's harness. Like with the single tree method, he/she must be ready for the slight shock load onto the rope caused by the release. Climber B then lowers Climber A and the pilot to the ground.

Note: These rescues are not limited to pilots since TRAP missions can be executed for any number of personnel, such as clandestine operators, aircraft crew, and anyone else who may be involved in airborne operations.

Other Considerations

A corpsman should be present to provide medical attention, if needed. A backboard and cervical collar should be ready when lowering the pilot. It is best to lower him/her directly on to the backboard or litter. If the climbers are well versed in high angle rescue systems, then the pilot can be put into the litter while still in the tree, if necessary.

The Department of Defense Form 1833 is a classified report containing key information to be used when identifying the pilot. This report is called the isolated personnel report or isoprep data. The information provided is personal and specific. Often, this information is verified before insertion. The TRAP recovery force needs it to authenticate the pilot's identity upon locating him/her.

Note: NEVER take a filled out Department of Defense Form 1833 or the data with you. Memorize it.

Fixed Ropes

Ropes and caving ladders assist heavily-laden troops ascending steep terrain. They should be used where a fall might result in injury any time a unit encounters steep, compartmentalized terrain—not just for cliff assaults. There are five types of fixed rope installations (see table 8-1 and the following subparagraphs).

Care must be taken when selecting routes that are "easy" to the assault climber or mountain leader, but very difficult to someone without climbing training. Leaders must choose a route that will allow personnel to be ready to fight upon reaching the top. The climbing unit's experience/ability and its load determine the difficulty of the route.

Simple Fixed Rope

The simple fixed rope is anchored at the top end of a rope. This type of rope installation is primarily designed to aid heavily-laden Marines in the ascent or descent of moderately steep slopes. The rope may be used as a climbing aid by pulling on it and walking the feet up the slope. Knots may be added to help on slippery or steeper sections. The entire length of the rope may be used as one section (see fig. 8-1) or divided to allow for varied terrain. Each individual section will have a

Table 8-1. Types of Fixed Rope Installations.

Type of Installation	On What Terrain is it Used	How Quickly Can it be Set Up	Number of Personnel that Can Use it at a Given Time
Simple fixed ropes	Moderate	Fast	Moderate
Semi-fixed ropes	Moderate to vertical	Moderate	Many
Fixed ropes	Moderate to steep with fall hazard	Slow	Many
Cable ladders	Vertical or slick surfaces	Slow	Few
Top ropes	Steep to vertical	Fast	Few

suitable anchor at the top with 10 feet of slack rope before running to the next section's anchor.

Advantages of Using the Simple Fixed Rope

This method is simple, fast, and easy to construct. Many Marines can climb this type of lane in a short amount of time and it requires no extra gear or time to attach each climber to the rope. It is also easily used as a hasty rappel without much modification.

Disadvantages of Using the Simple Fixed Rope

The simple fixed rope cannot be used on near vertical or steeper terrain. A major disadvantage is that, if a climber lets go of the rope, he/she may fall down the slope.

Simple Fixed Rope Construction Methods

The coiled and trail rope methods are two ways to make a simple fixed rope. The coiled rope method is the fastest and easiest of the installations and can be performed using the following steps:

- A climbing team will assemble at the bottom of its assigned climbing lane.
- The lead climber will climb the obstacle with a coiled static rope on his/her back.
- Once on top, he/she will uncoil the rope and attach it to a suitable anchor point.
- He/She will then deploy the rope down the obstacle.

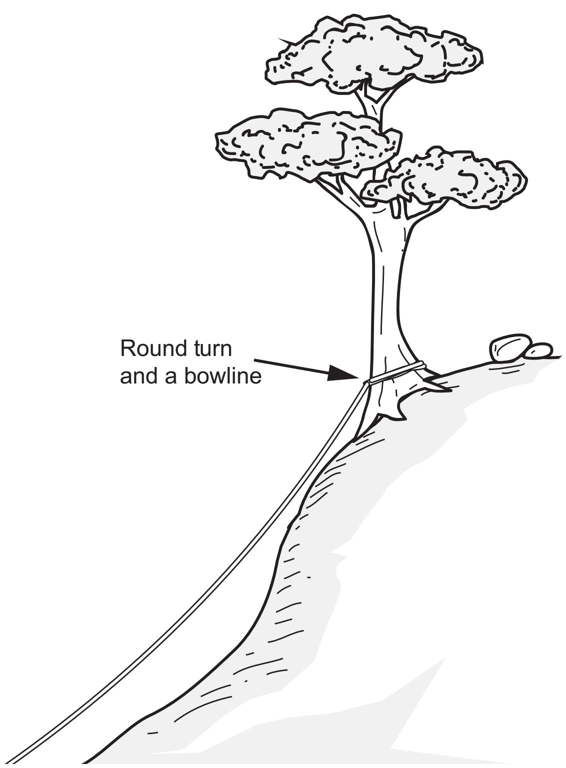

Figure 8-1. Simple Fixed Rope Installation with One Rope.

To perform the trail rope method—

- A climbing team will assemble at the bottom of their assigned climbing lane.
- The number 2 will flake a static rope while the lead climber visually inspects the designated route, prepares his/her equipment, and attaches the static rope to his/her harness.
- The lead climber will begin climbing up the obstacle while the number 2 climber ensures the rope feeds smoothly. A belay is not required because the terrain should be easy for the climbers.
- If the terrain becomes steep or wet, the number 2 should set up a belay for that section.
- The team will then set in another type of fixed lane.
- The number 2 will also hold on to the end of the rope or tie it off to an anchor near the start of the lane so that the number 1 climber will not pull up too much rope.
- It is possible to climb to the top of the obstacle and use the entire length of rope as one section; however, if the lead climber needs to vary the route he/she must set up a suitable anchor at every turn. He/She selects the anchor and pulls up most of the rope.

  Note: Do not pull until the rope is taut because there must be slack rope between each section.

- He/She will then attach the static rope with an appropriate anchor knot.

- The number 1 will continue with the route. If any section seems too steep, the number 1 will leave extra slack in the rope so the number 2 will be able to tie knots in the line.
- The number 2 climber ascends and ensures the rope is on the correct route, adding knots as needed. He/She will ensure the rope feeds smoothly at each anchor point on the route.
- Both climbers may carry extra ropes on their backs to increase the length of the lane—50-meter ropes are easier to work with than 100-meter ropes.

Ascending Simple Fixed Ropes

Ascending simple fixed ropes is accomplished using the hand-over-hand method. Gloves will not be worn during the ascent so climbers do not feel a false sense of grip on the rope. Only one Marine climbs at a time per section of rope (see fig. 8-2). If the entire rope is used as a single section, then only one climber may use the lane at a time. To climb the rope—

- Straddle the rope with your legs.
- Grip the rope palms down, thumbs toward your body, as in figure 8-3.

Figure 8-2. Multi-Section Simple Fixed.

- Walk up the slope pulling with your arms while twisting the hands downward, creating a bind between your grip and the rope and forcing a lower silhouette as you reach the top. Gripping in this manner ensures a low pull on the anchor, which is very important when anchoring in dirt.

Clearing the Lane

One key advantage to a simple fixed lane is its ability to allow troops to ascend and descend the same lane. If enough slack is available, a hasty rappel may be conducted. An assault climber should remove any directional figure-8 knots before the unit descends, while being careful about the rockfall hazard if used in areas of loose rock. If the lane is not being used for descent, an assault climber can climb the lane up or down and disassemble it. Then, it can be coiled at the top or bottom.

Semi-Fixed Rope

A semi-fixed rope is anchored at the top and bottom, but has no intermediate anchor points. This type of rope installation is designed primarily to protect personnel during the ascent or descent of steep slopes to vertical surfaces. It may be used where a simple fixed lane would be used, but it must be placed in a straight line. It is also used when ascending cable ladder lanes for safety.

Advantages of Using a Semi-Fixed Rope

Many climbers can use the lane at one time, making it fast to move through the climb. Climbers using a semi-fixed rope have the least chance of injury because of the use of the safety prusik.

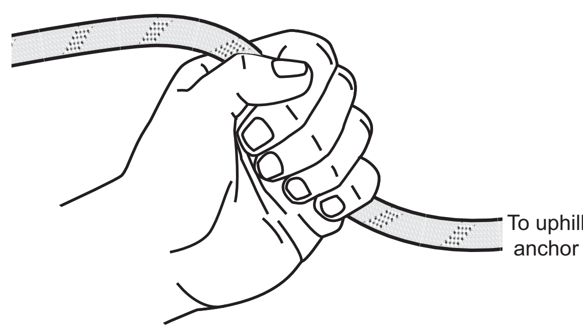

Figure 8-3. Simple Fixed Grip.

Disadvantage of Using a Semi-Fixed Rope

The route runs only in a straight line. Personnel take a longer time to load and unload this type of lane.

Methods of Constructing a Semi-Fixed Rope

This lane may be constructed in two different manners—method 1 is similar to the simple fixed lane and is constructed as follows:

- A climbing team will assemble at the bottom of its assigned climbing lane.
- The number 2 climber will flake a static rope, while the lead climber visually inspects designated route and prepares his/her equipment.
- The lead climber will attach the static rope to his/her harness. The number 2 will anchor the standing end of the rope.
- The lead climber will begin climbing up the obstacle, while the number 2 climber ensures the rope feeds smoothly. A belay is not required because the terrain should be easy for the climbers. If the terrain becomes steep or wet, the number 1 will have to switch to the second method for constructing a semi-fixed lane.
- When the number 1 climber reaches the top or the end of the rope, he/she will tie off as tight as possible. He/She may hand tighten or use a hasty 3:1 mechanical advantage.
- The number 2 will tie short prusiks onto the line using a four-finger end-of-the-line prusik knot. If the troops are heavily laden or the lines are wet, a six-finger prusik knot should be used—one for each person who intends to climb it. Prerigging the prusiks is recommended especially if the lane will be used at night.

Method 2 is the more common method, especially when using the semi-fixed lane to protect a climber on a cable ladder. Method 2 is constructed as follows:

- After ascending the obstacle by any other means, the number 1 will throw a rope down to the number 2 below.
- Both will anchor. Either one may tighten by hand or by using a hasty 3:1, ensuring the rope is next to the cable ladder.
- The number 2 will then prerig the prusik.

Ascending Semi-Fixed Ropes

Ascending a semi-fixed rope is accomplished by using the safety prusik method and performing the following steps:

- With type II cordage, a prusik knot will be tied on the static rope.
- The running end of the cordage will be attached to the climber.
- The climber will begin to climb the route, sliding his/her prusik up the rope as he/she climbs to protect themself in case of a fall.
- When he/she reaches the top, the climber will unhook from the prusik cord and leave it on the rope. The prusik cord may be used for the first person down, if required, when the unit descends.

Clearing the Lane

To clear the lane, untie the bottom and top anchors and then drop the rope. Prusik cords, if any, may remain on the line and be untied when the unit is not under tactical conditions.

Fixed Rope

A fixed rope is anchored or fixed at both ends and at intermediate anchor points. This type of rope installation is used to protect personnel who are negotiating exposed climbs of easy to moderate difficulty. Such slopes include snow/ice, difficult scrambles, traverses, or other areas where unprotected balance climbing would be very harmful.

The advantage of a fixed rope is that it protects the climber from a fall. It is useful on routes that change direction. On the other hand, the fixed rope is the most time-consuming to construct and requires more gear than other installations. It is also the slowest installation for climbers to negotiate and using it increases the chances of injury due to the increased fall factor.

Construction of a Fixed Rope

The assault climber picks a route and the climbing team sets up for a two-party climb with a static rope instead of a dynamic rope. This setup is appropriate because the climbing route is well within the climbers' abilities so a fall is not likely. In addition, the route is not vertical so a climber will likely fall on rocks, ledges, or gullies and not on the rope itself. The static line will simply keep him/her from rolling all the way down the hill.

The number 2 climber will add one extra step. He/she creates a large bight of rope with 15 to 20 feet of slack and clove hitches it to the anchor or the rope, as shown in figure 8-4. It is recommended that a rescue-8 be used for belaying because a static rope will often not fit in a standard belay plate and the climber will be climbing quickly.

The lead climber begins two-party climbing, placing protection or using natural protection where needed. Protection should be placed with every change of direction. The lead climber must always keep in mind that other less skilled climbers will be ascending this route. Factors to be considered while positioning the rope with regard to the other climbers are—

- The rope is positioned approximately waist high.
- The climbers should not be forced to cross the rope at any point once it is tightened.

Once on top, the lead climber will move further than 10 feet away from the cliff face and give the rope tug signal for OFF CLIMB. Once the number 2 is off belay, the number 1 will remove the static rope from his/her harness, pull up any remaining slack, and anchor it.

Once the number 1 is finished with his/her part of the fixed lane, he/she will prepare other lanes while the number 2 finishes the lane. The number 2 will remove the large bight he/she created when setting up the lane (see fig. 8-4) to give him/her the slack he/she needs to create the lane. Then, the number 2 will tie a short prusik knot onto the static rope. The running end of the cordage will be attached to his/her hard point with a locking carabiner.

The number 2 climber will begin to climb the route, sliding his/her prusik up the rope as he/she climbs to protect themself in case of a fall. The static rope will be secured to each piece of protection, also referred to as intermediate anchor points. The number 2 should remove any runners the lead climber placed unless he/she needs them to direct the rope, which is accomplished by tying the static rope to the piece of protection's carabiner using the slip figure-8 or clove hitch. He/She ensures that there is no slack between each intermediate anchor point.

Note: By anchoring the rope at the intermediate anchor points, each section of rope is

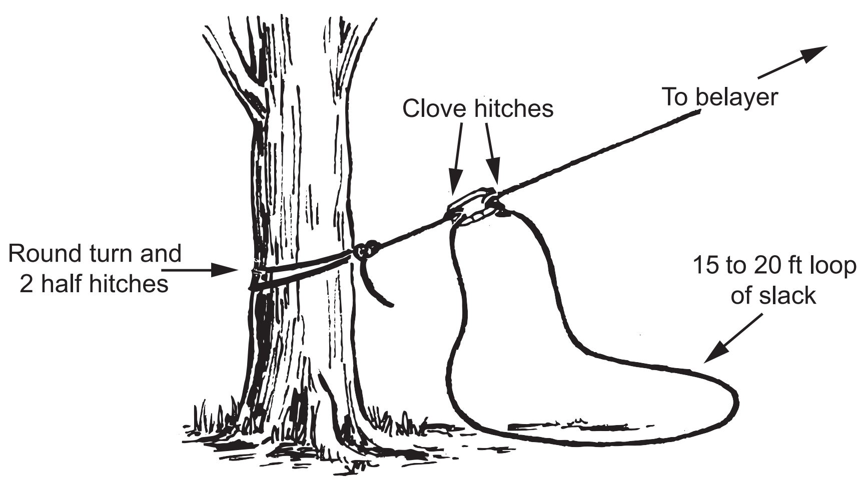

Figure 8-4. Slack for Fixed Line Bottom.

made independent of the others. Should one section fail, the other sections remain intact. All intermediate anchor point failures should be reported immediately to the installing unit and fixed promptly.

When the number 2 climber reaches the top, he/she will unhook from the prusik, remove all slack from the line, and attach it to the anchor point.

Note: If the route is more than one pitch, the same procedures will be followed with the incorporation of a multi-pitch climb. The number 2 climber will be responsible for carrying an additional static rope. When the number 2 climber reaches the lead climber's belay stance, their roles switch. The ropes will be tied to the same anchor point at the belay stance, creating a continuous lane.

Ascending Fixed Rope

Ascending a fixed rope is accomplished by using a safety line attached to the body and by performing the following steps—

- Tie a bowline around the chest using a sling rope.
- At the end of the pigtail, tie a large figure-8 loop.
- Place two locking or nonlocking carabiners into the figure-8 loop.
- At the bottom of the fixed rope installation, clip both carabiners onto the rope and begin climbing. If using locking carabiners, it is not essential to lock the carabiners.
- Upon reaching an intermediate anchor point, unclip one of the carabiners from the rope and reattach it to the rope above the anchor point. Repeat this same procedure with the second carabiner to ensure the climber is not disconnected at any time.
- Repeat this technique at each intermediate anchor until the climber tops off.
- Never allow more than one person between each intermediate anchor point.

Clearing the Lane

Four methods to clear a lane are discussed in the following subparagraphs—safety prusik from the top and bottom, rappel, and top rope methods.

Safety Prusik from the Top Method (recommended). The climber must create some slack in the lane by adjusting the top anchor point. He/She attaches a safety prusik to the rope and his/her harness with a locking carabiner and descends the fixed rope lane.

When he/she reaches an intermediate anchor point, he/she hangs on the prusik and unties the fixed rope from the protection. He/She then removes the protection, stows it, and continues to clear the entire lane in this manner.

Safety Prusik from the Bottom. The climber removes the bottom anchor to create slack and attaches themself to the rope with a safety prusik. He/She ascends the rope by sliding the safety prusik up as he/she climbs to protect themself in case of a fall.

When he/she reaches an intermediate anchor point, he/she unties the fixed rope from the protection, removes it, stows it away, and continues to clear the entire lane in this manner.

Rappel Method. The rappel method is used when clearing the route from the top. The rappel line should then be used for the unit to descend the cliff face. If a unit is not rappelling down the cliff face or this lane is not to be used for the unit, then the rappel method of clearing a fixed lane is too time consuming. To perform the rappel method—

- The climbing team establishes a standard double rope rappel line.
- The assault climber/mountain leader descends the rappel line using the first person down technique.
- When he/she reaches an intermediate anchor point, they will hang on the prusik, remove the protection, and stow it away.

- The climber will continue to clear the entire lane in this manner.
- When he/she reaches the deck, the rope may be lowered or raised.

Top Rope Method. The top rope method is used when clearing the route from the top or bottom. To perform the top rope method, the climbing team establishes a top rope. Then, one climber clears the route while the other climber belays him/her.

Cable Ladders

Cable ladders, also known as caving ladders, are used for vertical surfaces. They are anchored at the top and the bottom, but may also require intermediate anchor points. Multiple ladders may be attached together for taller obstacles. The cable ladder is constructed with stainless steel cables and aluminum crossbars, which are known as rungs. Each cable end has a steel ring (eyelet) large enough to accommodate the largest carabiner in the MACK. These rings allow cable ladders to be connected to each other. Each ladder is 30 feet long and weighs 4 pounds. A standard MACK contains 10 cable ladders (a total of 300 feet of cable ladder).

Cable ladders are the only type of installation that can be used on vertical faces. They provide hand and foot holds on surfaces that have none, regardless of how steep. The disadvantages of using cable ladders are that they are slow and noisy and there is only 30 feet per ladder.

Site Selection

When selecting a ladder site—

- There must be sound anchor points located at the top and bottom of the ladder.
- Marines must be able to anchor the ladder along the route to keep it from swaying.
- There must be suitable loading and unloading platforms.

Ladder Installation Using Natural Anchors

To build a ladder using natural anchors, Marines must perform the following steps:

- Beginning with the top of the obstacle, ensure that there are two sound anchor points—one for each eyelet.
- With one end of a sling rope/tubular nylon/ prusik cord, tie an appropriate anchor knot around a sound anchor point.
- With the other end of the cordage, tie a round turn and two half hitches onto a locking carabiner attached to the eyelet of the ladder. Use this knot because it is easy to adjust.
- Do the same to the opposite eyelet, pulling tightly enough so that there is no slack between the eyelets and the anchor points.
- Deploy the cable ladder down the obstacle.

Note: Any extra length of ladder will always be at the bottom, such as when setting up on a wall shorter than 30 feet. The bottom of the cable ladder needs to be secured; however, only anchors sufficient to hold the ladder down and keep it from swaying are required since the bottom anchors will not hold the weight of a person.

- When clipping the ladder at the bottom, clip a rung and the side cable together since the eyelets rarely line up perfectly with the bottom of the climb.
- Tie off the bottom with a round turn and two half hitches onto a carabiner because this knot is easy to adjust.
- If intermediate anchors are needed on the route of the ladder, make sure each side of the ladder has equal tension. These anchors are usually placed after the ladder's top anchors are in place. The mountain leader/assault climber climbs the ladder using the top rope from above method or the self-protecting method (discussed later in this chapter). Figure 8-5 shows a completed cable ladder installation.

Ladder Installation Using Artificial Anchors

To build a ladder using artificial anchors, Marines must perform the following steps:

- Beginning with the top of the obstacle, place two pieces of artificial protection for each eyelet of the cable ladder for a total of four pieces. Mixing natural and artificial anchors is acceptable.
- Attach a locking carabiner to each of the ladder's eyelets.
- Locate the middle of a sling rope/tubular nylon/prusik cord and tie a clove hitch.
- Clip a carabiner through the loop.
- Secure each sling rope's pigtail to its own piece of protection with a round turn and two half hitches. Use this knot because it is easy to adjust.
- Do the same to the opposite eyelet, pulling tight enough so that there is no slack between the eyelets and the anchor points.
- Deploy the cable ladder down the obstacle. The bottom and middle of the cable ladder will be secured as previously discussed in natural anchors.

Ascending the Ladder

As with fixed ropes, climbing a cable ladder requires the climber be protected while ascending. If fatigued, the climber should clip into a rung to rest, but he/she should remember that other climbers will be coming up behind soon

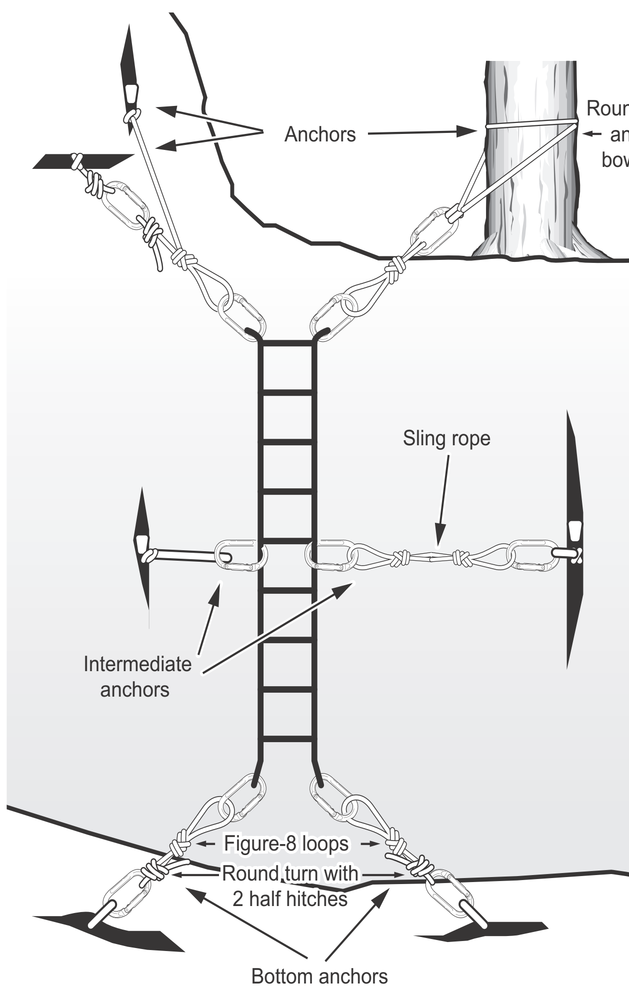

Figure 8-5. Cable Ladder.

and resting can slow an entire unit's progress. Ascen-ding the ladder can be done by one method or a combination of several:

- Climb as any other type of ladder, with both feet toes-in and both arms on the same side of the ladder. Concentrate on using leg muscles more than arms.
- Climb with one arm and one leg on each side of the ladder. Ensure that the outside foot is placed in the rung toe first while the inside boot is placed in heel first. Both arms may be on the same side of the ladder if that is more comfortable. Concentrate on using leg muscles more than arms.
- When climbing up a steep but not vertical slope, climb hand-over-hand on the rungs with the legs straddling the ladder, walking up the slope. This is similar to climbing a simple fixed rope.

Protecting the Climber

There are three methods commonly used to protect oneself while ascending a cable ladder—the top rope, safety prusik, and self-protecting methods.

The Top Rope Method. When using the top rope method, the top anchor for the top rope will be separate from the top anchor point for the ladder and set up as described earlier in this chapter. The climber will tie into an around-the-chest bowline or a bowline on a coil to the top rope. This method may be painful to the climber if the rope must stop a fall with only one line around the chest, but it *will* stop the fall—safety not comfort. It is possible to set up two top rope anchors per cable ladder.

The Safety Prusik Method. By installing a semi-fixed rope parallel and next to the ladder, the climber can use a safety prusik to ascend the cable ladder. The top anchor for the semi-fixed line will be separate from the top anchor for the ladder. The climber will already have his/her around-the-chest bowline on. He/She will clip the short prusik directly into his/her around-the-chest bowline. As he/she climbs, he/she will slide the prusik up with him/her. See figure 8-6.

Self-Protecting Method. This method is used only by assault climbers and summer mountain leaders when they need to install or check inter-mediate anchors on a ladder. The climber will tie an around-the-chest bowline with two long pig-tails. Each pigtail will have a figure-8 with a car-abiner in it.

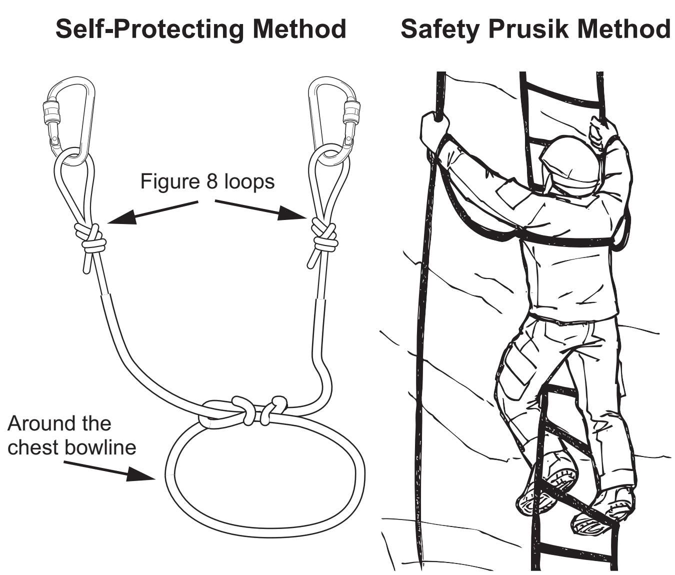

Figure 8-6. Protection Methods.

While climbing the ladder, the climber unclips one carabiner from low and places it higher, alternating carabiners as he/she goes so he/she is not completely disconnected from the ladder. He/She will clip to the cable on each side, not the rungs. In the event of a fall and a rung failure, he/she will simply slide down to the next rung. Both carabiners should not be attached above the same rung. Always alternate.

Clearing the Lane

There are three methods to clear a ladder lane—rappel, top rope, and self-protecting.

Rappel Method. This method is used when clearing the route from the top. The rappel line should then be used for the unit to descend the cliff face. If a unit is not rappelling down the cliff face or this lane is not to be used for the unit, the rappel method of clearing a ladder is too time consuming. To perform the rappel method—

- The climbing team establishes a standard double rope rappel line.
- The assault climber/mountain leader will descend the rappel line using the first person down technique.
- When he/she reaches an intermediate anchor point, he/she will hang on the prusik, remove the protection, and stow it away.
- The climber will continue to clear the entire lane in this manner.
- When he/she reaches the deck, the ladder may be lowered or raised.

Top Rope Method. This method is used when clearing the route from the top or bottom. It works best when a top rope was already in place for the unit. To set it up, the climbing team establishes a top rope and one climber clears the route while the other climber belays him/her.

Assault Climber/Summer Mountain Leader Self-Protecting Method. After climbing up or down the ladder to remove the intermediate anchors, the ladder may be raised or lowered.

Maintenance

The fixed rope is maintained by performing the following steps:

- All fixed rope installations should be buffed at points of abrasion.
- All fixed rope installation anchors should be inspected periodically for accidental dislodging, walking of cams, or improper direction of pull.
- All discrepancies should be reported immediately to the assault climbers for repair.

Cliff Assault

A cliff assault is a thoroughly planned action on a known danger area. The unit's mission is the raid beyond the vertical face and not simply climbing the vertical face. Once the commander decides to execute a cliff assault, the following factors must be considered:

- Surprise is paramount and silence must be maintained to attain surprise.
- Speed is essential and all ropes available must be used.
- The cliff head must be well organized.
- Initially, the raiding party is very vulnerable.

Reconnaissance Considerations

Reconnaissance teams should take an experienced assault climber team with them upon insertion to ensure that—

- Climbing points can be established on the vertical obstacles that are within the unit's ability.
- There are suitable top and bottom anchors.
- The team can direct assault climbers to specific routes upon arrival.

Tactical Considerations

If an enemy objective is in close proximity to a vertical face-head, it is possible that defensive forces will consider the vertical face an obstacle and focus their security to other more vulnerable areas. However, if the objective is outside small arms range from the vertical face, the enemy will likely defend it in a 360-degree fashion. If this is the case, mountain leaders have fatigued the assault unit with the climb, while not achieving the desired surprise. An objective that is near the cliff assault site offers the following advantages:

- An enemy could assume that the vertical face is impassable and that it is a protected "wall" that he/she can leave unattended, concentrating his/her defenses away from the cliff toward more likely avenues of approach.
- The cliff edge to the objective distance is within mortar range, so the assault unit does not have to expend the time and energy to haul mortars, crews, and ammunition up the vertical face to ensure fire support for their attack. Without a suitable platform, this advantage is void.
- The enemy security forces may not be comfortable looking over the edge of a vertical face under less than ideal conditions, potentially creating a gap in security that the assault unit can exploit.

Deception Plan

As part of the deception plan, the following points should be considered:

- Mask equipment and movement noise and use diversionary attacks.
- Rivers or ocean waves breaking at the base of vertical faces are common and mask the noise of a vertical assault very well.
- Weapons fire and impacts from supporting arms can also mask the noise of a vertical assault; however, it may put the enemy on alert.
- Shelling on or near enemy positions on a regular basis at the same time over a period of days may cause the enemy to become accustomed to the disturbance and be less vigilant during these times.

  Note: Do not plan to use fires on or near cliff heads because this can render the vertical faces dangerous and unstable due to loose rocks and rockfall.

- Use diversionary attacks by ground, air, or indirect fire from multiple directions.
- The vertical assault itself can be used as the diversionary attack.

Communications

Wire should be used as the primary mode of communications during a cliff assault, with radio as the alternative means, to minimize radio traffic and ensure good communications. A communication plan should be designed on standard signals according to the unit's SOP to include a few additional signals that deal specifically with the vertical assault. Key personnel should have a radio with a headset and a runner/messenger.

Fire Support Plan

The fire support plan should be developed using traditional deliberate attack parameters. When preparing a plan, consider the following:

- Using the attacking unit's organic mortars first.
- Using artillery, if in range of the vertical assault.
- Using the forward air controller for rotary and fixed-wing aircraft.
- Using naval gunfire, but be aware that it cannot hit reverse slopes.

Amphibious Considerations

When planning for amphibious cliff assaults, the following points unique to sea cliffs should be considered:

- Advance force reconnaissance operations should be employed.
- Hydrographic surveys/confirmatory beach reports should be conducted.
- All landing vehicles/crafts must be spread loaded.
- Debarkation must be done quickly.

Organization

Cliff assaults are organized in two waves. The billets, qualifications, and responsibilities of the personnel are listed in table 8-2.

First Wave

The first wave consists of 8 assault climbers, 2 mountain leaders (for a company-sized unit), platoon/unit commanders, radiomen, and cliff head security (top and bottom).

Second Wave

The second wave consists of the remainder of the task-organized units, the assault force, and the reserves. The executive officer is delegated to command the second wave; moreover, he/she will stay at the base of the vertical obstacle until the unit has negotiated the vertical face.

The amount of time the unit is stationary at the vertical obstacle should be minimized. Ideally, the main second wave should move from the boat/landing craft or rally point straight into the climbing lanes (via beach master).

Assault Climbing Techniques

The actual techniques used to negotiate personnel and equipment up the vertical obstacle may vary depending on a variety of factors, such as level of training, type of vertical obstacle to be negotiated, and/or equipment available. The following techniques or any combination of them may be used:

- Two-party climb for assault climbers, all other personnel use top rope.
- Two-party climb for assault climbers, all other personnel go up fixed rope installations.
- Two-party climb for assault climbers, all other personnel/equipment use VHL/suspension traverse.

Table 8-2. Cliff Assault Organization.

Billet	Qualifications	Responsibilities
Chief assault climber	Senior M7A mountain leader Senior assault climber	Supervision of the assault climbers
Number 1 and number 2 assault climbers	4 lead climbing teams from the assault climber's platoon	Lead climb routes and set in climbing points for the follow on force
Unit commander	Headquarters elements of the unit	Complete plan through visual reconnaissance
Control point NCO	M7A mountain leader Experienced assault climber	Organize top of obstacle, set up control features, coordinate with the cliff head officer
Cliff head officer	M7A mountain leader Experienced assault climber	Position security at bottom and top of vertical obstacle Be aware of all actions between beach master and control point
Beach master	M7A mountain leader Experienced assault climber	Same as control point NCO, but at bottom of vertical obstacle
Security teams	Security element of the unit	Provide security at bottom and top of vertical obstacle
Lane NCO	Tactical rope suspension technician or an experienced NCO	One per climbing lane, assists beach master and control point NCO in setting up control features, physically places individuals from beach master position to climbing points

Note: Within the first wave, a company-sized unit may want to designate a VHL/suspension traverse team to establish these installations on top for heavy equipment.

Assault Sequence

The assault sequence can best be understood and organized if it is broken down into five phases. Many of the actions and tasks within each phase take place simultaneously.

Phase One

Phase one begins with the arrival of the first wave at the vertical face base (see fig. 8-7) and continues with the following:

- The first wave moves into objective rally point (ORP).
- Cliff head officer (CHO) and leaders conduct reconnaissance of proposed climbs and establishes left and right lateral limits. Easiest climbing routes are selected for leaders.
- The number 2 climbers prepare gear for climbing.
- The CHO and beach master place flank securities into position.
- Climbing teams move to the designated lanes and prepare to climb.
- At least one climbing team must have a radio.
- All lead climbers should have night vision goggles.
- All lead climbers should climb with minimal gear.
- One or all of the lead climbers will carry a static rope to be used for the rope installations.
- Hardest climbs go to the best teams.
- CASEVAC plan is formulated and litters prepared.
- The area that the climbers ascend is not necessarily the only area in which climbing lanes are established. First wave must be ready to move if this is the case.

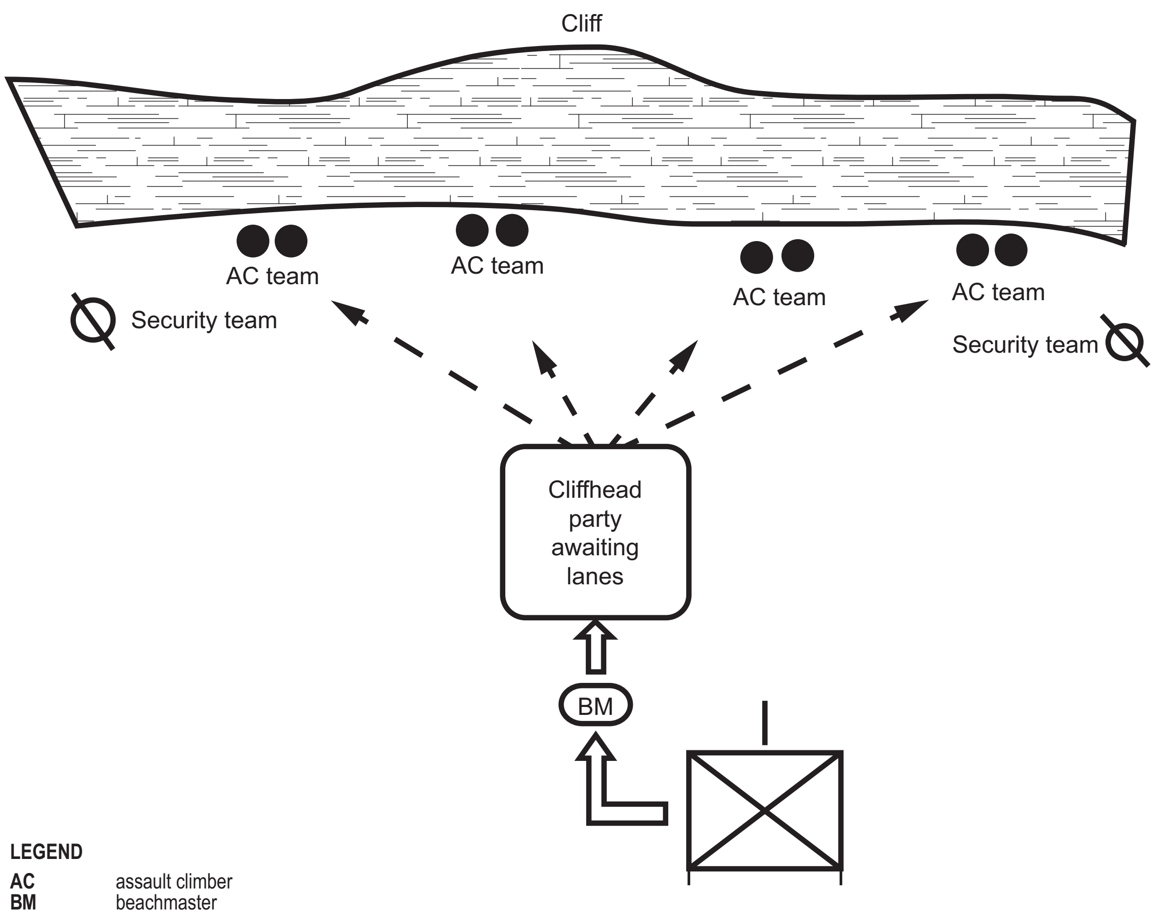

Figure 8-7. Phase One Initial Organization.

Phase Two

Phase two begins as soon as the first lead climber begins to climb (see fig. 8-8 below and fig. 8-9 on page 8-20). The first leader on top provides initial security and the following occur:

- As soon as the remainder of the leaders top out, construction of the climbing lanes begins with the radio being passed off to the security leader. The cliff head is divided into sections for easier control.
- Communication is established between the top and bottom of the vertical face. If possible, the chief assault climber should be one of the leaders and have a radio.
- Emergency rappel lanes (usually single rope rappels) are established to provide for a quick withdrawal if the mission is compromised. A 4:1 ratio is required.
- The number 2 climbers ascend with the gear needed to begin construction of climbing lanes.
- The remainder of the first wave needed on top, such as the CHO, control point noncommissioned officer (CPNCO), or security, begins to ascend as soon as a climbing lane is established. All lanes must be cleared "hot" by the CHO before they are climbed by the second wave. Security is positioned by the CHO.
- The CHO needs to ascend as soon as possible to make final decisions on the location of such things as VHLs, security, or control features.
- Assault climbers on security are relieved by designated security teams.
- Once on top, the RFC departs for the leader reconnaissance.

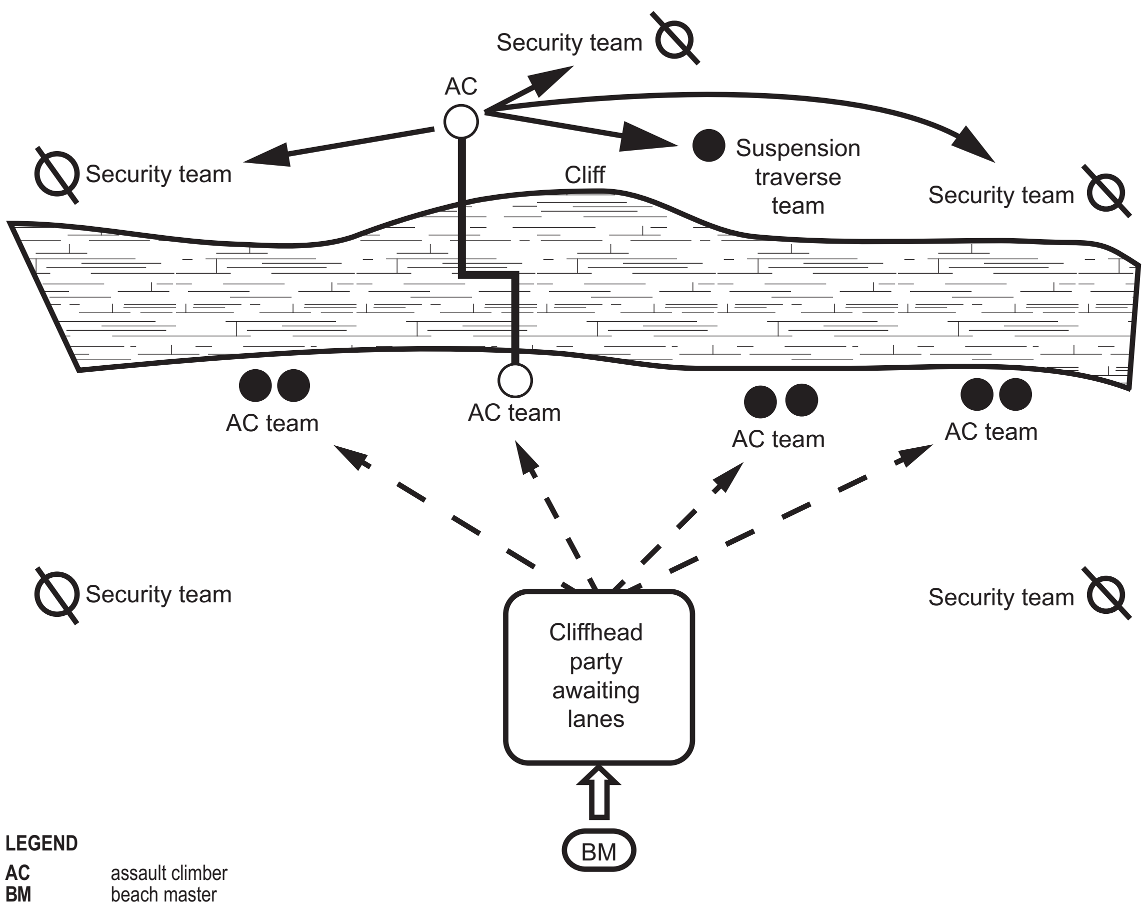

Figure 8-8. Phase Two Initial Ascent.

- The beach master begins constructing control features at the vertical face base, only when leaders have begun to construct lanes. The beach master position depends on the vegetation/terrain.
- Gear is prepared in ORP for hauling systems.
- VHL/suspension traverse is constructed. At least one assault climber must be left on the deck to aid in the construction/operation of the VHL.
- Lane NCOs move gear needed on top to the VHL and it is taken up to the vertical face head.
- The control point NCO establishes topside control features.
- A landline between the beach master and the CPNCO is established.
- Number 2 climbers climb the ladders to check for the need of intermediate anchors.
- Once the first wave is on top, the CASEVAC plan must be formulated to lower casualties, if necessary.
- The ORP may be moved closer to the vertical face base for better silence/security.

Phase Three

Phase three begins with the arrival of the second wave for its ascent of the vertical face (see fig. 8-10) and continues with the following:

- The company should establish radio contact 10 minutes prior to arriving at the cliff head.
- Second wave establishes an ORP and prepares to climb. The executive officer makes liaison with the beach master.
- The CHO is informed on the second waves' arrival and inquires of any changes in the numbers, injuries, and timeline.

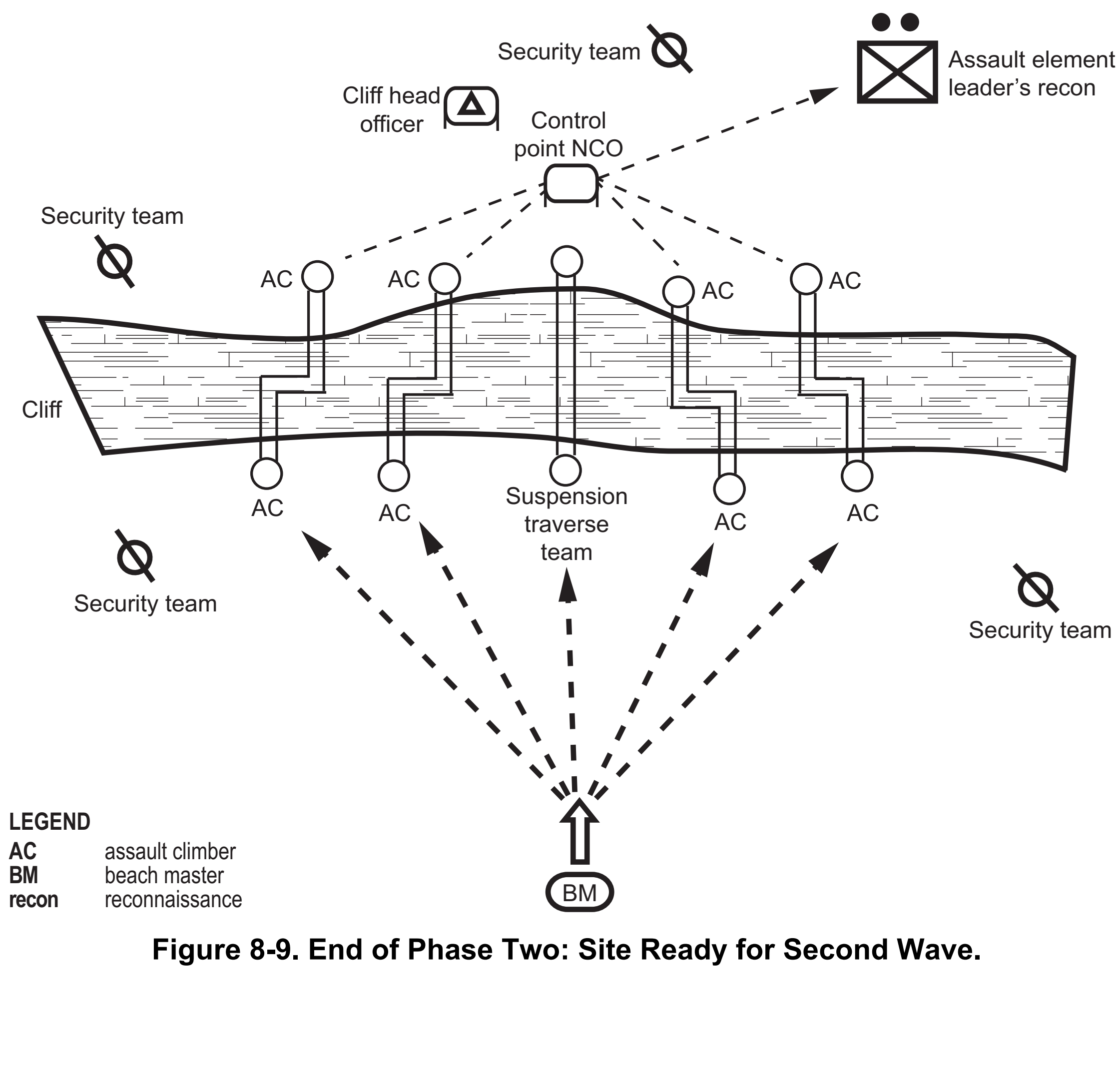

Figure 8-9. End of Phase Two: Site Ready for Second Wave.

- The company should already be broken down into climbing sticks for easier control. Each Marine is assigned an alphanumeric indicator within his/her element.
- Lane NCOs are stationed at the bottom of the lanes to assist Marines.
- Marines check in with the beach master and give their stick number. Beach master does final check for proper knots/equipment. The beach master will then direct the Marines to specific climbing lanes.
- Marines with heavy loads or crew-served weapons are directed to the VHL. These climbers are then directed to the climbing lanes closest to the VHL for easier recovery of their gear once on top.
- Once on top, all Marines follow control features to the CPNCO and give their stick numbers to him/her. The CPNCO will then direct the Marines to their new positions.
- The raid force begins to establish a 180-degree defensive perimeter and awaits the return of the RFC. There is an option to stagger the raid force by element within the control feature.
- Once all members of the second wave are on top, the executive officer ascends the vertical face.
- In the event that there are missing personnel at the top, stick numbers can be checked to

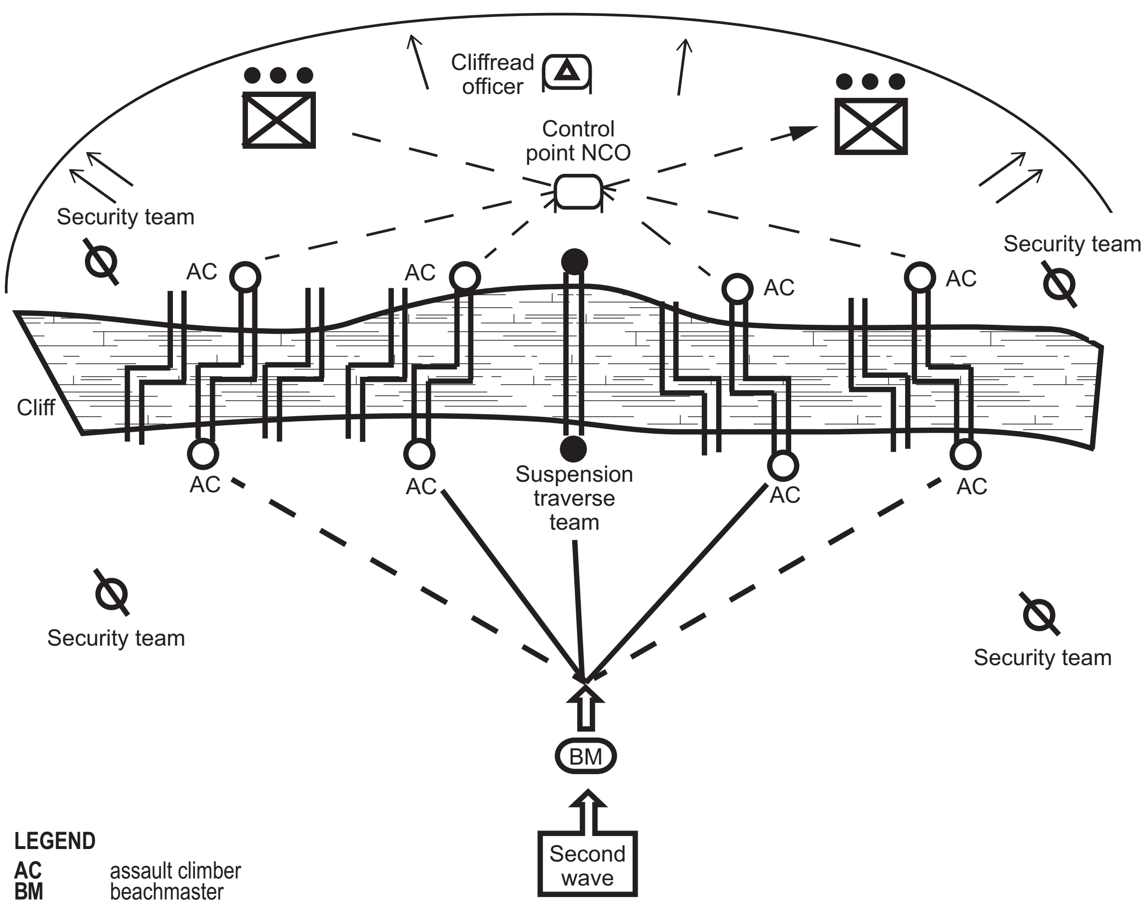

Figure 8-10. Phase Three: Second Wave Ascends.

ensure that a Marine came through the beach master and the CPNCO and that no one is still within the confines of the control features or the ORP.

- Upon his/her return, the RFC issues final orders and briefs possible shifts in his/her timelines. The raid force then moves out to its objective.
- If the raid force is not withdrawing via the vertical face, the first wave joins the second wave at the top of the vertical face and continues with the raid force. Options to the RFC are to either wait for the first wave to join the second wave and then move or to move without the first wave and link up later.

Phase Four

Phase four begins with the departure of the raid force. Approximately 15 minutes after departure of the second wave to the objective, the first wave will begin the following actions:

- The time hack is used for withdrawal if the mission is cancelled or compromised.
- The control features, top and bottom, are removed to prevent detection.
- All unnecessary equipment/personnel are moved to the vertical face base.
- Assault climbers begin to take down climbing lanes and establish retrievable rappel lanes. Belay people must be stationed at the vertical face base for the second wave.
- The VHL/suspension traverse is left in place. The systems may be slacked or A-frame collapsed to prevent detection.
- A central point for casualties and enemy prisoners of war is established and litters are prepared for possible medical evacuations.
- Personnel topside form an ORP and await arrival of the raid force.
- Personnel at the vertical face base do likewise.
- The CHO follows the progress of raid force by radio and stays aware of the situation with regard to such things as the number of casualties and enemy prisoners of war or changes in the plan.

Phase Five

Phase five is the withdrawal phase, if applicable. If the unit mission dictates a withdrawal by the cliff head, the following steps should be taken:

Note: If the unit is compromised before the mission has been completed, then the tactical situation will dictate how the withdrawal will be accomplished.

- Upon contact with the raid force confirming its return, control features are re-established at the top and bottom.
- Upon the rearrival of the raid force, raid force re-establishes a 180-degree defensive perimeter. Any casualties are moved to the vertical face head and evacuated.
- Once the order to withdraw is given, the beach master prepares to receive the descending Marines. In an amphibious operation, he/she would call the landing craft/boats at this time.
- The company executive officer is among the first to rappel down.
- A high concentration of automatic weapons and unit leaders are left on top.
- Squads thin their positions with the squad leader descending last. He/She reports his/her squad’s departure to the CPNCO.
- The unit commander descends after the main body departs.
- Once the entire second wave is down, the bulk of the first wave begins to withdraw.
- Assault climbers begin to tear down the rappel lanes and VHLs/suspension traverses. All ropes are dropped to the base of the vertical face and back stacked into rope bags. A-frame poles are lowered.
- The CHO is constantly aware of the state of the vertical face head.
- The CPNCO and beach master tear down their control features.
- Security descends the vertical face using the retrievable rappel lanes.
- Assault climbers descending with the chief assault climber and CHO are the last individual down.

- The retrievable rappel ropes are retrieved. Assault climbers account for all gear and personnel.
- Assault climbers check in with the beach master and then rejoin their units.

General Points

The following are some general considerations regarding cliff assaults:

- The first wave should precede the second wave with enough time to establish all climbing lanes and rope systems.
- Three climbing lanes per platoon should be established for the quickest ascent.
- Cable ladders should be used as much as possible for all climbing lanes.
- Communications between the CPNCO and the beach master should be by landline because it is reliable and secure.
- Communication among the CHO, chief assault climber, and assault climbers at the vertical face base should be maintained if communication assets are available.
- The planner should be aware of other options and scenarios that may arise while a unit ascends a vertical face. Cable ladders are an excellent means of ascending a vertical face, but may not always be the best method. Top ropes and fixed ropes are viable means (among others) to move up a vertical obstacle.
- Climbers could use the same route up. Instead of lead climbers climbing different routes up a vertical face, some leaders can climb up an easy route and then establish their lanes on other sections of the vertical face.
- Another scenario is one in which only a security element climbs on the established cable ladders on a true vertical face and then moves to secure the top of the vertical face where fixed ropes can be set up. This setup would allow for the remainder of the company to ascend quicker and easier.

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CHAPTER 9
SECURITY IN A MOUNTAINOUS ENVIRONMENT

Employment of Mountain Pickets

Maneuver elements should use scouts as forward reconnaissance elements. These elements should be small, light, mobile units that conduct route reconnaissance for the main body. In addition to a route reconnaissance, these elements should establish security at danger areas by securing the high ground and establishing mountain pickets.

Mountain pickets may consist of mounted elements, but they are usually dismounted. One-third of the unit may be dedicated to picketing, which is far more than normal overwatch. Use of pickets will decrease the speed at which a unit can move due to the difficulty of moving along the tops of ridgelines—a speed versus security tradeoff—but is strongly encouraged in mountainous terrain. The mountain leader should help organize and plan picket employment in order to have realistic loads (including personal protective equipment, which may be none at high altitude or for one- to two-week patrols), resupply plans (including poncho parachutes, prepacked labeled loads, and caches), routes, and duration parameters. Mountain pickets—

- Provide flank security for the main body.
- Provide surveillance of adjacent compartments.
- Provide observed fires into and across adjacent compartments.
- Serve as a relay for voice communications.
- Serve as connecting files in offensive operations.
- May be static or mobile along tops of ridgelines.
- Are normally 3- to 7-day patrols.
- Need to be in a high state of physical fitness, acclimatized, and have any specialized equipment needed to move across the specific ridge complex, such as crampons, ice axes, and ropes.

Guiding Units in Mountainous Terrain

Mountain leaders are responsible to the commander to plan and supervise the safe movement of units through class 4 and class 5 terrain, including surface coverings of rock, talus, scree, snow, ice, and glacier. The senior unit mountain leader uses all unit mountain leaders, assault climbers, tactical rope suspension technicians, and/or joint/coalition equivalents to conduct route reconnaissance, set in fixed ropes, train unit personnel to rig for the necessary movement techniques, and lead unit movement through those parts of a route that are dangerous and require technical mountaineering skills to negotiate.

Such tasks may be unnecessary in class 3 terrain or when suitable routes are available that avoid glaciers, cliffs, and all class 4 and 5 terrain. It also may be critical to mission accomplishment for a unit to use such terrain as *SLOW-GO* terrain versus *NO-GO*. The challenge of planning and guiding unit movements with limited equipment from the MACK and limited training of unit personnel should not be underestimated by the commander or senior mountain leader.

Tunnels and Caves

Tunnels and caves, such as those in Afghanistan and other mountainous areas, have historically been used as hiding places, caches for food and weapons, headquarters complexes, and protection against air strikes and artillery fire. Enemy personnel use these areas for both offensive and defensive actions.

An extensive tunnel system containing rooms for conferences, storage, and hiding as well as passages to interconnected fighting points is frequently encountered. These complexes present a formidable and dangerous obstacle to current operations, which must be dealt with in a systematic, careful, and tactical manner. Additionally, they are an outstanding source of intelligence, as evidenced by documents found in recent engagements during the clearing of tunnels.

Limestone and dolomite are natural cave-bearing rock formations. Natural caves can be augmented by additional manmade rooms and tunnels. Manmade tunnels and caves can be found in any type of rock, although sedimentary rock is easier and faster to excavate.

Tunnel Characteristics

The first characteristic of a tunnel complex is normally superb camouflage. Entrances and exits are concealed; bunkers are camouflaged; and even within the tunnel complex itself side tunnels are concealed, hidden trapdoors are prevalent, and dead-end tunnels are used to confuse the attacker. In many instances, the first indication of a tunnel complex will be fire received from a concealed bunker, which might otherwise have gone undetected. Spoil from the tunnel system is normally distributed over a wide area.

Trapdoors may be used, both at entrances and exits and inside the tunnel complex itself, to conceal side tunnels and intermediate sections of a main tunnel. In many cases, a trapdoor will lead to a short change-of-direction or change-of-level tunnel, followed by a second trapdoor, a second change of direction, and a third trapdoor opening again into the main tunnel.

There are several types of trapdoors—concrete covered by dirt, hard packed dirt reinforced by wire, or a “basin” type that consists of a frame filled with dirt. This basin type is particularly difficult to locate in that probing will not reveal the presence of the trapdoor unless the outer frame is struck by the probe. Trapdoors covering entrances/exits are generally a minimum of 100 meters apart. Booby traps may be used extensively, both inside and outside entrance/exit trapdoors.

Air shafts are usually spaced at intervals throughout a tunnel system. Recognition of their cellular nature, compartmentalized by hidden doors and passages, is important for understanding tunnel complexes. Tunnel complexes may also be interconnected with other tunnels, but concealed by trapdoors or blocked dirt passages that are up to three or four feet thick. These secret passages are usually known only to selected personnel and are used mainly in emergencies. Tunnels may also be interconnected by much longer passages through which relatively large groups of personnel may be transferred from one area to another.

Dangers

The following general categories of dangers inherent in tunnel operations should be considered by all personnel:

- The presence of mines and booby traps in the entrance/exit area.
- The presence of small but dangerous concentrations of carbon monoxide produced by burning-type smoke grenades after tunnel is smoked. (Protective masks will prevent inhalation of smoke particles, but will not protect against carbon monoxide.)
- Possible shortage of oxygen as in any confined or poorly ventilated space.
- Enemy still in the tunnel. The enemy poses a danger to friendly personnel both above and below ground, but in some instances, dogs can successfully detect enemy hiding in tunnels.

Preparation for Tunnel Clearance

A trained tunnel exploitation and denial team is essential to the expeditious and thorough clearing of enemy tunnels. Untrained personnel may miss hidden tunnel entrances and caches, take unnecessary casualties from concealed mines and booby traps, and may not adequately deny the tunnel to future enemy use. Each unit should designate tunnel teams. Tunnel teams should be trained, equipped, and maintained in a ready status to provide immediate expert assistance when tunnels are discovered. Careful mapping of a tunnel complex may reveal other hidden entrances as well as the location of adjacent tunnel complexes and underground defensive systems. Small caliber pistols or pistols with silencers are the weapons of choice in tunnels, since large caliber weapons without silencers may collapse sections of the tunnel when fired and/or damage eardrums.

Personnel exploring large tunnel complexes should carry a colored smoke grenade to mark the location of additional entrances as they are found. In mountainous desert areas, it is often difficult to locate the position of these entrances without smoke. Two- and three-person teams should enter tunnels for mutual support, since claustrophobia and panic could well cause the failure of the team's mission or the death of its members. Constant communication between the tunnel and the surface is essential to facilitate tunnel mapping and exploitation. A representative equipment list for a tunnel team includes—

- Protective mask—one per individual.
- Portable blower—one each.
- TA-1 telephone—two each.
- M7A2 CS grenades—twelve each.
- One-half mile field wire on doughnut roll.
- Powdered CS-1—as required.
- Compass—two each.
- Colored smoke grenades—four each.
- Sealed beam 12-volt flashlight—two each.
- Insect repellent and spray—four cans.
- Small caliber pistol—two each.
- Entrenching tool—two each.
- Probing rods—12 inches and 36 inches.
- Cargo packs on pack board—three each.
- Bayonet—two each.

Tunnel Exploitation and Destruction Technique

Tunnels are used extensively and frequently by enemy personnel and pose a huge threat to friendly forces. In addition, they are often outstanding sources of intelligence and should, therefore, be exploited to the maximum extent practical. Since tunnel complexes are carefully concealed and camouflaged, search and destroy operations must provide adequate time for a thorough search of an area to locate all tunnels. The use of local nationals and host nation scouts can be of great assistance in locating caves, tunnels, defensive positions, and likely ambush sites.

