MCRP 3-35.2B

Military Mountaineering

U.S. Marine Corps

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FOREWORD

1. Purpose. Marine Corps Reference Publication (MCRP) 3-35.2B, *Military Mountaineering*, will detail specialized skills and tactics, techniques (TTP), and procedures for military mountaineering.

2. Scope. The publication will address specialized skills and gear required for military mountaineering. It will also discuss training, acclimatization, and conditioning for individuals and units preparing for operations in the mountain environment. This publication complements the small unit TTP contained in MCRP 3-35.2A, *Small Unit Leader's Guide to Mountain Operations*.

3. Supersession. None

4. Certification. Reviewed and approved this date.

BY DIRECTION OF THE COMMANDANT OF THE MARINE CORPS

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CHAPTER 1
THE MOUNTAIN ENVIRONMENT

Mountain Safety: The key to safety in a mountainous environment is proper prior planning. Adhering to certain basic principles and predetermined actions will allow an individual or unit to efficiently perform their duties with minimum discomfort and maximum safety.

1. Planing and Preparation. As in any military operation, planning and preparation constitute the keys to success. The following principles will help you, the leader, conduct a safe and efficient operation in any type of mountainous environment. We find these principles in the acronym "BE SAFE MARINE". Remember to think about what each letter means and apply it in any type of environment.

a. **B**- *Be aware of the group's ability*. It is essential that you evaluate the individual abilities of your Marines and use this as the basis for planning. In your evaluation, you must include your group's overall physical conditioning; and the consideration of change in climate and how long the unit has had to acclimatize. Following are some considerations:

1) Mental attitude of your group. Is their morale high? How much tactical training has the group had in this particular type of terrain?
2) Technical aspect of your group. Have they had prior training in rope work, mountaineering, rappelling, stream crossing, etc.?
3) Individual Skills. At this point, you must choose who is the most proficient at the individual skills that will be needed for the accomplishment of your mission (navigation, call for fire, bivouac site selection, rope installations, etc.) Just as in the leadership principles, the better you know your Marines and how they have been trained, the more effective you will be in any environment, especially a mountainous one.

b. **E**- *Evaluate terrain and weather constantly.*

1) Terrain. During the planning stages of your mission, you must absorb as much information as possible on the surrounding terrain and key terrain features in your area of operation. Considerations for any obstacles must be planned for in advance. Will you need such things as fixed ropes, rope bridges, climbing gear, etc?
2) Weather . Mountain weather can be severe and rapidly changing. Drastic weather changes can occur in the space of a few hours with the onset of violent storms, reduced visibility, and extreme changes. In addition to obtaining current weather data, the leader must have a plan for the unexpected "worst case". During an operation, he must continually evaluate weather signs (See Mountain Weather) to be able to foresee possible weather changes. Being aware of the changes and trends will better prepare you to deal with any dangers it may pose. Remember, in most elevations over 8000 ft. (2,438 m) it can snow any month of year.

a) Constantly evaluate the conditions. Under certain conditions it may be advisable to reevaluate your capabilities. Pushing ahead with a closed mind could spell disaster for the mission and the unit.
b) When in a lightning storm, turn off all radios, stage radios and weapons away from personnel. Have personnel separate, preferably in low-lying areas, however personnel should

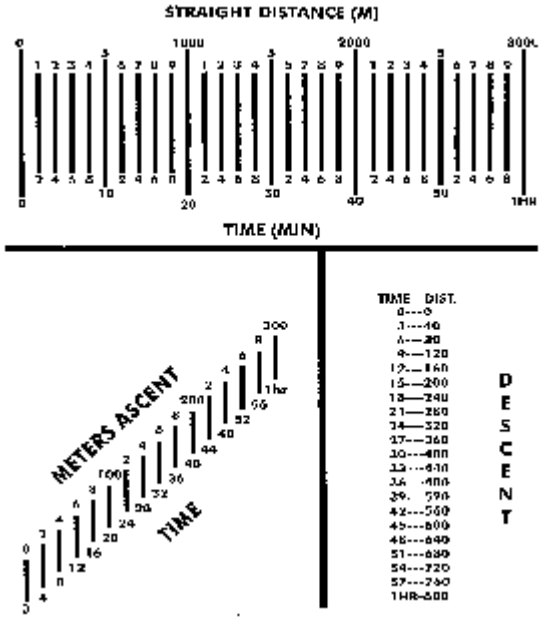
not sit underneath a lone tree. Being aware of these two factors will play a key role in keeping your unit healthy and operational.

c. **S**- *Stay as a group*. Individuals acting on their own are at a great disadvantage in this environment.

1) Maintain a steady pace so that it will allow the unit to reach the objective area as a complete fighting force.
2) Give the unit adequate rest halts. Consider the terrain and elevation, physical abilities of the unit, combat load and mission requirements.
3) Remember to use the buddy system in your group.

c. **A**- *Appreciate time requirements*. Efficient use of available time is vital. The leader must make an accurate estimate of the time required for his operation based on terrain, weather, unit size, abilities, and on the enemy situation. This estimate must take into account the possibility of unexpected emergencies and allow sufficient time to make unplanned bivouacs in severe weather conditions.

1) Time Distance Formula. This formula is designed to serve as a guideline. It is a good basis to start from in order to get an estimation for the amount of time required for your movement in ideal conditions.



Example: A patrol going 5000 meters straight line would need 1 hour and 40 minutes. If during that patrol they will also climb two hills, one 100 meters high and the second 200 meters high, then add 20 minutes and 40 minutes. If the patrol will descend those two hills and drops down into a 100 meter ravine, add 30 minutes for a total patrol time of an estimated 3 hours and 10 minutes.
(Straight line distance time + total elevation gain time + total elevation descent time = total time)

3) Route planning. Route cards are not to be used in the place of an overlay, but as a tool to be used in route planning. Overlays/ Route cards should contain the following information at the minimum:

Unit designation
Unit commander
Number of personnel
Inclusive dates and times of movement
Grid coordinates of each checkpoint and bivouac
Map references
Azimuth and distances for each leg
Elevation gain/ loss per leg
Description of the ground
ETA and EDT.

Unit I.D.	Unit commander	Number of Personnel	Date and Time	Map Referance			
LEG	AZM	DIST	GRID	ETA	ETD	ELEVATION GAIN/LOSS	DESCRIPTION OF GROUND

4) As in any military operation, route planning and execution are of vital importance. Prior to departure, the unit commander must submit a route card and patrol overlay to his higher headquarters and keep a duplicate copy for himself. This pre-planned route should be followed as closely as possible, taking into account changes based on the tactical situation. In non-tactical situations, the pre-planned route should be followed to reduce search and rescue time in an emergency situation.

e. **F**- *Find shelter before storms if required.* Under certain conditions, inclement weather can provide tactical advantages to the thinking unit commander, but, by the same token it can reduce the efficiency of the unit if an incorrect evaluation of the situation is made.

1) If there is a drastic change in the weather, shelter should be sought. Medical problems due to the elements can manifest themselves in a matter of hours resulting in death.
2) Locating or building a natural or man-made shelter will give an individual the best chance to have a safe bivouac with the prospect of continuing the effort toward mission accomplishment later. Exposure to the environment can kill or incapacitate more of your Marines than the enemy, if you allow it to.

f. **E**- *Eat plenty of food and drink lots of liquids*.

1) Food. The human body can be compared to a furnace which runs on food to produce energy and warmth. By planning the consumption of food to suit the specific situation, adequate nutrition and extra warmth can be supplied.
2) Water. The intake of adequate amounts of water will maintain the body in proper working order. Danger from dehydration is as high in mountain regions, due to the drier air, as in hot, dry areas. Loss of liquids is easily seen and felt in hot climates, whereas in the cold mountains, the loss of body fluids is much less noticeable, but just as prevalent. High water intake, at least 6 quarts per day when in bivouac, 8 quarts per day when active, will help to prevent dehydration.

g. **M**- *Maintain proper clothing and equipment.*

1) Clothing

a) Our clothing has to perform an important function in our mission. Therefore, when choosing our clothing we have to take incorporate some essential requirements.
(1) Vapor transmission layer
(2) Insulating layer
(3) Protective Layer
b) To help remember how to maintain and wear clothing, use the acronym "COLD".
C- Keep clothing CLEAN.
O- Avoid OVERHEATING
L- Wear clothing LOOSE and in LAYERS.
D- Keep Clothing DRY.

2) Required equipment (see Annex VI)

a) An assault load should always be carried and one safety pack should be carried per squad. As many Marines as possible should carry map and compass. A repair kit should also be carried to include those items necessary to do emergency repairs on your equipment such as a heavy-duty needle and nylon thread, extra fastex buckles, snaps and buttons.

h. **A**- *Ask locals about conditions*. An often-overlooked source of information is the indigenous population of an area. Local weather patterns, rockslide areas, watering points, and normal routes can all be obtained by careful questioning. The leader must try to obtain current information on the actual conditions along your intended route. Of particular importance are recent precipitation and enemy sightings.

i. **R**- *Remember to keep calm and think*. If faced with an emergency situation, the following principles should be used:

1) Keep calm and do not panic. At this point you must make every effort to conserve body heat and energy.
2) Think. When you are cold, tired, hungry, or frightened, you must force yourself to organize your thoughts into a logical sequence.

3) Above all else, the group must act as a team. In emergency situations, individual dissention can cause a total loss of control and unit strength.
4)

j. **I**- *Insist on emergency rations and kits*. Survival rations and a survival kit should always be carried.(see FMRP 3-35.2A)

k. **N**- *Never forget accident / emergency procedures*.

1) Causes of accidents. Accidents are no different in a mountainous environment than in a more benign environment, but several basic points should always be kept in mind. The most frequent causes of accidents are as follows:
   a) Overestimation of physical and technical abilities.
   b) Carelessness.
   c) General lack of observation of ones surroundings.
   d) Leaders lack of knowledge and experience.
   e) The failure to act as a group.
   f) Underestimation of time requirements to move through mountainous terrain or underestimation of the terrain itself.

2) Preventive measures. The only truly effective preventive measures for the above issues lie in the education and experience of leaders and Marines at all levels. Only through an active education and involvement can a leader of Marines gain the knowledge and experience needed to effectively lead in this environment.

3) General procedures for handling an accident. These procedure require only common sense as outlined below.

   a) Perform basic first aid.
   b) Protect the patient from the elements to include insulation on top and bottom.
   c) Evacuate if necessary.
   d) Send for help if required; if possible, never send one man alone for help.
   e) Send the following information regarding the accident:
      (1) Time of accident
      (2) Nature and location of accident.
      (3) Number injured.
      (4) Best approach route to accident scene.

4) If one man of a two-man team is injured, the injured man must be given all available aid prior to going for help. If the injured man is unconscious, he should be placed in all available clothing and sleeping gear and anchored down if on steep terrain. A note explaining the circumstances, and a reassurance to him that help is on the way should be left in a conspicuous spot. This note must also contain the following information:

   a) When you expect to return.

b) Where you went.
c) What you did before you left (medication, etc.)

5) International distress signal

a) Six short blasts in one minute from person requesting help.
The return signal is three blasts in one minute from the responder.

6) Other methods if help is required.

a) Red pyrotechnics.
b) SOS(. . . - - - . . .).
c) "Mayday" by voice communications.

l. **E**- *Energy is saved when warm and dry*. With the previous 11 principles in mind, this one should fall right into place. Save heat and energy by following these steps:

1) Dress Properly
2) Eat Properly
3) Drink Properly
4) Ensure shelter meets criteria.
5) Produce external heat (fire, stove, extra clothing, etc.) to save body heat and energy for future use.
6) Do not lose body heat by getting wet.

Conclusion: Staying combat effective in the mountains requires more vigilance on the parts of Marines and leaders than in more benign environments. By following the previous guidelines you can overcome or prevent most difficulties. As a Mountain Leader it is one of your responsibilities to inform your command and educate your Marines on these issues.

MOUNTAIN HEALTH AWARENESS: A study of military history in mountain regions reveals that success and failure rates are measured in terms of the regard held for the environment itself. The Marine who recognizes and respects these forces of nature can do his job and even use these forces to his advantage. The Marine who disregards or underestimates these forces is doomed to failure, if not destruction. In the mountains, care of the body requires special emphasis. If men fail to eat properly, or do not get sufficient liquids, efficiency will suffer. Lowered efficiency increases the possibility of casualties, either by high altitude injury or enemy action resulting in failure to accomplish the mission.

1. Physical Fitness. The body's ability to adjust to a harsh environment is greatly controlled by its physical condition, which is influenced by fitness, nutrition, water intake and other factors. Acclimatization is also vital, but to acclimatize properly, a person must force himself to enter the outdoor environment and work in it, which requires a healthy attitude. The importance of a healthy attitude cannot be stressed enough.

a. Nutrition: An adequate number of calories must be consumed on a daily basis. Consuming 1 Ration Cold Weather (RCW)/day or 4 MREs/day provides the required vitamins and calories.

b. Water Intake: A person cannot exist for long without adequate water intake. In the mountains, water intake becomes even more important than in the lower elevations because of the drier air of a higher/colder environment. Also, the loss of fluids as a result of sweating is not as noticeable as it is at sea level, as the sweat quickly evaporates into the drier air. Hydration must be emphasized.

2. Heat Generation. The human body, in order to run efficiently, must always maintain a constant temperature within a few degrees of 98.6°F (37°C) The food we eat is our fuel. The amount of energy in the food we eat is measured in calories. Typically, about 25% of the food we take in is used by the body to rebuild itself, while the remaining 75% is used to produce heat to maintain that small temperature range (usually from 96°F to 99°F). This generated heat is then distributed to various parts of the body. In the mountains at high altitude, especially in wet or cold areas, several other points need to be remembered:

a. The Diet

1) Calorie intake. At sea level, when in garrison and not physically active, a Marine typically requires about 2,000 calories per day. But at altitude, in the mountains and especially in the cold, the need for calories more than doubles to at least 4,500 calories per day. This is because one is much more physically active, and because of the cold, calories needed for heat generation greatly increases.
2) Carbohydrate intake. Carbohydrates are simple foods like sugars, bread, rice, and pasta. In the mountains an increase in carbohydrate intake is recommended because at high altitude these tend to taste better and are more easily converted into heat energy by the body.
3) Hot meals and hot wets. These should be consumed whenever possible to help the body maintain its core temperature and to help keep morale high.

b. The Body at Rest Produces Heat at a Specific Rate. With physical activity, heat production increases.

1) Moderate Exercise. This can increase heat production up to 5 - 6 times the normal rate, and can be tolerated for long periods of time.
2) Moderate Shivering. This can increase heat production by 20 times normal, but only for a few minutes. Shivering is not an efficient means of heat production as it quickly leads to exhaustion.
3) Intense Shivering. When muscle activity is at its maximum rate, as in intense shivering, heat production can increase by up to 50 times normal. However, exhaustion follows within minutes. Leaving the Marine susceptible to hypothermia.

3. Five Ways The Body Loses Heat

a. Radiation. This is direct heat loss from the body to its surroundings. If the surroundings are colder than the body, the net result is heat loss. A nude man loses about 60% of his total body heat by radiation. Specifically, heat is lost in the form of infrared radiation. Thermal targeting devices work by detecting radiant heat loss.

b. Conduction. This is the direct transfer of heat from one object in contact with a colder object.

1) Most commonly, conduction occurs when an individual sits or rests directly upon a cold object, such as snow, the ground, or a rock. Without an insulating layer between the Marine and the object (such as an isopor mat), one quickly begins to lose heat. This is why it is important not to sit or sleep directly on cold ground or snow without a mat or a pack acting as insulation.

2) Metals, like rocks, conduct heat very rapidly.

3) Water conducts heat away from the body 25 times faster than air.

c. Convection. This is heat loss to the atmosphere or liquid, such as water, in the following manner:

1) Air and water can both be thought of as "liquids" running over the surface of the body. Water or air, which is in contact with the body, attempts to absorb heat from the body until the body and air or water are both the same temperature. However, if the air or water are continuously moving over the body, the temperatures can never equalize and the body keeps losing heat.

2) Most commonly one encounters convection through the wind-chill effect. Whether walking, skiing, or moving in open vehicles, wind must be taken into account to determine the effective temperature experienced by the unprotected body. (see Wind Chill chart in Appendix V) However, if dressed properly (with the appropriate protective layers) wind-chill effects are minimized, except for areas of exposed skin. If Marines are cold because of wind-chill, it means that they are not dressed properly.

d. Evaporation . Heat loss from evaporation occurs when water (or sweat) on the surface of the skin is turned into water vapor. This process requires energy in the form of heat and this heat comes from the body.

1) This is the major method the body uses to cool itself down. This is why you sweat when you work hard or PT. One quart of sweat, which you can easily produce in an hour of hard PT, will take about 600 calories of heat away from the body when it evaporates.

e. Respiration. When you inhale, the air you breathe in is warmed by the body and saturated with water vapor. Then when you exhale, that heat is lost. That is why breathe can be seen in cold air. Respiration is really a combination of convection (heat being transferred to moving air by the lungs) and evaporation, with both processes occurring inside the body.

4. Physical Responses To Heat . When the body begins to create excess heat, it responds in several ways to rid itself of that heat. Initially, the blood vessels in the skin expand, or dilate. This dilation allows more blood to the surface where the heat can more easily be transferred to the surroundings. Soon afterwards, sweating begins. This contributes to heat loss through convection and evaporation.

5. Physical Responses To Cold. Almost the opposite occurs as with heat.

a. First, blood vessels at the skin surface close down, or constrict. This does two things:

1) Less blood goes near the surface of the body so that less heat is lost to the outside.

2) More blood goes to the "core" or the center of the body, to keep the brain, heart, lungs, liver, and kidneys warm. This means fingers and toes tend to get cold.

c. If that is not enough to keep the body warm, the next step is shivering. Shivering is reflexive regular muscular contractions, this muscular activity causes heat production. As mentioned before, shivering can only last for a short time before exhaustion occurs. With shivering you will either warm up, as usually occurs, or continue to get colder and start to become hypothermic. Hypothermia will be discussed later.

d. Another effect of more blood flow going to the body's inner core is that the kidneys are "fooled" into thinking that the body has more blood than it really does. The kidneys respond by producing more urine, and this can contribute to dehydration, which we will talk about next.

6. Dehydration. This is defined as a deficit of total body water.

a. Causes of dehydration. Dehydration is the most common illness seen, both in the winter and in the summer. Ultimately, the reason someone becomes dehydrated is because they lose more water than they take in. There are two reasons for this.

1) Excessive loss.

(a) Urination. Increased as a response to the cold and high altitude.
(b) Cold, dry air. In most mountainous areas, like the high Sierras, the air is often cold and always dry. Thus inhaled air must be humidified and warmed by the body - this takes water.
(c) Strenuous activity. Marines in the mountains are always involved in strenuous activity, and this leads to large amounts of sweating, even in the winter.
(d) Coffee and tea. These are mild diuretics, which stimulates the kidneys to produce excess urine.

2) Inadequate intake.

(a) Thirst. Thirst is not a good indicator of your state of hydration, especially in a high altitude, mountainous environment. *If you are thirsty, it is too late, you are already dehydrated.*
(b) Water inaccessibility. It is possible that adequate amounts of water may not be available or what water there is may be contaminated.

b. Symptoms of Dehydration.

(1) Headache.
(2) Nausea.
(3) Dizziness.
(4) Fainting.
(6) Dry mouth.
(7) Weakness.
(8) Lethargy.
(9) Stomach cramps.

(5) Constipation. (10) Leg and arm cramps.

c. Signs of Dehydration
1) Swollen tongue.
2) Dark urine.
3) Low blood pressure.
4) Rapid heart rate, at rest, greater then 100 beats per minute.

d. Prevention of Dehydration.
1) Since it is difficult to limit the water that you lose (except by limiting your coffee and tea consumption), you must then ensure adequate intake.
a) Drink a minimum of 6 - 8 quarts per day.
b) Watch the color of your urine. Try to keep it crystal clear. The more yellow it gets, the more you need to drink.
c) Do not rely on thirst as an indicator.

e. Field Treatment of Dehydration.
1) Oral Fluids. Give at least 6 quarts per day.
2) Intravenous (IV) fluids. Severe cases may require fluid by IV.

f. Leadership. A healthy Marine should *NEVER* become dehydrated. It is an entirely preventable condition. It is the responsibility of small unit leaders to ensure their men have adequate access to water and that they drink it. Failure to prevent dehydration in a healthy Marine is a failure in leadership.

7. Heat Cramps. These are painful spasms of skeletal muscle as a result of excessive loss of body salt.

a. Cause. Sweat is composed of water and salt. When a Marine is involved in strenuous activity and replaces the lost water but *not* the lost salt, a salt imbalance within the body may result. This salt imbalance may then lead to muscle cramps.

b. Symptoms of Heat Cramps. Muscle cramps in the arms, legs, or abdomen.

c. Prevention of Heat Cramps. Prevention is always better than treatment.

1) Avoid overheating by proper ventilation.

2) Eat correctly. There is no need to take salt tablets as long as proper diet is maintained. MRE's and RCW's contain more than enough salt.

d. Field Management for Heat Cramps.

1) Have the victim stop moving. (Rest)

2) Gentle massage of the affected muscles may help relieve the spasm.

3) Stretch the muscle out.

4) Ensure the victim is adequately hydrated. Replace the victim's salt by adding either I salt tablet or I tablespoonful of table salt (from an MRE accessory packet) to a quart of water. Have the victim sip the salted water over a period of a few hours.

8. Heat Exhaustion. This occurs when body salt losses and dehydration from sweating are so severe that a person can no longer maintain adequate blood pressure.

a. Causes of Heat Exhaustion. Heat exhaustion is really a severe form of dehydration combined with or as a result of strenuous physical activity. Blood is made up of mostly of water. When a large amount of water is lost in the form of sweat, the amount of blood volume in the body drops. When the blood volume drops low enough, in combination with tough physical exercise, heat exhaustion results.

b. Symptoms of Heat Exhaustion.

(1) Headache. (4) Fatigue.

(2) Nausea. (5) Fainting.

(3) Dizziness.

c. Prevention of Heat Exhaustion. It is the same as for heat cramps. Dress properly with adequate ventilation to avoid overheating. Dress comfortably cool.

d. Field Management for Heat Exhaustion.

1) Lay the victim down, with his feet higher than his head. Insulate the victim from cold ground, with an isopor mat.

2) Ensure that he is well ventilated. Open his outer garment or take it off**,** until he feels cool. Make sure he doesn't get too cold.

3) Fluids. If he is awake and not vomiting, he may be given fluids by mouth. Usually 3 quarts at a minimum are required.

9. Heat Stroke. Also known as Sunstroke, it is defined as a failure of the body's cooling mechanisms that rid the body of excessive heat build up.

a. Heat stroke is LETHAL Up to 40% of unrecognized/untreated cases die, while a majority of those who live may suffer permanent brain damage.

b. Risk Factors for Heat Stroke. Heat stroke occurs when the body is unable to rid itself of excess heat, such as when exercising in a hot, humid environment. Typically the air in a mountainous environment is cool and dry; nonetheless, heat stroke can and does occur in the mountains, even in the cold, due to overdressing. The elevation of body temperature levels is usually greater than 103°F (39°C).

c. Symptoms of Heat Stroke. In the majority of cases, the onset of heat stroke is sudden, and the victim becomes delirious or comatose, before he begins to complain of symptoms. However, approximately 20% of victims will complain of-

(1) Headache. (3) Dizziness.

(2) Nausea. (4) Fatigue.

d. Signs of Heat Stroke.
   1) Usually, victims are delirious or comatose.
   2) Pupils maybe pinpoint.
   3) Flushed skin may or may not be present.
   4) Rectal temperatures of 103°F or greater.
   5) Sweating. It is often taught that in heat stroke, sweating is absent. **THIS IS UNTRUE!!!** Sweating often is present in heat stroke, so do not assume a victim does not have heat stroke simply because he is sweating. As with hypothermia, the only way to absolutely diagnose a victim as having heat stroke is with a rectal thermometer. Anybody with abnormal behavior (hallucinations, bizarre behavior, confusion, etc.) and a rectal temperature of 103°F or greater should be considered a heat stroke victim, until proven otherwise.

e. Preventive Measures for Heat Stroke. For the most part, the same principles apply as with Heat Exhaustion. That is, drink 6 - 8 quarts of water per day and keep as well ventilated as possible. When the temperature and humidity are high, however, physical activity must be reduced.

d. Field Management for Heat Stroke. Remember, heat stroke is a true life and death emergency. The longer the victim remains overheated, the more likely it will be irreversible.

   1) Reduce heat immediately by dousing the body with large amounts of cool water or by applying wet, cool towels to the neck, the groin, chest, and armpits. If cold packs are available, then use them.
   2) Maintain an open airway.
   3) Remove as much of the victim's clothing as possible.
   4) Give him nothing by mouth.
   5) When his rectal temperature has dropped below 102°F, you may discontinue cooling. Be sure to recheck the temperature every 5 minutes, if his temperature rises to 103°F or greater, begin re-cooling.
   6) Medevac immediately!

10. Acute Mountain Sickness (AMS). AMS is a self-limited illness resulting from the rapid exposure of an un-acclimatized individual to high altitude.

a. Risk Factors for AMS. Anyone ascending rapidly from sea level to over 7,000 feet (2,133 m) may develop AMS. Approximately 25% of individuals who ascend rapidly to 8,000 - 9,000 feet will develop AMS. Virtually all un-acclimatized persons who rapidly ascend to 11,000 - 12,000 feet will develop AMS. Factors which will increase your chance of developing AMS or make it worse are overexertion at altitude and dehydration. The cause of AMS, or altitude illness in general, is not well understood. However, it is known that the

lower levels of oxygen's barometric pressure found at high altitude leads to a state of hypoxia, which means low levels of oxygen in the blood. The way in which the body responds to this hypoxia can lead to AMS or other altitude illness. Symptoms of AMS will usually occur 6 - 48 hours after reaching altitude.

b. Symptoms of AMS.

1) Headache, the most common symptom, may be severe.
2) Nausea.
3) Decreased appetite.
4) Difficulty sleeping due to irregular breathing.
5) Weakness, loss of coordination.
6) Easily fatigued.
7) Dizziness.
8) Apathy

c. Signs of AMS.

1) Rapid breathing or an irregular breathing pattern.
2) Rapid pulse.
3) Vomiting.

d. Prevention of AMS.

1) The best prevention of AMS is a staged ascent. For Marines going to altitude from sea level, the following ascent rates should be adhered to:

ALTITUDE	RATE OF ASCENT
< 8,000 ft.(2,438 m)	Unlimited, rest for 48 hrs @ 8,000 ft., then proceed.
8,000 (2,438 m)-10,000 ft. (3,048 m)	Rest for 24 hrs. @ 10,000ft., and proceed.
10,000 (3,048 m)-14,000 ft. (4,267 m)	1,000 ft. per day.
>14,000 ft.	500-1,000 ft. per day.

2) After 48 hours with no symptoms of altitude illness, proceed no higher than 10,000 ft. Remain at 10,000 for 24 hrs and then if no symptoms of altitude illness are present, proceed no faster than 1,000 feet per day.

3) Above 14,000 ft, ascend no faster than 500 – 1,000 feet per day. If no symptoms occur after 48 hrs at a given altitude, it is safe to assume you can ascend. But remember, there are no steadfast rules or guarantees.

4) Certain drugs, can be used to treat or even prevent AMS. These drugs are used ONLY under the direction of a medical department personnel. These drugs include diamox.

f. Treatment of AMS.

1) Light duties/rest.

2) Fluids - monitor fluid intake. (AMS is a fluid retention condition, be careful not to over hydrate, urine that is light yellow is one sign)

3) Drugs used for treatment of a AMS. Tylenol or aspirin can be given for the headache. Diamox is only to be prescribed by a Medical Officer.
4) **DESCEND**. Most cases of AMS should resolve with 2 - 3 days after treatment with the above measures. However, if this does not occur or if the symptoms are severe or worsening, then a descent of 1,000 - 3,000 feet should be done immediately in order to improve the condition of the victim. The victim may be able to re-ascend after several days of acclimatization at the lower level.

11. HIGH ALLTITUDE CEREBRAL EDEMA (HACE). HACE is a high altitude illness that is characterized by swelling of the brain.

a. Symptoms/Signs of HACE

1) Usually the symptoms of AMS are also present. In fact, the two may look exactly alike. However, because HACE is lethal and AMS is not, you must be able to distinguish the two. This can be done by testing the victim's balance. Simply have him walk heel to toe (like in a field sobriety test). A HACE victim will have difficulty executing this maneuver, whereas an AMS victim will not.

2) Other symptoms may include:

(a) Bizarre behavior.

(b) Hallucinations.

(c) Confusion.

(d) Excessive fatigue.

(e) In severe cases, coma.

b. Prevention of HACE. The preventive measures for HACE are the same as for AMS.

c. Treatment of HACE. Immediate descent is mandatory!

1) Drugs prescribed by medical personnel include Decadron (a steroid), Diamox, and oxygen if available.
2) A device called a Gamow Bag is available. This is a man-portable (14 lb.) hyperbaric chamber. A HACE victim is placed in the bag and zipped up. Using a foot pedal operated pump, the pressure in the bag is increased. This simulates a decrease in altitude. Altitude "drops" of up to 6,000 feet (1,828 m) may be achieved. However, the use of this bag should only reserved for emergencies when rapid descent is delayed. This is very labor intensive and only a temporary measure.
3) Remember: *HACE KILLS* if not treated.

12. HIGH ALTITUDE PULMONARY EDEMA (HAPE). HA.PE is a high altitude illness which is characterized by filling of the lungs with fluid.

a. Risk Factors for HAPE. They are the same as for AMS and HACE, except HAPE is rarely seen below **10,000** feet.

b. Symptoms of HAPE. The two key symptoms to look for are:

1) A cough that persists even at rest. Cough will be initially dry and then progress over several hours to days to produce a pink, frothy sputum.

2) Severe shortness of breath, which also persists even at rest.

3) Other symptoms of AMS are also usually present and include: disorientation and fainting.

c. Signs of HAPE.

1) Cool, clammy skin.

2) Rapid breathing.

3) Rapid, weak pulse.

4) Blue lips.

5) Undue fatigue.

d. Prevention of HAPE. The same as for AMS, slow graded ascent.

e. Treatment of HAPE.

1) The best treatment is an immediate and rapid descent, to as low as possible, preferably to sea level.

2) The victim should be given 100% oxygen by mask if available.

3) Medical can prescribe a drug called Nifedipine. Diamox may also be given.

4) Gamow Bag. See description in para. d. above.

5) Remember: *HAPE KILLS* if not treated.

13. HYPOTHERMIA. This is defined as the state when the body's core temperature falls to 95°F or less.

a. A core temperature is the inside temperature at the center of the body. Taking an oral or armpit (axcillary) temperature is not an accurate way to determine core body temperature. The best way to measure core temperature in the field is to take the temperature rectally. This must be done with a special low range rectal thermometer, which should be carried by all officers, SNCO's and corpsmen. These thermometers are available through the federal stock system. (FSN 6515-00-139-4593)

b. Commonplace misconceptions.

1) Exposure. Often in the media and in news reports you may hear that an individual has "exposure". While the term is usually used in reference to hypothermia, some also use it to describe frostbite or other cold weather injuries. Therefore, "exposure" has no real meaning and should not be used to describe hypothermia or any related injury. Your corpsmen and Battalion MO’s need as much detailed information as possible.

2) Extreme cold. It is a common belief that extreme cold is needed for hypothermia to occur. In fact, most cases occur when the temperature is between 30°F (-1°C) and 50°F (10°C). This temperature range is quite common all year round in the mountains.

c. Causes of Hypothermia. The ways in which the body generates and loses heat has been discussed earlier. Quite simply, hypothermia occurs when heat loss from the body exceeds the body's ability to produce heat. Contributing factors include:

1) Air temperature.
2) Wind chill. This only affects improperly clothed individuals.
3) Wet or sweat soaked clothing.
4) Cold water immersion.
5) Improper clothing.
6) Exhaustion.
7) Alcohol intoxication, nicotine or other drugs used such as barbiturates and tranquilizers.
8) Injuries, especially those causing immobility, major bleeding, major burns or head trauma.

d. Signs and Symptoms of Hypothermia.

1) The number one indicator to look for is altered mental status - the brain is literally getting cold. These signs might include confusion, slurred speech, strange behavior, irritability, impaired judgment, hallucinations, or fatigue.