Caves trenches, spider holes, and tunnels are well incorporated into the mountain terrain and enemy operations and may even be used as a deception to draw friendly forces into the area for offensive operations, to include booby traps and ambushes. The connectivity of these systems often allows the enemy to move unnoticed from one area to another, eluding friendly forces.

Complete exploitation and destruction of tunnel complexes is very time consuming and operational plans must be made accordingly to ensure success. The presence of a tunnel complex within or near an area of operations poses a continuing threat to all personnel in the area and no area containing tunnel complexes should ever be considered completely cleared.

The following technique is an example of tunnel clearing and exploitation operations:

- The area in the immediate vicinity of the tunnels should be secured and defended by a 360-degree perimeter to protect the tunnel team.
- The entrance to the tunnel is then carefully examined for mines and booby traps.
- Two members of the team enter the tunnel with wire communications to the surface. The team works its way through the tunnel, probing with bayonets for booby traps and mines and looking for hidden entrances, food and arms caches, water locks, and air vents.

- As the team moves through the tunnel, compass headings and distances traversed are called to the surface.
- A team member at the surface maps the tunnel as exploitation progresses.
- Captured arms and intelligence documents are secured and retrieved for destruction or analysis.
- Upon completion of exploitation, cratering charges or other available explosives are placed at all known tunnel entrances to seal each one and prevent reuse by the enemy. If time or materials are not available for immediate closure, CS-1 riot control agent can be placed at intervals down the tunnel at sharp turns and intersections. It must be emphasized, however, that the denial achieved by the use of CS-1 is limited in duration and only used until demolitions are available to completely destroy the complex.

Tunnel Flushing and Denial

In some areas, the combat situation will permit only a hasty search for hidden tunnel entrances, but lack of time or enemy occupation will not permit a thorough search by a tunnel team. In this case, a portable blower may be employed to flush the enemy from the tunnels, using burning-type CS-1 riot control agent grenades (M7A2). In addition, the smoke from the grenades will, in most cases, assist in locating hidden entrances and air vents. After flushing with CS grenades, powdered CS-1 can be blown into tunnel entrances with the blower to deny the tunnel to the enemy for a limited period of time. This method will only be effective up to the first "firewall."

CHAPTER 10
ALPINE EQUIPMENT AND MOVEMENT TECHNIQUES

Movement through alpine terrain will encounter all mountaineering challenges on rock, snow, and ice. Transitions among various equipment and skill sets are necessary. The mountain leader will be critical in macro and micro terrain route selection because there are numerous hazards to identify and avoid. Military operations in a high altitude, alpine environment are among the most difficult. The conflict between Pakistan and India in the Kashmir province on the Siachen Glacier provides excellent examples of the high rate of environmental casualties that may occur in alpine terrain.

Snow and Ice Equipment

A wide variety of specialized equipment is located in the MACK glacier module. Summer mountain leaders are trained in the use of this equipment and are required to outfit and train the unit in snow and ice equipment use.

Ice Axes

Various types of axes correspond to the different types of climbing. The longer walking axe is the preferred tool when alpine climbing or for moving across glaciated terrain. The shorter technical axe, which has a "hooked in" shaft, is ideal for vertical ice.

Nomenclature

Regardless of the type of axe the nomenclature will remain the same (see fig. 10-1):

- *Pick*. The pick is curved so that it follows the natural swing of the arm when in use on steep ice. The teeth on the underside prevent it from slipping out of the ice.

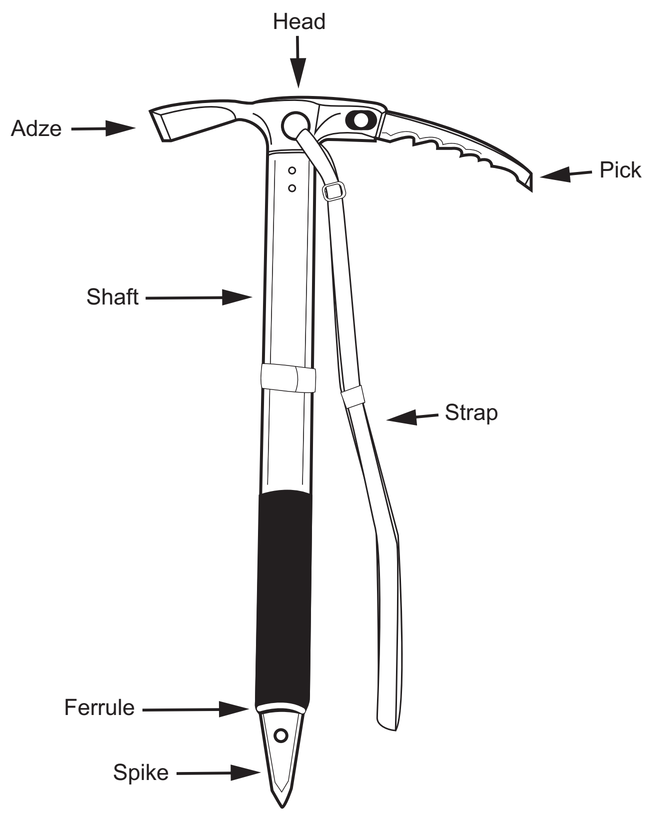

Figure 10-1. Nomenclature of the Ice Axe.

- *Adze*. This blade forms a right angle to the shaft. It is used in softer snow and for cutting steps.
- *Head*. The head is the top part of the axe that holds the adze and pick to the shaft. Some axes have an eyelet where the leash may be attached.
- *Shaft*. The shaft is the handle of the axe; its length varies from 40 to 90 centimeters. The shaft is oval, which enables the climber to achieve a solid grip and aids in directing the axe when placing it in the ice. The shaft should be rough to ensure that a good grip is maintained. If necessary, Marines can tape the shaft with surgical tape. It can be constructed from wood, metal, or fiberglass.

- *Ferrule*. The ferrule is the point just above the spike. On some axes, it is a separate band of metal.
- *Spike*. The spike is the point of the axe located at the base.

Ice Axe Leashes

The purpose of an ice axe leash—a long sling (also known as an umbilical cord)—is to act as a dummy cord or to provide support to a climber who is negotiating high angle ice. The leash can be attached from the head of the axe to a climber's harness. The leash is designed for easier/faster exchange of the axe between hands while traversing.

A wrist loop can be tied to the eyelet of the axe, using one-inch nylon tubular webbing. With a wrist loop, the climber does not have to grip the shaft as tightly, reducing the chance of cutting off circulation that may result in frostbite. To provide better stability, the wrist loop can be tied to the shaft or even wrapped around it. A sliding wrist loop attaches to the shaft of the axe with a metal ring and stopper screw. The metal ring allows movement up/down the length of the shaft, enabling quick adjustments. The stopper screw in the shaft prevents the metal ring from becoming detached from the axe. There are holsters available for the ice axe; however, these should only be used by experienced mountain leaders.

Care and Maintenance of the Ice Axe

Caring for and maintaining the ice axe involves—

- Checking the shaft for splits or cracks.
- Inspecting the leash and its knots for cuts or abrasions.
- Ensuring that the pick and adze are sharp.

Note: Do not use electrical grinders to sharpen the pick or the adze as they may remove the temper of the metal and greatly weaken the tool. The pick should be sharpened from the sides toward the tip with a file held at 20 degrees. The adze should be sharpened from the underside only. The spike should never be sharpened. Rubber protectors should be placed on the pick and the spike when not in use to prevent unnecessary damage.

Ice Hammers

Ice hammers are similar to an ice axe except that a hammer replaces the adze. They are used to drive in snow pickets and ice pitons. They differ in length, depending on their intended use.

Crampons

Crampons are attached to the boots to provide traction while traveling on crusted snow/ice. Each crampon has 12 points, with two projecting front points for climbing very steep snow or ice. Crampons are adjustable and should always be fitted to a full shank boot. There are two types of crampons—flexible and rigid.

Flexible Crampons

Flexible crampons have a toe section and a heel section, which are attached by an adjustable bar that can be extended or retracted to accommodate a boot size. The adjustment bar may have to be sawed to a shorter length to adjust for an extremely small boot size. See figure 10-2.

To adjust a flexible crampon—

- Place boot on the crampon and, with a screwdriver, loosen the flexible adjustment bar.
- Slide the heel piece from the toe piece until the desired length is achieved.

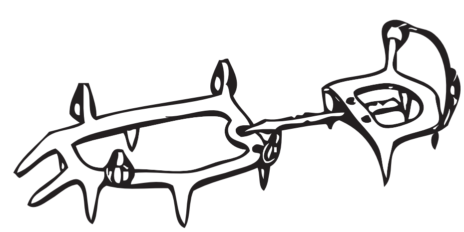

Figure 10-2. Flexible Crampon.

- Place the heel of the boot on the crampon so that the toe of the boot covers the two front points, leaving one-half to three-quarters of an inch of the front points exposed.
- With an allen wrench, make width adjustments by taking out the screws on the toe piece and heel piece.
- Slide the pieces in or out until the sole of the boot is snug.
- Line up the holes for the screws and tighten them. The boot should stay in the crampon without leather straps. The crampon is now ready to strap in a boot (see figure 10-3).

Rigid Crampons

Rigid crampons either come in two or four sections, depending on the manufacturer. Unlike flexible crampons, rigid crampons have a left and a right crampon—one for each foot. Adjustments are made by removing the screws to extend or retract the sections. See figure 10-4.

Rigid crampons are fitted to a full shank boot. The heel strap must be long enough to go around the ankle once and the toe strap must be secured so that it does not slip over the toe of the boot.

Figure 10-3. Flexible Crampon on Boot.

Care and Maintenance of Crampons

Caring for and maintaining crampons involves—

- Keeping the front points sharp. Using crampons on ice can dull and wear down the points. Careful hand filing will sharpen the crampons and reduce the possibility of a slip or fall. Lightly file down the top of the front points. File down on the other points from the rear only. Do not use power tools to sharpen crampons as this may cause the metal to weaken.
- Checking adjusting nuts frequently and retightening them as necessary.
- Checking all rivets, straps, and buckles and replacing or repairing as necessary.
- Taping a piece of plastic to the underside of the crampon to help prevent snow buildup.
- Avoiding unnecessary damage to the crampons, such as by covering the points or placing them inside the pack.
- Carrying a crampon repair kit in case of emergency. The repair kit should have the following items:
  - Allen wrench.
  - Screwdriver.
  - Heavy gauge wire.
  - Pliers.
  - File.
  - Spare straps, nuts, and bolts.

Snow Protection

The Marine Corps uses snow pickets for snow protection. Snow pickets are made of aluminum and come in various styles and sizes, such as snow stakes and coyotes.

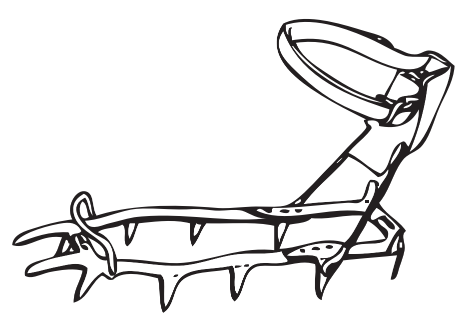

Figure 10-4. Rigid Crampon.

Snow stakes can be V- or T-shaped and 24 to 36 inches long. They have a hole at the top and are pointed at the bottom. See figure 10-5.

Figure 10-5. Snow Stake.

Coyotes are T-shaped and 18 to 36 inches long. They have holes throughout their construction and the same angle on both ends. See figure 10-6.

Figure 10-6. Coyote.

Snow pickets should be checked for fractures and obvious deformities. Since the tops of the stakes may become smashed or splintered due to hammering, they should be taped to prevent the stakes from snagging on gear.

Ice Protection

There are two types of artificial ice protection—ice pitons and ice screws. Ice pitons are constructed from steel or a metal alloy and come in various sizes. All ice pitons are hammered in, but, depending on the type, they are either pried or screwed out. The spectre ice piton is hammered in and pried out and is hook-shaped with teeth. The snarg is hammered in and screwed out. It is tubular in shape with a flanged top and an open slot on its side.

To check the serviceability of pitons, Marines must—

- Check the shaft for fractures and visible signs of obvious deformities.
- Inspect the threads to ensure they are not stripped.
- Keep the points of the pitons sharp.

Ice screws are constructed from a metal alloy or titanium, are tube-shaped, and come in various lengths from 4 to 7 inches. Most types include a protective plastic cover. Ice screws have teeth on the bottom, which makes starting the screw quicker. They also have a built-in ratchet for easier placement and a hollow design to minimize fracturing of the ice. See figure 10-7.

To check the serviceability of ice screws, Marines must—

- Check the shaft for fractures and visible signs of obvious deformities.
- Inspect the threads to ensure they are not stripped.

Figure 10-7. Ice Screw.

- Keep the teeth of the screw protected and sharp.
- Inspect the ratchet to ensure that it functions properly.

Techniques for Using Crampons and Ice Axes

Crampon Techniques

When the snow becomes so hard that it becomes difficult to kick steps, Marines must either cut them or put on crampons. Crampons normally come with 12 points (two of which are front points) to provide traction on snow- or ice-covered terrain. When walking with crampons on, the same fundamentals are used as in mountain walking, except that when a leg is advanced it is swung in an outboard motion to prevent the crampons from snagging on each other or on clothes. Crampons should be attached to the boot while on safe terrain. When using crampons, it is important to maximize the number of points in direct contact with the surface of the snow or ice for maximum traction. There are three basic crampon techniques—

- *The French technique*. Also known as flat footing, this technique is performed by keeping the feet flat against the surface at all times, which keeps all the points of the crampon in contact with the surface.
- *The German technique*. Also known as front pointing, this technique is performed by using the forward points of the crampon.
- *The American technique*. This technique is a combination of both flat footing and front pointing.

All of the snow and ice techniques apply to steep earth climbing. Marines should avoid using new snow and ice equipment in the dirt because it will dull the points; older snow and ice equipment is perfect for earth climbing. After using snow/ice items for steep earth, they must be sharpened by a mountain leader prior to storage.

The French Technique

The French technique is the easiest and most efficient method of climbing gentle to steep ice/hard snow. Good French technique demands balance, rhythm, and the confident use of the crampons and axe. Instead of edging the feet as one would without crampons, the ankles should roll out from the slope so that the soles of the boots lie at the same angle as the slope and all 10 points are able to bite (see fig. 10-8). There are three basic foot positions in the French technique:

- Marching is performed by walking flat-footed in any direction on gentle slopes of 0 to 15 degrees.
- Duck walking is performed by walking with the feet splayed out and standing back so the body weight is over the crampons. This technique is used on gentle slopes of 15 to 30 degrees.
- Flat footing is performed by keeping full sole contact with the surface on moderate to steep slopes of 30 to 45 degrees.

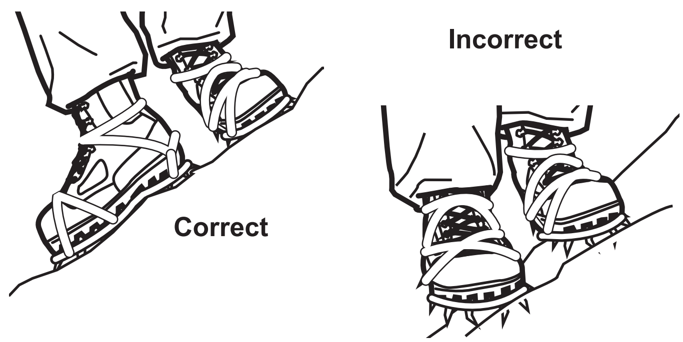

Figure 10-8. French Technique.

The German Technique

The German technique is much like step kicking straight up a snow slope, but, instead of kicking the boot into the snow, climbers kick the front crampon points into the ice and step directly up on them. The German technique is best performed on ice from 45 degrees to vertical. Factors to be considered are—

- The boot is placed rather than kicked because a sharp blow may result in a rebound vibration or in shattering the ice.
- The best placement of the crampon is straight into the ice, avoiding splaying the feet as that

tends to rotate the outside front points out of the ice. See figure 10-9.
- Boot heels need to be just above the horizontal. Resist the temptation to raise the heels higher as this will only bring the rear two stabilizing points out of the ice, endangering placement of the front points and tiring the calf muscles.
- Heels will normally feel lower than what they are. If they do feel low, then they are likely in the correct position— especially important when coming over the top of steep ice onto gentler terrain, where the natural tendency is to raise the heels.

Figure 10-9. German Technique.

The American Technique

The American technique is a combination of the French and German techniques. One foot is placed flat on the snow/ice using all points, while the other foot only uses the front points. This technique can be used on snow/ice ranging from steep to extremely steep slopes of 55 degrees and steeper. It has the advantage of allowing the leg muscles to relax by alternating the techniques and is a useful rest position while front pointing. See figure 10-10.

Figure 10-10. American Technique.

Descending with Crampons

As with ascending a slope, the descent technique is determined mainly by the hardness of the surface and the slope angle. In soft snow on a moderate slope, the plunge step can be used. On harder snow or ice, Marines could face outward and walk down. Climbers should not hesitate to set up a rappel if the slope is too steep (snow and ice anchors are discussed later in this chapter).

The plunge step is a confident, aggressive move. When descending—

- Face outward and step assertively away from the slope, landing solidly on the heel with the ankle rigid and leg vertical and transferring the weight solidly to the new position.
- Avoid leaning back into the slope, which can result in a glancing blow step and an unplanned glissade.
- Keep the knees bent a bit to maintain control of balance.

To descend gentle sloping ice/hard snow—

- Face directly downhill with the knees slightly bent.
- Walk downward, ensuring that all crampon points are in contact with the surface.
- As the descent angle increases, bend the knees more and spread them apart, ensuring the body's weight is center mast.

Ice Axe Techniques

The ice axe is the fundamental tool used to cross alpine terrain. It is versatile, being used to cut steps, provide balance, as a third point of contact, to arrest falls/slides, and as an anchor. It can be carried on the outside of the pack (some packs have loops provided). The head of the axe should be down, pick inboard, with the spike extending up. Covers should be used on the spike and the pick to prevent them from ripping any pack material or clothing.

Ice axes can be placed through a carabiner that is attached to the waist strap of the pack or equipment loop on the climbing harness. The adze should be forward with the pick to the rear and the spike facing down. In this position, it is readily available for use, as it can be stowed and retrieved quickly by sliding it diagonally between the back and pack. The spike of the axe should be placed down with the pick located between the two shoulder straps. To avoid chances of a runaway axe, it should be removed before taking off the pack. See figure 10-11.

Figure 10-11. Axe Stowage.

The axe/hammer can be carried in hip holsters that are attached to the waist harness. Axes carried in holsters should always be clipped into an equipment loop with a carabiner to retain them. An equipment loop on the harness should never be used as a holster.

Grasping the Axe

How one holds the head of the axe when climbing depends on the climbing situation. There are two basic ways to grasp the axe (see fig. 10-12)—the self-arrest grasp and the self-belay grasp. For the self-arrest grasp, the thumb is placed under the adze and the palm and fingers go over the pick, near the shaft. While climbing, the adze points forward. Because a climber can get into the arrest position quickly, this grasp is preferred when a fall is probable or when climbers are inexperienced.

For the self-belay grasp, the palm sits on top of the adze and the thumb and index finger drop under the pick. During the climb, the pick faces forward. This grasp is comfortable because the palm rides firmly on the adze. It is preferred when falling is improbable. As climbers gain

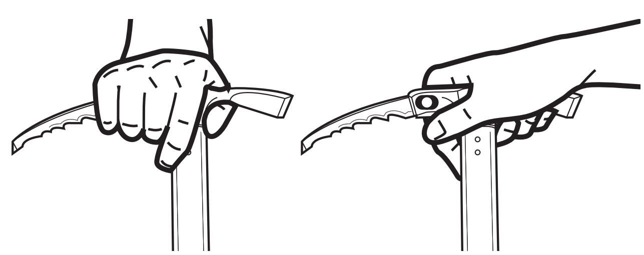

Figure 10-12. Axe Grasps.

more experience, this grasp becomes preferred because it allows a better, more balanced platform to prevent a fall, but requires a reflexive grip change to self arrest.

Climbing in Balance

While ascending slopes, climbers must try to stay in balance as much as possible, avoiding any prolonged stance in an unbalanced position. When in an unbalanced position, the ice axe can act as a supporting device. The ice axe is helpful when moving diagonally uphill or changing direction.

Diagonal Uphill Movement. On a diagonal uphill route, the most balanced position is with the inside (uphill) foot in front of and above the trailing outside (downhill) leg. The downhill leg bears most of the weight in this position and should be fully extended to make use of the skeleton and minimize muscular effort. The ice axe is always gripped with the uphill hand. The diagonal ascent, shown in figure 10-13, is performed in the following manner:

- From the in-balance position, place the axe above and ahead into the snow.
- The first step brings the outside (downhill) foot in front of the inside (uphill foot), putting the climber out of balance.
- The second step brings the inside foot up from behind and places it beyond the outside foot, putting the climber back in the balance position.
- The climber must be back in the balance position before repositioning the ice axe.
- Weight should always remain centered over the feet. Leaning into the slope should be avoided.

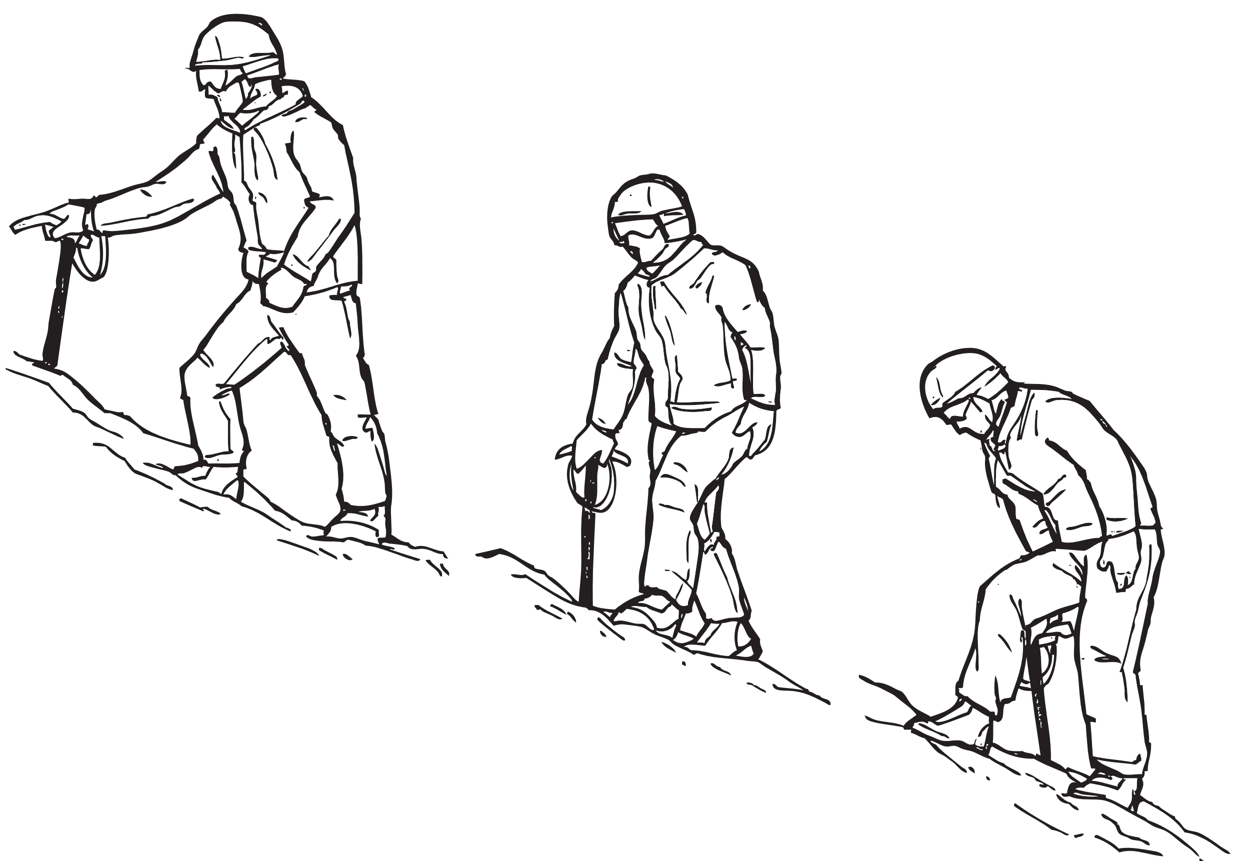

Figure 10-13. Uphill Diagonal Movement.

Changing Direction. The following steps should be performed to remain in balance while changing direction on a diagonal ascent:

- Place axe shaft directly uphill of center mass.
- Face uphill with feet splayed.
- Change axe leash to other wrist, if required.
- Turn in the new direction of travel. See figure 10-14.

Use of the Ice Axe

Using the ice axe while moving over snow- or ice-covered terrain will provide a third (and sometimes a fourth) point of contact with the surface. Depending on whether the climber is ascending or descending and the angle of the slope, the axe or axes are used in various ways, which are discussed in the following subparagraphs. Regardless of the method used, the ice axe or hammer should be secured to the climber by a leash.

Cane Position. Also known as the support position, the cane position is used on slopes of moderate angles of 35 degrees or less. While ascending, the axe is carried in the uphill hand with the hand grasping the head and the pick facing to the front or the rear. As the climber walks along, the axe is used as a cane to maintain balance. While descending, the climber holds the axe in either hand, faces directly downhill, bends his/her knees slightly, and walks firmly downward. He/She uses the axe as support when needed, with either downhill or uphill placements, as appropriate.

Stake Position. Also known as an anchor position, the stake position is used when going directly uphill at a slope angle between 45 and 60 degrees. While ascending, *but before moving upward*, the axe is placed firmly into the snow with both hands grasping the head, then a step is taken upward and the movement is repeated. See figure 10-15 on page 10-10. This technique is not usually used for descending because it is slow and inefficient for descent.

Cross-Body Position. Also known as the brace position, the cross-body position is used when traversing slope angles of 35 to 50 degrees. *While ascending*, the axe is held perpendicular to the angle of the slope with one hand grasping the head and the other holding the shaft. The axe will cross diagonally in front with the pick facing forward. The spike is placed into the surface with most of the weight on the shaft. The hand on the head will help stabilize the axe. The feet are moved up in sequence with the cane position. See

Figure 10-14. Changing Direction.

figure 10-16. *While descending*, the spike of the axe is planted perpendicularly to the slope in the cross-body position. As descending in the cane position, the knees are bent and body's weight is kept over the feet. See figure 10-17.

Dagger Position. This method is used when ascending slopes that are 60 degrees or steeper. The head is held like a dagger and thrust into the snow/ice. The head must be gripped where it meets the surface to avoid an upward advantage. There are three methods of placement using the dagger method—low, high, and shaft dagger.

This low dagger method is helpful when moving over relatively short, steep sections. The axe is held by the adze and the pick is pushed into the ice near the waist. Most of the climber's weight rests on the pick, using the arms to ease some of the strain from the legs. The feet move up using the front points. See figure 10-18.

The high dagger method is used for slopes that are too steep to insert the pick at waist level. One hand holds the axe head and places the pick into the snow/ice at approximately shoulder level. This method also takes the strain off the legs. The feet move up using front points. See figure 10-19.

This shaft dagger method is used on very steep snow slopes and where the snow is not firm enough to support the pick of the axe. The shaft is held like a dagger in the hand, thrusted into the snow, and used as a handhold. The shaft should be gripped near the surface of the snow.

Banister Position. This banister method is used for descending steep slopes. The axe is planted into the surface down slope and the hand is slid along the shaft while maintaining slight upward pressure. The axe is used as a banister rail for support. Having descended a few steps, the climber should stop, extract the axe, and repeat the steps. See figure 10-20.

Anchor. For harder ice or a steeper slope, climbers can use the anchor instead of the high dagger position. It is used mainly while front pointing, but can also be used while flat footing:

- Hold the axe shaft near the end and swing the pick in as high as possible without overreaching.
- Front point or flat foot upward, holding on higher and higher on the shaft as you progress and adding a self-arrest grasp on the adze with the other hand when high enough.
- Switch hands on the adze, converting to the low-dagger position.
- When the adze is at waist level, remove it from the ice and replant it higher. See figure 10-21.

Figure 10-15.

Figure 10-16. Cross-

Figure 10-17. Cross-Body Descent.

Figure 10-18. Low Dagger.

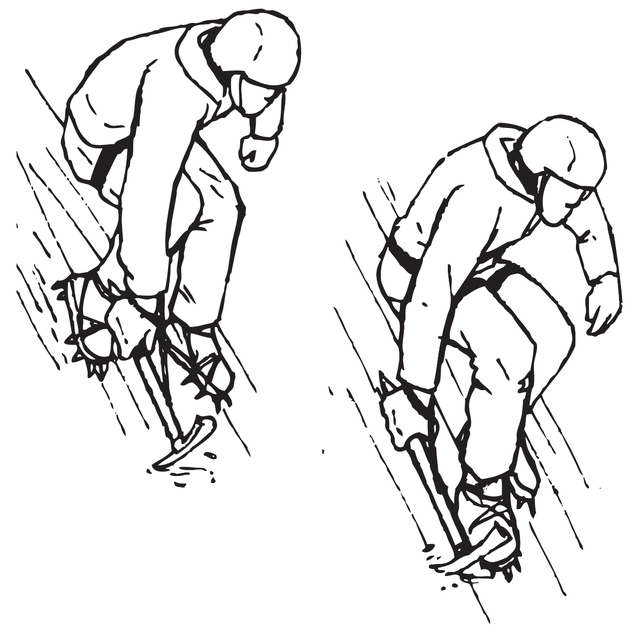

Figure 10-20. Banister Position.

Figure 10-19. High Dagger Position.

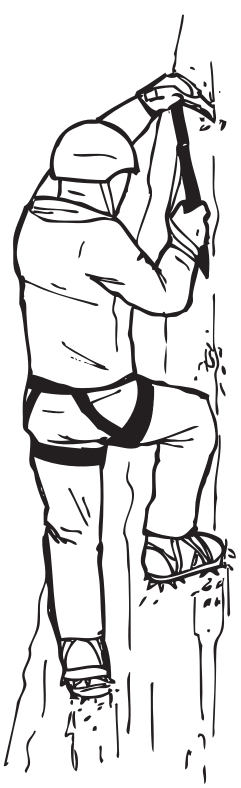

Figure 10-21. Anchor Position.

Traction. Also known as two tooling, the traction position is required for the steepest and hardest ice. The axe is held near the spike and planted high. The ice is then climbed by slightly pulling straight down on the axe while front-pointing up. When it becomes too difficult to balance on the front points, a second tool must be used, which is possible because all ice axe positions require only one hand, except for the anchor. Using two tools provides three points of contact (two crampons and one tool or two tools and one crampon) at any given time. The legs should carry most of the weight with the arms helping with both weight and balance. With two tools, climbers may vary the methods for each axe or keep them the same. See figure 10-22.

Techniques for Movement on Snow and Ice

Step Kicking and Cutting

Step kicking and cutting are movement techniques for hard snow and ice when climbers are not wearing crampons. A walking ice axe is required.

Figure 10-22. Traction Position.

Step Kicking

Step kicking is a fundamental of good movement on snow. It develops rhythm, balance, and correct body position. The diagonal ascent, straight ascent, and plunge step descent are the fastest and most effective ways of ascending and descending slopes of hard snow without crampons.

The diagonal ascent requires steps to be kicked using the side of the boot. The serrated edge of a lugged-sole boot, such as a vibram, should be used as saw teeth. The step should be made with a forward motion of the foot and not by pressing down. The sole of the boot should be kept horizontal. The ice axe is used as a third leg in the support position on moderate slopes. On easier terrain, the ice axe may be carried in the self-arrest position.

The climber must face square to the slope and kick the toe of the boot in at right angles. If an axe is not carried, handholds may be made by punching a clenched fist into the snow at about shoulder height. On moderate slopes, the axe may be used in the anchor position. On easier terrain, the axe should be carried in the support position.

The plunge step is used to descend as described earlier in this chapter. The ice axe is used in the banister position on moderate to steep slopes. On easier slopes, the axe is held in the self-arrest position.

Step Cutting in Snow

Normally, it is unnecessary to cut steps into a slope if all the members of a patrol are wearing crampons. However, in the event that no one is using crampons, the mountain leader may have to prepare a route for mountain troops by cutting steps. Step cutting is a slow and tiring task compared with kicking steps; however, with practice, the technique can be carried out quickly. Good step cutting skills include conservation of energy, a balanced position, and a rhythmic swing of the arm. The weight of the axe will help with the work. The types of steps to be cut in the snow are the slash step, the side step, the slab cut, and the pigeon hole.

Slash Step. The slash step conserves the most energy and is the fastest way to cut steps (whether to diagonally ascend or descend), but it can only be used on snow. When cutting on gentle slopes, the axe may be held in the hand nearest the slope. On steeper slopes, it is more convenient to cut using the outside arm. The cutting action should be powerful, with the whole arm swinging the axe from a fixed shoulder. The step is made with one glancing blow of the axe, which cuts out a 6-inch slash sufficient for the edge of a boot. See figure 10-23. It is important to be in the proper balance when cutting steps.

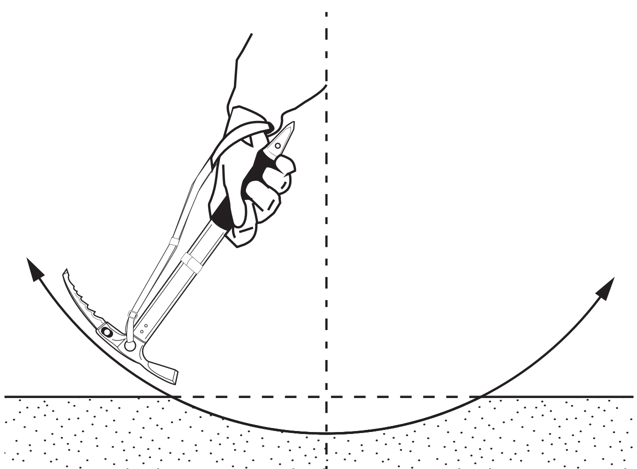

Figure 10-23. Slash Cutting.

Side Step. The side step is most often used when a more secure cut is needed to accommodate the whole boot. The cutting position and principles are the same as the slash step, but the angle of penetration is steeper. Usually, three blows are sufficient to make a good step.

The step should be sloped in toward the slope angle. A gentle nick is normally enough to start and the cut section can be flicked away as the axe is withdrawn. The second and third cuts are made into the existing nick making it larger. There is no reason to waste energy by trying to clear the debris from the steps; it will be packed down by troops as they cross. See figure 10-24.

Figure 10-24. Diagonal Ascent While Cutting Side Steps.

Slab Cut. Under certain conditions, the snow may break apart into slabs and it may be difficult to cut firm steps into the slope. In this type of condition, the slab cut should be used. A horizontal slit is made with the pick of the ice axe and then another slit is cut at a 45-degree angle to form a V, pointing toward the climber. The adze is then used to cut out the center of the V, leaving a triangular step with a flat base.

Pigeon Hole. This technique is used for both handholds and footholds when directly ascending a steep, snow-covered slope. See figure 10-25 on page 10-14. The hole is cut and scooped out by using two to three blows from the adze. It is important that the base is steeply angled so that it allows for a good hold for a gloved hand.

Step Cutting in Ice

Step cutting in ice is very hard work; therefore, it is important to have frequent relief to conserve energy. Natural steps in the ice that can be enlarged by a few blows of the axe should be sought first. As with cutting into snow, side steps and pigeon holes are used in ice as are ice nicks/finger holds.

Figure 10-25. Cutting Pigeon Hole Steps.

The same method of cutting the side step applies as with the snow side step; however, in very hard ice, it may be necessary to use the pick to cut a horizontal slit into the ice to start the step.

A pigeon hole is cut into the ice in the same way as in snow, except that the pick will have to be used. The adze may be used to finish the hole and to make a more pronounced lip for a good handhold.

It is not always necessary to cut a large step in ice. A small nick can be made for a finger hold and can be fashioned with one or two blows of the ice axe. Crampons on thin or brittle ice can be placed on these ice nicks to allow the crampons to work more effectively.

Step Patterns

There are three patterns that can be cut on snow- or ice-covered slopes—the single diagonal line, double diagonal line, and the straight up pattern.

Diagonal Line Patterns. The most convenient way of ascending or descending a slope is by a diagonal line because it is easier to cut steps slightly ahead of one's position. Both the single and double diagonal line techniques are used in conjunction with the slash step or the side step.

The single diagonal line steps are usually cut on gentle slopes where staying in balance is not much of a problem. See figure 10-26. To cut a single diagonal line—

- Stand in a position of balance with the axe in the downhill hand.
- Swing the axe from the shoulder, cutting with the adze and letting the weight of the axe do most of the work.
- Starting at the heel-end of the new step and working toward the toe, swing cut away from the body.
- Use the adze and pick to finish the step.

The double diagonal line steps are usually cut on moderate slopes where staying in balance is more difficult. This technique does require more time to accomplish, but it may prove to be safer to use, especially if the steps are going to be used for the descent. The same technique for the single pattern is used for the double pattern, except two foot placements are cut out offset from each other. See figure 10-27.

Straight Up Pattern. The straight up pattern can be used when directly ascending steep slopes and in conjunction with the pigeon hole step. A set pattern of pigeon hole steps are spaced at regular intervals, resembling the rungs on a ladder. It is important to cut the holes well ahead of one's position using this pattern and to never climb up to the top steps without already establishing handholds above for security. See figure 10-28 on page 10-16.

Glissade and Self-Arrest

The term *glissade* is French and means to slide. Glissading is a method used to quickly descend a slope with little use of energy. It should only be used on slopes where speed can be kept under

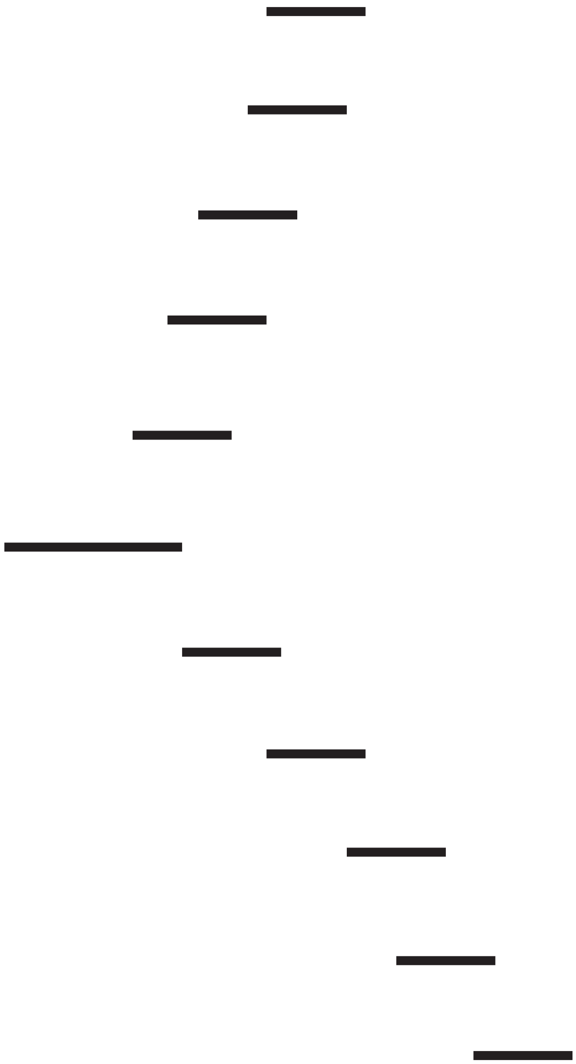

Figure 10-26. Single Diagonal Line Pattern.

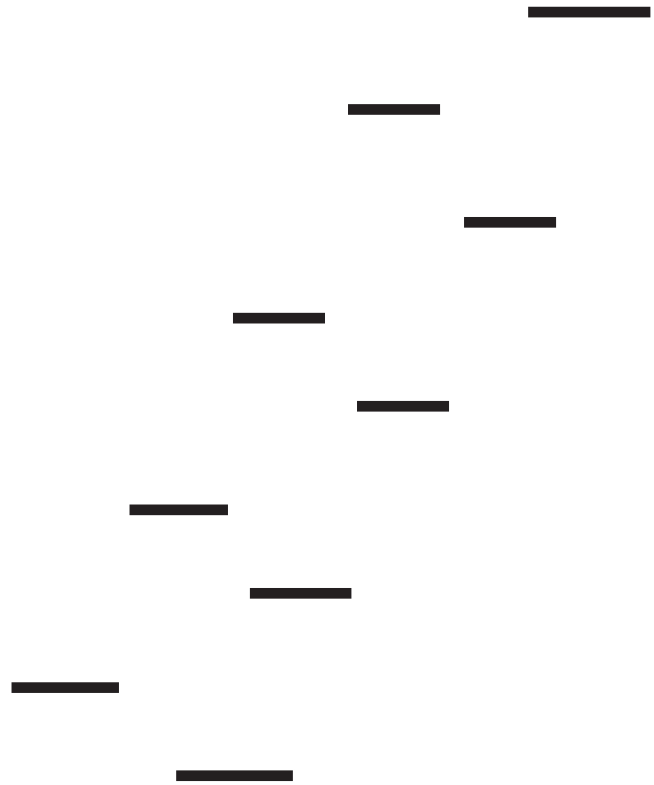

Figure 10-27. Double Line Pattern.

control. When preparing to glissade, planners should make the following considerations regarding equipment:

- *Uniform*. If conducting a sitting glissade, an outer water-resistant layer, such as Gore-Tex, should be worn and zipped up to prevent saturation of clothing. Material made of nylon also provides a good sliding surface. Gaiters should be worn on the outside of the trousers to prevent snow from entering.
- *Axe*. The axe is used as a rudder to help steer. Placing pressure on the axe’s spike helps to control the climber’s speed of descent. If the climber loses control of his/her speed, the pick of the axe will be used as in the self-arrest position.
- *Harness*. If a harness is worn, all gear on the rear loops should be removed to prevent it from becoming detached or interfering with the glissade.
- *Pack*. If a pack is worn, it should be inspected to ensure all equipment is properly attached and that all sharp objects are buffed or stowed inside.
- *Crampons*. Crampons will never be worn when glissading. The points may become stuck into the snow and cause the individual glissading to trip and fall out of control.

Methods of Glissading

There are three principal methods of glissading—standing, squatting, and sitting. The ideal snow for glissading is a firmly packed slope with a soft

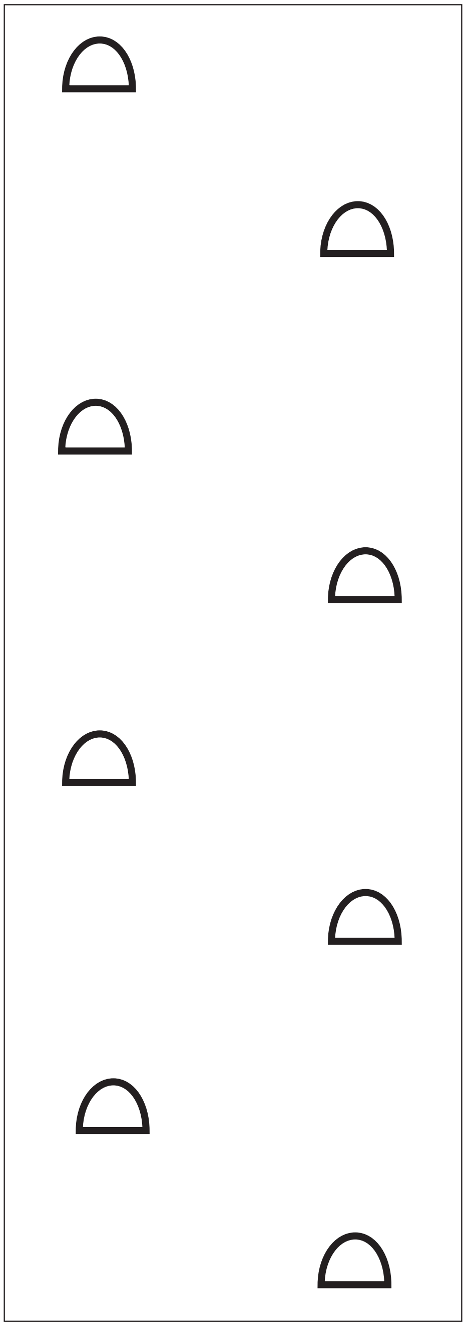

Figure 10-28. Straight Up Pattern.

top layer of snow, such as a slope that has been warmed by the early afternoon sun. It should be reasonably uniform, free of protruding obstacles, and have a reasonable run out zone. Steep, icy slopes should be avoided. Before glissading, the run out zone must be observable.

Standing Glissade. The standing glissade is the preferred method because it offers the earliest look at hazards on the route and is the most maneuverable. It also protects clothing from wetness and abrasion, but requires the most skill and training. The standing technique is very similar to downhill skiing. To perform a standing glissade, Marines must—

- Center the body's weight over the feet with bent knees and outspread arms for balance.
- Carry the ice axe in either hand, so it can be quickly brought into the self-arrest position. See figure 10-29.
- Place the feet together or spread them apart, as needed for stability. Advance one foot for improved stability.
- To increase speed, bring feet closer together, toes tilted downward, while leaning further down slope.
- Always maintain control of descent speed. The following are methods to slow down or stop:
  - Stand all the way up and dig the heels into the snow.
  - Turn the feet sideways using edging as with downhill skiing.
  - Crouch down and drag the axe spike into the snow.

Figure 10-29. Standing Glissade.

Squatting Glissade. The squatting glissade method is much the same as the standing position, except the climber holds the axe in the self-arrest position to one side of the body. The axe will act as a third point of contact to provide stability. See figure 10-30. To perform a squatting glissade, Marines must—

- Center the body weight over the feet in a semi-crouched position with both knees bent.
- Place the feet together or spread them apart, as needed for stability.
- To increase speed, lean forward down the slope.
- To decrease speed, drag the spike of the axe into the snow.

Sitting Glissade. The sitting glissade is the least preferred method, but is the easiest method to learn and works on very soft snow in which Marines may bog down using the other methods. The effects of wetness and possible tearing of the outer garments must be considered before using the sitting glissade. See figure 10-31. To perform a sitting glissade, Marines must—

- Sit on the snow surface with legs flexed on the snow and heels lifted off the slope to start. Once moving, he/she digs his/her heels in the snow as needed to regulate speed.
- Grasp the ice axe with one hand on the head with the pick outboard and the other hand on the shaft. The hand that is on the shaft should be locked into the side at the hip.

Figure 10-30. Squatting Glissade.

Figure 10-31. Sitting Glissade.

- Push down the slope either by throwing the body weight forward or by pushing off with the ice axe.
- Use the spike of the ice axe as a rudder to control direction.
- Apply downward pressure near the axe's spike to control the speed of descent.

Arresting a Fallen Rope Team Partner

Arrest technique serves as a method to brace oneself solidly in the snow to hold the fall of a roped partner. The most important factor when performing an arrest is to act quickly. When performing an arrest, the body must be in the following positions:

- *Hands*. One hand will grasp the head of the axe with the thumb under the adze and the fingers over the pick. The other hand is placed on the shaft just above the spike. Press the pick into the snow just above the shoulder so that the adze is near the angle formed by the neck and shoulder. The shaft will cross the chest diagonally with the spike of the axe near the hip. Pulling upward on the shaft will sink the pick firmly into the snow.
- *Chest and shoulders*. These parts of the body should be pressed firmly against the axe's shaft.
- *Back*. The spine should be arched slightly away from the surface, which helps sink the pick into the snow.

- *Knees*. The knees should be pressed against the snow to help stabilize the body's position.
- *Feet*. Dig the feet into the snow approximately shoulder-width apart to provide added support.

Self-Arrest Positions

Self-arrest is the life-saving technique of using the ice axe to stop an uncontrolled slide down a slope. As with arresting a fallen rope partner, quick reaction by setting the pick into the snow will prevent accelerating to an uncontrollable speed. Body position during the slide may be in one of four positions—head uphill or downhill and face down or face up.

Feet First, Face Down. This position is the desired position for self-arrest. To perform this position, Marines must—

- Position the axe diagonally beneath the chest with the spike of the axe near the hip.
- Arch the back while pulling upward on the shaft to place weight toward the shoulder by the axe head.
- Press the knees into the slope to help slow the fall and assist in stabilizing the body.
- If not wearing crampons, keep the legs stiff and spread apart with the toes digging in.
- If wearing crampons, keep the legs bent at the knees with feet in the air. As momentum slows down, dig the feet into the snow aggressively.

Feet First, Face Up. The side used to recover from this slide is decided by the placement of the head of the axe. See figure 10-32. To perform this position, Marines must—

- Roll toward the head of the axe and insert the pick into the snow aggressively. If the head of the axe is on the left hand side, roll to the left. If the head of the axe is on the right hand side, roll to the right.
- Position the body over the axe with the shaft diagonally beneath the chest and the spike of the axe near the hip.
- Arch the back while pulling upward on the shaft.

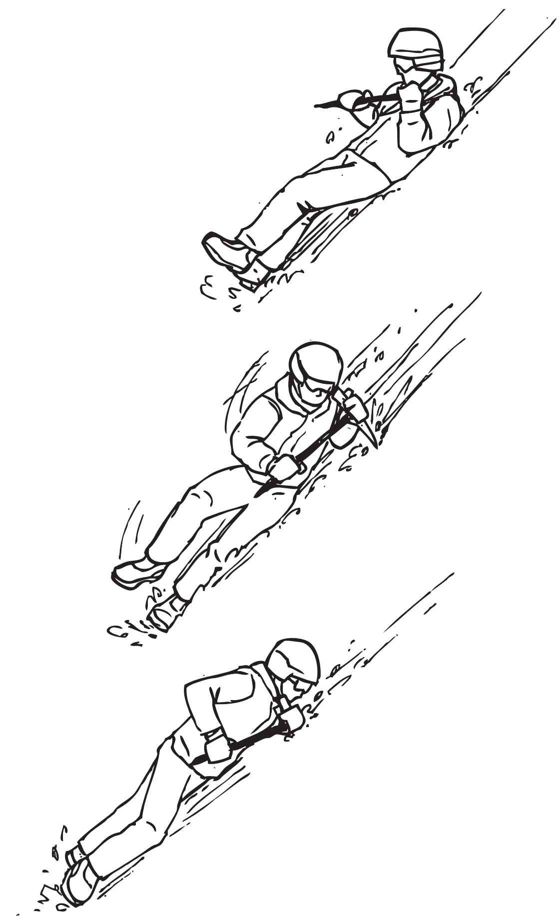

Figure 10-32. Feet First, Face Up.

- Press the knees into the slope to help slow the fall.
- Place the feet the same way as discussed earlier.

Head First, Face Down. This position is a more difficult slide from which to recover because the feet need to be swung downhill. See figure 10-33. To perform this position, Marines must—

- Arch the back upward while reaching downhill and off to the axe head side.
- Aggressively insert the pick of the axe into the snow to serve as a pivot to swing the body around.
- Swing the legs around so that they are pointed downhill.
- Position the body over the axe with the shaft diagonally beneath the chest with the spike of the axe near the hip.

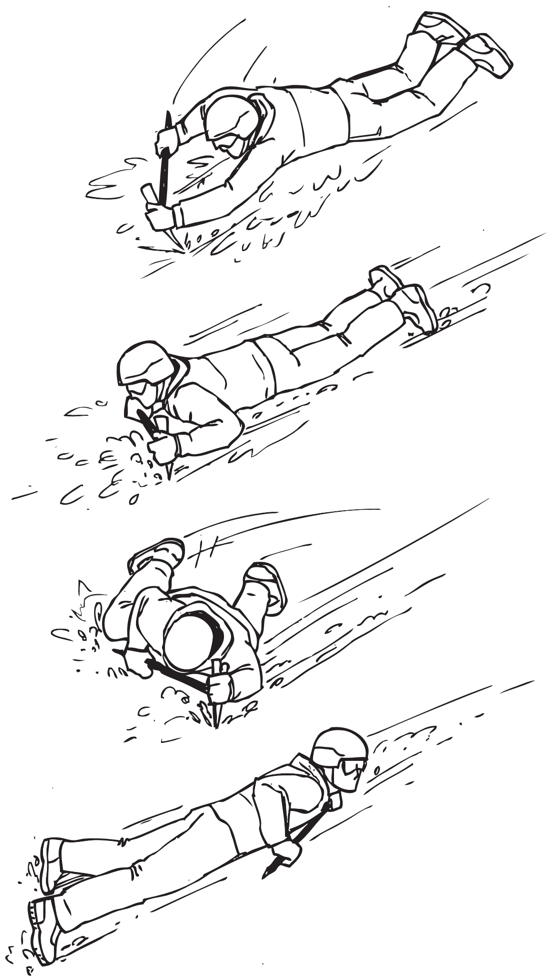

Figure 10-33. Head First, Face Down.

- Arch the back while pulling upward on the shaft.
- Press the knees into the slope to help slow the fall.
- Place the feet as discussed earlier in this chapter.

Head First, Face Up. Not being able to see possible obstacles in the slide makes this position dangerous. See figure 10-34. To perform this position, Marines must—

- Hold the axe across the torso and slide the pick into the snow. The pick serves as a pivot point. Sitting up will help with this maneuver.
- Twist and roll the chest toward the axe head while swinging the legs around so that they are pointed downhill.
- Position the body over the axe with the shaft diagonally beneath the chest with the spike of the axe near the hip.
- Arch the back while pulling upward on the shaft.
- Press the knees into the slope to help slow the fall.
- Place the feet as discussed earlier.

Snow and Ice Anchors

A Marine's ability to establish snow and ice anchors is fundamental to safe movement through alpine terrain.

Figure 10-34. Head First, Face Up.

Establishing Snow Anchors

Snow anchors will vary in strength, depending on snow conditions and placement. Their strength will also continue to change throughout the day due to sun exposure and changes in the snow. A sitting ledge can be constructed below the anchor for belaying.

Emplacement of the Snow Picket (Stake/Coyote)

The snow picket is a well-known snow anchor. It is a relatively easy piece of gear to place in snow, whether perpendicular or as a deadman. See figure 10-35.

Perpendicular Placement. The snow picket is placed perpendicular to the slope and then angled back away from the direction of pull 5 to 15 degrees. The snow stake is hammered in as far as possible and a carabiner or runner is attached to the picket near the snow surface to prevent possible leveraging.

Another perpendicular method is to cut or dig a large step into the slope and then hammer the snow stake into the step at a right angle to it. The side with the holes faces in the direction of the fall line. A carabiner is attached or a web runner is girth hitched directly to one of the holes on the snow stake nearest the surface of the snow.

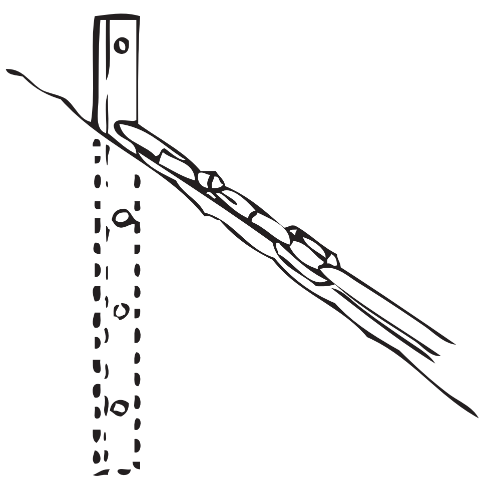

Figure 10-35. Coyote Placement.

Deadman Placement. A T-trench is dug perpendicular to the intended load, about a foot deep, and as long as the picket. The trench must be undercut toward the load. See figure 10-36. A runner is then girth hitched around the center of the picket and stamped into the trench, ensuring that the runner runs down the T-trench and is fully stretched with no slack. Everything except the tail of the runner is then buried and stamped down. The tail will be used as the anchor point, which can be strengthened by plunging an axe or two immediately in front of the picket.

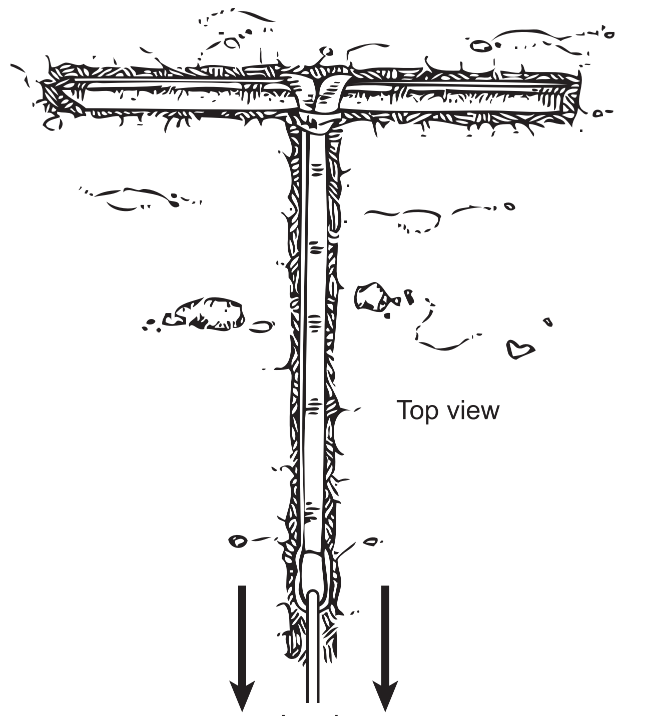

Figure 10-36. Deadman Anchor with Pickets.

Emplacement of the Ice Axe

To use an ice axe as a deadman anchor (see fig. 10-37), Marines must—

- Dig a T-trench perpendicular to the intended load about a foot deep and as long as the ice axe. While digging, undercut the trench toward the load.
- Girth-hitch a runner around the center of the ice axe and then place it into the trench with

the pick facing down. Ensure that the runner runs down the T-trench and is fully stretched with no slack.

- Bury and stamp down everything except the tail of the runner, which will be used as the anchor point. This anchor can be strengthened by plunging an axe or two immediately in front of the buried axe.

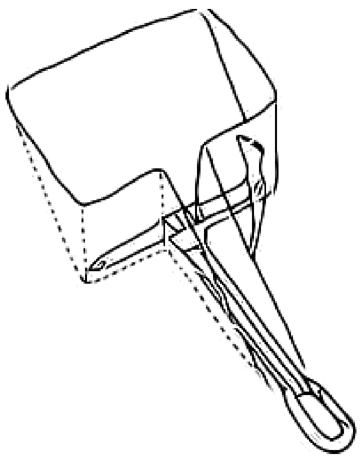

Figure 10-37. Ice Axe Deadman.

Snow Bollard

A solid bollard distributes the load around an even curve without the anchor rope running over any high spots. See figure 10-38. A mound of snow is the basis of this type of anchor. These teardrop-shaped anchors offer sturdy and reliable protection, but are time consuming to construct. To construct a snow bollard, Marines must—

- Look for a relatively high spot where the load will naturally pull downward, then scrape away any superficial snow that will not hold its shape.
- Create the mound by chopping the teardrop outline, gradually concentrating more on the three sides that will bear most of the weight.
- Make the snow bollard at least 4 to 10 feet wide, 12 to 15 feet long, and 18 inches deep.
- As the groove gets deeper, define the undercut lip with small blows with the axe's pick.
- Place the rope around the bollard to see if any protrusions might lift off. Eliminate the protrusions.

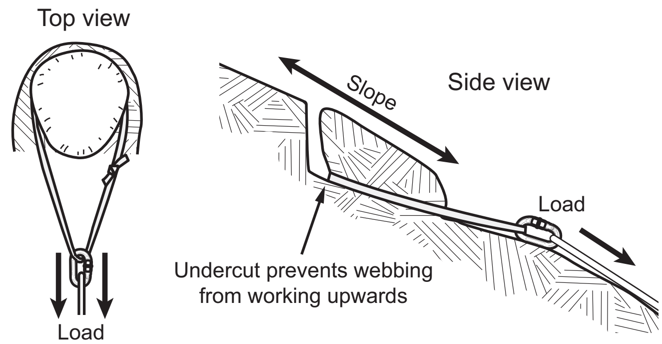

Figure 10-38. Bollard.

- Place the rope around the bollard only once and secure it with a suitable anchor knot.
- Provide additional support with an axe placed spike first in the back of the bollard.

Emplacing Ice Screws/Pitons

A favorable location for an ice-screw placement is the same as for an axe. A good choice is a natural depression where fracture lines caused by the screw are less likely to reach the surface.

Emplacement of Ice Screws

Ice screws are emplaced by performing the following steps:

- If there is any unstable surface ice, cut it away so that the screw can be inserted into solid ice.
- Punch out a small starting hole with the spike of an axe to create a good grip for the starting threads or teeth.
- Insert ice screws at an angle of 90 degrees to the slope and then tilt them back 10 to 20 degrees away from the load direction.
- Press the screw firmly and twist it into the ice at the same time. The pick of the axe can be used to screw after getting it started.

If the mountain leader is unable to sink the ice screw fully, then he/she must tie a hero's loop to the screw to prevent adding additional leverage to the ice, as seen in figure 10-39 on page 10-22.

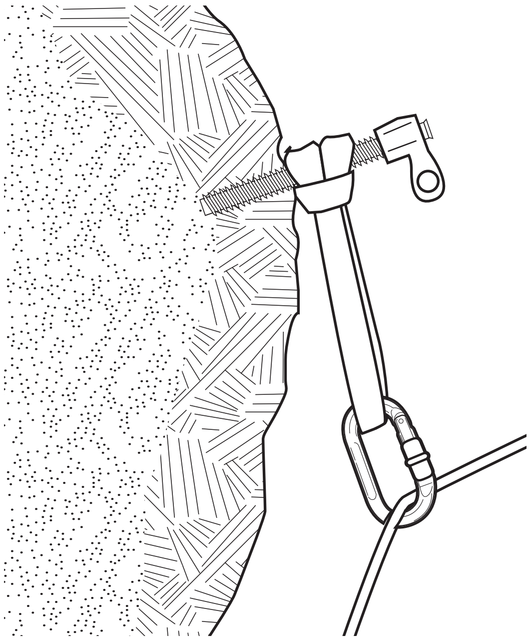

Figure 10-39. Hero's Loop.

If the mountain leader is unable to screw the length of the screw through the ice, then he/she must use the pick or spike of an axe to assist:

- When inserting the screw and the ice stars or crack, remove the ice screw and place it in another area. These signs would indicate that the ice is unstable and unsafe for an anchor point.
- To slow the process of melt-out due to soft summer ice or direct sunlight, pack snow or ice around the head of the screw.