2) As hypothermia worsens, victims will lose consciousness and eventual slip into a coma.

3) Shivering. Remember that shivering is a response that the body uses as it tries to warm itself early on, when it first gets cold. Shivering stops for 2 reasons:

a) The body has warmed back up to a normal temperature range.

b) The body has continued to cool. Below 95°F shivering begins to decrease and by 90°F it ceases completely.

c) Obviously, continued cooling is bad. If a Marine with whom you are working with was shivering and has now stopped, you must determine if it is because he has warmed up or continued to cool down.

4) A victim with severe hypothermia may actually appear to be dead. They may lack a conspicuous respiration or pulse. However, people who have been found this way have been successfully "brought back to life" with no permanent damage. So remember, *you are not dead until you are warm and dead.*

f. Prevention of Hypothermia.

1) Obviously, prevention is always better (and much easier) than treatment.

2) Cold weather clothing must be properly worn and cared for.

a) Keep your clothing as dry as possible.
b) If your feet are cold, wear a hat. Up to 80% of the body's heat can escape through the head.

3) Avoid dehydration. Drink 6 - 8 quarts per/day.

4) Eat adequately. At least 4,500 calories per day.

5) Avoid fatigue and exhaustion. A Marine in a state of physical exhaustion is at increased risk for hypothermia.

6) Increase levels of activity as the temperature drops. Do not remain stationary when the air temperature is very low. If the tactical situation does not permit moving about, perform isometric exercises of major muscle groups.

7) Use the buddy system to check each other for signs/symptoms of hypothermia.

g. Treatment of Hypothermia.

1) Make the correct diagnosis.

2) Prevent further heat loss.

a) Remove the victim from the environment where he became hypothermic, bring him into the BAS, a tent, a snow cave, etc.

b) As soon as possible, remove the victim's cold, wet clothes.

3) Insulate the victim.

a) First, wrap the victim in a vapor barrier liner (VBL). A VBL will prevent heat loss as a result of evaporation and slow down heat loss from convection. The easiest way to do this in the field is by wrapping the victim in plastic trash bags or space blankets. (Be sure not to cover the face.)

b) Next, place the victim in a sleeping bag.

4) Re-warm the victim.

a) The easiest way to do this in the field is to zip two sleeping bags together. Place the victim in the zipped up bags with 2 warm, stripped-down volunteers.

b) In addition to the two stripped volunteers, place warmed materials on either side of the victim's neck, his armpits, and his groin. Items such as warmed rocks, canteens of warm water, or heat packs can be used. Be advised, the warmed materials should not be hot, and the stripped volunteers should be in contact with the items as well. A hypothermia victim may not be able to tell if his skin is burning, but the volunteers will.

5) Evacuate the victim. A casualty evacuation may not be possible due to the tactical situation, weather, or other factors. However, the sooner a victim can be evacuated, the better. *Severe hypothermia is a medical emergency.*

6) Other Points to Remember:

a) Fluids. If the victim is mildly hypothermic, he may be given hot wets. Otherwise give him nothing by mouth if unconscious or in severely altered mental state.

b) Avoid, if possible, excessive movement of the victim, as his heart may stop beating if it is jarred.

c) Major Wounds. Apply first aid to major wounds first**,** before attempting to re-warm the victim. Re-warming a victim who has bled to death does little good.

d) Never give alcohol to hypothermia victims.

e) Even after you have started re-warming a victim, he must be constantly monitored.

14. FROSTBITE. This is the actual freezing of tissues.

a. Risk Factors of Frostbite. The high risk areas are fingers, toes, nose, cheeks, and ears.

1) Three Major Risk Factors. There are many factors that cause frostbite, of which three stand out as contributing to the majority of injuries:

a) Improper clothing or improper care of clothing. This is a major factor in frostbite.

(1) Wearing gloves when mittens should be worn.
(2) Failure to dry gloves or liners after they have become wet.
(3) Wet clothing of any kind.
(4) Improper footwear, such as wearing summer combat boots when VB or ski/march boots should be worn.
(5) Improper care of footwear. Failing to remove boots at night, sleeping with boots on, or failing to dry boots when they become wet.
(6) Wearing boots or clothes that are too tight.
(7) The proper use of cold weather clothing, as well as it's proper maintenance in the field, is dependent on small unit leadership. Small unit leaders must ensure that their men are adequately clothed and that the clothing is being adequately maintained.

b) Dehydration. This is another major contributing factor in frostbite. Marines who are well hydrated are much better equipped to fight off frostbite.

c) Poor diet or starvation. This is another major contributing factor in frostbite. Remember that the body can be thought of as a furnace, and that the fuel is food. When food intake is low, there is less fuel to feed the furnace and the risk for frostbite goes up.

2) Other factors that contribute to frostbite.

a) Outside temperature. Obviously, the colder it is, the greater the risks.
b) Snow or Ground temperature. The snow temperature can be 30°F-40°F colder than the air temperature.
c) Wind chill. As mentioned previously, wind-chill should not be a factor with properly dressed Marines.
d) Cold metals. Never touch very cold metals with bare flesh. Use contact gloves.
e) Petroleum products. Fuels and oils freeze at a much lower temperature than water. **Spilling cold fuel (such as white gas, gasoline, etc.) on bare skin can cause immediate, severe frostbite.**

f) Exhaustion. The body's natural defense mechanisms in general are lowered when you are exhausted.
g) Hypothermia. Body's response to hypothermia is to slow or stop the flow of blood to the extremities, which could lead to frostbite in hands and feet.
h) Race/Place of Birth. Those races of tropical ancestry (African, Mediterranean, dark complexion etc) are at increased risk for frostbite due to a decreased hereditary response known as cold induced vasodilation or "Hunter's Response". (2d Edit. Wilderness Medicine by Paul Auerbach, Chap. 3)
i) Other factors include prolonged immobility (as when sitting in an ambush position), wounds with blood loss, previous cold injury, and tobacco use.

b. Signs and Symptoms of Frostbite.

1) Signs of Frostbite.

a) The skin may appear red, white, yellow, gray, blue, frosty, or even normal.
b) The skin may feel woody or firm.
c) The joints may be stiff or immobile.
d) The affected part may feel like a block of wood or even ice.
e) Pulses may or may not be present.

2) Symptoms of Frostbite. A victim may complain of any of the following:

(a) Tingling. (d) Sharp pain.

(b) Burning. (e) Increased warmth.

(c) Aching cold. (f) Decreased sensation.

(g) No sensation at all. The victim may describe the affected part as clumsy, lifeless, bulky or club like.

c. Classification of Frostbite. Like burns, frostbite has been divided into 1st, 2nd, 3rd, and 4th degrees. But it is much easier to divide it up into Frosting, Superficial Frostbite, and Deep Frostbite.

1) Frosting. This is something we all have experienced at one time or another. It is when some part of the body (toes, fingers, or nose usually) becomes painfully cold, but does not freeze. It is a harmless condition and the affected part returns to normal with re-warming.

2) Superficial Frostbite. This is when the skin freezes, but not the tissue beneath (such as muscle, nerves, and bone).
a) Skin appears red, gray, or even blue, and has a waxy feel to it.
b) Pulses will be present, but decreased.
c) The sensation of pain and light touch may be absent, but deeper sensations such as pressure will be intact.
d) The joints will be mobile, but stiff.
e) Movement of the part by the victim will be possible, although it may be difficult.

3) Deep Frostbite.

a) Initially, the skin may appear the same as above.
b) Pulses will not be present.
c) The skin will feel woody, firm or even rock hard.
d) Tissues below will feel doughy or hard.
e) All sensation will be absent.
f) Skin will not move easily or not at all.
g) Joints will be stiff or immobile.
h) Movement of the affected part will be minimal or absent.

4) It is often difficult to say exactly how severe a case of frostbite is until several weeks have passed. Therefore, it is wise to assume the worst.

NOTE: Frostbite may be present in different degrees in the same affected part, for example: a frostbitten hand may be deep at the fingers, superficial at the palm and frosting at the wrist.

d. Prevention of Frostbite.

1) Frostbite is an entirely preventable injury. Obviously, there is little one can do about the weather, but Marines can ensure that the other risk factors that can lead to frostbite are minimized. The best way to prevent frostbite is to prevent the three major risk factors: Improper clothing or improper care of clothing, dehydration, and starvation.

a) Dress in layers. Keep comfortably cool. If you begin to become uncomfortable, add layers. If your hands or feet become uncomfortable, do not ignore them - you may have to add more layers, or you may want to change socks or gloves.

b) Keep clothes dry. This is vitally important. If your boots, socks, or gloves get wet, then dry them. **This may mean you have to change socks up to 4 - 5 times a day (especially with Vapor Barrier boots).** If your gloves or liners are wet, warm and dry them. Do not continue to wear wet clothing.

c) Dress properly. This may seem obvious, but Marines have gotten frostbite because they did not dress properly. If the wind is blowing, wear the correct protective layer. Always have a balaclava or watch cap available, and if it's cold - wear it. If your fingers are getting cold in gloves, wear mittens.

d) Avoid Dehydration. When you become dehydrated, the amount of blood available to warm your fingers and toes goes down, greatly increasing your risk of frostbite.

e) Avoid Starvation. Remember - Food is Fuel - and the body uses that fuel to make heat. When you are low on fuel, you will be low on heat.

2) If you notice your fingers or toes are getting cold even after you have tried to warm them, do not ignore it. Let your leaders know. Ignoring the problem will not make it go away, it will only get worse.

3) Small Unit Leaders must ensure that preventive measures are taken. Like dehydration, frostbite results from *a failure of leadership.*

e. Field Management for Frostbite. Only frosting should be treated in the field, all others should be evacuated immediately. If you don't know, assume the worst and evacuate.

1) Treatment of Frosting. This is easily done in the field using the 15 minute rule. Frosting will revert to normal after using this technique of body heat re-warming. Hold the affected area, as described below, skin to skin for 15 minutes. If the affected area does not return to normal, assume a frostbite injury has occurred and report it to your seniors.

a) Re-warm face, nose, ears with hands.
b) Re-warm hands in armpits, groin or belly.
c) Re-warm feet with mountain buddies armpits or belly.
d) *DO NOT RUB ANY COLD INJURY WITH SNOW EVER!*
e) Do not massage the affected part.
f) Do not re-warm with stove or fire, a burn injury may result.
g) Loosen constricting clothing.
h) Avoid tobacco products.

2) Treatment of Superficial or Deep frostbite. Any frostbite injury, regardless of severity, is treated the same - evacuate the casualty and re-warm in the rear. Unless the tactical situation prohibits evacuation or you are in a survival situation, no *consideration should be given to re-warming frostbite in the field.* The reason is something called freeze - thaw - re-freeze injury.

a) Freeze - Thaw - Re-freeze injury occurs when a frostbitten extremity is thawed out, then before it can heal (which takes weeks and maybe months) it freezes again. This has devastating effects and greatly worsens the initial injury.
b) In an extreme emergency it is better to walk out on a frostbitten foot than to warm it up and then have it freeze again.
c) Treat frozen extremities as fractures - carefully pad and splint.
d) Treat frozen feet as litter cases.
e) Prevent further freezing injury.
f) Do not forget about hypothermia. Keep the victim warm and dry.
g) Once in the rear, a frostbitten extremity is re-warmed in a water bath, with the temperature strictly maintained at 100°F (38°C) -108°F (42°C).

15. TRENCHFOOT/IMMERSION FOOT **.** This is a cold - wet injury to the feet or hands from prolonged (generally 7 - 10 hours) exposure to water at temperatures above freezing.

a. Causes of Trench foot/Immersion Foot. The major risk factors are: Wet, cold and immobility.

b. Signs and Symptoms of Trench foot/Immersion Foot.

1) The major symptom will be pain. Trench foot is an extremely painful injury.
2) Trench foot and frostbite are often very difficult to tell apart just from looking at it. Often they may both be present at the same time. Signs include:

a) Red and purple mottled skin.
b) Patches of white skin.
c) Very wrinkled skin.
d) Severe cases may leave gangrene and blisters.
e) Swelling.
f) Lowered or even absent pulse.

3) Trench foot is classified from mild to severe.

c. Prevention of Trench foot/Immersion Foot. This is simply preventing cold, wet and immobile feet (or hands).

1) Keep feet warm and dry.
2) Change socks at least once a day. Let your feet dry briefly during the change, and wipe out the inside of the boot. Sock changes may be required more often.
3) Exercise. Constant exercising of the feet whenever the body is otherwise immobile will help the blood flow.

d. Treatment of Trench foot/Immersion Foot

1) All cases of trench foot must be evacuated. It cannot be treated effectively in the field.
2) While awaiting evacuation:
a) The feet should be dried, warmed, and elevated.
b) The pain is often severe, even though the injury may appear mild, it may require medication such as morphine.

3) In the rear, the healing of trench foot usually takes at least two months, and may take almost a year. Severe cases may require amputation. *Trench foot is not to be taken lightly.*

16. SNOW BLINDNESS This is defined as Sunburn of the cornea.

a. Causes of Snow Blindness. There are two reasons Marines in a winter mountainous environment are at increased risk for snow blindness.

1) High altitude. Due to the thinner atmosphere, less ultraviolet (UV) rays are filtered out. UV rays are what cause snow blindness (as well as sunburn). So at altitude, more UV rays are available to cause damage.

2) Snow. The white color of snow, at any altitude, reflects more UV rays off of the ground and back into your face.

b. Signs and Symptoms of Snow Blindness.

1) Painful eyes**.**
2) Hot, sticky, or gritty sensation in the eyes, like sand in the eyes.
3) Blurred vision.

4) Headache, may be severe.
5) Excessive tearing.
6) Eye muscle spasm.
7) Bloodshot eyes.

c. Prevention of Snow Blindness. Prevention is very simple. Always wear sunglasses, with UV protection. If sunglasses are not available, then field expedient sunglasses can be made from a strip of cardboard with horizontal slits, and charcoal can be applied under the eyes to cut down on reflection of the sun off the snow.

d. Treatment of Snow Blindness.
1) Evacuation, when possible.
2) Patch the eyes to prevent any more light reaching them.
3) Wet compresses, if it is not too cold, may help relieve some of the discomfort.
4) Healing normally takes two days for mild cases or up to a week for more severe cases.

17. CARBON MONOXIDE (CO) POISONING. CO is a heavy, odorless, colorless, tasteless gas resulting from incomplete combustion of fossil fuels. CO kills through asphyxia even in the presence of adequate oxygen, because oxygen-transporting hemoglobin in the blood has a 2 to 10 times greater affinity for CO than for oxygen. What this means is that CO replaces and takes the place of the oxygen in the body causing Carbon Monoxide poisoning.

a. Signs/Symptoms. The signs and symptoms depend on the amount of CO the victim has inhaled. In mild cases, the victim may have only dizziness, headache, and confusion; severe cases can cause a deep coma. Sudden respiratory arrest may occur. The classic sign of CO poisoning is cherry-red lip color, but this is usually a very late and severe sign, actually the skin is normally found to be pale or blue.
CO poisoning should be suspected whenever a person in a poorly ventilated area suddenly collapses. Recognizing this condition may be difficult when all members of the party are affected.

b. Treatment. The first step is to immediately remove the victim from the contaminated area.

1) Victims with mild CO poisoning who have not lost consciousness need fresh air and light duty for a minimum of four hours. If oxygen is available administer it. More severely affected victims may require rescue breathing.

2) Fortunately, CO is excreted by the lungs within a few hours.

c. Prevention. Prevention is the key. Ensure that there is adequate ventilation when running vehicle engines, operating stoves in closed spaces (tents), or when cooking over open fires. When operating personal stoves, a blue flame produces less CO than an orange flame.

18. PERSONAL HYGIENE. The five most important areas of personal hygiene are:

a. Body.

1) The body should be washed frequently in order to minimize the chances of small cuts and scratches developing into full blown infections and as a defense against parasitic infections.

2) A daily bath or shower consisting of soap and hot water is ideal. However, when this is not possible you should:

a) Give yourself a sponge bath using soap and water, making sure particular attention is given to body creases (i.e. armpits, groin area, face, ears, and hands).

b) If water is in extremely short supply, you should take an air bath. To do this:

1 Remove all clothing and hang it up to air.

2 Expose the body for two hours to sunlight, which is ideal, but the effects will nearly be the same if done indoors or during an overcast day. BE CAREFUL NOT TO SUNBURN.

b. Hair.

1) Should be cleaned frequently.

2) Should be inspected at least once a week for parasites.

c. Fingernails.

1) Should be kept trimmed to prevent accidentally scratching yourself

2) Should be kept cleaned to prevent harborage areas for bacteria.

d. Feet.

1) The feet should be inspected frequently for:

a) Blisters.

b) Infections, Bacterial and fungal.

2) They should be kept dry by:

a) Frequent sock changes (one to three times daily) in conjunction with: Foot powders, and Anti- perspirants.

e. Oral Hygiene. The mouth and teeth should be cleaned at least daily to prevent tooth decay and gum disease.

1) Ideally, cleaning should be done with:

(a) Toothbrush. (c) Dental floss.

(b) Toothpaste.

2) If these items are not available, the following methods can be used:

a) Make a chew stick from a clean twig about 8" long and about finger width. Chew one end until it becomes frayed and brush-like, then brush the interior and exterior surfaces thoroughly.

b) The gums should be stimulated at least once a day by rubbing them vigorously with a clean finger.

c) Field expedient dental floss can be made from the inner strands of a 10 inch section of paracord.

19. WATER PURIFICATION. Water purification simply consists of removing or destroying enough impurities to make water safe to drink. Giardia cysts (a type of microorganism common due to animal feces) are an ever present danger even in clear mountain water, even though that water appears clean and safe to drink.

a. Boiling is the oldest way of water dis-infection. Recent studies have shown that the old recommendation of boiling water for 10 minutes and adding 1 minute of boiling for each 1,000 feet in elevation is not necessary and wasteful of limited fuel supplies. The studies found that the thermal death point of microorganisms is reached in shorter time at higher altitudes, while lower temperatures are effective with a longer contact period. Therefore the minimum critical temperature needed to render water safe to drink is well below the boiling point at elevation. With these findings in mind it can now be safely said that once water is brought to a boil, and allowed to cool it is disinfected and safe to drink. For an extra margin of safety the Wilderness Medical Society recommends boiling water for 1 minute no-matter what altitude you're at to render water safe to drink.

20. WASTE DISPOSAL. Waste should be disposed of by either burning, burying, or hauling it away.

a. The importance of waste disposal cannot be overemphasized.

1) It serves to:
   a) Eliminate harborage areas for rodents and vermin.
   b) Preclude an attractant for rodents and vermin.
   c) Prevent a source of pathogenic contamination.

2) Two basic types:

   a) Organic wastes
      (1) Human waste - burn or haul away to a designated waste pit area.

      (2) Urine - Use only assigned, marked areas away from food and water sources.

      (3) Edible garbage - Burn. Do not leave exposed for animals, vermin, or the enemy.
   b) Non-organic wastes

      (1) Papers should be burned.

      (2) Metals should be hauled away or buried.

(3) Liquids should be burned or buried.

Conclusion: We have covered the way a body loses heat, dehydration, heat injuries, high altitude sickness, hypothermia, frostbite, trench foot, snow blindness, carbon monoxide poisoning, and personal hygiene. While these injuries occur in any environment you will operate in, they are especially prevalent in a Mountainous or Cold Weather environment.

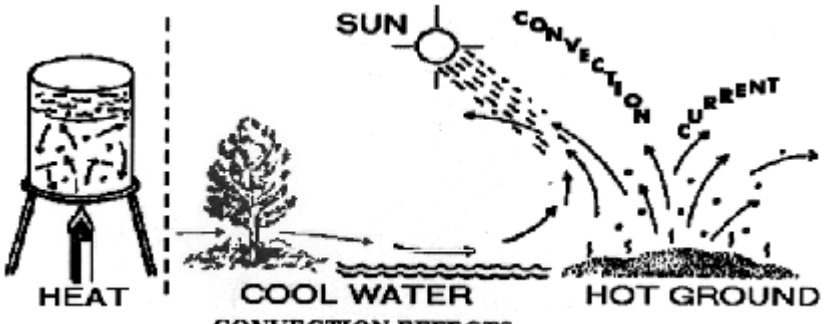
Mountain Weather. Normally, as Marines in temperate climates we think of bad weather as possibly a tactical advantage, giving us concealment in order to move undetected. But in a cold weather/ mountainous environment, bad weather can be devastating if not properly prepared. For you, it is crucial that you be able to understand the fundamentals of meteorology and determine what to expect from incoming weather patterns. While this section will not, nor is it intended to make you an expert, it will help you in the evaluation of your environment and recognize when a potentially dangerous situation may be arising.

1. **Lifting and Cooling**: Air can only hold so much moisture depending on its temperature. If air is cooled beyond its saturation point, it must release the extra moisture in one form or another, i.e. rain, snow, fog, etc. There are three ways that air can be lifted and cooled beyond its saturation point.

OROGRAPHIC UPLIFT

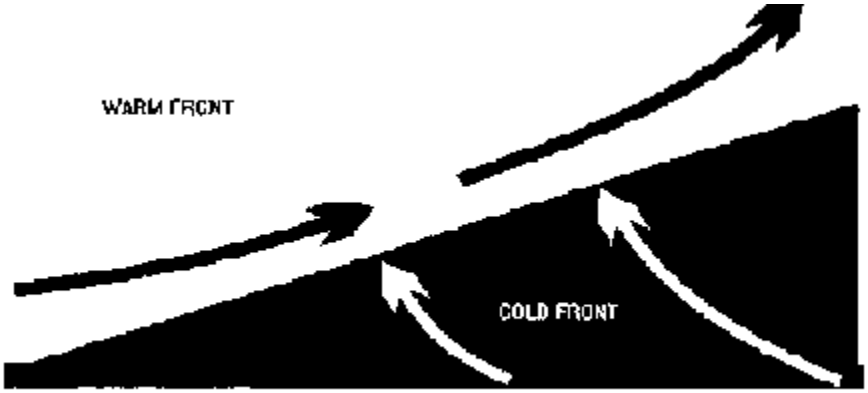
a. Orographic uplift. This happens when an air mass is pushed up and over a mass of higher ground such as a mountain. Due to what is called the adiabatic laps rate, the air is cooled with altitude and if it reaches its saturation point the result is precipitation. Obviously, being in a mountainous environment, this is the one that we will be the most concerned with.

b. Convection Effects. This is normally a summer effect due to the sun's heat re-radiating off of the surface and causing the air currents to push straight up and lift air to a point of saturation.



CONVECTION EFFECTS

c. Frontal lifting. As we know when two air masses of different moisture and temperature and moisture content collide, this is a front. Since the air masses will not mix, the warmer air is forced aloft; from there it is cooled and then reaches its saturation point. Frontal lifting is where we receive the majority of our precipitation. A combination of the different types of lifting is not uncommon.

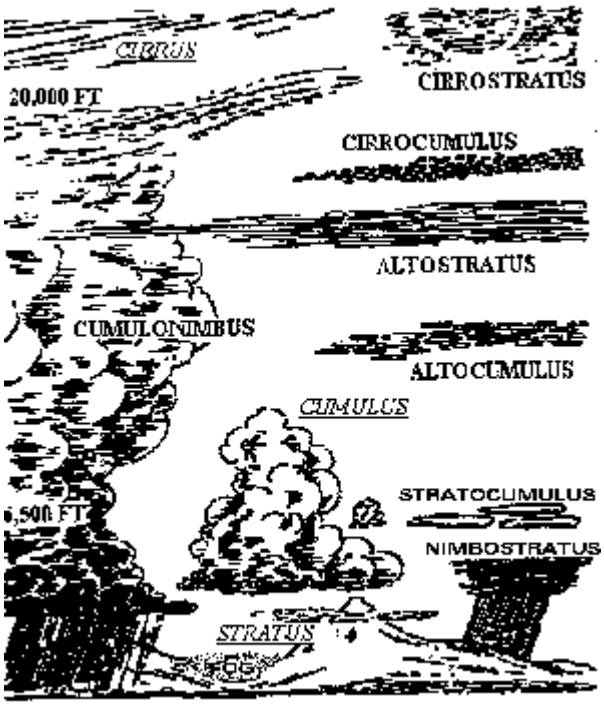


FRONTAL LIFTING

2. **Clouds**: Any time air is lifted or cooled beyond its saturation point (100% relative humidity), clouds are formed. Clouds are one of our signposts to what is happening. Clouds can be described in many different ways, they can also be classified by height or appearance, or even by the amount of area covered, vertically or horizontally.

a. Cirrus. These clouds are formed of ice crystals at very high altitudes (usually 20,000 to 35,000 feet) in the mid-latitudes and are thin, feathery type clouds. These clouds can give you up to 24 hours warning of approaching bad weather, hundreds of miles in advance of a warm front. Frail, scattered types, such as "mare tails" or dense cirrus layers are a sign of fair weather but predict a prelude to approaching lower clouds, the arrival of precipitation and a front.

b. Cumulus. These clouds are formed due to rising air currents and are prevalent in unstable air that favors vertical development. These currents of air create cumiliform clouds that give them a piled or bunched up appearance, looking similar to cotton balls. Within the cumulus family there are three different types to help us to forecast the weather:



1) Cotton puffs of cumulus are fair weather clouds but should be observed for possible growth into towering cumulus and cumulonimbus.

2) Towering Cumulus are characterized by vertical development. Their vertical lifting is caused by some type of lifting action, such as convective currents found on hot summer afternoons or when wind is forced to rise up the slope of a mountain or possibly the lifting action that may be present in a frontal system. The towering cumulus has a puffy "cauliflower-shaped" appearance.

2) Cumulonimbus clouds are characterized in the same manner as the towering cumulus, forming the familiar "thunderhead" and produce thunderstorm activity. These clouds are characterized by violent updrafts, which carry the tops of the clouds to extreme elevations. Tornadoes, hail, and severe rainstorms are all products of this type of cloud. At the top of the cloud, a flat anvil shaped form appears as the thunderstorm begins to dissipate.

c. Stratus. Stratus clouds are formed when a layer of moist air is cooled below its saturation point. Stratiform, clouds lie mostly in horizontal layers or sheets, resisting vertical development. The word "stratus" is derived from the Latin word for "layer". The stratus cloud is quite uniform and resembles fog. It has a fairly uniform base and a dull, gray appearance. Stratus clouds make the sky appear heavy and will occasionally produce fine drizzle or very light snow with fog. However, because there is little or no vertical movement in the stratus clouds, they usually do not produce precipitation in the form of heavy rain or snow.

d. As previously stated, clouds are formed when air is lifted to a point where it cools to its saturation point. We also know that frontal lifting affects our fronts, which produce the largest portion of our precipitation.

3. **Fronts:** As we know, fronts often happen when two air masses of different moisture and temperature content interact. One of the ways we can identify that this is happening. Is by the progression of the clouds.

a. Warm Front. A warm front occurs when warm air moves into and over a slower (or stationary) cold air mass. Since warm air is less dense, it will rise naturally so that it will push the cooler air down and rise above it. The cloud you see at this stage is cirrus. From the point where it actually starts rising, you will see stratus. As it continues to rise, this warm air, cooled by the cold air, receives moisture at the same time. As it builds in moisture, it darkens becoming "nimbus-stratus", which means rain or thunderclouds. At that point some type of moisture will generally fall.

b. Cold Front. A cold front occurs when a cold air mass (colder than the ground that it is traveling over) overtakes a warm air mass that is stationary or moving slowly. This cold air, being denser, will go underneath the warm air, pushing it higher. Of course, no one can see this "air", but one can see clouds and the clouds themselves can tell us what is happening. The cloud progression to look for is cirrus to cirrocumulus to cumulus and, finally to cumulonimbus.

c. Occluded Front. Cold fronts move faster than warm ones so that eventually a cold front overtakes a warm one and the warm air becomes progressively lifted from the surface. The zone of division between cold air ahead and cold air behind is called a "cold occlusion". If the air behind the front is warmer than ahead, it is a warm occlusion. Most land areas experience more occlusions than other types of fronts. In the progression of clouds leading to fronts, orographic uplift can play part in deceiving you of the actual type of front, i.e. progression of clouds leading to a warm front with orographic cumulus clouds added to these. The progression of clouds in an occlusion is a combination of both progressions from a warm and a cold front.

2. **Using Pressure as an indicator**. A very important factor of telling us what might happen is the pressure. As we know, low pressure or dropping pressure normally indicates deteriorating weather whereas high pressure usually gives us more good weather or clearing of bad weather. There are a couple of ways to monitor the pressure.

a. The Barometer. A barometer could be described as a pan of mercury with a tube leading out of the pan. Pressure from the atmosphere causes the mercury to rise in the tube.

1) The tube is marked in millibars and the station that's reading these millibars will know how much it should rise for that location. Once again, if it rises more than normal, it would be considered a high-pressure reading.

b. The Altimeter. Another means that is used to measure pressure is an altimeter, which is commonly used by mountaineers. It works like this:

1) As you rise in elevation the pressure becomes less, thus allowing the needle in the altimeter to rise. If the needle rises without you actually rising in elevation, there is less pressure in the atmosphere than before and thus, a low-pressure area.

NOTE: There are many watches now that can be bought on the open market, that have an altimeter and/or barometer included. When used properly, they are a useful tool in determining your elevation or as a barometer.

c. Contrail Lines. A basic way of identifying a low-pressure area is to note the contrail lines from jet aircraft. If they do not dissipate within two hours, that indicates a low-pressure area in your area. This usually occurs about 24 hours prior to an oncoming front.

d. Lenticulars. These are optical, lens-shaped cumulus clouds that have been sculpted by the winds. This indicates moisture in the air and high winds aloft. When preceding a cold front, winds and clouds will begin to lower.

3. **Using signs from nature**. These signs will give you a general prediction of the incoming weather conditions. Try to utilize as many signs together as possible, which will improve your prediction. All of these signs have been tested with relative accuracy, but should not be depended on 100%. But in any case you will be right more times than wrong in predicting the weather. From this we can gather as much information as needed and compile it along with our own experience of the area we are working in to help us form a prediction of incoming weather. The signs are as follows:
    a. A spider's habits are very good indicators of what weather conditions will be within the next few hours. When the day is to be fair and relatively windless, they will spin long filaments over which they scout persistently. When precipitation is imminent, they shorten and tighten their snares and drowse dully in the centers.
    b. Insects are especially annoying two to four hours before a storm.
    c. If bees are swarming, fair weather will continue for at least the next half day.
    d. Large game such as deer, elk, etc., will be feeding unusually heavy four to six hours before a storm.
    e. When the smoke from a campfire, after lifting a short distance with the heated air, beats downward, a storm is approaching. Steadily rising smoke indicates fair weather.
    f. Red sky at night is a sailor's delight and red sky in the morning is a sailor's warning. This poem is correct in only some places of the world. When the sun rises in the morning and there is moisture present, the sky will be red. If the wind is moving west to east, that moisture has already past. This does not mean that it will not rain, it just means that the moisture making the sky red is already past. When the sun sets in the west, and there is moisture in the sky, the sunset will be red. If the winds are moving west to east, it means that the moisture in the west making the sky red will move east and possibly form as clouds later.
    g. A gray, overcast evening sky indicates that moisture carrying dust particles in the atmosphere have become overloaded with water; this condition favors rain.
    h. Gray morning sky indicates dry air above the haze caused by the collecting of moisture on the dust in the lower atmosphere; you can have a reasonably fair day.
    i. A rainbow in the late afternoon indicates fair weather ahead. However, a rainbow in the morning is a sign of prolonged bad weather.
    j. A corona is the circle that appears around the sun or the moon. When this circle grows larger, it indicates that the drops of water in the atmosphere are evaporating and the weather will probably be clear. When this circle shrinks by the hour, it indicates that the water drops in the atmosphere are becoming larger, forming into clouds and rain is almost sure to fall.
    k. In fair weather, air currents flow down streams and hillsides in the early morning and start drifting back up towards sunset. Any reversal of these directions warns of a nearing storm.
    l. It is unusually quiet before a storm because wildlife are inactive a couple of hours before a storm.
    m. In the mountains, mist rising from ravines in the morning is a good sign of clear weather the rest of the day.

n. A heavy dew or frost in the morning is a sign of fair weather for the rest of the day. This is due to the moisture in the atmosphere settling on the ground vice in the form of precipitation such as rain, snow, etc.

CONCLUSION: This is only a basic knowledge of the factors that affect weather and how weather happens. Only practice and experience at actually doing some field forecasting will give you a feel for these weather patterns. Also this is no substitute for getting an accurate forecast prior to operations.