Emplacement of Ice Pitons

When using an ice piton, begin the hole gently with light taps to prevent fracturing of the ice. If starring or cracking occurs, the ice piton should be removed and placed in another area. These signs indicate that the ice is unstable and unsafe for an anchor point. The pick of the ice axe can be used to assist in removal.

Establishing Ice Anchors

Ice anchors will vary in strength, depending on ice conditions and strength. Anchors' strength will also continue to change throughout the day due to the ice melting. A sitting ledge can be constructed below the anchor for belaying.

Equalized Anchor System

The equalized anchor system is similar to artificial anchors on rock. To establish this system, Marines must—

- Place two ice screws offset approximately 18 inches apart.
- Ensure that the ice screws are placed parallel in relation to the direction of the belay.
- Attach carabiners to each of the screws.
- Attach a web runner through each carabiner and equalize the system.
- Tie an overhand loop into the runner and attach a carabiner into the overhand loop. The anchor is now prepared to perform either a direct or an indirect belay.

Note: The rope itself can be tied into each carabiner with a clove hitch if no web runner is available.

Natural Anchors

Natural ice anchors, such as ice pillars or ice pinnacles, can provide a very secure anchor point for a belay position. If there are no natural ice anchors available, ice can be cut and shaped in order to provide a solid anchor point.

Ice Bollard

Very similar to the snow bollard, the ice bollard should be cut out of a solid base of ice that is approximately 18 inches wide and 24 inches long. At a minimum, the trench should be 6 inches deep. The backside of the bollard must be undercut to accommodate the rope to help keep it in place.

If there is any starring or opaqueness in the center of the bollard, the belay should be removed and placed in another area. These signs indicate that the ice is unstable and unsatisfactory for a safe anchor point.

Note: Back up the bollard by placing a piece of ice protection to the rear of the bollard with a runner and a carabiner attached to the rope.

Belaying on Snow

Snow belays can be constructed from established snow anchors or by using an ice axe. No matter what belaying technique is employed, every snow belay should be as dynamic as possible to help limit the force on the anchor. Quick belays are used when their consequences would not result in death or serious bodily harm.

The Boot Axe Belay

The boot axe belay is a fast and easy method to provide protection as a rope team moves up together. It is conducted in the following manner:

- Stamp a firm platform in the snow.
- Drive the axe shaft deep into the rear of the platform with the axe head perpendicular to the fall line.
- Stand below the axe at a right angle to the fall line and face the side on which the climber's route lies.
- Plant the uphill boot into the snow against the downhill side of the shaft, bracing it against a downward pull.
- Plant the downhill boot in a firmly compacted step far enough below the other boot so that the downhill leg is straight and provides a stiff brace.
- Flip the rope around the axe. The final configuration will have the rope running from the direction of the potential load, across the toe of the uphill boot, around the uphill side of the axe, and then back across the boot above the instep. See figure 10-40.
- Hold the rope with the downhill hand, applying extra friction by bringing the rope uphill behind the heel, forming an S-bend. The braking hand must never leave the rope.
- Use the uphill hand to grasp the head of the axe to brace the shaft and belay the climber.

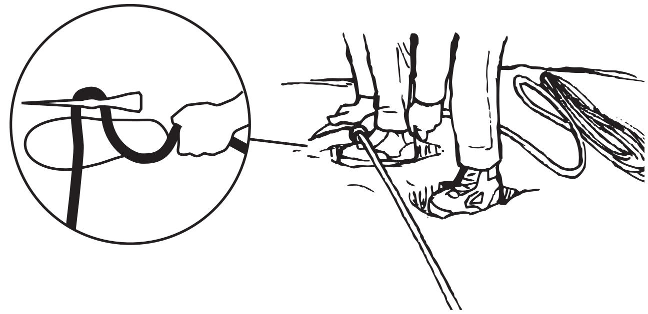

Figure 10-40. Boot Axe Belay.

The Carabiner Ice Axe Belay

The carabiner ice axe belay system provides the same level of security as a boot axe belay, but with easier rope handling. It is conducted in the following manner:

- Stamp a firm platform in the snow.
- Drive the axe shaft deep into the rear of the platform with the axe head perpendicular to the fall line.
- Attach a short sling to the axe shaft at the surface snow line and clip a carabiner through it.
- Stand below the axe at a right angle to the fall line and face the side on which the climber's route lies.
- Brace the axe with the uphill boot, standing on top of the axe head but leaving the sling exposed.
- Run the rope from the potential direction of pull, up through the carabiner, then around the back of the shoulder and into the uphill hand.

Instead of placing the rope around the body, if wearing a harness, the rope can go straight to the hard point onto a mechanical belay device or munter hitch, as seen in figure 10-41 on page 10-24. Anchored belays require an established anchor.

The Sitting Hip Belay

The sitting hip belay system is very dynamic and secure on hard or deep, heavy, wet snow. To establish this belay, Marines must—

- Stamp or chop out a belay seat in the snow and a platform to brace against each boot.
- As in rock climbing, tie into the anchor point from the retrace figure-8 on the harness. See figure 10-42.
- Pull in all the slack from the number 2.
- Place the number 2 on a belay device. All is ready to bring up the number 2 climber.

Note: The belayer may want to insulate themself from the snow by using an isopor mat or pack.

Standing Hip Belay

The standing hip belay is easier to set up than a sitting hip belay because only slots for the boots will need to be dug. However, it is far less secure because the belayer may topple over under the force of a fall. To establish a standing hip belay, Marines must—

- Stamp or chop out a belay ledge on which to stand.
- From the retrace figure-8 on the harness, tie into the anchor point.
- Pull in all the slack from the number 2.
- Place the number 2 on a belay device or munter hitch.
- Stand sideways and face the same side as the climber's route.
- Bring up the number 2. See figure 10-43.

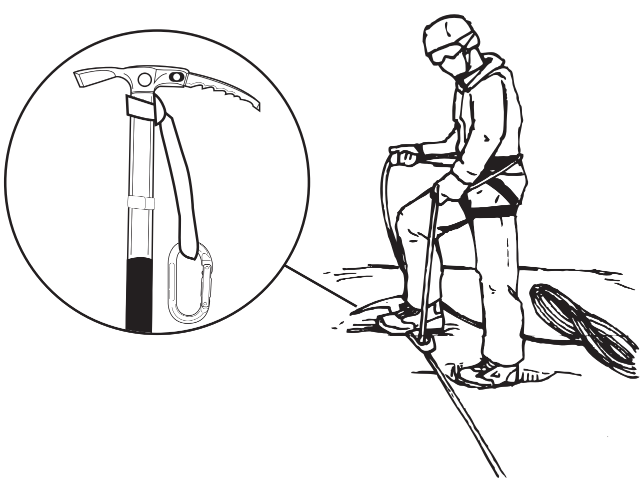

Figure 10-41. Carabiner Ice Axe Belay.

Figure 10-42. Sitting Hip Belay.

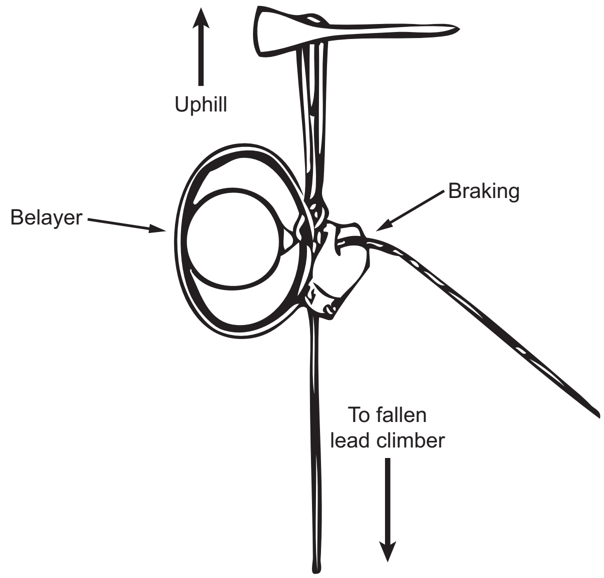

Figure 10-43. Standing Hip Belay.

Note: Ice belay anchors are constructed similar to rock climbing belay anchors.

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CHAPTER 11
GLACIER TRAVEL AND RESCUE

A glacier is often a good avenue of approach to the interior of a mountain range. It can be frustrating, slow, and dangerous; however, it is usually easier than traveling on steep, loose ridgelines. Because units traveling on glaciers are subject to observation from all the surrounding high ground, a highly capable detachment may have to provide pickets for the force traveling below.

Individual Equipment for Glacier Travel

The following is equipment necessary for movement on glaciers and can be found in the 2011 MACK Alpine Module or commercially off the shelf:

- *Harness*. The climbing harness from the MACK works well; a rappel harness is not recommended for glacier travel as it may loosen during movement. A commercially off the shelf lightweight alpine harness may be used. A tape harness may be tied from 34 feet of tubular nylon, included in the MACK, if a harness is not available. The first 22-foot section is tied as shown in figure 11-1 on page 11-2. The second 12-foot piece is tied around the waist twice. Both are tied off with square knots or water knots and clipped with a locking carabiner.
- *Chest harness*. This item is required when traveling with a heavy pack or a sled to prevent tipping upside down in the event of a crevasse fall. It may be tied with 8 feet of nylon webbing from the MACK. See figure 11-2 on page 11-3.
- *Helmet*. A helmet is always worn when there is a danger of falling, in areas of loose rock and ice, or if there is a possibility of crevasses.
- Two locking carabiners per person and at least four nonlocking carabiners per person.
- *Ice axe with leash*. See chapter 10 for more information on ice axe techniques.
- *Crampons*. See chapter 10 for more information on crampon techniques.
- *Reinforced haul/grab loop on issued pack*. Clip with a short (2- to 3-inch) leash with figure-8 loops at both ends. Climbers may also girth hitch multiple points with a runner or cordage, such as the grab loop and one shoulder strap.
- *Anchor material*. In addition to the items needed for snow and ice anchors, it is a good idea to carry a few extra runners, 22 feet of prusik cordage, a belay device, and mechanical ascenders. While traveling roped up, these items should be carried by the leader, but can otherwise be spread loaded throughout the unit. Avoid clipping anchor material to the pack, except the larger items, such as flukes, stakes, and pickets.

Rope Use

Ropes are used for team safety when moving on a glacier as many hazards are hidden by snow. The dynamic rope in the 2011 MACK is used, which has a dry rope finish. Because most falls on glaciers are not high impact dynamic falls, a dynamic UIAA-rated half rope can be used (this type of rope cannot hold a leader fall by itself). These ice ropes are about 9 mm in diameter, have a water resistant coating, and are about 50 meters long. However, in a mixed rock and snow environment, where rockfall is a potential hazard or if crevasses are suspected, two half ropes or a thicker full rope, such as a 9.5 mm dynamic rope, should be used. If an ice rope (half or full) is unavailable then a standard 11-mm diameter dynamic climbing rope from the original MACK may also be used.

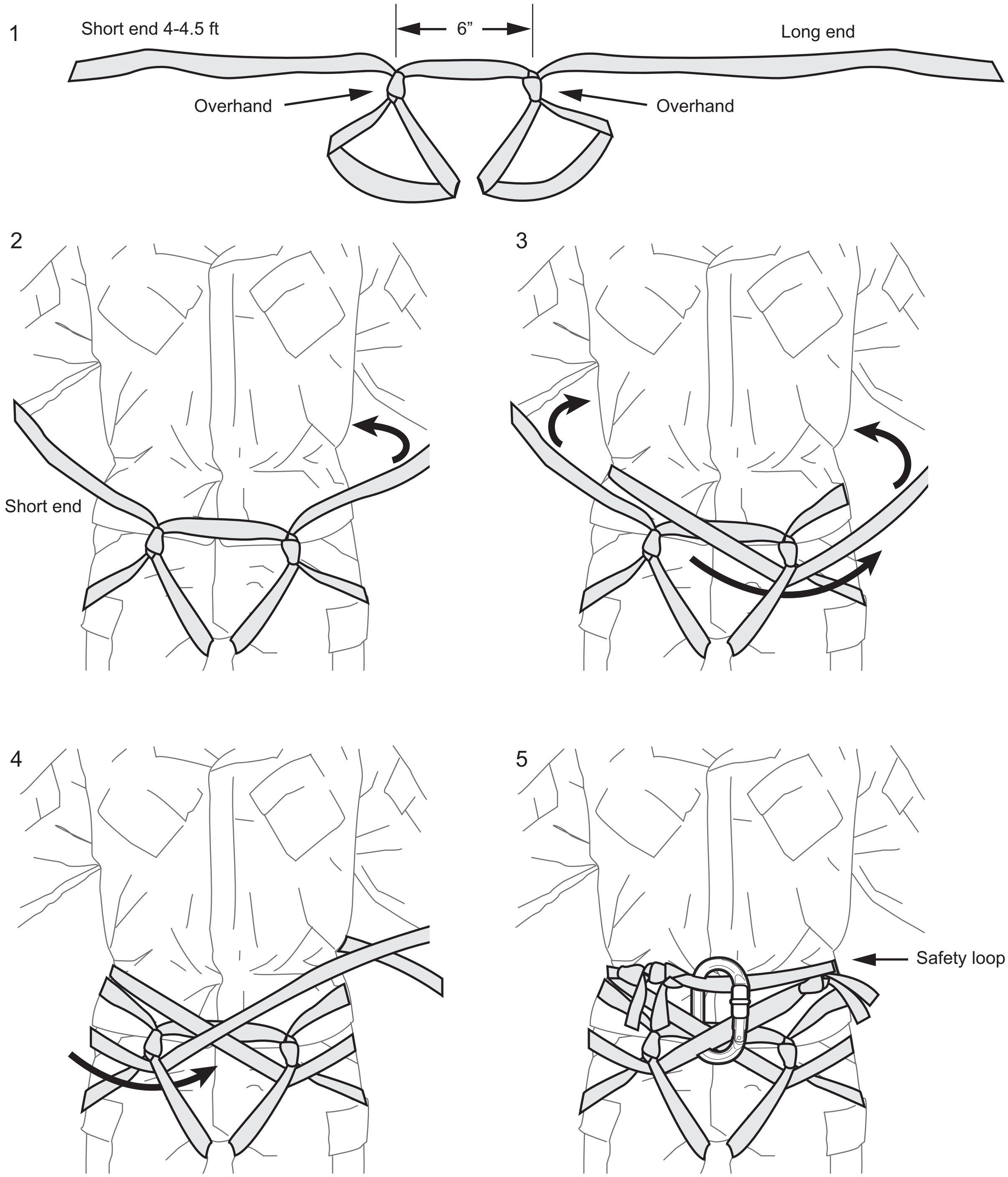

Figure 11-1. Tape Harness.

Note: Standard dynamic ropes will absorb water and freeze, which will make them heavier and more difficult to manage.

Rope Team

The spacing between individuals on a rope team depends on the crevasse hazard and the

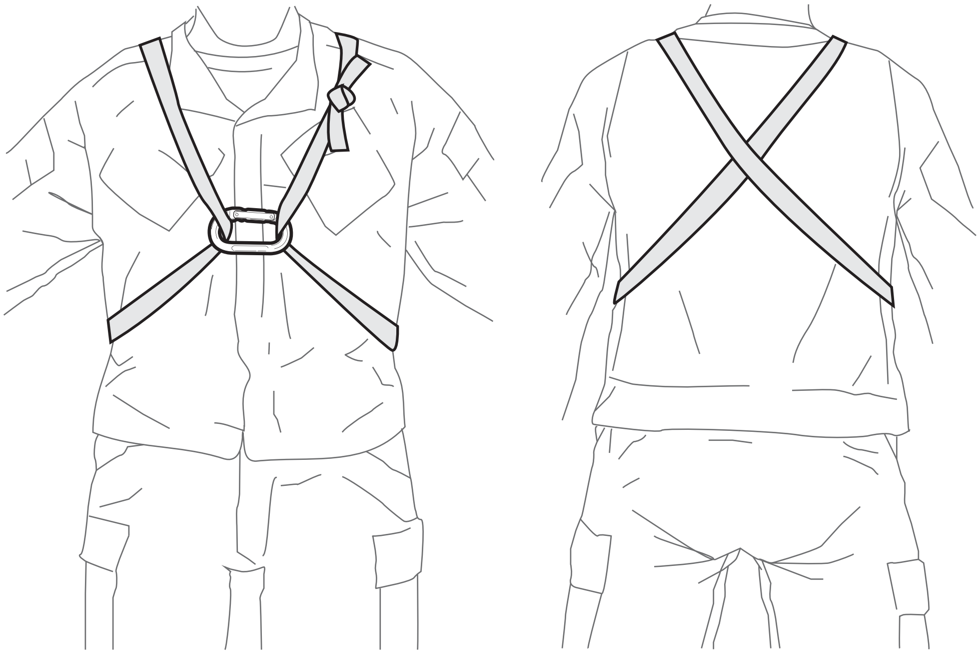

Figure 11-2. Chest Harness.

equipment available. Ideally, the climbers are spaced wider than the crevasse hazard. Three to five climbers are ideal per rope. The earth/glacier module of the 2011 MACK allows for ropes for a 200-person company, one per four individuals. Often, a mountain leader may assign a rope team many more ropes, which may be safer than it appears as long as the rope team is not the lead team in the formation. With many individuals on the line, there is a lot of weight to hold a crevasse fall, even without a good team arrest. It also allows for more help in the event of a crevasse rescue. See figure 11-3, on page 11-4, for spacing.

Generally the most experienced person will travel first in a rope team to scout the route. The second most experienced person should travel last to coordinate the rescue if the first person goes into a crevasse. In addition, he/she may become the lead person if the rope team dead ends and has to reverse direction. A four-person fire team traveling on the same rope is ideal and the three-person team is the smallest independent team. If multiple small teams are traveling together, then two-person teams will suffice. The method of tying the climbers into the rope is known as the kiwi coil method. The kiwi coil is established on a three-person rope team by performing the following steps:

- With the end of the rope, the first and third climber will tie into the rope in the same method as for two-party climbing.
- The climbers will then place a locking carabiner into their harness's hard point.
- The second climber will locate the middle of the rope and tie a 3-foot overhand knot. With the bight he/she has now created, he/she ties a figure-8 loop. He/She will clip the loop into his/her harness's hard point, using a locking carabiner. He/She is now secured to the rope.
- The first and second climbers will begin to wrap coils from over the shoulder to under the arm ensuring that the coils reach just to the bottom of their rib cages.

Note: If wearing a pack, the first coil will be attached to the pack's hard point with a carabiner. The hard point on the pack is constructed using a web runner woven around the pack straps.

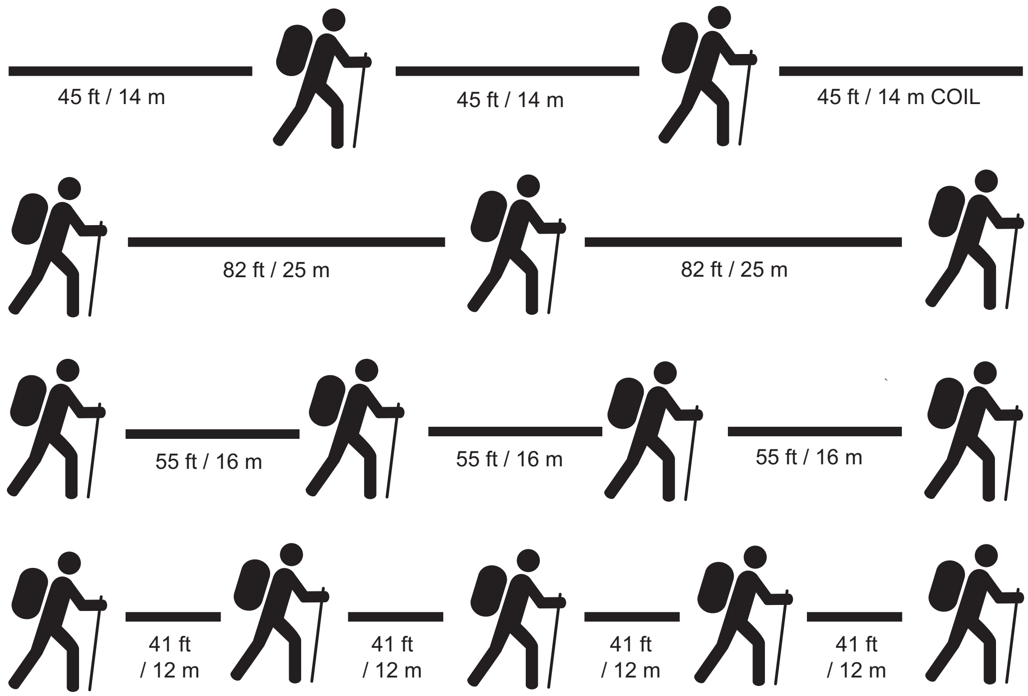

Figure 11-3. Rope Team Spacing.

- Depending upon the situation, they will continue to wrap the coils until they are spaced at the desired distance (based on the crevasse threat, length of rope, number of individuals in the team, and the tactical situation) away from the second climber.
- After the desired distance has been reached, the climbers will ensure that the rope runs in a straight line from the hard point up over the shoulder and then reaches under the coils and pulls through a bight of the live rope running to the middle climber. The length of this bight is important, as it should just reach the locking carabiner on the hard point.
- Climbers run the bight through the coils into the hard point of the harness and tie an overhand knot around the live rope. See figure 11-4.The climbers will clip this bight into the locking carabiner on the harness's hard point and lock it down.
- The climber should now test pull the live end of the rope to ensure it does not cinch around the climber's shoulder. All climbers are now secured into the rope.

Self-Rescue System

Self-rescue systems can be built into the climbers in the following ways:

- *Waist prusik*. The waist prusik is a 10-foot cord tied into an endless loop with a double fisherman knot. The prusik cord must be at least 3 mm smaller than the rope on which it is to be used. A six-finger prusik is tied on the rope and clipped into a separate locking carabiner. See figures 11-5 and 11-6.
- *Foot stirrup*. For this system, climbers use a 12- or 13-foot cord (3 mm smaller than rope) to tie an end-of-the-line figure-8 and clip it into the same locking carabiner as the waist prusik. He/She pulls up on the carabiner and then ties a middle-of-the-line figure-8 with a 9-inch loop. The knot should be at nose height. He/She then ties a figure-8 loop in the running end with a 9-inch loop, which is tied to the glacier travel rope below the waist prusik with a 6-finger prusik. The running end is tucked into a pocket. See figure 11-7 on page 11-6. This system should be used on a fixed rope to make minor adjustments.

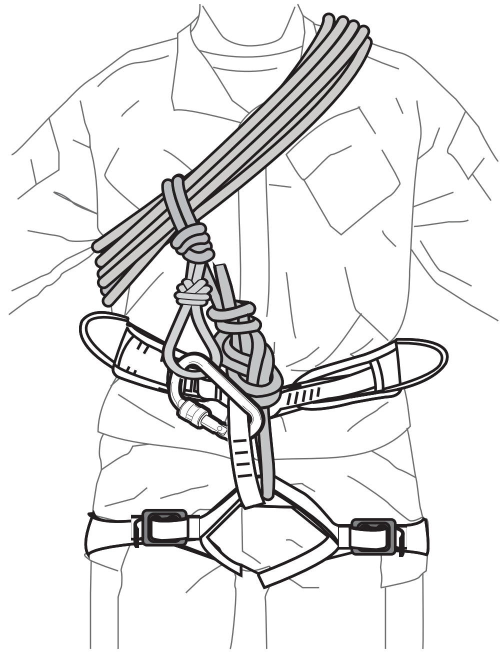

Figure 11-4. Coils on End Person in a Rope Team.

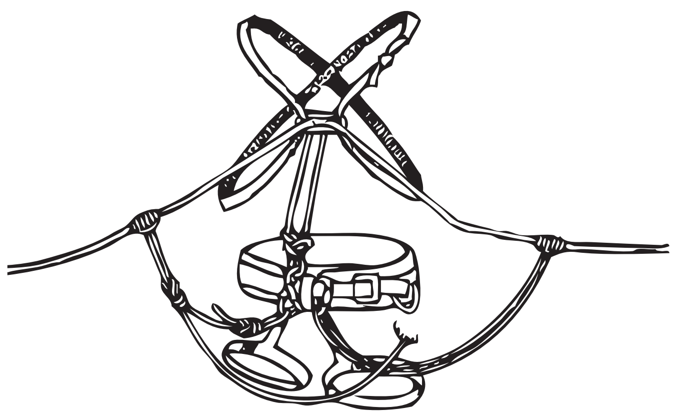

Figure 11-5. Self-Rescue System.

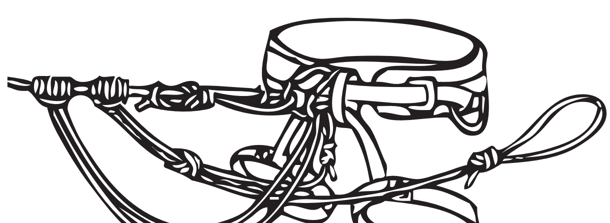

Figure 11-6. Self-Rescue System (End Person).

If traveling with mechanical ascenders, such as when towing a sled, climbers should not travel with the ascenders on the rope. They should be clipped to the harness. See chapter 8 for information on mechanical ascender use.

The middle person should make the following special considerations:

- Put the waist prusik on the line to the front and the foot stirrup on the line to the rear.
- If middle person falls in, then move the appropriate prusik line to climb out.
- Do not drop the cord when transferring it.

Packs

Heavy packs should be tethered from the reinforced grab loop to the end-of-the-line figure-8 loop tied in the rope used for glacier travel. Using this configuration, the individual can, after a fall, shrug off the pack and he/she will not lose it. A light pack can be clipped onto the rope itself so that, as a climber ascends the rope, the pack is hauled up as well on a 2:1. This system will not work for a heavy pack. Both methods place the weight of the pack on to the rope, which makes ascending easier. See figure 11-8.

The Whole Rope Team System

The rope systems of the end and middle people are detailed in figure 11-9. The middle person should be wearing the anchor gear sling under the pack. The last step is to slide the prusik up next to the figure-8 knot and to clip the rope(s) into the chest harness. Team members should always check each other.

Over-the-Snow Mobility Considerations

A unit may find itself in a high altitude, snow-covered, glaciated region. The unit must not only rope up to cross the glacier, but also must wear over-the-snow mobility equipment. All over-the-snow mobility equipment must be dummy-corded to Marines' boots so the equipment will not be lost in a crevasse fall.

Glacier Skiing

When skiing on a glacier, Marines should remember the following tips—

- Keep the rope at a 45-degree angle.
- The best skier should be in the rear.
- The next best skier is in the front.
- The novice skiers should be in the middle. See figure 11-10 on page 11-8.

Sled

On extended operations the Marine Corps cold weather infantry kit sled may have to be hauled. The sled is pulled in the following manner:

- Sled pullers should be in the middle of a rope team.
- Sled pullers should have mechanical ascenders for self-rescue, which are much easier to pass around the knots holding the sled.

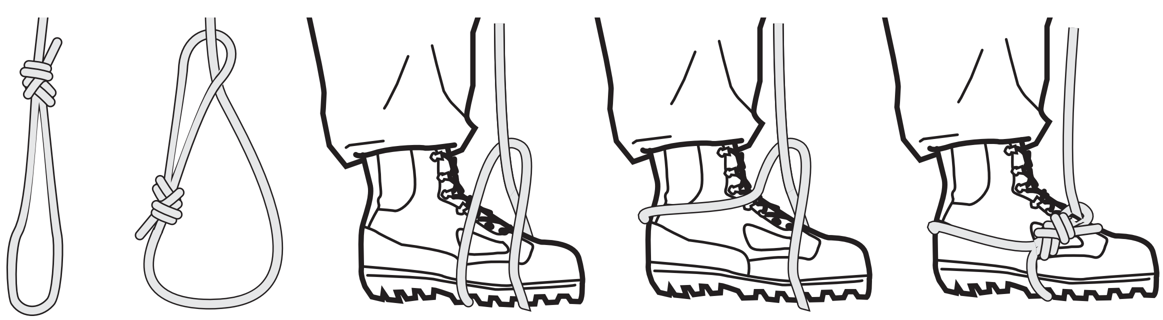

Figure 11-7. Tying Foot Stirrup.

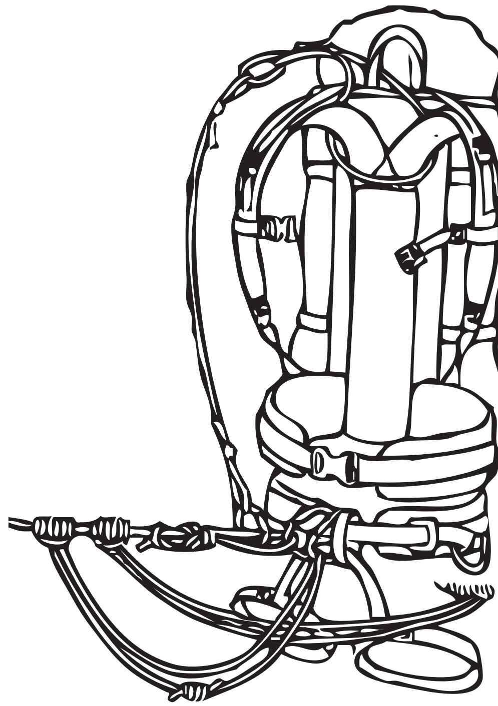

Figure 11-8. Pack Tether.

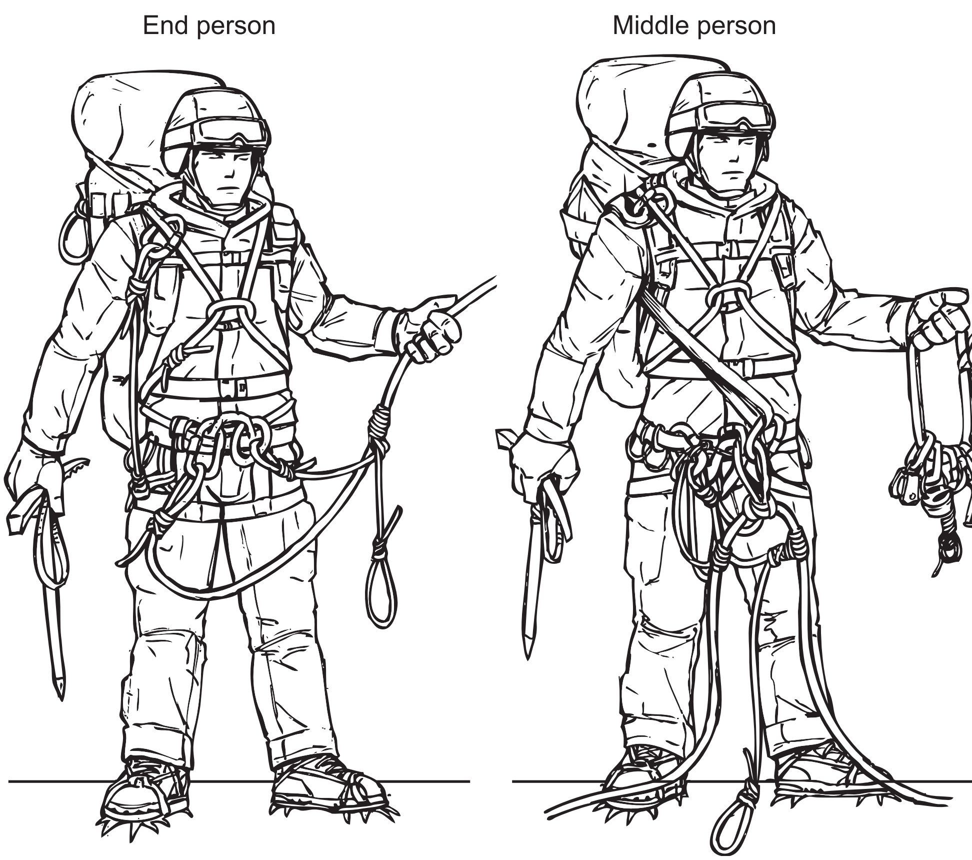

Figure 11-9. Whole System Rigged.

The sled should be rigged with strong cordage and a carabiner clipped into the front and back of the sled. The rope should be clove hitched to both carabiners, as in figure 11-11.

Route Finding

Route finding is normally assigned to the most experienced mountain leader, who considers the following points:

- Use vantage points. Once on the glacier, it is hard to see the big picture. Before traveling on a glacier, try to find a high observation point and sketch the glacier. Note the positions of crevasse patterns, avalanche hazards, and icefalls. Aerial photos also help.
- Predict where crevasses might appear.
- Note zones of tension in the glacier, such as bulges, flanks, and the outside of bends.
- Look for subtle terrain features, such as sagging snow, cracking, or faint swells. All may indicate the edge of a crevasse.
- Pay attention to all of the features that run in parallel lines.
- Know the weather patterns and seasonal changes of the area to predict the likely state of snow bridges.
- Be especially cautious after a storm because new snow may cover the hazards.
- Probe for crevasses with a probe pole, ski pole with the basket removed, or (as a last resort) an ice axe. Always use a leash with the probe.
- Do not forget to look up as well. Check for avalanche, rockfall, and icefall danger.

Figure 11-10. Ski Formation for Glacier Travel.

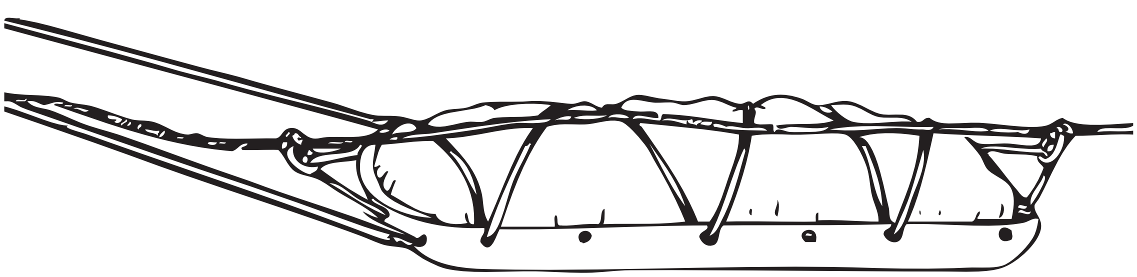

Figure 11-11. Sled Rigged for Glacier Travel.

- Cut steps and set up fixed lines for the unit. In most cases, units will only need to cross short sections of glaciated terrain. Limited equipment and the tactical situation will prevent lengthy movements over glaciers.
- Assist retransmission teams, forward air controllers, or sniper teams, which are small elements that may require the specialized skills of a mountain leader to travel extensively in the mountains.

General Traveling Tips

The following points should be considered when planning to travel on glaciers:

- The most experienced mountain leader in the unit will make the decision to rope up.
  - If there is no danger of crevasses (such as streams running on the surface and no snow cover to hide crevasses) and the terrain is relatively flat, there is no need to rope up or to wear crampons.
  - If there is snow cover, steeper terrain, or crevasse hazard, teams should rope-up.
- If conditions allow individual and team arrest, then travel in normal roped fashion.
- If it is impossible to arrest (hard ice) and roping up will increase the hazard for the group if one person should fall, then the mountain leader should use running belays or short pitches.
- If the terrain dangers continue to become worse, the mountain leader should determine the use of belayed climbing or fixed ropes.
- There should be no slack in the rope between individuals. The rope should just skim the surface when walking normally and should be taut when probing for crevasses.
- The rope should be on the uphill side of the individual. In case of a fall, the individual will be pulled into the slope, instead of away, which is sometimes very hard to do, especially for the middle-of-rope team members.
- Travel should be perpendicular to crevasses, if possible.
- All equipment should be attached so it is not lost in a fall.
- The self-rescue prusik should be kept near the hard point. Under tension in a fall, the prusik will take the impact and not the dynamic rope.
- Coils should never wrap around a hand. If someone falls, the coils will constrict around the hand or arm. Climbers should carry a bight if it is necessary to pick up the rope to manage slack.
- When taking breaks, climbers should try to aim for a safe spot, such as a moraine or area of compression. If none are available, a break with the rope fully extended is the next safest. The group should not be assembled until the area has been probed for crevasses.
- If a route dead ends, it is usually easier to have the last person become the new leader and move out in the new direction, which may not be possible if he/she is inexperienced.
- Climbers should always wear sunscreen or lip balm (with an SPF [sun protection factor] of at least 15) and high quality sunglasses or glacier glasses, if available.

Travel Techniques

To safely cross a field of crevasses, Marines can use various techniques, depending on the situation and their skill levels.

End Run

Crossing over a crevasse is seldom the preferred choice. The safest and most dependable technique is to go around the crevasse as in the end run. See figure 11-12 on page 11-10. When conducting an end run—

- Approach the crevasse at a perpendicular angle, if possible. The leader makes a wide swing around the corner while probing carefully for any hidden crevasses.

- Be aware of adjacent crevasses. They may be an extension of the crevasse around which climbers are maneuvering. Team members may be required to back out.
- Keep the rope taut and perpendicular to the crevasse.

Echelon Formation

If the route demands travel that is parallel to the crevasses, the echelon formation is the preferred technique to maneuver safely. This technique should not be used where hidden crevasses are likely. The leader will choose a lane parallel to the crevasses and travel directly down it. The rest of the rope team will take up lanes also parallel to the crevasses and travel behind and offset from the leader. See figure 11-13.

Snow Bridges

The strength of a snow bridge will vary depending on the temperature. Climbers should not assume a bridge crossed early in the morning is safe to cross during the afternoon. The leader will visually study the bridge from all angles (even underneath, if possible) before attempting to cross, making sure he/she is on belay. The leader should probe the bridge to determine its thickness and exactly where the crevasse begins and ends. The belayer will keep a taut rope to help safeguard against a possible breakthrough. After the leader crosses the bridge, the rest of the rope team will follow the leader's example. Marines can also crawl over a bridge, spreading their weight out. Skis and snowshoes will also aid in spreading the weight across the surface of the snowpack.

Crevasse Jumping

Most jumps across crevasses are short, simple leaps. If planning a larger jump, ensure that all other alternatives have been ruled out. See figure 11-14. To jump over a crevasse, Marines must perform the following steps:

- The leader will determine the true edge of the crevasse by performing the probing method as with snow bridges.
- The leader may want to trample down the snow near the crevasse's edge to create a better jumping platform.
- The leader should make final equipment preparations, such as by adjusting gear and clothing and checking prusik cords and harness.

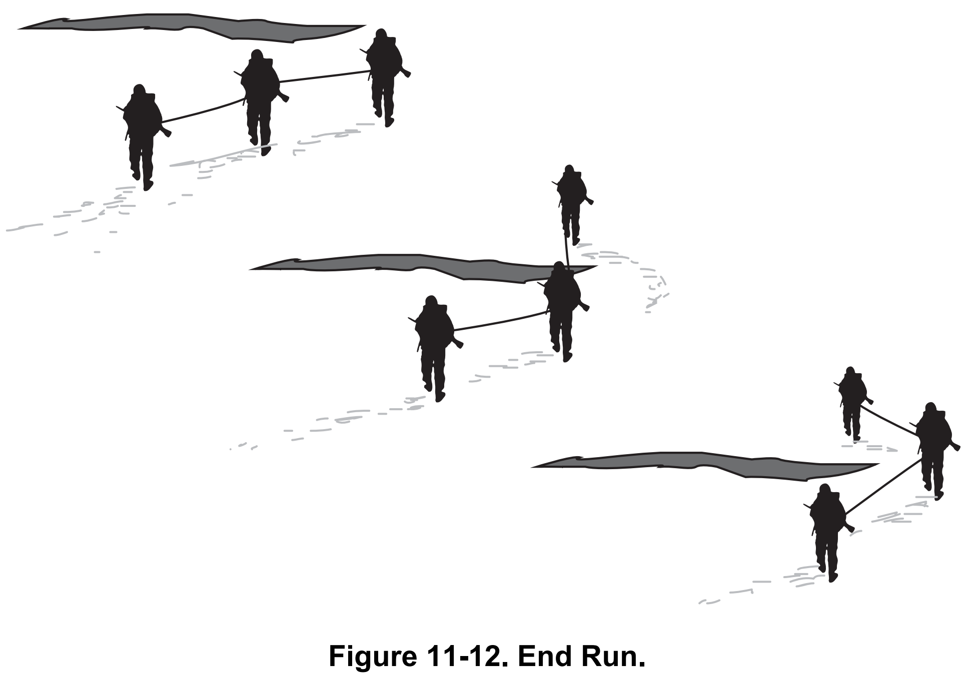

Figure 11-12. End Run.

- The leader will determine the amount of rope required to clear the crevasse and back stack it near the next climber in the rope team.
- All the other climbers will assume the arrest position, while giving the leader enough rope to make the jump.
- The leader will jump the crevasse with his/her axe in the self-arrest position.
- Upon clearing the crevasse, the leader will assume the arrest position slightly offset so that the rest of the rope team does not land on him/her.

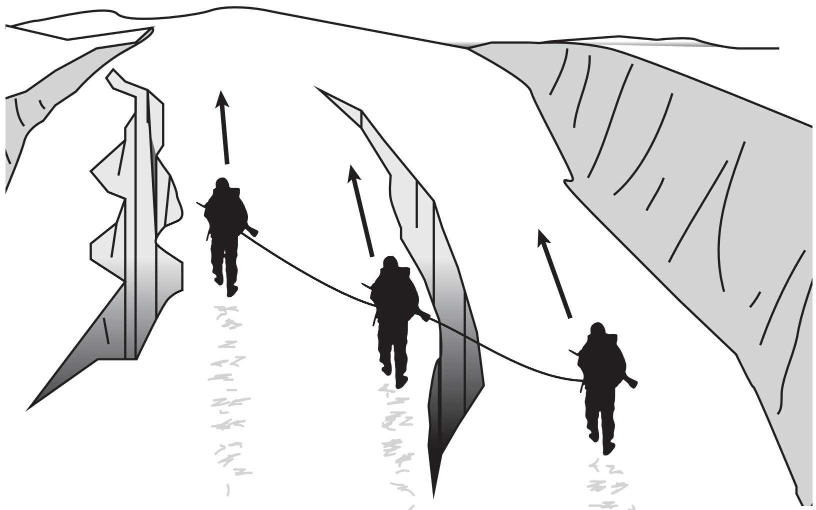

Figure 11-13. Echelon Formation.

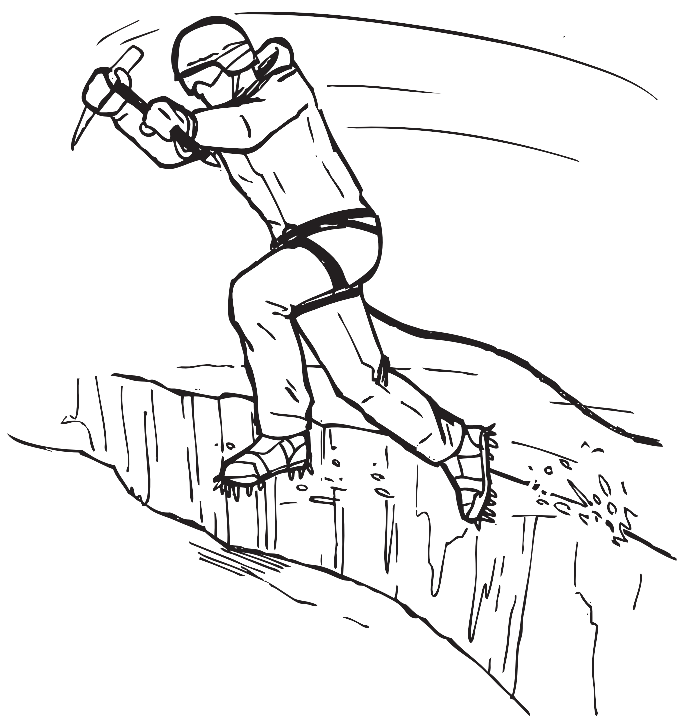

Figure 11-14. Crevasse Jumping.

- The remaining members of the rope team will adjust their position to allow enough rope for the next climber to jump.
- This process is repeated until all members of the rope team successfully complete the jump.

Crossing a Bergschrund

Moving over a Bergschrund may require a belay stance to ensure safety of the climbers. The lead climber will climb the route as in a party climb. See figure 11-15. A rope may have to be deployed as a rappel lane and an anchor established as described in chapter 10.

Running Belays

The running belay method allows relatively quick movement and safety and is generally used when a team arrest is not enough to stop a fallen climber. When performing a running belay, the leader places protection and clips it into the rope behind him/her. As each person comes to the protection, he/she clips around it as shown in figure 11-16.

When the last person reaches it, he/she sounds off LAST MAN to signal the leader to place more protection. At a minimum, there must be one piece of protection for the rope team. More will be used as required. When the leader is low on

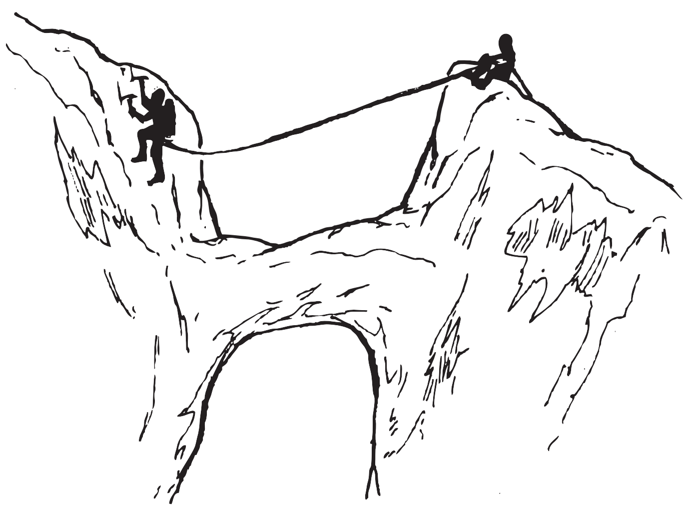

Figure 11-15. Crossing a Bergschrund.

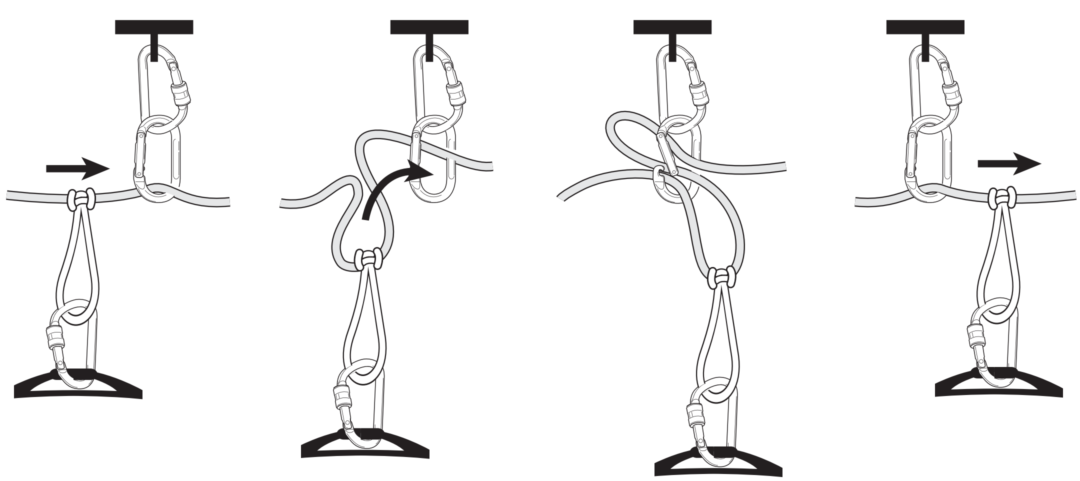

Figure 11-16. Passing Protection on a Running Belay.

protection, he/she probes and sets in a belay and brings everyone in. The last person can now lead since he/she has the protection or give it back to the leader.

Belaying from or into a Safe Area

When traveling and the party enters or leaves a safe area, it is necessary for each climber to be belayed one at a time by the person behind him/her, which can be done with a prusik, as in figure 11-17. Climbers should be ready to go into a self-arrest. For an even stronger belay, the belayer digs a bucket seat or positions themself behind a large anchor.

Short Pitching

Short pitching allows the leader to climb short, difficult, steep, or dangerous areas while the rest of the team stays in a safer area. As the leader prepares to climb, the number 2 person will tie in closer to the last person (approximately 3 meters) and will then set up a belay. The leader will then begin climbing, placing protection as needed and avoiding any loose rock or ice. Once the leader has reached a safe point, he/she will establish an anchored belay and bring the next two up. This process will continue until the obstacle has been overcome.

Figure 11-17. Prusik Belay into a Safe Area.

Bivouac on a Glacier

It is difficult to have a tactical bivouac in the middle of a glacier because it is too open to observation, so Marines should try to get off the glacier to establish a bivouac. During periods of low visibility, however, setting up shelter on a glacier would be acceptable. Hide positions for small teams may be available on moraines and in compartmented sections of the glacier. In general, leaders should look for large, flat moraines and zones of compression that are free of crevasse hazard and rockfall, icefall, or avalanche danger.

After selecting a site, Marines must—

- Probe the entire area with the team members still roped up and on belay with the prusik by the middle person.
- Bisect the circle with an X.
- Probe each section of the bisected circle or pie.
- Wand the entire perimeter. Wands are 4-foot lengths of bamboo with rigger's tape attached to the top like a flag. They are used for marking crevasse danger, avalanche perimeters, the perimeter of bivouac sites, and as route markers. Units must open purchase wands, as required. Climbers should not go outside the perimeter without roping up.
- If required, build wind walls out of blocks of snow. Build these as thick as time allows.
- Anchor tents well.
- Dispose of waste in a crevasse.

Crevasse Rescue

Even when a rope team takes all the necessary precautions when traveling through a crevassed glacier field, the chance of a crevasse fall still exists. The methods of rescue discussed in the following subparagraphs are designed for at least a three-person rope team if the lead climber is the victim. With some adjustment to the organization, these methods can also be used for any member of the rope team who has fallen through or for larger climbing parties. Regardless of the situation, each member of the rope team must react quickly to affect a safe rescue. When any member of a team falls (in a crevasse or not), he/she should immediately sound off with FALLING. Other team members will immediately execute a self-arrest. See figure 11-18.

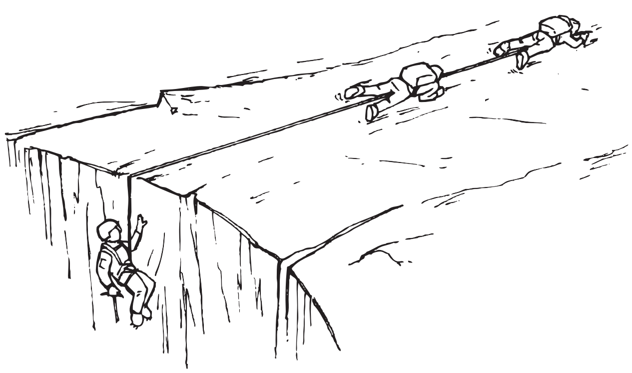

Figure 11-18. Initial Reaction to a Crevasse Fall: Team Arrest.

Anchoring a Semi-Submerged Climber

The most common type of fall is when the climber falls through the snow layer up to the waist or chest. If this happens, the rest of the rope team will immediately assume the arrest position. They will try to dive backwards and remove any slack from the system. The fallen climber will perform self-rescue by pulling themself out using his/her axe. The other climbers that are still on the surface will plant their axes and walk or crawl backwards in their tracks, also known as the gang haul technique. One Marine will coordinate the team so they can pull at the same time. The other members of the rope team will assist the fallen climber by establishing a sound anchor and belaying him/her to safety.

Anchoring a Totally Submerged Climber

If a climber falls and is completely submerged, the rest of the rope team will assume the arrest position to stop and hold the fallen climber. After this immediate action, they attempt to communicate with the fallen climber and then attempt a gang haul. The number 2 (middle) person on the rope team takes the entire load onto his/her arrest position. The number 3 (last) person eases off his/her arrest position slowly, ensuring that he/she does not shock load the number 2 person's arrest position. These two individuals must communicate with each other. The number 3 person moves down toward the number 2 person's position while trying to establish communication with the fallen climber to determine his/her condition. He/She will self-belay with his/her waist prusik.

Once at the number 2 position, he/she will drop his/her pack nearby, anchoring it if on steep terrain. He/She will first probe the area a few feet behind the number 2's feet to ensure the area is safe. Then, the number 3 constructs two separate snow or ice anchors (as discussed in chapter 10) and creates a two-point equalized anchor—either in line or side by side.

To construct in-line anchors—

- Place the first anchor and then a second one directly behind and in line with the first.
- Ensure the anchors are several feet apart so they do not end up sharing any localized weakness in the snow.
- Connect these two anchors together using a long runner or piece of cordage in the manner shown in figure 11-19. If the first anchor is a T-trench or fluke, a long or extra runner may be needed in order to reach the rear anchor. If so, attach the runner from the first anchor carabiner to the second anchor carabiner using a round turn and two half hitches in order to tension and secure the two points.

To construct side by side anchors—

- Place the second anchor offset to the primary anchor.
- Attach a carabiner to each anchor.
- Clip a long runner or piece of cordage into both anchors, ensuring that the angle between the two is less than 90 degrees, to reduce the forces applied to the both anchors.
- Equalize them in the direction of pull and tie an overhand or figure-8 knot.

Once the equalized anchor is established, the number 3 will extend this equalized point by clipping a quick draw into it. He/She then attaches a short prusik to the loaded rope, which will function as the safety prusik within the mechanical advantage system. This prusik is then attached to the runner already placed in the equalized anchor. See figure 11-20.

The number 3 then places a locking carabiner into the equalized anchor point, grabs the rope above where the number 2 is tied in, and attaches it to the locking carabiner with a tied off munter hitch (figure 11-21 on page 11-16).

Once complete, the number 2 will slowly ease off the loaded rope, ensuring not to shock load the anchors. At the same time he/she will be ready to jump back into self-arrest should the anchor fail. He/She anchors themself in by his/her ice axe or by clipping into one of the anchors and removes his/her pack. See figure 11-22 on page 11-16.

The number 2 will then unclip from the rope and untie the knots, not forgetting to also remove the foot stirrup prusik. Meanwhile, the number 3 will take in the slack. When the system is taut, the munter hitch is tied off with two half hitches.

> *Note: If the munter hitch is used to lower the fallen climber to use another passage out of the crevasse, such as a shallow depth crevasse or ledge, then the team will release the prusik or they can cut it.*

Next, the number 2 and number 3 switch jobs. The number 2 stays at the anchor and the number 3 moves toward the crevasse with his/her axe/pack. The number 3 should probe his/her path to ensure there are no other hidden dangers. He/She may self-belay using his/her waist prusik.

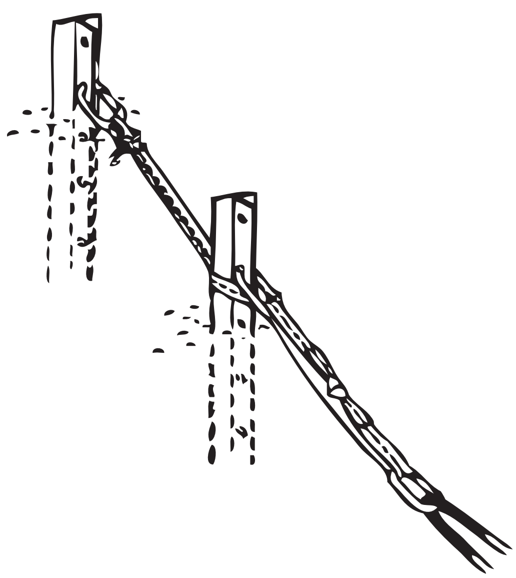

Figure 11-19. In-line Anchors.

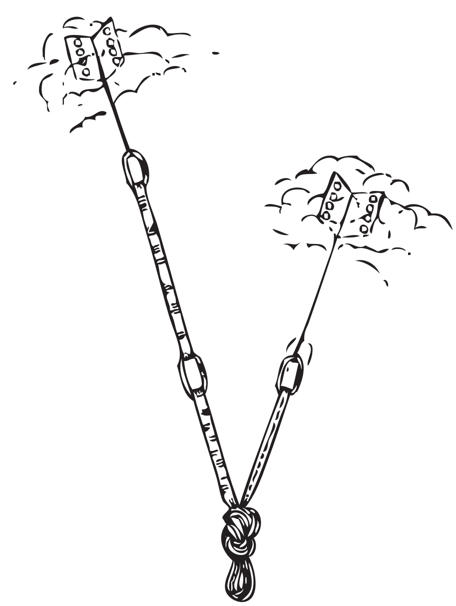

Figure 11-20. Side-by-Side Anchors.

Once at the edge of the crevasse, the number 3 climber checks on the condition of the fallen climber (see fig. 11-23). If the fallen climber is unconscious, the number 3 will ensure that he/she is not entangled in the rope, which may be strangling him/her; submerged in water; or in immediate need of first aid. If so, a rappel line, which should be a separate rope on a separate anchor, into the crevasse may be needed.

Extraction

If immediate first aid is not required, the number 3 will determine if the victim should be lowered, raised, or allowed to perform a self-rescue.

Lowered

When preparing to lower a victim, the number 3 stays and observes him/her, while the number 2 removes the prusik and clips it into the last locking carabiner. The munter hitch is untied and the victim is lowered. The number 2 person controls the munter hitch and the prusik, listening for commands from the number 3.

Raised

The number 3 prepares the lip of the crevasse by padding it to minimize further entrenchment of the rope; he/she slides the axe shaft, pack, or other piece of equipment under the rope, being

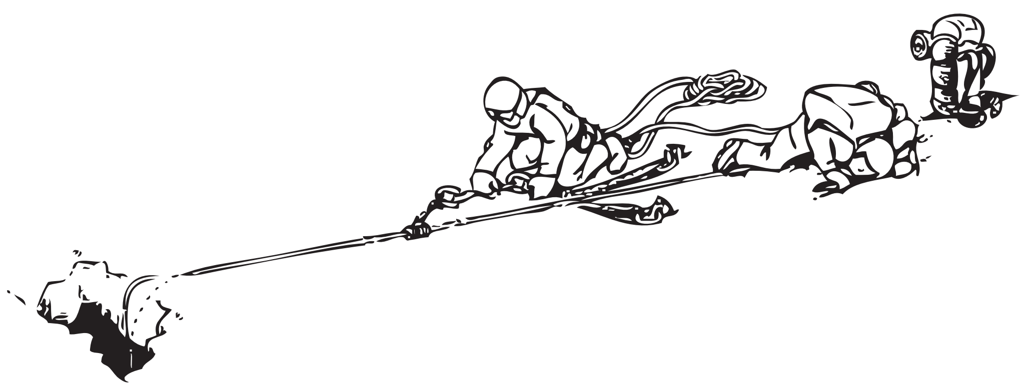

Figure 11-21. Anchoring Off Fallen Climber.

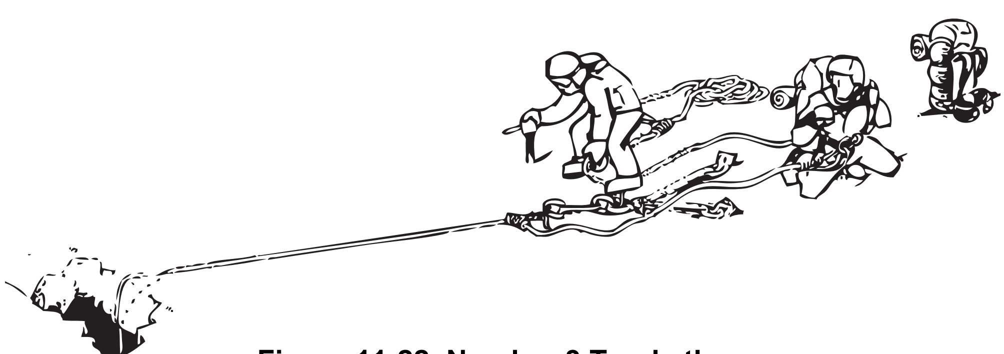

Figure 11-22. Number 3 Tends the Munter Hitch While Number 2 Eases Off the Arrest.

careful to not cut the rope on sharp edges and anchoring the equipment to prevent it from falling onto the victim and into the crevasse. The team then builds either a 3:1 or 9:1 mechanical advantage system for raising the victim.

Z Pulley System (3:1 Mechanical Advantage). Once the number 3 has padded the lip of the crevasse, he/she will move back a few feet from the edge and place another six-finger prusik on the line to the victim. He/She clips the rope that is on him/her into that prusik with a carabiner to help create the mechanical advantage system. The number 3 is still attached to the end of the rope that is attached to the anchors by his/her waist prusik. He/She will now move back toward the anchors using his/her prusik for belay. The number 2 unties the munter hitch, ensuring that the rope now runs freely through the carabiner without completely unclipping the rope from the carabiner.

Both climbers will now attempt to pull the victim out of the crevasse with the number 2 person attending to the safety prusik to keep it from passing around to the other side of the carabiner. The number 3 person can pull on the end of the rope or on his/her prusik. See figure 11-24. Before cycling the system, the safety prusik must be set.

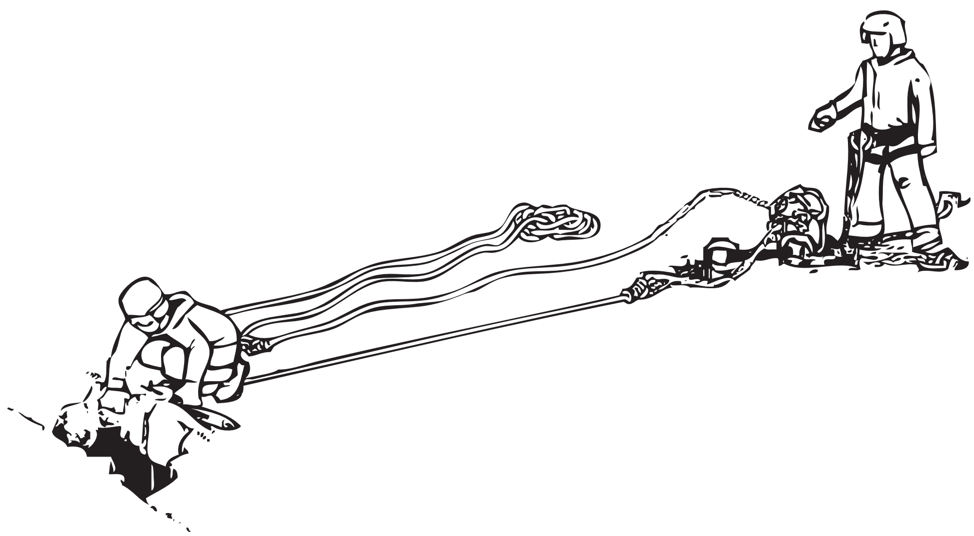

Figure 11-23. Number 3 Checks Victim.