CHAPTER 2
MOUNTAINEERING EQUIPMENT

MARINE ASSAULT CLIMBER'S KIT: As in any military operation requiring special skills, such as mountaineering, some special equipment requirements particular to the mission must be covered. The Marine Corps has adopted the Marine Assault Climber's Kit (MACK) for this very reason.

1. Description: The Marine Assault Climber's Kit (MACK) is a comprehensive collection of climbing equipment that enables a Marine rifle company, approximately 200 Marines with organic equipment, to negotiate an average 300 foot vertical danger area. The kit contains sufficient climbing equipment to equip four, two man climbing teams plus the additional items necessary to supply the remainder of the Rifle Company. The climbing teams use their equipment to conduct 2-party climbs over vertical obstacles and establish various rope installations to facilitate movement of the remainder of the company. The MACK will be used by Marines engaged in training and combat operations in mountainous areas having rugged compartment terrain and steep slopes. 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.

2. SL-3 Components: 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 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. Containers #2, #3, #4 contain the company climbing equipment. A manual for care/maintenance of SL-3 components is included with each MACK.

TABLE OF CONTENTS

BOX #1		
ITEM	QUANTITY	MINIMUM BREAKING STRENGTH
CARABINER, ALUMINUM NON-LOCKING	136	4,400 lb.
CARABINER, STEEL LOCKING "D"	40	7,000 lb.
NUT, WEDGE, WIRE (set of I each size I- 1 2)	4	550 lb. To 2,800 lb.
NUT, HEXCENTRIC (set of I each size 1-10)	4	2,800 lb.
CAMMING DEVICE, 4 CAM (SMALL) (set of I each size 1-5)	4	2,600 lb.
CAMMING DEVICE, 4 CAN (LARGE) (set of I each size 1-4)	4	2,400 lb.
PULLEY,RESCUE	8	5,000 lb.
PLATE, BELAY	8	
ASCENDER	8	1,500 lb.
TOOL, NUT	8	
HARNESS, CLIMBING	8	3,500 lb.
BAG, ROPE	8	
ROPE, DYNAMIC	4	5,400 lb.

ROPE, STATIC	4	6,500 lb.
RUNNER, SPECTRA 2”	8	5,500 lb.
RUNNER, SPECTRA 6”	8	5,500 lb.
RUNNER, SPECTRA 12”	8	5,500 lb.
RUNNER, SPECTRA 24”	8	5,500 lb.
RUNNER, SPECTRA 48”	8	5,500 lb.
GEAR, SLING ADJUSTABLE	2	5,500 lb.
CLIMBING LADDERS	2	1,322 lb.
ROPE, PRUSSICK 7’ (7mm)	8	2,200 lb.
ROPE, PRUSSICK “TEXAS KICK” 22’ (7mm)	8	2,200 lb.
EIGHT RING	8	6,000 lb. (brake strength- 2Kn)
18’ TUBULAR NYLON RUNNER, 1”	1	6,000 lb. (brake strength- 2Kn)

2-2

BOX #2		
ITEM	AMOUNT	MINIMUM BREAKING STRENGTH
ROPE, DYNAMIC	5	5,400 lb.
ROPE, STATIC	15	6,500 lb.

BOX #3		
ITEM	AMOUNT	MINIMUM BREAKING STRENGTH
ROPE, DYNAMIC	6	5,400 lb.
ROPE, STATIC	8	6,500 lb.
CARABINERS, STEEL LOCKING “D” 85’s	200	7,000 lb.
CARABINERS, STEEL LOCKING “D” 82’s	200	3,300 lb.
ROPE, PRACTICE COIL 25’	16	5,000 lb. (approx.)
ROPE, BAG 165’	16	

BOX #4		
ITEM	AMOUNT	MINIMUM BREAKING STRENGTH
ROPE, STATIC 300’	9	6,500 lb.
WEB RUNNER 7’	50	4,000 to 4,500 lb.
PRUSSICK CORD 7’ (7mm)	30	2,200 lb.
ROPE, PRUSSICK CORD 22’ (7mm)	10	2,200 lb.

3. 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. A damaged or broken component should be disposed of using standard supply procedures. Replenishment should be accomplished using the standard MILSTRIP process. Kit components not available through the MILSTRIP process may be purchased through local purchase.

4. Certified Users: Any Marine using components of the MACK must be supervised by a Marine who has received formal training as a Mountain Leader or Assault Climber. This training is provided by the Marine Corps Mountain Warfare Training Center's Summer Mountain Leaders Course or the Special Operations Training Group Assault Climber's Course. The school code, M7A for Mountain Leaders and YAK for Assault Climbers, will be on their BIR/BTR.

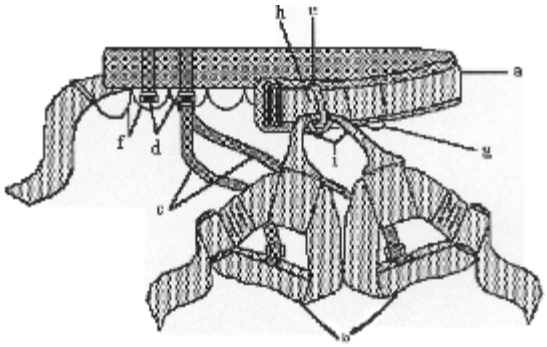
5. Preparing the MACK For Use.
   a. Company Equipment:
      1) Use the electric rope cutter to cut/whip one 15-18 foot sling rope for each Marine in the company using the dynamic rope (finish one complete spool before cutting another spool). Each Marine will also receive one non-locking carabiner and one locking carabiner.
      2) Cut the static rope for the mission at hand. Some spools are already 300 feet or 165 feet (50m)long, others may be 600-foot spools. Cut some of the one inch tubular tape for static anchor chord (15-25 foot lengths). When static rope becomes unserviceable, cut out good sections of 15-25 foot lengths for static anchor cords. Cut some 7mm nylon cord for use in tightening systems (3-6 foot lengths). Do not cut 7mm cord for company personnel to use as anchors because of the relatively low tensile strength (static rope or tape only should be used).
   b. Team Equipment:
      1) Rope: The dynamic climbing rope is olive drab and already in 165 foot (50m) lengths.
      2) Cordage: Cut/ whip 7mm nylon cord for use in tightening systems and anchors as part of each teams rack. Cut/whip one inch tubular 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 four to forty-eight inches. Tubular tape can also be used for anchors.
      3) Racks: Use the 5.5mm kevlar cord to wire the hexcentrics, secure the ends using 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. Use the kevlar cord for wiring hexcentrics only (it is not pliable enough for use as utility cord, nor is there a large quantity provided). Tie a small loop of 7mm cord on the stitch plate (belay device) in the appropriate hole (to keep it from running down the rope during use).
      4) Silencing the rack can be done by wrapping vinyl tape around the non-locking carabiner bodies and the large (size7-11) hexcentrics (ensure the tape is only one layer thick so it will not interfere with the function of the item). Nut picks can be taped or dummy-corded so that they do not rattle on a carabiner.
   c. Tailor the preparation of the MACK, when possible, to the mission, terrain, and size of using unit. Keep as much unused rope and cordage as possible for use as back up. Maintain a log of rope/cordage usage, and replace after two seasons of use. Inspect frequently for serviceability (before, during and after use).
   b. After use, clean and dry all MACK components according to the respective instructions in the MACK's care and maintenance manual. Most importantly, ***ensure that all items are thoroughly***

dry before returning items to the container for storage. One wet or damp item will spread its moisture to all other items in that container, causing mildew, rot, rust, etc.

CONCLUSION: Maintenance of your equipment will ensure that you will be able to accomplish your missions requiring the use of the MACK, and minimize placing your Marines in jeopardy.

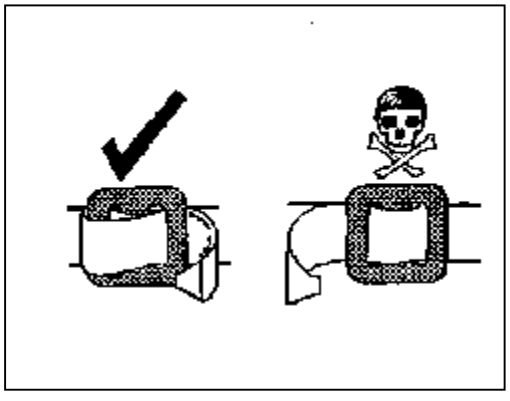
MWTC SIT HARNESS. The number of climbing harnesses available today is staggering. The Marine Corps, in co-operation with Yates Inc., has designed a climbing harness that can be used in a multitude of mountaineering operations, including two party climbing on rock or ice, rappelling, direct aid climbing, and many other techniques. It was one of the first harnesses made in the USA that passed the ANSI test and is rated to 5,950 lbs. tensile strength. It is also more comfortable than most harness as a result of the padded waist belt, and is a one size fits all.

1.**NOMENCLATURE**.



a) Waist Belt
b) Leg Loops (adjustable)
c) Buttocks straps (adjustable)
d) Fastex buckle x 2
e) Doughnut
f) Equipment Loops
g) D-Ring
h) Waist Belt Tie-in Point
i) Crotch Strap

1. **<u>WEARING OF THE SIT HARNESS</u>**.
    a) First, disconnect the fastex buckle at the rear of the harness.



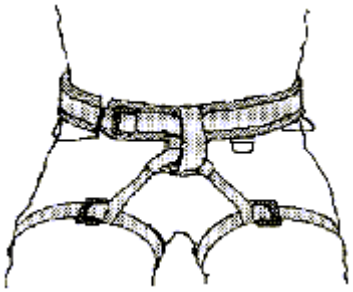
b) Hold the harness in front of you, put your feet through the leg loops, ensuring that the buckles are on the outside in your thighs.

c) Thread the waist belt through the buckle, ensuring a tight but comfortable fit. **You must ensure that the waist belt is**

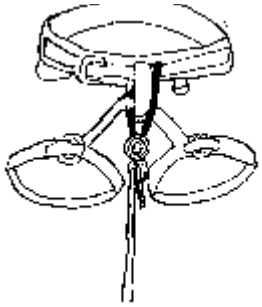
now threaded back through the buckle, this locks the waist belt into the buckle. Failure to do this will cause the waist belt to slip through under the load of a fall. Every year, more climbing injuries and deaths are caused by failing to do this than all other accidents.

d) Adjust your leg loops so that they are high on your thighs, once you have them adjusted, get a buddy to clip the fastex buckle in the rear to one of the two adjoining buckles, which ever is more comfortable. Then adjust the buttocks strap so that the leg loops are held up. Once this is done the straps should be threaded back through the buckle in the same manner as the waist strap.

d) When all of the above are done correctly, the harness should now be a comfortable but snug fit. After you have fitted it for the first time there is no need to go through the same procedures again each time you put the harness on. Only the waist belt needs to be undone and re-threaded properly for each use.



2. **<u>TYING INTO THE END OF THE ROPE</u>**.
   a) First begin with a retraceable figure of eight. Before you retrace the knot, pass the pigtail end of the climbing rope up under the crotch strap, then through the doughnut, and through the waist belt tie in point. Then continue to retrace the knot as taught. Adjust the knot to get it as close to the harness as possible with at least a fist of pigtail at the end.



3. **<u>TYING INTO THE MIDDLE OF THE ROPE</u>**.
   a) Take up a bight of approximately three feet and tie a figure of eight loop with the loop being approximately three feet. Then at the end of the loop tie another, smaller figure of eight loop. This excess will give the middle climber that amount of slack for freedom of movement. Then take a locking carabiner and attach it to the figure eight loop and hook into the harness by hooking the carabiner through the crotch strap, doughnut, and the waist belt tie in point.

4. **<u>CARE AND MAINTENANCE</u>**.
   a) Avoid contact with any chemicals, as these will damage the nylon.

b) Regularly inspect for signs of abrasions and normal wear. Pay particular attention to wear points such as the tie in loops, buckles, and sewn joints.

c) Keep away from heat such as running ropes, cigarettes, stoves, etc.

d) If soiled by grit or sea water, wash in lukewarm water with pure laundry detergent (no fabric softener) and allow to dry in a room away from direct heat or sunlight.

e) Two to three years of life can be expected during normal climbing use.
f) It is recommended that a harness that has experienced a serious fall should be discarded. See section on Fall Factors.

g) Under no circumstances will you ever tie into the equipment loops of any harness as a belay, anchor point, or any other method that has to sustain life.

CONCLUSION: The sit harness is one of the Mountain Leaders/ Assault Climbers most important pieces of equipment. Proper wear will ensure a comfortable operation but you must also learn to maintain and care for it in order to save you and your partners life should a serious fall ever take place.

NOMENCLATURURE AND CARE OF MOUNTAINEERING EQUIPMENT.
Operating in a mountainous environment calls for the use of many varied pieces of equipment. Much of this equipment is not familiar to most Marines. Using this equipment incorrectly can inhibit your ability to operate and in some cases can cause serious injuries or death to you or your fellow Marines.

1. **ROPES.**
   a. Climbing Ropes.
      1) Kernmantle Static: Tensile Strength of 6,500 lbs.
         A. Uses: For all rope installations not involving top roping or two party climbing.
         B. Construction: Nylon kernmantle rope.
      2) Kernmantle Dynamic: Tensile strength of 5,400 lbs. The rope has a stretch factor for absorption of sudden shock, such as a fallen climber.
         A. Uses: For all types of lead/party climbing.
         B. Construction: Nylon kernmantle rope.
      3) 9mm Maxim Dry Rope: Tensile strength of 4,500 lbs.
         A. Uses: For glacier travel and ice climbing.
         B. Construction: Nylon Kernmantle treated with water repellant/lubricant.
      4) Gold Line II: Tensile Strength of 4,500 lbs. (used at MCMWTC for miscellaneous training purposes).
         A. Uses: Sling ropes and for litters only.
         B. Construction: Eight strand braided nylon plymor.

NOTE: Sling ropes are made from 15 foot lengths of plymor or dynamic rope, *not static rope*. Twenty-five foot practice coils are either static or dynamic. Tensile strengths will vary with different manufacturers.

2. **ADVANTAGES AND DISADVANTAGES**. All comparisons are to the older Manila Rope.

a. Advantages of nylon rope.

1) High strength to weight ratio.
2) Good energy absorption in dynamic ropes.
3) Flexible.
4) Rot resistant, not affected by frost.

b. Disadvantages of nylon rope.

1) Low melting point. Nylon fuses at 400 degrees Fahrenheit and melts at 480 degrees Fahrenheit.
2) Susceptible to abrasions and cuts.
3) Affected by chemicals and light.

c. Advantages of Manila Rope.

1) Easily griped.
2) Hard wearing.
3) Does not deteriorate in heat.

d. Disadvantages of Manila Rope.

1) Heavy, kinks, especially when wet. Absorbs water and swells.
2) Burns at +300 degrees Fahrenheit.
3) Edible by rodents.

3. **GENERAL INFORMATION**.

a. Nylon rope stretches under tension and will rupture at between 30% and 70% elongation, depending on construction.

b. Nylon rope loses as much as 30% strength when wet. After drying will lose 2 to 3% permanently.

c. Temperatures as low as 250° Fahrenheit will damage a nylon rope.

4. **NYLON WEBBING.**

a. 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 nylon webbing. There are two types used.

1) 1 inch tubular nylon. Tensile strength approximately 4,000-4,500 lbs. depending on the manufacturer.
2) Pre-sewn spectra runners. Tensile strength approximately 5,500 lbs.

NOTE: These are minimum strengths. Some manufacturers make even stronger webbing. When knotted the breaking strength remains relatively the same as unknotted webbing.

5. **CARABINERS**. Also commonly known as snaplinks. There are two types of carabiners frequently used in the Marine Corps. The steel locking carabiner and the aluminum non-locking carabiner.

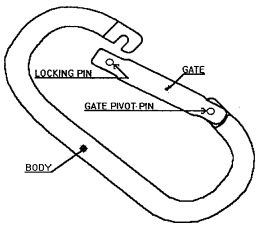
a. Steel Locking. There are two different sizes of steel locking carabiners.

1) Steel locking Stubi 82: Tensile strength of 3,300 lbs..
2) Large Steel "D" locking Stubi 85: Tensile strength of 5,500 lbs..

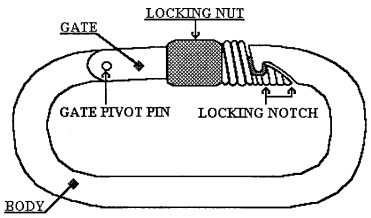
b. Aluminum non-locking carabiners. The Omega standard D carabiner. Tensile strength of 4,400 lbs.

c. Nomenclature.

1) There are four parts to a non-locking carabiner
a) Gate
b) Gate Pivot Pin
c) Locking Pin
d) Body



2) There are five parts to a locking carabiner.



STEEL LOCKING CARABINER

a) Gate
b) Gate Pivot Pin
c) Locking Notch
d) Locking Nut
e) Body

6. **CARE, MAINTENANCE AND SERVICEABILITY OF A CARABINER**.

a. Care.
1) Avoid dropping a carabiner on any hard surface, as hairline fractures can occur.
2) Keep the carabiners off the ground. Dirt and grit can get into the working parts and damage the carabiner.
3) If a carabiner has fallen off a cliff it should be retired and replaced.

b. Maintenance.
1) Remove all dirt, moisture and grime.
2) Lubricate with Tri-flow or similar graphite lubricant, and wipe off with a dry cloth.

c. Serviceability checks.
1) The gate snaps shut with no friction and with no gap between the locking pin and the locking notch.
2) There is no excessive side to side movement of the gate.
3) The pivot pin is tight.
4) The locking nut travels freely and locks securely.
5) There are no cracks, bends or flaws.

NOTE: WHENEVER YOU USE A LOCKING CARABINER ENSURE THAT THE LOCKING NUT IS ALWAYS LOCKED DOWN!

7. **PROTECTION.**

a. Purpose: Protection or "Pro" is used to protect climbers as they ascend a cliff face. This is accomplished by wedging the pieces of protection into cracks and openings in the rock and securing the climbers rope to them. Since they can be installed into the rock without any type of hammering, they are quiet to install and are very suitable for a tactical situation that may

require silence. A disadvantage of protection is that it is directional. This means that when it is installed it is meant to take a strain or pull in a specific direction, usually down. As you are climbing, you can inadvertently pull the rope in an undesired direction, causing you to pull your protection all or part of the way out of the rock. This renders it useless in the event of a fall. How to avoid this will be covered in more detail in protection Placement and Two Party Climbing.

b. Stoppers. These have a wedge-shaped structure and are designed to be used in small cracks. They come in sizes, ranging from widths of 0.16(#1) to 1 inch (#13). The sides of the wedged portion are slightly beveled, enabling the climber to insert the same stopper into a crack two different ways. This allows for greater versatility.

c. Hexcentrics. These chocks have a six-sided structure shaped like a hexagon; the sides being of unequal width. This allows for the same chock to be inserted in different size cracks depending on which way it is inserted. These chocks come in different sizes and are used in larger cracks that stoppers would be too small for use.

d. Spring Loaded Camming Devices (SLCD). 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 can not be placed. Also their ease of placement, once mastered, makes them a favorite of climbers in a tough situation. They also add a degree of safety and comfort to the climber, as they are much more difficult to accidentally kick or otherwise come out of their placement when placed properly.

e. Serviceability Check.

1) Stoppers and hexcentrics.
    a) Check the holes, used for stringing the chocks, for burs that could damage the cord the chocks are strung with.
    b) Check accessory cord for wear, fraying, rupture of the outer sheath and ensure the knot is still secure.
    c) If wired, check wires for frays that could damage the climbing rope or weaken the piece of protection.
    d) If wired, check soldered (or otherwise joined) area for cracks or looseness.
    e) Check the body for splits or cracks.
        (1) SLCD's
            (a) Ensure wires leading from the trigger to the cam are not bent or frayed.
            (b) Check to ensure that the cam movement is free and easy, for both contraction and expansion, by pulling and releasing the trigger.
            (c) Check that any pre-sewn runners are not frayed and that no stitching has popped.
            (d) If it is stiff or corroded by seawater, spray with Tri-flow graphite and clean off thoroughly.

f. Tensile Strengths.

1) The strength of a chock depends on the manufacturer specifications and on the type and size of material used for the sling (rope, webbing, or wire). Below are the strengths of some of the types of chocks that are in a MACK.

TYPE	STRENGTH
#1-#2 Stopper – wired	350 kg (approx. 770 lb.)
#3-#5 Stopper – wired	650 kg (approx. 1,430 lb.)
#6-#12 Stopper – wired	1,100 kg (approx. 2,420 lb.)
#1-#3 Hexcentrics – wired	1,100 kg (approx. 2,420 lb.)

2) If strung with accessory cord, the tensile strength is dependent on the size and manufacturer of the cord used.

CORD SIZE	STRENGTH		
5.5 millimeters (Spectra)	4,500 lb.		
	Blue Water	Climb High	New England
6 millimeters	1,700 lb.	1,986 lb.	1,150 lb.
7 millimeters	2,600 lb.	2,420 lb.	1,360 lb.
8 millimeters	3,100 lb.	2,640 lb.	1,650 lb.
9 millimeters	3,600 lb.	3,586 lb.	N/A

NOTE: Also recently hexcentrics have become available equipped with wires, like stoppers. While more expensive, this wire increases the tensile strength of the hexcentric. Before, hexecentrics were limited to the strength of the cordage used to string it.

3) SLCD's vary in strength depending on the manufacturer, as well as the size.

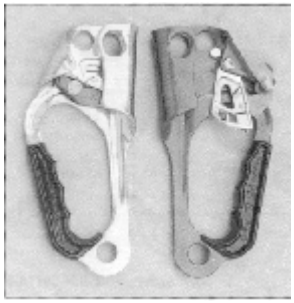
TYPE / SIZE	STRENGTH
Hugh Banner 00	2,645 lb.
0	2,866 lb.
0.5	2,976 lb.
1	3,086 lb.
1.5	3,086 lb.
2	3,080 lb.

g. Care of protection.

1) When placing protection, insure that the cord or wire does not rub against the rock.

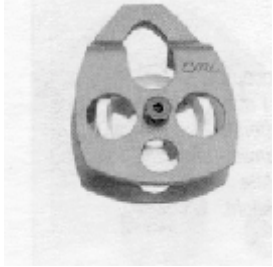
2) Do not drop the protection, which may deform it, or the accessory cord that the protection is strung with, which may lead to deterioration of the cord.

8. **OTHER EQUIPMENT USED IN MOUNTAINEERING.**



a) Caving Ladder. Constructed of stainless steel cables and aluminum crossbars. Several ladders can be connected together, by the use of two large steel rings on each end of the ladder. (If rings are not present, clip carabiners into crossbars.)

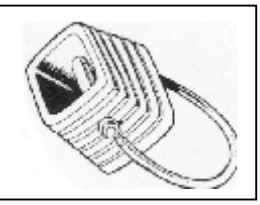
b) Ascenders. Easily placed and removed from a rope with one hand and allows the rope to run through it in one direction while it grips the rope and does not slide in the other direction. A safety device is incorporated to ensure that the cam only releases the rope when the trigger is pressed and out of position.



c) Rescue Pulleys. Has two independent side plates that enable a user to insert the rope onto the wheel without having to thread the rope through. The pulley is large enough to accommodate a ½ inch rope and has an eye large enough to accommodate two locking carabiners.

d) Figure Eight Descenders. Made of heat-dissipating aluminum alloy so the device stays cool after a rope has run through it. Care must be taken not to drop or bang these devices onto a hard surface or damage may occur. The figure eight's can be used as a belay and rappel device.

e) Belay Devices. These have several different names depending on manufacture. They may be stitch plates, belay slave, pyramid, or air traffic controller (ATC).



Left: Pyramid or ATC
Right: Stitch Plate

ROPE MANAGEMENT. The rope must treated properly and with care as the rope will save the life of you, your partner and your Marines.

1. **TERMS USED IN ROPE WORK.**

a. Bight. A simple bend in the rope in which the rope does not cross over itself

b. Loop. A simple bend in the rope in which the rope does cross itself

c. Half Hitch. A loop which runs around an object in such a manner as to bind on itself.

d. Running End. The free end of the rope which can be used.

e. Standing End. The part of the rope that is anchored and cannot be used, also called the static end.

f. Lay. The same as the twist of the rope. (Applies only to hawser laid ropes, such as manila.)

g. Pigtail. The short length left at the end of a rope after tying a knot or coiling a rope. It may or my not be tied off with a secondary knot, depending on the circumstances.

h. Stacking (or Flaking). Taking off one wrap at a time from a coil, and letting it fall naturally to the ground.

i. Dressing the knot. This involves the orientation of all of the knot parts so that they are properly aligned, straightened, or bundled and so the parts of the knot look like the accompanying pictures. Neglecting this can result in an additional 50% reduction in knot strength.

j. Setting the Knot. This involves tightening all parts of the knot so that all of the rope parts bind upon other parts of the knot so as to render it operational. A loosely tied knot can easily deform under strain and change character.

2. **CONSIDERATIONS FOR THE CARE OF ROPE.**

a. The rope should not be stepped on or dragged on the ground unnecessarily. Small particles of dirt will be ground between the strands and wear the rope internally.

b. The rope should never come in contact with sharp edges of any type. Nylon rope is easily cut, particularly when under tension. If a rope must be used around an edge which could cut it, then that edge must be padded or buffed using fire hose if available, or several small sticks.

c. Keep the rope as dry as possible. If it should become wet, hang it in large loops, above the ground, and allow it to dry. A rope should never be dried out by an open flame or be hung to dry on metal pegs, as this will cause rust to get in the rope thus rendering it unserviceable.

d. Never leave a rope knotted or tightly stretched longer than necessary.

e. When using rope installations, never allow one rope to rub continually against another. **NOTE:** With manila ropes this will cause the rope to fray, whereas nylon ropes can melt under the friction that this causes.

f. The rope should be inspected prior to each use for frayed or cut spots, mildew, rot or defects in construction.

g. Mark all climbing ropes at their midpoints to facilitate establishing the midpoint for any procedure requiring you to use the middle of the rope. The rope should be marked with a bright colored adhesive tape.

h. The rope should not be marked with paints or allowed to come in contact with oils or petroleum products for these products will weaken it.

i. A climbing rope should ***NEVER*** be used for any other purpose except for mountaineering (i.e., towing vehicles).

j. The ends of a new rope or ends caused by a cut should be cut with the rope cutter contained in the MACK and marked with a serial number.

k. The rope should never be subjected to high heat or flame as this can significantly weaken it.

l. Nylon ropes can be washed by using a mild soap and water solution, after which they should be rinsed thoroughly.

m. When not in use, ropes should be coiled and hung on wooden pegs rather than on nails or any other metal object. They should be stored in a cool place out of the direct rays of the sun.

n. When in areas of loose rock, the rope must be inspected frequently for cuts and abrasions.

o. Always maintain an accurate Rope Log whenever using a rope.

3. **ROPE LOG.** The purpose of the Rope Log is to maintain an accurate record for the use of each rope contained within the Marine Assault Climbers Kit (MACK). Due to the turnover of personnel, and the fact that no one person may have the same rope twice, the rope log is used to ensure the safe use, serviceability, and account of each rope.

a. 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 marked or assigned a serial number by the responsible unit. The rope can first be marked on the ends with color coded tape that corresponds to an entry in the rope log. Or the rope should be labeled with the serial number in some permanent manner. The best method for this is as soon as the ends of the new rope have been whipped and fused, mark both ends of the rope with the serial number and then dip the ends of the rope, in effect, laminating the serial number to the rope ends.

1) A rope serial number has five parts. The proper format for a rope serial number is as follows:

a) Type of rope; (S) - Static or (D) - Dynamic.

b) Last two digits of the year the rope was manufactured. Each rope has a shelf life of two years, after that it must not be used for any mountaineering purpose.

c) A four digit number for that individual rope which is assigned by the responsible unit. This should be assigned sequentially as new ropes are issued out.

d) The length and diameter of the rope. The length may be recorded in feet, and the diameter in millimeters.

e) Responsible unit code. Example: S-96-0001-150/11mm -F2/8

This rope is a 150 foot, 11mm, static rope, manufactured in 1996. It is the first rope issued by Fox Co 2/8.

b. Recording Information in a Rope Log. Once a new rope has been serialized, the rope log for that rope should be started up. At a minimum, it should contain the following information:

1) The rope serial number.

2) Manufacturer. Depending on the manufacturer, ropes of the same type and diameter may vary in tensile strength, stretch factor, and durability.

3) Date of manufacture. Two years from this date, ropes are considered to have reached their normal expiration date, and should be destroyed.

4) Date unit received the rope. This should be recorded for tracking purposes to aid in establishing how much of a rope's shelf life is actually being used.

5) Each time a rope is used, the using unit is responsible to record how that rope was used and how much use the rope got. Additionally, before checking out a rope and prior to turning it back in, rope must be inspected by qualified personnel, and initial in the "Inspected By" block of the rope log.

NOTE. ANY TIME A DYNAMIC ROPE IS SUBJECTED TO A FALL FACTOR 2, THAT ROPE SHOULD NOT BE USED AGAIN FOR MOUNTAINEERING

DYNAMIC					
SERIAL #					
MANUFACTURE					
DATE OF MANUFACTURE					
DATE RECEIVED					
INDICATE THE DATE AND NUMBER OF EACH SPECIFIC USE					
CLIMBS	**FALLS/ FACTOR**	**TOP ROPES**	**RAPPELS**	**REMARKS**	**INSPECTED BY**

ROPE LOG

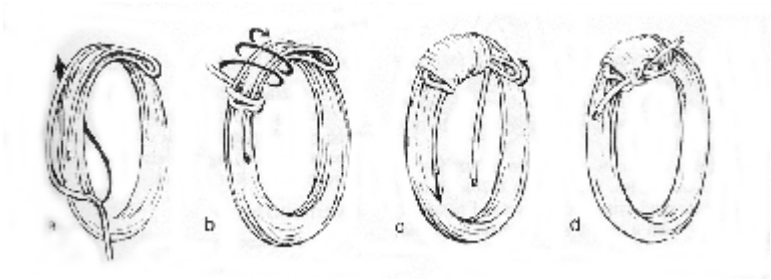
4. **<u>COILING A ROPE</u>.** There are two types of rope coils used. The Mountain Coil and the Butterfly Coil.

a. <u>Mountain Coil.</u> This coil is useful for carrying the rope over a pack or a climber's shoulder and neck. It can be used for a short time for storage also. The mountain coil can be tied in the following manner:

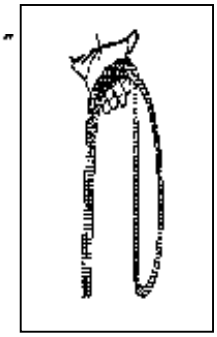
1) <u>The Leg Method.</u> This is done with the assistance of another Marine.

a) One Marine sits down with his leg bent at a 90° angle, heel on the deck. Starting at one end, the rope is looped around the leg in a clockwise fashion, going over the knee and under the boot sole until all but 2-3 feet is coiled. In finishing off the Mountain Coil, a bight approximately 12 inches long is formed with the starting end of the rope and laid along the top of the coil. Using the left over 2-3 feet begin making wraps around the coil and the bight, wrapping towards the closed end of the bight and making the first wrap bind upon itself so as to lock it in place. Four to six wraps should be made to secure the coil. The end of the rope is then pushed down through the closed end of the bight. The running end of the bight is then pulled tight to secure the coil. The two pigtails should now be joined with a square knot to prevent the wraps from uncoiling.

b) When coiling a 150 foot rope use only one leg to wrap the rope around. When coiling a 300 foot rope two legs should always be used to coil the rope and should be coiled in a mountain coil only.

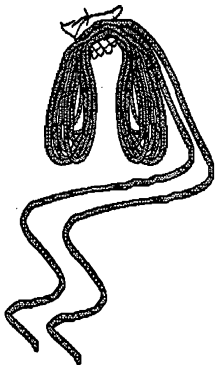


b. <u>The Butterfly Coil.</u> This method is used for carrying a rope when the individual needs to have maximum use of his upper body, (i.e. while climbing), without the encumbrance of a large rope coil hanging across his chest.

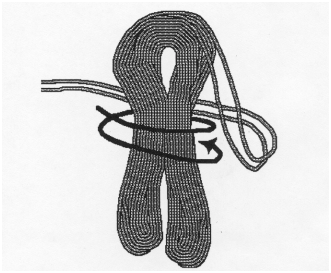


1) Coiling the Butterfly Coil

a) <u>Step 1:</u> Find the middle of the rope, then form a three foot bight laying both ropes in the upraised palm at the two foot point.

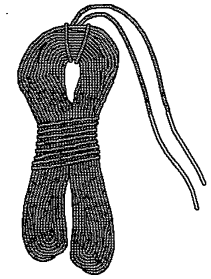


b) Step 2: Form another two foot bight with the running end. Place the rope at the two foot bight along side on top of the original bight ensuring the running end is on the same side as the original bight.



c) Step 3: Continue making two foot bights, laying them alternately into your palm until there is only six to eight feet remaining. At that point, begin wrapping the two pigtails horizontally four to six times at the midway point of the bighted ropes from bottom to top.

d) Step 4: After completing your wraps, form a bight with the remaining pigtail and then thread it underneath your palm and upward to one foot above the coiled rope.



e) Step 5: With the remaining pigtail, thread it through the one foot bight formed in step four.

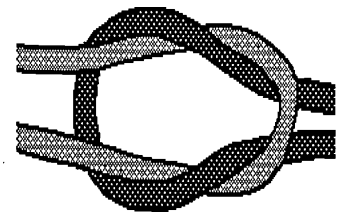
2) Carrying the Butterfly Coil. Separate the running ends, placing the coil in the center of the back carrier, then run the two ends over his shoulders so as to form shoulder straps. The running ends are then brought under the

arms, crossed in the back over the coil, brought around the body of the carrier and tied off with a square knot at his stomach.

5. **ROPE THROWING.** To insure that the rope will not get tangled when thrown, it will be necessary to carefully recoil the rope. This is done by stacking the rope, which is done by taking off one wrap at a time and letting it fall naturally to the ground. When the rope is flaked out, anchor off one end of the rope, then pick up the opposite end of the rope and make 6-8 coils in your left hand, and set them on the ground next to you. Pick up the remainder of the rope and begin making a second set of coils. You should now have two separate stacks of coils. Pick up the stack with the 6-8 coils and place it in your weak hand, the other stack of coils will go in your strong hand. There are two methods in which to throw the rope; underhand and overhand. The overhand method should be used when trees or shrubs or high winds are on or near the rappel point. Once the method of throwing has been determined, make a few preliminary swings with the strong arm (this arm holds the second set of coils) and shout "STANDBY FOR ROPE". Just before the rope leaves the hand shout the warning, "ROPE", which will alert anyone on the bottom, thus enabling them to move out of the way. As the coils are going down the cliff face you will feel a tug, at that time you will throw down the coils in your weak hand. Throwing the rope in this manner is the best way to ensure your rope will reach the bottom without snagging.

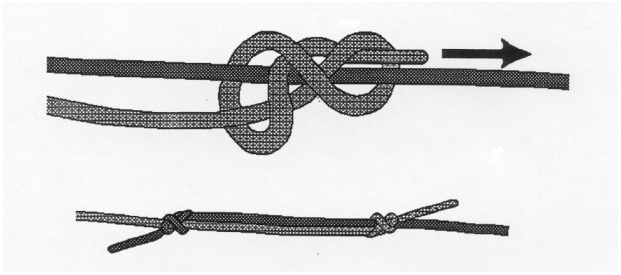
6. **MOUNTAINEERING KNOTS:** The following are knots and times applicable to Assault Climbers and Mountain Leader courses. All knots must be set and dressed properly while blindfolded within the time limit.

KNOT	TIME LIMIT
Square Knot	30 Seconds
Double Fisherman's	30 Seconds
Water/Tape Knot	30 Seconds
Round Turn and a Bowline	30 Seconds
Round Turn and Two Half Hitches	30 Seconds
Clove Hitch (around an object)	30 Seconds
Munter Hitch	30 Seconds
Slip Figure Eight	30 Seconds
Figure Eight Loop	30 Seconds
Directional Figure Eight	30 Seconds
Retraced Figure Eight	45 Seconds
End of Line Prussic	45 Seconds
Kragur Knot	45 Seconds
Rappel (Swiss) Seat	60 Seconds

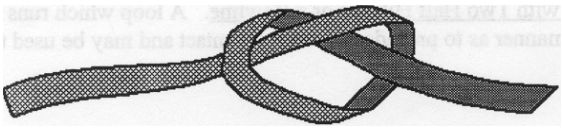


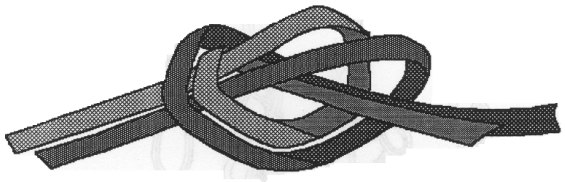
1) Square Knot. Used to tie the ends of two ropes of equal diameter together. It should be secured by overhand knots on both sides of the square knot. If the square knot and two over hands are going to be put under tension, run one end of the pigtail through the center of the square knot. Once the tension is released, pull the pigtail out. This procedure will aid you in untying the square knot. Since the knot was tightened down on the pigtail vice the knot itself.

2) Double Fisherman's Knot. This knot is used to tie rope runners to chocks. It is used to join two ends of equal thickness and is a strong joining knot. It is also difficult to untie and somewhat bulky.



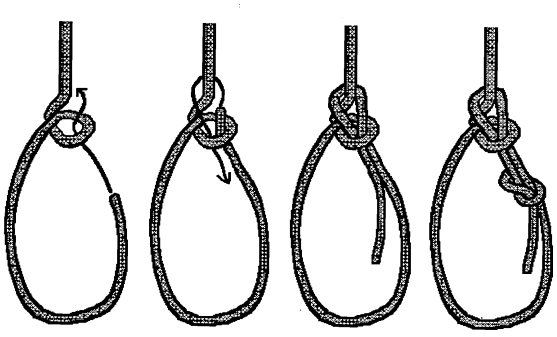
2) Water/Tape Knot. Used to secure webbing or tape runners. It is constructed by tying an overhand knot (without twists) in one end of the tape, and threading the other end of the tape through the knot from the opposite direction. After the knot is dressed down, each pigtail should be a minimum of one inch long.



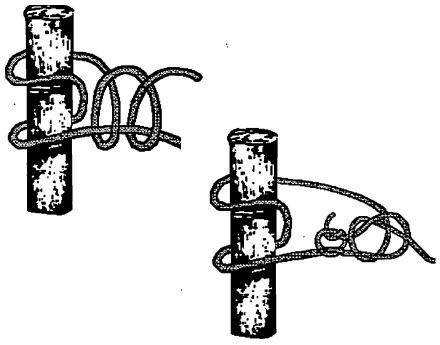


b. **Class II** -Anchor Knots. Used to tie the rope to an object and secure it. This will allow the rope to then be used for any of the several mountaineering skills.

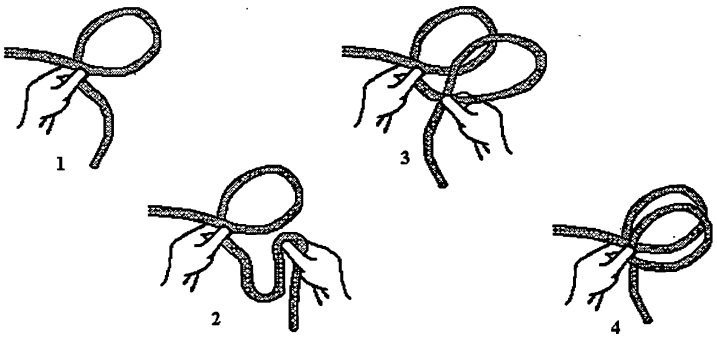
1) Bowline. Used to tie a fixed loop in the end of a rope. The bowline is always finished off with an overhand knot unless it is being used as a secondary knot. If the bowline is a secondary knot, it may be finished off with an overhand.



2) Round Turn with Two Half Hitches or a Bowline. A loop which runs around an object in such a manner as to provide 360° contact and may be used to distribute the load over a small diameter anchor. It will be secured with two half hitches or a bowline.



3) Clove Hitch. Constant tension must be maintained on this knot to prevent slipping. When a clove



hitch is tied, no loose ends are left. In other words, the clove hitch could be considered a middle-of-the-rope anchor knot but has application as an anchor knot at the end of the rope when used in conjunction with a bowline or round turn with two half hitches.

Class III - *Middle-of-the-rope.* Tied without using the ends. Used to form a fixed loop in the middle of the rope.

1) Figure of-Eight Loop. This knot forms a single bight and is used as an anchor in the middle or end of the rope. This knot also has a variety of different uses and situations ranging from fixed rope installations, securing a climber to his rope, secure a belay man in, used in the safety lines for a one and three rope bridge, fixed ropes, belayed method for stream crossings,

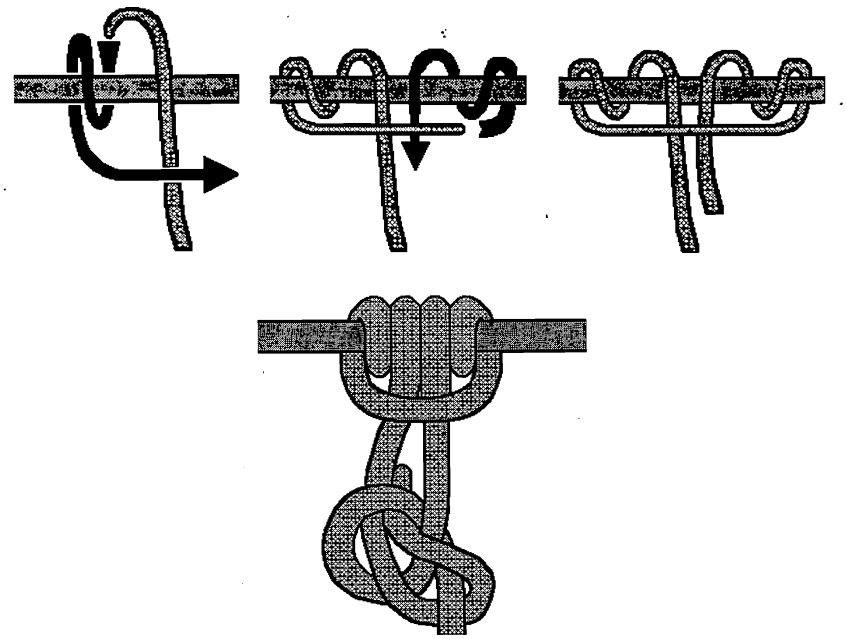
2) The double Figure of Eight Loop is a strong knot and the double loop reduces the wear and strength loss from the rope bending around the carabiner by splitting the load between the two loops.

NOTE: When tying a Double Figure of Eight or a Retraced Figure of Eight it is possible to tie it incorrectly, resulting in an additional 10 percent strength loss. If the standing line (or load bearing line) takes the short radii of the first bend, the knot is tied incorrectly.

d. Class IV - *Special Knots*

1) Prussic Knot. Tied with a smaller diameter rope around a larger diameter rope. If a rope of equal diameter is tied with a prussic to another rope of equal diameter, the prussic will slip and not hold what it is intended for. So, for the prussic knot to work, ensure that the rope you are using to tie the prussic with is a smaller diameter rope than the rope you are tying to. The prussic may be tied either with a bight or with the end of a rope, but when tied with the end of the rope it must be finished off with a bowline. Also, if the standard prussic is slipping due to icing, etc., extra wraps may be used to form a more secure prussic.

a) End-of-the-rope Prussic. This knot is used for tightening systems, climbing ropes, offsetting anchor points, etc. Dress the knot well before using.

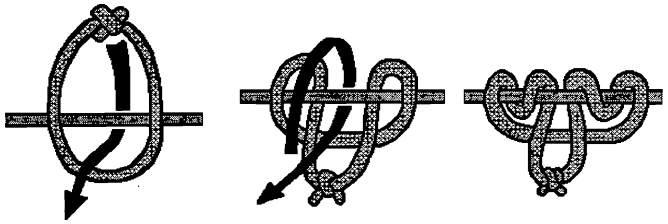


b) Middle of the Rope Prussic

1) Start with a regular, end-of-the-rope prussic.

2) Make a loop with the running end, and use the pigtail to tie a bowline through the loop.

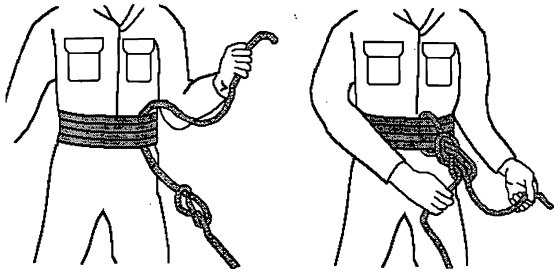
3) Make sure that the distance between the bowline and the prussic is equal for both the pigtail and the running end. This ensures equal tension on both ends of the prussic when tension is applied to the knot. The knot may be pulled on, via the running end, from either direction.



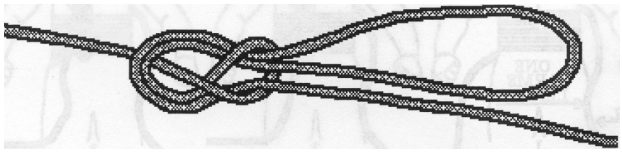
2) Kragur Knot. This knot is used to tie a prussic onto a rope of the same diameter. To tie the kragur knot, follow steps one, two and three of the prussic knot as stated earlier, but before you dress the knot down in step three, run one end of the pigtail through the wraps along the rope the kragur is tied onto. Dress the knot

down and tie an overhand knot onto the pigtail itself. What you have done is increase the diameter of the rope the kragur is tied on, thus increasing the reliability of the knot. Also ensure that the pigtail with the overhand points in the opposite direction of pull of the kragur.

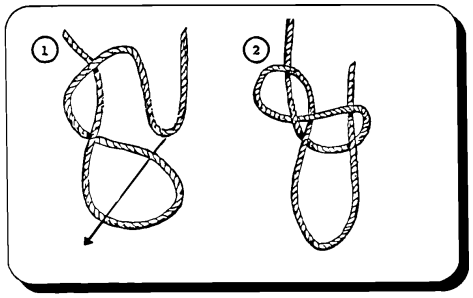
4) Retraced Figure of Eight. Used to tie the end of the climbing rope into a harness or swami wrap. The pigtail may or may not be secured with an overhand.



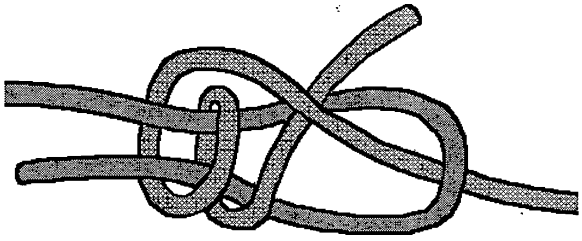
5) Directional Figure-Of-Eight. May be tied at the end of the rope or in the middle of the rope. Primarily used with casualty evacuations and the endless rope of a vertical hauling line. When tied and tension is applied to both ends (running and standing) the knot will not pull apart as the double figure-of-eight would; subsequently Preventing stress on only a part of the knot vice the whole knot. Notice the tail and the bight must be together.



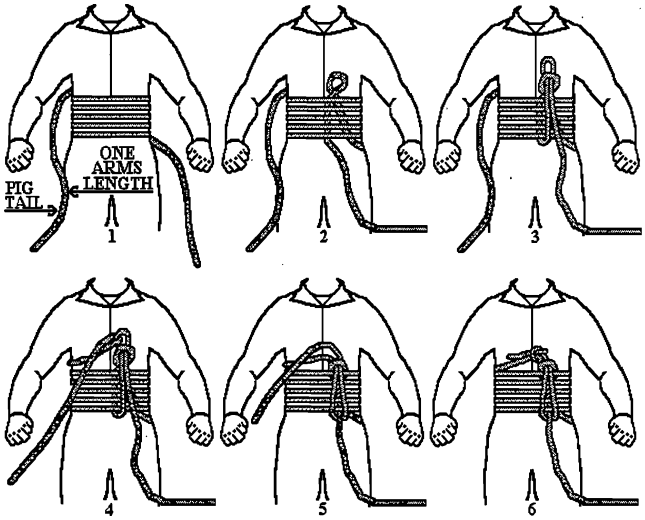
6) Slip Figure 8. This knot is used for retrievable anchors and fixed rope installations for the ease of untying the knot.



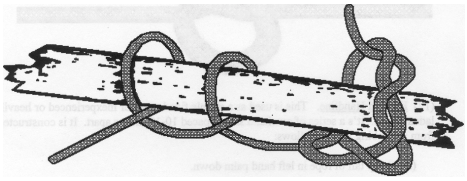
7) Double Sheet Bend. Used to tie the ends of two ropes of equal or unequal diameter together. It can also be used to tie the ends of several ropes to the end of one rope. When a single rope is tied to more than one rope, the bight is formed with the multiple ropes.



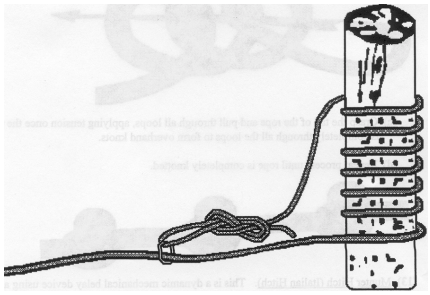
8) Bowline on a Coil. Used by the first and last men on a climbing rope to tie into the rope. An over hand knot is used behind the knot. It distributes the force of a fall over a larger area of a climber's waist and is preferable to a single bowline around the waist. The bowline on a coil can also be used to take up excessive rope. The bowline on a coil should have 4-6 wraps around the waist.



9) Timber Hitch. A timber hitch is used to fix a rope to a pole or equivalent for hoisting or towing purposes. It casts off easily.

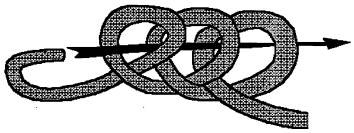


10) Tree Wrap. The tree wrap is an anchor knot used to relieve tension on the actual knot. Tie a double figure-of-eight in the end of the rope and wrap it around the anchor. The number of wraps will depend on the surface of the object, in trees 18" or more ensure to use 2 to 3 wraps, for trees 18" or less ensure to use 4 to 6 wraps. Hook the double figure-of-eight back to the main line with a carabiner.



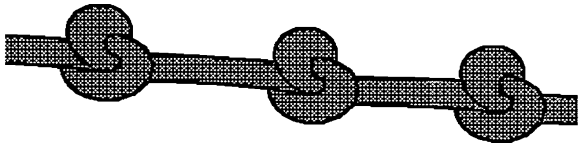
11) Overhand Knot. Used to make a knotted rope for a handline, a carrying rope for a suspension traverse, and in making the stirrups in direct aid climbing. This knot can also be used to temporarily whip the end of a rope and to secure other knots.

12) Knotted Handline. This is used as a simple fixed rope for inexperienced or heavily laden troops. It's a series of overhand knots spaced 10-12 inches apart. It is constructed from a climbing rope as follows:



a) Grasp tail of rope in left hand palm down.
b) Make 5 inch diameter inboard loops outward in series of 5-8 loops. This will make approximately 10-12 inches between each knot.

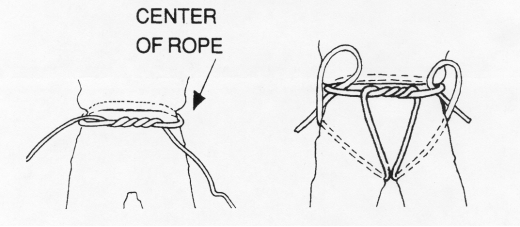
c) Grasp the tail of the rope and pull through all loops, applying tension once the tail is completely through all the loops to form overhand knots.



d) Repeat this process until the rope is completely knotted.

13) Munter Hitch (Italian Hitch). This is a dynamic mechanical belay device using a carabiner and rope. With the standing end of the rope, form an outboard loop and then bend the rope under the loop to form a bight. Pass both sides of the bight the carabiner gate. This method, when used with kernmantle rope, provides a simple and secure belay. It does not work well with hawser laid ropes because of the kinks created when moving the hitch through the carabiner.

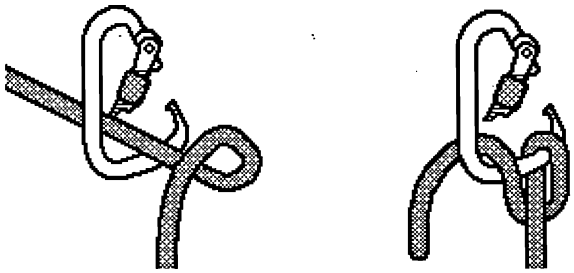
14) Rappel Seat. This is used as an expedient support harness for rappelling, crossing rope bridges, etc. It is constructed as follows:



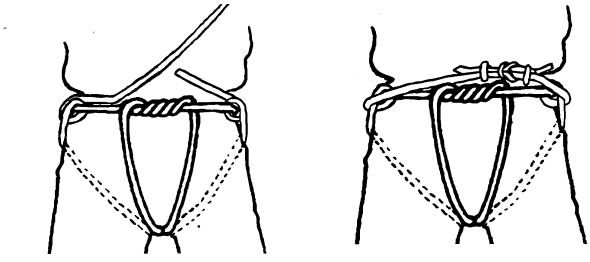
a) Center the sag rope on the left hip.

b) Wrap the sling rope around the waist and tie at least one overhand knot (preferably two) in front.

c) Bring the running ends down through the legs, up over the buttocks, and over the original waist wrap, down between the waist wrap and the waist, and over itself, forming a bight. Cinch this up tightly.



d) Now tie a square knot with two overhand knots on the left hip.



e) Tuck any excess rope into a pocket.

15) Ranger Seat. This seat has the same uses as the Swiss Seat.

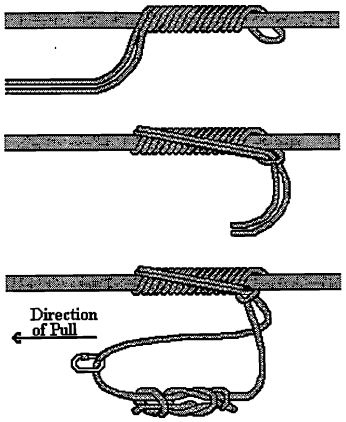
a. Taking a bite from the midpoint of the sling rope, bring the bite through the legs.

b. Bring the pigtails around the waist on the left and right. Take the pigtails through the bight that is between the legs pulling up slack until tight. Then tie a square knot and two over hands on the left hip.

16) Diaper Seat. This seat has the same uses as the other rappel seats. The diaper seat must be pre-tied to fit tightly.

a. Tie an overhand with the two pigtails. Pull one bight around each hip and one bight through the legs so that the three bites meet in the center in the front.

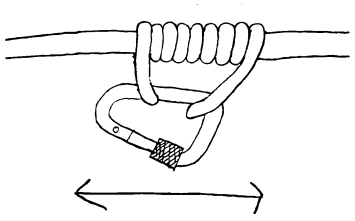
b. Clip a locking carabiner into all three loops. A hot and cold carabiner must be used. The cold carabiner is the carabiner in the three bites, the hot carabiner is attached to the cold carabiner. This prevents rope on rope friction.



17) Kliemheist. This is a friction knot that can be used effectively in all high tension rope installations. It can easily be loosened and readjusted as necessary within a system.

18) Swami wrap (Swami belt). The swami wrap (four to six wraps of rope or nylon webbing tied around the waist) popular with rock climbers who wanted to increase the working length of their climbing ropes. It also offers some improvement over the bowline on the coil in distributing the forces sustained in a fall over a larger area of the midsection of the body, but does not eliminate the problem of suffocation when hanging. Swami wrap is constructed as follows:

a) Take a sling rope and find the middle.
b) Place the middle of the sling rope in the small of your back.
c) Bring both pigtails to the front and continue to wrap around your body until both pigtails are about 15-20 inches long.
d) Tie the pigtails together with a square knot and two overhangs



19) French Prussic. This knot, using a prussic loop or single length of cord, is a multi- directional knot that locks off when put under tension but can be adjusted easily when loose.

a) Take a small prussic loop and clip through a secured carabiner (if using a single length tie figure eights into the ends of the length and proceed as if it was a loop). The loop is then wrapped around the climbing rope, keeping the knot out of the workings. After 5 or 6 turns, the end is then taken back towards the carabiner and clipped through the gate.

b) Any load on the rope will cause friction between the rope and the prussic loop. The loop, because it is secured at both ends, will tighten around the climbing rope, ceasing any movement of the rope.

c) To loosen the knot, tug it in the opposite direction.

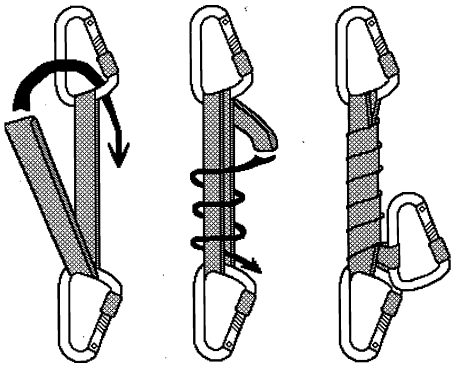
NOTE: This system works with small prussic loops, but if a tape is used, the tape will ride over the carabiner and reverse itself on the other side making it difficult to loosen.

20) Mariners Hitch. The main advantage of the Mariners hitch over a prussic is that the Mariners Hitch can be untied from the carabiner end, even though there is a load in the climbing rope.

a) Attach the large prussic loop to the climbing rope using a prussic knot. Then take the loop and pass it through a secure carabiner, making a round turn around the carabiner.

b) The remainder of the prussic loop is then wrapped around itself, working towards the prussic knot.

e) When there is about 5"-6" left, take a bight in the loop and pass it through the two main strands of the prussic loop. The end left is brought up towards the bight and a carabiner is passed through both the end and the bight. This secures the hitch with no possibility of it slipping.



CONCLUSION: This chapter has covered all the essential equipment to conduct mountainous operations. Your ability to properly use and maintain your unit's equipment that is in the MACK will determine your success. Mastery of the knots will make you more efficient in your construction of all systems that may be needed.

CHAPTER 3
NATURAL AND ARTIFICIAL ANCHORS

NATURAL ANCHORS. Natural anchors are any natural feature that can be used for an anchor, e.g. trees, rocks, etc. A natural anchor is the preferred type of anchor. Some examples of natural anchors are:

1. Types of Natural Anchors.
    a. Trees- Select a tree that is live and has not been chopped, burned, or is rotten. The tree should be at least 6" in diameter and strong enough to support the intended load. Any tree that is growing on rocky terrain should be treated with caution and tested since the roots are normally shallow and spread out along a relatively flat surface.
    b. Shrubs and Bushes- Select a shrub or bush that is live and is not brittle, charred or loose. To avoid leveraging the shrub loose, locate the central root and construct the anchor as near to the base as possible.
    c. Boulders- Stability and soundness is of prime importance in considering a boulder for an anchor. It must be large enough and secure enough to handle the intended load. All surfaces of the boulder should be inspected for any rough or sharp edges that may abrade or cut the rope. Any sharp edges that can not be avoided should be padded to protect the rope.
    d. Spikes, Horns or Flakes- To check their stability, thump or knock on it with your hand. Anything that sounds hollow should be treated with caution. Check them for cracks or other signs of weathering that may impair their soundness. Sharp edges will almost always be present on these features, so they must be padded to protect the rope.
2. Tying Natural Anchors.
    a. Tree Wrap- The tree wrap is an anchor used to keep tension off the actual knot. It can be tied on any suitable anchor point.
        1) Tie a figure of eight loop on the standing end of the rope and wrap the rope 4 to 6 times around an anchor point.
        2) Attach an 85 carabiner through the figure eight loop and clip it into the running end of the rope.

NOTE: If the anchor point to be wrapped is greater than 18" around. Then two to three wraps will suffice.

b. Swami Wrap. The swami wrap anchor can be constructed on either trees or large boulders using either a sling rope or a practice coil. It is tied in the following manner:

1) Select a suitable anchor point and wrap your sling rope or practice coil around it 4 to 6 times (If your rope is not long enough, join two or more together using a square knot and two over hands.). Again if the anchor is larger than 18" in diameter two wraps will suffice.
2) Once your wraps have been completed the two ends are tied off with a square knot and two over hands. A locking carabiner is then clipped into the swami wrap, incorporating as many ropes as possible and the carabiner is then used as the attachment point.

c. Figure Eight Anchor- The figure eight anchor is a quick and efficient system used in securing both high and low-tension systems.

1) Tie a figure of eight loop on the standing end of the rope and wrap the knot around a suitable anchor point. Attach a locking carabiner through the loop of the figure eight loop and clip it onto the running end of the rope.
2) Before tensioning the anchor system, adjust the wrap so that the running end of the rope runs smoothly through the carabiner towards the direction of pull. This will prevent any lateral tension.
3) If two ropes are used, the upper rope's carabiner has its gate facing upward, and the lower carabiner has it's gate facing downward.

d. Primary and Secondary Natural Anchor System. The two anchor points should be in line with the direction of pull. The anchor is the point toward the running end while the secondary anchor is behind the primary. It is tied in the following manner:

1) The primary anchor knot should be an Around-the-Object clove hitch. This is utilized for ease of untying the system after tension has been placed on the rope.
2) The secondary anchor knot is tied around a suitable point ensuring that the rope is taunt between the two anchor points.

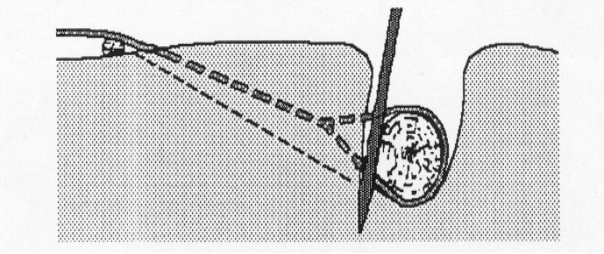
ARTIFICIAL ANCHORS. Anytime we use anything other than a natural feature, we are using an artificial anchor. Artificial anchors can be constructed in the ground, or on the rock itself.

1. Single Timber Dead Man- This anchor is constructed in the ground and its construction requires considerable effort and time. The construction is as follows:

   a. Dig a trench 6 feet long and 3 feet deep and wide enough to work in at a 90 degree angle to the direction of pull.

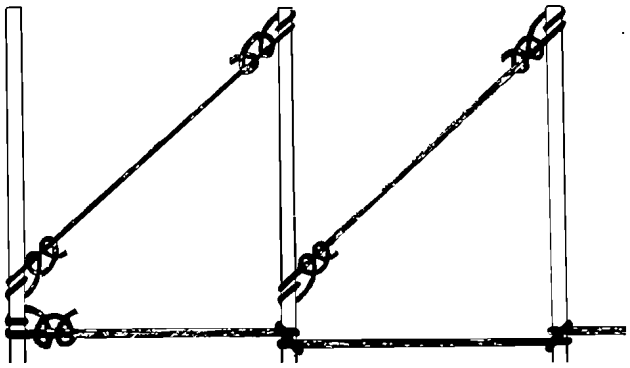
   b. Dig another trench about 12 inches wide. This trench is dug so that it intersects the main trench at a right angle in the middle. The bottom of this trench should be parallel to the direction of pull and should join the bottom of the main trench,

   c. Take an anchoring device (i.e. log, engineer stakes, bundled up branches, etc.) that is strong enough to support the intended load. The anchor is placed into the main trench and covered with dirt with the exception of that part of the anchor that joins the second trench. Stakes approximately 3 feet long should be driven approximately 1-1/2 feet into the ground between the dead man and the slanted side of the trench to assist in holding the dead-man in place, if the soil is soft.



DEADMAN

2. Picket Hold Fast. The picket hold fast is an easier anchor to construct than the dead man, and can be used almost anywhere. The strength of the picket system depends on the pickets and the soil or snow conditions. The picket system can be used for both high and non-tension systems. Construction is as follows:



a.

a. Three stakes (i.e. logs, engineer stakes, etc.) are driven into the ground at a 30° angle against the direction of pull.

b. The line of pickets should be driven in line with the direction of pull. The distance between the pickets can be anywhere from 3-12 feet apart depending on the terrain and soil conditions.

c. Before tying any rope to the picket anchors, the base of the pickets must be buffed or padded.

d. To tie a rope to the pickets, go to the furthest picket away from the cliff edge. Tie a round turn and two half hitches at the base of the picket. Take the running end of the rope and tie an over the object clove hitch to the base of the middle picket. Then with the running end of the rope tie an over the object clove hitch to the picket closest to the edge of the cliff face. Ensure that there is tension on the rope in between each picket.

e. To tie off the pickets to themselves, go to the furthest picket from the cliff edge. Tie a round turn and two half hitches at the base of the picket. With the running end of that sling rope tie a round turn and two half hitches at the top of the middle picket. Using a second sling rope tie a round turn and two half hitches to the base of the middle picket. Then with the running end of that sling rope tie a round turn and two half hitches to the top of the picket closest to the cliff edge.