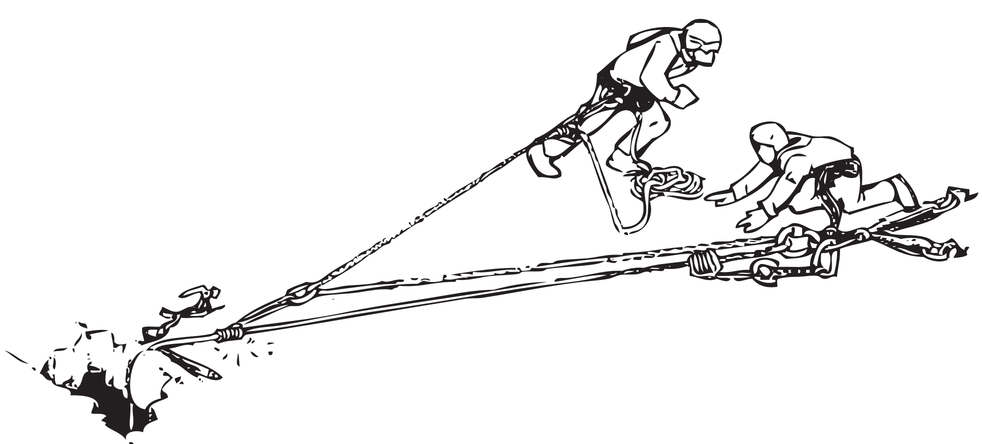

Figure 11-24. Pulling the Victim Out.

Note: Pulleys, if available, will be placed on the carabiners through which the rope runs to reduce friction and ease the hoisting of the victim.

Z-Z Pulley System (9:1 Mechanical Advantage). This system is constructed in the same manner as in chapter 5's discussion of the one-rope bridge except for the munter hitch attachment.

Note: The 9:1 will only be used if the victim is conscious and the rescuers have positive communications with him/her because the Marine could be suffocated by the pressure if caught against a roof.

Multi-Rope Team Gang Haul

The decision to use this method will depend on the situation, such as if a fallen climber is conscious and able to assist in his/her extraction, the victim is in immediate need of medical care, or another team is in the area to assist. When employing the multi-rope team gang haul, one team member on another rope will position themself near the edge of the crevasse to watch the victim and to control both rope teams. All rope team members attach themselves to the line and will pull the victim slowly out of the crevasse.

Self-Rescue

If the victim is in shallow, within quick mantling or short tooling to get out, the number 3 will stay to observe and help the victim, while number 2 tends the anchor.

If the victim is in deep and beyond a quick mantling, the fallen climber ascends out of the crevasse by using the cordage already prerigged from his/her harness to the rope (see fig. 11-25) and performing the following steps:

- Removes any rope coils he/she may be carrying.
- Takes off his/her pack and gently lowers it.
- May unclip the rope from his/her chest harness.
- Slides the waist prusik up as far as it will go. He/She may need to step up in the foot stirrup to get weight onto the waist prusik.
- Unclips the locking carabiner from the end of the rope.
- Ascends the rope by weighting one prusik and sliding the other up the rope and then switching.

Once he/she reaches the lip, he/she may have to use his/her axe or crampons as discussed in chapter 10 to get out of the crevasse.

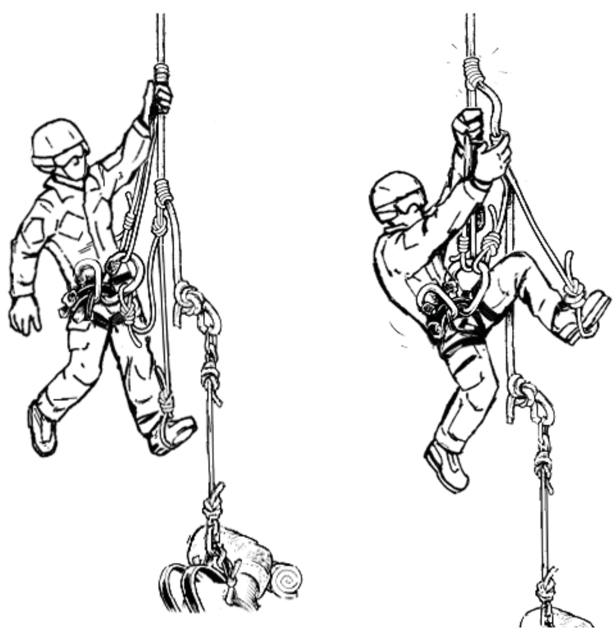

Figure 11-25. Self-Rescue.

If the climber is injured or unable to self-rescue, he/she will do the first three steps. He/She will get warm gear from his/her pack and wait for rescue. He/She also has the option of clipping their pack to the rope below his/her tie-in figure-8, so the surface team is only hauling half the weight of the pack, since it is on a 2:1. When the surface team begins to haul, he/she should help in any way possible.

Note: If the number 2 climber happens to be the one to fall into a crevasse, he/she may be suspended between the two walls of the crevasse due to the rope being taut by the first and last members of the rope team. The surface members must communicate and determine who will set up an anchor.

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CHAPTER 12
FIRES IN A MOUNTAINOUS ENVIRONMENT

All aspects of fires, whether kinetic, nonkinetic, small arms, or fire support assets, are affected in the mountains. Planning for effective fires employment must include factors such as the effect of cold weather and the mountainous environment on mortars, artillery, naval gunfire, and close air support (CAS). Other factors include communications; slope angle; surface material; altitude; and strong, changing winds.

Fires Planning Considerations

Due to the high angle of fires, the impact of a round on its target needs to be adjusted. To compensate for the effect of slope angle, Marines must aim low and use the map distance for sight settings or estimate the range and make sight adjustments. They must then aim at six o'clock or less and adjust from impact. The actual trajectory of rounds is from the horizontal distance they travel, not the LOS distance; hence, using map distance is a simple, effective way to make initial sight settings. See figure 12-1 on page 12-2.

The mountainous environment will put an additional burden on foot-mobile troops. Planners must consider the transport/emplacement of crew-served weapons at altitude and on slopes as well as ammunition re-supply from a limited road network. They must also understand the ability/inability to fire into defilade, such as the difference between the effectiveness of the MK-19 and the M2 .50 caliber guns. Indirect firing tables for machine guns become necessary.

In snow-covered terrain, Marines must remember that snow cover reduces depth perception and obscures ground features and landmarks; ice fog can also limit observation if the conditions exist for it. During extreme cold, the rate of fire will be slow until the weapons have warmed up, so weapons and ammunition should be kept at the same temperature as the surroundings to avoid condensation and have consistent ballistic computations.

Mortars

Mortars are the most responsive indirect fire support in the mountains, but Marines should consider the following points when planning for mortar employment:

- 60-mm mortars in the hand-held mode are effective while on the move.
- 81-mm mortars are too heavy to move effectively outside the wire because there is not enough range for defending a FOB/fire base; however, leveraging pack animals or vehicles helps to mitigate those shortfalls.
- Mortars are less affected by steep terrain.
- High angle of fire limits dead zones.
- Reverse slope positioning is feasible.
- Mortars have smaller firing position requirements.
- Observation and adjusting fire change significantly.

Those adjusting mortar fire on a slope need to understand that a shift of deflection will often also affect range. This spatial problem will cause more rounds in adjustment than on flat ground. Sheaf elongation will also occur on slopes. The steeper the slope, the more spread out the sheaf will become.

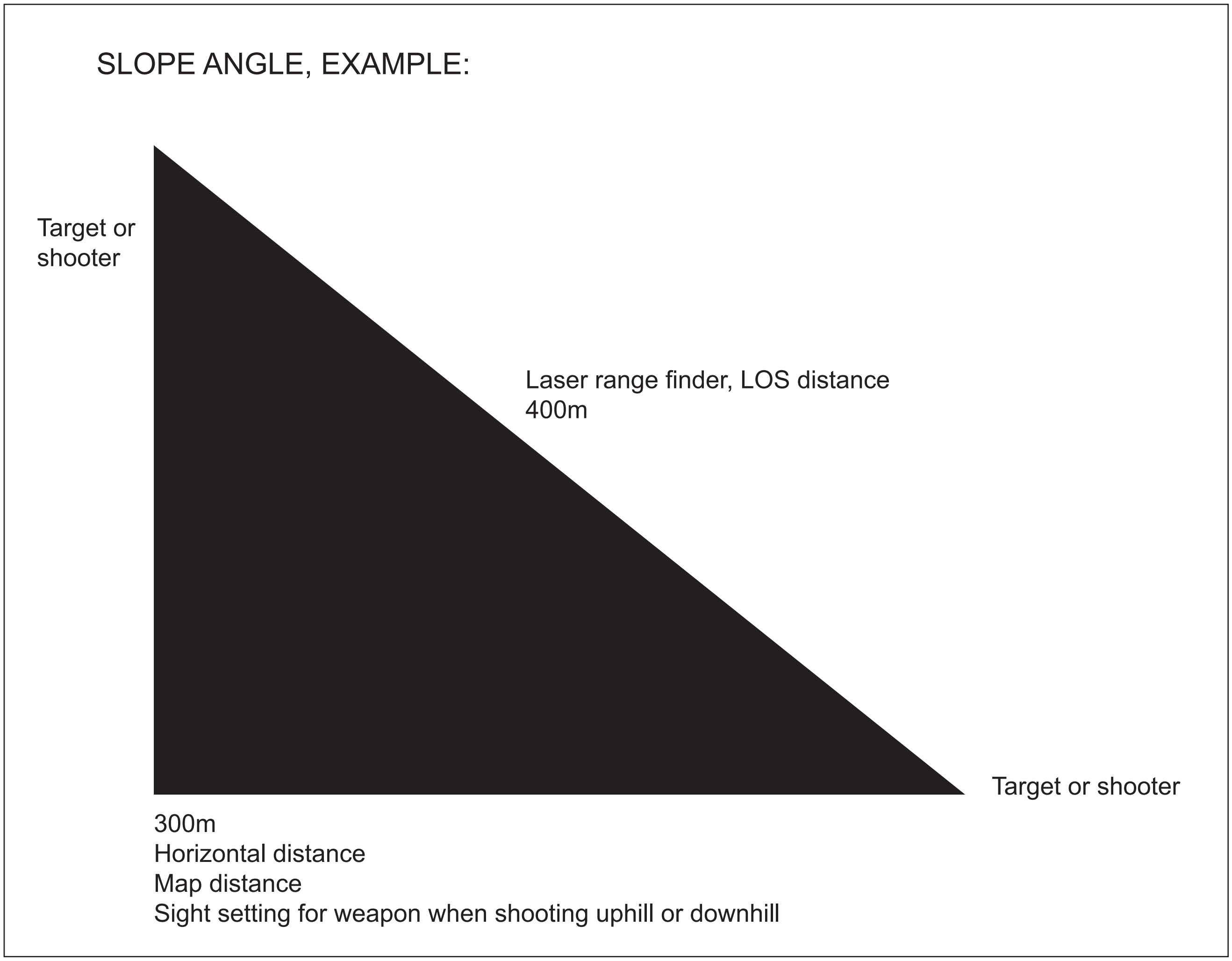

Figure 12-1. Aiming at Angles.

> *But consistently with the 120-mm mortar and also with our mortars at the company/battalion level, we were able to respond within that seven- or eight-minute period and we got a lot of kills with the mortars. I would say probably half the guys we killed we killed with mortars so I'm a very big fan of that system.*
>
> *—Commanding Officer 1/3*
> *2010 OEF, MCCLL after action report*

In mountainous terrain the observer will determine the vertical difference between the observer and the target. The vertical difference will be transmitted in the call for fire as an up or down shift from the altitude of the observer to the altitude of the target if the shift is 35 meters or more. Any vertical shift that is determined will be transmitted to the nearest 5 meters. The vertical shift increases the accuracy of the target location and should always be given, if possible.

Artillery

The following points should be considered with respect to artillery support:

- Mobility is severely restricted.
- The altitude limits helicopter transport.
- Resupply and the ability to displace artillery are severely affected by the lack of mobility in this environment.
- Increased amount of dead space cannot be covered by artillery, depending upon the positioning of the howitzers.
- The same considerations as mortars apply for artillery when observing and adjusting fires.
- Meteorological data is generally only consistent to 20 kilometers, resulting in the need for individual meteorological capability for disaggregated positions.
- Probable error in range is greater for high-angle fires than low-angle fires. There is an enhanced reliance on tabular firing tables for high-angle fire.

Naval Gunfire

Targets in valleys or on reverse slopes will be very difficult to effectively engage due to the flat trajectory and high muzzle velocity of the rounds. The advantages of naval gunfire are that the weapon systems are not affected by environmental conditions, limited rounds, or sustainment considerations.

Close Air Support

The following points should be considered with respect to close air support:

- Terrain will limit attack options available to pilots and forward air controllers.
- Foul weather may cancel aviation capabilities for extended periods of time.
- The same considerations as mortars and artillery apply when observing and adjusting fires.
- Rotary wing CAS at a high altitude will have reduced ordnance/time on station due to reduced lift capability.
- Targets can be marked with white phosphorus and illumination rounds for suppression of enemy air defense missions.
- The capabilities of aerial observers should be exploited, particularly for the adjustment of fires in dead spaces.
- Lasers can reflect off of ice or smooth snow when designating targets, causing false tracks/misses.

Nonkinetic Fires

The environment affects nonkinetic fires, such as information operations, civil-military operations, and electronic warfare. Compartmentalized terrain leads to isolated, often very different human environment within relatively short lateral distances, so information operations requires specialization of products/materials. The effectiveness of equipment is affected by the complex terrain. For example, radio in a box and the long range acoustic device are limited in distance.

Considerations for civil-military operations include an increased security footprint in order to mitigate dead space and potential enemy avenues of approach, such as when conducting medical civil-affairs programs. The reparations process also takes longer in this environment due to the increased time it takes to travel to remote and isolated valleys. See Marine Corps Warfighting Publication (MCWP) 3-35.1, *Mountain Warfare Operations*, for more information.

Electronic warfare LOS is also limited when using IED defeat equipment. Planners must also consider the force protection implications regarding how terrain affects electronic warfare capabilities.

Fire Support Considerations

Maps alone are not good enough for planning. Detailed IPB and development of a MCOO must occur. The MCOO must be continuously updated as more information about the terrain is gathered. These updates will facilitate proper terrain selection that mitigates geometries of fire. Planners must also ask themselves at what level in the chain of command that fires are cleared for disaggregated units (see fig. 12-2). They must also understand the specific personnel requirements throughout the battlespace.

Observer transmits CFF to FDC.

    BN FSCC monitors CFF.

FDC post fire mission in mIRC.

FSCC deconflicts all units in A/O.

Air officer deconflicts all air.

FSCC sends approval/disapproval over mIRC.

FDC passes MTO and shot to observer.

Method of comunication:

    Primary - mIRC

    Secondary - TACSAT

    Tertiary - phone

LEGEND

A/O	area of operations	**FSCC**	fire support coordination center
BN	battalion	**mIRC**	multi-user internet relay chat
CFF	all for fire	**MTO**	message to observer
FDC	fire direction center	**TACSAT**	tactical satellite

Figure 12-2. Fires Deconfliction Procedures Example.

Communications

Communication considerations include identifying and prioritizing the available communications networks for approval of fires, such as multiuser internet relay chat, tactical satellite nets, and high frequency nets. Forward air controller (airborne) and airborne command and control can significantly increase control and help shape the battlefield.

> *It was really easy to get on your little portable PRC-148 and call for fire, but when there is only one net it made calls for fire very difficult.*
>
> *—Center for Army Lessons Learned OEF Commanders Handbook*

Targeting

Complex terrain increases the importance of suppression of enemy air defense, but planners must be aware of ROE implications when employing harassment and interdiction fires. Targeting approval is restricted due to terrain masking.

Cold Weather Effects

The following are general considerations regarding the effects of cold weather (see MCRP 3-35.1A for detailed information):

- Reduced velocity and range of projectiles. As the temperature drops, so does the muzzle velocity and the range of projectiles because of a change in both internal and external ballistics.
- Internal ballistics. Internal ballistics occurs inside the weapon. The burning rate of propellant decreases, also decreasing the rate of gas expansion and the speed of the projectile down the bore.
- External ballistics. External ballistics occurs after the projectile leaves the muzzle. Decreased muzzle velocity reduces the projectile's stability once it leaves the muzzle, possibly severe enough to cause projectiles to tumble. At longer ranges, this reduced stability further reduces velocity, range, and accuracy. Colder air is denser than warmer air, which increases drag on the projectile, further reducing range.
- Condensation forms on weapons when they are brought from a cold environment into a

heated shelter. The moisture in the air condenses on a surface, leaving a film of moisture. This film can freeze when taken outside again, causing malfunctions.

- Crew-served weapons requiring some type of base or platform for firing will need special consideration. Emplacement of a weapon on snow, ice, or frozen ground may result in breakage or inaccuracy because of sinking or the inability to absorb shock.
- An increase in breakage or malfunction may occur when the first few rounds are fired due to the uneven expansion of metal parts caused by the rapid temperature rise. Firing slowly or in short bursts, at the sustained rate initially, will give the weapon time to warm up and alleviate the problem.
- Ammunition will be greatly affected.
- On frozen ground, ice-covered ground, and/or rocky terrain, fuze quick (point detonation) should be used. Fuze quick increases the fragmentation of high explosive rounds due to secondary projectiles.
- Fuze quick is ineffective in snow-covered terrain, as up to 80 percent of the fragmentation is absorbed.
- The standard temperature for firing tables is 70 °F. During extremely cold periods, indirect fire support rounds commonly impact 100 meters short for every 1000 meters of range.

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CHAPTER 13
LOGISTICS AND SUSTAINMENT

This chapter addresses various aspects of logistics that are unique to mountainous operating areas.

Casualty Evacuation by Pack Animal

Equipment and animal availability dictates the response to critical situations. The many parts of saddles and gear strapped on the animals can be utilized in ways other than those for which they were intended. In these situations, Marines should use their imaginations and common sense to help devise almost any type splint, bandage, sling, or stretcher. They can rig slings for transportation with equipment not necessarily intended for that purpose; however, using any part of the equipment may hinder the ability to ride out for help or transport the casualty. Most of the items of equipment mentioned can be unbuckled or unsnapped rather than cut. If a strap needs to be cut, it should be cut close to a ring, buckle, or snap, so as to possibly save hours of repair later.

When being transported by animal, a casualty who is subject to fainting or severe pain when moving should not sit up in the saddle; he/she will be subject to further injury if he/she falls. Such a fall could also upset the animal. In most cases of back, neck, or spinal injury, it is best not to transfer the casualty a great distance using animals. Key considerations include whether or not the casualty is on an emergency backboard and the distance to medical assistance. In most short distance transports a hand-held stretcher or travois pulled by a member of the team will be faster than rigging a horse for transportation.

When considering transporting a victim with animals, Marines should NOT—

- Drape a wounded person head down across a saddle.
- Allow a victim who is inclined to pass out or is unsteady to ride alone.
- Trot or run the animal carrying a seriously sick or wounded casualty; a slow, easy walk gets him/her to assistance in better condition.
- Leave an animal unattended with a victim strapped or tied to the saddle.

Marines should maintain control of a horse's head at all times and, before riding double with a victim, find out if the horse will ride double by sliding behind the saddle, without the victim. If the horse will ride double, the buddy rides behind the victim and holds him/her in the saddle.

Travois Litter

One of the simplest and fastest means of transporting a casualty who cannot ride is a travois drawn behind one horse. This method requires getting a gentle horse used to pulling the travois before putting the casualty on one. Personnel can construct a stretcher with two strong 15- to 20-foot poles that will support 200 pounds and running the poles through barrel hitches on the onside and offside of the animal. It takes the horse a little while to get used to this rigging. In the travois, the poles form an X over the back of the packsaddle.

If the emergency involves only two team members and the casualty is conscious, the buddy should place the casualty's head toward the horse and have him/her hold the reins. If this is not possible, he/she should tie the bridle reins to the poles, one on each side. This type of emergency stretcher is good for rough country or long-distance transportation. Most horses will tolerate the stretcher between them when they have a little time to become accustomed to it.

In the travois, the ends of the poles drag along the ground and leave ruts behind. This system does not work well if the ground is muddy or waterlogged. The casualty will be soaked in only a few minutes and the handler must pick up the end of the litter and lift it over rocks, logs, or other obstructions. Crossing water obstacles requires the handler to hold up the litter and wade through the stream. A drape, stretching from the animal's rump to the poles of the litter, will prevent gas or manure released from the animal to distress the casualty.

Stretchers

Gunnysacks, canvas panniers, raincoats or saddle slickers, pannier tarps, saddle pads, mortuary adult shroud sheets (body bags), and blankets can be used to make a stretcher. In most pack outfits, there are gunnysacks that can be used either to chink up a pannier or to carry grain. By cutting two holes in the bottom corners of the sack and inserting two good poles, Marines can create a wilderness stretcher.

Marines can make a stretcher with panniers as with the gunnysacks. They can also use them to lower or raise an unconscious casualty over such obstacles as a cliff or deep cut by cutting two holes the size of the casualty's legs in the bottom corners, slipping his/her legs through these two holes, and pulling the fabric up around his/her chest. The knots used in tying a rope to the pannier should be tested with one's own weight before trusting them on the casualty. Raincoats, heavy coats, jackets, and saddle slickers can also be used to make a short-distance stretcher by buttoning them up the front (zippers are the best and most reliable) and running two poles through the inside of the garment and out the armholes. Pannier tarps and large double saddle pads can also be used to make an emergency stretcher.

Splints

Stirrup straps and fenders, pack pads, pannier tarps, pieces of wood, box panniers, and the bars out of pack saddles can be used to make splints. The following examples describe ways splints can be made from these materials:

- Make a backboard by taking wood box panniers apart and either lashing or using the old nails in the box to fasten the flat boards to two small dry poles.
- Using their flat surface, bars out of a packsaddle can make a serviceable splint in a situation where other natural materials are not available.
- Stirrup straps and fenders out of a riding saddle are by far the best and simplest to obtain. They can be unlaced or unbuckled and pull out from the saddle without damaging the equipment.
- Stirrup straps and fenders from a riding saddle are already formed to the legs; therefore, using both straps and fenders can immobilize the legs of a victim. Rescuers can use one stirrup strap to immobilize arms.
- Several small poles lashed flat and then padded with pack pads can make a backboard.
- An open bayonet scabbard either down the seam or laid flat can make a splint.

Straps for Lashing to Backboards

Latigos, lash cinches, saddle cinches, breast collars, brichens, and bridle reins can all be pressed into service. There are many large, heavy straps and cinches on a pack outfit or riding saddle that can be used for the bindings of splints or backboards easily without cutting them and damaging the equipment unnecessarily.

Sustainment Planning Considerations

There are many things to consider when planning to sustain the force in a mountainous area of operations. Supplies, delivery times and methods, maintenance, and the provision of healthcare to those who need it have unique considerations in the mountains.

Fuel Consumption Rates

The efficiency of vehicles, animals, and personnel is significantly decreased when operating in a cold weather, mountainous environment due to the decrease in oxygen. All are impaired and planners must consider ways to mitigate inefficiencies.

Vehicles

Trucks are important to logistic support and gasoline-powered trucks are preferred over diesel. As a vehicle ascends a mountain, the amount of oxygen available is reduced, so the engine's cross-country driving and climbing efficiency drops and fuel usage increases. On average, vehicles lose 20 to 25 percent of their rated carrying capacity and use up to 75 percent more fuel. Figure 13-1 illustrates the average increase in fuel consumption at altitude. Additionally, idling a vehicle's engine is a wasteful and hazardous practice that could have detrimental effects on supply due to increased fuel consumption, discharge of batteries, and excessive engine overheating.

Animals

High mountains impede the technological solutions that typically give the military a tactical advantage because they do not work the way they are intended in a cold weather, mountainous environment. Consequently, animals are a viable option for high-altitude logistics. American mules, for example, can carry up to 300 pounds (about 20 percent of their body weight) for 15 to 20 miles per day in mountains. However, at high altitude, the maximum carrying weight drops below 200 pounds. When planning to pack an animal string, individual animals vary in their feed requirements—approximately 2 percent of the animal's body weight in feed (dry weight) is required per day. As the temperature drops below freezing, animals will require an additional 1 percent of feed for each degree the temperature drops.

Personnel

High altitude operations increase energy requirements by as much as 50 percent and, coupled

			Light Vehicles (Gasoline)	Trucks 3 - 5 Tons (Diesel)		
		Type of Slope	Average Load	Loaded	Unloaded	Observations
Low Mountains	Under 3000 meters	3 to 5%	16	25	20	Good engine performance
		6 to 8%	17	30	25	
Medium Mountains	Up to 3000 meters	3 to 5%	17	30	25	With good roads
		6 to 8%	18	32	27	
High Mountains	3000 to 4000 meters	3 to 5%	18	32	27	Head winds increase consumption by 10%
		6 to 8%	20	35	30	
	Above 4000 meters	3 to 5%	20	35	30	
		6 to 8%	25	38	33	

Figure 13-1. Fuel Consumption Rates in Liters per 100 Kilometers.

with cold temperatures and increased physical activity, can make Marines' missions a secondary thought to surviving. The increase in physical activity may only be offset by thorough acclimatization, conditioning, proper equipment, and special skills and training.

Weight loss is a characteristic of operations at high altitudes. The average weight loss for a special forces team living on Pakistani rations and working with the high-altitude mountain school in 1994 was 20 to 25 pounds. High altitude operations increase energy requirements by as much as 50 percent (6,000 calories and up to 8 quarts of water daily). When coupled with cold temperatures and increased physical activity, requirements can increase. Working at high altitudes requires more energy and Marines will lose weight, but weight loss must be controlled so it does not become incapacitating. Appendix F discusses warfighting load requirements.

Lead Times Associated with Ordering Items

Unlike regular operations, such as Operation Iraqi Freedom, which have a substantially more developed and robust supply system, operations in cold weather and mountain terrain make expediting item delivery much more difficult and time consuming. The following points should be considered:

- High priority and sensitive items could be moved internally via helicopter.
- Items procured locally can take 30 to 90 days.
- Items procured from the United States can take 3 to 7 days if using a commercial vendor, such as DHL or FEDEX.
- Distance is measured in time, not space.

Classes of Supply

Each class of supply needs to be examined for operations in a cold-weather, mountainous environment. Classes I, II, III, V, and IX are especially affected.

Class I

Additional meals, ready to eat (MREs) should be ordered to account for the increase in energy expenditure. Other options include the long range reconnaissance ration and the First Strike ration.

Class II

Cold weather considerations require the procurement of squad stoves, which are crucial for melting snow in below freezing environments. The stoves are used to sterilize water when potable water is unavailable. Cold weather clothing, such as over boots, down mitten jackets, and 100 percent ultraviolet protection glacier glasses should also be ordered.

Class III

Antifreeze materials specified for operations in cold weather are a 50/50 mix of water and antifreeze. Oil, engine arctic is a synthetic SW20 lubricant used for temperatures down to -65 °F and is approved for engines, power steering systems, hydraulic systems, and both manual and automatic transmissions. For weapon systems, lubricant, arctic weather should be used unless otherwise specified.

Class V

Ammunition transfer points need to be as far forward as possible to lessen the chance of a resupply mission being postponed/delayed due to unforeseen circumstances, such as weather and downed vehicle/aircraft. Contingency packages of ammunition stock should be bundled by numerous methods of delivery, such as a platoon-sized raid package being bundled in both a highly mobile multi-purpose wheeled vehicle and a CDS, should the only means of resupply be an air drop.

Class IX

Due to the increased wear and tear on vehicle parts, a unit should increase its class IX block by 300 percent.

Methods of Distribution

Each method of distribution has considerations.

Combat Logistics Patrols

These are the typical ring routes or main supply routes used frequently for resupply. Combat logistic patrols are most effective when the terrain is relatively flat and the risk level is acceptable. Combat logistic patrols can be used for any class of supply, but primarily for sensitive cargo, class VII, and class IX. In areas in which snow accumulation is too deep, tactical marginal terrain vehicles/over-the-snow vehicles should be used if available, such as the small unit support vehicle (BV-206).

Host Nation

The use of the host nation's resources is important in complex, compartmentalized, mountainous terrain because of the people's familiarization and experience traversing the terrain. Host nation support could include motorized assets, whereby locals would load equipment on to their trucks and haul it to the destination. Porters may be contracted from the local populace, since they are acclimated to the elevation and are accustomed to moving around the mountains safely. Locals used to carrying loads have developed endurance and are accustomed to breathing the thin air; however, porters will probably be reluctant to work too far away from their homes and villages and there is always a security consideration when using local porters.

Once in the mountains, all operations will cease if we are not able to conduct resupply. When moving at altitude, it is nearly impossible to carry enough water to sustain a unit for more than a day. Soldiers are able to carry enough water for one day of long movement. It would regularly take an entire day to move up to three KM in the mountains. The map does not accurately depict the terrain at all and as a result there must always be secondary, tertiary, and emergency plans to conduct resupply.

—Rob Stanton 10th Mountain Division OEF VII

Bottled water has been our biggest sustainment issue.

—Executive officer BLT 1/6 OEF (24 MEU)

In Nuristan province, we depend on air re-supply in most locations. In order to get a re-supply, the weather must be good from Bagram to Nuristan and all places in between.

—Capt Matt Gooding

The fire base in Aranas received over three feet of snow during the first week of December. This resulted in our inability to conduct aerial resupply, local and long range patrols, and limited potential CASEVAC options. We were prepared for this due to a stockpile of Class I, winterization efforts, achio sleds for CDS recovery, and the fact that the weather affected the enemy's ability to move as well. Items that would have assisted us would be snowshoes suited for mountainous terrain, crampons for boots to conduct local patrols, and accurate CDS drops.

—Capt Joe Evans

Pack Animals

Pack animals were used by the US Army during World War II to advance in Italy and were a critical element of the Mujahedeen supply effort in the Soviet-Afghan war. Where vehicular and tracked assets for surface transportation and resupply are not feasible, animals may be the only way to support operations in the mountains. When this is the case, Marines should find out all they can about local pack animal methods—and their availability to the Marine air-ground task force (MAGTF)—so they can understand how best to use them to accomplish the mission.

Fixed Wing

Used in major bases and logistic hubs, fixed wing aircraft continue to be the safest and fastest means of transportation. They are used to deliver equipment, supplies and personnel and can aerial drop supplies in more rural areas where surface resupply may not be feasible.

In the past decade, great strides have been made in the field of aerial delivery, with technology advancing to the point that supplies weighing as much as 10,000 pounds can be delivered within an average of 150 meters of the target from altitudes as high as 25,000 feet. The most recent advancement is the joint precision air drop system (JPADS) (see fig. 13-2). The JPADS is a family of GPS-guided parachute systems, which vary in the amounts of weight they are capable of delivering. The Marine Corps has purchased three different versions, each able to carry 750 pounds, 2,000 pounds, and 10,000 pounds, respectively.

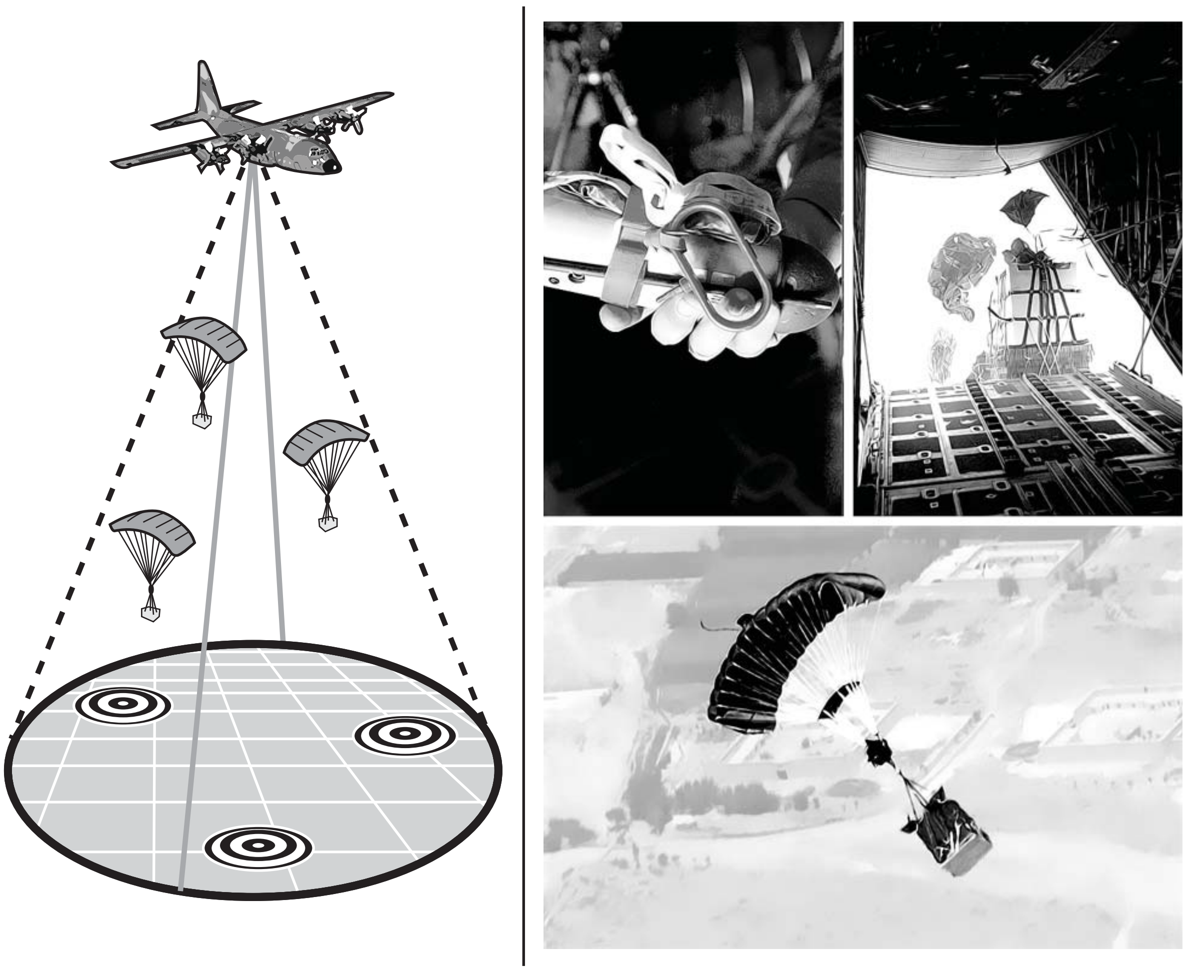

Figure 13-2. Joint Precision Air Drop System.

Each system consists of the canopy and an airborne guidance unit. Prior to being deployed from the aircraft, a GPS coordinate is entered into the airborne guidance unit and guides the parachute in a planned trajectory. The JPADS has been proven to be accurate within 75 meters of its intended target. (The Army uses C-17 fixed wing transport aircraft, which can fly a route six times faster than a rotary wing platform.) Lessons learned reflect the need for an NCO to become familiar with pathfinder techniques and competent running a landing zone/drop zone.

Rotary Wing

Although not as powerful and without de-icing on the rotor blades as the Army CH-47, the Marine Corps CH-46 is still a viable resource to transport equipment and personnel; however, due to the altitude, the cargo loads are significantly decreased. Another method of aerial delivery is the low altitude/low cost method whereby a helicopter will hover over the drop zone and the supplies are kicked out of the ramp. The CH-53E is able to carry more equipment than a CH-46; however, its payload is also decreased because of the altitude.

Limitations of Transportation

Each method of transportation has limitations.

Vehicles

Due to the terrain in mountainous regions, light and fast vehicles are preferred over heavy vehicles for their ability to better negotiate obstacles. The medium tactical vehicle replacement continues to be the favorite vehicle in Afghanistan for its proven reliability and ability to negotiate rough terrain; however, because of the loose sand and complex terrain, the payload is cut in half. As for the highly mobile multi-purpose wheeled vehicle, many after action reports have stated that more "unique" parts are breaking. As more drivers operate in unfamiliar terrain, the main safety concern is the possibility of vehicular rollover.

Host Nation

The use of host nation support involves, to some degree, a security risk because those working for the unit are unknown. Additionally, host nation support is limited because such things as US personnel, ammunition, and US mail may not be transported via host nation assets.

Pack Animals

Planning to use pack animals is not simple, nor is it always a satisfactory solution to a transportation problem. Crude or improvised pack equipment, unconditioned animals, and the general lack of knowledge in the elementary principles of animal management and pack transportation will tend to make the use of pack transportation difficult, costly, and possibly unsatisfactory. Hiring native packers may give the local populace warning that the column is about to move out.

Aircraft

Helicopter-lifted logistics are the preferred mode in mountain warfare, but the mountains are not the optimum helicopter environment. Air density decreases with altitude and mountain winds and updrafts are unpredictable and dangerous. Proper landing zones are difficult to find and, if close to the enemy, probably under mortar and small-arms coverage. Helicopters must follow terrain features of the mountains, adding predictability to their approaches and increasing the risk to the crew, but fog, sudden storms, icing, and variable winds can quickly shut down air support. Mountain terrain also interferes with air-to-ground and air-to-air communications. Detailed planning for helicopter support in the mountains is required as is first-rate liaison and a habitual association between the helicopter and the ground unit.

Convoy Operations

Convoy operation considerations aside from the enemy are visibility, weather, and terrain.

Visibility

Personnel must take note of their exact positions and plan a route to safety before visibility decreases as fog, rain, and blowing snow can lead to disorientation. Cold combined with fog can cause a thin sheet of ice to form on rocks and white-out conditions can be extremely dangerous.

Weather

Weather conditions in the mountains may vary from one location to another as few as 10 kilometers away. Approaching storms may be hard to spot if masked by local peaks, so a clear, sunny day in July could turn into a snowstorm in less than an hour. In preparation, Marines should always pack emergency gear and constantly evaluate the conditions. Under changing conditions, it is advisable to re-evaluate unit capabilities: pushing ahead with a closed mind could be disastrous for the mission and the unit. In winter months, mountain passes close due to heavy snow fall and avalanches and flight days are fewer due to cloud cover. In the summer months, the spring floods increase the chance of vehicles getting stuck or swept away.

Terrain

Route reconnaissance should determine likely ambush locations, which are predominately canalizing areas. Although valleys will most often be the easiest route, they may also prove to be the most dangerous since it is very difficult to engage an enemy that maintains the high-ground. Route reconnaissance and mountain picketing should also focus on maintenance/recovery challenge areas, equipment collection points, locations where vehicle rollovers are likely, and the estimated maximum throughput of vehicles on a road network or bridge. Due to the increased travel times associated with moving in high altitude, combat trains should be positioned as close to the tactical unit as possible.

Health Services Support

Operating in the mountains not only causes added stress on fuel-powered engines, but also on the human body. In order to become acclimated, the body must go through physiological changes, which vary from person to person. Successful acclimation depends on the degree of hypoxic stress (altitude), the rate of onset of hypoxic stress (ascent rate), and individual physiology (genetic differences between individuals). See MCRP 3-35.1A for detailed information.

Acute Mountain Sickness

An acute, self-limiting illness, AMS results when an unacclimatized individual ascends rapidly to

The most serious accidental risk is vehicle rollover. The terrain here is extremely dangerous. A good driver's training program will help prevent it, but they are still going to happen. I think the most important thing is to rehearse rollover drills, and ensure everything in the truck is tied down IAW the load plan. This will go a long ways towards preventing injury when a rollover does happen. Also, using the HEAT trainer, to show soldiers what it feels like when the truck is about to rollover, helps.

—Capt Ryan Workman 10th MTN Div, OEF VII

Speaking of terrain, it is really canalized, and there aren't a lot of options [for] getting from point A to point B. With the cell phone coverage, the enemy can easily call ahead to let people know your route. The IED threat is very real and because of the terrain—irrigation canals, culverts—it is extremely difficult to predict.

—Capt Jason Toole 10th MTN Div

high altitude. It is rare below 8,000 feet, but will occur in approximately 42 percent of persons rapidly exposed to altitudes greater than 10,000 feet. Aerobic fitness is no predictor for risk of AMS with exposure to altitude. Prior ascents to altitude without symptoms of AMS are no guarantee against having symptoms of AMS with future ascents. However, those with past AMS are at an increased risk of AMS with repeat exposure to high altitude.

Symptoms tend to occur within the first 1 to 3 days of exposure to altitude. Symptoms should resolve spontaneously within 15 to 24 hours if the individual descends. The three most prominent symptoms are headache, nausea, and vomiting. Although nonspecific, headache must be present to make a diagnosis of AMS, but 95 percent of AMS victims will complain of one or more of these three. Other common complaints include dizziness, drowsiness, malaise, weakness, and insomnia.

If personnel begin demonstrating signs and symptoms of AMS, leaders must stop any further ascent as further ascent puts individuals at risk for more severe altitude illness. Symptomatic treatments, such as aspirin, Motrin, and Tylenol, may be used for headache; Compazine, Phenergan, and Alka-Seltzer are used for nausea. Other medications, such as acetezolamide (Diamox, national stock number [NSN] 6505-99-210-8425) and dexamethasone (Decardron, NSN 6505-00-394-1862) can be taken separately. If none of these methods helps, then individuals should descend 1,000 to 3,000 feet which will usually ease the symptoms. Most cases, however, improve in 1 to 2 days with symptomatic treatment.

The best approach to high altitude travel is staged, gradual ascent, when moving at altitudes greater than 3,000 meters. Gradual ascent means no faster than 3,000 feet per day up to 14,000 and no greater than 1,000 feet per day over 14,000 feet, with an additional day of rest for every 4,000 feet gain. Other key measures to prevent altitude sickness are to avoid alcohol, maintain adequate fluid intake (will not prevent high altitude sickness, but will prevent dehydration), and work at a higher altitude than one sleeps.

High Altitude Cerebral Edema

A high altitude sickness, HACE is caused by swelling of the brain. It can occur as low as 8,000 feet, but typically occurs higher than 12,000 feet. Considered to be a progression of AMS, HACE occurs due to a failure to heed the warnings of AMS signs and symptoms and continued ascent. Signs and symptoms include mental status changes, poor judgment, personality change, hallucinations, confusion, difficulty in concentration, and decreased level of alertness.

Descent is the only definitive treatment. Like AMS, Decadron can be used in conjunction with oxygen. If available, a gamow bag (NSN 6515-01-504-6306), which is a portable hyperbaric chamber that weighs 14 pounds, can take a casualty from 14,000 feet to 7,000 feet in 4 to 6 hours. Operated by a foot-pump, the bag is pressurized to an internal pressure of 2 pounds per square inch.

High Altitude Pulmonary Edema

A high altitude illness, HAPE is characterized by filling of the lungs with edema fluid and rarely occurs below 12,000 feet. It presents in 1 to 2 percent of climbers brought rapidly to 12,000 feet and commonly occurs within 2 to 4 days of ascent. Signs and symptoms include cough, chest tightness/pain, increased respiratory rate, and increased heart rate. Immediate descent to a lower altitude with emergency care is necessary as fatalities can occur within 6 to 12 hours in severe cases.

Maintenance

Maintaining equipment is particularly challenging in a cold, mountainous environment. Due to the inhospitable conditions, maintenance personnel require shelters, lighting, and some specialized equipment to perform their duties.

Preventive Maintenance/Checks and Services

Maintenance of mechanical equipment is exceptionally difficult in the field during cold weather. Even shop maintenance cannot be completed with normal speed because the mechanic must allow the equipment to thaw out and warm up before making the repairs.

One important consideration in cold weather operations is the additional time it takes to perform tasks. This time lag cannot be emphasized enough and must be included in all planning. Personnel efficiency is reduced by bulky and clumsy clothing that must be worn in cold areas. Because it is dangerous to handle cold metal with a bare hand, operators/mechanics must wear some form of mitten or glove at all times; moreover, losing the sense of touch further reduces the Marine's efficiency. Even the most routine operations, such as handling latches or opening engine compartments, become frustrating and time consuming when performed with protected hands. At temperatures below -20 °F, maintenance requires up to five times the normal amount of time. Complete winterization, diligent maintenance, and well-trained crews are the keys to effective cold weather operations.

Buildings and Shelters

Heated buildings or shelters must be provided for cold weather maintenance. Proper and satisfactory servicing is difficult unless personnel are working in reasonably comfortable temperatures. Maintenance of many components requires careful and precise servicing. Without the use of heaters, maintenance time will increase 25 to 200 percent above normal requirements. When buildings are not available, maintenance tents are a temporary expedient. If possible, tents should have wood flooring and be heated by portable duct heaters or tent stoves.

Note: Personnel must be constantly on the alert to detect vehicle deficiencies that expose them to carbon monoxide poisoning. When vehicles; generators; and petroleum, oils, and lubricants containers are brought into warm storage from the cold, the fuel tanks/containers should only be three-quarters full. If this practice is not followed, the expansion of the cold petroleum, oils, and lubricants products in the fuel containers could cause spillage and a fire hazard.

Lighting Equipment

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

Maintenance Personnel, Tools, and Equipment

A large portion of Marines' time and energy in cold weather areas is expended on self-preservation, which reduces efficiency of personnel in the operation and maintenance of material. As a result, more mechanics are needed (40 percent more is recommended) to maintain equipment in cold weather. As a minimum, a highly organized, more intensive effort is required of generator mechanics.

Providing heated buildings or shelters for maintenance of material will increase efficiency and morale. An additional supply of battery chargers must be available to meet the heavy requirements for battery maintenance in temperatures below zero—one of the greatest hindrances to successful military operations in a winter environment is the effect of cold on power sources, specifically batteries. Current delivered at 15 °F will be only 50 percent of that which would be produced at normal temperatures. At -40 °F, the available current is practically zero.

Hand wear will become saturated with fluids when performing maintenance on fuel systems and cooling systems, which reduces the insulating value of the hand wear and possibly results in cold injury. Therefore, Marines should carry extra hand wear when performing maintenance in the field under arctic winter conditions. Personnel should avoid leaning on cold-soaked equipment or kneeling and lying on the ground. Rapid body cooling caused by heat transfer to equipment or ground may cause cold injury. The mechanic should place insulating material, such as fiber packing material, corrugated cardboard, rags, or tarps between him/her and the cold-soaked equipment.

Material

Cold weather affects the material with which parts are made. Since metals contract at lower temperatures and expand as the temperature increases, improper clearances may result in either binding or increased clearances. The effects of cold weather on rubber, tires, glass, and plastic should also be considered.

Metals

Since metals become brittle in cold temperatures, parts cannot withstand the shock loads that they sustain at higher temperatures. For example, at -20 °F, certain steels only withstand 50 percent of the shock load that they can stand at room temperatures. For a given change in temperature, various metals will expand or contract differently. These characteristics will especially affect bearings in which the bearing and shaft are of different metals, parts of different types of metals are bolted together, and meshing gears are of different metals. Special care should be taken when adjusting parts of this type for cold weather operations, especially when adjusting bearing clearances.

Rubber

In addition to natural and synthetic rubber, there are hundreds of rubber substitutes. These synthetic rubbers look and usually react like natural rubber, although most of them do not attain a greater flexibility at high temperatures. However, as it is cooled, natural rubber will gradually stiffen, although it retains a large part of its elasticity until temperatures reach below -20 °F. Extreme care must be taken in handling rubber-covered cables in low temperatures. If the rubber jackets become hard, the cables must be protected from shock loads and bending to prevent short circuits caused by breaks in the covering. If cables are to be bent, they must first be warmed. Neoprene jackets on cables become very brittle and break readily at low temperatures.

Tires

Tires become rigid in cold, causing flat spots on portions that come in contact with the ground during nonoperating periods. At severe cold temperatures, sidewalls become brittle and crack. Tires must be inflated to the appropriate pressure at cold temperatures. A tire inflated to 40 pounds per square inch (PSI) indoors will change to 25 PSI when moved outside at -50 °F; this change can result in the tire slipping on the rim and ripping the valve stem off the tube.

Note: In general, tires should be inflated 10 PSI over the normal pressure for winter operations.

Glass

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

Plastics

In general, plastics expand and contract much more than metal or glass. Any parts or materials made of plastic must be handled carefully. Many of the vehicular canvas covers have plastic windows, which become very brittle and, in many cases, break due to a combination of cold and vibration.

Aviation Planning Considerations

Aviation assets can be integrated with all six of the warfighting functions. Often, there is an overlap of multiple functions with concurrent aviation support operations. For example, while a platoon is executing a mounted patrol, they may be being supported by aviation ISR, attack, and command and control platforms that provide route reconnaissance, on-call CAS/escort, and a radio relay spanning four of the warfighting functions. Due to the nature of the terrain, environment, and possible disaggregated operations, all six functions of Marine aviation may be used and overlap as well. The affects of mountainous, complex, and compartmentalized terrain, to include the weather and environmental conditions, will have a significant impact on both ground and aviation assets. Thorough planning must be conducted in order to maximize the strengths of all involved and mitigate the negative effects for maximum efficiency and success.

Command and Control

Aviation assets may be used to mitigate some communications limitations due to the environment's impact on LOS. Aviation assets are less impacted by terrain due to their altitude. Using airborne platforms may enable the use of VHF/UHF when it would otherwise be severely degraded or impossible.

Airborne Radio Relay

An airborne radio relay can greatly enhance the commander's command and control capability. It must be planned as a separate mission similar to establishing a retransmission site. Using attack or assault assets employed in specific roles for the mission is not advisable because operational efficiency may be degraded, but it should not be ruled out if needed and if only these assets are available. There are many capable platforms, such as the KC-130, UH-1N, and EA-6B, that can provide this capability as well as any attack or assault support aircraft. Consideration should be given to requesting a direct air support center (DASC) (airborne), an assault support coordinator (airborne), a tactical air coordinator (airborne), and/or using a helicopter coordinator. Critical mission timelines (when do these assets need to be on station and for how long?) must be considered and planned accordingly as do FOB or airfield locations, fuel, and times of flight.

Organic Marine Ground-Based Assets

Organic ground-based assets may be used to augment the commander's command and control capabilities. Task-organized elements of the Marine Air Command and Control System can provide a robust capability. Marine air traffic control mobile teams can be embedded with a maneuver element to provide landing zone or drop zone control, weather observations, and communications. A DASC echelon or air support element can be employed in a combat operations center in all configurations, such as main, forward, and jump, in addition to the DASC already being located with the senior fire support coordination center. These attachments are self contained with an organic communications capability, which may increase the number of total communications assets that can be integrated with the limited communications assets and nets of the supported unit. It may also increase capability for VHF/UHF, enabling more efficient integration in the overall Marine Air Command and Control System.

Maneuver

Combat assault support provides mobility for MAGTF forces. It is used to rapidly deploy forces, bypass obstacles, or redeploy forces to meet the enemy threat. It provides for speed, surprise, and flexibility, allowing the MAGTF commander to mass forces quickly at a time and place of his/her choosing.

Assault Support

Rotary wing capabilities are severely affected by weather, temperature, and altitude. For example, a landing zone may be at 8,500 feet, but density altitude, pressure altitude, and temperature may create the effects of an 11,000-foot elevation. This situation will affect cargo, fuel, and/or ordnance capacity and require more maneuver space for the aircraft to operate. Ingress and egress routes, landing zone, and pick-up zone locations must be carefully selected. Canalizing terrain and weather must be analyzed. Cloud ceilings, enemy positions, and enemy antiaircraft weapons positions must be considered during planning.

Load Computations

The ground combat element (GCE) must provide an accurate Helicopter Employment and Assault Landing Table and Helicopter Wave and Serial Assignment Table. The information contained within those tables directly impacts aircraft performance and, ultimately, affects support capability. Torque available is based on the aircraft's basic weight, fuel, ordnance, cargo, and ambient conditions, such as temperature, density altitude, and pressure altitude. For example, 1 percent torque may equal 200 pounds of weight, which is significant when operating at high altitudes. Torque margins, when compared to the maximum torque allowed, keep aircraft within safe operating conditions. As ambient conditions increase, this margin significantly decreases. Tables 13-1 and tables 13-2 and 13-3, on page 13-14, illustrate the previously stated situations.

Landing Zone Considerations

Terrain, weather, and altitude may limit the size, number, proximity, and ingress/egress routes of landing zones. The following points should be considered:

- Wind direction is critical as helicopter pilots prefer to take off and land into the wind to maximize the aircraft's power available.
- Obstacles and terrain may rapidly affect wind direction and speed, causing wind shift, up drafts, and down drafts.
- The surface of the landing zone must be as level as possible.
- Snow will provide the same effect as sand. It may cause a white out situation and hide obstacles.
- Ice in the surrounding terrain, such as ice on trees, may pose a safety hazard to troops when broken loose by rotor wash.

Table 13-1. Load Computations.

Type Aircraft	UH-1N	CH-46E	CH-53D	CH-53E	MV-22	KC-130
Mission	Command and control Terminal control	Troop lift	Equipment/cargo lift	Equipment/cargo lift	Troop lift	Equipment/cargo lift
Normal crew (tactical)	4	4	4	4	4	4–6
Troop capacity	6	20/9	37	37	24	64
Maximum troop seating capacity	13	25 (no XM-218s)	55	55	24	92
Litter capacity	6	15	24	24	12	60
Combat radius (nm)	85	150	250	250	500	>1,000
Endurance (hours) (combat load)	1+30	2+30 (12 Marines)	3+45	4+00	3+15	>8+00
Payload (pounds)	2,000	2,100	8,000	20,000	10,000	42,000
Weapons	2.75 rockets GAU-16 (.50 caliber) GAU-17 (7.62 mm) M-240 (7.62 mm)	XM-218 (.50 caliber) M-240 (7.62 mm)	XM-218 (.50 caliber) GAU-21 (.50 caliber)	XM-218 (.50 caliber) GAU-21 (.50 caliber)	M-240 (7.62 mm) tail gun	Not applicable

Table 13-2. Load Computations.

	Take-off Point		Destination LZ	
Outside air temperature	15		9	
Pressure altitude	6,000		9,000	
Density altitude	7,400		10,400	
Aircraft operational weight	17,500		17,500	
Fuel weight	3,000		1,600	
Cargo	2,400		2,400	
Aircraft mission weight	22,900		21,500	
Engine torque available	98%N/104%M		92%N/96%M	
Torque required HIGE/HOGE	85%	98%	82%	95%
Torque margin	13%	0%	10%	(-3%)

Legend
HIGE hover in ground effect
HOGE hover out ground effect
LZ landing zone

Table 13-3. Load Computations.

Landing Zone Elevation	PA	DA (feet)	Temperature	HOGE MGW	Load in pounds (for range in nm)			Load in passengers (for range in nm)		
					Range			Range		
					220	440	660	220	440	660
					Load			Load		
4,000 ft	4,000 ft	5,900	24 °C	48,500	11,000	8,000	5,000	24	24	20
6,000 ft	6,000 ft	7,300	16 °C	46,200	8,700	5,700	2,700	24	22.8	10.8
8,000 ft	8,000 ft	8,800	8 °C	43,500	5,900	2,900	0	23.6	11.6	0
10,000 ft	10,000 ft	11,700	0 °C	40,200	2,700	0	0	10.8	0	0
12,000 ft	12,000 ft	14,500	-4 °C	37,200	0	0	0	0	0	0

Temperature reduced at standard 4 °C per 1,000 ft (adiabatic lapse rate)
Range/fuel assumes 220 knots as average ground speed
Fuel burn rate: 3,000 pounds per hour
Average weight of troop is 250 pounds (with equipment)

Range of 220=3,000 pounds of fuel
Range of 440=3,000 pounds of fuel
Range of 660=9,000 pounds of fuel

Legend
C Celsius
DA density altitude
HOGE hover out ground effect
MGW maximum gross weight
PA pressure altitude

- When using frozen lakes or other bodies of water, qualified personnel, such as mountain leaders, must assess ice thickness. Assault aircraft will require ice to be a minimum of 15 inches thick. Snow packs will also have to be evaluated.
- The aircraft may rest on the belly with mounts or skids buried, which poses a hazard to troops with regard to rotor distance from rotor tip to the deck. See figure 13-3.

Sustainment

When using rotary wing assets, the planning considerations are the same as for maneuver. In mountainous, complex, and compartmentalized terrain air delivery may be the primary means of resupply for static elements located at FOBs or maneuver elements, especially when combined with disaggregated operations. This mission is often conducted on terrain with a vertical component either by parachute or free-fall. A solid control and recovery plan must be in place. Both rotary and fixed wing aircraft can be used. High-speed chutes with a break-away capability are recommended to prevent the cargo from being dragged by the chute once on the deck. Chute systems guided by GPS, such as Sherpa, can greatly enhance accuracy while allowing the aircraft to drop from much higher altitudes than

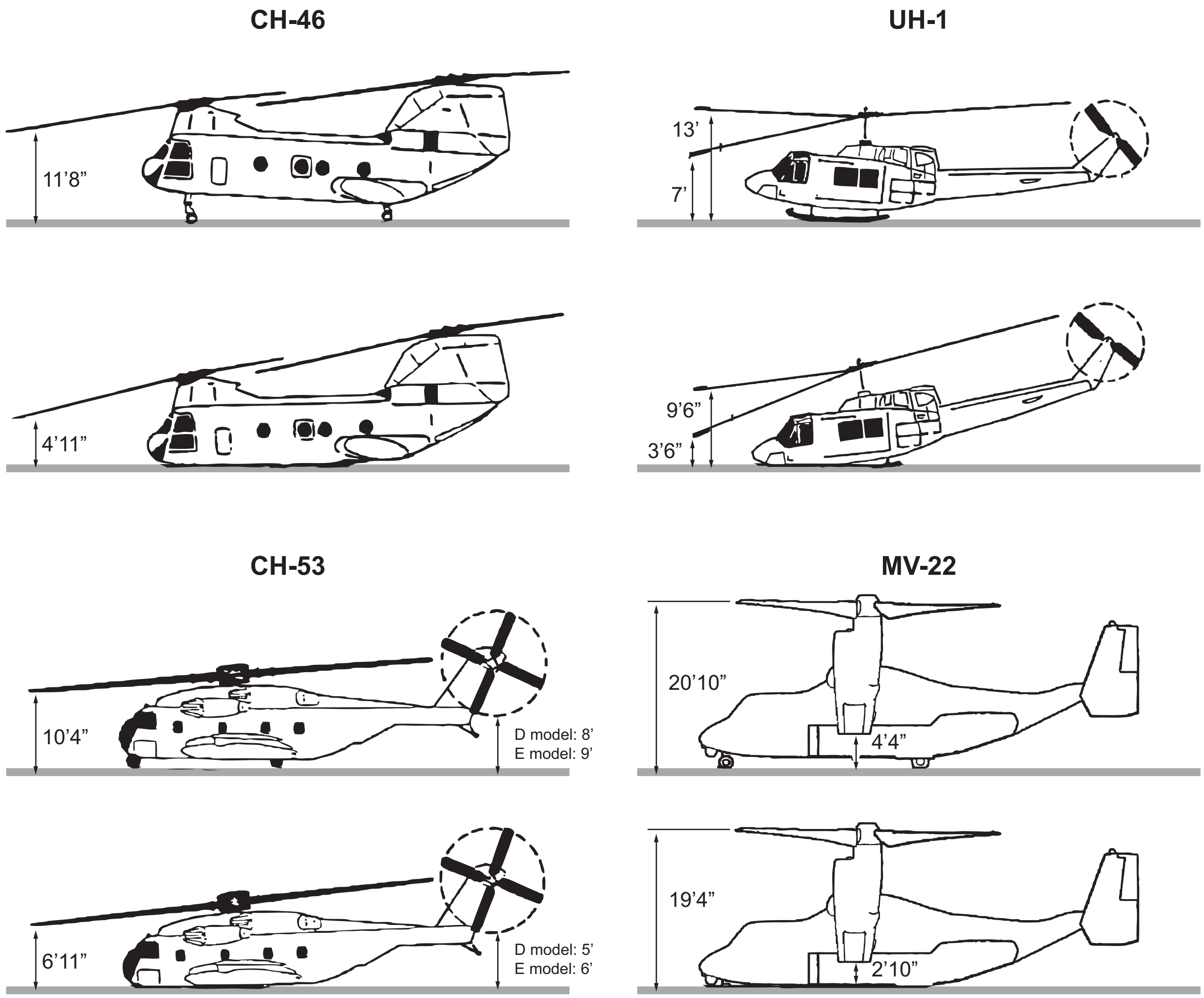

Figure 13-3. Landing Zone Considerations.

unguided parachutes. Guided systems can be dropped in excess of 20,000 feet mean sea level, while unguided systems are typically dropped between 800 and 1,000 feet above ground level.

Force Protection

Attack and ISR assets can be integrated with the force protection plan for both static and maneuver elements. They can be employed to conduct screening operations, conduct surveillance, and/or deliver fires. Fixed wing, rotary wing, and UAS assets are able to access areas limited by terrain in order to mitigate ground-based weapons and surveillance system limitations, such as large or multiple terrain features and reverse slopes.

Electronic Warfare

Airborne electronic warfare assets may be integrated with the force protection plan by providing electronic attack and electronic protection and conducting jamming operations and counter-IED operations. Integrated with the radio battalion, airborne electronic warfare assets provide for a flexible and robust capability. With the same considerations as the other warfighting functions, these assets are much less affected by terrain than ground-based assets are and can be employed rapidly in specific or general locations.

Protection for Supporting Aviation Assets

When assessing the enemy air defense system, this type of environment will negatively impact system emplacements, to include radar systems (early warning, target acquisition, and target tracking) and weapons systems. The terrain will also negatively impact radar coverage and, consequently, many weapon systems as well as the size and mobility of some of the more advanced systems.

Mitigation

The enemy will mitigate the impact of terrain by using mobile systems, such as wheeled, tracked, or personally-carried. Antiaircraft artillery and man-portable air defense systems (MANPADS) are often used in this type of environment because they offer flexibility and are easily concealed in or on the terrain. Confirmed or likely enemy positions and subsequent weapons engagement zones will influence aviation operations on ingress, in the objective area, and egress. These systems may be employed in defilade, enfilade, and/or firing down on or level to aircraft being canalized by the terrain.

Reducing the Threat

These targets may be difficult to locate, track, and engage effectively due to their cover and concealment. Other considerations for targeting will include supply chains, storage caches, and operators.

Intelligence

Aerial reconnaissance is used to obtain information concerning terrain; weather; and the disposition, composition, movement, installations, lines of communication, and electronic and communications emissions of enemy forces. Aerial reconnaissance is divided into three components: visual, imagery, and electronic. It is an implied mission of all aviation platforms. Aviation assets can provide a robust and flexible capability by being able to operate in inaccessible/distant terrain not practical for ground assets. The information gathered can be integrated with the overall collection plan.