3. Chock Anchor System. This is an artificial anchor that is built with a minimum of three chocks. This system can be tied on the standing end of the rope or by utilizing a practice coil.

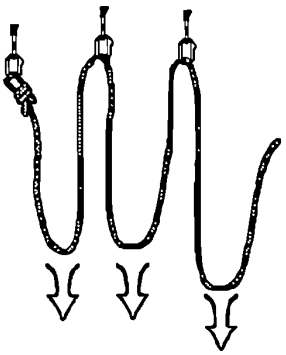
   a. Standing End of the Rope:

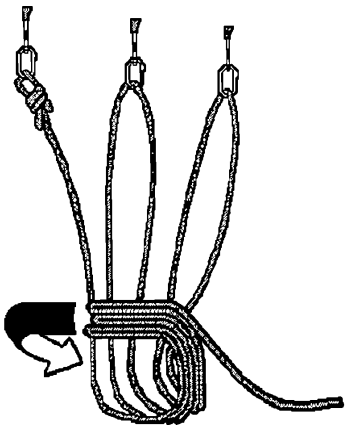
   1) Place a carabiner in each piece of protection and attach an end of the rope figure eight loop in either of the outside carabiners. Clip the remainder of the rope into the other carabiners.

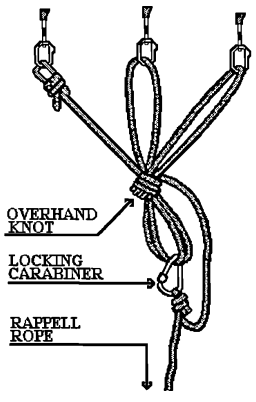
   2) A bight of rope is then pulled down after each carabiner into the anticipated direction of pull.

   3) With all three bights tie an overhand knot around itself.

   4) With the running end of the rope coming from the overhand knot, tie a figure of eight loop and attach it to the overhand knot's loops with a locking carabiner. Ensure that there is slack in the dead rope.







b. Practice Coil:

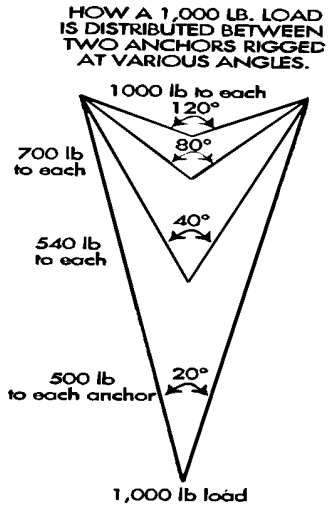
1) Construct an endless loop with a practice coil and clip it into each of the carabiners.
2) A bight of rope is then pulled down between each carabiner into the intended direction of pull.
3) With all three bights, tie an overhand knot on itself.
4) Place a locking carabiner into the loop. This will serve as the attachment point for the anchor system.

NOTE: If constructing a two-rope high-tension installation. A minimum of three chocks per rope will be used.

4. Equalizing Figure Eight Loop. This method can be faster and easier on some anchors.

a. Tying the equalized figure eight loop.

1) Tie a large figure eight loop and clip a locking carabiner into the top of the knot.
2) Wrap the large loop twice through the locking carabiner to create three equalizing loops, one for each of the anchors you wish to equalize. (Simply clip the large loop once to create a two loop equalizing knot.)
3) To prevent shock loading the anchor, you can tie off using two different methods.
   a) Tie an overhand knot in the loop going to the middle anchor point, which will prevent shock loading if one anchor point fails.
   b) For double security, clove hitch the two wraps through the locking carabiner.



5. General Considerations. Anytime you employ natural or artificial anchors; there are special considerations that you must apply. These considerations apply both to the anchor itself and the materials being used to build the anchor. Some of these considerations are:

a. Whether using natural or artificial anchors, the installing unit must ensure that the anchor is suitable for the load.

b. The anchor position must be relative to the direction of pull on the anchor.

c. The angles between the anchor points should not exceed 90 degrees. This is to ensure that no added stress is put on the anchors, as well as the equipment being used to construct the anchor.

d. To decrease the angle between anchor points, materials (i.e. sling ropes, web runners, prussic cord, etc.) could be used to extend the anchor which will decrease the angle between anchor points.

CONCLUSION: Anchor points are a cornerstone to everything you will do as a Mountain Leader/ Assault Climber. Not only are you protecting you and your partner from a fall, but you will also be building systems that entire companies of Marines will be using. To say you need strong and properly tied anchors is an understatement.

CHAPTER 4
RAPPELLING

RAPPELLING- This is a method for descending vertical or near vertical cliffs. Rappelling will enable your unit to move quickly over rugged terrain to swiftly accomplish the mission. Learning how to establish and operate a rappel site is critical to successful operations in the mountains. The following are essential skills that all of your Marines should possess.

1. **SITE SELECTION**. When selecting a rappel site consider these three factors.
    a. There must be a good anchor. As previously taught in NATURAL and ARTIFICIAL ANCHORS, natural anchors are preferred.
    b. The rappel route down should be as free of obstacles (i.e., vegetation, debris) as possible.
    c. There must be suitable loading and unloading platforms.
2. **RAPPEL SITE**.
    a. Two ropes will always be used for safety. However, this is a safety measure, and all the rappels we will cover can be done with a single rope if the tactical situation dictates. The same procedures apply for single ropes that are going to be taught for two ropes, except for the procedures for hooking the rope up to the carabiner. This procedure is different for a single rope and will be discussed when we discuss how to hook up when using two ropes.
    b. Whether a natural or artificial anchor is used, the ropes will be tied off as taught in NATURAL and ARTIFICIAL ANCHORS.

3. **DUTIES OF A RAPPEL POINT NCO**. Once a rappelling site has been selected, one Marine will be placed in charge of the rappel point. He is the rappel point NCOIC and, as stated before, should be the most experienced rappeller in the unit. He has nine duties that he is responsible for as follows:
    a. Ensures that the anchors are sound and the anchor knots are tied properly.
    b. Ensures that the loading platform is clear of all loose rock and debris.
    c. Allows only one Marine on the loading platform at a time and ensures that the rappel point is run in an orderly manner.
    d. Ensures that each Marine is properly prepared for the particular rappel; gloves on, sleeves down, helmet with chin straps fastened, gear prepared properly, rappel seat and knots correct (if required). Also, that the rappeller is hooked up to the rope according to that particular rappel and is aware of the properly braking position.
    e. Ensures that the proper sets of signals or commands are used.
    f. Dispatches each man down the rope.
    g. The rappel point NCOIC will be the last man down the rope.
    h. The rappel point NCOIC will ensure that the ropes are inspected after every 50 rappels.
    i. The rappel point NCOIC will maintain a rope log.

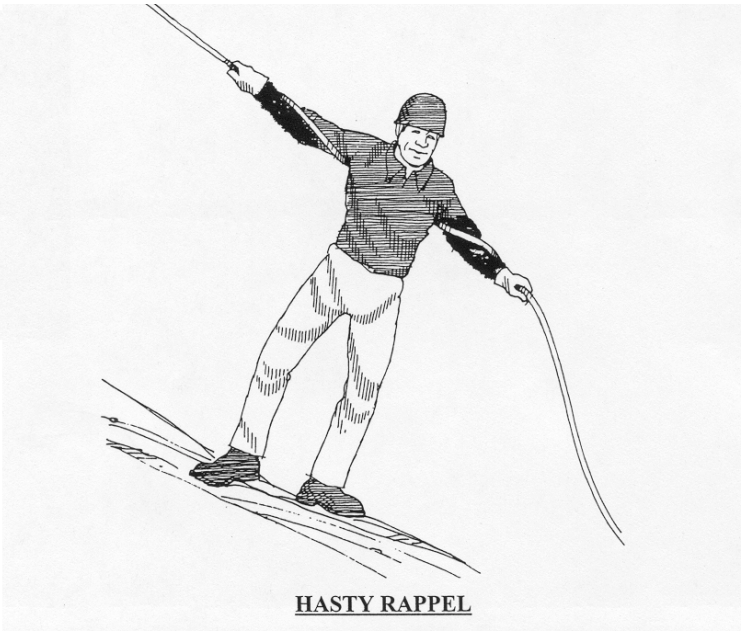
4. **DUTIES OF THE FIRST MAN DOWN THE ROPE**. The first man down the rope has the following duties:
    a. Selects a smooth route down for the ropes.
    b. Clear the route of loose rocks and debris.
    c. He will straighten the ropes once he reaches the bottom.
    d. He belays the next man down the rope.
    e. Take charge of personnel as they arrive at the bottom and appoint the next belay man.

f. A safety line will be used. The first man down the rope will belay himself down the rope by using a safety line attached to his rappel seat with the appropriate prussic knot.

5. **RAPPELLING COMANDS**. As with any operation it is essential that everyone knows what is going on. Communication is an important key to a smooth and safe operation. The following commands are used for rappelling:

COMMAND	GIVEN BY	MEANING
"Last name, on rappel"	Rappeller	I am ready to begin rappelling.
"Last name, on belay"	Belayer	I am on belay and you may begin your rappel.
"Last name, off rappel."	Rappeller	I have completed the rappel and am off the rope.
"Last name, off belay."	Belayer	I am done belaying the rappeller down.

NOTE: In a tactical situation a series of tugs on the rope may be substituted for the verbal commands to maintain noise discipline. The type of commands used is determined by unit SOP. An example of one that is used is: two tugs from top "On Rappel", two tugs from bottom "On Belay", one tug from bottom "Off Rappel".



HASTY RAPPEL

6. **TYPES OF RAPPELS**. These are the three types of rappels and when they are preferred.

a. Hasty Rappel. Used when carrying loads down moderate slopes. This rappel is the easiest rappel to prepare for. It requires only a rope and gloves.

1) Conduct- A hasty rappel is conducted in the following manner

2) Sleeves will be rolled down and gloves worn.

3) 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.

4) Lean out at a moderate angle to the slope.

5) Descend down the hill facing half sideways, taking small steps and continually looking downhill while leading with the brake hand.

6) Feet should not cross and the downhill foot should lead at all times.

7) Braking- To brake, first bring the lower (brake) hand across the front of the chest to brake. At the same time, turn to face up toward the anchor point.

a. Seat- Hip Rappel. It is used when carrying loads over vertical to near vertical cliff faces. This rappel the most commonly used.

1) Conduct. A seat-hip rappel is conducted in the following manner:

a) Construct a rappel seat, roll down sleeves and put gloves on.

b) The locking carabiner is placed on the rappel seat so that the gate opens up and away.

c) Step up to the rope with your left shoulder facing the anchor, right shoulder facing the cliff edge.

d) The rappel rope is snapped into the carabiner as follows:

(1) Put the rope into the carabiner, insuring that the running end of the rope runs into the right side of the carabiner and out the left side to the anchor.

(2) Take slack from the standing (anchor) end of the rope. Holding the rope with your right hand, make one wrap with the rope around the body of the carabiner and through the gate again. This creates a round turn around the carabiner.

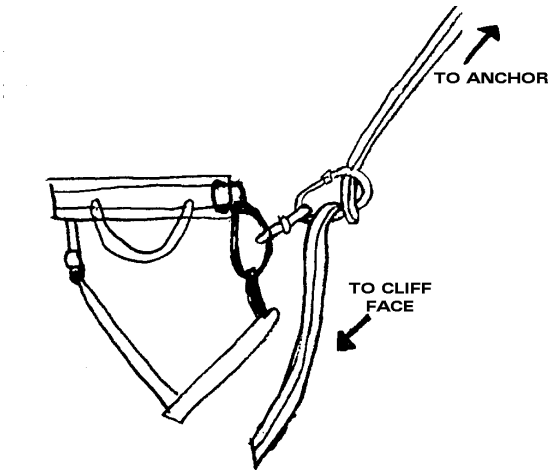
(3) Ensure that the locking nut is fastened to lock the carabiner closed.

NOTE: If, because of a tactical or emergency situation, you are using only one rope to rappel with. The procedures are the same, except the individual must make two wraps around the body of the carabiner, instead of one.

e) The running end of rope runs from the carabiner to the bake hand, which is held on your right hip.

f) Firmly grasp the rope with your right hand, palm down and inboard.

g) Braking- Grasp the rope tightly with the brake hand. Take the brake hand and place it in the small of the back. This will create enough friction to stop.



TYING IN FOR A SEAT HIP RAPPEL

c. Seat-Shoulder Rappel. It is used for very heavily laden Marines moving over vertical to near vertical cliff faces. The seat-shoulder is somewhat similar to a seat-hip, but is slower and creates more friction. It is efficient for Marines with heavy packs because it provides support for heavy loads on the back.

1) Conduct. A seat-shoulder is conducted in the following manner.

a) Put on your rappel seat, roll down your sleeves and put on your gloves.

b) The steel locking carabiner is placed 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.

c) Step up to rope with your left shoulder facing the anchor and right shoulder toward the cliff edge.
d) The rappel rope is inserted in the carabiner as follows:
(1) Put the rope into the carabiner, insuring that the running end of the rope runs into the right side of the carabiner and out the left side of the anchor.
(2) Take slack from the standing (anchor) end of the rope. Holding the rope with your right hand, make one wrap with the rope around the body of the carabiner and through the gate again.
(3) Ensure that the locking nut of the carabiner is fastened to lock the carabiner closed.

NOTE: If you are using one rope, the procedure is the same except that you will make two wraps around the body of the carabiner instead of one.

e) Take the rope across your chest, over your left shoulder, diagonally across your pack and down to the right (brake) hand.
f) Descending using the same technique as for the seat-hip rappel.
g) Braking- Lean back and face directly uphill. Bring the brake hand across the front of the body to the chest.

7. **RESCUE TECHNIQUES**. There are many ways that a Marine can get caught on a rope when rappelling, However, usually their clothing or equipment will get caught in the carabiner, or he has a problem when tying off. We will discuss two rescue techniques used for rescue over the side of the cliff/rock face.
   a. The Self-Rescue Technique. Used only by experienced rappellers.
      1) After realizing that you are caught up on the rope, check with your belay man to ensure that he has a solid brake set. Failure to do this could result in serious bodily harm.
      2) Using a prussic cord tie a prussic knot arms length above the area that is caught onto the rappel rope. Anchor the other end of your prussic knot to the rappel seat. This will be your safety line.
      3) Work the safety rope up until the tension on the rappel rope at the problem area is relieved enough to give you the necessary slack to work on the problem area.
      4) Once you have corrected the problem do one of the following:
         a) If you were caught up while rappelling down, rappel down to the ground using the first man down technique taught earlier in this lesson.
         b) If you were caught up while tying-off, repeat the tying off process until you complete it properly. After you have done it properly, tie-off again so that you can remove your safety rope and then rappel down.
   b. The Buddy Rescue Technique. This method should be used when the individual is unable to correct the problem by himself.
      1) Using another rope, the rescuer will rappel down to the victim/casualty who is caught up and tie-off.
      2) He will then establish a safety rope onto the victim as taught in the self rescue technique. The rescuer may have to help the victim in doing this depending upon the situation.
      3) Once the problem is corrected, the victim will rappel down or repeat the tying-off sequence, once again depending on the situation.
   c. Rappelling Casualty Rescue. There are three methods to get a casualty down in case of injury.
      1) The first method is to allow the belay man to lower the casualty by slowly releasing the tension on the rappel rope.
      2) The second method is used for critical injuries or when the belay man cannot properly control the victim's descent.

a) The rescuer will rappel down using another rope, once the rescuer gets to the victim the rescuer will have his belay man brake him off, to allow the rescuer to use both hands.

b) If necessary, the rescuer will perform any basic first aid needed. Once the victim is ready to be lowered, the rescuer will call down to both of the belay men (the victim's and the rescuer's), and they will simultaneously lower both men. The rescuer will hold onto the victim the entire way down so that he does not bounce off the rock face.

3) The third method is called a tandem rappel. It is used to rescue a casualty who has sustained an injury serious enough that he cannot operate the rappel device and requires the assistance of a second rappeller. Depending where the injury occurred, this type of rescue can be conducted from the top of the cliff face or while on rappel.

a) If the injury occurs while on the top of the cliff face, the following steps should be taken:

(1) Take either a long sling rope or prussic cord and tie a figure eight in the middle of it.

(2) Take the two free ends and tie figure eight knots ensuring one end is shorter than the other.

(3) Take the rappel device and attach it to the middle figure eight knot with a carabiner and hook it up to the rappel rope.

(4) Next, attach the casualty's hard point to the short end of the sling rope/prussic cord and the rescuer to the other end.

(5) In order to tie on your safety prussic, the first step is to tie the prussic cord in an overhand knot near the middle of the loop.

(6) The part of the loop that does not contain the double fisherman's knot will be used to tie a prussic knot on the rappel ropes below the rappel device, near the rescuer's waist. The safety prussic will be clipped into the rescuer's leg loop with a locking carabiner.

(7) At this point you are ready to rappel both rescuer and casualty at the same time.

NOTE: Your rappel device will be far enough in front of you that the casualty will not be able to reach it.

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

(1) Set up the system as with the injury occurring on the top of the cliff face.

(2) Once the rescuer ties his prussic on the rappel rope he rappels down to the casualty.

(3) Take the short end of the sling rope and attach it to the casualty's hard point.

(4) Take a knife and cut the casualties original rappel rope away so that he is on your rappel rope.

(5) Rappel down to the bottom of the cliff face.

NOTE: THIS IS THE ONLY TIME THAT A KNIFE SHOULD BE USED DURING A RAPPEL. EXTREME CAUTION SHOULD BE USED. IT IS NOT TO BE DONE IN TRAINING, BUT ONLY IN AN ACTUAL RESCUE, AND AS A LAST RESORT.

8. **RETRIEVABLE RAPPELS**. Once a unit has rappelled down a cliff face, it will be necessary to retrieve the ropes. This is done by selecting a suitable anchor as near the edge of the cliff as possible and then constructing one of the following two types of retrievable rappels.

a. One Rope Retrievable Rappel.

1) First, find the middle of the rope.

2) Take the pigtails of the rope around the anchor, tree, large rock, etc., so that the mid point of the rope is directly behind the anchor point.

3) Rejoin tails of the rope and throw rope over cliff edge.
4) Using the middle of the rope pull up a bight. Ensure that the tails of the rope are equal, the middle mark on the rope must be in the middle of the bight,
5) Make a round turn with the bight and secure the bight into the rappel line by using a bowline finished with an overhand.
6) Prior to sending the first man down, the NCOIC will ensure that the first man down uses a prussic on the rappel line tied into the rappel seat.
7) The first man down will carry out procedures previously mentioned.
8) Remainder of unit may now rappel down.
9) The NCOIC is the last man down. The steps he will take with the rappel line are as follows:
    a) Untie the bowline finished with an overhand from the anchor point.
    b) Adjust rappel line to set mid-rope point on the back of the anchor.
    c) Ensure rappel line will move freely around anchor when retrieved.
    d) Ensure that belay man is on belay. If a belay man is not available, then the NCOIC will carry out the procedures defined for the first man down.
    e) Rappel down.
    f) To retrieve the rope by pull either end slowly and steadily to prevent the end of the rope from whipping around the anchor point and possibly getting hung up on a shrub or limb.
    g) Watch for loose rock and debris that may be pulled over the edge and call "rope" just before the end of the rope is ready to come over the edge and down.
    h) If the rope gets stuck on the anchor point and both ends of rappel line are present, then the NCOIC will use a prussic to climb up the rappel line and correct the problem. If only one end of the rappel line is at the bottom, the NCOIC will have to select a safe route back up to the anchor point, insuring he uses correct climbing procedures.

b. Two-Rope Retrievable Rappel. This type of rappel is used by up to squad-sized unit. The procedures for this installation are basically the same as for the one rope retrievable except for a few considerations.
    1) The initial reason for using two ropes vice one rope is that the length of the rappel is longer.
    2) When two ropes are used they should be tied together using a square knot. Position the square knot directly behind the anchor it is around and pull up a bight long enough to tie a round turn and a bowline.
    3) A suitable anchor knot is tied by using the bight and going around the anchor from right to left. The knot used to join the two ropes together should be totally out of the system after tying the anchor knot. Now the system does not rely totally upon the square knot in the bight, and the number of knots under tension in the system is reduced. At this point the rope is ready to use; however, as long as the anchor knot is tied, the rope is not retrievable. All personnel except the last man will go down the rope while it is constructed like this.
    4) The first man down will use a prussic as prescribed earlier.
    5) To make the rope retrievable and ready for the last man to go down, the following steps are taken:
        a) Untie the round turn and a bowline finished with an overhand.
        b) The NCOIC will adjust the rappel line and remember that the knot must be moved as close to the edge as possible to avoid snagging during retrieval.
        c) Attach the rappel line to the seat using the appropriate method.
        d) Now, the NCOIC will place a carabiner on the line below the knot and carry it down the rappel with him.

e) Again, if the belay man is not available to belay the NCOIC, he will carry out the procedures described for the first man down.
f) Once off rappel he pulls on the side of the rope with the carabiner attached. The rope should be pulled slowly and steadily to prevent the end of the rope from whipping around the anchor point and possibly getting caught on a limb or vegetation.
g) Watch for loose rock and debris that may be pulled over the edge and call "rope" just before the end of the rope comes over the edge.

c. Neither the one-rope retrievable rappel, nor the two-rope retrievable rappel, uses a secondary anchor knot. This is allowed and is suitable for situations that require rapid movement of up to a squad-sized unit (approximately 13 personnel) from the top to the bottom of a cliff.
d. More than a squad. A primary anchor may be used alone if that anchor meets the minimum criteria established. A secondary must be used when the primary is less than adequate. To retrieve a system with a secondary anchor, the NCOIC will break down the system, after everyone else is down, and set up a retrievable rappel for himself.

9. **EQUIPMENT**. Equipment should be worn in accordance with unit SOP. The unit has the responsibility to determine which methods it feels are most beneficial to the mission. However, here are some training considerations: Weapons will be worn across the shoulder, muzzle down and away to the left, away from the brake hand. With the sling securely attached to the weapon. Weapons should also be dummy corded to the individual Marine. Tying a knot in the end of the sling or taping down the sling keeper is needed to prevent the sling from coming loose.

CHAPTER 5
MILITARY CLIMBING

BALANCE CLIMBING- This is also refereed to as "bouldering" by civilians. Either way the techniques used in balance climbing are the base for all other climbing techniques. Practicing and learning these techniques will enable you to be more successful in any precipitous terrain.

1. Safety Precautions. There are two safety considerations that must be followed when ever balance climbing.
   a. Never climb higher than ten feet off of the ground. By this it is meant that the climber's feet are never more than ten feet above the ground.
   b. A spotter is required for all balance climbing.

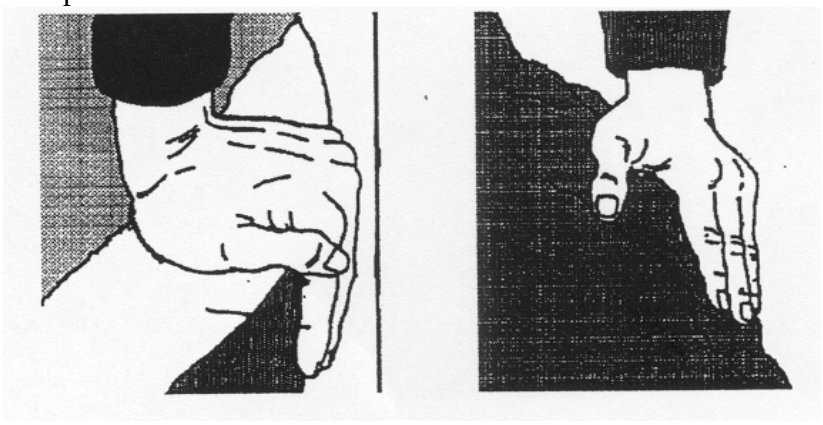
2. Individual Preparations. Prior to beginning a climb there are seven things that the climber must do to prepare himself:
   a. Helmet with a serviceable chinstrap must be worn.
   b. Sleeves rolled down to give hands and arms freedom of movement and give protection during a fall. Blouse will be tucked in to your trousers.
   c. All watches, rings, and jewelry must be removed before climbing; Including necklaces and I.D. tags.
   d. Gloves will not be worn, because they give a false feel of the rock and can cause an individual's hands to slip.
   e. Unblouse trousers if they restrict movement.
   f. Soles of boots clean and dry as possible. Wipe soles on trousers prior to beginning the climb.
   g. Select route where vegetation is minimal. Never use vegetation for hand or foot holds.
3. Duties of the Spotter. The spotter is the balance climber's partner and is the safetyman for the climber during the climb. The five duties of the spotter are as follows:
   a. Positions himself facing the cliff, directly below the climber and approximately 3-4 feet away from the base of the cliff, for the duration of the climb. He will move diagonally as necessary to remain below the climber.
   b. Maintains his position facing the cliff, directly below the climber and approximately 3-4 feet away from the base of the cliff, for the duration of the climb. He will move left or right, as necessary, to remain below the climber.
   c. The spotter will stand with his feet shoulder width apart and arms ready to stop the climber if he falls.
   d. If the climber falls, the spotter will not "catch" him. He will prevent the climber from falling further down the hill. He will do this by pushing the climber towards the base of the cliff, thereby preventing him from tumbling backwards.
   e. At no time will the spotter allow anyone to come between him and the face of the cliff while a balance climb is taking place. Anyone who wants to pass must go behind him.

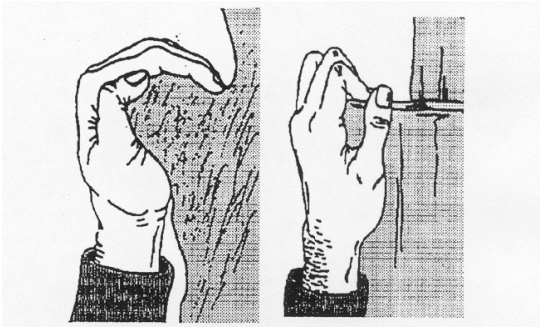
4. Spotting and Climbing Commands. Here are the commands used by both the spotter and the climber.

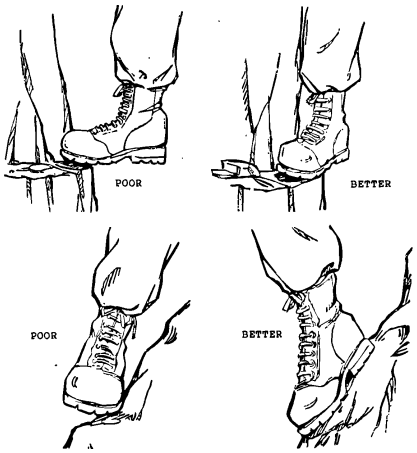
COMMANDS	GIVEN BY	MEANING
"Last name, climbing."	Climber	I am ready to climb.
"Climb Climber."	Spotter	I am ready to spot you.

"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.

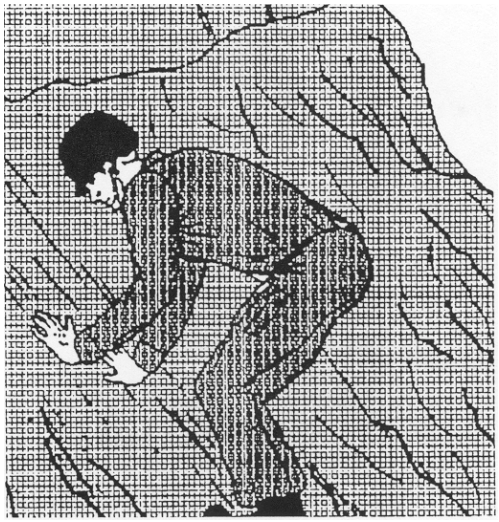
a. If the command "ROCK" is given, all personnel in the vicinity will take the following action:
   1) If close to the cliff face, move against the cliff face with your face against the cliff and your hands between you and the cliff.
   2) If not close to the cliff face, look up to locate the rock and avoid it.
b. Remember this command must be used even during tactical training to avoid injuries. Also the volume of the command "ROCK" is in direct correlation to the size of the rock falling down the cliff.

5. **Types of Holds**. There are five basic holds that are used in balance climbing:
   a. Push Holds. These are most effective when hands are kept low, and are most often used in combination with a pull hold.
   b. 
   c. Pull Holds. These are the easiest to use and, consequently, often overused. They are very effective on small projections that one might not think could be used.



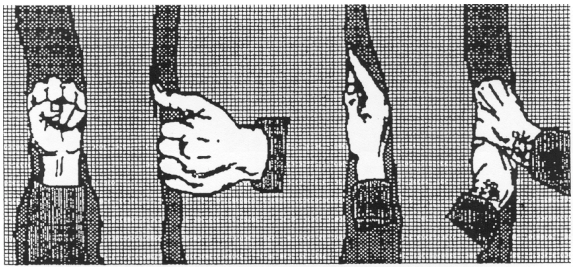


c. Foot Holds. Feet should be positioned with the inside arch of the foot toward the rock. Using the full sole of the boot when possible. Avoid crossing your feet. If you feel you must cross your feet use a change step instead. (A change step is a method of substituting one foot for the other on the same foothold.) Because your leg muscles are much stronger than your arms make maximum use of foot holds. Climbing with your feet is an effective means of conserving your body strength.



d. Friction Holds. A friction hold is any time you are relying on the friction of your foot or hand against the face of the rock for traction, rather than pushing or pulling against a projection on the face of the rock. Friction holds feel very insecure to an inexperienced climber. But through a little practice they can be used very successfully. The effectiveness of this hold is dependent upon many factors like the type, condition, and angle of the rock face, the type of boot soles being worn and the confidence of the climber.

e. Jam Holds. This type of hold involves jamming or wedging any part of your body or your entire body into a crack or opening in the rock. An important consideration is that you do not jam a portion of your body into a crack such that you cannot free that portion of your body after you complete the move. The most common types of jams are with the feet and hands, but there are numerous variations of both using both hands or feet or using entire arms or legs etc..

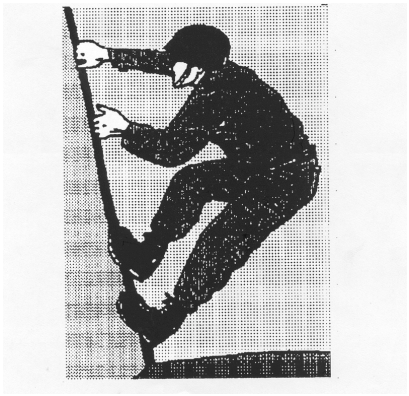


f. Combination Holds. The five types of holds just mentioned above are not just used individually. They are most often used in combination with each other. Some examples are:

1) Chimney Climbing. This is when you insert your entire body into a crack in the rock and by using both sides of the opening, and possibly all five types of basic holds, move up the crack.

STEMMING

SQUEEZE CHIMNEY

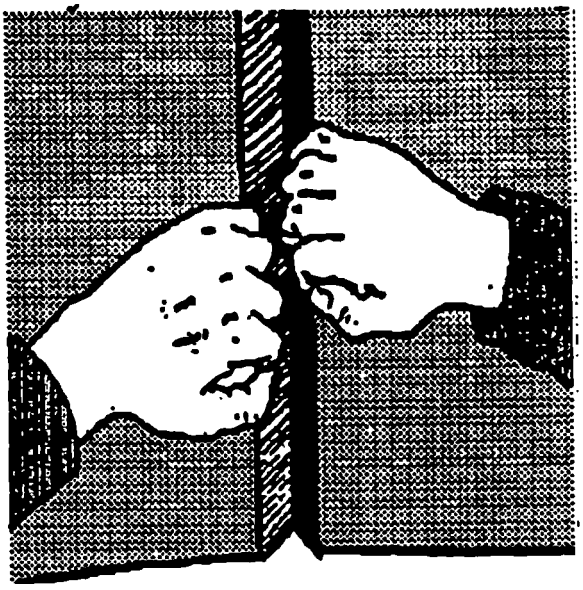


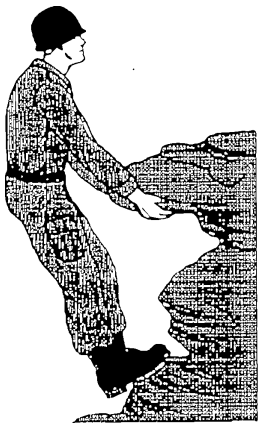
2) Lie Back. This is a combination of both pull holds with your hands and friction holds with your feet.

3) Push-Pull. As the name implies, this is where you use a push hold and a pull hold together.

4) Mantling. This is a technique where you continue to climb with out moving your hands off a projection by pulling yourself up until your hands are at chest level and then invert your hands and push on the same projection.

5) Cross-Pressure in Cracks. This is a technique of putting both hands in the same crack and pulling your hands apart to hold and raise yourself.





6) Inverted. Pull or push.

7) Pinch. As the name implies this is a grip used on tiny little nubbins.

8) Stemming. The spreading of arms or legs to maintain a proper body position. (i.e. usually used in a book or chimney.)

g. General Use of Holds. How you use an individual hold is dependent on your experience level, or sometimes, your imagination. But here are some general guidelines:

1) Most handholds can be used as foot holds as you move up the rock.
2) Use all holds possible in order to conserve energy.
3) Even the smallest projections may be used as holds.
4) Use of knees and elbows is discouraged because they are moveable joints (unstable) and can lead to serious injury if used.

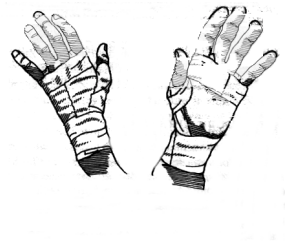
h. Movement on a Slab. Movement on a slab is based on friction holds.

1) Use any and all irregularities in the slope to gain additional friction.

2) Traversing requires both hands and feet.
3) Descending a steep slab may require turning inboard to face the slab and backing down.
4) The biggest mistake in slab climbing is leaning into the rock. Maintain maximum friction by keeping weight centered over your feet.

6. Body Position. The climber should climb with his body in balance by keeping his weight centered over and between his feet. Do not hug the rock. Do not over extend and become "spread eagled". While climbing, keep in mind the acronym "CASHWORTH" for proper body position and movement.

C- Conserve Energy.
A- Always Test Holds.
S- Stand Upright on flexed joints. When not moving keep muscles and joints relaxed.
H- Hands Kept Low between waist and shoulder level. This will keep you from over stressing your upper body and forearms.
W- Watch Your Feet. This way you can see and place your foot on the next hold.
O- On Three Points Of Contact. To prevent you from "swinging" out away from the rock.
R- Rhythmic Movement. Make a few moves, stop, breathe, make another move. Set a pace that you can maintain for the duration of the climb.
T- Think Ahead. Look ahead to see what you have available and how you will approach the climb.
H- Heels Kept Lower than Toes. Prevents over exertion of the calves, which are relatively weak muscles compared to the rest of your leg.

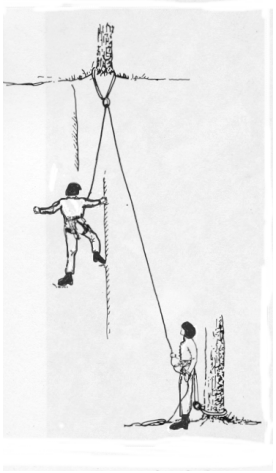


NOTE: When climbing very course and abrasive rock, like granite, the use of tape to protect the hands is recommended, but not required. As shown in the picture to the left. Fingers should still be left uncovered for feel of the rock. Medical tape from your corpsman or commercially produced tape can be used. Ensure that you have proper circulation and that range of movement is not hindered.

TOP ROPING- This is a method for getting a unit to the top of a rock face after Assault Climbers have already secured lanes. All balance climbing techniques apply. Top roping is a good training tool for weaker climbers and a chance to climb on routes above ones known ability, because of the safety provided by the belay minimizing any fall to a minimum.

1. Belay Positions. There are two types of belays used for top roping. One from the top and one from the bottom. The one that will be used for operations is the one from the top. Which you will need to be most experienced with.
    a. Establishing A Belay Stance From The Top. A siting belay will be established on top of the cliff head by:
        1) Constructing a suitable top anchor with the standing end of the rope as covered in Natural and Artificial Anchors.
        2) With the direction of pull over the cliff face. Tie a directional figure of eight loop near enough to the cliff edge so that, once hooked in, the belayer can observe the climber if possible.

3) The belayer, if not wearing a sit harness, will tie a swami wrap around himself. Then he will clip two locking carabiners through all the wraps of the swami wrap. The square knot on the swami wrap should be on the left side.
4) Rotate one carabiner to the rear and use it to hook into the directional figure of eight. This is his safety. This should be done back from the cliff face by pulling the rope back to you.
5) Once the appropriate signal is given. Pull up the slack between you and your climber and secure the running end of the rope to the carabiner in the front, utilizing a suitable belay device, i.e. munter hitch, stitch plate, ATC.



b. Establishing A Belay Stance From The Bottom. Belaying from the bottom is commonly known as a "YO-YO", as the effect given is the same as a toy yo-yo. The belay method used for a yo-yo can be either an indirect or a direct belay. Establishment of the belay remains unchanged except that two anchors are needed, one on top and one on the bottom. The anchor on the top is needed to allow the rope coming up from the bottom to pass through and return to the bottom. Any appropriate anchor can be used. A pulley or two locking carabiners are used to pass the rope through the top anchor.

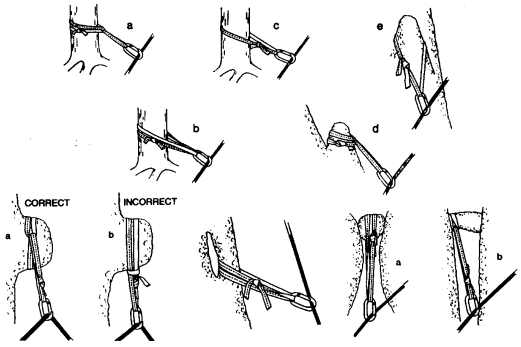
2. Climber's Responsibilities.
   a. Tying into the rope. The climber will tie first tie a swami wrap around himself and then hook into the rope as follows:
      1) A retraced figure of eight can be tied, going around all wraps of the swami wrap.
      1) Or a figure of eight loop can be hooked into a locking carabiner that is hooked through all wraps of the swami wrap.
      2) A bowline on a coil can be tied as discussed in rope management.
      3) Or tie into the hard point of the harness as discussed in MWTC Sit Harness.
      3. Climbing Commands. Commands are used to coordinate movements between the climber and the belayer. They may be either prearranged tug commands on the rope, or verbal commands depending on the tactical situation. Commands with an asterisk are either prefaced by a lane number or the Marines last name.

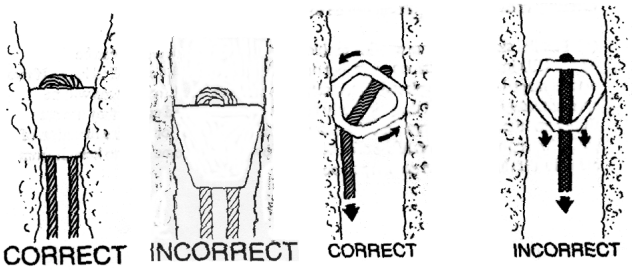
COMMAND	GIVEN BY	MEANING
"Up rope"	Climber	Take up the excess rope between the climber and belayer.
"That's me"	Climber	Excess rope has been taken up between us.
"On belay"*	Belayer	I have a belay position and am on belay.
"On climb."*	Climber	I am ready to climb.
"Climb on climber"	Belayer	You may begin to climb.
"Slack"	Climber	Give me some slack in the rope.
"Slack"	Belayer	Take the slack you need.

“Tension”	Climber	Take up all excess slack in the rope.
“Tension”	Belayer	All slack is out of the rope.
“Hold”	Climber	Put on your brake and be ready to hold me.
“Holding”	Belayer	I have put the brake on and am ready.
“Climbing”	Climber	I am ready to resume climbing.
“Falling!”	Climber	I am falling.
NO RESPONSE	Belayer	WILL BRACE HIMSELF AND SET HIS BRAKE.
“Okay”*	Climber	I have recovered.
“Off Climb”*	Climber	I have moved back and in a safe position or anchored in.
“Off belay”*	Belayer	I am off belay following your command off climb.

PLACING PROTECTION- When it comes to two party climbing, there is nothing more important than how to place protection. No matter how good of a belay man you have or how good your equipment is, if your protection is improperly placed, it can be a fatal mistake. And most off all it is solely up to you as a lead climber to place your protection properly. For there is no one around to double-check it when you are 100+ feet above your belay man.

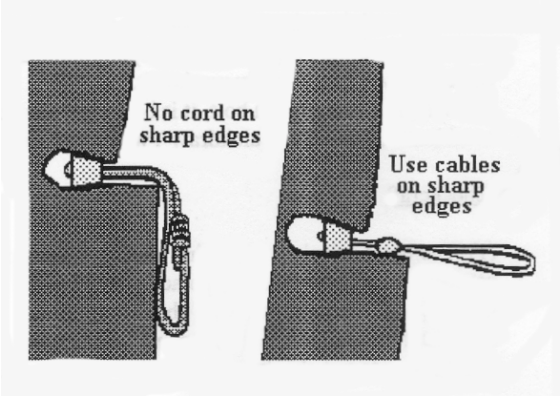
1. General. Since carabiners are used in virtually all protection placements, the novice should learn some general principals for their use:
    a. The gates of the carabiners clipped into the protection should be down and out, or the gates should be down and facing to whichever side minimizes the risk of the gate being forced open by a rock edge or nubbin during a fall.
    b. Rope should run from the climber through the carabiner without twists and kinks.
    c. When using a runner, be sure the runner is not twisted before clipping into the carabiner; otherwise, the carabiner may end up facing the wrong way.
2. Protection On Trees.
    a. Trees and large bushes, when available, provide the most obvious points of attachment for protection. The best way of attaching a runner is to loop the runner around the tree and clip a carabiner into both ends.
    b. The runner should usually be as low on the tree trunk as possible, although it may sometimes be desirable to put it higher up or even on a branch, to avoid putting a sharp bend in the climbing rope or to provide a higher point of protection.
3. Protection On Rock Horns and Chock Stones. Rock horns often provide good placement. A runner is attached by placing it over the horn or using the same method used with trees. Sometimes, to prevent the action of the climbing rope from pulling the runner off, it can be attached with a girth hitch or clove hitch around the rock horn. When possible, avoid placing the runner where it will be pulled against a sharp edge of the rock in a fall. When this is unavoidable, pad sharp edges with soft material as much as possible.





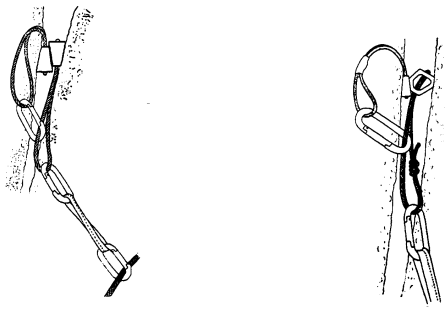
4. Using Fixed Bolts.
    a. Fixed bolts are often found in civilian rock climbing areas and are not uncommon on alpine rock climbs. Bolts are most commonly used for belay anchors, but will also provide protection on otherwise unprotected stretches of rock. All climbers should know how to use them.
    b. Bolts, when available and sound, generally provide the best and certainly the most convenient Protection. Unfortunately, they are not always sound and should be carefully checked. Bolts can be checked by examining the rock around them for evidence of crumbling or cratering, and they should be tested by clipping into them with a separate carabiner and jerking on it before clipping in the rope. Never hammer on a bolt to test it or improve it, since this will permanently weaken it.
    c. When clipping into a bolt, it is best to do so with a carabiner-runner-carabiner combination, called a “quick-draw”. To reduce rope drag.
5. Chock craft.
    a. The basic principle in placing chocks is deceptively simple; find a crack with a constriction at some point and place a chock of the appropriate size above the constriction. Jerk down on the chock loop to set the chock. However simple in theory, chock-craft is a complex skill that requires experience to develop an eye for good places to put chocks and an ability to place them skillfully.
    b. The crack itself is the first thing to consider. When possible, avoid cracks that have crumbling or deteriorating rock on the side. Many cracks that look good could have a small, loose flake on one side; often well disguised with grass and dirt. Some very tempting cracks are in fact formed by a detached flake against a large mass of rock. Even if the flake is large and seemingly solid, it may only have to move a fraction of an inch for the chock to come loose. This is important because the expansion force of a chock against the sides of a crack during a fall can be enormous.

    c. When attempting to place a chock, always look for a likely constriction in the crack first, then select a chock that will fit, rather than selecting a chock and looking for somewhere to put it. When a place is found, choose a chock that will have as much surface area as possible in contact with the rock; (at least three points of contact to prevent wiggling or rotation.). A chock with just one side resting on a small crystal is likely to be unsound and unsafe. If the crack is too shallow to get the chock all the way in, use a smaller chock or find a deeper portion of the crack.



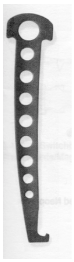
5-15 EDGE PICTURE

d. When placing a #1 or #2 stopper, always back up that piece with a secondary piece of protection as soon as possible.
e. Outward flaring cracks can be a problem. A few types of chocks are specifically designed to fit in flaring cracks as long as the angle of the flare is not too great. Most chocks; however, if placed in a flaring crack, will simply wobble on two corners. Occasionally, a climber must make do with such a placement because there is nothing better to be found and then he climbs very, very carefully until another placement can be found.
f. Parallel-sided cracks are another problem. Chocks of various sizes can be STACKED in many ingenious ways, but only one method will be described here. If two wedge shaped chocks are placed in contact, one upside-down, their surfaces will be approximately parallel. If the pair barely fits into a parallel-sided crack, they are set firmly and the rope is clipped into the one placed with the direction of pull down. The upper chock should be clipped to the lower one in some way to keep it from being lost if the placement should pop out.



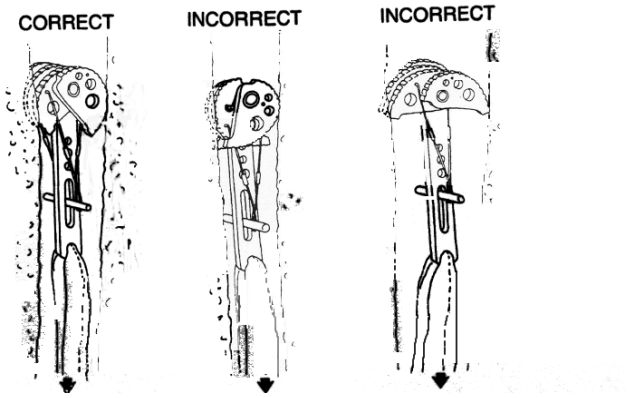
g. Horizontal cracks can take simple placements if the interior of the crack is wider than the edges at some point. If not, a placement of stacked chocks may hold. In either case if the chock is on a rope loop which runs over a sharp lower edge, as often happens, it cannot be depended on to hold a hard fall, for the loop may be cut. If it is on a wire it is usually safe.
h. When placing a chock with a rope loop, the side of the loop with the knot should face out when posible to ensure that at least one-half of the loop fits into the crack. When the loop will not fit into the crack at all, a wired chock is usually a better choice. Once a chock is placed, the climber can either clip the climbing rope into it directly or extend the chock loop with a runner. The loop of a wired chock is always extended with a quick draw to prevent

"walking" the protection out of the rock. Ensure that enough quick draws are carried for use on placements.



i. Often a chock or hexcentric will be placed and the climber will not be able to remove it. Either from sustaining a fall or a climber setting the nut to forcefully. To get the piece out a nut tool is used. Use the tool by tapping the piece in the apparent direction needed. A locking carabiner can be used to help tap on the end of the tool. A nut tool can also be used to clean a crack in the rock of debris and dirt, to allow for the placement of protection.

6. Camming Devices.
   a. These are the most modern types of protection. Camming devices come in several types and name brands, but the use of each type is generally the same. Camming devices, also called SLCD's, are spring activated and provide reliable placements in cracks where ordinary chocks are difficult or impossible to place; such as parallel sided cracks, flaring cracks, and cracks under roofs. Camming devices can be placed quickly and make it possible to do some extremely difficult pitches that are otherwise virtually impossible to protect. On more modest climbs, they can be very convenient, saving time and effort in places where protection is needed and ordinary chocks would be tricky and time consuming to place.
   b. A camming device seems easy to place, just hold it like a hypodermic syringe, pull the cross-bar back, place it in a crack and release the bar. But there are some pitfalls of which the climber should be aware:



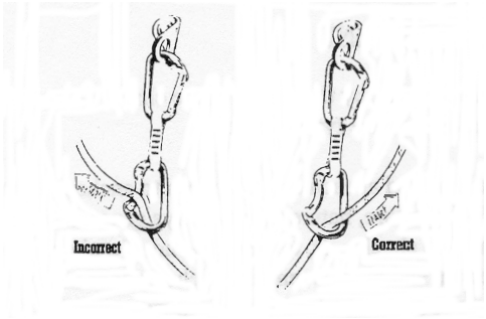
   1) Care should be taken to ensure all individual cams of the camming device have a good purchase on the rock. If one or more cams have no purchase, this is an incorrect placement, and the cam can easily be pulled out of the rock during a fall.
   2) If the trigger must be pulled all the way back to get it into a crack, it may be impossible to remove. Use a smaller one or another type of protection.
   3) Do not put the camming device any deeper into the crack than it has to be for a good placement. If placed too deeply, it may be impossible to reach the crossbar to remove it.
   4) When placed behind flakes or in deep cracks, a camming device has been known to "walk back" into the crack out of reach as a result of rope action. A camming device

will be extended with a runner in such placements. To reduce "walking" of the protection out of the crack..

5) A camming device should always be placed so that in a fall the direction of pull is parallel to the shaft, or it can rotate and pull out, which often destroys the protection, not to mention what it can do to you.
6) A solid stem camming device (Friends) should never be placed where the stem would be forced against an edge in a fall, i.e. in a horizontal crack with the stem resting on the edge, as it could easily snap off. With the new flexible stem SLCD's, this can be done but they should be thoroughly inspected after taking a fall in this position.

c. Although camming devices are extremely versatile and can usually reduce the total amount of protection for a climb, occasionally a more convenient chock in the same size range may be easier to place. When carrying SLCD's it is a good idea to carry at least a couple of other kinds of chocks in the same size range.

7. Clipping In. Once having placed a piece of protection and extended it with a runner, there is a proper way to clip the rope into the protection. Clipping the rope proficiently can make the difference between sending the route and pitching off. Depending on which way the gate of the bottom carabiner is facing will decide which way you will clip. Grabbing from your retrace figure of eight, pull up a bight, hold it between your teeth and pull up more rope to make the clip. When clipping, if the gate is to the left you will clip from the left. If the gate is to the right you will clip from the right. If done improperly, the rope can lay across the gate and if a fall should occur, the gate can open and the rope could come out of the carabiner, increasing the length of the fall. When done correctly, the rope going to your retrace figure of eight should be coming out of the front of the carabiner. The rope going to the belayer will be between the carabiner and the rock.



8. Racking Equipment.
   a. A climber's selection of gear for protection is called his rack. A rack consists of a varying numbers of chocks, SLCD's, carabiners and quick draws. Protection should be carried in a logical sequence of size and type so that the lead climber can quickly find the correct type of protection for the crack. Protection can be carried on a gear sling across the body, attached to the equipment loops on the harness, or a combination of both. The amount of protection carried is dependent upon the type and length of climb. The most popular method is to rack several chocks of the same size on one carabiner, arranging these on the rack in order of size. This has the advantage of having extra protection on hand if you do not get the placement right the first time. The same racking arrangements should be used when racking camming devices.
   b. Long slings are worn by doubling the loop over and clipping both ends with a carabiner. Or they can be worn across the chest like a gear sling.
   c. Quick draws are preset carabiner/runner combinations that allow quick and easy extension of a piece of protection. It is helpful to have the gates of the carabiners opposite of each other so that the bottom carabiner is down and away from the rock. This makes clipping in much easier.

d. Other items of equipment that are usually carried, such as stitch plate, rappel gloves, nut pick, etc., need to be placed at the back of the harness.

9. Amount of Equipment.
    a. This is going to be determined by the length of the climb, degree of difficulty, the experience of the climber and the type of crack being climbed.
    b. If three chocks are to be used at the end of a pitch to anchor the belays, one chock is left for protection. Furthermore, nature is not always generous in providing cracks of the right size for the available chocks. If, toward the end of a pitch, the climber wants one more piece of protection, and his one remaining chock does not fit any available crack, he must either back down or finish the lead with no more protection. If a climber regularly uses more than two-thirds of the rack on a pitch, he is going too light and pushing his luck. When on an unfamiliar route, it is easy to get into a position where more equipment is required than you thought was necessary.
    c. While carrying a large rack may eliminate the above problem, weight is a hazard that should always be taken seriously. A climber who takes a rack of thirty or more chocks on a moderate climb will likely have problems with balance and making some of the harder moves. Consequently, he will spend too much time fussing with equipment to have much success. While there is much variation in the optimum amount of equipment from climb to climb, and from climber to climber, a few numbers might serve as useful suggestions for the novice. probably the great majority of free rock climbs are done with racks of 10-20 chocks. Sometimes the chocks will be concentrated toward one end of the range if the climbers know that the climb takes mostly small or mostly large chocks. Eight to twelve quick draws are a typical number, depending partly on the number of chocks per racking carabiner. Two to six runners, including at least one double-length runner, is average, the actual number depending partly on the length of the chock loops.

BELAYING FOR PARTY CLIMBING

1. Introduction Belaying Concepts.
    a. Hiking and scrambling become climbing when progress becomes difficult enough to make falling a real possibility and when the consequences of a fall would be serious. At that point, mountaineers use a rope to continue with security. Unless the rope is used in a safe and knowledgeable manner it may actually increase the danger rather than reduce it. On heavily crevassed glaciers and when alpine climbing, a climbing team routinely ropes up and travels together. In all other situations when the security of the rope is called for, particularly when climbing a technically difficult pitch of rock or ice, one person is stationary and protecting his partner with the technique known as **BELAYING**.
    b. Belaying is the procedure by which the stationary climber, the belayer, manages the rope that is tied to the climbing member, the lead climber, of the team and uses it to stop a fall if necessary. The belayer takes a position with an ANCHOR (a strong attachment point to the mountain) and a STANCE (bracing against the terrain to resist a hard pull on the rope). Rope is let out or taken in as the climber advances, keeping a minimum of slack between the roped partners so that any fall will be stopped as short as possible. If the climber does fall, the belayer tightens up the rope, braces against the stance and the anchor, and absorbs the force of the fall by the use of a belay device such as a stitch plate.

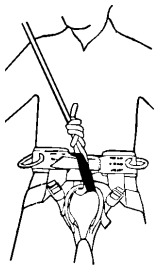
c. A climber with a belay from above (as in TOP ROPING), referred to as a ***number two*** or ***second***, can make difficult climbing moves in the blissful knowledge that any slip would merely take up the little slack and slight stretch of the rope. What makes LEADING or climbing above the belay so much more serious is the distance the falling leader will fall before the rope becomes taut and the belay can begin to hold the fall. Because of the great resulting forces, belaying the leader is as vital and demanding a task as any found in mountaineering. But, belaying is boring, and laxness is brought on by the relative rarity of hard falls. Alertness and appreciation for the importance of the belayer's role is critical. A leader belayed by a novice without this understanding or lacking knowledge and training in belay techniques would be wise to climb as if there were no belay at all. An old-timers saying "the leader must not fall", recognizes the difficulty of belaying a leader and the inadequacy of equipment and techniques of the time

d. Once a party begins belaying, the climb is divided into segments from one belay position to the next, each called a PITCH. Each pitch is limited by the length of the rope. Ideally, each belay point ending a pitch becomes the belay point for the leader of the succeeding one.

2. Methods of Belay. There are two methods of belaying a lead climber: Static and Dynamic.
   a. Static Belay.
      1) A static belay is a method that does not allow the rope to run through the belay device, therefore stopping the falling climber quickly. The belayer brakes immediately as a fall occurs. This way a belayer prevents any unnecessary slack from developing between himself and the climber.
      2) This technique is used when the belay anchors and the running belays are sound. It is also used to stop a falling climber from hitting any projection (a ledge or rock outcrop) that is below him when he falls. This is the most common belay used on rock.
   b. Dynamic Belay.
      1) A dynamic belay is a belay method that deliberately allows some of the rope to run through the belay device, thus slowly bringing the falling climber to a halt. As the belayer brakes he should gradually apply the braking force to the rope, this reduces the impact force on the belay anchors and the running belays.
      2) This technique is used when the belay anchors, and the running belays are not the best, and may not take the impact force of even a low impact fall. It is used mostly when ice climbing, although the technique is widely used when climbing unsound rock.
3. Types of Belay. There are two basic types of belays that may be set up, Indirect and Direct.
   a. Indirect Belay. The indirect belay is the type of belay you should be the most familiar with. (i.e. the belay for top roping). The term stems from the fact that you as the belayer are in between the anchor belay and the climber, therefore absorbing some of the ***impact force*** in the event of a fall. So the force of the fall goes indirectly to the belay anchor through you. (*To summarize, the belayer's body is part of the belay chain*.)
   b. Direct Belay. The direct belay exerts the ***impact force*** of a falling climber directly to the belay anchor. You as the belayer are not in the system, you just control the belay device as normal. There are many ways of setting up a direct belay. (*To summarize, the belayer's body is not part of the belay chain.*)
4. Components of the Belay Chain. The belay chain used in rock climbing can be divided into ***four*** basic parts.

a. The Harness. This can be the MWTC sit harness or any UIAA approved climbing harness.
b. The Anchor. The anchor is a term used to describe the method by which a static climber attaches himself (with the rope or additional equipment) to the mountain so that he cannot be pulled off his belay stance, the anchor can use either natural or artificial points, or a combination of both. The anchor can be either an *Indirect or Direct belay.*
c. Method of Belaying. The method of belaying describes the means by which the belayer uses to stop a fall by a lead climber; this can be either a *Static or Dynamic belay*.
d. Intermediate Anchor Points. These are points of Protection placed between the lead climber and the belay man by the lead climber. The points can be natural such as trees, chock stones, or rock horns. Or artificial pieces such as SLCD's or stoppers. The climber's rope is attached to the points using a carabiner. This will shorten a lead climber's fall and prevent him from hitting the ground.

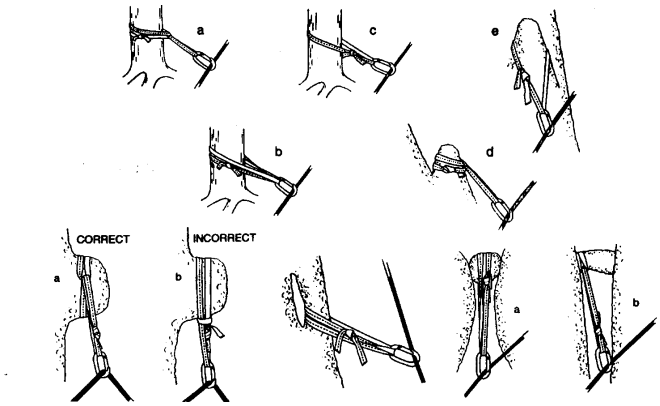
5. The Belay. As you can tell, a well planned and secured belay is essential, if the risk of serious injury is to be minimized while conducting climbing operations.
   a. Equipment. The following equipment is suggested for establishing anchors.
      1) MWTC sit harness, or any UIAA approved climbing harness.
      2) ***Two locking carabiners***.
      3) An 11mm kernmantle, dynamic rope.
      4) A climbing rack with Protection devices, quick draws and extra runners and cord.
      5) Any appropriate belay device. (i.e. Munter Hitch, stitch plate, ATC.)
   b. Principles of Belays.
      1) Belay anchors on the bottom should normally be behind the belay man and below his hips. On the top the anchors should be behind him and above his hips.
      2) The belayer or No. 2 man will normally be in a standing position on the bottom with his anchor and belay stance in line with the climbing route. On the top a sitting position close to the cliff edge is desirable.
      3) When establishing his belay stance on the bottom he should consider the risk of being hit by rock fall or possibly the lead climber and position himself accordingly. On the bottom, the No. 2 must also consider the use of a redirect depending on how far away his anchors are from the cliff. Guidelines for this are as follows:
         (a) If the anchor points (the point of attachment to the natural or artificial anchor) are within approximately 5 feet or closer, a redirect is not applicable.
         (b) If the anchor points are further than approximately 5 feet away a redirect should be used and the belay stance should be backed off 2-4 feet from the cliff (this is to ensure that escaping the system is possible, discussed later in *RESCUES*).



c. Securing an Artificial Belay Anchor. On arrival at the base of a climb, the No.2 climber's basic drill is as follows:

1) Examine the base of the climb for a good anchor point for the belay anchor, and a position from which to belay. Ideally the anchors and belay stance will be in line with the route that the No. 1 will take.

2) The No. 2 will then place his artificial protection in the rock, keeping in mind that the anticipated direction of pull if the lead climber fell would be in an upward direction. The No. 2 would place a minimum of two good points down low behind him, his third point can be placed in front of him to hold him in if he is belaying on a small ledge. ***The minimum amount of protection required to make a belay anchor, is THREE points.***



3) Once the protection is set in the rock:
   a) Both the No. 1 and No. 2 tie into the ends of the rope using a retrace figure of eight.
   b) The No. 2 then selects the furthest away anchor point and clips the climbing rope into it.
   c) He now connects the locking Main Anchor Carabiner (MAC) into the retrace 8 loop.
   d) Still holding the rope leading from the first anchor, the No. 2 moves to his desired belay position. Now the No.2 connects the rope to the MAC with a clove hitch.
   e) The climbing rope is then clipped into the second anchor point, and brought back to the MAC and clove hitched again. The clove hitch should now be adjusted for equal tension.
   f) The climbing rope is now taken directly to the third anchor and clove hitched into that anchor if it is within reach. If not, then an additional non-locking carabiner is clipped directly into the MAC and the clove hitch is placed on this carabiner. Finally, it is finished off by adjusting it so as there is equal tension on all three points.
   g) The No. 2 climber is now secure.
   h) A munter hitch, stitch plate, or any other type of mechanical belay device is added along with an additional locking carabiner. This additional carabiner is then attached to the MAC and once the carabiners are locked down, the belay is established.

2) Securing a Natural Belay Anchor. On arrival at the base of the climb, the No. 2 goes through the same basic drill; however, this time he finds that he can use natural anchors for his belay. ***The minimum amount of natural anchors that are required is TWO points***. The types of natural anchors and the method of tying onto them are as follows:
   a) Trees/Boulders. Trees or boulders are the most common natural belay anchors that are found at rock features, and common sense must be used to determine their ability to be used as a belay. For example a four foot thick Jeffery Pine or a 400 pound boulder would be an ideal natural belay anchor. Whatever their size, they should be inspected for safety and stability. When tying on to trees, branches, or boulders there are two methods you can use:
      (1) Take a long web runner and put it round the tree or boulder, where the ends meet, connect it with a carabiner. If you are worried about the runner slipping off, then use a girth hitch or clove hitch. Next, take the rope and clip it through the carabiner, bring the rope back to the MAC and secure it in the normal manner. (This is the easiest method). Ensure that the carabiners are loaded along the long axis vice the short axis.
      (2) Another method used on a single bomber anchor is to take the rope and run it around the tree or boulder. The bight that comes back to you is then clove hitched into the MAC. Next, pick up the running end and pull the slack out of it and clove hitch it to the MAC. This method can use up a lot of rope if the anchors are far away but is extremely efficient if used on a single bomber anchor that is close to the belay stance.

b) Spikes or Flakes. Spikes or flakes are reasonably common on most types of rock faces, though some types of rocks are notably devoid of good spikes or flakes. They can range in size and shape from tiny sharp flakes a few inches across to huge pinnacles. Whatever their size, they should be inspected for safety and stability. When using a spike or flake for belay anchor, position the rope on either the left or right side of your body, depending on which side you will be belaying. Next, take a large bight and run it around the spike or flake and clove hitch the center of the bight into your MAC. This method is very similar to anchoring to a tree or boulder.