Assets

Assets may include national, theater, and organic, whether manned and unmanned. Often requested and used for visual and imagery reconnaissance, UASs provide flexibility and significant sensor capabilities (electro optical, infrared, and synthetic aperture radar) and an extended time on station. Manned systems with an advanced tactical air reconnaissance system provide similar capability, although time on station may be shortened if an aerial refueling capability is unavailable. Other aviation platforms, both fixed and rotary wing, may conduct aerial reconnaissance via a targeting pod, visually, or with a digital camera.

Planning Considerations

Weather and environmental conditions may limit or prohibit use of aerial reconnaissance assets. Low cloud layers, winds, and icing will significantly impact employing such assets. Personally-carried UASs, such as Dragoneye and WASP, are most affected, especially by winds due to down drafts, up drafts, and venturi effects caused by the terrain. Such conditions will cause a reliance on larger, theater assets, such as Shadow, Pioneer, or Predator. Information connectivity is also a concern with regard to mode of transmission due to LOS implications and may require a retransmission site or other means of communication, such as SATCOM. The capabilities of each asset must be planned for and weighed carefully when using them for aerial reconnaissance.

Fires

Close air support is the air actions taken by fixed and rotary wing aircraft against hostile targets in close proximity to friendly forces. Such support requires detailed integration of each air mission with the fire and movement of those forces. Deep air support are air actions taken by fixed and rotary wing aircraft against hostile targets at such a distance from friendly forces that detailed integration is not required. For purposes of this publication, the focus is primarily on CAS.

Defining Close

Close is situational. It may be defined within the GCE’s organic weapons range, a TIC situation, or danger close by. These situations must be considered in conjunction with the type of aviation ordnance used. The terrain will significantly impact what is considered close due to canalizing effects, cover and concealment, and the type of weapon system and method of employment.

Integration

Missions must be integrated with the GCE fire and maneuver plan. The plan may include multiple aviation and indirect fire assets and may not occur prior to a flight, such as a TIC situation or a divert from a concurrent mission via the DASC. Planning must still occur, albeit hastily, via communications channels (such as the DASC, battalion air officer, or joint terminal attack controller [JTAC]) prior to the delivery of any fires. Integrated execution is also a requirement. A well-integrated plan that uses all available assets will provide for proper deconfliction, but deconfliction must not be the sole factor.

Threat Assessment/Matrix

The supporting aviation unit, concurrent with the GCE, must evaluate and prioritize threats and their impact on the mission. The assessments must match. For example, the aviation priority threat may be MANPADS with the GCE being armor. Each threat significantly impacts the respective MSC; however, if the MANPADS threat is too great, the aviation unit may not be able to provide the support required. Given the nature of the terrain, the potential location of enemy threat systems will greatly influence planning factors. For example, a light antiaircraft artillery on open ground may be a low threat, but canalizing terrain with antiaircraft artillery systems in higher elevations may elevate the threat level.

Management of Aircraft and Airspace

The JTAC must have a plan prior to aircraft arrival for both a preplanned and immediate mission. Airspace and aircraft maneuver space may be limited due to terrain both vertically and horizontally. Depending on the nature of the terrain and airspace to be used, the overhead or key hole template may be optimal. Time utilization impacts are greater than in open terrain, especially for rotary wing platforms. Safe areas, such as holding areas, may be multiple terrain features away or limited due to altitude. Aircraft exposure events must be minimized while tempo is maximized; time not utilized is time on station and support lost. Allowing the aircraft to loiter will increase enemy acquisition and engagement opportunities.

Target Acquisition

Target acquisition may be more challenging for both aviation assets and JTACs on the ground, which may affect the type of control used. The following considerations should also be made:

- The JTAC or aircraft may not have LOS to the target.
- Aircraft sensors do have limitations and, due to the terrain, acquisition time may be significantly decreased.
- Target marking is critical whether by laser, infrared pointer, smoke, or talk-on.
- Use of equipment, such as the precision strike suite for special operations forces, StrikeLink, and remote operated video enhanced receiver systems, will aid in target acquisition and validation.

Targeting and Weaponeering

Target composition, type, and location are essential for the appropriate weapon and desired effect. The proper weapon with appropriate shell-fuze combination should be selected to the maximum extent.

The terrain will impact ordnance effectiveness. For example, since snow pack is similar to sand and may absorb the blast effect, a high angle profile, such as a joint direct attack munitions fired at 89 degrees, may skip or have minimal effect on a sloped target.

Attack Geometry

The GCE scheme of maneuver, enemy, terrain, and environment will influence attack geometry, including ingress, objective area, egress, and the following:

- The terrain may channel attack routing and multiple options may not exist.
- Communications may be degraded due to LOS, especially when using rotary wing assets. The same consideration will exist when employing laser guided munitions if designated by a ground designator.
- Geometry will differ for rotary and fixed wing aircraft, depending on the terrain, threat, and mode of flight (low level and map of the earth).

General Considerations

When operating in mountainous, complex, and compartmentalized terrain, all aspects of aircraft capabilities and support must be considered. Due to degraded lift capabilities, planning for a longer time on station may result in less ordnance or cargo carried due to the higher fuel requirement. The thin air decreases the ability to control rotary wing aircraft and they may require more maneuver space or a lightened load. All Marine rotary wing aircraft are restricted to 10,000 feet pressure altitude due to the lack of pressurized cabins and supplemental oxygen. Conversely, Army rotary wing aircraft may operate at 12,000 feet pressure altitude for 60 minutes and up to 14,000 feet pressure altitude for 30 minutes.

Marine Assault Climber’s Kit

The MACK is a comprehensive collection of climbing equipment that enables a Marine rifle company (reinforced), which comprises approximately 200 Marines with organic equipment, to negotiate, on average, a 300-foot vertical danger area. The kit contains sufficient climbing equipment to outfit four 2-person climbing teams plus the additional items necessary to supply the remainder of the rifle company. The climbing teams use their equipment to conduct two-party climbs over vertical obstacles and establish various rope installations to facilitate the movement of the remainder of the company. Marines that engage in training and combat operations in mountainous areas with rugged, compartmented terrain/steep slopes would use the MACK. Certain items contained in the MACK will also be used during training and combat operations in urban environments for scaling vertical obstacles, such as buildings.

Procurement Information

The MACK (short title: SL-3-10161A PCN: 12310161000) includes its own care and maintenance manual, but electronic copies are also available from Mountain Warfare Training Center (MWTC) academics section.

The MACK is available in special training and allowance pool. Replenishment of component items should be procured using the standard military requisitioning process. Kit components not available through the standard process may be procured through local purchase of a comparable item. The unit mountain leader must approve what is comparable in function and safety.

Four containers hold all the items contained in the MACK and have features that facilitate the organization and accountability of MACK items. Each container protects the contents from degradation due to sunlight and moisture during storage periods of up to 5 years. The lid's interior has a permanently affixed list of the components and quantities stored within that container. Container 1 contains the climbing team equipment, while containers 2, 3, and 4 contain the company climbing equipment. A manual for care/maintenance of SL-3 components is included with each MACK. Refer to the SL-3 components list for current quantities and items.

Serviceability

Any item that becomes unserviceable or shows excessive signs of wear must be replaced immediately. With the exception of the rope bag and climbing rack bag, no attempt should be made to repair the components of the MACK. All ropes, runners, harnesses, or slings are made from nylon. Nylon climbing equipment has a maximum shelf life (vacuum-sealed) of 10 years and a working life not to exceed 5 years. Any damaged or broken components should be disposed of, using standard supply procedures. Detailed information is available later in this chapter and in the MACK's care and maintenance manual.

A summer mountain leader (school code M7A) or assault climber (school code YAK) must supervise any Marine using components of the MACK. The summer mountain leader designated by the unit commander is responsible for inventory, periodic checking serviceability, ordering replacement items via the supply officer, and supervising issue and recovery of items to ensure accountability and proper storage SOPs.

Note: The Marine Corps no longer allows lead climbing with the standard issue Kevlar helmet. All lead climbing must be done wearing a MICH [Modular Integrated Communications Helmet] or civilian climbing/mountaineering helmet (or equivalent).

Preparing the Marine Assault Climber's Kit for Use

New MACKs require equipment to be prepared for use by the mountain leader, who is assisted by assault climbers. Both company and climbing team equipment need preparation.

Company Equipment

Company equipment is prepared for the individual and for the group as follows:

- For the individual, the electric rope cutter is used to cut/whip one 15- to 18-foot sling rope (using the dynamic rope) for each Marine in the company. Each Marine will also receive one nonlocking carabiner and one locking D carabiner. If crossing semi-fixed ropes, a 7-foot piece of type 2 cordage can be cut for the prusik safety line for each Marine.

  Note: Marines should finish one complete spool before cutting another spool.

- For the group, the static rope is cut for the mission at hand. Some spools are already 300-, 165-, or 600-foot spools. When static rope becomes unserviceable, good sections of 15- to 25-foot lengths should be cut out for static anchor cords as follows:
  - Cut 1-inch tubular tape for static anchor cords (15- to 25-foot lengths).
  - Cut 7-mm nylon cord for use in tightening systems (3- to 6-foot lengths). Do not cut the 7-mm cord for company personnel to use as anchors because of the relatively low tensile strength (only static rope or tape should be used).

Climbing Team Equipment

Climbing team equipment should be prepared as follows:

- *Rope*. The dynamic climbing rope is olive drab and already in 165-foot (50-meter) lengths.
- *Type 2 cordage*. Cut/whip 7-mm nylon cord for use in tightening systems and anchors as part of each team's rack.
- *Tubular tape*. Cut/whip one-inch tubular nylon tape of varying lengths for use as web runners. Tie loops using the water/tape knot and range the size of the web runners from 4 to 48 inches. Tubular tape can also be used for anchors if cut in 18-foot lengths.
- *Type 1 cordage for racks*. Use the 5.5-mm Kevlar cord to wire the hexentrics. Secure the ends by tying a triple fisherman's knot. A knife will be needed to cut this cord because it will not burn. Use the electric rope cutter to whip the nylon sheath around the Kevlar core. The knife blade will dull quickly when used to cut through the Kevlar core. Use the Kevlar cord for hexentrics only (it is not pliable enough for use as utility cord, nor is there a large quantity provided). Tie a small loop of 7-mm cord on the belay device in the appropriate hole to keep it from running down the rope during use and for racking it to the harness.
- *Silencing the rack*. Wrap vinyl tape around the nonlocking carabiner bodies and the large (sizes 7 to 11) hexentrics. Ensure the tape is only one layer thick so that it will not interfere with the safe function of the item. Nut picks can be taped or dummy-corded so that they do not rattle on a carabiner.

The preparation of the MACK should be tailored to the mission, terrain, and size of the using unit. Any unused rope and cordage should be kept for use as a backup. A log of rope/cordage usage must be maintained. Ropes should be replaced after two seasons of use or when unserviceable; they should be inspected frequently for serviceability (before, during, and after use).

Actions After Use

Clean and dry all MACK components according to the respective instructions in the MACK's care and maintenance manual. Most importantly, all items must be thoroughly dry before returning them to the container for storage. One wet or damp item will spread its moisture to all other items in that container, causing mildew, rot, or rust. If carabiners are being oiled for long-term storage, they should not be placed in the same container as any of the ropes/cordage.

Steep Earth/Glacier SL-3 Equipment Addendum to the Marine Assault Climber's Kit

The MACK 2 includes steep earth/glacier equipment for 200 Marines. Until MACK 1 is phased out, the items in the following subparagraphs must be open purchased. These items are not in the MACK 1.

Steep Earth

The purpose of this list is for acquisition of steep-earth mission-specific equipment, when needed. These items augment the SL-3 complete MACK 1. Vendor information can be provided from MWTC.

The following items are required for 8 assault climbers (4 teams):

- 4 short ice axes (40 to 50 cm) with classic curve pick.
- 4 ice hammers (40 to 50 cm) with classic curve pick.*
- 24 snow pickets (24 inches long).*
- 8 pairs of strap on, flexible, and 10 to 12 point crampons.*
- 4 grappling hooks.
- 8 5-finger grip fasts fabricated by engineers or the boson's locker.
- 36 pieces of rebar cut 20 to 30 inches long, three-eights to five-eights inch in diameter, with an eyelet welded in one end for a carabiner. Engineers or the boson's locker must fabricate these pieces of protection.

*These items have the same NSN as the items on the following glacier list.

Glacier Movement

The purpose of this list is for acquisition of glacier mission-specific equipment, when needed. This list augments the SL-3 complete MACK 1, so it must be open purchased as needed until procured in the system. Vendor information can be provided from MWTC. The following items are required for individual Marines in a 120-person company:

- 120 pairs of strap-on, flexible, 10-12 point crampons.*
- 120 walking axes (60 to 80 cm) with classic curve.
- 24 9-mm by 50-meter dry line dynamic ice ropes (5-person rope teams).

Items for 2 mountain leaders (per company) include:

- 2 pairs of strap-on, flexible, 10-12 point crampons.*
- 2 walking axes (60 to 80 cm) with classic curve.
- One 9-mm by 50-meter dry line dynamic ice rope.
- 2 ice hammers (40 to 50 cm) with classic curve.
- 30 snow pickets (24 to 30 inches).
- 30 deadmen (snow flukes).
- 40 ratcheting ice screws (4-inch and 7-inch mix).

* These items have the same NSN as the items on the previous steep earth list.

Sit Harness

The sit harness (see fig. 13-4), also called climbing harness, is in the MACK. There are eight sit harnesses for the mountain leader and assault climbers of the company and each comprises—

- A waist belt.
- Leg loops (adjustable).
- Buttock straps (adjustable).
- Fastex buckles.
- Doughnut (belay point).
- Equipment loops.
- D-ring (older models).
- A waist-belt tie-in point.
- A crotch strap.

Figure 13-4. Marine Corps Sit Harness.

Wearing the Sit Harness

To wear the harness, Marines must—

- Disconnect the fastex buckle at the rear of the harness.
- Hold the harness in front and put feet through the leg loops, ensuring that the buckles on the leg loops are outboard on the thighs.
- Fasten the waist belt into the buckle, ensuring that it is a tight but comfortable fit.
- Ensure that the waist belt is threaded back through the buckle. This action locks the waist belt to the buckle. Failure to do this will cause the waist belt to slip through the buckle when it is under load. See figure 13-5.
- Adjust the leg loops so that they are high on the thighs. Once adjusted, get another person to clip the fastex buckle male to the most comfortable female fastex. Then adjust the buttock straps so the leg loops are held up.

If all the above are done correctly, the harness should now be a comfortable but snug fit. After the harness has been fitted for the first time, there is no need to go through the same procedure each time it is worn. The Marine simply holds his/her harness in front of him/her, steps into it, and attaches the waist belt to the buckle in the approved manner as shown in figure 13-6.

Tying In to the Rope

Climbers can tie into the end or the middle of the rope. To tie in to the end of the rope, Marines must tie the beginning of a retrace figure-8 knot and then pass the standing end of the climbing rope up through the crotch strap, through the doughnut, and through the waist-belt tie-in point. They then finish the retrace figure-8, adjusting the knot to get it as close as possible to the body. See figure 13-7.

To tie in to the middle of rope, Marines must take up a bight of rope and tie a figure-8 loop in it. They then attach a locking carabiner to the harness by securing both the crotch straps and the doughnut and attach the figure-8 loop to the carabiner, securing the locking nut.

Care and Maintenance

The harness is made of various sizes of nylon webbing and should be maintained in the same manner as a climbing rope (refer to chapter 4), paying particular attention to—

- Avoid contact with chemicals, as chemicals will damage the nylon.
- Regularly inspect the harness, especially the tie-in loops, buckles, and sewn joints, for signs of abrasions and normal wear.
- Keep harness away from heat, such as open flames and cigarettes.
- If soiled by grit and seawater, wash in lukewarm water with pure soap and allow the harness to dry in a warm room away from direct heat.
- Three to five years of life can be expected during normal climbing use. It is recommended that a harness that has experienced a serious fall be discarded. Under no circumstances should anyone ever tie into the equipment rack of any sit harness as a belay or anchor point.

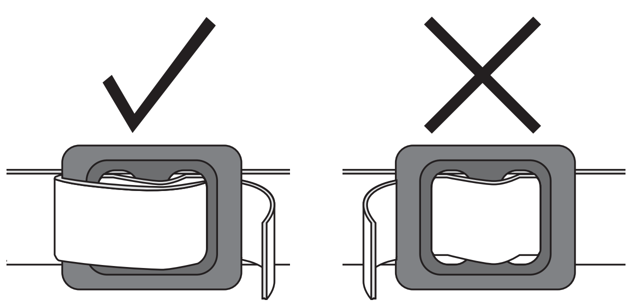

Figure 13-5. Proper and Improper Threading of the Buckle.

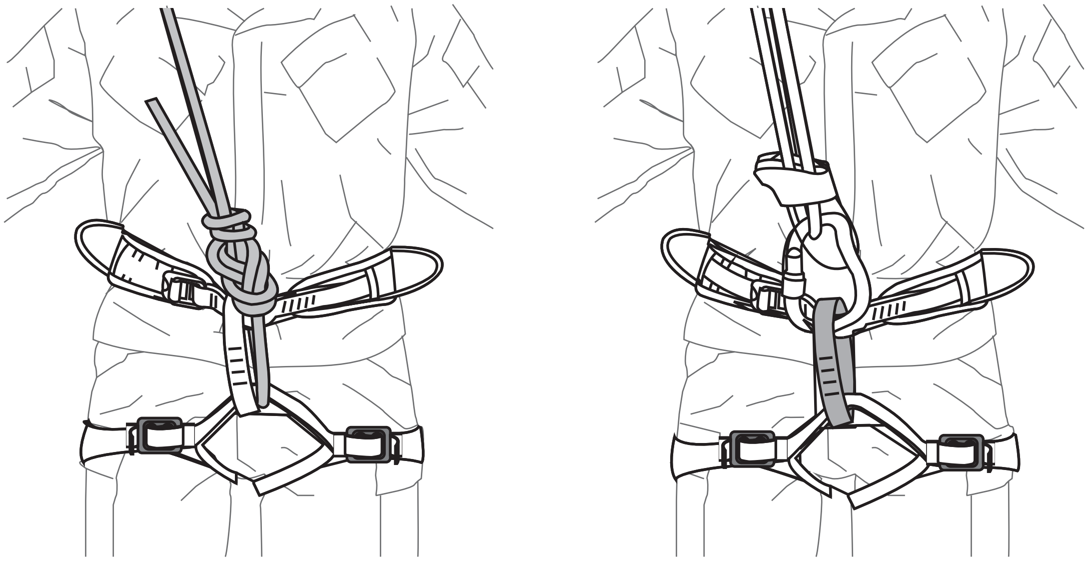

Figure 13-6. Properly Adjusted Sit Harness.

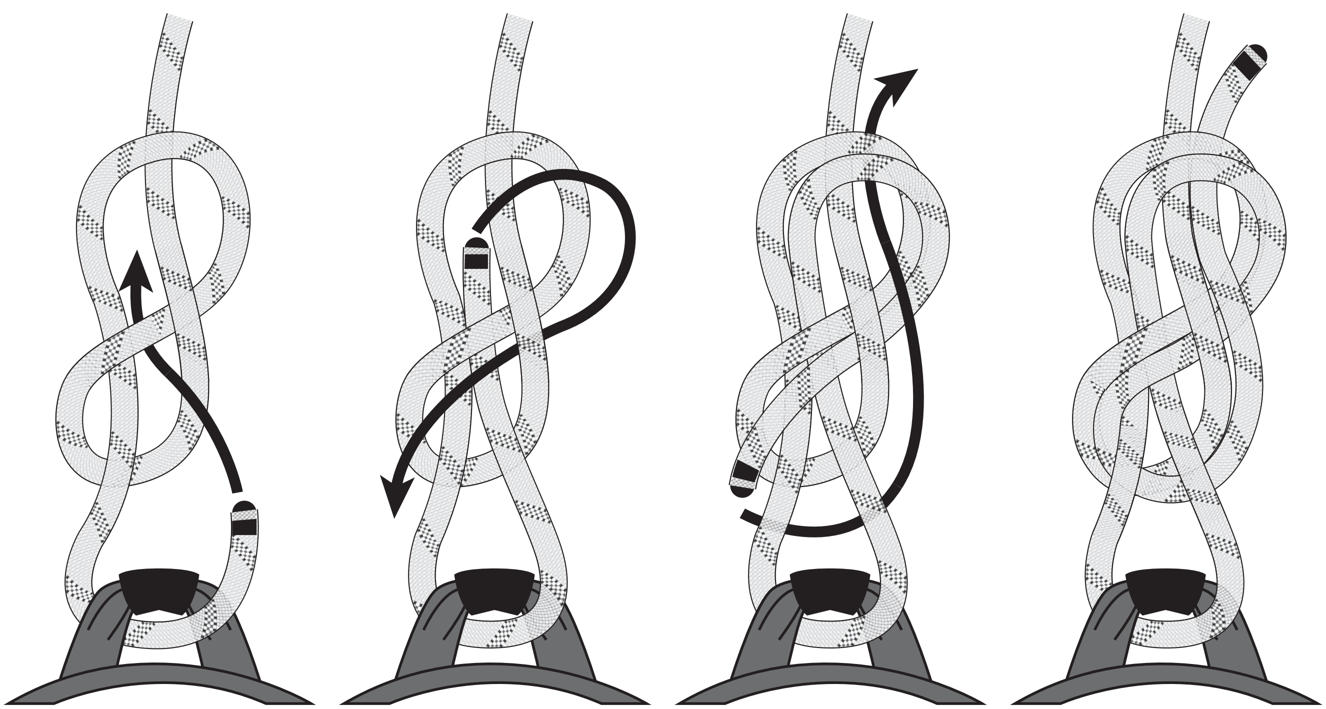

Figure 13-7. Retrace Figure-8 in Sit Harness.

Care and Maintenance of Mountaineering Equipment

Mountaineering equipment has specific procedures for care and maintenance.

Ropes

All ropes used in the military must meet UIAA standards or United States Federal Test Standard 191A. Most ropes have a 5-year shelf life and maximum 2-year service life. See figure 13-8 for construction detail of various types of rope. Ropes are classified as static, dynamic, or dry dynamic glacier ropes.

Static ropes are black and have the following qualities:

- Construction: kernmantle.
- Minimum tensile strength: 6,500 pounds.
- Maximum static elongation: 1.5 percent.
- Diameter: 11 mm.
- Sizes: 600-foot spools, usually cut into 150- and 300-foot lengths.
- Average weight: 3.5 to 4 kilograms (150-foot rope).
- Usage: rescue operations and bridging where a low amount of elongation is desirable under a working load.

Dynamic ropes are olive drab and have the following qualities:

- Construction: water-resistant treated kernmantle to reduce friction.
- Minimum tensile strength: 5,500 pounds.
- Maximum static elongation: 6 percent.
- Diameter: 10.5 mm and 11 mm.
- Size: 165 feet (50 meters) plus 5 feet extra.
- Average weight: 3.5 to 4 kilograms.
- Usage: for lead climbing/party climbing.

Three strand twisted or laid rope.

Static, kernmantled rope showing core (kern) and sheath (mantle).

Dynamic, kernmantle rope used for rock climbing.

Double braid rope showing the braided sheath and braided core.

Figure 13-8. Types of Rope Construction.

Dry dynamic glacier rope is olive drab or can be multi-colored and has the following qualities:

- Construction: water-repellent treated kernmantle.
- Minimum tensile strength: 3,500 pounds.
- Maximum elongation: 6 percent.
- Diameter: 8.8 mm or 9 mm.
- Size: 165 feet (50 meters) plus 5 feet extra.
- Average weight: 2.5 to 3 kilograms.
- Usage: for glacier travel/ice climbing.

Note: Sling ropes are made from 18-foot lengths of polymer or dynamic rope ONLY. Twenty-five foot practice coils should be constructed with static rope, but dynamic rope can be used.

Ropes have advantages and disadvantages, depending on their construction material. They can be made of either nylon or manila. The advantages of nylon rope are that it has a—

- High strength to weight ratio.
- Good energy absorption in dynamic ropes.
- Flexible.
- Rot resistant.
- Not affected by frost.

Disadvantages of nylon rope are:

- Low melting point (nylon fuzes at 400 °F and melts at 480 °F).
- Susceptible to abrasions and cuts.
- Affected by chemicals and light.
- Nylon rope stretches under tension and will rupture at between 30 and 70 percent elongation, depending on construction.
- Nylon rope loses as much as 30 percent strength when wet.
- Temperatures of 250 °F and above will damage a nylon rope.

Engineers use manila rope, which is included in the engineer kit and is easily gripped, hard wearing, and does not deteriorate in heat. However, manila rope is heavy, kinks (especially when wet), and absorbs water and swells. It burns at 300 °F and is edible by rodents.

Nylon Webbing

The type of nylon webbing available is tubular. Tubular nylon webbing is very strong and flexible. All rules that apply to nylon rope apply to tubular nylon webbing. The types of nylon webbing used are 1-inch tubular nylon, which has a tensile strength of approximately 4,000 to 4,500 pounds depending on the manufacturer, and pre-sewn Spectra runners, which has a tensile strength of approximately 5,500 pounds.

Note: These are minimum strengths. Some manufacturers make even stronger webbing.

Carabiners

Also commonly known as snap links, both locking and nonlocking carabiners are used. The uses of carabiners are to—

- Attach ropes or runners to pieces of protection.
- Attach the rappel rope to the rappel seat for seat-hip rappels or for crossing rope bridges.
- Attach the climber's safety rope to a safety line on a rope installation.
- Form field expedient pulley systems.
- Attach items (ropes and belay devices) to a sit harness.

Nonlocking carabiners (see fig. 13-9 on page 13-26) consist of a gate, gate pivot pin, locking pin, and body. They are made by various manufacturers and have a minimum tensile strength of about 4,200 pounds.

Locking carabiners (see fig. 13-10 on page 13-26) are made up of a gate, gate pivot pin, locking notch, locking nut, and body. They have a large locking D (various manufacturers) shape and their minimum tensile strength is about 5,500 pounds. The locking nut must always be locked down (tightened) when in use.

Serviceability Check for a Carabiner

The following steps are used to check a carabiner for serviceability:

- The gate snaps shut with no friction and with no gap between the locking pin and locking notch.
- There is no excessive side-to-side movement of the gate.
- The pivot pin is tight.
- The locking pin is tight.
- The locking nut travels freely and locks securely.
- There are no cracks or flaws in the metal.

Note: The weakest part of a carabiner is the gate. If an engraver is used to mark a carabiner, it should be applied to the gate and not the load-bearing side.

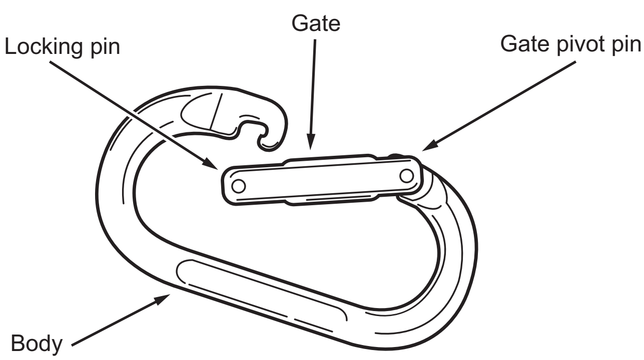

Figure 13-9. Nonlocking Carabiner.

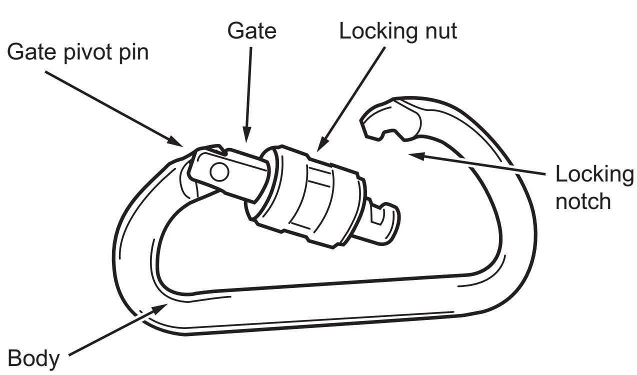

Figure 13-10. Locking Carabiner.

Preventive Maintenance for a Carabiner

Carabiners should be kept clean and all dirt, moisture, and grime removed. They should be lubricated with tri-flow graphite and cleaned thoroughly. The carabiner should not be dropped as this may result in either actual damage to the carabiner or in dirt getting into the workings of the carabiner and damaging it.

Protection

Artificial protection is for use by mountain leaders and assault climbers. There are various types of protection:

- *Stoppers*. Stoppers have a wedge-shaped structure and are used in small cracks. They come in twelve sizes, ranging from widths of 0.16 inch (#1) to 0.90 inch (#12). The sides of the wedged portion are slightly beveled, enabling the climber to insert the same stopper into a crack two different ways.
- *Hexentrics*. These chocks have a six-sided structure shaped like a hexagon; the sides are of unequal width, which allows the same chock to be inserted in different sized cracks, depending on which way it is inserted. These chocks come in various sizes and are used in larger cracks for which stoppers are too small.
- *SLCDs*. Spring-loaded camming devices are a unique solution for shallow, horizontal, or vertical cracks, thin tips, cracks, and narrow pockets where other types of protection cannot be placed. They offer an advantage over rigid camming devices, which can only be placed in a vertical crack.

Serviceability is checked for stoppers and hexentrics by—

- Checking holes used for stringing chocks for burrs that could damage the cord with which the chocks are strung.
- Checking accessory cord for wear, fraying, rupture of the outer sheath, and knots.
- If wired, checking wires for frays that could damage the climbing rope.

- If wired, checking soldered (or otherwise joined) areas for cracks or looseness.
- Checking nut for splits or cracks.

Serviceability of SLCDs is checked by—

- Ensuring wires leading from the trigger to the cam are not bent or frayed.
- Checking to ensure that cam movement is free and easy and for contraction and expansion by pulling and releasing the trigger.
- Checking that the runner is not frayed and no stitches have popped.
- Spraying with triFlow graphite and cleaning off thoroughly if it is stiff or corroded by seawater.

The strength of a chock depends on the manufacturer's specifications and on the type and size of material used for the sling (rope, webbing, or wire). Table 13-4 shows the strengths of some of the common types of chocks.

Hexentrics number 4 through number 10 are only strung with type I cord. Type II cord is used for prusik cordage. Table 13-5 shows specific cord strength.

Depending on the manufacturer as well as the size (see table 13-6), SLCDs vary in strength.

When placing protection, the cord or wire must not rub against the rock. Also, it should not be dropped because it may become deformed.

Other Mountaineering Equipment

A variety of other equipment besides ropes, carabiners, and protection are used in military mountaineering, such as caving ladders, ascenders, pulleys, helmets, and belay devices.

Caving ladders are constructed of stainless steel cables and 6-inch aluminum crossbars. Several ladders can be connected together using two large steel rings on each end of the ladder. Each ladder

Table 13-4. Chock Strengths.

Type	Strength
Number 1 – number 2 stopper-wired	350 kg (approximately 770 pounds)
Number 3 – number 5 stopper-wired	650 kg (approximately 1,430 pounds)
Number 6 – number 12 stopper-wired	1,100 kg (approximately 2,420 pounds)
Number 1 – number 3 hexentrics-wired	1,100 kg (approximately 2,420 pounds)

Table 13-5. Cord Strengths.

Type	Diameter	Construction	Strength	Length
I	5.5 mm	Spectra Kevlar	4,400 pounds	150 feet ± 10 feet
II	7 mm	Kernmantle	2,200 pounds	300 feet ± 10 feet

Table 13-6. Strength of Spring-Loaded Camming Devices.

Type	Minimum Strength
Camming device large	2,400 pounds
Camming device small	2,600 pounds

is 30 feet long and weighs 4 pounds. The caving ladder is also referred to as a cable ladder.

Easily placed and removed from a rope with one hand, ascenders allow the rope to run through in one direction while it grips in the other. A safety device is incorporated to ensure that the cam only releases the rope when the trigger is pressed and out of position.

Pulleys have two independent side plates that enable a user to insert the rope onto the wheel without having to thread the rope. The pulley is large enough to accommodate a one-half-inch rope and has an eyehole large enough to accommodate two locking carabiners.

Helmets are worn to protect the head from falling rocks or from head injury should the climber happen to fall. It should be checked for cracks or chips and a serviceable chinstrap. The climbing helmet used at MWTC is light weight. Anyone leading a climb should wear a mountaineering-specific helmet and not a Kevlar helmet. Military helmets used in parachuting are suitable as are helmets designed for blunt impact protection vice ballistic protection.

Various devices used for rappelling or belaying should be used with a locking carabiner only. Such devices are made from a heat dissipating aluminum alloy so they are cool to the touch after a fast running rope has passed through. Belay devices are both user and rope friendly. Care must be taken not to bang or throw these devices onto any hard surface or damage may occur.

Racking Equipment

Protection, quick draws, and other equipment should be organized on the climbing harness. Gear should be silenced and it should not interfere with the climber’s movement, such as in the case of a web runner caught on the climber’s foot or on rocks and vegetation as he/she approaches the cliff face. The gear should be easily accessible for either hand and the climber should know where it is on the harness. More detail is discussed in chapter 6.

CHAPTER 14
FORCE PROTECTION

Force Protection Planning Considerations

There are a number of planning considerations for force protection in mountain operations.

High-Angle Fires and Key Terrain

When planning to establish a fixed site, the position and angle of enemy fires plays a significant role in choosing the site location. Whoever maintains the high ground has an advantage of fire and cover, so the unit's position should be elevated. Fixed sites, however, should not be placed on peaks or ridges because such placement allows the site to be fired upon from 360 degrees. Ideally, the site should be located on the reverse military crest, or the reverse slope, with observation posts on the forward military crest and surrounding key terrain.

When there is no other option, placing the site on a hillside is much better than in the valley floor. It is best to find some defilade and a location that has good concealment and favorable observation post characteristics. Marines should avoid taking the easy way out and settling for a position close to the local national main supply route, which is typically at the lowest elevation in the region. Using FOBs in Afghanistan as examples, there is an obvious trend to locate fixed sites on terrain that is convenient rather than tactically sound.

When high elevation sites are unavailable or if taking over a pre-established position surrounded by higher terrain, the enemy will have the tactical advantage. There are numerous ways to deny the enemy access to these positions, but the most effective method is to establish predesignated targets for supporting mortar/artillery systems. Once these targets are registered, daily area denial rounds will both deny the enemy access to these locations and show them that the Marines are ready to hit their positions at a moment's notice. Local ROE may prohibit area denial rounds, so Marines should ensure they understand local rules before employing indirect fire systems.

Area denial fires should be carefully planned and precise. Regardless of the local attitude toward the Marine presence, great care should be taken to prevent any friendly fires from potentially injuring locals or their livestock or hindering their daily lives more than necessary. Deterring rounds should be targeting the dominant terrain features, such as high peaks and ridgelines, because those are the most likely enemy points of origin and these locations are typically uninhabited. The local population should still be informed of the dangers of moving through those areas, especially since those often are common grazing areas. Marines should routinely visit with community leaders to emphasize the importance and understanding of area denial fires.

Defensive Planning

In a mountainous environment, avenues of approach are pronounced and easily identified; however, micro terrain often provides an advancing enemy with covered positions. The role of direct fire weapons is thereby mitigated and indirect systems, such as the MK-19 and M203, should be emphasized.

Defensive positions must also be engineered to account for high-angle firing, both high and low elevation, depending on the site. Friendly weapon systems must be capable of the necessary elevation ranges.

All covered positions should emphasize overhead cover. Due to the likeliness of being fired on from a higher elevation, more rounds will impact on the overhead cover. Standard engineering techniques are effective, but overhead cover cannot prevent damage from penetrating weapon systems, such as artillery or rocket propelled grenade rounds, fired from positions of high elevation. Living positions and positions of high value should be located as far from higher elevation enemy positions of observation as possible.

If the site is located at a lower elevation than enemy positions of observation, the perimeter wall will only serve to prevent the position from being overrun and will not provide a significant source of cover. When possible, flat terrain should be selected for a perimeter. If the terrain is sloped, significant effort will have to be put into cutting a flat path for the wall in order to prevent it from collapsing.

Drainage in a mountainous environment can cause quick and severe damage to the site's infrastructure as well as critical sanitation issues. Perimeter walls are typically built hastily and do not account for drainage. Natural drainage must be used primarily and not impeded by construction. If necessary, artificial drainage should be over-engineered to account for unexpected precipitation.

Overwatch

Overwatch in mountain operations is time and manpower intensive. Mountain pickets are the primary way that overwatch is provided in the mountains. A third of the unit (not just ISR assets) can easily be busied picketing.

Mountain Pickets

Mobile units have an advantage at a higher elevation. In order to protect the maneuvering units from surprise and to ensure that there is an equal if not advantageous position over the enemy, overwatch positions or mountain pickets should be placed on key terrain to cover friendly unit movements. This placement will also improve VHF communications.

Compartmentalized terrain narrows the sector of security coverage provided by a single weapon system. In order to cover all avenues, extra personnel will be required to provide adequate security for mobile units. Moving mountain pickets is a long, painstaking process. Leap frogging the pickets is tactically sound, but almost always impractical. The bump method is a little bit quicker, but commanders may find it necessary to move the pickets continuously along with the main body. Pickets should be placed out in advance, if possible.

Indigenous forces are typically much better suited for providing overwatch, due to their proficiency in moving in their own environment and their relatively light combat load. However, some indigenous forces may be carrying a similar load and their skills may not be as proficient as Marine units, so leaders should consider sending a few Marines to supervise.

If indigenous forces are unavailable, members of the unit with the ability to move quickly in mountainous terrain should be identified to fulfill this role. Normally, these would be mountain leaders, assault climbers, and those in good physical condition. Also, in cold weather situations involving deep snow, unit members adept at skiing should also be identified. Skiborne mountain pickets are able to move rapidly, but snowshoes will work if trained scout skiers are unavailable.

Aviation Assets

The best protection for ground units is CAS. Nothing will prevent the enemy from engaging more than the sound of an aircraft that they cannot see.

Mountain Roads/Mounted Movement

Mountain roads are often narrow and in poor condition. Ground vehicles must be assessed to match the road conditions. Risk assessments, threat assessments, and vulnerability assessments must be completed to determine the feasibility of using lighter armored vehicles instead of a heavier alternative that is too wide or heavy for the route. Since high mobility multipurpose wheeled vehicles are often too wide for mountain passes and with their weight increase due to armor, they can cause significant damage to dirt roads, possibly preventing the use of the road for a return trip. Mine resistant ambush protected vehicles are even wider and heavier and will often be unfeasible for mountain roads.

Most mountain roads follow a ridgeline with a steep increase in elevation on one side and a steep decrease in elevation on the other. Most machine guns employed in vehicle turrets will be unable to elevate to target enemy positions on the higher elevation side of the road. Turret gunners should be designated to cover the high ridgeline with their small-arms weapon systems.

Mountain roads often take the path of least resistance, which usually follows the path of the local river at a comparable elevation. This makes the roads susceptible to severe erosion damage during the spring snow melts. Alternate routes should be identified to prevent units from being stranded in areas with limited road access.

Dismounted Troop Movement

Dismounted troops are severely affected mentally and physically by the difficulties associated with moving across complex and compartmentalized terrain. Movement rates are significantly reduced and fatigue diminishes a unit’s ability to operate effectively. Furthermore, the slow movement rate of friendly dismounted troops relative to that of the enemy can present the enemy with the advantage of being able to outmaneuver friendly units. Therefore, leaders must consider the dangers associated with equipment loads that make dismounted movement difficult. Risk and threat assessments must be conducted in order to determine the necessary armor and gear load in relation to the disadvantages associated with the extra weight. A few pounds of load weight can make a difference. The modular tactical vest without side small arms protective insert plates weighs an average of six pounds more than a plate carrier, but its body coverage is barely more in comparison. Depending on the mission profile and analysis, it may be beneficial to save a few pounds of weight at the risk of losing a small amount of coverage.

Improvised Explosive Devices Considerations

There are several aspects of the mountainous environment that promote unique techniques for the use of improvised explosives. They can easily be placed above the ground level on the side of the road, intended to target personnel in a turret or driving position. They can also be placed high above the road systems to cause avalanches or rock slides. Large amounts of explosives can also be used to collapse narrow road systems and cause the target vehicles to fall off of steep ridgelines. Due to the rapidly varying elevation of the mountainous environment, there are many places near road systems where command wire only has to be run over an embankment to a radio frequency device in order to defeat the effect of an ECM.

Chemical, Biological, Radiological, and Nuclear Considerations

The general effects of chemical, biological, radiological, and nuclear (CBRN) agents are altered in the cold weather environment. Temperatures are a constant problem because all CBRN protective equipment and supplies must be kept from freezing. Below 0 °F, the radius of a nuclear blast is increased. Most chemical agents remain hazardous down to -50 °F. The survival of most biological agents is significantly enhanced as the temperature drops. Marine Corps CBRN operations are covered in MCWP 3-37, *MAGTF Nuclear, Biological, and Chemical Defense Operations*.

Severely Degraded Chemical, Biological, Radiological, and Nuclear Equipment Effectiveness

Equipment for CBRN is severely degraded during extreme cold in the following ways:

- Secondary frostbite occurs when personal protective equipment, such as the field protective mask, is used.
- Materials become brittle, crack, and tear easily in extreme cold.
- Frozen solutions clog and damage equipment.
- Heat must be supplied when conducting decontamination operations.
- Agent detection reactions are slow or will not work even when rewarmed with reagents.
- Contamination problems arise due to the cold's effects on donning and doffing procedures.
- There is an increased logistic requirement for CBRN defensive operations against chemical attack in extreme cold.

Psychological Stress

Extreme cold and high altitudes produce psychological problems, which numb the intellect and degrade personal and unit security. Current knowledge is insufficient to estimate what the added impact on the military operation will be. Casualty rates cannot help but increase if psychological stress slows or stops normal reaction of individual Marines or units to a chemical attack.

Mountainous Areas

Aside from breathing being more difficult at higher altitudes, the following will also affect CBRN equipment:

- At the lower barometric pressure of high altitudes, chemical agents will evaporate or sublime more rapidly.
- The increased isolation may, by localized surface heating, speed the vaporization of chemical agents.
- Contamination may spread quicker by greater wind speeds at higher altitudes.
- Contamination may collect in depressions and small valleys.

It is unknown if CBRN equipment will work better in the extreme cold of high altitudes than in the cold at low altitudes.

Cold Effect on Nuclear Weapons

Cold affects the blast, thermal, radiation, and electromagnetic pulse effects of nuclear weapons.

Blast

Below 25 °F, the effective radius of a nuclear blast increases up to 20 percent. Icepack or snowpack extends the distance of static overpressure, the crushing effect of the blast. Conversely, the distance of dynamic pressure may decrease due to the soft, absorbent characteristics of drifts and snow cover. Tundra and ice formations can break up pressure waves and the cratering effects in ice and frozen ground may be reduced, similar to those in solid rock.

Primary and reflected waves and ground shock from even small yield nuclear weapons may create earthquake-like fissures, crevasses, avalanches, and rockslides as far as 30 kilometers from ground zero. Secondary effects include snowstorms, avalanches, quick thaws, and ice breakup on lakes and rivers, which can interfere with troop movement.

Blast will increase damage on equipment due to its inflexibility from cold soaking, which makes metals and alloys brittle. In heavily forested areas, blown down trees will make large areas virtually impassible to vehicles and personnel. Since, during winter months, trees freeze and become brittle, in a nuclear blast, they can be converted into many splinter-like projectiles; puncture injuries should be expected. Personnel can reduce their risk of injury from flying debris if they wear layered clothing.

Thermal

Minimum safe distances may need to be increased by as much as 50 percent due to increased density of cold air and the high reflection of snow and ice. However, cold temperatures, frost, ice, and snow may reduce thermal effects on combustibles. The thermal effect may produce flash flooding in low-lying areas when the ice and snowpack melt. Thawing can greatly reduce troop movement in some zones. The snow, ice, and low temperatures may reduce destruction from post-blast fires. Muskeg, tundra, and wet terrain are average reflecting surfaces that reduce thermal radiation. Ice fog and snow cloud cover reduce thermal effects if the device is detonated as an air burst. Snow is a good reflecting surface, which increases thermal effects due to winter darkness dilating the pupils. Injurious heat absorption by personnel and equipment may be reduced by reflective overwhite camouflage clothing and netting.

Radiation

Weather plays an important part in radioactive fallout patterns. Snow can mask radiological hot spots from detection. Snow deposition is erratic due to rapidly changing winds. High winds extend radiation fallout patterns, but, correspondingly, may reduce radiation dose rates due to dispersion of contamination. At extremely low temperatures, the increased density of the atmosphere may reduce the distance of initial radioactive fallout by as much as 25 percent.

Contaminated snow may still spread the fallout, but amounts of induced radioactivity in the soil are reduced and even prevented by deep snow. Poorly drained areas, such as meadows, limit natural flushing and may act as collective points for radioactive contaminants. Most of the arctic is poorly drained. New snow may lessen fallout contamination of areas; hence, personnel and equipment may safely cross it.

Levels of local radiation can change quickly in windy conditions, which can lead to hot spots far removed from ground zero and very low intensity areas near ground zero. Consequently, the need for radiological surveying is increased.

Either the M-1950 or the extreme cold weather clothing system (ECWCS) clothing provides excellent protection from fallout. Radioactive particles may be removed by rigorous shaking and brushing of the outer garments. Snow caves and below ground shelters provide excellent shielding against radiation. Marines should avoid melting snow and ice for drinking water.

Electromagnetic Pulse

Effects of an electromagnetic pulse are expected to be the same as in temperature zones. Electromagnetic pulse will hamper or negate radio and tactical SATCOM for extended periods. Electromagnetic pulse mitigating practices, such as burying cables and wire links, may be difficult or impossible because of permafrost or frozen ground and recovery may be out of the question.

Cold Effect on Biological Agents

Biological attacks cannot be ruled out. Up-to-date immunizations, acclimated personnel, and strictly enforced personal hygiene (often considerably more difficult in the cold) are the best ways to avoid a secondary spread of any infection (see MCWP 4-11.1, *Health Support Operations*). Cold weather discourages the use of vector borne agents since they cannot survive. Toxins are less susceptible to the cold and the possibility of their use by covert means must be considered. Research by the Dugway Proving Grounds indicates that the survival of most microorganisms increases significantly below 32 °F. Layers of snow and reduced sunlight in northern regions lengthen the hazard period for biological agents. Organisms remain alive, but dormant and become active when exposed to warmer temperatures. The most effective means of biological warfare in cold weather is the delivery of live organisms by covert means. After a known biological attack, precautions to prevent its spread must be made just as they would in a temperate climate.

Temperature inversions frequently found over snowfields and bodies of water tend to prolong aerosolized biological clouds. With the exception of thermal inversions, aerosol biological agents are less effective. Aerosolizing live biological agents becomes more difficult at extremely cold temperatures, since only some spores form bacteria and certain viruses survive. Tents and other areas where living conditions are crowded and temperatures are higher than outside are likely areas where a biological agent may spread rapidly.

Cold Effect on Chemical Agents

Chemical agents work so well in the cold that they are considered a significant hazard. Exposure to any chemical agents will require masking. Aerosol dispersal is good. Most agents freeze at -50 °F. Chemical agents either thickened or frozen on clothing or equipment produce deadly off gas concentration once they come into heated areas.

Blood and Choking Agents

Blood and especially choking agents remain extremely hazardous and nonpersistent throughout low temperatures. These agents can be disseminated as a liquid, solid, or aerosol. Masks are required whenever they are used as hazard times may be longer than usual. The blood agent hydrogen cyanide is extremely hazardous even as low as -65 °F.

Blister Agents

Blister agents freeze below 0 °F. They can be brushed from clothing and equipment. However, some mixtures, such as HL (a mixture of mustard and lewisite gases), remain a liquid hazard at low temperatures. The standard winter blister agent is considered a mixture of mustard and lewisite. In areas that lack water, frozen or otherwise, this blister agent is expected to persist in liquid form for up to 6 months. If water is present, then the agent decomposes to form pure mustard that freezes at 58 °F. Blister agents usually are employed to cause blisters on contact with the skin, blindness, and inhalation casualties.

Nerve Agents

Nerve agents will freeze in severe cold and present a very serious vapor hazard when brought into warm areas. When used to contaminate key facilities, such as lines of communication or major population centers, nerve agents become an immediate long-term hazard. This hazard may require tremendous decontamination efforts or even a change in seasons to reduce below lethal levels. Persistency is controlled by an increased temperature, a smooth terrain surface, and wind speed. Nerve agents, particularly VX, are effective when absorbed through the skin or eyes, but its low volatility makes the vapor hazard negligible below 32 °F. The physical behavior of persistent nerve agents is only slightly affected by decreasing temperature. As the temperature nears 32 °F, persistent nerve agents dissolve in water, have reduced vapor hazard, and increase in persistency. Nerve agents, such as GB, tend to become semi-persistent in cold weather and can last from 2 to 10 days.

Employment of Chemical Agents

The offensive capabilities (excluding aerial delivery) of units to deliver toxic chemicals will be limited. The usual method for conducting toxic chemical attacks is to place the available concentration of fires directly on the small, well-located targets that are most vulnerable to chemical attack. Artillery and mortars to place a maximum number of rounds on the target in minimum time will use “time on target” fire techniques. Fuze settings should be varied depending on the nature of the soil, depth of the snow, and the type of target being attacked. Minefields placed to restrict the enemy’s use of key terrain should be composite minefields. The chemical mines should be placed to force the enemy off the road net and to use undesirable terrain. Approaches to bridges and bridge abutments can be contaminated when destroying the bridge, causing delay in reconstruction.

Chemical weapons will function in cold temperatures. However, the general usage rule for analyzing a friendly unit's vulnerabilities is to double the munitions requirements for each 20 °F decrease in temperature below 40 °F (i.e., 20 °F, 0 °F, -20 °F, -40 °F) to achieve the same result expected at the warmer temperature. Agents have been developed with a variety of regulated persistency, which give the field commander a known factor to plan operations with a high degree of result certainty. Weather, terrain, and logistical considerations limit the arctic areas where forces can operate effectively. The size of available targets for chemical attacks will usually be small.

Chemical, Radiological, Biological, and Nuclear Defense

To defend against the effects of CBRN weapons, four fundamentals must be applied: detection, contamination avoidance, protection, and decontamination. In a mountainous, cold weather environment, the first three fundamentals become extremely important as decontamination quickly becomes a logistical nightmare.

Detection

Detection is vital to identify a hazard; however, automatic detectors must be heated and detector paper is not always readable. The vapor hazard of chemical agents may be limited, making the M-256 chemical agent detector kit unreliable. Persistent agents will probably freeze into solids that may or may not be identifiable, creating a pick-up hazard that will not materialize until temperatures warm up. Reagents in the M-256 chemical agent detector kit will freeze and provide inaccurate reading in temperatures less than -25 °F. These kits must be kept close to the body to prevent freezing.

Cold slows the response of M-8 chemical detector paper, so extra time must be allowed for the paper to work. The M-9 paper is of little value because all the substances that react to it are affected by the cold. Extreme cold and/or the physical state of a chemical agent may make the M-8 alarm system ineffective. Detection will also determine the extent of the hazard and if the direction of advance should change to avoid contamination.

Every 50 to 100 feet, detection teams melt snow, heat it to 70 °F, and test the water with M-8 paper or chemical abstract machines. If an agent is suspected, water is taken into a heated shelter and heated until a vapor is given off above 70 °F. It is then tested with the M-256A1 kit. Data is then reported and plotted according to unit SOP. Because of the restraints the mountains place on radio communications, it may be necessary to use messengers. Contaminated areas are then marked with the standard NATO contamination signs. See NATO Standardization Agreement (STANAG) 2521, C*onduct of NBC Defense in Operations* (Allied Tactical Publication [ATP]-3.8.1, Volume 1).

Contamination Avoidance

Passive measures, such as concealment or dispersion, are used to avoid offering the enemy a lucrative target. Suggested passive measures include—

- Hardening positions by improving overhead cover.
- Avoiding detection.
- Providing early warning.
- Developing CBRN environmental discipline.
- Seeking protection from a potential chemical attack.
- Remaining mobile.
- Keeping supplies and equipment covered.
- Limiting exposure to CBRN hazards.
- Preventing spread of contamination.

Active measures include—

- Find and destroy enemy munitions/delivery systems.
- Use CBRN reconnaissance teams to monitor contamination of specific areas. See STANAG 2103, *Reporting Nuclear, Biological and Chemical Attacks, and Predicting/Warning of Hazard Areas (Operator's Manual)* (ATP-45).

- Use the standard NATO warning and reporting system to warn others of hazards or to pass the alarm locally by the most expedient means when a hazard is detected. Mountains or electromagnetic pulse can disrupt radio transmissions from detonation of a nuclear device.
- Separate mission-essential equipment from the nonessential equipment when both are contaminated. Cover equipment vital to mission accomplishment with readily available material. Restrict personnel movement in the contaminated area.

Protection

Collective protection shelters provide a contamination-free working environment for selected personnel for tactical or administrative use. They also provide a relief from continuous wear of full mission-oriented protective posture (MOPP) gear. See STANAG 2451, *Allied Joint Doctrine for NBC Defense* (Allied Joint Publication [AJP]-3.8).

Decontamination

Decontamination is the process of making any person, object, or area safe by absorbing, destroying, neutralizing, making harmless, or removing chemical or biological agents or by removing radioactive materials clinging to or around it. (Joint Publication 1-02, *Department of Defense Dictionary of Military and Associated Terms*) The extensive time and logistical support needed to perform deliberate decontamination requires commanders to avoid contamination, if possible. Temperatures below 32 °F limit the effectiveness of decontamination operations. Current chemical decontamination procedures that require wet water rinses are unacceptable in freezing weather. Effective decontamination procedures for below freezing temperatures have not been developed. Decontamination must be done in heated facilities. To decontaminate, Marines must—

- Perform hasty decontamination. Reduce the contamination hazard as quickly as possible by removing or neutralizing the chemical.
- Continue to fight after hasty decontamination.
- Understand the effects of chemical agents.
- Be proficient in individual decontamination procedures.

Shelter Control

In cold weather operations, decontamination and detection must be accomplished in heated shelters. One of the most challenging problems is how to prevent warm areas from becoming contaminated. For example, if individuals get frozen agents on their clothing, it will be hard to detect because low temperatures slow the effects of the agents. However, if the temperature warms or if the contaminated individual enters a heated area, the agents will give off gas. It may be necessary to set up a thawing station for each warm shelter and then unmask; otherwise, all occupants may be subject to hazardous liquids or vapors. Additional personnel and equipment will be necessary to operate these warming stations.

Individual Protection Equipment

The use of individual protective equipment for a CBRN threat in below freezing temperatures/snow require specific considerations.

Mask Carrier

The mask carrier should be adjusted to be worn in a slide carry beneath the cold weather parka. Body heat will help keep the mask warm and flexible; however, masking will be slow and difficult. Marines must be aware of this requirement when donning their cold weather clothing. They must ensure that the ECWCS parka is large enough to accommodate insulating layers and the gas mask with its carrier.

Outserts

Two outserts are provided to prevent fogging of the eye lenses. Green and amber tinted outserts can be used for bright light and fogging. Avoid wiping eyepiece with glove when firing because it will smear.

Donning the Mask

To don the mask—

- Hold your breath.
- Remove the mask from under your parka, lower the parka hood, and don the mask.
- Adjust the head harness only tight enough to create a good seal.
- Raise the parka and fasten the outer garment.
- Put on gloves or mittens.

Removing the Mask

To doff the mask—

- Remove gloves or mittens before removing the mask.
- Loosen the outer garment and lower the hood.
- Brush snow or ice particles from the mask.
- Remove the mask and immediately dry face and the inside of the mask.
- Raise the parka hood and fasten the outer garment.
- Wipe the mask thoroughly before storing to prevent ice formation.
- Store the mask in the carrier.
- Put on gloves or mittens. When possible, further dry the mask by placing it in a warm area, but not in direct heat.

Wearing the Chemical Protective Over-garment

Wearing the chemical protective over-garment presents a particularly difficult operational/logistic decision that the MAGTF commander must make before entering the operational theater. Tariff sizes and the impact of MOPP conditions on the operations must be considered. Tariffs must be up-sized.

Marine Corps policy is that the chemical protective over-garment will be worn over the ECWCS. The policy allows the possibility of exercising MOPP II to IV, providing the commander with the greatest mission accomplishment flexibility. If the ECWCS parka is not needed because of the additional warmth provided by the chemical protective over garment, it should be stored and sealed in a plastic bag. Wearing insulated layers of the ECWCS beneath the chemical protective over garment will necessitate that the tariffs be sized up for cold weather operations. If the ECWCS is worn outside the chemical protective over-garment, it would permit the layering required for additional warmth; however, it would require that the contaminated clothing worn over the over-garment be removed before entering a heated shelter where the agents can revaporize. Upon decontamination, the external layers of the over-garment would have to be discarded.

In addition, once the ECWCS is donned, it is not possible to adjust the over-garment. Cold weather clothing replacements would need to be issued; however, stocks of ECWCS are not adequate to support this requirement. A method of decontamination of this cold weather clothing would be necessary. The chemical protective over-garment will produce internal moisture and dehydration problems, which can lead to hypothermia. In full MOPP gear, speed is reduced to 50 percent; it may be reduced more due to build up of condensation and the potential danger of hypothermia.

Chemical Protective Glove Set

Vapor barriers, medical examination gloves, wool inserts, and the leather shell covered by the butyl-rubber glove make up the chemical protective glove set. This set allows the insulator (the wool insert) to remain warm and dry. If either outer glove is punctured or torn, the glove set must be replaced. In extreme cold when mittens are needed, this combination may result in frostbite.

Vapor Barrier Boots

The vapor barrier boots are effective and an adequate replacement for the normal over-boots; however, chemical agents that contain mustard gas will penetrate the boots' natural rubber. After 50 hours of exposure, they must be replaced and thoroughly decontaminated.

Decontamination Kits M-258A1 and M-13

The M-258A1 decontamination kit works properly until 32 °F; therefore, it must be kept next to the body to prevent freezing. Because it assumes surrounding air temperature, the solution should be used quickly once it is opened to avoid possible frostbite. The M-13 consists of a bag of Fuller's earth equipment decontamination. It is not affected by the cold.

Nerve Agent Antidote Kit Mk-1

At temperatures below 40 °F, the NAAK [Nerve Agent Antidote Kit], which is an atropine and pralidoxime chloride injection (NSN: 6505-01-174-9919), should be protected from freezing, removed from the mask carrier, and stored in a parka pocket.

Unit Protection

Units will have to be self-sufficient in CBRN defense. Terrain and weather in mountainous areas will dictate a requirement for a high degree of CBRN defense preparedness. Cold weather conditions will impose many special considerations on defense planning. Because deployments of large forces are limited, adjacent units may not be able to provide mutual support. Logistical support may be drastically reduced and rapid maneuver difficult.

Bivouac Location

The well dug infighting position with overhead cover remains the best means of protection for the individual. Because of terrain and weather restrictions, locating the bivouac for effective CBRN defense requires considerable planning. Gullies, ravines, ditches, natural depressions, fallen trees, and caves become effective only when used with normal precautions; however, toxic clouds can settle in low-lying areas. If tactically feasible, positions should be constructed upwind of a possible threat. Reverse slopes are good protection from nuclear attack. Hills absorb most heat, light, and initial radiation, while the slope deflects the rest up.

Predicting the actual point of an enemy nuclear attack is almost impossible. Likely targets, such as main supply routes and mountain passes, should be avoided. Wooded areas present a mixed blessing. On one hand, biological agents persist longer as the area retains moisture and keeps out sunlight. On the other hand, the heavily-wooded forested overhead found in the coniferous forests of Europe and the northwestern United States will reduce the possibility of liquid contamination from chemical weapons though chemical vapor hazard will increase.

Construction of Fighting Positions

Once the bivouac location is chosen, the construction of fighting positions capable of providing CBRN defense is paramount. Open CBRN fighting positions provide protection mainly against nuclear effects. The fighting position reduces exposure to thermal effects, initial alpha and beta radiation fallout, live biological agents, and liquid chemical agents. To construct effective overhead cover:

- Use dense covering materials.
- Be sure to construct cover in depth.
- Use strong supports.
- Cover as much of the opening as possible.
- Thoroughly line or revert positions on the sides using log forms, ammunition boxes, or empty MRE boxes filled with ice-crete or snow-crete.

Work Rate

Dehydration injuries are likely when Marines are required to perform difficult physical tasks. Though Marines will not suffer the same degree of heat buildup as in warmer climates, they are likely to suffer subsequent cold weather injuries. Freezing air inside of protective clothing or perspiration which cannot evaporate leads to chilling or hypothermia. Generally, Marines in MOPP IV conditions at 20 °F will require twice the normal amount of time to accomplish tasks. Additional supervision of workloads is necessary to alleviate cold weather injuries at all levels.

Mission-Oriented Protective Posture Gear Exchange

If a unit becomes contaminated, it is decontaminated by MOPP gear exchange (gloves and over-garment only). Two complete sets of MOPP gear and waterproof bags in which to seal contaminated clothing should be available for each Marine. Care must be taken with packaging the over-garment because tears and exposure to air degrade protective qualities. Extra suits must be provided when crossing water obstacles or conducting amphibious operations. Any contaminated cold weather clothing item must be replaced.

Decontamination of Equipment

Cold temperatures can be expected to adversely affect aqueous solutions, pumps, sponges, swabs, and brushes. Everything will be difficult and time consuming. The list of equipment and supplies can be used as general guidelines for decontamination needs.

Water is the most common ingredient in decontamination operations and it is useless if frozen. It should not be used when temperatures are so low that it freezes on contact with equipment. In these temperatures, undiluted decontamination solution number two (DS2) should be used, but Marines must remember that DS2 corrodes equipment quickly. Equipment will need to be replaced rapidly. Because of their low freezing points, solvents, such as jet petroleum 4 (also known as JP4), diesel fuel, or kerosene, may be used to physically decontaminate. Equipment decontamination problems are difficult to overcome in an arctic environment.