3) Securing an Anchor with Natural and Artificial Anchors. Using a combination of the preceding two methods gives us our last way of setting up a belay anchor, and should enable you to be anchored just about anywhere safely.

a) When you arrive at your belaying position and, after inspection, you find that you are left with having to utilize both Natural and Artificial means, the method of construction is as follows: You should first tie into the natural using the method described in trees and boulders. Clip the rope through the carabiner in the runner, take it back to the MAC and tie the clove hitch. Then take the rope to the first artificial point, clip the rope into the carabiner then take it back and clove hitch it into the MAC. Finally, take the free end of rope and clove hitch it directly into the last piece of Protection if it is within reach. If not, bring it back to an additional non-locking carabiner attached to the MAC, and clove hitch it on the non-locking carabiner.

6. Basic Rules For Belay Anchors.
   a) Make sure that all points, whether natural or artificial, are safe and sound. You and your partner's life depend on it.
   b) A good natural belay anchor is always better than an artificial one.
   c) Always utilize a minimum of three points when using artificial Protection.
   d) Always utilize a minimum of two points when using natural Protection.
   e) If you are using one natural anchor it must be backed up by two artificial anchors.
   f) If in doubt, put in another point.

PARTY CLIMBING.- Two party climbing is the means by which trained military mountaineers ascend vertical to near vertical rock features. A party climb uses two or more experienced climbers, climbing with a rope and using runners for Protection. In the military, party climbing is used as a means of ascending a cliff face to set up ropes and other associated equipment from the top of a rock feature, to prepare the way for a unit to undertake a cliff assault, or as a means of crossing the obstacle.

1. The Belay. Where a belayer chooses to establish his belay is an important consideration. It is possible that the belayer may sit or stand for hours on end and a comfortable position should be chosen if possible. There are two basic stances, sitting and standing, and they can be used in most belay positions. Normally sitting is used on the top anchor and standing on the bottom.

2. Route Selection. A feature that is going to be used by the military for a cliff assault probably will not have a guide book written for it, although it is a faint possibility. Therefore, it is essential that a detailed reconnaissance be conducted to find the best route up a rock feature, and if possible the easiest. The reconnaissance needs to be done by the teams who are going to climb it, as they know their limitations. The following factors in assessing the feature for climbing should be taken into account:
   a. The best covered line of approach to the rock feature.
   b. The type of rock, the height and angle of the feature, and the approximate degree of difficulty of the chosen routes up it.

c. Can it be free climbed? Or will the assault climbers have to use direct aid techniques? If direct aid techniques are used can the main body follow?
d. Can it be ascended using natural lines of concealment, such as chimneys, chutes, shadows or overhangs?
e. Remember the number of men that are going to move over the obstacle and their degree of proficiency at ascending the types of lanes required.
f. Estimate number of lanes that can be used, and how much equipment is required for the task.
g. Observe from at least two vantage points to obtain a three dimensional understanding of the climbs to be attempted.
h. Use the early morning or late afternoon light, as the shadow it creates can be helpful.
i. A ground reconnaissance should always be made.

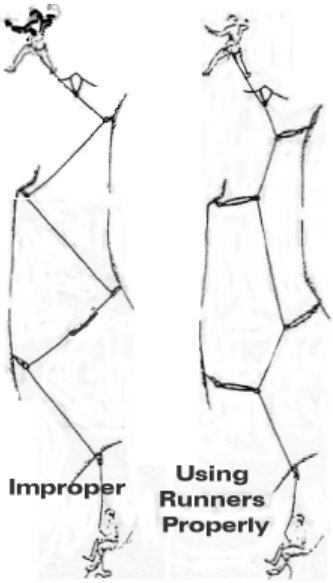
3. Dangers to Avoid When Selecting a Route.
   a. Wet or icy rock. These impediments can make an otherwise easy route almost impossible.
   b. Rocks overgrown with moss, lichen, or grass. These areas can be very treacherous when wet or dry.
   c. Tufts of grass and small bushes growing from loosely packed soil. These normally appear firm, but can give way suddenly when they are pulled or stepped on.
   d. Gullies that are subject to rock fall. If you have to use a gully that has evidence of rock fall in it, then try to stay to the sides.
   e. The most common danger is overestimation of your ability.

4. Lead Climber Responsibilities. Prior to beginning climbing the lead climber must perform these steps.
   a. Pre-select a probable route.
   b. Ensure that he has the proper equipment to complete the route.
   c. Ensure that the No. 2 has selected proper anchors for the belay anchor system.
   d. Ensure that the climber and the No 2 are tied into tier respective ends of the rope.
   e. When necessary, the lead climber will have to construct a gear rack to carry his equipment on. To construct it take a length of 1 inch tubular nylon webbing and tie the ends together using a water/tape knot forming a loop so it fits over your head and shoulder and runs diagonally across your chest. If tubular nylon webbing is not available, then utilize one of your runners, if the route will permit it.

1. Rules For Placing Protection. In the Placing Protection section the methods of placing protection were covered; however, there are four rules for placing protection that the lead climber must follow.
   a. First Runner Rule. A good piece of protection should be placed as high as possible just before leaving the ground to prevent taking a fall to the ground. Once that first piece of protection is at the lead climber's waist level, a second piece should be placed as high as possible. A third piece should be placed following the same guidelines as the second piece (this will reduce the chances of the leader bottoming out). The first runner rule will be repeated just after leaving the belay stance on a multi-pitch climb, to stop a potential Factor two fall (see Hanging Belays and Fall Factors).
   b. Every 10 to 15 feet. This is done to prevent the possibility of taking an unnecessary long fall.
   c. Before and After a Hard Move. A leader should place protection before and after a crux as it is the hardest section of the route and a fall is more likely. If you are not happy with that piece of protection, back it up with another one.
   d. When needed. **If you need one, put it in!** You are at the sharp end of the rope. "When in doubt….Stitch the route."
   e. When placing #1 or #2 stoppers always backup that piece of protection with a secondary piece as soon as possible.

6. Preventing Rope Drag. As the No. 1 climber climbs, placing protection as detailed above, he has to be conscious of where the rope is going in order to stop the problem of rope drag. Rope drag is at best an

annoyance, and at worst, can cause a leader to fall. Keeping the rope in a straight line from the belayer to the climber is the best way to reduce rope drag.



a. Reducing rope drag: Rope drag causes all sorts of problems. It can hold a climber back, throw him off balance, pull his protection out, and can 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.

b. If the protection placements do not follow a straight line up the pitch, and if the rope is clipped directly to these placements, it will zigzag up the cliff, causing severe rope drag.

c. The way round this problem is to extend the runners with a quick draw; this allows the rope to hang straighter and run more freely through the protection system. (Shown on left diagram.)

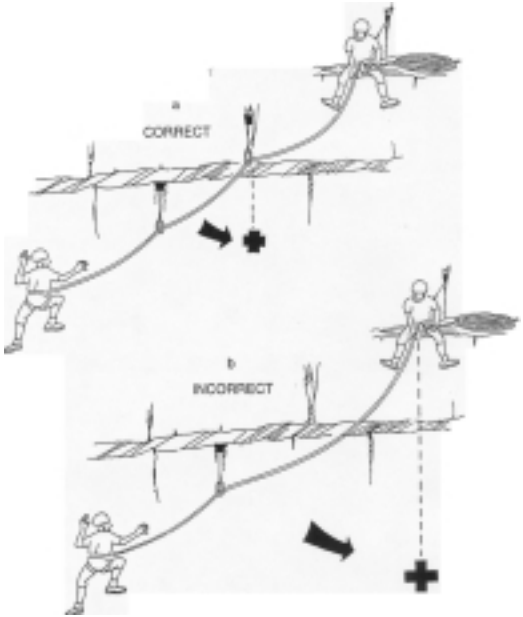
d. If you use an extra long runner you can create another problem. The extension may keep the rope in a straight line, but it may also add dangerous extra feet to the length of a fall. In such a case, it is sometimes better to accept some rope drag in order to have better security in case of a fall.

e. If the protection placements happen to be in a straight line, the rope will run straight and there will be negligible rope drag even if it is clipped directly to the protection. However, you must be aware that rope movement can and will jiggle, or "walk", a chock out of position. To that end, a quick draw is used to isolate the protection from rope movement.

f. Quick draws should always be placed on wire protection and SLCD's without pre-sewn runners that are used for intermediate points of protection. There is no requirement to place quick draws on wire runners used for a belay stance, unless you need some extension.

g. Quick draws do not need to be placed on corded hexcentrics or chocks unless you need extension.

h. Zippering: The full-scale zipper effect is a dramatic demonstration of the importance of anticipating force directions in the event of a fall. It happens when the belay is established away from the base of the climb. The rope runs at a low angle from the belayer to the first piece of protection on the cliff. There, the rope changes direction and goes directly upwards. In a leader fall, the rope goes taut and tries to run in a straight line from the belayer to the top piece of protection which is the one putting considerable pressure on the bottom chock. If it pulls out, the line of chocks could be yanked out one by one from the bottom up. Zippering may be prevented by using a SLCD as the first piece of protection or by using a redirect as described in *BELAYING FOR PARTY CLIMBING.*



7. <u>Considerations for Party Climbing</u>.

a. A two man climbing team is faster than a three man team.

b. The strongest climber of a team always takes the hardest pitch.

c. Climbers will tie into their harness with a retrace figure of eight, they will not untie until they are off the climb. (10 feet back away from the cliff edge)

d. As you climb you must use the correct climbing commands

e. Where possible, the leader should use natural anchors for protection.

f. The leader must not climb to the end of the rope before selecting a good belay stance, ideally 15 feet of rope is required for a belay anchor.

g. When the lead climber reaches a good position, he will set up a belay position and bring up the No. 2 climber. As the No. 2 climbs to reach the new belay position, he removes all the protection.
h. When the No. 2 reaches the belay position, he should stop and reorganize his gear for the next pitch, and then continue climbing.
i. If a traverse is encountered it is protected as described in the following diagram. The leader is not only protecting himself but also the No. 2 man as well.

8. Climbing Commands. During a climb, you will often find yourself in a position where you cannot see your climbing partner. This, accompanied by the effects of the wind, weather conditions and the distance between you, often makes communication very difficult. For this reason, we use a set group of commands in order to communicate with as little confusion as possible.
   a. Verbal Commands.

COMMAND	GIVEN BY	MEANING
"On belay"	Belayer	I have a solid anchor and am ready for you to climb.
"Climbing"	Climber	I am ready to begin the climb.
"Point"	Climber	I have reached a point where I am going to place Protection.
"Point"	Belayer	I am watching, giving or taking rope as needed.
"20 feet"	Belayer	Tells the leader he has 20 feet of rope left, repeated at 10 and 5 feet.
"20 feet"	Climber	I understand, and must find a belay position soon.
"FALLING!"	Climber	I am falling.
"Slack"	Climber	I need some rope.
"Slack"	Belayer	I will give you rope as you need it.
"Tension"	Climber	Take up excess rope.
"Tension"	Belayer	I am taking up excess rope.
"Off climb"	Climber	I am at the next belay and I am anchored with a minimum of one natural point or two artificial points.
"Off belay"	Belayer	I am off belay.

NOTE: At this point the belayer becomes the number 2 climber and the lead climber is the belay man.

COMMAND	GIVEN BY	MEANING
"Up rope"	No.2	Take up excess rope between us.
"That's me"	No.2	The climber is ready to be put on belay and the rope is taut on the climber and not snagged.
"On belay"	No.1	I have a belay set and I am ready for you to climb.

   b. Non-verbal Commands. When undertaking a tactical cliff assault the use of verbal climbing commands are not of much use. Also on long multi-pitch routes voices seldom are heard. Therefore, the climbing pair may utilize a method of sharp tugs on the rope to communicate with each other.

COMMAND	MEANING
1 Tug	Give me slack.
2 Tugs	Give me tension.
3 Tugs	I am secured on the belay/the rope is secure.

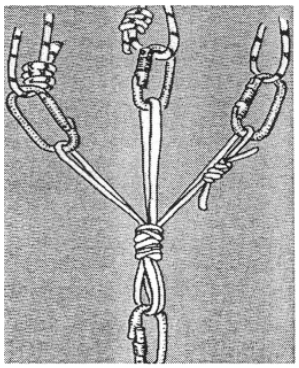
CONCLUSION: Two party climbing can be a very dangerous and trying experience, and that is with a partner you trust and you both have experience. All of the techniques covered here must be known thoroughly by each man prior to beginning a climb, from anchors to commands.

HANGING BELAYS AND FALL FACTORS. Eventually, as a climber you will come across a cliff that is taller than your rope is long. Obviously if the mission is to get over the cliff, it must be accomplished. Since our rope is only 165 feet long we must set in a belay along the route in the middle of the cliff. Possibly multiple times depending on how tall the cliff is.

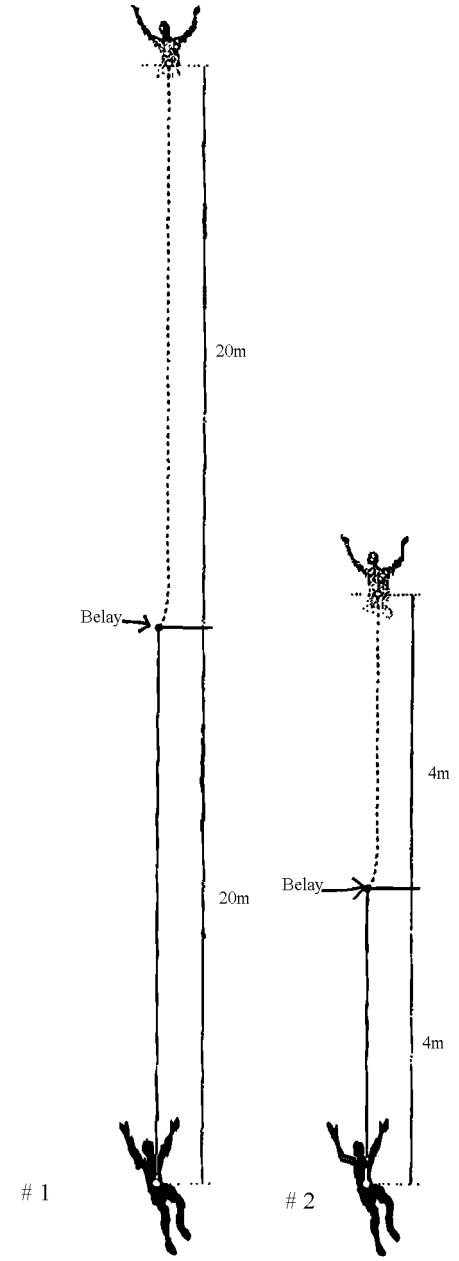
1. Rope Method. When choosing this method, it is important to remember that approximately 15 feet of rope is needed to construct the anchor.
   a. Construction of the anchor. The first step in constructing this anchor is to set in a good piece of Protection and either tie a clove hitch directly on this piece or clip into it as a normal piece of protection and tie a clove hitch on the anchor carabiner. This will provide more security while the second and third pieces of protection are being placed. If the decision is made to tie a clove hitch on the first piece of protection, it is necessary to come back to the MAC carabiner and tie a clove hitch onto it as in a normal belay anchor. Since the first piece will be the most obvious placement, it may not always be the farthest away, however the second piece to clip into will be the farther away of the next two. This piece will also be clipped into and a clove hitch tied onto the MAC. At this point the MAC will be locked down and the climber is "OFF CLIMB". With the third piece of protection, the rope will be clipped in and a clove hitch tied onto an additional carabiner that is clipped into a MAC. If possible, the climber should place a piece of protection below waist height with an anticipated direction of pull up. The reason for this is that the No. 2 climber will pass the belay stance and become the leader. This fourth piece of protection will prevent the belayer from being pulled up if the leader falls and if that happens on an anchor made of three passive chocks the results could be catastrophic. If a good placement can be reached the protection will be placed in and a clove hitch tied onto it. If a good placement cannot be reached the No. 2 climber can do it as he nears the belay stance. If there is nowhere to place a good piece of protection, one consideration is using one or more SLCD's in the construction of the anchor. At this point the next pitch continues as normal.
   b. Removal of Anchor. When the leader reaches the next belay stance, he secures himself to one natural of two artificial anchors and announces "Off Climb", the belayer will come off belay but will not begin to disassemble the anchor until the leader is on belay. Once he is on belay, the belayer will take the anchor apart in apart in reverse order, taking out the bottom piece first. As each piece comes out, the command "Tension" will be given to eliminate any slack in the rope. Once the last piece is taken out, the belayer may begin climbing.
   c. Figure Eight Equalized Anchor. Another option to the rope method is the figure eight equalized anchor that was taught *in Natural and Artificial Anchors*. To use this anchor in a hanging belay, the climber will place his first piece of protection at the belay and secure himself to it using a sling, cordage, etc. After

the second and third pieces of protection are placed, tie a large figure eight next to the retraced figure eight in the sit harness and clip into all three points of protection. Next, clip a locking carabiner to the top of the knot and pull a bite down from between the anchor and clip it into the locking carabiner. Equalize the anchor as taught in *Natural and Artificial Anchors*, and the climber is now off climb. The belay carabiner will be clipped into either the MAC, bottom of the figure eight knot, or the retraced figure eight in the climber's harness. If the climber belays off his harness, before he escapes the system he must secure the belay carabiner to the anchor carabiner. The redirect can be tied the same way as in the previous rope method, before the leader passes the belay stance. When removing this anchor, the belayer will wait until the leader is on belay and will untie the large figure eight loop giving the command "tension" to eliminate the slack.

2. Cordelette Method. This method is good because sometimes the extra 10 or 15 feet of rope may be required to get to a better belay stance.
   a. Construction of The Anchor: The first piece of protection is set in the same manner as the rope method. The climber again has the choice to tie a clove hitch on the protection or to clip into the protection and tie a clove hitch on the anchor carabiner. Once the second and third pieces are placed in the rock, the 21 foot Prussik cord, with the ends tied together with a square knot and two overhands, will be clipped into all three pieces with the square knot close to one of the pieces. A bight will be pulled down from between each of the anchors so that there are three equal bights pulling in the anticipated loading direction. Next, an overhand knot will be tied with the bights forming three separate, equalized loops. These three loops are clipped into the anchor carabiner, the carabiner locked and the climber is "Off Climb". With this method another piece of protection with an anticipated direction of pull up and a clove hitch tied onto it must be placed below the climber's waist. If this cannot be done, the alternatives mentioned in the rope method are available. At this point the belay can be established and the No. 2 climber brought up.



   b. Removal of anchor. Removal of this anchor is identical to the removal of the anchor tied with the rope method. Once the leader is "On Belay", the belayer can begin to disassemble the anchor in reverse order, calling for "Tension" to remove any slack in the rope.
3. Changing Over Gear. The most efficient method of multi-pitch climbing is for a pair of climbers to alternate leading pitches. At each belay stance the climbers will have to change over and reorganize the gear for the next pitch. When the No. 2 climber reaches the belay stance, the No. 1 climber will tie off the belay device and connect a web runner from his donut to the No. 2 climber's donut. Now the No. 2 climber is effectively secured so that the gear can be changed over.



4. Fall Forces. The general standard of climbing equipment is continuously being improved. Nevertheless, in the event of a fall by a lead climber an enormous force is applied on the belay system.

a. Impact Force. This is the amount of force the belay man has to exert on a falling climber through the rope, anchor and belay device to stop his fall. The amount of impact force needed to stop his fall is determined by the fall factor.

b. Fall Factor. Fall factor is simply the length of the fall divided by the length of the rope from the falling climber to the belay man. The equation looks like this:

$$\text{Fall Factor} = \frac{\text{Length of Fall}}{\text{Length of Rope From the Belay}}$$

This example shows that the length of the fall does not matter as much as the fall factor.

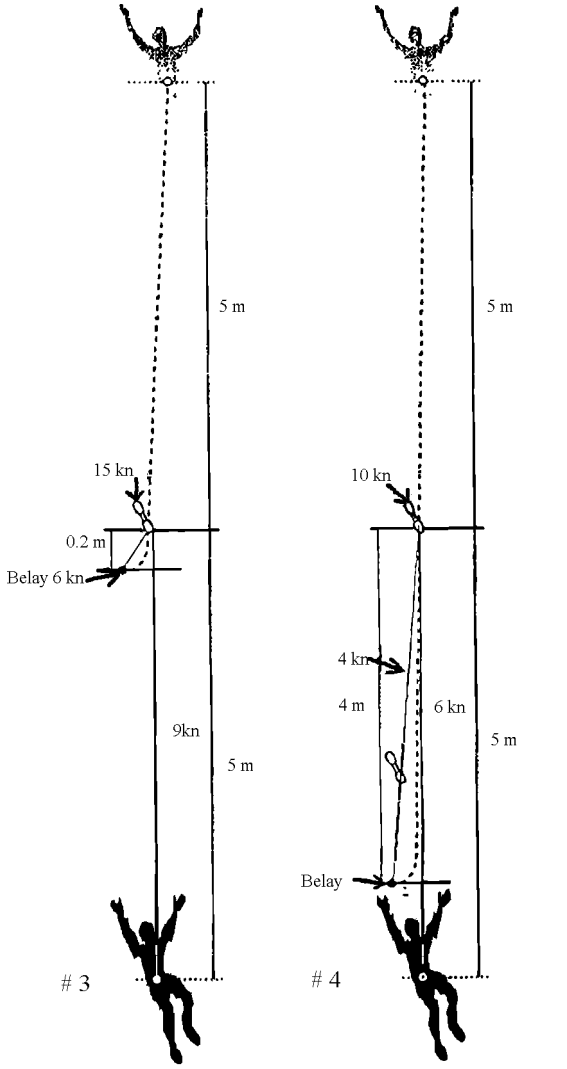
Example #1
40 meter fall on 20 meters of rope.

$$\text{Fall factor} = \frac{\text{40 meter fall}}{\text{20 meters of rope}} = 2$$

Example #2
8 meter fall on 4 meters of rope

$$\text{Fall Factor} = \frac{\text{8 meter fall}}{\text{4 meters of rope}} = 2$$

The impact force experienced by both climbers is the same, 9 KN or about 2,023 pounds of force. (A Kilo Newton (KN) is 224.8 pounds of impact force.)



Fall 10 m
Dynamic rope
length: 5.2 m
Fall factor:1.9
Shock force (on climber): 9kn
Shock force (on quickdraw):15kn

Fall: 10m
Dynamic rope
length: 9m
Fall factor: 1.1
Shock force (on climber):6kn
Shock force (on quickdraw):18kn

In example #3, the climber put in one piece of Protection 0.2 meters above the belay, and failed to put any more in from that point on. The leader climbed another 5 meters past that piece before falling, which means he fell 10 meters.

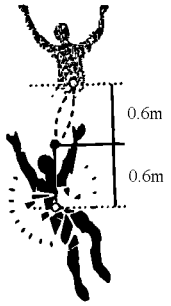
$$\text{Fall Factor} = \frac{\text{10 meter fall}}{\text{5.2 meters of rope}} = 1.9$$

The impact force on the climber was still 9KN, but look what happened at his piece of Protection. The impact force almost doubles on the piece of Protection.

In example #4, the leader put in two pieces of Protection with the last piece 4 meters above the belay. The climber the climbed another 5 meters without placing any Protection and fell.

$$\text{Fall Factor} = \frac{\text{10 meter fall}}{\text{9 meters of rope}} = 1.1$$

The impact force on this climber was 6KN, but again the force on the piece of Protection was almost doubled.



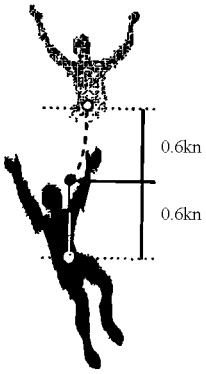
Fall: 1.2
Static rope or sling length: 0.6m
Fall factor: 2
Shock force: 18kn

The following examples show the difference between falls on static ropes and dynamic ropes.

In example #5, the climber anchored himself with a static double length runner (0.6 meters), and climbed as far above his anchor as the sling would let him before his fall.

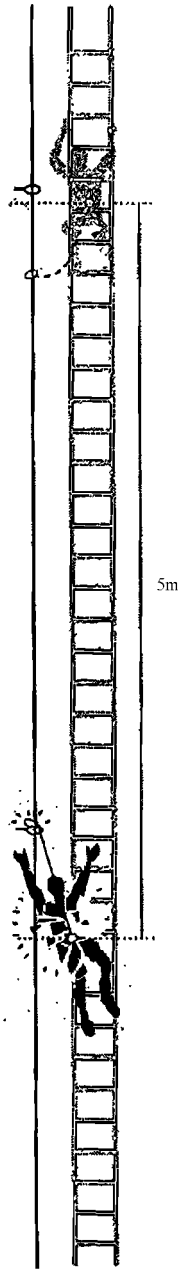
$$\text{Fall Factor} = \frac{\text{2 meter fall}}{\text{0.6 meter rope}} = 2$$

The impact force on a static rope doubles from that of a dynamic rope, so the climber hit with a shock force of 18KN or about 4,050 pounds of force. Enough to snap your bones, harness, gear, or the anchor.



Fall: 1.2m
Dynamic rope
Length: 0.6m
Fall factor: 2
Shock force: 7kn

In example #6, the climber was smarter and used a dynamic rope, but took the same fall. It was a fall factor of two, but because the dynamic rope stretched, it absorbed the majority of the force, he only had to sustain 7KN.



Fall: 5m
Length of rope: 1m
Fall factor: 5

Equipment Failure
Fatal Fall

Here is a lethal example of fall forces at work. The climber was clipped into a fixed rope next to a caving ladder on a vertical cliff face. The intermediate anchors were 5 meters apart, and his safety line was about one meter long. The fall happened before the climber clipped into the next anchor and he fell to the one piece 5 meters below him.

Fall Factor = $\frac{\text{5 meter fall}}{\text{1 meter rope}} = 5$

We do not even care about how many kilo newtons of impact force was generated, because our gear will not sustain that type of fall. This is the exact reason that we do not use fixed ropes on a vertical to near vertical cliff face.

This table shows what impact force a 180 pound climber sustains in different fall factors.

FALL FACTOR	IMPACT FACTORS
0	360 pounds
0.1	683 pounds
0.2	868 pounds
0.4	1,137 pounds
0.6	1,347 pounds
0.8	1,521 pounds
1	1,676 pounds
1.2	1,817 pounds
1.4	1,947 pounds
1.6	2,067 pounds
1.8	2,181 pounds
2	2,288 pounds

5. Considerations For Hanging Belays.
   a. Using multiple cracks for protection is better than stacking three pieces in one crack.
   b. It is better to stop at a ledge that is wide enough for the climbing team to stand on than to set up a true hanging belay.
   c. Do not stop and set up a hanging belay just before a crux move or underneath a ceiling unless necessary.
   d. To keep the rope out of the way, the belayer can stack the rope on his leg or in front of him by his waist.
   e. The belay anchor must be strong enough to with stand a factor 2 fall.
   f. The leader must always use the first runner rule to prevent a factor 2 fall.
   g. Any fall involving a fall factor greater than 1 is a serious fall and the rope should never be used for climbing again. After a factor 2 fall the rope should be destroyed.

RESCUES FOR PARTY CLIMBING: Climbing and mountaineering by their very nature are activities that involve a certain amount of risk, butmany of these risks can be eliminated or reduced by sound training, common sense, and by wearing and using the right equipment for the task at hand. However, accidents may occur even though you have taken all prudent precautions to protect yourself and your partner. You may very well find yourself having to rescue your partner or even have to be rescued yourself. It is therefore important that you should have a good working knowledge of the basic self help and rescue techniques used.

1. Determining the Need to Conduct a Rescue. A party climb rescue can become time consuming and precious minutes are involved when dealing with injuries. Whenever an injury occurs while climbing, whether it involved the #1 or #2 climber, you should first assess the situation and determine the following:
   a. How severe is the injury?
   b. What is the location on the cliff? (i.e., 10 feet off the ground, or 100 feet up on the 6th pitch of a 10 pitch climb)
   c. How much gear is needed to conduct a safe rescue and do you have the gear?
   d. How familiar are the climbers with the rescue techniques?
   e. Whether to leave and go for help or remain and conduct the rescue yourself?
   f. Are other climbing teams in the area to assist the rescue attempt?
   NOTE: The answers to the above questions will determine whether a lead climber rescue should be attempted.

2. Escaping the System. This is a term used to describe the techniques of releasing one's self from the belay, while ensuring that the climber you are responsible for is safe and secure. The reasons for escaping are varied and too numerous to mention; however, once you have established the need to escape, you should work logically, safely, and try to keep it as simple as possible. The procedures are as follows:
   a. Lock the Climber Off!! Once the belay device is locked off pass a bight through the belay device carabiner. Tie the belay device off around the load rope with two-half hitches. An alternate method is to tie a thumb knot backed up with a carabiner.
   b. Untie your retraced figure of eight knot and pull the end of the rope out through your harness.
   NOTE: If you are off the ground, ensure you are anchored off before untying your retrace figure of eight knot.

3. Rescue an Injured Lead Climber. When conducting two party climbing there is a greater chance that the lead climber will suffer injuries from a fall vice the #2 climber who is being top roped.
   a. If other teams are available for assistance there are two options:

1) If the other team is on top, they can set up a rappel lane and conduct a tandem rappel.
2) If the other team is on the bottom, they can party climb up to the victim and the leader can establish a hanging belay as described in *Hanging Belays and Fall Forces*.
   (a) The leader will pull up all of the rope and tie a figure 8 loop in the end of the rope. This loop will be clipped into the victim's donut with a locking carabiner.
   (b) Next, the leader will establish a belay to the victim and tie the belay off.
   (c) Finally, the victims retrace figure eight can be untied or cut if necessary. The leader can now untie the belay and lower the victim to the ground.

NOTE: A climbing rope will not be cut unless it is a true emergency and extreme caution must be taken so that only the victims rope is cut.

b. Ascending the Cliff Face. The climbing rope must be ascended in order to reach the injured climber since he can not be lowered to you. However, before you can ascend the climbing rope you need to determine whether the piece of protection that is holding the fallen climber is still set well enough to hold the weight of both you and the fallen climber. Escape the system as described above.
   1) If you feel there is a chance that the piece of protection will not hold the weight of both individuals, you will probably want to back it up with another piece before attempting to rescue the fallen climber. Therefore, the following steps should be conducted in order:
      (a) Utilizing a long Prussik cord, tie the cord onto the climbing rope with a middle of the rope Prussik knot and with free ends of the rope tie stirrup hitches for your feet. Above that tie a small Prussik cord onto the climbing rope using either an end of the rope or middle of the rope Prussik knot and connect that to the hard point of your harness.
      (b) At this point ascend the climbing rope utilizing the Texas Kick method, unclipping each piece of Protection as you approach it and then clipping it back in as you pass. Continue this process until you have reached the top piece of protection.
      (c) At this point back up that piece of protection with another piece of protection.
      (d) Now that you are secure, you may descend the rope removing the pieces of protection on your way down, you should also stop and take the time to apply essential first aid to the casualty and then continue down the rope until you reach the bottom.
   2) If you feel there is no chance that the last piece of protection, that is holding the fallen climber, will come out when you ascend the rope, or if you have already backed it up utilizing the above steps, the following should be conducted in order:
      (a) First, escape the system as described.
      (b) Utilizing a long Prussik cord, attach a middle of the rope Prussik above the belay device on the loaded rope.
      (c) Utilizing both free ends of the Prussik cord run the free ends down through the MAC carabiner and back up until all the slack has been taken out of it.
      (d) Wrap the free ends around the tightened cordage about 4-6 times, then pull a bight through the slot at the top of the cordage near the Prussik knot and place a non-locking carabiner into the bight to ensure that the mariners knot does not come untied.
      (e) Unlock the belay device and gently release the load onto the mariner's knot, and then take out the belay device.
      (f) Replace the belay device, only this time put the belay device onto the donut of your harness and lock it off.
      (g) Untie the mariner's knot and lower the casualty's weight onto the belay device so that the weight is back on you.

(h) Next tear down the bottom anchor so that the only thing that should be holding you and your casualty in place will be each other's weight.

NOTE: As long as your weight remains on the load rope your #1 will not move.

(i) With the Prussik knot still in place, take one of the free ends and connect it to the hard point of your harness. The other free end will be used in the form of a stirrup hitch in which one of your feet will be placed.