Commanders will have to consider fighting contaminated (dirty) in cold weather areas. Fresh units can be rotated into the contaminated areas so that dirty units can be moved to decontamination stations. Super tropical bleach and DS2 freeze at approximately -15 °F. In temperatures below -15 °F, JP4 can be used to remove contamination. Removing contamination does not *deactivate* the chemicals; it only *removes* them. The ground and equipment used to remove contaminates must be destroyed or removed properly. Highly flammable, JP4 may ignite because of the large amount of static electricity in cold dry climates, so Marines must use extreme caution. There is a definite risk of frostbite when fuel contacts exposed flesh. Rinse water must be heated or antifreeze added to the rinse solution to prevent freezing on contact with a cold vehicle. If the vehicle cannot be rinsed, the DS2 will quickly corrode the vehicle.

The chemical agent monitor is limited by the cold’s degradation on battery life. Two nitrogen cylinders may be required to expand the contents of the M-11 decontamination apparatus at temperatures below 32 °F/0 °C.

Difficulties will develop in dispensing DS2 as temperatures near 32 °F. To overcome this problem, the decontamination apparatus portable must be warm enough for the DS2 to be pumped through the brush assembly. Commanders should consider positioning a contingency supply of the M-13 inside heated vehicles and develop a plan to rotate into heated shelters.

The M-17 cenator decontamination apparatus has problems in cold temperatures because the system relies on a water-based decontamination method. Normal engine cold-soaking problems have been observed along with internal pumps and lines cracking from the expanding freezing water. This system must be used in a heated shelter.

Decontamination stations should be situated in built-up areas, near road junctions or intersections of forest lanes, or where they may be approached from several directions. Snow can be used to cover contaminated areas; however, when the snow blows away or when vehicles or personnel break through this surface, the contamination will reappear. Snow cover provides some protection if left undisturbed, but this protection is unreliable.

Unfrozen earth may not be available to make super tropical bleach dry mix. Snow may be used in place of dirt in the same proportion in shuffle pits and for other decontamination purposes. Burying contaminated materials in frozen ground will be difficult, so burned or abandoned materials should be marked with standard contamination signs.

CHAPTER 15
SURVIVAL

Requirements for Survival

The will to survive is a mind-set, an attitude. It is so important that, without it, one may not survive. The memory aid SURVIVAL is used to remember survival requirements.

- S *is for size up:*
  - *Size up the situation*. Conceal oneself from the enemy. Use the senses to hear, smell, and see to determine and consider what is developing on the battlefield before making a survival plan.
  - *Size up the surroundings*. Determine the rhythm or pattern of the area. Note animal and bird noises and their movement. Note enemy traffic and civilian movement.
  - *Size up self/unit physical condition*. Check all wounds and give first aid. Take care to prevent further bodily harm. Evaluate condition of self and unit before developing survival plan.
  - *Size up equipment*. Consider how available equipment may affect survival senses and tailor accordingly.
- U *is for undue haste makes waste*. Plan movements so that Marines can move out quickly without endangering themselves if the enemy is near.
- R *is for remember where you are*. If you have a map, plot the location and relate it to the surrounding terrain. Pay close attention to where you are and where you are going. Constantly orient, trying to determine, at a minimum, how the location relates to the following:
  - The location of enemy units and controlled areas.
  - The location of friendly units and controlled areas.
  - The location of local water sources.
  - Areas that will provide good cover and concealment.
- V *is for vanquish fear and panic*. Realistic and challenging training builds self-confidence and confidence in a unit's leadership. The feeling of fear and panic will be present, but the survivor must control these feelings.
- I *is for improvise and improve*. Use tools designed for one purpose for other applications. Use nearby objects for different needs, such as using a rock for a hammer.
- V *is for value living*. Place a high value on living. Refuse to give in to the problems and obstacles. Draw strength from individuals that rise to the occasion.
- A *is for act like the natives*. Observe the people in the area to determine their daily eating, sleeping, and drinking routines. Observe animal life in the area to help find sources of food and water.

  Note: Animal reactions can reveal your presence to the enemy. Animals cannot serve as an absolute guide to what you can eat and drink.

- L *is for live by your wits, but, for now, learn basic skills*. Practice basic survival skills during all training programs and exercises.

Stress

Stress has many positive benefits, such as providing challenges and opportunities to learn about values and strengths. Too much stress leads to distress. While many of these signs may not be self-identified, it remains critical that all survivors remain attentive to each other's signs of distress. Listed are common signs of distress:

- Difficulty in making decisions (do not confuse this sign for a symptom of hypothermia).
- Angry outbursts.
- Forgetfulness.
- Low energy level.
- Constant worrying.
- Propensity for mistakes.
- Thoughts about death or suicide.
- Trouble getting along with others.
- Withdrawing from others.
- Hiding from responsibilities.
- Carelessness.

Survival Stressors

Any event can lead to stress and such events often occur simultaneously. The events, called stressors, are not stress, but they produce it and add up. In response to a stressor, the body has a flight or fight reaction. Anticipating stressors and developing strategies to cope with them are the two ingredients in the effective management of stress. It is essential that the survivor be aware of the types of stressors they will encounter, such as illness or death, uncertainty, the environment, hunger and thirst, fatigue, and isolation.

A survivor might face injury, illness, and death. Perhaps nothing is more stressful than being alone in an unfamiliar environment in which death from hostile action, an accident, or from eating something lethal is possible.

Some people have trouble operating in settings where everything is not clear-cut. This uncertainty and lack of control also adds to the stress of being ill, injured, or possibly killed. A survivor will also have to contend with the stressors of weather, terrain, and the types of creatures inhabiting an area. Environmental and climate changes, coupled with insects and animals, are just a few of the challenges awaiting the Marine who is working to survive.

Without food and water, any person will weaken and eventually die. Getting and preserving food and water are even more important as the length of time in a survival situation increases. Replenishing electrolytes also becomes critical as diarrhea is likely. For a Marine used to having his/her provisions issued, foraging can be a significant source of stress.

It is essential that survivors employ all available means to preserve mental and physical strength. While food, water, and other energy builders may be in short supply, maximizing sleep to avoid deprivation is controllable. Sleep deprivation directly correlates with increased fear.

Isolation can also be extremely stressful. Being in contact with others provides a greater sense of security and a feeling that someone is available to help if problems occur.

Natural Reactions

Humans have been able to survive many shifts in his/her environment throughout the centuries. The ability to adapt physically and mentally to a changing world kept him/her alive. The average person will have some psychological reactions in a survival situation and might experience major internal reactions, such as fear, anxiety, anger and frustration, depression, loneliness and boredom, and guilt.

Fear is an emotional response to dangerous situations that are believed to have the potential to cause death, injury, or illness. Fear can have a positive effect if it forces us to be cautious in situations where recklessness could result in injury. Anxiety is an uneasy, apprehensive feeling experienced when faced with dangerous situations. A survivor reduces his/her anxiety by performing those tasks that will ensure his/her coming through the ordeal alive.

Frustration arises when a person is continually thwarted in his/her attempts to reach a goal. One result of frustration is anger. Getting lost; damaging or forgetting equipment; or experiencing weather, inhospitable terrain, enemy patrols and physical limitations are just a few sources of frustration and anger. Frustration and anger encourage impulsive reactions; irrational behavior; poorly thought-out decisions; and, in some instances, an "I quit" attitude.

Depression is closely linked with frustration and anger when faced with the privations of survival. A destructive cycle between anger and frustration continues until the person becomes worn down physically, emotionally, and mentally. At this point, he/she starts to give up and focus shifts from "What can I do?" to "There is nothing I can do." Since humans are social animals and enjoy the company of others, loneliness and boredom can be another source of depression. Marines must find ways to keep their minds productively occupied.

The circumstances leading to the survival setting are sometimes dramatic and tragic. It may be the result of an accident or military mission where there was loss of life. Perhaps the Marine is the only survivor. While naturally relieved to be alive, he/she may be simultaneously mourning the deaths of others who were less fortunate. Marines should not let guilty feelings prevent them from living.

Priorities of Work in a Survival Situation

Each survival situation will have unique aspects that alter the order in which tasks need to be accomplished. A general guideline is to think in blocks of time.

The first 24 hours are critical in a survival situation. Marines must make an initial estimate of the situation. Enemy, weather, terrain, time of day, and available resources will determine which tasks need to be accomplished first, but shelter, fire, water, and signaling should be the priority.

After the first 24 hours have passed, Marines will know they can survive and must expand their knowledge of the area. By completing the following tasks, Marines will be able to gain valuable knowledge:

- *Tools and weapons*. By traveling a short distance from shelter to locate the necessary resources, Marines will notice edible food sources and game trails.
- *Traps and snares*. Moving further away from the shelter to employ traps and snares, Marines will be able to locate the shelter area from various vantage points, enabling them to identify likely avenues of approach to the shelter area.
- *Path guards*. Knowing the likely avenues of approaches, they can effectively place noise and casualty producing path guards to ensure the security of the shelter area.

The remainder of the time in the survival situation is spent on continuously improving until rescue.

Group Survival

The group's survival depends largely on its ability to organize activity. An emergency does not bring people together for a common goal; rather, the more difficult and disordered the situation, the greater are the disorganized group's problems.

Group Morale

High morale must come from internal cohesiveness and not merely through external pressure. The moods and attitudes can become wildly contagious. Conscious, well-planned organization and leadership because of delegated or shared responsibility often can prevent panic. High group morale has the following advantages:

- The individual feels strengthened and protected, since he/she realizes that his/her survival depends on others he/she trusts.
- The group can meet failure with greater persistency.
- The group can formulate goals to help each other face the future.

Factors that Influence Group Survival

The following factors will influence whether a group can successfully survive:

- *Organization of manpower*. Organized action is important to keep all members of the group informed, so the members of the group will know what to do and when to do it, both under ordinary circumstances and in emergencies.
- *Selective use of personnel*. In well-organized groups, the person often does the job that most closely fits his/her personal qualifications.
- *Acceptance of suggestion and criticisms*. The senior person must accept responsibility for the final decision, but must be able to take suggestion and criticisms from others.
- *Consideration of time*. On-the-spot decisions that must be acted upon immediately usually determine survival success.
- *Check equipment*. Failure to check equipment can result in failure to survive.
- *Survival knowledge and skills*. Confidence in one's ability to survive is increased by acquiring survival knowledge and skills.

Shelters and Fires

In a survival situation in the mountains or cold weather, shelters and fires are a necessity.

Shelter Chracteristics

Any type of shelter, whether it is a permanent building, tentage, or an expedient shelter, must meet the following six basic characteristics to be safe and effective:

- *Protection from the elements*. The shelter must provide protection from rain, snow, wind, and sun.
- *Heat retention*. It must have some type of insulation to retain heat and prevent the waste of fuel.
- *Ventilation*. Ventilation must be constructed, especially if burning fuel for heat, to prevent the accumulation of carbon monoxide. Ventilation is also needed for carbon dioxide given off when breathing.
- *Drying facility*. A drying facility must be constructed to dry wet clothes.
- *Free from natural hazards*. Shelters should not be built in areas of avalanche hazards, under rockfall, or around "standing dead" trees, which all have the potential to fall on the shelter.
- *Stability*. Shelters must be constructed to withstand the pressures exerted by severe weather.

Natural Shelters

Natural shelters are usually the preferred types because they take less time and material to construct. Caves, rock overhangs, or hollow logs may be made into natural shelters with some modification. Caves or rock overhangs can be modified by laying walls of rocks, logs, or branches across the open sides. Hollow logs can be cleaned or dug out and then enhanced with ponchos, tarps, or parachutes hung across the openings.

A disadvantage of a natural shelter is that it may already be inhabited by animals, such as bears, coyotes, lions, rats, and snakes. Other concerns from animals may be disease from scat or decaying carcasses. Natural shelters may not have adequate ventilation. Fires may be built inside for heating or cooking, but may be uncomfortable or even dangerous because of the smoke build up. Many caves in a mountainous region may even have natural gas pockets in them. Natural shelters may appear stable, but in reality may be a trap waiting to collapse.

Manmade Shelters

Many configurations of manmade shelters may be used. Overlooked manmade structures found in urban or rural environments, such as houses, sheds, or barns, may also provide shelter. Limited by imagination and materials available, the following manmade shelters can be used in any situation:

- Poncho shelter.
- Sapling shelter.
- Lean-to.
- Double lean-to.
- A-frame shelter.
- Fallen tree bivouac.

The poncho shelter is one of the easiest shelters to construct. Materials needed for construction are cord and any water-repellent material, such as a poncho, parachute, or tarp. It should be one of the first types of shelter considered if planning a short stay in any one place. To construct a poncho shelter—

- Find the center of the water-repellent material by folding it in half along its long axis.
- Suspend the center points of the two ends using cordage.
- Stake the four corners down with sticks or rocks.

The sapling shelter is constructed in an area where an abundance of saplings are growing. It is an excellent evasion shelter. To construct a sapling shelter, Marines must—

- Find or clear an area so there are two parallel rows of saplings at least 4 feet long and approximately 6 to 24 inches apart.
- Bend the saplings and tie them together, forming several hoops that will create the framework of the shelter.
- Cover the hoop with a water-repellent material.
- The shelter then may be insulated with leaves, brush, snow, or boughs.
- Close one end permanently and hang material over the other end to form a door.

A lean-to is built in heavily forested areas. It requires a limited amount of cordage to construct. The lean-to is an effective shelter, but does not offer a great degree of protection from the elements. To construct a lean-to—

- Select a site with two trees (4 to 12 inches in diameter) spaced apart enough that an individual could lie down between them. Two sturdy poles can be substituted by inserting them into the ground the proper distance apart.
- Cut a pole to support the roof. It should be at least 3 to 4 inches in diameter and long enough to extend 4 to 6 inches past both trees. Tie the pole horizontally between the two trees approximately one meter off the deck.
- Cut several long poles to be used as stringers. They are placed along the horizontal support bar approximately every 18 inches. All stringers may be tied to or laid on the horizontal support bar. A short wall, rocks, or logs may be constructed on the ground to lift the stringers off the ground, creating additional height and living room dimensions.
- Cut several saplings and weave them horizontally between the stringers.
- Cover the roof with water-repellent and insulating material. See figure 15-1.

The double lean-to shelter is constructed for 2 to 5 Marines by making two lean-tos and placing them together. See figure 15-2 on page 15-6.

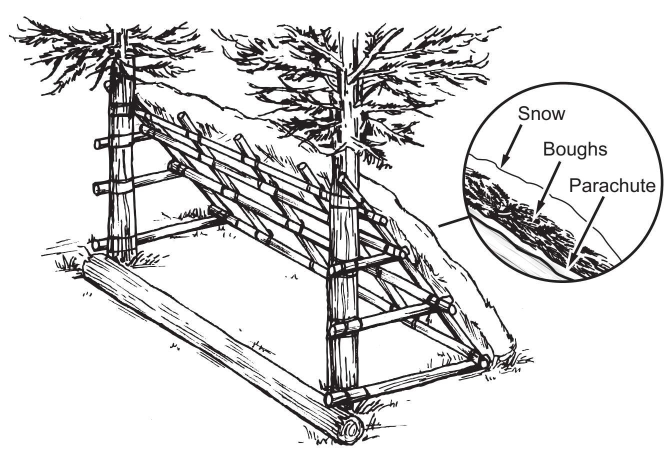

Figure 15-1. Lean-To.

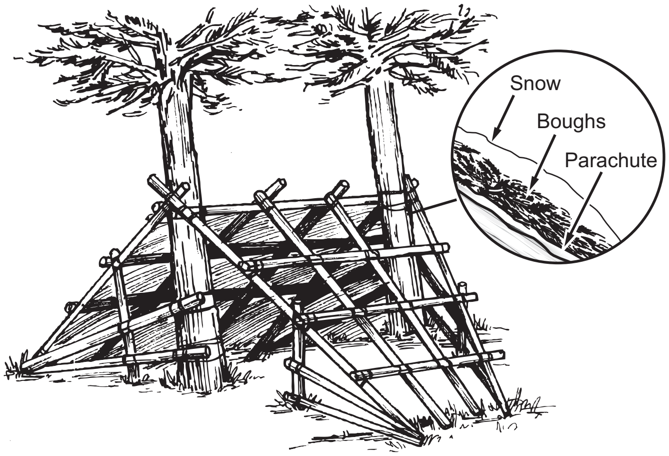

Figure 15-2. Double Lean-To.

An A-frame shelter is constructed for 1 to 3 Marines. After the framework is constructed, the bough/tentage is interwoven onto the frame. Snow, if available, is packed onto the outside for insulation. See figure 15-3.

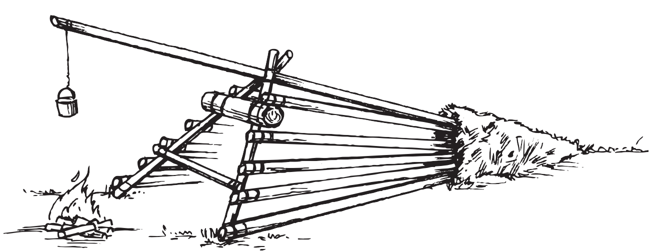

Figure 15-3. A-Frame.

The fallen tree bivouac is an excellent shelter because most of the work has already been done. To construct a fallen tree bivouac, Marines must—

- Ensure the tree is stable before constructing.
- Cut away branches on the underside, making a hollow underneath.
- Place additional insulating material to the top and sides of the tree. See figure 15-4.
- Build a small fire outside of the shelter.

Figure 15-4. Fallen Tree Bivouac.

The following general considerations apply to all shelters:

- Construct it big enough for the group's size.
- Construct it with a low silhouette and reduced living area dimensions for improved heat conservation.
- Avoid exposed hilltops, valley floors, moist ground, and avalanche paths.
- Create a thermal shelter by applying snow, if available, to roof and sides of shelter.
- Locate the shelter near to firewood, water, and signaling, if necessary.
- Determine the time and effort needed to build the shelter.
- Determine if the shelter can adequately protect Marines from the sun, wind, rain, and snow. Plan for the worst-case scenario.
- Determine if the tools to build the shelter are available. If not, use improvised tools.
- Determine the type and amount of materials available to build it.

When in a tactical environment, Marines must also consider the following:

- Provide concealment from enemy observation.
- Maintain camouflaged escape routes. Use the memory aid BLISS as a guide:
  - B—Blend in with the surroundings.
  - L—Low silhouette.
  - I—Irregular shape.
  - S—Small.
  - S—Secluded location.

Reflector Walls

Heating a shelter requires a slow fire that produces lots of steady heat over a long period. A reflector wall should be constructed for all open-ended shelters. A reflector wall is constructed with a flat rock or a stack of green logs propped behind the fire. A surprising amount of heat will bounce back from the fire into the shelter.

Fires

Fires fall into two main categories: those built for cooking and those built for warmth and signaling. The basic steps are the same for both—preparing the fire lay, gathering fuel, building the fire, and properly extinguishing the fire.

Preparing the Fire Lay

There are two types of fire lays: fire pit and Dakota hole. Fire pits are the most common. To create a fire pit—

- Create a windbreak to confine the heat and prevent the wind from scattering sparks.
- Place rocks or logs used in constructing the fire parallel to the wind. The prevailing downwind end should be narrower to create a chimney effect.
- Avoid using wet rocks. Heat acting on the dampness in sandstone, shale, and stones from streams may cause them to explode.

The Dakota hole is a tactical fire lay. Although no fire is entirely tactical, this fire lay will—

- Reduce the signature of the fire by placing it below ground. See figure 15-5.
- Provide more of a concentrated heat source to boil and cook, preserving fuel and lessening the amount of burning time.
- Create a large air draft so there is less smoke.
- Make it easier to light in high winds.

Gathering Fuel

Many Marines take shortcuts when gathering firewood. Taking a few extra minutes can mean the difference between ease and frustration when building a fire. The following materials can be used to start and fuel a fire:

- *Tinder*. Tinder is the initial fuel. It should be fine and dry. Gather a double handful of tinder for the fire to be built and an extra double handful to be stored in a dry place for the following morning. Dew can moisten tinder enough to make lighting the fire difficult. Some examples of tinder are—
  - Shredded cedar/juniper bark, pine needles.

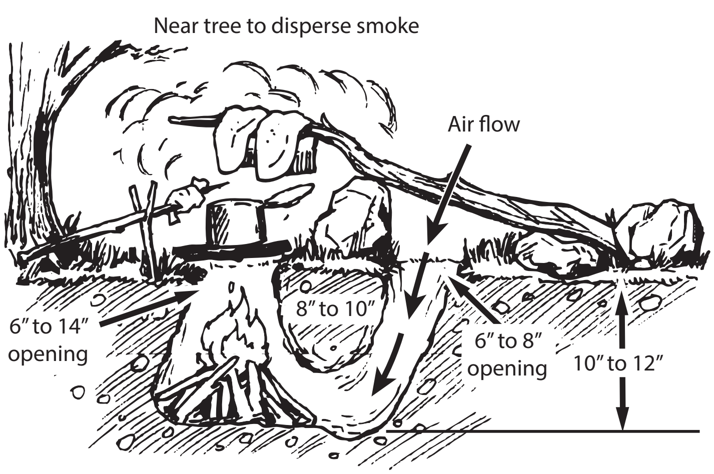

Figure 15-5. Dakota Hole.

- Dry grass.
- Slivers shaved from a dry stick.
- Hornet's nest.
- Natural fibers from equipment, such as cotton battle dressing, supplemented with pine pitch.
- Cotton balls and petroleum jelly or Charcloth.

Note: Sticks used for tinder should be dry and not larger than the diameter of a toothpick.

- *Kindling*. This material is ignited by the tinder that will burn long enough to ignite the fuel. Kindling should be dry, small sticks/twigs that range from the thickness of a pencil to that of a thumb. Due to their high resin content, evergreen limbs often make the best kindling. They burn hot and fast, but do not last long.
- *Fuel wood*. Fuel wood is used to keep the blaze going long enough to fulfill its purpose—make plenty of heat and leave an ample supply of long-lasting coals.

In general, Marines should consider the following points about gathering materials:

- Firewood broken from the dead limbs of standing trees or windfalls held off the ground will have absorbed less moisture and therefore should burn easier.
- Refrain from cutting down live, green trees.
- Softwoods (evergreens and conifers) will burn hot and fast with lots of smoke and spark, leaving few coals.
- Hardwoods (broad leaf trees) will burn slower with less smoke and leave a good bed of coals.
- Learn the woods that are indigenous to the area: birch, dogwood, and maple are excellent fuels; osage orange, ironwood, and manzanita, though difficult to break up, make terrific coals; aspen and cottonwood burn clean, but leave few coals.
- Stack the wood supply close enough to be handy, but far enough from the flames to be safe. Protect the supply from additional precipitation.
- In the case of a plane crash after which the aircraft did not burn, fires may be started using a mixture of gas and oil. Use caution when igniting this mixture.

Building the Fire

The type of fire built depends on its intended use—cooking, heating or signaling:

- *Teepee fire*. The teepee fire is used to produce a concentrated heat source, primarily for cooking. Once a good supply of coals can be seen, the teepee is collapsed and the embers pushed into a compact bed. See figure 15-6.
- *Pyramid fire*. Pyramid fires are used to produce large amounts of light and heat. It is suitable for heating and signaling. This type of fire will dry out wet wood or clothing. See figure 15-7.

Figure 15-6. Teepee Fire.

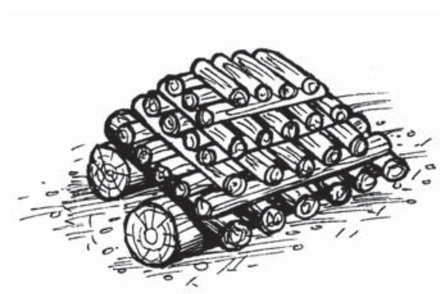

Figure 15-7. Pyramid Fire.

Starting Fires

Fires can be started by either modern or primitive sources of ignition. Reliance upon the following modern methods may result in failure during a survival situation:

- *Matches and lighters*. Waterproof these items.
- *Convex lens*. A Binocular, camera, telescopic sights, or magnifying lens can be used on bright, sunny days to ignite tinder.
- *Flint and steel* (sometimes known as metal matches or mag block). Scrape a knife or carbon steel against the flint to produce a spark onto the tinder. Some types of flint and steel designs will have a block of magnesium attached to the device, which can be shaved onto the tinder before igniting. Other designs may have magnesium mixed into the flint to produce a higher quality of spark.

Primitive fire methods are those developed by early humans. Marines should also learn and practice the bow and drill method to use it, if necessary. This technique requires a piece of cord and knife from the survival kit to construct. The components of the bow and drill are bow, drill, socket, fireboard, ember patch, and bird's nest:

- *Bow*. The bow is a resilient, green stick about three-quarters of an inch in diameter and 30 to 36 inches long. The bowstring can be any type of cord, but 550 cord works best. Tie the string from one end of the bow to the other, without any slack.
- *Drill*. The drill should be a straight, seasoned hardwood stick about one-half to three-quarters of an inch in diameter and 8 to 12 inches long. The top end is tapered to a blunt point to reduce friction generated in the socket. The bottom end is slightly rounded to fit snugly into the depression on the fireboard.
- *Socket*. The socket is an easily grasped stone or piece of hardwood or bone with a slight depression on one side. Use it to hold the drill in place and to apply downward pressure.
- *Fire board*. The fire board is a seasoned softwood board which should be three-quarters of an inch thick, 2 to 4 inches wide, and 8 to 10 inches long. Cut a depression three-quarters of an inch from the edge on one side of the fireboard. Cut a U-shape notch from the edge of the fireboard into the depression. This notch is designed to collect and form an ember that will be used to ignite the tinder.
- *Ember patch*. The ember patch is made from any type of suitable material, such as leather, aluminum foil, or bark. It is used to catch and transfer the ember from the fireboard to the bird's nest. Ideally, it should be a 4-inch square.
- *Bird's nest*. The bird's nest is a double handful of tinder that will be made into the shape of a nest. Tinder must be dry and finely shredded material, such as the outer bark from juniper/cedar/sage brush or the inner bark from cottonwood/aspen or dry grass/moss. Lay the tinder out in two equal rows about 4 inches wide and 8 to 12 inches long. Loosely roll the first row into a ball and knead the tinder to further break down the fibers. Place this ball perpendicular onto the second row of tinder and wrap. Knead the tinder until all fibers of the ball are interwoven. Insert the drill half way into the ball to form a partial cylinder. This is where the ember will be placed.

To produce a fire using the bow and drill method—

- Place the ember patch under the U-shaped notch.
- Kneel with the left foot on the fireboard near the depression.
- Load the bow with the drill. Ensure the drill is between the wood of the bow and bowstring. Place the drill into the depression on the fireboard. Place the socket on the tapered end of the drill.

- Use the left hand to hold the socket while applying downward pressure.
- Use the right hand to grasp the bow. With a smooth sawing motion, move the bow back and forth to twirl the drill.
- Once a smooth motion is established, smoke will appear. Once smoke appears, apply more downward pressure and saw the bow faster.
- When a thick layer of smoke has accumulated around the depression, stop all movement. Remove the bow, drill, and socket from the fireboard, without moving the fireboard.
- Carefully remove the left foot off the fireboard.
- Gently tap the fireboard to ensure all of the ember has fallen out of the U-shaped notch and is lying on the ember patch. Remove the fireboard.
- Slowly fan the black powder to solidify it into a glowing ember. Grasping the ember patch, carefully drop the ember into the cylinder of the bird's nest.
- Grasp the bird's nest with the cylinder facing toward you and parallel to the ground. Gently blow air into the cylinder. As smoke from the nest becomes thicker, continue to blow air into the cylinder until fire appears.

If Marines are having trouble staring a fire with the bow and drill method, they can troubleshoot by using the following techniques:

- If the drill will not stay in the depression, apply more downward pressure and/or increase width/depth of depression.
- If the drill will not twirl, lessen the amount of downward pressure and/or tighten bow string.
- If the socket is smoking, lessen the amount of downward pressure.
- If the wood is too soft when compared to the hardness of the drill, add some lubrication, such as animal fat, oil, or grease.
- If there is no smoke, drill and fireboard may be the same wood (the drill should be hardwood and the fireboard should be softwood) or the wood may not be seasoned. Check drill to ensure that it is straight. Keep left hand locked against left shin while sawing.
- If there is smoke, but no ember, check to ensure that there is a U-shaped notch cut into center of the depression.
- If the bowstring runs up and down drill, use a locked right arm when sawing. Check the drill to ensure that it is straight. Ensure bowstring runs over the top of the left boot.
- If the bird's nest will not ignite, the tinder may not be dry, the nest may be woven too tightly, the tinder may not be kneaded enough, or you may be blowing too hard (ember will fracture).

Extinguishing the Fire

The fire must be properly extinguished, using the drown, stir, and feel method:

- Drown the fire by pouring at water in the fire lay.
- Stir the ember bed to ensure that the fire is completely out.
- Check the bed of the fire by feeling for any hot spots.
- If any hot spots are found, repeat the process.

Signaling Devices

Signaling devices should be kept on the body or inside an aircraft. Generally, items are used as signaling devices while on the move. They must be accessible for use at any moment's notice. Additionally, in a summer mountainous environment, Marines may experience areas that are snow-covered and must be familiar with the effects that snow will have on specific signaling devices, which include pyrotechnics, flares, lights, whistles, radios, and mirrors.

Pyrotechnics include star clusters and smoke grenades. When using smoke grenades in snowpack, a platform must be built. Without a platform, the smoke grenade will sink into the snowpack and the snow will absorb all smoke. A rocket parachute flare or a hand flare has been sighted an average of 10 miles away and as far away as 35 miles. Pyrotechnic flares are most effective at night. During daylight, their observable ranges are reduced by 90 percent.

The M-186 pen flare is a signaling device carried in the vest of all crew chiefs and pilots. They must remember to cock the gun before screwing in the flare. A strobe light is generally carried in the flight vests of all crew chiefs and pilots. It can be used at night for signaling. Care must be taken because a potential rescue pilot wearing goggles may not be able to distinguish a flashing strobe from hostile fire.

A Morse code message can be sent using flashlights. An SOS distress call consists of sending three dots, three dashes, and three dots and continuously repeating this signal. The whistle is used in conjunction with the audio international distress signal. It is used to communicate with forces on the ground.

The AN/PRC 112 survival radio is a part of the aviator's survival vest. Both radios can transmit either tone (beacon) or voice. Frequency for both is 282.8 MHz [megahertz] for voice and 243.0 MHz for beacon. Both of these frequencies are on the UHF band.

The day/night flare is a good peacetime survival signal. The flare is for night signaling while the smoke is for day. A red cap with three nubbins identifies the older version flare, while the new generation has three rings around the body for identification during darkness. The flare burns for approximately 20 seconds while the smoke burns for approximately 60 seconds.

Note: Once one end is used up, douse in water to cool and save the other end for future use.

A mirror or any shiny object can be used as a signaling device. It can be used as many times as needed. Although the average detection distance is 5 miles, mirror signals have been detected as far away as 45 miles and from as high as 16,000 feet. It can be concentrated in one area, making it secure from enemy observation. A mirror is the best signaling device for a survivor; however, it is only as effective as its user. Marines must learn how to use one now, *before* getting in a survival situation. Military signal mirrors have instructions on the back showing how to use it. It should be kept covered to prevent accidental flashing that may be seen by the enemy. Any shiny metallic object can be substituted for a signal mirror.

Haze, ground fog, or a mirage may make it hard for a pilot to spot signals from a flashing object. So, if possible, Marines should get to the highest point in the area when flashing. If one cannot determine the aircraft's location, the signal should be flashed in the direction of the aircraft noise. See figure 15-8 on page 15-12.

Methods of Communication

There are two types of communication: audio and visual. Signaling by means of sound may be effective, but it does have some disadvantages. It has limited range unless using a device that will significantly project the sound; however, it may be hard to pinpoint a Marine's location due to echoes or wind. To sound the international distress signal, the survivor will make six blasts in one minute, returned by three blasts in one minute by the rescuer.

Visual signals are generally better than audio signals. They will pinpoint the survivor's location and can be seen at greater distances under good weather conditions. The visual international distress symbol is recognized by a series of three evenly spaced improvised signaling devices.

Improvised Signaling Devices

Improvised signaling devices are generally static in nature. They must be placed in a position to be seen by rescuers. They are made from any resources available, whether natural or manmade.

Smoke Generator

The smoke generator is an excellent improvised visual signaling device. It gives the survivor the flexibility to signal in either day or night conditions. This type of signal has been sighted as far away as 12 miles, with an average distance of

8 miles. Smoke signals are most effective in calm wind conditions or open terrain, but effectiveness is reduced with wind speeds above 10 knots. Smoke generators should be built as soon as time and the situation permits and protected until they are needed. To build a smoke generator, Marines should—

- Construct a fire in a natural clearing, along the edge of streams, or make a clearing. Signal fires under dense foliage will not be seen from the air.
- Find two logs, 6 to 10 inches in diameter, and approximately 5 feet long. Place the two logs parallel to each other 3 to 4 feet apart.
- Gather enough sticks that are approximately 2 inches in diameter and 4 feet long to lie across the first two logs. This setup serves as a platform for the fire.
- Gather enough completely dry branches to build a pyramid fire. The pyramid fire should be 4 feet by 4 feet by 2 feet high.
- Place the tinder under the platform.
- Gather enough pine boughs to lie on top of the pyramid fire, which protects the fire and the tinder.

To light the generator, the pine boughs are removed and the tinder ignited. If available, a torch can be constructed to speed up the lighting process, especially for multiple fires. See figure 15-9.

To create a smoke effect during the daylight hours, the pine boughs are placed on the ignited fire. Placing a smoke grenade or colored flare under the platform will change the color of the smoke generated. Marines should remember that the fire should draw in the colored smoke to create a smoke color that contrasts with the background, increasing the chances of success.

Arrangement or Alteration of Natural Materials

Twigs or branches can be tramped into letters or symbols in the snow and filled in with contrasting materials. To attract more attention, ground signals should be arranged in big geometric patterns. The symbols in figure 15-10 are internationally known.

If no other means are available, survivors may have to construct mounds that will use the sun to cast shadows. These mounds should be

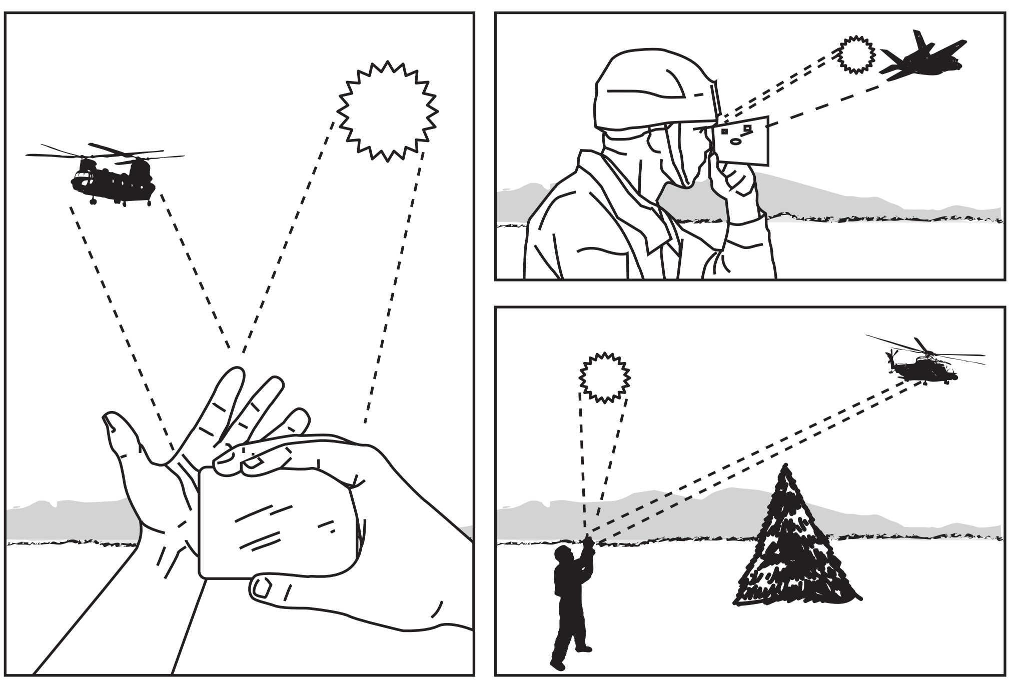

Figure 15-8. Aiming the Signal Mirror.

constructed in one of the International Distress Patterns. To be effective, these shadow signals must be oriented to the sun to produce the best shadows. In areas close to the equator, a North-South line gives a shadow anytime except noon. Areas further north or south of the equator require the use of an East-West line or some point of the compass in between to give the best result. The letters/symbols should be large as possible for a pilot or crew to spot as in figure 15-11 on page 15-14.

When constructing letter symbols, the letter should constrast from the surrounding vegetation and terrain. Ideally, material should be brought

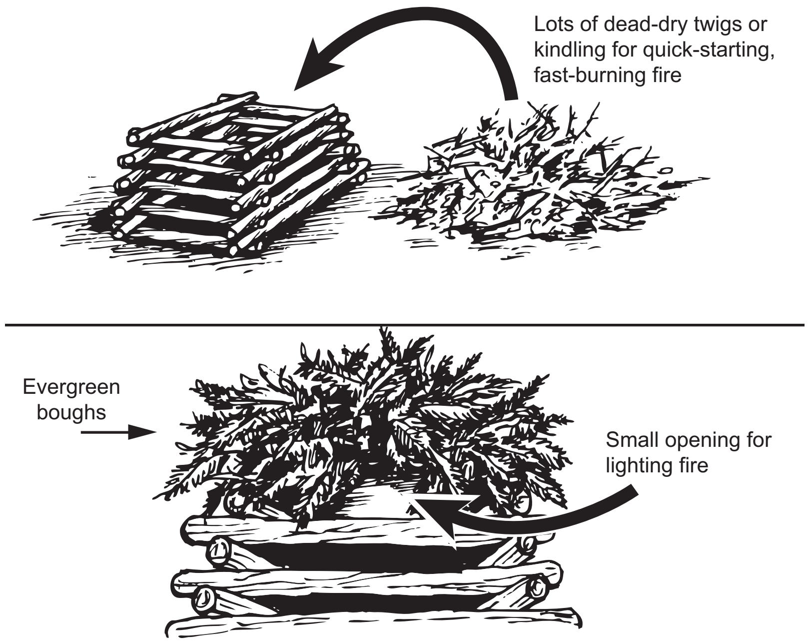

Figure 15-9. Smoke Generator.

Number	Message	Code Symbol
1	Require assistance	V
2	Require medical assistance	X
3	No or Negative	N
4	Yes or Affirmative	Y
5	Proceed in this direction	↑

Figure 15-10. International Symbols.

from another location to build the letter. This could be clothing, air panels, or a space blanket. On snow, boughs can be piled or sea dye from a personal life preserver can be used. Fluorescent sea dye markers have been sighted as far away as 10 miles, although the average detection distance is 3 miles.

Signaling Considerations

Military personnel trapped behind enemy lines in future conflicts may not experience quick recovery; they may have to move to a place that minimizes risk to the recovery force. No matter what signaling device an individual uses, he/she must take responsibility for minimizing the danger to the recovery force.

Placement Considerations

In a hostile situation, improvised signaling devices should not be placed near the following areas due to the possibility of compromise:

- Obstacles and barriers.
- Roads and trails.
- Inhabited areas.
- Waterways and bridges.
- Natural lines of drift.
- Manmade structures.
- All civilian and military personnel.

Tactical Consideration

Consider the following points in a tactical situation:

- Use the signals in a manner that will not jeopardize the safety of the recovery force or those being rescued.
- Locate a position that affords observation of the signaling device and facilitates concealed avenues of escape if detected by enemy forces. The position should be located relatively close to extraction site in order to minimize time spent on the ground by the recovery force.
- Maintain continuous security through visual scanning and listening while signaling devices are employed. If weapon systems are available, signaling devices should be covered by fire/observation.
- If enemy movement is detected in the area, attempt to recover the signaling device, if practical.
- Employ improvised signaling devices only during the prescribed times briefed in the mission order, if applicable.

Air-to-Ground Communications

Air-to-ground communications can be accomplished by standard aircraft acknowledgments. Aircraft will indicate that ground signals have

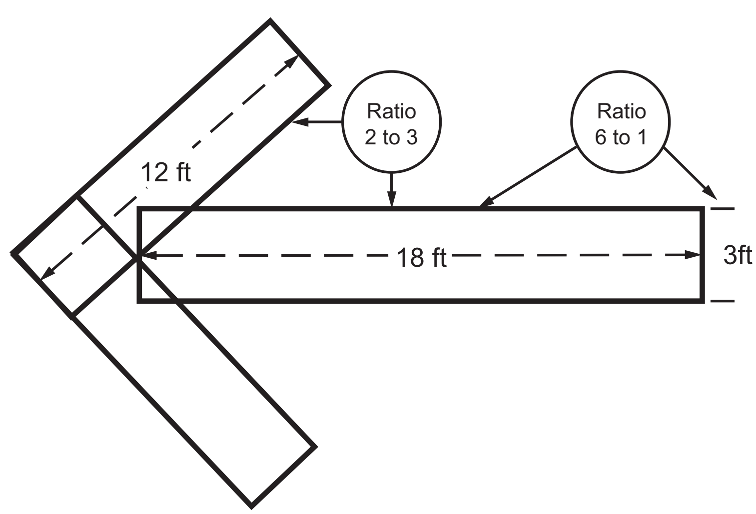

Figure 15-11. Size and Ratio.

been seen and understood by rocking wings from side to side. This acknowledgement can be done during the day or in bright moonlight. Aircraft will indicate that ground signals have been seen but not understood by making a complete, clockwise circle during the day or in bright moonlight.

Water Procurement

Thirst is not a strong enough sensation to determine how much water Marines need. The best plan is to drink plenty of water anytime it is available and particularly when eating. Dehydration is a major threat in mountains or cold weather. A loss of only 5 percent of body fluids causes thirst, irritability, nausea, and weakness. A 10 percent loss causes dizziness, headache, inability to walk, and a tingling sensation in limbs. A 15 percent loss causes dim vision, painful urination, swollen tongue, deafness, and a feeling of numbness in the skin. A loss of more than 15 percent of body's fluids could result in death. Water intake is of particular importance in survival or when resupply is unavailable.

Water Requirements

Water requirements will be increased if the Marine:

- Has a fever.
- Is experiencing fear or anxiety.
- Evaporates more body fluid than necessary, such as not using the proper shelter to his/her advantage.
- Has improper clothing.
- Rations water.
- Overworks.

Incidental Water

During movement, Marines may have to ration water until reaching a reliable water source. Incidental water may sometimes provide opportunities to acquire water. Although not a reliable or replenished source, it may serve to stretch the water supply or sustain personnel in an emergency. See figure 15-12. Dew and rainfall are sources for incidental water.

In areas with moderate to heavy dew, dew can be collected by tying rags or tufts of fine grass around the ankles. While walking through dewy grass before sunrise, the rags or grass will become saturated and can then be rung out into a container. The rags or grass can be replaced and the process repeated.

Rainwater collected directly into a clean container, or inside of plants that do not contain any harmful toxins is generally safe to drink without disinfecting. The survivor should always be prepared to collect rainfall at a moment's notice. An inverted poncho works well to collect rainfall.

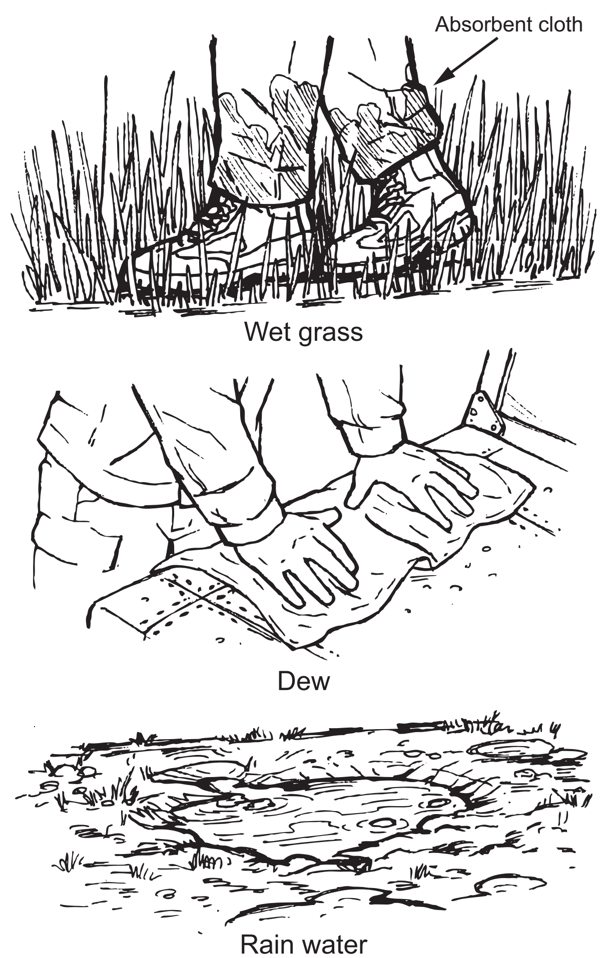

Figure 15-12. Incidental Water.

Hazardous Fluids

Survivors have occasionally attempted to augment their water supply with other fluids, such as alcoholic beverages, urine, blood, or seawater. While it is true that each of these fluids has high water content, the impurities they contain may require the body to expend more fluid to purify them.

Seawater

Seawater in more than minimal quantities is actually toxic. The concentration of sodium and magnesium salts is so high that fluid must be drawn from the body to eliminate the salts; eventually, the kidneys cease to function.

Alcohol

Alcohol dehydrates the body and clouds judgment. Super-cooled liquid, if ingested, can cause immediate frostbite of the throat and potential death.

Blood

Blood, besides being salty, is a food. Drinking it will require the body to expend additional fluid to digest it. It is a carrying source of disease like raw meat.

Urine

Drinking urine is not only foolish, but also dangerous. Urine is nothing more than the body's waste. Drinking it only places this waste back into the body, which requires more fluid to process it again.

Water Quality

Water contains minerals, toxins, and pathogens. Some of these, consumed in large enough quantities may be harmful to human health. Pathogens are a Marine's primary concern. Pathogens are divided into viruses, cysts, bacteria, and parasites. Certain pathogens are more resistant to chemicals and small enough to move through microscopic holes in equipment, such as a T-shirt or parachute. Certain pathogens also have the ability to survive in extremely cold water temperatures. Pathogens generally do not live in snow and ice. Water quality is divided into three levels of safety—disinfection (the most desired level), purified, and potable.

Disinfection

Water disinfection removes or destroys harmful microorganisms. Giardia cysts are an ever-present danger in worldwide mountain water that appears clear. By drinking nonpotable water, one may contract diseases or swallow organisms that could be harmful. Examples of such diseases or organisms are dysentery, cholera, typhoid, flukes, and leeches. Impure water, no matter how overpowering the thirst, is one of the worst hazards in a survival situation. The first step in disinfecting water is to select a treatment method, either heat or chemical.

According to the *Manual of Naval Preventive Medicine* (P-5010), water must be brought to a rolling boil before it is considered safe for human consumption. This method is the most preferred. Bringing water to the boiling point will kill 99.9 percent of all giardia cysts. The giardia cyst dies at 140 °F (60 °C) and cryptosporidium dies at 149 °F (65 °C). Water will boil at 14,000 feet at 186.8 °F (86 °C) and at 10,000 feet at 194 °F (90 °C), but it will take longer to reach that temperature than at sea level. The higher the altitude, the more time and fuel is used to boil the same amount of water due to the inefficiency of the stove at higher elevations. At extremely high altitudes, this method is impractical.

Many chemicals can be used to disinfect water. The most common are iodine tablets, chlorine bleach, iodine solution, and betadine solution (see tables 15-1 and 15-2). In a survival situation, Marines use whatever they have available.

Military water purification tablets are standard issue for all Department of Defense agencies. These tablets have a shelf life of four years from the date of manufacture, unless opened. Once the seal is broken, they have a shelf life of one year, not to exceed the initial expiration date of four years (see table 15-3).

Purification

Water purification is the removal of organic and inorganic chemicals and particulate matter, including radioactive particles. While purification can eliminate offensive color, taste, and odor, it may not remove or kill microorganisms. Water can be purified using a filtration method or by using commercial water filters.

Filtration purifying employs a three-tiered water filter system: the first layer, or grass layer, removes the larger impurities; the second layer, or sand layer, removes the smaller impurities; the final layer, or charcoal layer (not the ash but charcoal from a fire), bonds and holds the toxins. All layers are placed on some type of straining device and the charcoal layer should be at least 5-6 inches thick. Layers should be changed frequently and straining material should be boiled. Filtration purifying is not a disinfecting method as cysts can move through this system. See figure 15-13 on page 5-18.

Commercial water filters are generally available in most retail stores and may be carried. Understanding what the filter can do is the first step in safeguarding against future illnesses:

- A filter that has a .3-micron opening or larger will not stop cryptosporidium.
- A filter system that does not release a chemical, such as iodine, may not kill all pathogens.
- A filter that has been overused may be clogged. Usage may result in excessive pumping pressure that can move harmful pathogens through the opening.

Table 15-1. Water Disinfection Techniques and Halogen Doses.

Iodination Techniques Added to 1 liter or 1 quart of water	Amount for 4 ppm	Amount for 8 ppm
Iodine tablets Tetraglycine hydroperiodide EDWGT Potable Aqua Globaline	½ tablet	1 tablet
2 percent iodine solution (tincture)	0.25 mL 5 gtts	0.5 mL 10 gtts
10% Providone-iodine solution[1]	0.35 mL 8 gtts	0.70 mL 16 gtts
Chlorination Techniques	**Amount for 5 ppm**	**Amount for 10 ppm**
Household bleach 5 percent Sodium hypochlorite	0.1 mL 2 gtts	0.2 mL 4 gtts
Aqua Clear Sodium dichloroisocyanurate		1 tablet
Aqua Cure, Aqua Pure, Chlor-floc Chlorine plus flocculating agent		8 ppm 1 tablet

[1]Providone-iodine solutions release free iodine in levels adequate for disinfection, but little data is available.
Measure with dropper (1 drop=0.05 mL) or syringe.

Legend
EDWGT emergency drinking water germicidal tablet
gtts drops
mL milliliter
ppm part per million

Table 15-2. Concentration of Halogen.

Contact time in minutes at various water temperatures

	5 °C / 40 °F	15 °C / 60 °F	30 °C / 85 °F
2 ppm	240	180	60
4 ppm	180	50	45
8 ppm	60	30	15

Note: These contact times have been extended for the time needed in very cold water to kill giardia cysts. Chemicals may not destroy cryptosporidium.

Table 15-3. Expiration Information.

49703 Month / Year / Batch Number

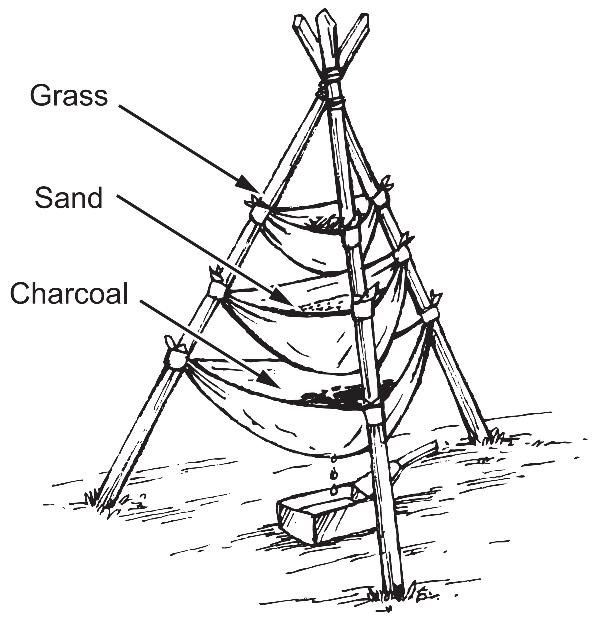

Figure 15-13. Water Filter.

Potable

Potable only indicates that a water source, on average over a period, contains a "minimal microbial hazard," so the statistical likelihood of illness is acceptable. Sedimentation is the separation of suspended particles large enough to settle rapidly by gravity. The time required depends on the size of the particle. Generally, one hour is adequate if the water is allowed to sit without agitation. After sediment has formed on the bottom of the container, the clear water is decanted or filtered from the top. Microorganisms, especially cysts, eventually settle, but this takes longer and the organisms are easily disturbed during pouring or filtering. Sedimentation should not be considered a means of disinfection and should be used only as a last resort or in an extreme tactical situation.

Solar Stills

Contrary to belief, solar stills will not provide enough water to meet the daily requirement for water. They are designed to supplement water reserves and can be built either above ground or below ground.

Above Ground Solar Still

This device allows the survivor to make water from vegetation. To make the above ground solar still, Marines must—

- Locate a sunny slope on which to place the still, a clear plastic bag, green leafy vegetation, and a small rock.
- Fill the bag with air by turning the opening into the breeze or by scooping air into the bag.
- Fill the bag one-half to three-quarters full of green leafy vegetation. Be sure to remove all hard sticks or sharp spines that might puncture the bag.

> **CAUTION:**
> Do not use poisonous vegetation, as it will produce poisonous liquid.

- Place a small rock or similar item in the bag.
- Close the bag and tie the mouth securely as close to the end of the bag as possible to keep the maximum amount of air space.
- If available, insert a small piece of tubing, small straw, or hollow reed into the mouth of the bag before tying it securely.
- Tie off or plug the tubing so that air will not escape. This tubing will allow condensed water to drain out without untying the bag.
- Place the bag, mouth downhill, on a slope in full sunlight. Position the mouth of the bag slightly higher than the low point in the bag.
- Settle the bag in place so that the rock works itself into the low point in the bag.
- To get the condensed water from the still, loosen the tie and tip the bag so that the collected water will drain out.
- Retie the mouth and reposition the still to allow further condensation.
- Change the vegetation in the bag after extracting most of the water from it.

Using 1-gallon plastic resealable bags instead of trash bags is a more efficient means of construction. See figure 15-14.

Below Ground Solar Still

Materials needed for a below ground solar still include a digging stick, clear plastic sheet, container, rock, and a drinking tube. They should select a site where the soil will contain moisture (such as a dry streambed or a low spot where rainwater has collected). The soil should be easy to dig and exposed to sunlight. See figure 15-15. To construct a below ground solar still, Marines must—

- Dig a bowl-shaped hole about 1 meter across and 24 inches deep.
- Dig a sump in the center of the hole. The sump depth and perimeter will depend on the size of the container that will be placed in it. The

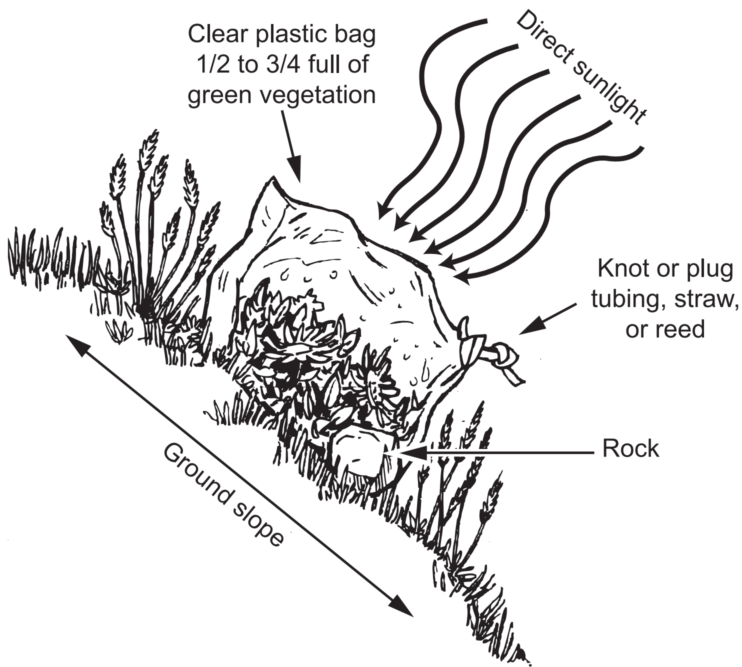

Figure 15-14. Above Ground Solar Still.

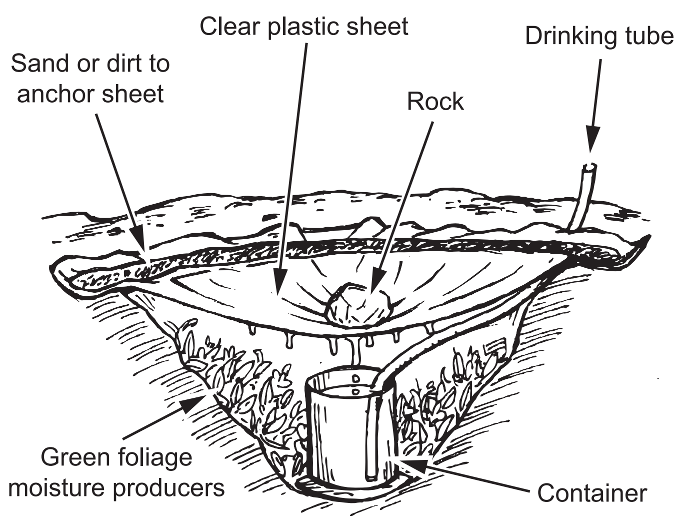

Figure 15-15. Below Ground Solar Still.

bottom of the sump should allow the container to stand upright.

- Anchor the tubing to the container's bottom by forming a loose overhand knot in the tubing.
- Extend the unanchored end of the tubing up, over, and beyond the lip of the hole.
- Place the plastic sheet over the hole, covering its edges with soil to hold it in place.
- Place a rock in the center of the plastic sheet.
- Lower the plastic sheet into the hole until it is about 18 inches below ground level. Make sure the cone's apex is directly over the container.
- Ensure the plastic does not touch the sides of the hole because the earth will absorb the moisture.
- Put more soil on the edges of the plastic to hold it securely and prevent the loss of moisture.
- Plug the tube when not in use so that moisture will not evaporate.
- Plants can be placed in the hole as a moisture source. If so, dig out additional soil from the sides.

If polluted water is the only moisture source, then Marines must—

- Dig a small trough outside the hole about 10 inches from the still's lip.
- Dig the trough about 10 inches deep and 3 inches wide.
- Pour the polluted water in the trough, being careful not to spill any polluted water around the rim of the hole where the plastic touches the soil.

The trough holds the polluted water and the soil filters it as the still draws it. This process works well when the only water source is salt water.

Note: Three stills will be needed to meet one Marine's daily water intake needs.

Snares and Traps

In long-duration survival situations, Marines will need to aquire food. The skills of trapping and snaring game will enable sustained survival. Knowing a few general hints and tips will make trapping animals easier and considerably more effective. Most of these considerations relate to the ambush mentality. Each of the following eight points for trapping animals should be considered as if planning an ambush on an enemy unit:

- *Know local game*. Knowing such things as when and where they move, feed, and water will help determine where the set can be most effectively placed.
- *Keep things simple*. Do not waste time in a survival situation constructing elaborate sets that do not necessarily do a better job.
- *Place sets in the right place*. Animals will travel and stop in certain locations. That is where to build sets.
- *Cover up human scent*. Animals will avoid a set that smells threatening or unusual to them, such as a human scent or chemicals from equipment or clothing. Since humans leave a scent through the skin, use an odorless contact glove when building a set. It may take up to three days for human scent to dissipate from the set if it is made without gloves. Certain boot soles and clothing may also leave a scent that can generally be detected by the human nose. If noticed, attempt to mask the scent with smoke from a fire.
- *Use the right type of set*. Certain sets work better than others do for a particular animal.
- *Use the correct equipment*. The weight of the lifting device in proportion to the animal's weight, the cordage or wire to hold the animal's strength, and trigger tension all contribute to success.

- *Check traps twice daily—morning and evening*. Checking traps less than twice a day can allow game to escape, rot, or be taken by other predators.
- *Lure the sets*. Lures will add to the chances of success. Certain lures are appropriate at certain times of the year, depending upon the animal desired. Lures fall into four different categories:
  - Bait lures, which may be MRE peanut butter, cheese spread, jelly, or dead carcasses.
  - Call lures, which are audio devices.
  - Gland or territorial lures, which may be animal urine mixed with beaver castors or animal glands.
  - Curiosity lures, which may be a single feather, bird wing, or a piece of fur tied and suspended under a tree limb and allowed to freely move with the breeze.

A general technique is the method in which the trap is intended to kill the animal. The memory aid "SICK" is useful in learning these techniques:

- S—*Strangle*. This method strangles the animal, such as a snare.
- I—*Impale*. This method pushes a stake through the animal, such as a spiked dead fall.
- C—*Crush*. This method crushes the animal, such as a deadfall for a chipmunk.
- K—*Knock*. This method knocks a larger animal unconscious, such as a deadfall.

Snares

A snare comprises a piece of wire, rope, or cord with a loop at one end that tightens down around animal's neck. Snares are much easier and less time consuming to construct than traps and produce better results. Although snares can be used with rope or cord, wire is the most effective. Wire should have memory and resist kinking. Aircraft cable type 7x7, in sizes one-sixteenth to three-eights inch should be used. This type of wire prevents animal chew out and resists breakage. The smallest diameter cable capable of holding the animal should be used.

A locking device, which secures the snare around the animal's neck, is imperative for a snare to work properly. There are several locking devices available, as in figure 15-16.

Requirements for Snaring

There are three requirements to effectively employ snares—location, presentation, and construction. Location is paramount to success. The

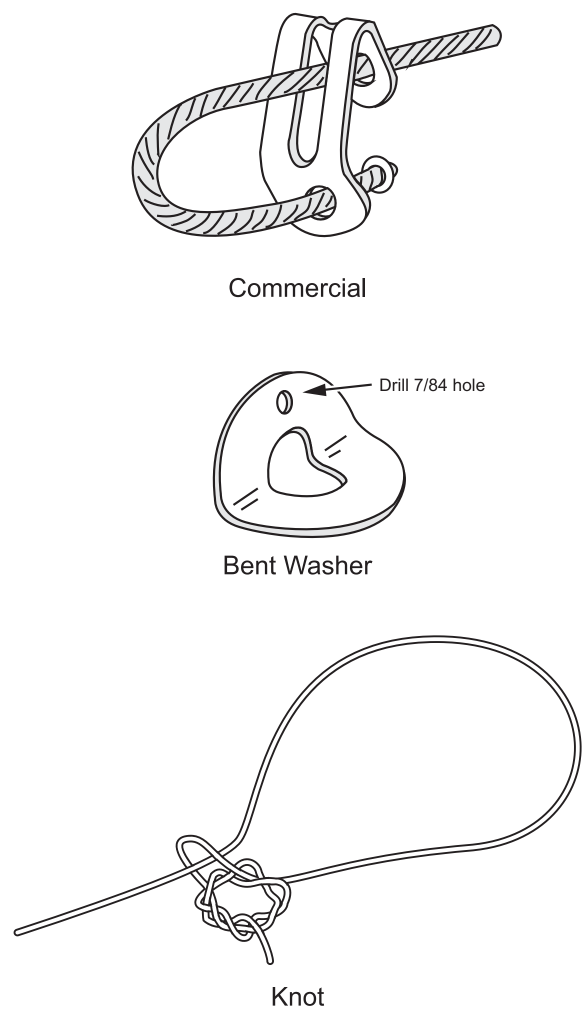

Figure 15-16. Locking Devices.

following animals usually prefer specific locations, making those spots ideal for setting snares:

- *Coyotes, foxes, and badgers*. These animals frequent rarely traveled roads, fire lanes, irrigation ditches, fence lines, saddles, ridge tops, meadow borders, and nearby carcasses.
- *Bobcats and lynxes*. These animals are often found at bases of cliffs and large rock faces, on ridges and saddle crossing, and along stream bottoms. Cats need security, so they are rarely far from trees, brush, or escape cover.
- *Raccoons, opossum, skunks, and ring-tailed cats*. These animals frequent stream beds, banks, trails along stream beds, ponds, rivers, and other water courses. Raccoons like a combination of water, old mature trees, buildings and junk piles, and a consistent food supply, such as grain or prepared feed.
- *Weasels*. Weasels are found in marshy, grassy meadows.
- *Martens and fishers*. These animals are found along meadow edges, ridge lines, and downfalls.
- *Mink*. Mink are found under bridges; around culverts, tiles, and junk in or near streams, rivers, lakes, springs and seeps; and in muskrat and beaver lodges and dams. Mink will stop and investigate nearly every hole or cavity around a streambed.
- *Beaver and muskrat*. These animals frequent the food cache under the ice.
- *Rabbits*. Rabbits dwell in thick willow stands along runs and trails.

Presentation is the type of set for the intended animal. The cubbie set works well for bobcat, raccoon, marten, fisher, opossum, and skunk while trail sets work well for coyote, fox, mink, and rabbit. To construct a cubbie set—

- Use a split stick to support the snare and ensure the snare fires properly. The split stick can be either green or seasoned wood; however, the snare must not slip through the split.
- Place the locking device next to the split stick.
- Place the split stick securely in the ground. If using a weighted snare, the locking device may be in the 12 o'clock position.
- Attach or anchor the snare to a drag and load it so it will fire quickly. See figure 15-17.

A correctly employed snare will hold the animal around the neck. The loop size placed on the snare depends on the intended animal (see table 15-4). A loop too large may just catch the animal's body or leg, resulting in possible chew out or breakage; too small and the animal may force

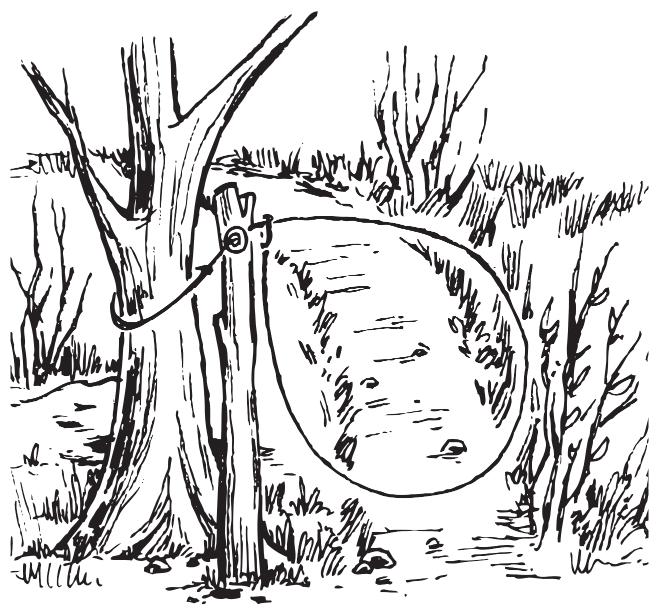

Figure 15-17. Snare Set.

Table 15-4. Noose Sizes for Animal Snares.

Animal	Noose Size	Ground Clearance
Squirrel	2½ to 3 inches	½ to 1½ inches
Rabbit	4 to 5½ inches	1½ to 3 inches
Raccoon	6 inches	3 to 4 inches
Fox	7 to 10 inches	8 to 10 inches
Coyote	12 to 14 inches	12 inches
Bobcat	9 inches	8 inches

Note: Noose size is the diameter of the snare loop. Ground clearance is measured from the bottom of the loop to the ground.

the snare to the side, resulting in a miss. Additionally, the loop must be placed with specific ground clearance. Ideally, the bottom of the loop, the snare trigger, should hit the intended animal chest high.

Fencing is a technique used to guide the intended animal to the snare. It must be subtle (see fig. 15-18).

Snare Sets

Figures 15-19 through 15-21 and figures 15-22 and 15-23, on page 15-24, are examples of snare sets—the trail set, the cubbie set, the den set, log sets, and the tree set.

Improvised Traps

Improvised traps are made from a variety of materials. These traps are designed to hold or kill animals with some type of action. This action is generally caused by either a weight or spring-loaded device.

Figure 15-18. Fencing.

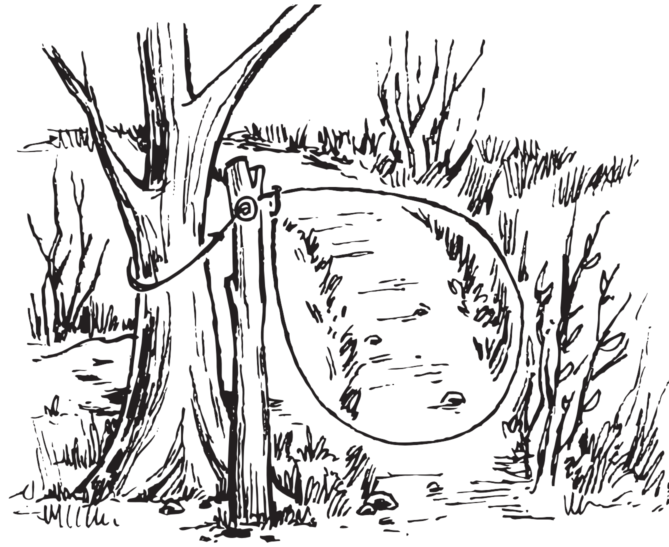

Figure 15-19. Trail Set.

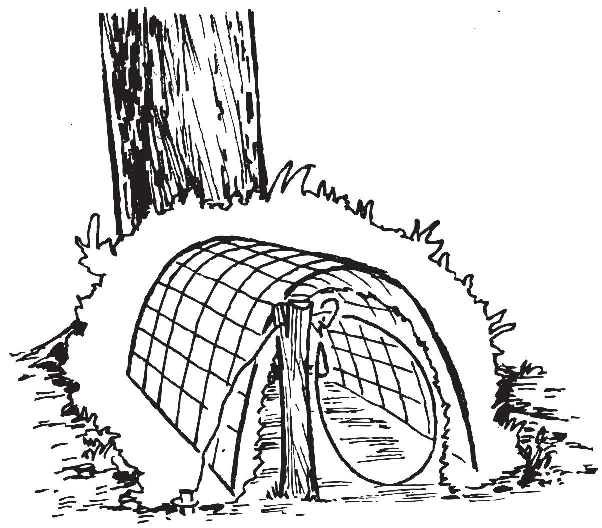

Figure 15-20. Cubbie Set.

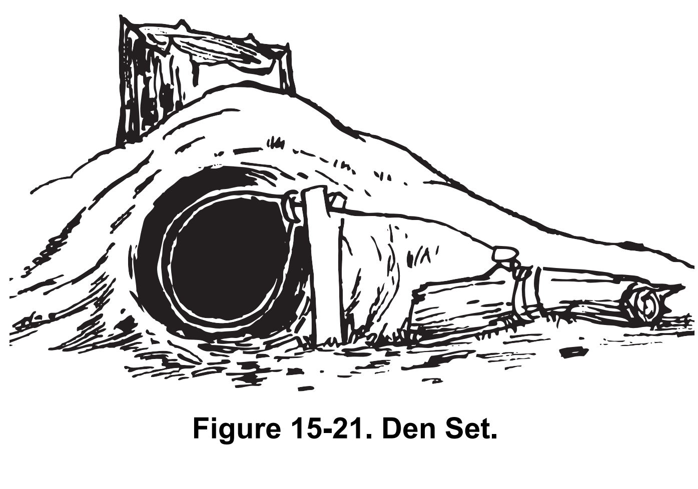

Figure 15-21. Den Set.

Trigger

The key to all improvised traps is the trigger system. Depending on the situation, the following three triggers can be used—the modified figure-4 (see fig. 15-24), the toggle (see fig. 15-25), and the universal (see fig. 15-26 and fig. 15-27 on page 15-26). The spring pole (see fig. 15-28 on page 15-26), the box trap (see fig. 15-29 on page 15-26), and the baited treble hook are variations of the three basic triggers that can be employed.

The modified figure-4 is a deadfall that requires a knife and piece of cord to construct. It is designed to mangle small rodents. The trigger for the deadfall is the modified figure-4.

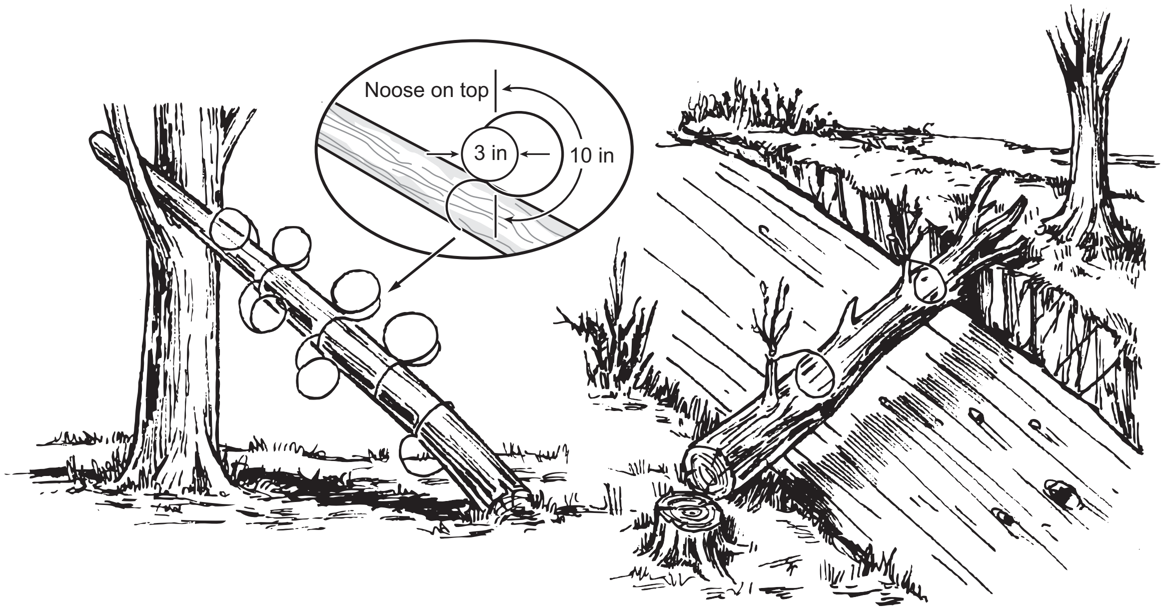

Figure 15-22. Various Log Sets.

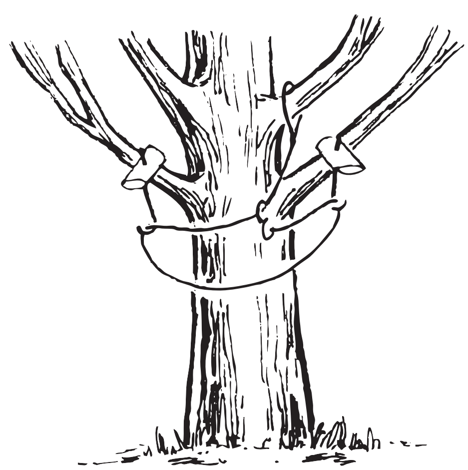

Figure 15-23. Tree Set.

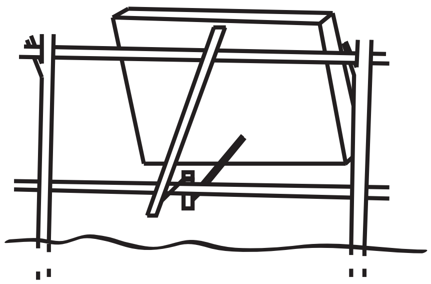

Figure 15-24. Modified Figure-4.

The toggle is a common trigger used with tension-initiated traps.

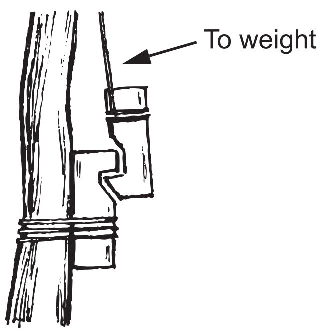

Figure 15-25. Toggle.

The universal trigger is more complex, but can be used with a wider variety of traps.

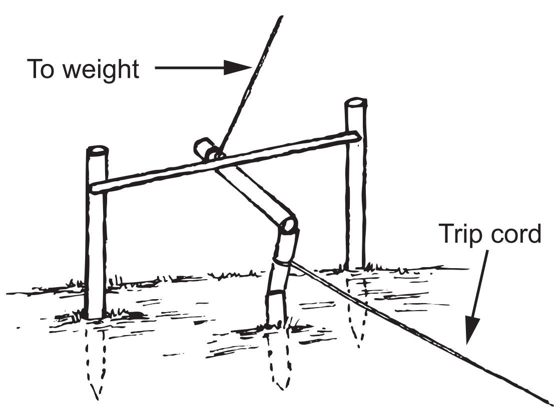

Figure 15-26. Universal.

The spring pole requires a small sapling and cordage to construct. The trigger for the spring pole is the toggle. It is designed to lift the animal off the ground, not allowing predatory animals to then take it.

Note: The trigger cannot be so tight that the intended game cannot set it off. See figure 15-28 on page 15-26.

The box trap requires limited cordage to construct. It is designed to hold live small rodents and birds. The box trap trigger is the figure-4. See figure 15-29 on page 15-26.

The baited treble hook is constructed by tying a large treble hook onto a tree limb high enough to cause the animal to jump, but not so high it cannot reach it. The treble hook should be baited.

Path Guards

Path guards are designed to protect and provide security for the shelter area against the enemy and predatory animals. They are classified as either noise- or casualty-producing path guards.

Noise-Producing Path Guards

Noise-producing path guards serve as an alarm for the shelter area. When triggered, it should produce some type of loud noise or visual signal. Although construction can vary depending on materials available, a noise-producing path guard can be constructed by—

- Securing a young sapling to a universal trigger.
- Tying several pieces of metal to the end of the sapling. Use whatever is available for metal.
- Camouflaging the metal on the ground.

When triggered, the sapling should swing back and forth, causing the metal to rattle.

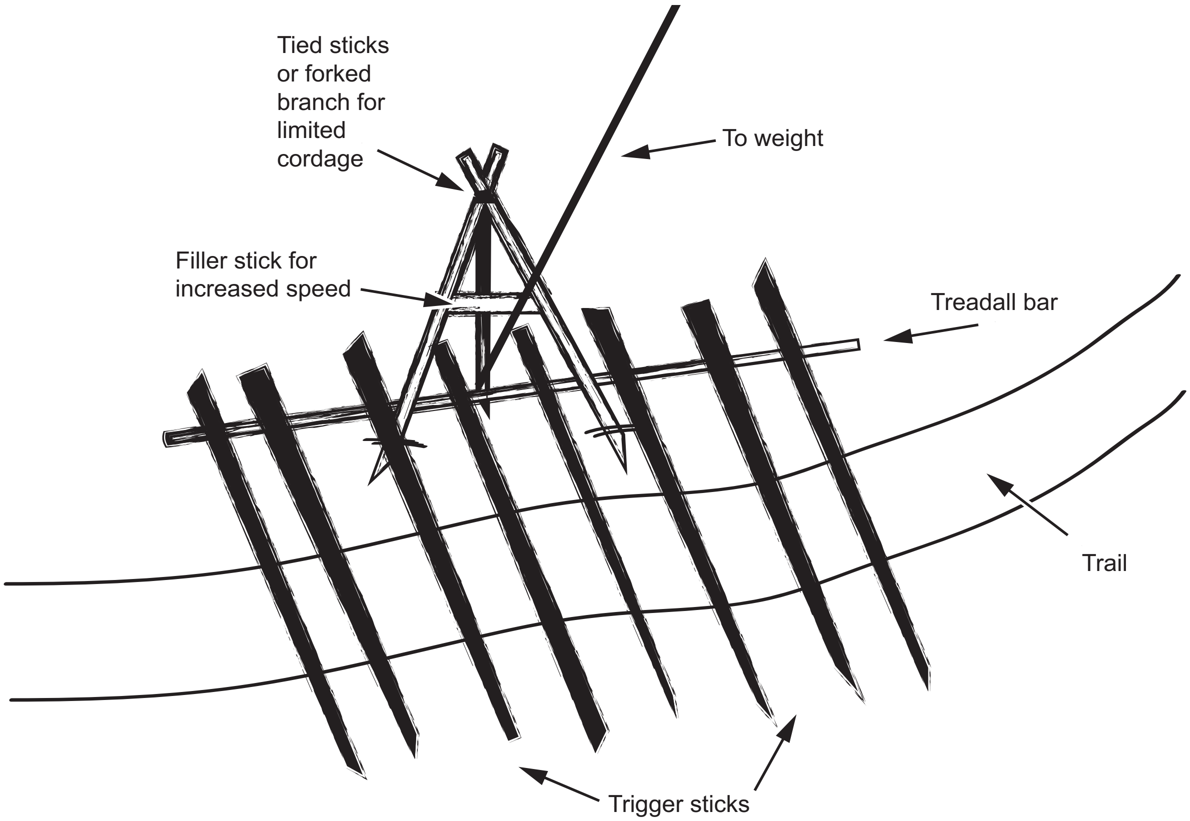

Figure 15-27. Universal.

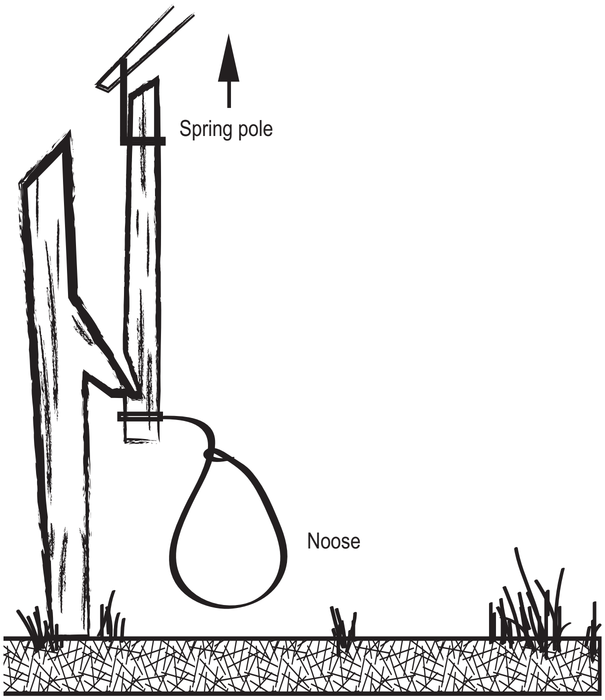

Figure 15-28. Spring Pole.

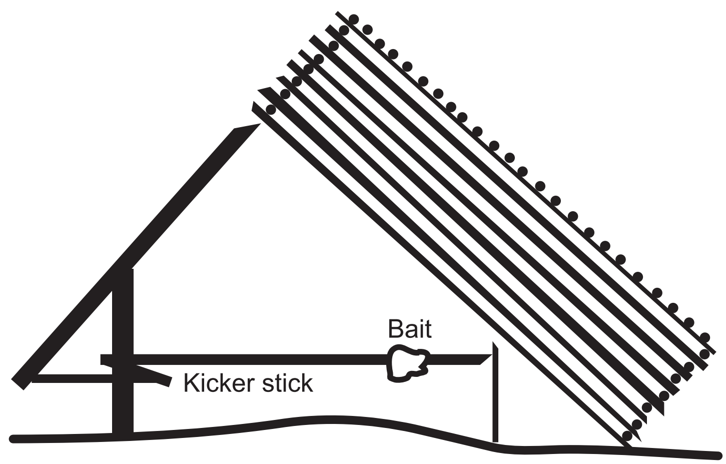

Figure 15-29. Box Trap.

Casualty-Producing Path Guards

Casualty-producing path guards, when triggered, should cause death or injury to the enemy or predatory animal. Tips should be poisoned as discussed in this chapter. For this type of path guard, the universal trigger should be used. The log jerk (see fig. 15-30) and the fishhook nightmare (see fig. 15-31) are examples of casualty-producing path guards.

Game and Fish

Once fish and game are acquired, they must be killed and prepared properly for consumption and other uses.

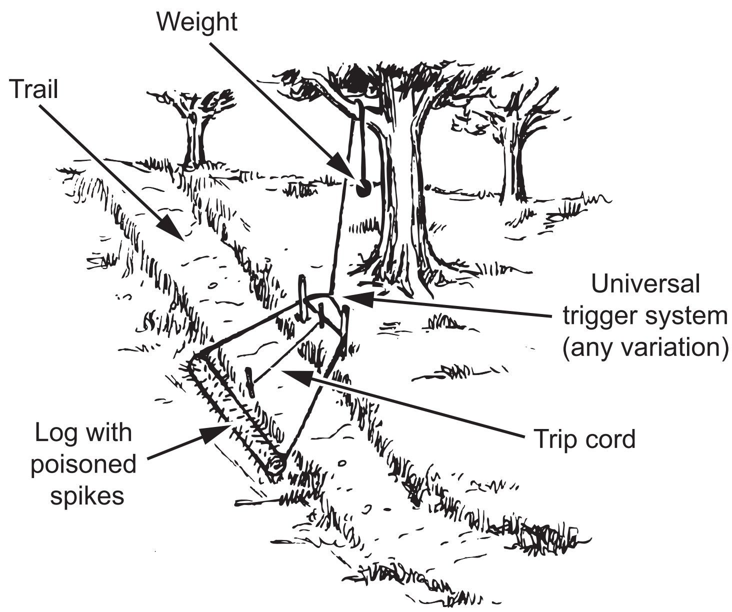

Figure 15-30. Log Jerk.

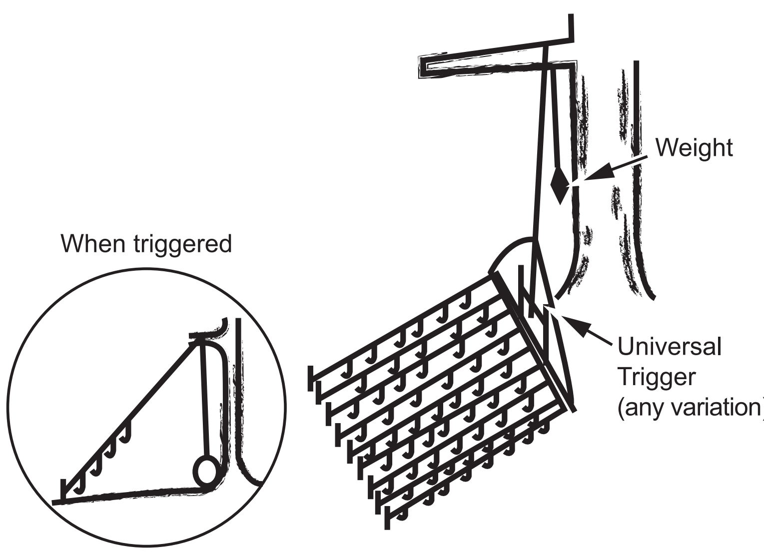

Figure 15-31. Fishhook Nightmare.

Killing Game

The following four methods are used to kill game:

- *Nose tap and heart stomp*. Using a club, hit the animal on the nose, which will knock the animal unconscious. Lay the club across the animal's neck. Placing one foot on the club to keep the animal down, use the heel of one's other boot to give the animal several sharp blows to the chest area, which causes the heart to swell and the animal to bleed internally.
- *Bleeding*. Slicing the animal's throat or piercing the chest cavity accomplishes this method.
- *Bludgeoning*. Beat the animal until it stops moving.
- *Breaking the neck*. The first step is the same as the nose tap. Laying the club across the neck, pull on the rear legs until a "snap" is heard and release. Once the animal straightens its hind legs, it is dead.

Preparing Game

Once the animal is dead, dressing should occur immediately, which allows the chest cavity to cool and slows the decay and bacterial growth rate. The use of chest cavity propping sticks will aid in this process.

Dress Game

To dress game—

- Cut around anus using a well-sharpened pocket knife. Be careful not to puncture intestines or kidneys.
- Cut the hide from the anus toward the chest cavity, which is performed by placing two fingers under the skin and then placing the blade of the pocket knife in between the fingers. These steps prevent rupturing the intestines and contaminating the meat.
- Reach in and pull out the heart, lungs, and liver, keeping them separate from the guts. These organs are edible. Check the liver for white spots. If white spots appear on the liver, the animal may have tularemia.

Dress Birds

To dress birds—

- Pluck feathers while the body is warm or the bird could be dipped into hot water to remove the feathers.
- A bird may also be skinned; however, this process removes the bird's fat layer, which is wasteful in a survival situation.
- Make incision from vent to tail and draw out intestines.

Dress Reptiles/Amphibians

To dress reptiles/amphibians, first cut off the animal's head well down behind poison sacs. The next step is to cut open its skin from anus to neck, and then pull out its internal organs. The organs are then discarded.

Note: Box turtles, brightly colored frogs, frogs with X mark on their backs, and toads should be avoided.

Skinning

Although the hide acts as a protective layer, it should be removed as soon as possible, which allows the meat to cool and develop a glaze. Since blood is a food source, it should be collected when possible.

Large Game

To skin large game—

- Find the Achilles tendon just above the feet and cut a small hole between the bone and the tendon.
- Thread a rope or string through the hole in order to hang the animal upside down from a tree branch or a makeshift rack.
- Cut completely around the hind legs, just below where the animal is suspended. Then cut toward the anus on the inside of the hind legs.
- Pull the hide straight down toward the head. The procedure used on the hind legs will be repeated for the front legs.
- Continue pulling the hide until it is free of the head. The hide will have to be cut if the animal has antlers.

Small Game – Casing

Small game can be skinned like large game or it can be cased. Casing a hide means to pull the entire skin off the carcass from rear forward, with cuts made only around the feet of the animal and from the back legs to the tail. This method allows the skin to be made into mittens, bags, and other holding devices. See figure 15-32.

Other Animals

The skin of fish, birds, and reptiles is usually left on.

Butchering

Butchering is cutting the meat into manageable portions. Smaller animals are generally best left whole. See figure 15-33 on page 15-30.

> *Note: Animals that were killed by the use of poisons should have a 2-inch cube of meat removed at the point of contamination.*

Washing

Meat should be rinsed to remove dirt. It should be especially cleaned if any bladder or fecal organs were ruptured during the skinning process.

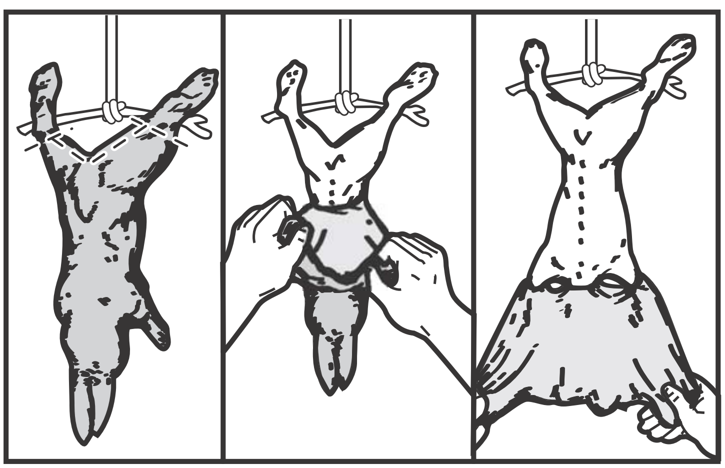

Figure 15-32. Hide Casing.

Cooking of Meats

Cooking meat thoroughly will kill bacteria and parasites. Since there are no leftovers in survival, Marines should cook only what they can immediately consume. Ideally, they should eat the heart and liver first to avoid spoiling. Meat can be cooked by boiling or roasting. Boiling is the best method for cooking and enables the survivor to consume the animal fat and nutrients, which collect in the broth. The roasting method is wasteful and will not be used in a survival situation.

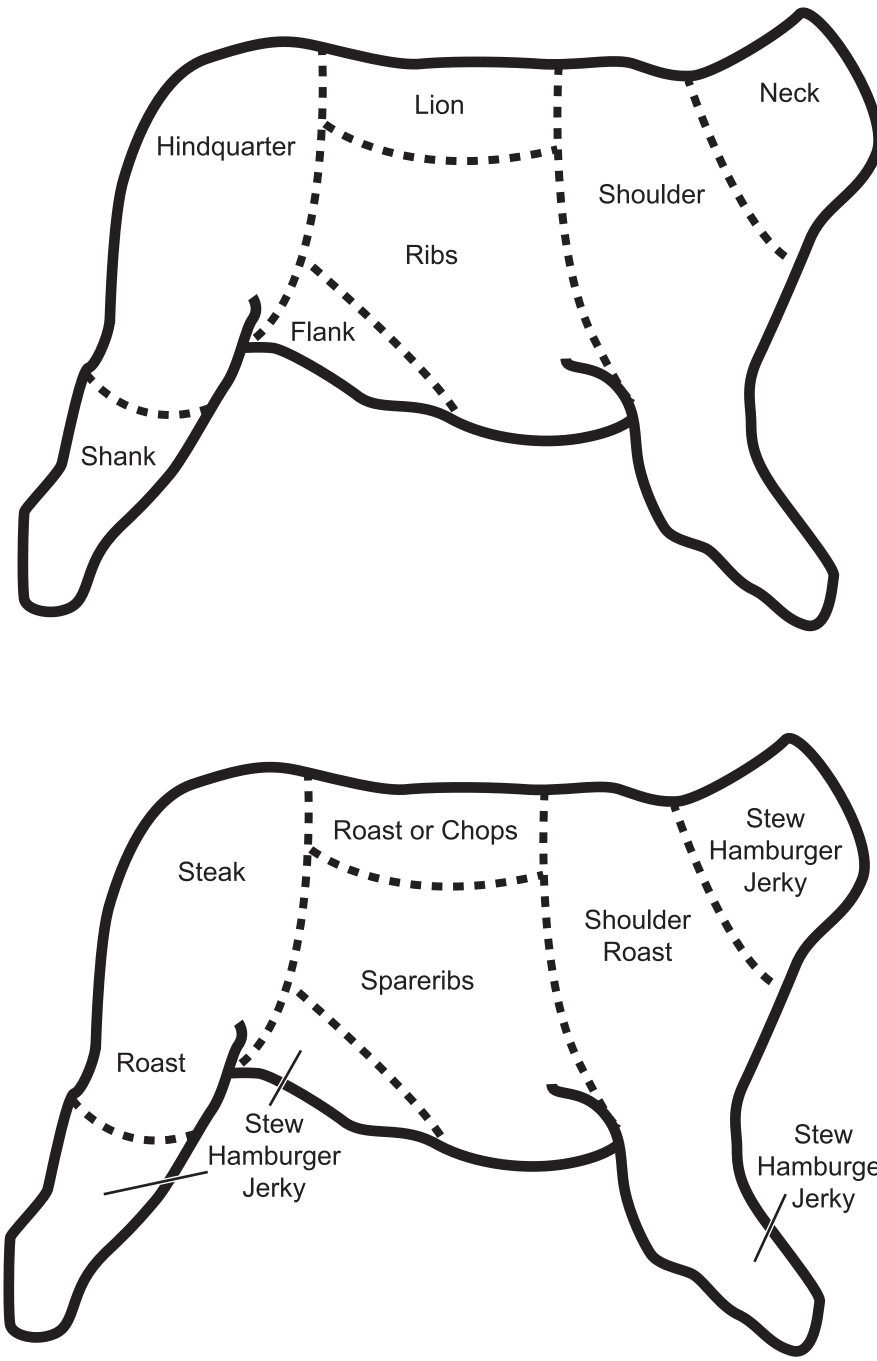

Figure 15-33. Butchering.

Tanning Hides

Hides can be used for shelter, blankets, and clothing. There are several methods and considerations for tanning hides.

Fleshing

Fleshing is the actual removal of meat, tissue, and fat from the hide. Fleshing is easier when done as soon as possible, preferably before the hide starts to dry. To flesh the hide—

- Soak or wet the hide if dry.
- Lay the hide on a solid, smooth, round object, such as a log or canteen.
- Hold a bayonet, blunt knife, sharp stone or bone tool scraper at a 10-degree angle away from the body and push the fat and membrane off the leather. Be careful not to make holes in the more tender parts of the belly. For beaver and badger, the fat must be cut off the hide.
- Continue this process until all the fat is completely removed.

Stretching

A fresh green or soaked hide must be stretched because the less a hide shrinks and hardens, the softer it will be at the end of the process. Stretching is accomplished by either making a frame or using the ground. Frame stretching involves lacing the hide to a frame with cordage and pulling it tight. A frame can also be created by bending a stick back on itself. Ground stretching involves staking the hide tight to the ground.

Hair

The animal's hair is removed by scraping it off with a sharp stone tool. Soaking the hide in water will make this process easier.

Braining

The brain acts as a lubricant and can make a hide temporarily water repellent. This process is accomplished by soaking the hide on the stretcher, extracting the brain from the animal, and mixing the brain with water to create a pasty solution. Once the brain matter is warm and thoroughly mixed, it should be firmly rubbed into the hide only on the hairless side.

Graining

The graining step forces the brain matter thoroughly into the leather. First, water is sponged on to further dampen hide. Then, using a blunt end of a pole, pressure is applied over every inch of the hide, scraping and stretching the fibers until most of the water is gone from the skin. The hide is tightened on the stretcher and allowed to dry.

Rubbing

The next critical step is the high friction rubbing needed to create the heat necessary to finish the drying, stretching, and breaking of the grain. Either of the following methods can be used:

- Cut the skin from the frame around the perimeter, leaving only the lacing holes and hair that could not be removed.
- Use a one half inch rope attached between two trees. Grasp the skin at different points all around its perimeter and pull, pull, pull. If rope is not available, rub the skin by sitting on the ground and hooking the skin over your feet and pulling.

Smoking

Smoking the hide will help make it water repellent. To smoke a hide, Marines must add wet or green wood chips to the fire. Sage and willow are good woods. The object is to get the chips to smoke, not burn. It only takes a few minutes to smoke a hide, but Marines should be careful to prevent a flame from ruining it.

Preserving Meats

The skill of preserving meat to take on the move is very valuable in a survival situation. There are several methods to preserve meat, such as freezing, cooling, making jerky, and pemmican. There are also risks, such as botulism, if meat is not properly preserved. Often a fatal food poisoning, botulism grows in a controlled environment. The memory aid TOM is useful in defeating botulism. If any one of the three elements is removed from the preserving process, botulism cannot live:

- *Temperature*. Botulism thrives between 40 and 140 °F.
- *Oxygen*. Botulism needs an airtight environment to live.
- *Moisture*. Botulism needs a moist environment to live.

Freezing

Before freezing, the meat should be cut into pieces of a size that can be used one at a time and kept frozen until it is ready to use. Meat will spoil if thawed and refrozen.

Cooling

To cool meat, it is placed in a metal or wooden container with a lid. The container should be ventilated. It should then be placed in water or buried in damp earth, preferably in a shaded location. Moldy meat should not be discarded; instead, the mold should be cut or scraped off and the meat cooked as usual.

Jerky

Jerky allows the meat to last for a couple of weeks and reduces its weight by dehydrating it. Jerky is made from the meat only as follows:

- Cut the meat into thin strips about one-quarter inch thick and remove all thick portions of fat.
- Place the meat by a fire to lightly smoke it and develop a thin crust layer. This crust serves to deter the bugs and insects. Hard woods (not conifer type wood) should be used to *smoke* it, not *cook* it.
- Once the meat has a crust layer, remove it and place strips on a hanger for the air to dry it for approximately 24 hours. Once dry, break down fibers by slightly pulling apart the meat and allowing it to dry for another 24 hours.
- When it becomes hard and brittle, take the meat down and store it in breathable bags or cloth. It is used in stews, soups, or roasted lightly on coals and eaten.

Small animals, fish, and birds are dried whole. After they are skinned, the back is cracked between the legs and a stick is inserted to hold the body cavity open. The animal is lightly smoked and laid out in the sun to dry. When thoroughly dried, they are pounded until the bones are crushed. Another day in the air will dry the marrow and ensure preservation.

Pemmican

Pemmican allows meat to last for several months and should be made as follows:

- Dry berries and pound into a paste.
- Add dried jerky to the paste.
- Mix melted suet (the hard fatty tissues around the kidneys) with the berries and jerky.
- Roll the mixture into small balls and place in the cleaned intestines of a large animal.
- Tie the intestine sack shut, seal with suet, and store in plastic or leather bags.

Other Edible Parts

Besides the actual meat, there are other edible parts of animals, such as—

- Brain.
- Eyes.
- Tongue.
- Liver.
- Heart.
- Lungs.
- Kidneys.
- Gizzards.

Fish

In a mountainous region, fish are normally an abundant resource. Not only are they a food source, the "leftovers" provide excellent bait for traps and snares. Fishing in mountain streams is generally best done with a hand line. Figure 15-34 shows good places to fish.

Fishing Equipment

Depending on the location, resources available, type of water source, and type/size of fish, certain fishing equipment may be needed, such as expedient hooks and a fishing spear. Although hooks should be carried in a survival kit, the survivor should be able to construct additional hooks if the situation arises. Expedient hooks are made to become lodged in the throat of the fish. If near shallow water (about waist deep) where fish are large and plentiful, they can be speared. To make a spear—

- Cut an 18- to 24-inch straight hardwood sapling. Fire harden if green.
- Sharpen one end of the sapling.
- Shave two green saplings to serve as prongs.
- Carve barbs on the prongs.
- Notch main staff to support prongs.
- Lash the prongs to the main staff.
- Prongs that do not easily flex under the weight of a finger need to be shaved and thinned, prior to lashing.

To spear fish—

- Find an area where fish either gather or where there is a fish run.
- Place the spear point into the water and slowly move it toward the fish.
- With a sudden push, impale the fish on the stream bottom. Do not try to lift the fish with the spear. Hold the spear with one hand and grab and hold the fish with the other. Do not throw the spear because you will probably lose it. See figure 15-35 on page 15-34.

A fish gaff is another effective method to procure fish from a concentrated area near the bank or to lift fish out of the water when hooked on a hand line. It is made from a single piece of wood and sharpened on the short end.

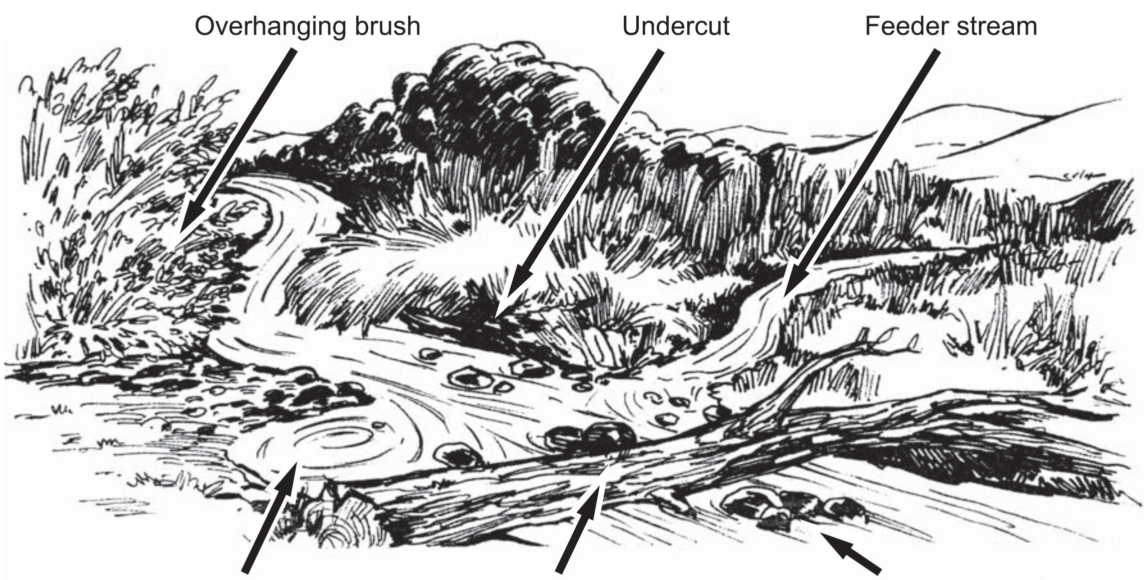

Figure 15-34. Fishing Locations.

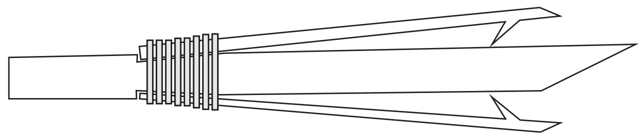

Figure 15-35. Fishing Spear.

Chum can be used to encourage fish to gather in one spot. The chum basket is a loosely woven basket that is filled with fish intestines and hung over the water's edge. Within a couple of days, maggots will form and drop into the water, causing the fish to concentrate in the area. The maggots can also be used for bait on a hand line.

Fish Traps

A fish trap can be effective if Marines have a shallow stream and time to construct the trap. A basic fish trap consists of two barricades of rocks or sticks across a stream that has a funnel-shaped entrance. Fish can be driven into the trap, but have a difficult time finding their way out. Once fish are trapped between these two barricades they may be speared, clubbed, or grabbed. This trap can be very effective when certain types of fish are moving in large groups to spawn. A door can be constructed at the mouth of the trap so that excess fish can be kept live until needed. See figure 15-36.

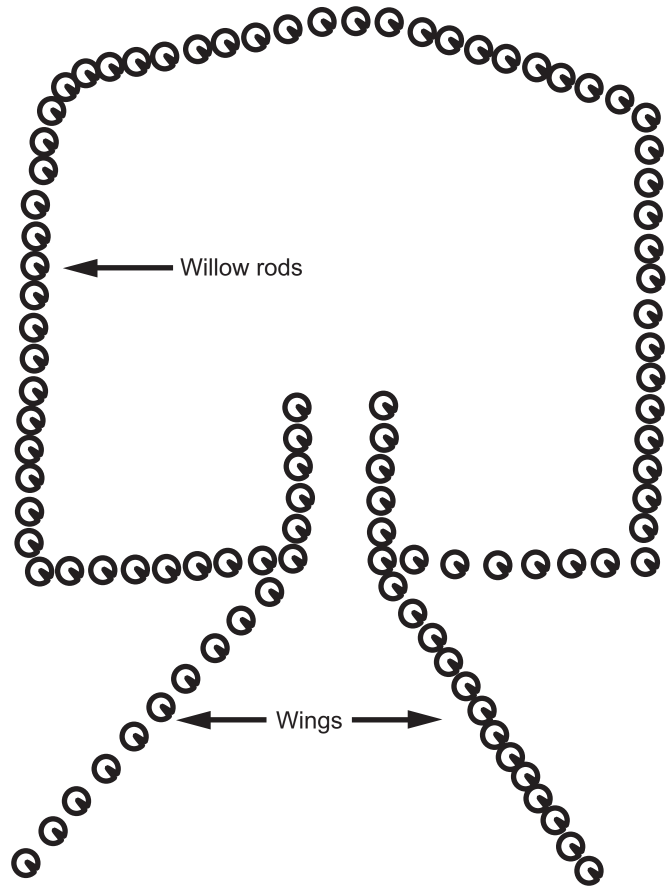

Figure 15-36. Fish Trap.

Fishing Set Lines and Netting

In a survival situation, fishing sets are means to catch fish while working on other tasks or weathering out a storm. Set lines are an effective method of fishing while conserving energy, since they are put out overnight with several baited hooks attached. The lines are placed with the hooks either on the bottom or suspended off the bottom until the fisher has determined where the fish are feeding. See figure 15-37.

A gill-net is most effective in still water, such as a lake (near the inlet and outlet are good locations) or back water in a large stream (for survival, Marines should not hesitate to block the stream). Nets can be constructed using the inner cords of parachute shroud lines. Floats are placed on top and weights on the bottom to keep the net vertical in the water. When ice is on a lake, the fish are inclined to stay deeper. The smaller the mesh, the smaller the fish Marines can catch, but a small net will still entangle a large fish. A 3-inch mesh is the standard. A gill-net is very time consuming and requires a lot of material to construct.

Preparing Fish for Consumption

Fish may contain many parasites, which, if prepared improperly, can infect the human body. To clean fish—

- Scrape the scales off the fish, going back and forth from tail to head with a pocket knife.
- Cut the fish open, starting at the anus and working toward the gills.
- With your finger or thumb, push all the guts out and wash thoroughly.

Look throughout the intestines to find out what the fish has been eating. It may aid Marines in procuring more fish. To ensure that all parasites have been destroyed, fish should be boiled in a canteen cup or similar container.

Plants and Insects

Foraging on plants and insects may be the only practical option in some situations.

Plant Considerations

There are very few regions in the world without some type of edible vegetation, but plant dormancy and snowfall make foraging plants difficult during the winter months. Plants contain vitamins, minerals, protein, carbohydrates, dietary fiber, and sometimes fats, so they can be very nutritious. However, just because birds or animals have eaten a plant, Marines should not assume that it is fit for humans to eat too. Plant recognition skills are paramount to survival. Plants generally poison by—

- *Ingestion*: when a person eats a part of a poisonous plant.
- *Contact*: when a person makes contact with a poisonous plant that causes any type of skin irritation or dermatitis.
- *Absorption*: when a person absorbs the poison through the skin, which can interrupt a bodily function.
- *Inhalation*: poisoning can occur through the inhalation of smoke that contains poisonous plant residue.

Plant properties can change throughout the growing season. Plants can be edible during certain periods, while being poisonous in others.

Plant Identification

Proficiency in plant identification is complex and requires diligent study. Marines can identify plants by memorizing particular varieties through familiarity or by using such factors as leaf margins, shape, arrangement, and root structure.

Leaf Margins

Basic leaf margins are toothed, lobed, and toothless or smooth. See figure 15-38 on page 15-36.

Leaf Shape

Leaves may be lance-shaped, elliptical, egg-shaped, oblong, wedge-shaped, triangular, long-pointed, or top-shaped. See figure 15-39 on page 15-36.

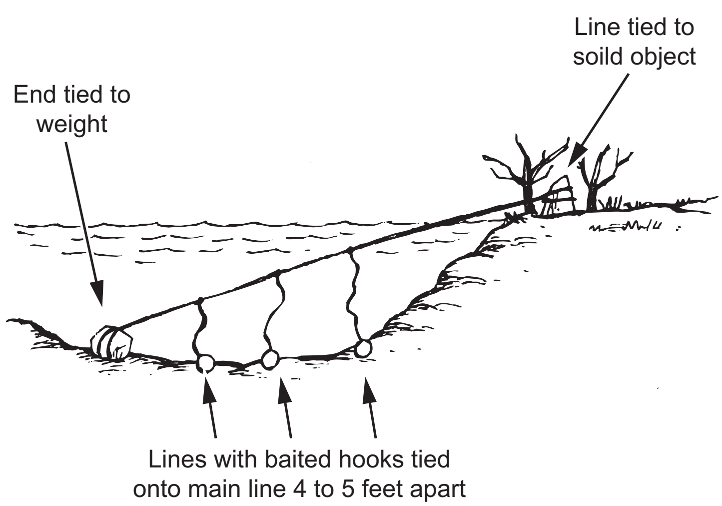

Figure 15-37. Set Lines.

Leaf Arrangement

The basic types of leaf arrangements are opposite, alternate, compound, simple, and basal rosette. See figure 15-40.

Root Structure

The basic types of root structures are the bulb, clove, taproot, tuber, rhizome, corm, and crown. Bulbs are familiar to us as onions and, when sliced in half, will show concentric rings. Cloves are those bulb-like structures that remind us of garlic and will separate into small pieces when broken apart. Taproots resemble carrots and may be single-rooted or branched, but usually only one plant stalk arises from each root. Tubers are like potatoes and daylilies and these structures can be found either on strings or in clusters underneath the parent plants. Rhizomes are large creeping rootstocks or underground stems and many plants arise from the "eyes" of these roots. Corms are similar to bulbs but are solid when cut rather than possessing rings. A crown is the type of root structure found on plants, such as asparagus, and

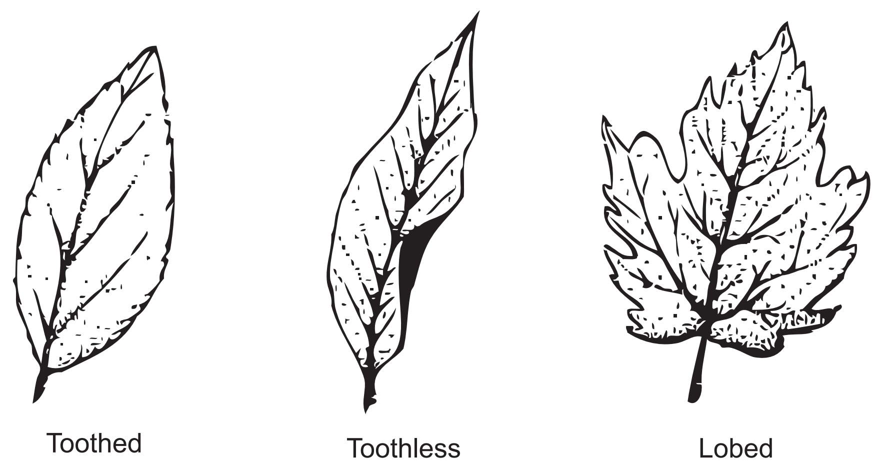

Figure 15-38. Leaf Margins.

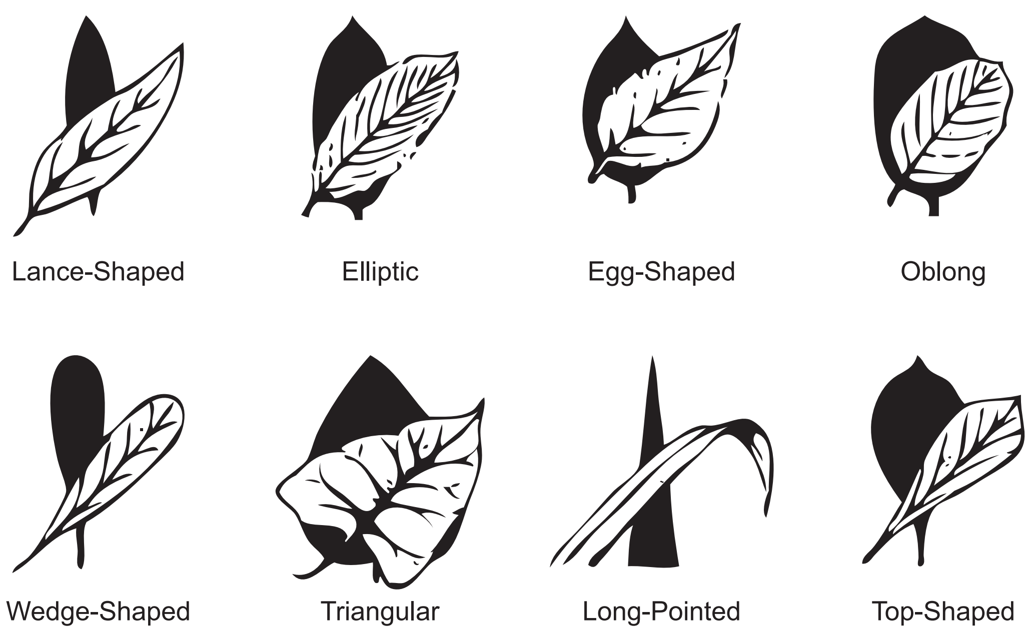

Figure 15-39. Leaf Shapes.

looks much like a mop-head under the soil’s surface. See figure 15-41.

Determining Edibility

The thought of having a diet consisting only of plant food can be distressing unless Marines enter the survival episode with confidence and intelligence that is based on knowledge or experience. If a Marine knows what to look for, can identify it, and knows how to prepare it properly for eating, there is no reason why he/she cannot find sustenance.

Types of Plants to Avoid

Experts estimate there are about 300,000 classified plants. There are two points to remember when procuring plant food—that the plant be edible and, preferably, palatable and that it must be fairly abundant. If the plant includes an inedible or poisonous variety in its family, the edible plant must be distinguishable from the poisonous one. Usually, a plant is selected because one special part is edible, such as the stalk, the fruit, or the nut. When selecting an unknown plant as a possible food

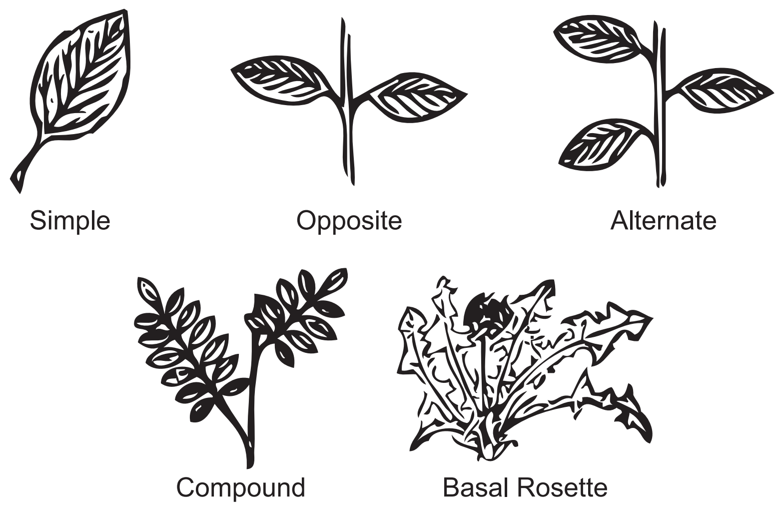

Figure 15-40. Leaf Arrangement.

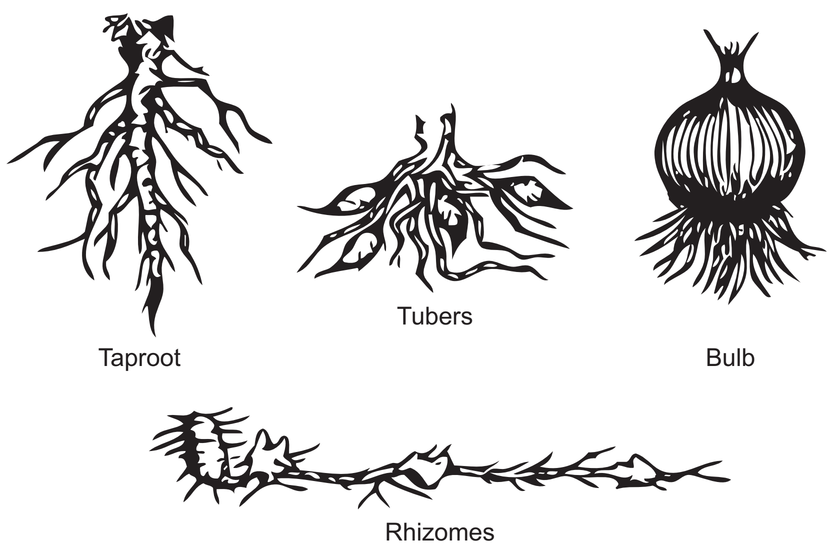

Figure 15-41. Root Structure.

source, general rules should be applied for each of the following types of plants:

- *Mushrooms and fungi*. These should not be selected because they have toxic peptides, a tasteless protein-based poison.
- *Plants with umbrella-shaped flowers*. These plants are to be completely avoided, although carrots, celery, dill, and parsley are members of this family. One of the most poisonous plants, poison water hemlock, is also a member of this family.
- *Beans, peas, and seeds in pods*. All of the legume family should be avoided (beans and peas). They absorb minerals from the soil, the most common of which is selenium, which gives locoweed its fame.
- *Three-leafed and whorled-leafed growth patterns*. These leaf patterns are members of the lupinas genus and other poisonous plants.
- *All bulbs*. As a general rule, all bulbs should be avoided. Examples of poisonous bulbs are tulips and death camas.
- *White and yellow berries*. The colored berries are to be avoided as they are almost all poisonous. Approximately half of all known red berries are poisonous.
- *Plants with a milky sap*. A milky sap indicates a poisonous plant.
- *Plants with shiny leaves*. These types of plants are considered poisonous and caution should be used.
- *Plants that are irritants to the skin*. These types of plants include poison ivy.

Preparing an Unknown Plant

All plants that cannot be positively identified must be prepared properly prior to testing for consumption. Do not prepare plants that are described as plants to avoid. Many harmful toxins contained in plants can be destroyed by heat, or are water soluble, though some toxins remain exceptions. Marines should prepare plants using the following steps:

- Place one part (leaves, flowers, stems, or roots) in a canteen cup.
- Fill the canteen cup with water and boil.
- After the water has boiled, remove the canteen cup from the heat source. Strain the water out, leaving the plant inside the canteen cup. Cooking and discarding the water can lessen or remove the amount of toxins that may be contained in the plant.
- Fill the canteen cup with water and repeat the process. These boiling periods should last at least 5 minutes each.

After straining the water out a second time, the plant may be tested.

Plant Testing Procedure

Though the military has developed a plant testing procedure, testing may not always guarantee the safety of plants for human consumption. The following procedure should only be used in a long-term survival situation as a last resort:

- Do not eat any food for at least 8 hours. Prepare one canteen cup of charcoal for emergency consumption.
- Select a plant that grows in sufficient quantity in the local area. Separate the part of the plant to be tested—root, stem, leaf, or flower. Certain parts of plants are poisonous, while the other parts may be edible.
- Rub a portion of the plant selected on the inner forearm. Wait 15 minutes and look for any swelling, rash, or irritation. This testing is for contact poisoning.
- Prepare the plant using the unknown plant procedure as described above.
- Touch a small portion (a pinch) of prepared plant to the outer surface of the lip to test for burning or itching. If after 3 minutes there is

no reaction, place a pinch of the prepared plant food on the tongue and hold for 15 minutes. **Do not swallow**.

- After holding on the tongue for 15 minutes, if there is no reaction, thoroughly chew and hold it in the mouth for another 15 minutes. **Do not swallow**.
- If unpleasant effects occur, such as a burning, bitter, or nauseating taste, remove the plant from the mouth at once and discard it as a food source. If no unpleasant effects occur, swallow the plant material and wait 8 hours.
- If after 8 hours no unpleasant effects have occurred (nausea, cramps, diarrhea), eat one-quarter cup of the plant prepared the same way and wait 8 hours.
- If no unpleasant effects have occurred at the end of this 8 hour period, the plant may be considered edible if prepared in the same manner.
- If at any time symptoms, such as nausea, cramps, or dizziness, appear, attempt to induce vomiting and consume prepared charcoal.
- Completely document and sketch the plant in a log book to refer to for future use. Documentation will aid in future procurement of this plant. If plant properties have changed, repeat the plant testing procedure.

Edible Plants

There are many recognizable plants, such as green apples or wild onions, located throughout the world, but eating large portions of a single plant food on an empty stomach may cause diarrhea, nausea, or cramps. Foods should be eaten in moderation.

General Considerations

The following points can be applied to plant selection throughout the world:

- Plants resembling those cultivated by people are generally edible.
- Single fruits on a stem are generally considered safe to eat.
- Blue or black berries are generally safe for consumption.
- Aggregated fruits and berries, such as thimble berry, raspberry, salmonberry, and blackberry, are always edible.
- Plants growing in the water or moist soil are often the most palatable.
- All cone-bearing trees produce seeds in their cones which are edible. The cambium layer, pitch, and pine needles are a rich source of vitamin C.
- All fruits having 5-petals at the end of a single fruit belong to the rose family. The hip (fruit) and flower are edible and a rich source of vitamins A and C.
- The seeds from all grasses are edible.

Specific Plants

There are several edible plants found in the western region of the United States that are easy to recognize. Marines should become familiar with common edible plants in their area of operations.

- Wild onions—complete plant.
- Dandelion—roots and leaves.
- Watercress—complete plant.
- Cattail—root, stalk, and stem.
- Thistles—anderson, bull, and elk thistle root and flower.
- Yampah—bulb.
- Juniper tree—berries.
- Currants—berries.

Medical Plants

A Marine's or a unit's bid for survival may be complicated by medical problems. Injuries incurred will reduce survival expectancy and the ability to evade. Some plants have medicinal qualities that can aid the body's healing process.

Willow

Willow is a thick shrub with clustered stems and very narrow leaves. Its habitat includes wet soils, riverbanks, sandbars, and silt flats. Willow has the following medicinal properties:

- A fever can be reduced by drinking tea made from the inner bark.
- The dried and powdered inner bark can be used to stop severe bleeding.
- Diarrhea can be treated by administering a half cup of willow charcoal dissolved in water.
- The willow roots can be mashed and applied to toothaches.

Yarrow

Yarrow is a tall plant and it is usually not branched. It has many white, slat-topped group flowers, but must not be confused with poison hemlock. Yarrow has the following medicinal properties:

- Insect repellent can be made by rubbing a handful of crushed yarrow flowers and leaves on any exposed skin.
- Bleeding can be stopped by placing a yarrow leaf poultice on the wound.
- Relief from minor burns and many rashes, including poison oak and ivy, can be achieved by applying a yarrow leaf compress to the affected area.
- The yarrow root can be chewed to relieve the pain of a tooth ache or break a fever.
- A potent anesthetic can be made by scrubbing fresh yarrow roots in water to clean them. Once the roots are clean, crush them into a spongy mass and apply gently to the wounded area.

Medicinal Terms and Definitions

The terms infusion or tea, poultice, and compress are associated with medicinal plant use. An infusion or tea refers to the preparation of medicinal herbs for internal or external application. To prepare an infusion or tea a small quantity of an herb is placed in a container and hot water is poured over it. It should steep (covered or uncovered) for 20 minutes before use.

A poultice is a name for crushed leaves or other plant parts that are applied to a wound or sore either directly or wrapped in cloth. To prepare a poultice, the plant is placed in gauze or another similar material. The material is folded so it holds the plant in place. The gauze is then placed in a larger cloth, about 6 by 8 inches, and the sides rolled inward. The cloth is folded over without losing the plant. The bottom portion of the cloth containing the plant is dipped into boiling water by holding the edges. The plant is submerged in the boiling water until it becomes saturated. The cloth is then brought straight up and with a twisting motion and the excess water wrung back into the pot. The poultice is applied to the affected area as soon as it has cooled enough to place on the wound. To be effective, the poultice should be as hot as the patient can tolerate.

A compress is made just like a poultice, except it is cold when applied to the wound.

Note: A poultice or compress should be applied for 1 to 24 hours, as needed. When applying a poultice, one may experience a throbbing pain as it draws out the infection and neutralizes toxins. When the pain subsides, the poultice has accomplished its task and should be removed. Apply a fresh poultice as needed until the desired level of healing has been reached.

Poisonous Plants

Rarely will a survivor have an ideal means of killing large game, though there are certain plants that can aid him/her. Two of these plants are the water hemlock and monkshood, which can be used to poison the tips of arrows or spears. Poisonous plants can be prepared by performing the following steps:

- Once a poisonous plant has been located, dig up the root of the plant. The roots of the water hemlock and monkshood generally grow 8 to 10 inches deep.
- Split the root lengthwise to expose the inside of the root where the toxin is located. With the

root splits, rub the tip of the spear/arrow inside of the root opening. In a slow, controlled manner, work from the bottom of the tip to the top.
- Once the tip is thoroughly coated, allow the toxin to dry and apply another coat to the tip.
- Continue to apply coat after coat of toxin, until the root is completely drained of its toxin. The tip is now ready for use.

> **EXTREME CAUTION:**
> Do not handle the root without a barrier between one's hands and the root. A barrier can be gloves, socks, a T-shirt, or even moss.

Insects

Insects are the most abundant life form on earth and are an excellent survival food. They are easy to catch and comprise 65 to 80 percent protein, compared with 20 percent for beef. They may not be too appetizing, but personal bias has no place in a survival situation. The focus must remain on maintaining health. Insects to avoid are—

- All adults that sting or bite.
- Hairy or brightly colored insects.
- All caterpillars.
- Insects that have a pungent odor.
- All spiders.
- Disease carriers, such as ticks, flies, or mosquitoes.

Edible insects are—

- Insect larvae.
- Grasshoppers.
- Beetles.
- Grubs.
- Ants.
- Termites.
- Worms.

Foraging for Insects

Marines must be careful not to expend more energy harvesting food than can be replaced. For example, catching insects, such as grasshoppers, can become frustrating and tiring. Survivors must consider the following points when foraging for insects:

- At night grasshoppers climb tall plants and cling to the stalks near the top. They can be picked from the plants in the early morning while they are chilled and dormant.
- Worms are found in damp humus soil, under rocks/logs, or on the ground after it has rained.
- Carpenter ants are found in dead trees and stumps and can be gathered by hand.
- Most other insects can be found in rotten logs, under rocks, and in open grassy areas.

Preparing Edible Insects

The following points are important to remember when preparing edible insects:

- Insects with a hard outer shell have parasites. Remove the wings and barbed legs before cooking.
- Drop worms into potable water for at least a half hour. They will naturally purge themselves. Worms can either be cooked or eaten raw.
- Most other insects can be eaten raw. Cooking insects will improve their taste. If the thought of eating insects is unbearable, grind them into a paste and mix with other foods.

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CHAPTER 16
TRAINING

Mountain leaders must develop training programs that are extremely challenging to meet the demands of mountain warfare operations (MWO), which are tough and inherently hazardous. A dangerous generalization that occurs in conducting training is that injuries incurred indicate a failure of leadership, but a certain portion of injuries are unavoidable accidents. For example, moving Marines over uneven terrain at night with a combat load under difficult conditions will lead to falls. Is a fall and subsequent injury a leadership failure?

To a lesser degree, the same is true of other environmental injuries and casualties. As much as leaders may supervise, inspect, harass, and threaten, dehydration or cold injuries may occur for reasons as varied as stupidity or accident. One of the most important tenets of MWO is that strong and consistent leadership is essential to survival and to minimize injuries.

Training must not lose its credibility and effectiveness because of uncompromising absolutes. The commanding officer must not reduce the challenge of training because MAGTF or subordinate commanders want to avoid casualties at any cost. If a *failure of leadership* philosophy prevails, the zero defect mentality implied will be insidious and prevent effective training.

Training Objectives

The training objective is to train individuals and units to accomplish their combat missions under all conditions of weather, climate, altitude, and terrain encountered in MWO. Since units will often operate in small, disaggregated groups, the standards of training must be high, emphasizing leadership by small unit leaders and developing individual confidence and initiative.

Specific training objectives for the unit include pre-environment training for all personnel. Pre-environmental training consists of at least the following classes: mountain safety, mountain leadership, mountain health awareness, clothing and equipment, and mountain warfighting load. Given time, Marines can take a significant number of classes prior to going to the field, such as effects on weapons, fire support, logistics, route planning and selection. (Schedule templates can be acquired from MWTC academics.) Each command element has the following specific training:

- The command element uses the seven core classes for staff planning considerations (the six warfighting functions and aviation).
- The GCE learns to shoot, move, and communicate and the displacement of the combat operations center; they conduct reconnaissance operations and combat support.
- The logistics combat element is trained to provide logistic support and security for logistic trains and conduct rear area security operations.
- The aviation combat element is trained to conduct flightline operations, air/antiair missions, maintenance, logistical support, exercise concept of FOBs and forward arming and refueling points, rear area security, interdiction and reconnaissance missions, and command and control.

Perishable Skills

Unit training and individual capabilities are extremely perishable due to the rapid turnover and turbulence of personnel, particularly the junior enlisted ranks. Training is seasonal and, therefore, relatively short so that only a limited number of troops can be trained annually. Most of today's Marines are from urban backgrounds and have not had the opportunity to live and survive in the mountains while growing up. On an individual basis, skills learned in mountain and cold weather training will be retained for a lifetime; however, TTP are constantly being revised and upgraded.

Training Requirements

The basic requirements for training for MWO remain the same as those when training in a temperate climate. Toughness, resourcefulness, initiative, and ability to live and operate in the field are required of each Marine. Simply stated, if a unit can say, "We are comfortable conducting sustained operations in a mountainous, cold weather, high altitude environment," then the goals of the training have been met.

All Marine units and their attachments assigned to MWO need specialized training. Mountain warfare training requires a well-coordinated program and a competent instructional and administrative staff. The senior unit mountain leader is responsible to plan and conduct this training if the unit cannot go to MWTC.

Scope

Units selected for deployment to mountainous, cold weather areas should have completed normal individual and unit training before beginning mountain warfare training. Mountain warfare training falls under mission-oriented training, skill-progression training, and functional training. Unit members should have high standards of physical fitness, emphasizing training outdoors, at altitude, in cold, and on actual mountainous terrain.

Contingency Planning

In the event of the outbreak of general war, many of the troops that may be assigned to the cold weather operating area may not have been trained at all or may have been marginally trained for cold weather operations. Commanders must plan on providing indoctrination and basic mountain and cold weather skills training to personnel, especially replacements, concurrent with combat operations. This training requirement can be anticipated and should be practiced during peacetime exercises.

Responsibility

Success in mountain warfare training is achieved through strength at the small unit level, due to the disaggregated nature of mountain warfare, placing the responsibility for training at the fire team, squad, and platoon level. Because of this, the carryover of training to any other area of operations is exceptional.

Challenge

Each Marine is confronted with the terrain and weather, a real enemy. This enemy must be successfully conquered to continue the mission and for the unit to succeed.

Prioritized Training

First, Marines should learn confidence training: how to survive and use their special cold weather equipment. Followed by military occupational specialty (MOS) skills training, training concludes with the integration of fighting skills into the training program.

Progressive Training

Regardless of the MOS, environmental training should be phased. A phased training approach is advantageous. Phase I educates all individuals with basic skills and awareness, introducing the Marines and Sailors (probably in garrison) to clothing and equipment, shelters and bivouac routine, mobility, and physical conditioning. Phase II is environmental training, an extended practical application of basic skills in the arduous mountain/cold weather environment. Phase III includes unit operations/exercises where all previously learned skills can be practiced in a realistic scenario. Phase IV is optional and consists of participation in a major joint/combined mountain or cold weather exercise that takes place outside of the continental United States. At each stage, Marines and Sailors must be required to perform MOS skills in the mountain environment and be provided feedback.

Training Areas

Training areas that ensure all possible conditions of terrain and climate must be selected. The MWTC is the formal mountain and cold weather training school and the primary training site for infantry battalions and their selected attachments. It uses the Hawthorne Army Ammunition Depot and the intervening mountains to allow integrated MAGTF training, which includes live fire and convoy operations in compartmented terrain.

Instructor Requirements

Commanders must realize that their unit training will only be as successful as the quality of the unit's instructors. Qualified instructors are necessary to prepare a force for cold weather operations. Summer and winter mountain leaders should be the planners, organizers, and primary instructors for unit training. If the unit comprises some prior MWTC or special operations training group mountain cadre instructors, these assets would be the best choice for officer in charge and staff NCO in charge.

The minimum requirements are two mountain leaders per company-sized unit. Assistant instructors may be hand picked based on training and experience. A preliminary course for all unit instructors should be conducted before mountain or cold weather training starts. This course should follow the program of instruction developed at MWTC and must be supervised by mountain leaders who are thoroughly experienced in the various techniques peculiar to MWO. Practical field experience should be provided for unit instructors before starting the unit training program. Marines and Sailors who have attended MWTC formal courses and/or unit training should also assist. The following school codes identify trained unit personnel:

- Summer mountain leaders (M7A).
- Winter mountain leaders (M7B).
- Assault climbers (YAK).
- Mountain medicine (KAR).
- Cold weather medicine (WAC).
- Animal packers (MN6).
- Mountain communicators (CXJ).
- Mountain scout snipers (UNC).
- Mountain operations staff planners (M3D).
- Mountain machine gunner (no code at this time).
- Scout skiers (no code at this time).
- Tactical rope suspension technician (no code at this time).

Evaluation—Marine Corps Center for Lessons Learned

A unique aspect of planning for MWO is that exercises are conducted annually in the contingency areas. The MAGTF's operational success depends on addressing the problems identified in these exercises. The mission of MCCLL is to assemble the lessons learned in a computerized bank so that these problems can be addressed and solved in a timely manner. It identifies mistakes so that the commanders may avoid repeating them in future operations or exercises. This program will only be successful and the unique environmental problems that are identified in annual exercises will only be addressed if MAGTFs provide accurate, undoctored after-action reports to MCCLL.

Specialized Training

Success in cold weather operations greatly depends on specialized expertise. The Marine Corps must constantly continue to train Marines so that, in the event of contingency operations, there are adequately trained Marines who can solve specific problems, such as driving on ice and snow and knowing the basics of using demolitions in the cold. Commanders should identify perceived problem areas and develop training packages that can be presented during cold weather training exercises.

Use of Enemy Assets

Mobility in mountainous terrain is extremely difficult. Ammunition expenditure in the attack can be much higher than normal due to the increased length of time needed to cover the same distance. Undoubtedly, once an objective has been consolidated, enemy weapon systems and quantities of enemy ammunition will be found on site. These assets may be needed in the immediate defense of the objective due to the difficulty in carrying enough ammunition in the attack and conducting rapid resupply. Every effort should be made to train all Marines in the use of enemy weapon systems.

Sample Mountain Warfare Training Program

Mountain warfare training requires a well-coordinated program and competent instructional and administrative staffs. Units will not deploy into mountainous environments long enough for all required training to be accomplished. The suggested training is meant only as a guide for mountain leaders to use while planning unit training.

Phase I, Pre-Environmental Training

This training is conducted over three to five days, preferably before units deploy to environmental training areas (upon initial arrival, if necessary). Classes are lecture and practical application on 2000-level tasks from the MWO training and readiness manual. This phase is designed to educate Marines on environmental considerations, hazards and mitigation, specialized clothing and equipment, and historical lessons learned. This phase can be conducted on ship or prior to deployment. Refresher training, such as a brief pre-environmental training series in November/December on winter considerations, prior to any significant change in altitude, topography, and/or temperature is recommended.

Phase II, Environmental Training

This training is conducted over 7 to 11 days at the operational altitude. This phase consists of 3000- to 6000-level tasks from the MWO training and readiness manual. Emphasis is initially placed on survival, movement, and fighting skills. Environmental considerations for TTP are then taught at the small unit through company levels. All units fire organic weapons and practice MOS skills in the environment. Specialized training is conducted as needed, such as driver education, medical, CBRN, and animal packing.

CAUTION
Conduct a staged ascent as required to safely reach the operating altitude. See chapter 3 for ascent rates.

Phase III, MEB/MEU Mission Rehearsal Exercise

This training is conducted over four to five days. The final phase is to exercise the entire MAGTF on 6000- to 9000-level tasks from the MWO training and readiness manual. The command element tests its ability to effectively plan, command, and control the conduct of anticipated mission profiles across all elements of the MAGTF and all warfighting functions, whether in theater or in an area that replicates the theater environment.

The GCE tests its ability to shoot, move, and communicate. The aviation combat element conducts air missions; maintenance of aircraft; logistical support; landing zone use at high altitude, on ridgelines, and/or in snow; and the exercise of FOBs and forward arming and refueling points. The combat service support element tests its ability to provide combat service support to the MAGTF in complex, compartmentalized, mountainous terrain, pushing to the highest theater altitude through snow, sub-freezing temperatures, and beyond vehicle reach as applicable to the particular theater. Marines should train for the environment’s worst case potential/scenario.

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APPENDIX A
MOUNTAINS OF THE WORLD

All elevations are in meters. Countries that share a peak are listed.

South America and the Caribbean		
Argentina		
Aconcagua	6,959 (Highest mountain outside the Himalayas)	
Bonete	6,872	
Mercedario	6,770	Argentina/Chile
El Libertador	6,720	
Llullaillaco	6,723	Argentina/Chile
Tupungato	6,550	Argentina/Chile
El Toro	6,380	Argentina/Chile
Cerro Palermo	6,350	
Las Tortolas	6,332	Argentina/Chile
General Belgrano	6,300	
Olivares	6,252	Argentina/Chile
Chani	6,200	
Callaqui	6,164	Argentina/Chile
Queva	6,130	
Quemado	6,120	
Copiapo	6,080	Argentina/Chile
Cienaga	6,030	
Nevado Acay	6,000	
Castillo	5,485	Argentina/Chile
Volcan Maipo	5,290	Argentina/Chile
Sosneado	5,189	Argentina/Chile
Volcan Lanin	3,845	Argentina/Chile
Tronador	3,554	Argentina/Chile
Fitzroy	3,441	Argentina/Chile
Cerro Torre	3,122	Argentina/Chile
Copahue	2,969	Argentina/Chile
Pico Catedral	2,409	Argentina/Chile
Bolivia		
Sajama	6,542	
Illimani	6,452	
Ancohuma	6,427	
Illampu	6,362	

Bolivia (continued)		
Parinacota	6,330	
Pomerape	6,240	
Huayna Potosi	6,194	
Aucanquilcha	6,200	Bolivia/Chile
Chearoco	6,127	
Chachacumani	6,094	
Guallatiri	6,060	
Chachani	6,057	
Acotango	6,050	
Tacora	5,988	
Licancabur	5,921	Bolivia/Chile
Mururata	5,868	
Gigante Grande	5,748	
Cashan	5,723	
Cayesh	5,721	
Santa Rosa	5,706	
Murrorajo	5,688	
Machu Sochi Conchi	5,679	
Condoriri	5,648	
Soral Oeste	5,640	
Katantica	5,592	
Yankho Huyo	5,512	
Chile		
Ojos del Salado	6,880	
Juncal	6,300	Chile/Argentina
Marmolejo	6,300	Chile/Argentina
Sairecabur	5,971	
Volcan San Jose	5,850	Chile/Argentina
Lascar	5,675	
Cerro El Plomo	5,450	
El Altar	5,222	
San Francisco	5,200	
Morado	5,200	
Cerro Negro	5,100	
Cerro Guane Guane	5,097	
La Paloma	5,000	
Volcan de Purace	4,756	
Tres Hermans	4,300	
Cerro Arenas	4,300	
Cerro Retumbadero	4,100	
Catedral	4,100	

Chile (continued)		
Diente del Diablo	4,050	
Mirador del Morado	3,850	
Sierra Velluda	3,385	
Volcan Llaima	3,180	
Paine Grande	3,050	
Vulcano Antuco	2,985	
Volcan Lonquimay	2,890	
Tolhuaca	2,708	
Volcan Osorno	2,661	
Darwin	2,488	
Shipton	2,469	
Columbia		
Cristobal Colon	5,776	
Simon Bolivar	5,776	
Ritacuba Blanco	5,493	
Cunurana	5,420	
Pico Mayor	5,365	
Nevado El Ruiz	5,335	
Tolima	5,215	
Volcan de Purace	4,756	
Costa Rica		
Cerro Chirripo	3,819	
Cuba		
Pico Turquino	1,994	
Dominican Republic		
Pico Duarte	3,087	
Ecuador		
Chimborazo	6,310	
Cotopaxi	5,896	
Cayambe	5,840	
Antisana	5,753	
El Altar (Obispo)	5,465	
Iliniza Sur	5,305	
Sangay	5,230	
Iliniza Norte	5,116	
Tungurahua	5,087	
Volcan Wolf	1,707	

French Caribbean		
La Soufriere	1,467	
Mt. Pelee	1,397	
Guatemala		
Tajumulco	4,220	
Acatenango	3,976	
Mt. Santa Maria	3,789	
Fuego	3,763	
Atitlan	3,537	
Toliman	3,158	
Haiti		
La Sella	2,674	
Jamaica		
Blue Mountain Peak	2,257	
Panama		
Volcan Baru (Chiriqui)	3,474	
Peru		
Huascaran	6,768	
Yerupaja	6,617	
Coropuna	6,400	
Huantsan	6,395	
Huandoy	6,395	
Ausangate	6,372	
Ampato	6,360	
Chinchey (Rurichichay)	6,309	
Salcantay	6,271	
Ranrapallca	6,162	
Chaupi Orco	6,100	
Solimani	6,093	
Pumasillo	6,070	
Chachani	6,057	
AlpaMayo	5,947	
Ticlla	5,897	
El Misti	5,822	
Champara	5,795	
Huaycay Huilque	5,750	
Urusa	5,735	
Tunshu	5,730	

Peru (continued)		
Raujunte	5,650	
Jallacata	5,557	
Surihuiri	5,556	
Yana Cuchilla	5,472	
Chinchina	5,463	
Cerro Burro	5,450	
Cunurana	5,420	
Aricoma	5,350	
Cerro Quenamari	5,294	
San Julian	5,275	
Puerto Rico		
El Torro	1,074	
El Yunque	1,065	
Venezuela		
Pico Bolivar	5,007	
Pico Espejoe	4,765	
Europe		
Austria		
Grossglockner	3,797	
Wildspitze	3,772	
Weisskugel	3,739	Austria/Italy
Grossvenediger	3,674	
Hintere Schwarze	3,628	Austria/Italy
Grosswiesbachhorn	3,565	
Wazespitze	3,533	
Hochfeiler	3,510	Austria/Italy
Zuckerhutl	3,507	
Rotespitze	3,495	
Schankogel	3,486	
Hochwilde	3,482	Austria/Italy
Olperer	3,480	Austria/Italy
Moseler	3,478	Austria/Italy
Hochgall	3,435	Austria/Italy
Wilder Freiger	3,418	
Turnerkamp	3,418	Austria/Italy
Dahmannspitze	3,401	
Schneebiger Nock	3,377	Austria/Italy
Wilde Leck	3,361	

Austria (continued)		
Gross Geiger	3,360	
Glockturm	3,355	
Bulgaria		
Musala Vrh	2,925	
Vihren Vrh	2,914	
Goljam Kupen	2,731	
Canary Islands		
Teide	3,718	
Czechoslovakia		
Gerlach	2,655	
Lomnica Stit	2,632	
Slavkovsky	2,452	
Dumbier	2,043	
France		
Mont-Blanc	4,807	France/Italy
Pic Lori	4,102	
La Meije	3,983	
Mont Pelvoux	3,946	
La Grande Casse	3,855	
Monte Viso	3,841	France/Italy
Mont Pourri	3,779	
Charbonnel	3,752	
Grande Sassiere	3,751	
La Dent Parrachee	3,697	
Les Bans	3,669	
La Grand Motte	3,653	
Albaron	3,637	
Ronce	3,612	
Tsanteleina	3,605	France/Italy
Peclet	3,562	
Polset	3,534	
Les Aiguilles D'Arves	3,510	
Pic de Etendard	3,463	
Sirac	3,440	
Pico Aneto	3,404	France/Spain
Brec Chambeyron	3,389	France/Italy
Posets	3,375	France/Spain
Cirque du Gavarnie	3,355	France/Spain

Faroe Islands		
Sleaettaratindur	882	
Germany		
Zugspitze	2,962	Germany/Austria
Greece		
Mytikas Peak	2,917	
Mt. Smolikas	2,637	
Mt. Gamila (Timti)	2,497	
Pachnes	2,453	
Iceland		
Hvanndalshnvkur	2,119	
Barbarbunga	2,000	
Kverkfjoll	1,920	
Snaefell	1,833	
Ireland		
Carrauntoohil	1,041	
Italy		
Matterhorn	4,478	Italy/Switzerland
Jorasses	4,208	Italy/France
Gran Paradiso	4,061	
Geant	4,013	Italy/France
Grivola	3,969	
Ortler	3,902	
Konigs	3,859	
Dolent	3,820	Italy/France
Peutery	3,772	Italy/France
Zufall	3,764	
Cliarforon	3,642	
Vioz	3,640	
Presanella	3,556	
Adamello Peak	3,554	
Vertain Spitze	3,544	
Care Alto	3,462	
Cima de Piazzi	3,439	
Zufritt	3,438	
Marmolata	3,342	
Monte Etna	3,340	

Macedonia		
Korab (Titov Vrh)	2,764	
Montenegro		
Bobotov Kuk	2,523	
Norway		
Galdhpiggen	2,469	
Glittertinden	2,465	
Store Skagastlstind	2,403	
Surtningshui	2,302	
Tverratind	2,302	
More than 50 peaks between 2,500 and 2,000		
Poland		
Rysy	2,499	
Mieguszowiecki Szczyt	2,438	
Swinica	2,301	
Kozi Wierch	2,291	
Granaty	2,239	
Zabi Szczyt Wyzni	2,259	
Miedziane	2,233	
Orla Perc	2,182	
Romania		
Moldoveanu	2,544	
Omul	2,507	
Russia		
El Brus	5,642	
Rustiveli	5,201	
Dykh-Tau	5,198	
Kazbek	5,047	
Klyuchevskaya	4,750	
Ushba	4,710	
Krestovski	4,030	
Ushkovski	3,930	
Ostri Tolbachik	3,682	
Kamen	3,460	
Slovenia		
Triglav	2,863	

Spain		
Mulhacén	3,482	
Sweden		
Kebnekaise	2,117	
Partejakka	2,005	
Switzerland		
Monte Rosa	4,634	Switzerland/Italy
Dom	4,545	Switzerland/Italy
Dente Blanche	4,357	Switzerland/Italy
Nadelhorn	4,327	Switzerland/Italy
Grand Combin	4,314	Switzerland/Italy
Lenspitze	4,294	Switzerland/Italy
Finsteraarhorn	4,274	
Aletschhorn	4,195	
Dent d'Herens	4,171	Switzerland/Italy
Breithorn	4,159	Switzerland/Italy
Jungfrau	4,105	
Monch	4,099	
Schreckhorn	4,078	
Ober-Gabelhorn	4,063	Switzerland/Italy
Pik Bernina	4,049	Switzerland/Italy
Weissmies	4,023	
Lagginhorn	4,010	
Fletschhorn	3,996	
Eiger	3,970	
Bietschhorn	3,934	
Roseg	3,920	Switzerland/Italy
Palu	3,908	
Mont Blanc de Cheilon	3,870	Switzerland/Italy
Wetterhorn	3,701	
Mont Collon	3,667	Switzerland/Italy
Blumlisalp	3,664	
Dammastock	3,630	
T'di	3,614	
Gallenstock	3,583	
Leone	3,553	
Sustenhorn	3,503	
Bifertenstock	3,421	
Piz Kesch	3,417	
Piz Linard	3,411	Switzerland/Austria
Rheinwaldhorn	3,402	

Switzerland (continued)		
Fluchthorn	3,399	Switzerland/Austria
Calderas	3,397	
Castello	3,392	Switzerland/Italy
Guferhorn	3,383	
Blinnenhorn	3,374	Switzerland/Italy
Turkey		
Agri Dagi (Mt. Ararat)	5,137	
BOyOkagri	5,123	
Suphan Dagi	4,434	
Gelyasm (Resko)	4,136	
Buzul (Suppadurek)	4,116	
Kackar Dagi	3,932	
Seytan Bogazi	3,917	
Demirkazik	3,756	
United Kingdom		
Ben Nevis	1,343	
Ben Macdui	1,309	
Cairn Gorm	1,245	
Snowdon	1,085	
Scafell Pike	977	
Helvellyn	949	
Bow Fell	902	
Asia		
Afghanistan		
Shah Fuladi	5,143	
Mt. Noshaq	7,485	
Even Passes can be very high:		
Killick	4,755	
Wakhjir	4,923	
Baroghil	3,798	
Kachin	5,639	
Dorah	4,511	
Sad Eshtragh	5,319	
Agram An	5,069	
Afsik	3,749	
Molla Khak	3,548	
Bhutan		
Chomo Lhari	7,313	Bhutan/Tibet

Burma		
Popa Taung	1,518	
China		
Xixabangma Feng	8,012	China/Nepal
Muztag	7,723	
Konkur	7,719	
Gongga (Minya Konka)	7,555	
Muztaghata	7,546	
Pik Pobeda	7,439	China/Kyrgyzstan
Pik Bobedy	7,439	
Mt. Kallas	6,714	
Anyemaqen	6,282	
Sigunaiang	6,250	
Bogda Shan	5,447	
Emei Shan	3,099	
Wu Tai Shan	3,058	
Bai Yun Feng	2,744	
Heng Shan Bei	2,017	
India		
Nanda Devi	7,816	
Kamet	7,756	
Nun Kun	7,135	
Jaonli	6,632	
Gangotri	6,600	
Bremeh	6,575	
Siachen Glacier	5,653 (by 75km long)	Pakistan
Iran		
Damavand	5,671	
Alum Kuh	4,840	
Sabalon Kuh	4,821	
Zardeh	4,548	
Hazar	4,420	
Lalezar	4,374	
Shotaran Kuh	4,328	
Japan		
Fuji San	3,776	
Kita Dake	3,192	
Okuho Dake	3,190	
Yari Dake	3,179	

Japan (continued)		
Akaishi	3,130	
Tateyama	3,015	
Komaga Dake	2,956	
Asahi	2,290	
Kyrgyzstan		
Khan Tengri	6,995	
Nepal		
Mt. Everest	8,848	Nepal/Tibet (highest peak in the world)
Kangchenjunga	8,586	Nepal/India
Lhotse	8,511	
Makalu	8,463	Nepal/Tibet
Cho Oyu	8,201	Nepal/Tibet
Dhaulagiri	8,167	
Manaslu	8,163	
Annapurna	8,091	
Langtang Lirung	7,245	
Ganesh Himal	7,150	
Jugal Himal	7,083	
Kinjiroba	7,045	
Langtang Himal (Kyungka Ri)	6,979	
Ama Dablam	6,856	
East Ridge of Hiunchuli	6,441	
Pakistan		
K-2	8,611	
Nanga Parbat	8,125	
Gasherbrum I	8,068	
Broad Peak	8,047	
Gasherbrum II	8,035	
Distaghil Sar	7,885	
Kunyang Chhist	7,852	
Masherbrum	7,820	
Rakaposhi	7,788	
Batura	7,785	
Saltoro Kangri	7,742	
Trivor	7,720	
Tirich Mir	7,690	
Chogolisa	7,654	
Shispar	7,619	
Haramosh	7,406	

Pakistan (continued)		
Ultar	7,398	
Malubiting	7,291	
Ogre (Baintha Brak)	7,285	
Minipin	7,273	
Kampire Dior	7,142	
Koyo Zom	6,872	
Ghul Laast	6,665	
South Korea		
Hella San	1,950	
Jiri San	1,915	
Sorak San	1,708	
Odaesan	1,563	
Sri Lanka		
Pidurutalagala	2,524	
Adams Peak	2,233	
Tadjikistan		
Pik Kommunizma	7,495	
Pik Lenina	7,134	
Pik Korzhenevskoj	7,105	
Taiwan		
Yu Shan (Jade Mountain)	3,997	
Hsuih Shan	3,884	
Lam Whoa Shan	3,740	
Jong Yong Gien Shan	3,703	
Chida Shan	3,605	
Tibet		
Aling Kangri	7,815	
Kamet	7,756	Tibet/India
Namjagbarwa Feng	7,756	
Baruntse	7,129	
Yemen		
Jabal Hadur	3,760	

Africa		
Algeria		
Tahat	2,918	
Llamane	2,729	
Lalla Khedidja	2,308	
Cameroon		
Cameroun	4,095	
Egypt		
Katernina	2,642	
Qasp	2,383	
Musa	2,285	
Ras Jibal	2,228	
Ethiopia		
Ras Dashen	4,533	
Waynobar	4,472	
Buahit	4,437	
Abba Yared	4,416	
Mischigu	4,352	
Schiwana	4,120	
Yasus	3,500	
Kenya		
Batian Peak (Mt. Kenya)	5,201	
Kirinyaga	5,200	
Nelion	5,190	
Elgon	4,321	Kenya/Uganda
Malawi		
Sapitwa Peak	3,003	
Nakodzwa	2,964	
Dzole	2,715	
Namasile	2,686	
Mamene	2,650	
Matambale	2,643	
Nandalanda	2,590	
Chambe	2,557	
Chilembe	2,358	
Morocco		
Toubkal	4,165	

Namibia		
Knigstein	2,585	
Numas Felsen	2,545	
Horn	2,510	
Tsisab	2,257	
Rwanda		
Karisimbi	4,507	Rwanda/Zaire
Mikeno	4,437	Rwanda/Zaire
Muhavura	4,127	Rwanda/Zaire
Visoke	3,711	Rwanda/Zaire
Sabinyo	3,634	Rwanda/Zaire
Gahinga	3,474	Rwanda/Zaire
Muside	3,000	Rwanda/Zaire
Dunyo	2,775	Rwanda/Zaire
South Africa		
Mafadi	3,446	
Mt. Aux Sources	3,295	
Cleft Peak	3,281	
Cathkin Peak	3,148	
Cathedral Peak	3,004	
Matroosberg	2,249	
Rooderbert	2,208	
Groothoek	2,103	
Sudan		
Jebel Marra	3,042	
Jebel Gimbala	2,976	
Tanzania		
Uhuro Point	5,963 (highest point in Africa)	
Kilimanjaro	5,895	
Meru	4,565	
Uganda		
Stanley	5,110	Uganda/Zaire
Zaire		
Margherita Peak	5,119	Zaire/Uganda
Mt. Speke	4,890	Zaire/Uganda
Mt. Baker	4,844	Zaire/Uganda
Mt. Emin	4,792	Zaire/Uganda

Zaire (continued)		
Mt. Gessi	4,717	Zaire/Uganda
Mt. Savoia	4,627	Zaire/Uganda
Portal Peaks	4,391	Zaire/Uganda
Nyiragongo	3,470	
Nyamulagira	3,056	
Australia and the South Pacific		
Australia		
Kosciusko	2,230	
Mt. Olga	1,069	
Ayers Rock	867	
French Polynesia		
Orohena	2,241	
Pito Ito	2,110	
Aorai	2,066	
Rooniu	1,332	
Indonesia		
Jaya	5,030	
Naga Pulu	4,862	
Kerintji	3,809	
Rinjani	3,727	
Semeru	3,677	
Arjuno	3,340	
Raung	3,334	
Lawu	3,265	
Welirang	3,200	
Merbabu	3,142	
Agung	3,142	
Merapi	2,968	
Singgalang	2,877	
Diampit	2,839	
Bromo Caldera	2,770	
Rante	2,644	
Abang	2,152	
Malaysia		
Kinabalu	4,094	

New Zealand		
Cook	3,764	
Mt. Aspiring	3,025	
Ruapehu	2,797	
Mt. Egmont	2,510	
Papua New Guinea		
Mt. Wilhelm	4,510	
Giluwe	4,368	
Mt. Hagen	3,778	
Philippines		
Mt. Pulog	2,930	
Volcan Mayon	2,462	
North America		
Canada		
Logan	5,951	
Mt. St. Elias	5,490	
Lucania	5,228	
Steele	5,074	
Mt. Wood	4,843	
Mt. Vancouver	4,786	
Mt. Fairweather	4,671	Canada/Alaska
Mt. Hubbard	4,558	
Mt. Bear	4,527	
Mt. Walsh	4,506	
Mt. Alverstone	4,421	
Mt. Kennedy	4,238	
Mt. Waddington	4,017	
Mt. Robson	3,954	
Mt. Colombia	3,748	
Mexico		
Citlaltepetl (el Pico de Orizaba)	5,675	
Popocatepetl	5,452	
Ixaccihuatl	5,286	
Nevado de Toluca	4,704	
La Malinche	4,431	
Cofre de Perote	4,282	
Nevado de Colima	4,240	
Volcan de Colima	3,820	
Encantada	3,095	

United States		
Alaska		
McKinley	6,194 (highest point in North America)	
Foraker	5,303	
Mt. Blackburn	5,037	
Mt. Bona	5,006	
Mt. Sanford	4,941	
Hunter	4,445	
Mt. Hayes	4,189	
Marcus Baker	4,017	
Silverthrone	4,015	
Gerdine	3,841	
Mt. Deborah	3,823	
Carpe	3,802	
Arizona		
Mt. Humphreys	3,862	
Mt. Agassiz	3,766	
California		
Mt. Whitney	4,418	
North Palisade	4,342	
White Mountain	4,342	
Mt. Shasta	4,317	
Split Mountain	4,286	
Mt. Humphreys	4,264	
Mt. Morgan	4,191	
Mt. Tom	4,162	
University Peak	4,156	
Black Mountain	4,051	
Mt. Lyell	3,998	
Mt. Dana	3,995	
Kuna	3,938	
Mt. Parker	3,921	
Mt. Gibbs	3,891	
Blacktop	3,875	
Mt. Wood	3,853	
Mt. Simmons	3,812	
Colorado		
Mt. Elbert	4,398	
Mt. Harvard	4,396	
Mt. Blanca	4,373	
Uncompahgre	4,362	
Crestone Peak	4,357	
Mt. Lincoln	4,355	

Colorado (continued)		
Grays Peak	4,351	
Mt. Antero	4,350	
Torreys Peak	4,350	
Castle Peak	4,349	
Mt. Evans	4,349	
Mt. Quandary	4,345	
Longs Peak	4,345	
Mt. Wilson	4,343	
Mt. Shavano	4,338	
Mt. Princeton	4,328	
Crestone Needle	4,326	
Mt. Bross	4,320	
El Diente	4,317	
Mt. Tabequache	4,316	
Sneffels	4,314	
Mt. Democrat	4,311	
Pikes Peak	4,302	
Kit Carson Peak	4,299	
Snowmass Mountain	4,296	
Windom	4,295	
Mt. Eolus	4,294	
Mt. Humbolt	4,291	
Mt. Sunlight	4,286	
Handies	4,283	
Culebra Peak	4,282	
Mt. Lindsey	4,281	
Mt. Little Bear	4,279	
Mt. Sherman	4,279	
Redcloud	4,279	
Mt. Pyramid	4,275	
Wilson Peak	4,273	
Wetterhorn	4,273	
Mt. San Luis	4,272	
North Maroon Bell	4,272	
Holy Cross	4,269	
Sunshine	4,268	
Mt. Stewart	4,263	
Mt. Iron Nipple	4,216	
Hawaii		
Mauna Kea	4,205	
Mauna Loa	4,170	
Puu Ulaula overlook (Red Hill)	3,055	

Idaho		
Borah Peak	3,858	
Diamond Peak	3,719	
Hyndman Peak	3,682	
Maine		
Baxter Peak	1,605	
Montana		
Granite Peak	3,902	
Mt. Hilgard	3,450	
Mt. Douglas	3,444	
Nevada		
Boundary Peak	4,006	
Wheeler Peak	3,982	
Wilson Peaks	3,979	
Mt. Moriah	3,674	
North Schell	3,623	
New Hampshire		
Mt. Washington	1,917	
New Mexico		
Wheeler Peak	4,012	
Trunchas Peak	3,995	
North Carolina		
Mt. Mitchell	2,037	
Oregon		
Mt. Hood	3,425	
Mt. Jeffersons	3,200	
South Sister Peak	3,158	
Utah		
Kings Peak	4,124	
Mt. Gilbert	4,098	
Mt. Emmons	4,097	
Mt. Loveina	4,030	
Mt. Peal	3,878	
Mt. Waas	3,759	
Mt. Delano	3,711	
Ibapah Peak	3,684	
Washington		
Mt. Rainier	4,393	
Mt. Adams	3,758	
Wyoming		
Gannett Peak	4,208	
Grand Teton	4,197	
Wind River Peak	4,085	

Wyoming (continued)		
Francs Peak	4,006	
Mt. Owens	3,946	
Trout Peak	3,733	

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APPENDIX B
GLACIERS

The following regions are covered by glaciers. The areas covered are measured in square kilometers.

Antarctica	13,586,000
Greenland	1,700,000
Canada	200,000
Central Asia	109,000
Russia	82,000
United States	75,000
China and Tibet	33,000
South America	26,000
Iceland	12,000
Scandinavia	3,100
Alps	2,900
New Zealand	1,000
New Guinea	15
Africa	12

The following are facts about glaciers around the world:

- Ten percent of all the land in the world is covered by glaciers.
- North America's longest glacier is the Bering Glacier in Alaska, measuring 204 km long.
- The Malaspina Glacier in Alaska is the world's largest piedmont glacier, covering more than 8,000 km and measuring 193 km across at its widest point.

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APPENDIX C
CLIMBING RATING SYSTEMS

There are different climbing rating systems for rock, ice, and mixed terrain. In the United States, the *grade* of a climb is a subjective indication of its severity. In the United Kingdom, the grade also indicates the technical difficulty of the climb—called the *rating* in the United States. Some grading systems measure the average length of a climb, while others consider the general safety of the climb. The more common grading systems, discussed in this appendix, generally cover both free and aid climbing, but not ice climbing.

The North American Grading System

In North America, grades denote the normal amount of time required to complete a route. The time is based on a team of average climbers using normal techniques and is shown before the difficulty rating: a rating noted as III 5.9 A2 means that the climb requires most of a day free climbing on terrain graded 5.9 or lower and direct aid sections of A2 or lower on the route. If a climb only shows a rating of the American or YDS or an equivalent, it is assumed that the climb is a grade I or II and will only take a few hours. The following are durations for each grade:

- Grade I requires 1 to 2 hours.
- Grade II requires half a day.
- Grade III requires most of a day.
- Grade IV requires a very long day.
- Grade V requires an overnight stay on the route.
- Grade VI requires a few days.
- Grade VII requires an expedition.

Yosemite Decimal Grading System

The YDS is the common rock climbing grading system in the United States and is used at the MWTC. Table C-1, on page C-3, shows a comparison of the YDS and other common world systems.

The Alpine Grading System

Routes in the western Alps are generally given an overall grade in addition to a pitch-by-pitch rating. The overall grade describes the general difficulty of the climb. It takes into account the technical difficulty, the quality of the belays, the nature of the rock, the exposure of the climb, and the objective dangers. The grading system uses letters (derived from the French words) and sometimes uses "+" and "–" to indicate smaller differences:

- F—Easy (*facile*).
- PD—Moderately difficult (*peu difficile*).
- AD—Fairly difficult (*assez difficile*).
- D—Difficult (*difficile*).
- TD—Very difficult (*très difficile*).
- ED—Extremely difficult (*extrêmement difficile*).
- ABO—Horrible (*abominable*).

The German Grading System

The German grading system considers the seriousness of a climb. This grading scale considers all aspects of the climb that have nothing to do with the technical difficulty—average run-out distance, quality of the protection placements, objective dangers, and quality of the rock. The scale goes from E0, a normal route with solid fixed protection and ample opportunities for placing protection, to E5, a largely unprotected and unprotectable route with weak piton placement and poor rock. On an E5 climb, falling is generally lethal. On most European maps, routes above E0 are marked as such.

Aid Climbing

The good news about aid climbing rating scales is that the whole world uses a single scale that goes from A1 to A5. The bad news is that there are many interpretations of that scale. The rating depended on where and when that first ascent was made. The following general aid rating scale are used for most purposes:

- A1: All placements are solid and easy.
- A2: Placements are still strong, but the placements are awkward and a few may be difficult.
- A3: Many placements are difficult, but there is the occasional strong piece.
- A4: There are several placements in a row that will hold nothing more than body weight.
- A5: 20 meters or more of body placements in a row.

Table C-1. Climbing Scale Comparisons.

YDS	UIAA	GREAT BRITIAN	FRANCE	BRAZIL	AUSTRALIA
Class 1	I	E			
Class 2	II	E			
Class 3	III	E	1a, b, c		
Class 4	III-	MOD	1a, b, c		
5.0	III	MOD	2a, b		4
5.1	III+	DIFF	2a, b		5
5.2	IV-	Hard DIFF	2c, 3a		6
5.3	IV	Very DIFF	3b, c, 4a		7
5.4	IV+	Hard very DIFF	3b, c, 4a	II	8,9
5.5	V-	Mild severe	3b, c, 4a	IIsup	10,11
5.6	V	Severe, hard severe, 4a	4a, b, c	III	12,13
5.7	V+	Severe, hard severe, 4b	4a, b, c	IIIsup	14
5.8	VI-	Hard severe, hard very severe, 4c	5a, b	IV	15
5.9	VI	5a	5b, c	IVsup	16,17
5.10a	VII-	E1, 5b	5b, c	V	18
5.10b	VII	E1, 5b	5b, c	Vsup	19
5.10c	VII	E1, 5b	5b, c	VI	20
5.10d	VII+	E1/E2, 5b-5c	5b, c	VIsup	21
5.11a	VIII-	E3, 6a	6a, b, c	VII	22
5.11b	VIII	E3/E4, 6a	6a, b, c	VII	23
5.11c	VIII	E4, 6b	6a, b, c	VIIsup	24
5.12a	IX-	E5, E6/7, 6c	7a	VIII	26
5.12b	IX	E5, E6/7, 6c	7a	VIIIsup	27
5.12c	IX	E5, E6/7, 6c	7a		28
5.12d	IX+	E6/7, 7a	7a		29

Legend
E easy
MOD moderate
DIFF difficult

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APPENDIX D
METRIC CONVERSION SCALES

The Celsius scale was devised by dividing the range of temperature between the freezing and boiling temperatures of pure water at standard atmospheric conditions (sea level pressure) into 100 equal parts. Temperatures on this scale were at one time known as degrees centigrade; however, it is no longer (since 1948) correct to use that terminology.

The degrees Fahrenheit nonmetric temperature scale was devised and evolved over time so that the freezing and boiling temperatures of water are whole numbers, but not round numbers as in the Celsius temperature scale. The temperature conversion formulas are:

°F = °C x 1.8 + 32
°C = (°F - 32) / 1.8

The following are baseline temperatures in both temperature scales:

- Boiling point of water—100 °C, 212 °F.
- Average human body temperature—37 °C, 98.6 °F.
- Average room temperature—20 to 25 °C, 68 to 77 °F.
- Freezing point of water/melting point of ice—0 °C, 32 °F.

There are several memory aids that can be used to help the novice understand the degrees Celsius temperature scale. One such mnemonic is: When it's zero it's freezing, when it's 10 it's not, when it's 20 it's warm, when it's 30 it's hot!

Note: The United States is the only nation that continues to use Fahrenheit temperatures for surface weather observations. However, as of July 1996, all surface temperature observations in National Weather Service METAR/TAF reports are transmitted in degrees Celsius. All upper-air (nonsurface) temperatures have always been measured and reported in degrees Celsius by all countries.

Common conversion from/to metric and imperial and US measurement systems:

- 1 millimeter [mm] = 0.0394 inch
- 1 inch [in] = 2.54 cm
- 1 centimeter [cm] = 10 mm = 0.3937 inch
- 1 yard [yd] = 3 feet = 0.9144 m
- 1 meter [m] = 100 cm = 1.0936 yd
- 1 mile = 1760 yd = 1.6093 km
- 1 kilometer [km] = 1000 m = 0.6214 mile
- 1 nm = 2025.4 yd = 1.852 km

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APPENDIX E
TEMPERATURE CONVERSION CHART

Table E-1. Celsius to Fahrenheit Conversion.

°C	°F	°C	°F	°C	°F	°C	°F
50	122.0	27	80.6	4	39.2	-19	-2.2
49	120.2	26	78.8	3	37.4	-20	-4.0
48	118.4	25	77.0	2	35.6	-21	-5.8
47	116.6	24	75.2	1	33.8	-22	-7.6
46	114.8	23	73.4	0	32.0	-23	-9.4
45	113.0	22	71.6	-1	30.2	-24	-11.2
44	111.2	21	69.8	-2	28.4	-25	-13.0
43	109.4	20	68.0	-3	26.6	-26	-14.8
42	107.6	19	66.2	-4	24.8	-27	-16.6
41	105.8	18	64.4	-5	23.0	-28	-18.4
40	104.0	17	62.6	-6	21.2	-29	-20.2
39	102.2	16	60.8	-7	19.4	-30	-22.0
38	100.4	15	59.0	-8	17.6	-31	-23.8
37	98.6	14	57.2	-9	15.8	-32	-25.6
36	96.8	13	55.4	-10	14.0	-33	-27.4
35	95.0	12	53.6	-11	12.2	-34	-29.2
34	93.2	11	51.8	-12	10.4	-35	-31.0
33	91.4	10	50.0	-13	8.6	-36	-32.8
32	89.6	9	48.2	-14	6.8	-37	-34.6
31	87.8	8	46.4	-15	5.0	-38	-36.4
30	86.0	7	44.6	-16	3.2	-39	-38.2
29	84.2	6	42.8	-17	1.4	-40	-40.0
28	82.4	5	41.0	-18	-0.4		

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APPENDIX F
WARFIGHTING LOAD REQUIREMENTS

The following six pocket items should be carried in the pockets of a Marine's utility uniform:

- Pocket knife.
- Flashlight/headlamp.
- Lip balm and sunscreen.
- Sunglasses with 100 percent ultraviolet protection and polarized.
- Emergency ration.
- Note taking material.

The following six items and an example of each are required for a survival kit:

- Fire starting material: lighter, flint, and steel.
- Water gathering material: plastic bag.
- Signaling device: mirror, whistle. Audio and visual signals are needed.

  Note: Marines should plan for night and day signalling.

- Food gathering: fishing hooks and lures and snare building material.
- Shelter material: 550 cord and a finger saw.
- First aid items: pressure bandages and iodine.

Assault loads are carried in a Marine's load bearing vest and in his/her pack system. Items include—

- Extra insulating layer.
- Protective layer.
- Load bearing vest with 2 quarts of water and first aid kit.
- Helmet.
- Rations for the time away from the bivouac.
- Cold weather hat or balaclava.
- Individual mountaineering gear, such as a sling rope, one locking and one nonlocking carabiner, and rappel gloves.
- Specialized mountaineering equipment.
- Mission-essential gear.

Combat load is carried in addition to the assault load for missions of longer duration. Combat load items include sleeping bag, Isopor mat, stove, fuel bottle, thermos, and poncho.

Existence load items are packed for long duration operations, when it will be necessary to replace worn out items, including uniforms, boots, and personal hygiene gear.

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APPENDIX G
MOUNTAIN LEADER WEATHER DATA COLLECTION FORM

Data Item	Previous 24 Hours	Current
Temperature, high		
Temperature, low		
Barometer		
Altimeter		
Pressure trend, up/down		
Wind direction		
Wind strength		
Precipitation		
Cloud type(s)		
Notes:		

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GLOSSARY

SECTION I. ACRONYMS AND ABBREVIATIONS

AMS . . . . acute mountain sickness
AJP . . . . allied joint publication
ATP . . . . allied tactical publication

BFT . . . . Blue Force Tracker

C . . . . Celsius
CAS . . . . close air support
CASEVAC . . . . casualty evacuation
CBRN . . . . chemical, biological, radiological, and nuclear
CDS . . . . container delivery systems
CHO . . . . cliff head officer
cm . . . . centimeter
CPNCO . . . . control point noncommissioned officer

DAMA . . . . demand assigned multiple access
DASC . . . . direct air support center
DISA . . . . . Defense Information Systems Agency
DS2 . . . . . . decontamination solution number two

ECM . . . . electronic countermeasure
ECWCS . . . . extreme cold weather clothing system

F . . . . Fahrenheit
FOB . . . . forward operating base

G-6 . . . . assistant chief of staff, communications system
GCE . . . . ground combat element
GPS . . . . global positioning system

HACE . . . . high altitude cerebral edema
HAPE . . . . high altitude pulmonary edema

IED . . . . improvised explosive device
IER . . . . information exchange requirement
in . . . . inch
IPB . . . . intelligence preparation of the battlespace
ISR . . . . intelligence, surveillance, and reconnaissance

JPADS . . . . joint precision air drop system
JTAC . . . . joint terminal attack controller

km . . . . kilometer

LOS . . . . line of sight

m . . . . meter
MAC . . . . main anchor carabiner
MACK . . . . Marine assault climbers kit
MAGTF . . . . Marine air-ground task force
MANPADS . . . . man-portable air defense system
MCOO . . . . modified combined obstacle overlay
MCRP . . . . Marine Corps Reference Publication
MCWP . . . . Marine Corps Warfighting Publication
mm . . . . millimeter
MOPP . . . . . . mission-oriented protective posture
MOS . . . . military occupational specialty
MRE . . . . meal, ready to eat
MWO . . . . mountain warfare operations
MWTC . . . . . Mountain Warfare Training Center

NATO . . . . . . North Atlantic Treaty Organization
NCO . . . . noncommissioned officer
nm . . . . nautical mile
NSN . . . . national stock number

OEF . . . . Operation Enduring Freedom
ORP . . . . objective rally point

PSI . . . . pounds per square inch

RFC . . . . raid force commander
ROE . . . . rules of engagement
RTX . . . . retransmission

S-2 . . . . intelligence officer
S-4 . . . . logistics officer
SATCOM . . . . satellite communication
SLCD . . . . spring-loaded camming devices

SOP . . . . standard operating procedures
STANAG . . . . standardization agreement
STEP . . . . standard tactical entry point
SWAN. . . . . support wide area network

TIC . . . . troops-in-contact
TRAP . . . . tactical recovery of aircraft and personnel
TTP . . . . tactics, techniques, and procedures

UAS . . . . unmanned aircraft system
UHF . . . . ultra high frequency
UIAA . . . . Union Internationale des Associations d'Alpinisme

VHF . . . . very high frequency
VHL . . . . vertical hauling lines

YDS . . . . Yosemite decimal system

SECTION II. DEFINITIONS

aid climbing—Climbing assisted without the use of anything beyond the rock or what's naturally there.

alpine style (climbing) —An approach to multiday climbs in which a team progresses toward the summit in one continuous push, using neither stocked camps or fixed ropes in the ascent. Basically, the team is carrying everything they need for their time on the mountain. This is pushed to the extreme on many of the world's highest peaks.

anchor—How the climber and the belayer are connected to the rock. Permanent anchors are usually bolts that are drilled and tapped into solid rock. Temporary anchors include pitons, wedges, and cams.

arete—An outside corner of rock.

armbar, armlock—A means of holding onto a wide crack.

barn door—The movement made when climbers become off balance and pivot without control at two points.

belay—To keep the climber safe by controlling the rope. The act of monitoring the rope that is attached to the lead climber, protecting against a serious fall. The belayer is anchored to the rock and feeds rope to the climber as he or she progresses upward, always on the ready to brake the rope with a belay device which should stop the climber's fall.

bergschrund—Also referred to as 'shrund. A broad crevasse or series of crevasses occurring at the head of a glacier where moving ice separates from static ice or rock.

beta—Information about the route.

betaflash—A clean first ascent of a route with knowledge about it.

big wall—A climb that is so long it has multiple pitches.

biner—Slang for carabiner.

bivouac—A camp, or the act of camping. On a big wall, camp can be made on a natural ledge or an artificial one, generally an aluminum and nylon cot like device called a portaledge that hangs from one or more anchors on the wall. Also referred to as "bivy."

bivy—A place to spend the night.

bolt—A piece of metal put in a drilled hole in the rock. That in combination with a hanger, allows Marines to clip into the rock with a quickdraw.

bomber—A very secure point or anchor. A hold of large size. Also referred to as "aircraft carriers."

bombproof—Very secure. Won't move under any circumstances.

boulder—A rock small enough to climb without a rope. Or to climb low to the ground without a rope.

bucket—A handhold that is easy to hold on to.

buttress—A shallow ridge projecting from a face.

cam—Short for camming device. Removable, portable protection used by climbers.

campus—To climb using only your hands and dangling your feet.

campus board—A ladder like training apparatus used by climbers to train. Usually inverted.

carabiner—A loop of metal with a spring-loaded hinging gate. Used to attach to piece of protection.

ceiling—An overhang of sufficient size to loom overhead.

chalk—White powder used to keep your hands free of sweat while climbing.

chimney—Parallel sides of rock wider than a body width.

chipping—Altering the rock by breaking it.

chockstones—Naturally occurring rocks or stones jammed into chimneys and cracks, sometimes a barrier to ascent, sometimes useful for handholds or placement of protection.

cirque—An area ringed by mountains; also called a cwn (Welsh) or corrie (Scottish).

clean—The act of removing any nonfixed protection from the rock.

col—The low point or saddle on a ridge connecting two peaks.

cornice—A cap of windblown snow overhanging the leeward side of a ridge. Cornices pose two kinds of hazards: they can break off, smashing into climbers moving below them, or they can give way under the weight of climbers crossing above them.

crack climbing—Climbing by use of a long continuous crack in the rock.

crater—To fall to the ground from a climb.

crevasse—A crack in a glacier that can be tens, even hundreds of feet deep.

crimp—To grip with the fingers with the knuckles raised slightly.

cross—Over reaching with one arm or leg so that it crosses past the other appendage to reach the hold.

crux—The most difficult part of the climb.

deadpoint—To catch a hold at the exact moment your body's upward momentum becomes zero, and transferring the least amount of force to the climber.

dihedral—An inside corner. Conducive to stemming.

downclimb—To climb down the rock rather than rappel.

draw—Short for quickdraw.

drag—Usually used in reference to the resistance of rope through carabiners.

dyno—Short for dynamic movement. A move that requires the use of momentum to complete.

edge—A horizontal hold.

Elvis leg—The uncontrollable shaking of a leg during a climb. Caused by nerves or over contraction of leg muscles. Also called sewing machine leg.

expedition style—An approach to mountaineering in which climbers establish progressively higher camps and fix rope over difficult sections of the route to assist in ascent and descent.

exposed—Used to describe a section of a route which is high, usually a few pitches up. Often means the climber is uncomfortable at the thought of taking a fall in this section.

figure 4—An awkward climbing technique where Marines raise one leg above an arm and the body resembles a "4."

figure 8—A common belay device that's shaped like an "8." Often not allowed in gyms because it twists the rope.

figure-8 knot—The most common knot used to tie into your harness.

finger jam—A climbing technique where Marines slide their hand into a crack and twist or otherwise change the shape of their hand so they won't pull out.

fixed protection—Gear that is left on the rock for future protection.

fixed rope (line)—Rope that is left in place on steep snow slopes or rock faces to facilitate subsequent ascent and descent.

flag—To flare out a leg in a way that improves balance.

flash—To complete a climb on your first try with no falls.

follow—To climb after a leader has setup a top rope. Involves removing the protection as Marines climb.

free climb—To climb using the features of the rock without placing protection.

gaston—A climbing technique that involves using opposing forces by side pulling with elbows out.

greasy—Slippery.

hand jam—Climbing technique where the entire hand is placed into a crack and manipulated in such a way it won't pull out.

hang dog—To repeatedly rest by hanging on the rope during a climb.

hanging belay—A belay on a sheer rock face in which the belayer, lacking a surface to stand on, hangs from protection placed at the point of the belay.

gaul bag—Large and robust bag used to haul food, water, climbing gear, sleeping bag, and more up a big wall. Also known as "the Pig" since it is comparable in size and possibly in weight.

heel hook—A climbing technique where the heel of the foot is placed on top of a hold and used to pull up.

heel toe lock—A technique where Marines wedge his/her foot in a crack lengthwise.

jam—Wedging feet, hands, fingers of other body parts to gain purchase in a crack.

jug—A large easy to hold feature.

jummar—A device used to ascend a rope by only sliding in one direction.

lead—To climb with the rope starting at the ground and clipping into protection on the way up.

mantel—A technique that involves the transfer of force from a pulling up motion to a pushing up motion.

mono—A pocket only one finger can fit into.

mountain pickets—Are team to squad sized patrols (2–13) that post on or move along the tops of ridgelines to provide reconnaissance, surveillance, security, calling and adjusting supporting arms into adjacent or unoccupied compartments in a unit's area of operations. They may be employed as flank security during movements or to control terrain within a mountainous area of operations.

move—Movement; one of a series of motions necessary to gain climbing distance.

nuts—A piece of metal that is wider at one end. It is inserted into cracks for protection.

offwidth—A crack that is too wide for a hand jam and too narrow to fit the entire body into.

open hand—Grabbing a hold and relying on getting the maximum amount of friction possible to hold on.

pitch—A section of climb between two belays and no longer than the length of one rope.

pitons—Metal spikes of various shapes, hammered into the rock to provide anchors in cracks. Also called **pins** or **pegs**.

placement—The quality of a nut or anchor (i.e., "How good is your protection placement?").

pocket—An indented feature in the rock for use when climbing.

pro—Short for protection.

Prusik—The sliding knot or the method to ascend a rope (named after its designer Dr. Karl Prusik).

rack—The full set of gear needed to climb a route.

rappel—Lowering yourself down the rope instead of a belay to descend a route.

rating—A number denoting the technical difficulty of the climb.

red point—Leading a route, placing protection as Marines climb.

roof—Significant overhanging part in a climb (more or less horizontal).

route name—All climbing routes are assigned a name and a rating. They are usually named by the person who first put up the route. Walls and entire areas are also given names such as your city (wall), street (route), then address (rating).

run-out—When the distance between two points of protection is far enough that it could make the climber nervous. Eight to ten feet or more could be considered run-out.

screamer—A very long fall.

send—To successfully climb a route.

simul-climb—The act of leader and belayer climbing at the same time with a reasonable amount of space between them.

siege—An expedition style of ascent in which a mountain or big wall is accomplished in stages with multiple trips from base camp to higher camps, both for supplying camps and promoting acclimatization.

slab—Any climb that is less than vertical.

sling—A webbing loop often used to connect gear and sometimes belayers and climbers to anchors or protection. Slings can be as short as two feet or as long as needed for hanging portaledges and handling haul bags.

sloper—A downward sloping hold.

smear—Placing your foot so that it stays on the rock by friction rather than a hold.

solo—Short for solo climbing. Climbing without aid or protection.

solo climbing (free solo)—To climb without any man made protection at all.

stance—A standing rest spot, often the site of the belay.

stem—Movement where Marines extend an arm or leg to create outward opposing forces.

thin—A climb or hold of relatively featureless character. (For example, that climb is very thin!)

top rope—A climb that already has the anchors and rope present at the top of the route.

traditional climbing—Climbing that requires removable protection. Also called trad climbing.

traverse—To move sideways, without altitude gain on the rock.

tri-cam unit—A piece of equipment used for protection in larger sized cracks.

undercling—A hold that requires Marines to hold with palm facing up.

Yosemite decimal system—A method of rating climbs used in North America.

Z-pulley system—Complicated rope setup that allows Marines to hoist heavy weights with relatively little force. Excellent for rescues or hauling bags.

zipper—To pull out protection sequentially through a fall.

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Joint Publication (JP)

1-02	Department of Defense Dictionary of Military and Associated Terms

Army Field Manuals (FMs)

3-97.6	Mountain Operations
3-97.61	Military Mountaineering
9-207	Operations and Maintenance of Ordnance Material in Cold Weather

Marine Corps Publications

Marine Corps Doctrinal Publications (MCDPs)

1	Warfighting
1-0	Marine Corps Operations
1-2	Campaigning
1-3	Tactics
4	Logistics
5	Planning

Marine Corps Warfighting Publications (MCWPs)

3-35.1	Mountain Warfare Operations (under development)
3-37	MAGTF Nuclear, Biological, and Chemical Defense Operations
4-11.1	Health Service Support Operations
5-1	Marine Corps Planning Process

Marine Corps Reference Publications (MCRPs)

3-35.1A	Small Unit Leader's Guide to Cold Weather Operations (under development as Small Unit Leader's Guide to Mountain Warfare Operations, number remains the same)
3-35.1B	Instructor's Guide to Combat Skiing (under development as Mountain Leader's Guide to Winter Operations, number remains the same)
3-35.1D	Cold Region Operations
5-12C	Marine Corps Supplement to the Department of Defense Dictionary of Military and Associated Terms

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X-File 3-35.23.1x	Small Wars Animal Packers Manual, revised 2009

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7-21	Tactical Fundamentals for Cold Weather Operations (information to be incorporated into new MCWP 3-35.1, Mountain Warfare Operations)
7-22	Tactical Fundamentals for Aviation in Cold Weather Operations (information to be incorporated into new MCWP 3-35.1, Mountain Warfare Operations and MCRP 3-35.1A Small Unit Leader's Guide to Cold Weather Operations)

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Various 2009–2010 OEF Marine Corps Center for Lessons Learned after action reports

North Atlantic Treaty Organization (NATO) Standardization Agreements (STANAGs)

(NATO STANAGs may be obtained from the NATO Standardization Agency at http://nsa.nato.int or by e-mail to doctrine@usmc.mil)

2103	Reporting Nuclear, Biological and Chemical Attacks, and Predicting/Warning of Hazard Areas (Operator's Manual) (ATP-45)
2451	Allied Joint Doctrine for NBC Defense (AJP-3.8)
2521	Conduct of NBC Defense in Operations (ATP-3.8.1 Volume 1)

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