(j) At this time you are ready to ascend the climbing rope, to do so unlock the belay device keeping it in the brake position. With your foot in the stirrup hitch, move the Prussik knot as high as you can get it. Then stand up completely taking up the slack on the belay device. Continue this procedure until you have reached the casualty taking out the protection along the way.

c. Descending the Cliff Face. To descend the cliff face with a casualty can become both time consuming and gear intensive depending on how high off the ground you are. Follow the steps below to descend a cliff face:

1) Once you have reached the climber, tie off your belay and apply essential first aid to the casualty if you have not done so already.
2) Pull up your end of the rope that you were originally tied into and tie it into the casualty's harness with a figure of eight knot clipped into a locking carabiner.
3) From the end of the rope that is tied into the casualties harness, take 4 feet of slack and put the climbing rope into a separate belay device and tie it off.
4) Untie your original belay device and lower both yourself and the casualty down at the same time until either you reach the ground or just about to run out of rope.
5) If you are required to use the full length of the rope because you are on several pitches off the ground, stop just before running out of the rope and find a place to put another piece of protection.
6) Once you have placed your protection, lower yourself and the casualty down again until that 4 feet of slack that is tied off between you and him is lowered down on that protection.
7) Now untie the casualty's retrace figure of eight knot from his harness and pull the rope down through the top piece of protection and retie the end of the rope back into the casualties harness using a figure of eight knot clipped into a locking carabiner.
8) Take another 4 feet of slack and put the rope back into the second belay device and tie it off.
9) Now, untie the belay device that has you and your casualty secured to the protection and lower off again continuing this process until you are both on the ground.

4. Rescue an Injured Number Two Climber. In some circumstances you may have to rescue the No. 2 climber. Normally he will be either injured from a falling rock and possibly unconscious. There are several ways to assist an injured No.2 climber but only a few of which will be covered here.

a. Assisted Hoist. The assisted hoist is most frequently used in situations where your second is unable to climb a particular part of a climb or he may have fallen off to one side and is unable to get back onto that climb. It is not necessary for the rescuer to escape from the system to set up the hoist, however in some circumstances it may well be easier to set up and work if you get yourself out of the system, but remember to secure yourself once you are out.

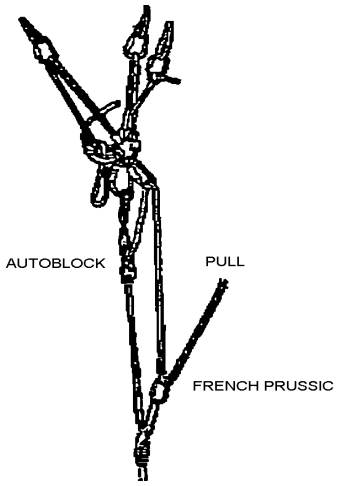
NOTE: This system can only be set up and used if you are within 1/3 of the ropes length of each other.

1) Tie off the belay device. Attach an Autoblock knot on the load rope, then secure it back to the MAC, and slide it down until all the slack is taken out.

NOTE: Make sure that the Autoblock is not to long; no more than 1 foot from the belay device. Otherwise, it will slide out of arms reach when loaded.

2) Take a bight in the loose end of the rope and clip a carabiner into it.
3) Lower the bight and carabiner down to victim and tell the victim to clip it into the waist belt tie in point of their harness, making sure that the rope is not twisted.
4) Untie belay device and gently lower victims weight onto the Autoblock, victim pulls the center downward moving rope.
5) Both rescuer and victim pull at the same time, the victim walks up the rock face to assist the hoist. Should either require a rest, you simply lower the victim's weight onto the Autoblock.

b. Unassisted Hoist. There may be circumstances on a multi-pitch climb when you might need to hoist an injured or unconscious victim rather than try to lower them down to a stance. If you should be unfortunate enough to be in this type of situation, then a pulley system will save you a lot of energy and back ache. Although it still requires a certain amount of both to hoist a victim any distance.



1) Three-To- One Hoist. One of the simplest of the pulley systems to set up, but remember to work logically and safely.
   a) First, tie off your belay device and escape from the system as previously mentioned and anchor yourself off.
   b) Attach an Autoblock to the loaded rope and secure it back to the MAC, slide it down until slack is taken up.
   c) Untie the belay device and gently release the load rope onto the Autoblock.
   d) The load rope is then secured by retying the belay device.
   e) Take a short Prussik loop and put a French Prussik onto the load rope as far down as you can reach, and clip in a carabiner.
   f) Untie the belay device and take the slack rope from the carabiner at the anchor point and run it down and back through the French Prussik carabiner previously placed on the load rope.
   g) The victim's weight is now hanging on the Autoblock that was put on after you escaped from the system. It may be necessary to shorten the Autoblock closer to the anchor point for greater effectiveness; this can be done when the weight has been taken off the Autoblock during hoisting.
   h) To hoist the victim, you pull on the slack end of the rope. The victim can help by walking, if he is conscious.
   i) As you pull, the French Prussik will come up to meet the Autoblock. At this point lower the victims weight onto the Autoblock and then slide the French Prussik back down the load rope as far as possible. This procedure is repeated until the victim is where you need him. If there is enough space you can attach the pulling rope to your harness through your belay device, and use your body weight instead of your arms.

2) Improved Three-To- One Hoist. The three-to-one-hoist just described, although simple to set up, can be difficult to put into practice in a less than perfect situation. It can be improved with a simple addition:

(a) Set up the system as for a three-to-one-hoist, tie a figure of eight on the bight in the slack end of the rope and clip it into the MAC.
(b) Tie a Prussik onto the original three-to-one pulling rope and clip the Prussik into the slack rope that has the figure of eight clipped into the MAC, this rope now becomes the pulling rope.
(c) To hoist, simply pull the slack rope and the French Prussik comes up to the Autoblock. Lower the victims weight back onto the Autoblock and slide the French Prussik back down the load rope as far as possible. Slide the Prussik back down the slack rope until all the slack rope is taken up and carry on with the procedure.

NOTE: Pulleys can be put into the system, or double carabiners can be used to reduce the friction.

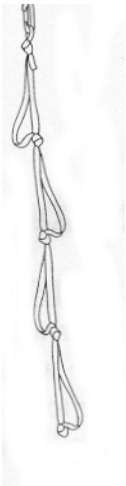
5. Leaving the Victim. Of course, this choice is as a last resort only. However, should you take this option, then make sure that the victim is as comfortable as possible and not likely to expire while you go for help. It may be necessary to rig a full body harness to ease the pressure and distribute their weight evenly.

CONCLUSION: All of these methods are very intensive and need to be practiced regularly before climbing. Three pitches off the ground is not the place to be wishing you could remember how to rescue a fellow Marine.

MILITARY AID CLIMBING: Occasionally, a military climber may find himself up against a rock barrier, that has insufficient handholds, or foot holds to climb. Or hat the technical grade is above what he can climb. One way or another, the climber has to get to the top of the cliff in order to complete the mission. Using aid techniques can get a climber through a tough section where he would normally be stuck and unable to continue.

1. **INTRODUCTION TO AID CLIMBING** A free climber depends entirely on his footwork, ability, skills and physical strength to move up the rock face. The equipment used while free climbing is for safety; i.e., protection. Equipment is not used to ascend the rock directly. If you were to place a piece of protection and hang on it, or use it to reach a higher hold, you would not be free climbing in the "pure" sense of the word. Any use of equipment to directly ascend a rock face is called aid. Aid techniques are used when a section of rock cannot be free climbed and equipment must be used to make progress up the rock.

2. **GEAR FOR AID CLIMBING.** Some specialized gear is required for aid climbing; however, this gear can be constructed from the equipment a climbing team already possesses.



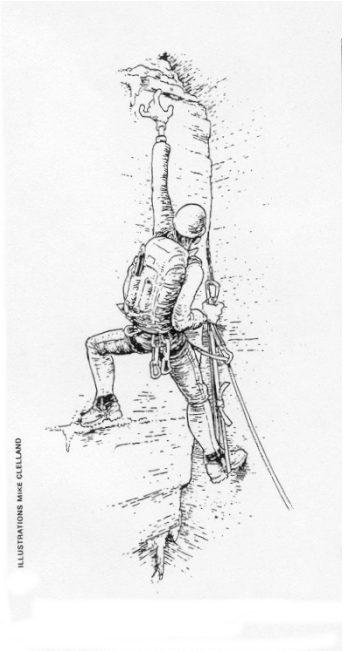
a. Etrier. These are ladder like slings that allow climbers to step up from one placement to the next when they are clipped into a piece of protection. Etriers can be constructed from an 18 foot tape or 21 foot Prussik cord (tied in a loop with a square knot). At the top of the web/cord, tie a two inch 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.

b. Daisy Chain A length of webbing or cordage with clip in loops along its entire length used to connect a climber to a piece of protection. 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 only 3 to 6 inches apart and on the same side. Keep in mind that the daisy chain should not extend beyond arm's reach.

3. **TECHNIOUES USED IN AID CLIMBING**

a. The simplest form of aid climbing is what is known as "hang dogging" in the civilian climbing community. This involves clipping into a piece of protection, having the belayer take in all the slack and locking the belay device off so the climber can rest.

b. Another type of aiding is using protection to pull up on or stand on. Called “French Free” in the climbing community. The most basic method is using aid for one move. 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 stability of the piece of protection. Step up higher in the etrier and bypass the difficult move. If the problem is lack of a handhold, a short web runner can be clipped into the protection and used as a handle, or a long runner or piece of webbing can be improvised to use instead of an etrier.



c. Aiding through multiple moves is more difficult and time consuming.

(1) The first aid movement is the same as just mentioned but when the protection that the etrier is clipped into is at waist level, set in another piece of protection and test it.

(2) If it is a solid piece, clip the daisy chain into it. Once your body weight is on the daisy chain, retrieve the etrier and clip it into the piece that the daisy chain is clipped into.

(3) Finally, clip the rope into the piece of protection that is at waist height. Never clip the rope into the piece that you are aiding on.

d. The #2 climber will also have to climb through the aided sections. He can use an etrier to move up until the protection it is clipped into is no lower than knee level. The belayer will lock him off so he can unclip the etrier, retrieve the protection, and clip the etrier into the next piece of protection if necessary.

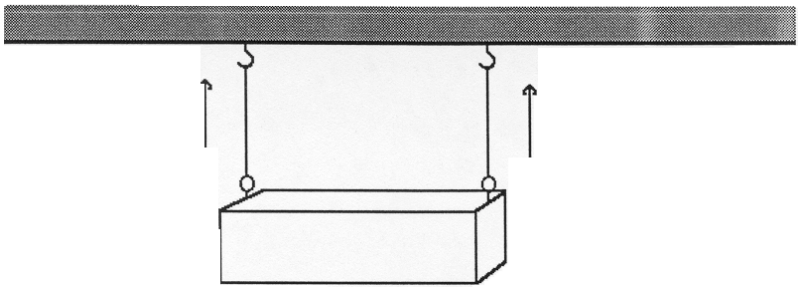
CONCLUSION: This method of direct aid is intended only to assist you in making it over short hard sections that were not recognized in you initial reconnaissance of the route. Do not use this on a route that is designated as a Direct Aid route. While it is good to get a certain degree of practice in this method. Still concentrate on your climbing ability to get you through a climb in training.

CHAPTER 6
ROPE INSTALATIONS

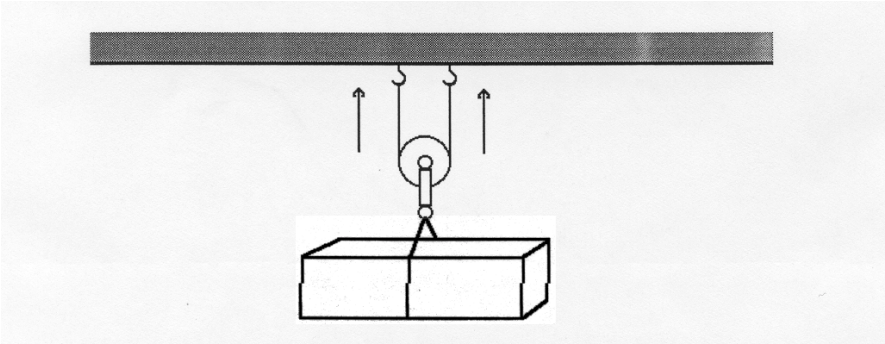
MECHANICAL ADVANTAGE SYSTEMS FOR LIFTING AND TIGHTENING:

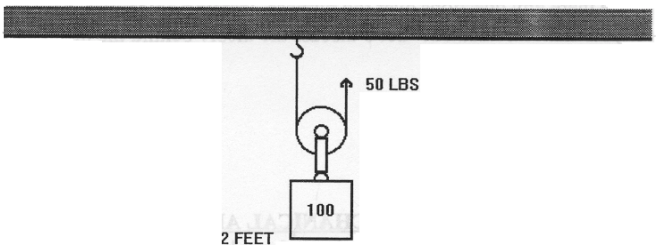
1. **BASIC THEORY OF THE MECHANICAL ADVANTAGE SYSTEM.** How can a man weighing 200 pounds lift a load three times his weight with ease?

a. Consider first the heavy block in the diagram below suspended from two ropes. 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 rope is under tension equal to half the weight of the block.



Now look at the diagram below where the block has been attached to a pulley. There is now only one rope that 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, since it exerts two upward forces on the block.





c. The Work Principle

1) While pulleys are useful, they do not give something for nothing. Ignoring the problem of friction, the input and output forces are in inverse ratio to the respective distance. To solve this we use this

$$\frac{\text{EFFORT}}{\text{LOAD}} = \frac{\text{LOAD DISTANCE}}{\text{EFFORT DISTANCE}}$$

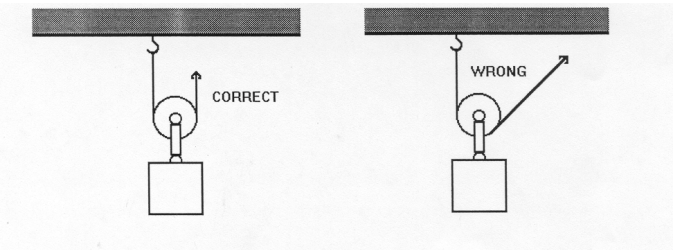
EXAMPLE*:* If you have a 2:1 ratio system and the load weighs 100 pounds and you want to raise it up two feet, the formula is:

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

2) You would have to pull the line four feet to raise the load two feet, but the effort to raise 100 pounds with a 2:1 ratio system would be 50 pounds to bring the load into equilibrium.

3) The frictionless pulley, then, does not alter the product of force and distance; it is the same for the mover who pulls on the rope as it is for the piano. The product occurs repeatedly in physical situations so it is given a special name: Force times distance is called WORK.

4) Work is done whenever a force moves something through a distance. If you stand still holding a boulder over your head, you might get tired, but in the physical sense, you are doing no work.



5) There is another limitation on the definition of work. Only the force in the direction of motion counts. For example: If you are pulling a sled with a rope attached to the front, the tension in the rope is pulling the sled, but it is also lifting the sled. Only the component of the force that is acting in the direction of the sled is going is doing the work on the sled. What does this mean? The angle on which you direct the pull of your system will determine the actual advantage that it will receive.

2. **CONSTRUCTION OF THE RATIO SYSTEMS**

a. Construction of a 1:1 ratio system

1) Anchor the pulley to a suitable anchor point.

2) Anchor one end of the rope to the load.

3) Run the other end of the rope through the pulley.

4) To bring the load into equilibrium, pull the rope until there is tension on the system. If the load weighs 100 Kg, theoretically it should only take 100 Kg of force to lift the load, but due to friction it may require 110 Kg of force to bring the load into equilibrium. To lift the load one foot, you will have to pull the rope one foot.

5) If you add another pulley and put the rope through, you do not gain any advantage, all you are doing is changing the direction of the force applied.

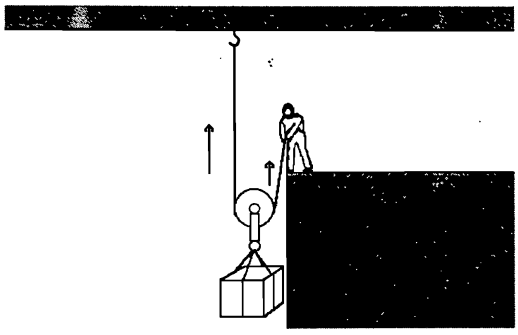
b. Construction of the 2:1 ratio system (C-pulley).

1) Anchor one end of the rope.

2) Attach a pulley to the load.

3) Make a bight with the rope and insert it into the pulley.

4) Now you can raise the load. With the amount of force equal to half of its weight.



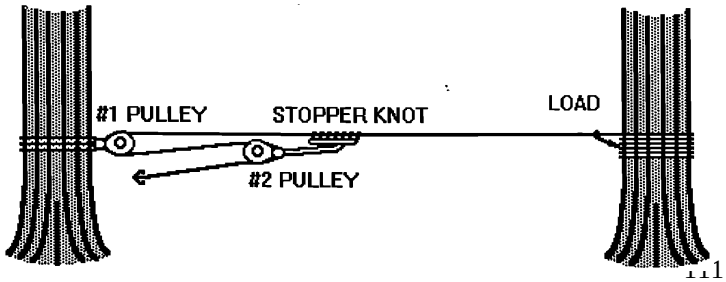
5) To lift the load two feet with this system, you must pull four feet of rope through the pulley.

6) When each rope is in equilibrium, it is divided by two. So if the load weighs 100 Kg, each line has 50 Kg of supported weight.

c. Construction of the 3:1 ratio system (Z-Pulley)

1) For Tightening a Rope Installation:

a) Anchor one end of the rope to a suitable far anchor.



b) Run the running end of the rope around the rear anchor or tie a swami wrap around the near anchor, attach a carabiner with a pulley clipped into it and run the rope through the pulley. All we have done up to this point is change the direction of the rope.

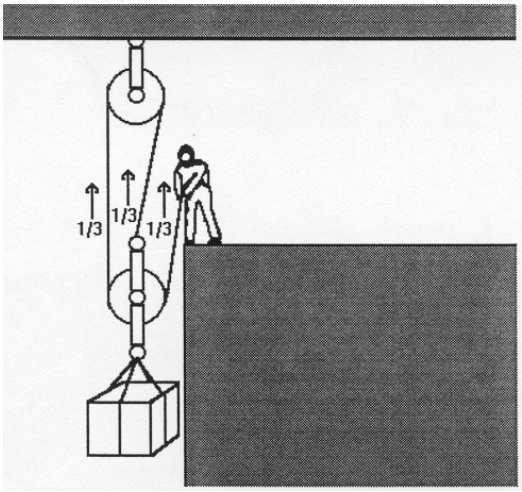
c) On the rope running from the far anchor point, tie some type of stopper knot, i.e., Kliemheist, Prussik etc. Clip a carabiner in the bight of the stopper knot and then attach a pulley into the carabiner. Run the running end of the rope through the pulley.

d) Now pull the running end of the rope to tighten the rope installation.

2) For Lifting Loads:

a) Attach a load to the pulley.

b) Attach a pulley to a suitable anchor point.



c) Anchor the end of the rope to the pulley attached to the load.

d) Run the running end of the rope through the pulley that is attached to the anchor.

e) Take the running end of the rope and run it through the pulley that is attached to the load.

f) Lift the load with the running end of the rope.

g) To lift the load two feet with this system, you will have to pull the rope six feet. Each line of the rope is taking one-third of the weight of the load, so if the load weighs 120 Kg, then it will take 40 Kg of force to lift the load.

d. Construction of the 6:1 Ratio System (Z-C Pulley). This next pulley system Probably has a lot of friction; still, if you want to raise the load 5 feet, how much rope would you have to pull through the system? Friction does not affect the geometry of the system, you still have to shorten all six supporting lines, so in order to lift the load 5 feet, you must pull 30 feet of rope through the system. The running end you are pulling does not count because it is not connected to the load.

1) Unfortunately there is a limit to how much you can reduce the effort. The analysis we have done so far neglects a few things such as friction and the weight of the movable pulleys themselves. Every time you add a pulley, the friction in the system is reduced. If you use a movable pulley that produces a reduction in force, you have to lift it along with the load. The effort in any real system is always larger than the ideal effort we calculate by dividing up the load. If you are using a lot of pulleys, it may be considerably larger, and friction while it increases the force you might exert, has no effect on the distance you have to pull that rope.

2) For tightening/lifting:

a) Anchor one end of the rope to the load.

b) Take the running end of the rope and run it through the pulley at the first anchor, i.e. tree with a swami, snow stake, ice screws, etc.

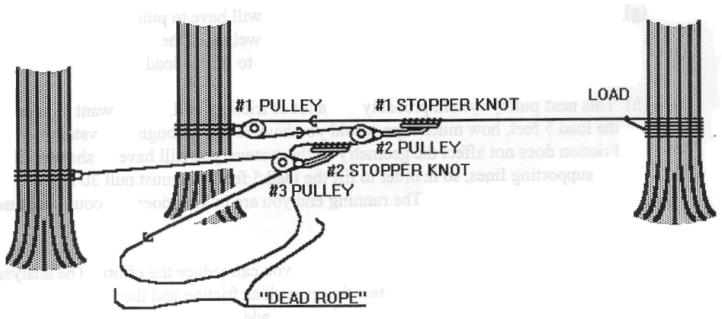
c) Attach a stopper knot to the rope running from the load, then attach a carabiner with a pulley into the bight of the stopper knot and run the running end of the rope from the first anchor through the pulley.

d) So far, all we have done is make a 3:1 ratio system (Z-Pulley).

e) Find another anchor just off set, but in line with the first anchor and ensure that it is at least ten feet from the first anchor.

f) Take the running end of the rope and tie a figure-of-eight loop on the end of the rope and attach it to the second anchor.

g) Where the running end of the rope comes out from the stopper knot, attach a second stopper knot and then attach another carabiner and pulley into the bight of the second stopper knot.



h) From the second anchor, pull the rope with the figure-of-eight loop and make a bight and run it through the pulley from the inside to outside.

i) Care must be taken to avoid breakage of the pulleys and ropes while using the 6:1 ratio system.

NOTE: The 2:1 ratio system that makes up 1/2 the 6:1 ratio system can be made with different rope, if necessary.

j) Since you have a 2:1 ratio system (C-Pulley) pulling a 3:1 ratio system (Z-Pulley), you multiply the ratio and that's how we get a 6:1 ratio system (Z-C Pulley). The rope that is off to the side has nothing to do with the system, so use good rope management.

NOTE: Care must be taken when increasing the ratio system. Breakage and damage of the ropes, carabiners and pulleys is very possible if the force end of the rope is greater than the load end of the rope.

CONCLUSION: While all of these different systems and ratios can be confusing. A little time doing them and they become second nature. Remember these are used not only with the one rope bridge but also in glacier travel to raise your partner out of a crevasse if needed.

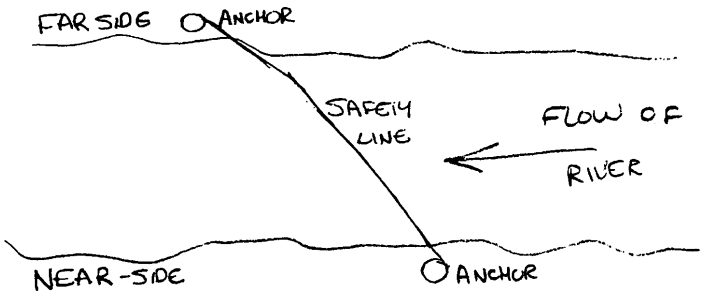
ONE-ROPE BRIDGE: At times in mountainous terrain, it will become necessary to cross rivers or streams. If the obstacle is a river, it can normally be crossed by utilizing various fording techniques. If it is a ravine, you may have to rappel down one side and scramble up the other. The most expeditious technique that can be used for crossing such an obstacle, particularly where a large number of men are involved, is by using a man portable easily erected and dismantled rope bridge.

1. **SITE SELECTION**

a. The two criteria for site selection for a one-rope bridge are:

1) There must be suitable anchors on both sides of the stream.

2) The anchors must offer good loading and unloading platforms.



b. Other considerations involved are:

1) There must be suitable anchors on both sides of the stream.

2) The site chosen for the lead swimmer to cross should be free from obstacles in the water, such as large boulders, stumps, or logs.

3) The anchors must be close enough for the 150 foot coil to reach. Keep in mind that it will take approximately 1/3 of the 150 foot rope for tightening and anchoring the bridge.

2. **Construction:**

a. Organization. If a river has to be crossed, then the following method is to be used by the squad/platoon. First the squad will bread down into three teams.

1) The Bridging Team - consisting of the bridge NCO and another Marine

2) The Safety Line Team - consisting of the lead swimmer and his belay man

3) The Mule Team - consisting of 3-6 Marines, depending on the length of the bridge

b. Once the bridge NCO has designated the site for the bridge, the Safety Line Team will move up stream from this site to enter the water. Their first step is to flake out the rope. The lead swimmer will then take a bight of the rope and tie a figure 8 loop at the end that will be going to the far side, ensuring the knot has a

18"-24" loop. The lead swimmer's upstream arm will go in it, with the belay man tending his rope the lead swimmer will cross the river using the flow to assist him. (Ferry angle as taught in STREAM CROSSING)

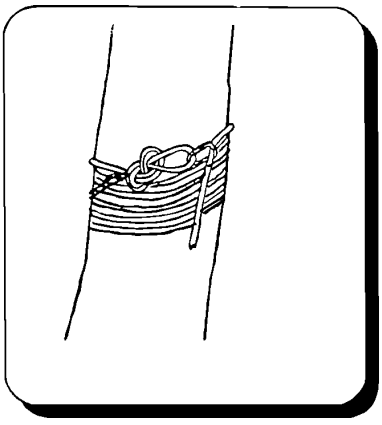
c. At the same time as the lead swimmer is crossing, the bridging team will be preparing the near side anchor. The bridging team will tie a swami wrap around the anchor, using a sling rope or practice coil, and ensuring the square knot is behind or on the side of the anchor. Once the anchor is secure, flake out the bridging line in order to send it across.

d. Once the lead swimmer is across he will move to the site where the far side anchor will be established and secure his rope. The belay man will then move down to the near side anchor, and as close to the waters edge as possible. He will attach the bridging line to the safety by tying a middle of the rope figure 8 knot to the safety line and an end of the rope figure 8 knot to the bridging line connecting the two ropes with an 85 carabiner. The lead swimmer will then pull the rope across. The belay man with the help of another Marine will belay the bridging line across keeping tension on the rope to keep the rope out of the water.

e. After the bridging line is across the lead swimmer will detach the bridging line from the safety line and secure it to the far side anchor using a tree wrap, wrapping from right to left, ensuring there are 3-5 wraps.

f. Once the bridging line is secure. The lead swimmer and the belay man will secure the safety line on both banks, ensuring the rope is creating a ferry angle (45°). This will be the safety line for the Marines crossing the bridge.

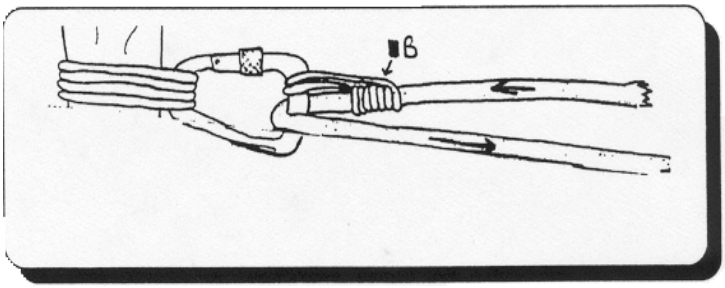
NOTE: If the distance is over 100 ft or the fall would be over 20 ft high, the safety line will then be anchored parallel with the bridge and hand tightened. The Marine crossing will need to clip in to both ropes before crossing.



g. On the near side bank:

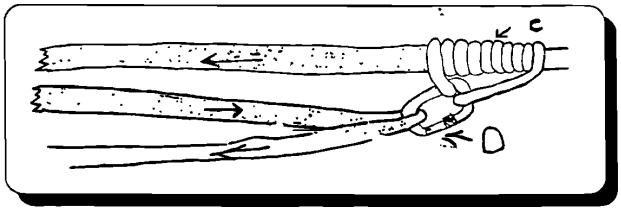
1) The bridging team will need the following gear to build the mechanical advantage: 4 Locking carabiners, 3 Three foot Prussiks

2) Once the bridging line is secured on the far side, the bridging team will take one locking carabiner and clip it into the near side anchor (swami wrap). Then they will take the bridging line and clip into that locking carabiner, then using one three foot long Prussik (16" loop) the bridging line will be secured to the locking carabiner by tying a French Prussik, which will act as a braking knot. The bridging team will now pull the rope taut, and begin construction of the mechanical advantage.

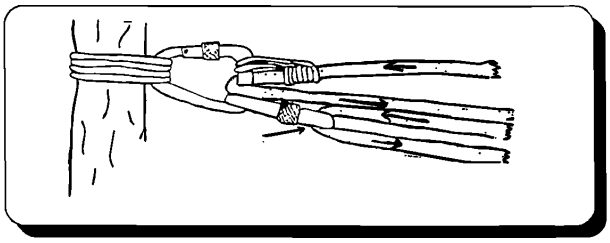


3). The first step is to take one three foot Prussik (16" loop) and tie a French Prussik on the bridging line as far away from the anchor as possible. Then take one locking carabiner and clip it to the two loops of the French Prussik.

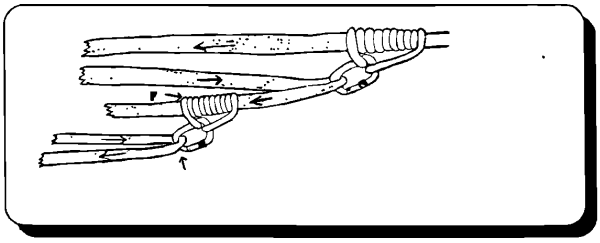
4) Taking a bight from the running end of the rope clip it into the locking carabiner hanging from the tails of the French Prussik.



5) Then bring a bight back to the anchor, and taking one locking carabiner clip it into the carabiner created in step (b), take the bight of rope and clip into this carabiner.



6) Take one three foot Prussik and tie a French Prussik onto the bottom end of the bight clipped into the carabiner created in step (c), take one carabiner and clip it into the tail loops of the French Prussik.



7) From the anchor, take a bight of rope from the carabiner created in step (e) and clip it into the carabiner created in step (f).

8) You have made approximately a 9:1 mechanical advantage.

NOTE: If the manpower is available the squad/platoon has the option of building a 3:1 mechanical advantage vise a 9: 1, the mule team will just have to add another body having no more then 3 bodies on a 9:1 and 4 bodies on a 3:1

3. **Tensioning of the Bridge**.

a. Now that the bridge is built, the bridge NCO can call up the mule team to tension the bridge.

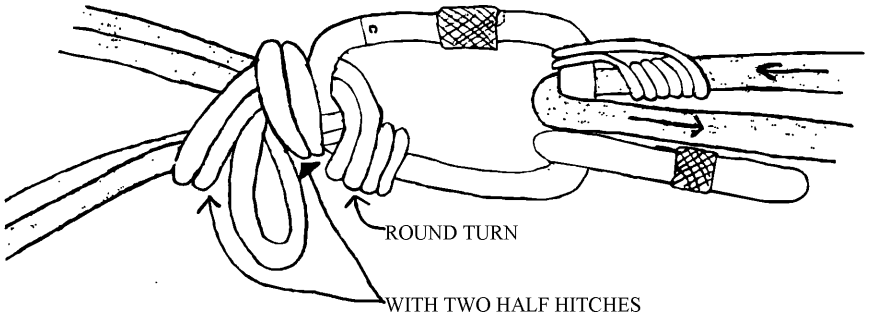
b. This procedure is facilitated by the mechanical advantage system that was just put into place. The braking knot (French Prussik) is used to hold tension on the bridging line while the bridge is being tensioned

c. The mule team will begin to pull on the running end of the rope coming out of the mechanical advantage. They will pull the rope straight back, trying to keep it in line with the bridge as best as possible.

d. The mule team will tension the rope as much as possible, the bridge NCO will monitor the system. Once the mule team cannot pull anymore tension, the bridge NCO will then have them hold the rope in place, and will reset the braking knot. Once the braking knot is set, the bridge NCO will ask for slack from the mule team and cycle the system out. This process will continue until the bridge is tight.

e. On the last cycle the bridge NCO will set the brake knot and with the help of another Marine they will make a bight out of the running end and bring it around the tree while keeping tension.

f. Take a bight and make a complete round turn on the body of the locking carabiner created in step (b). Last, the bridge NCO will tie two half hitches encompassing all the ropes just behind the anchor locking carabiner.



g. 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.

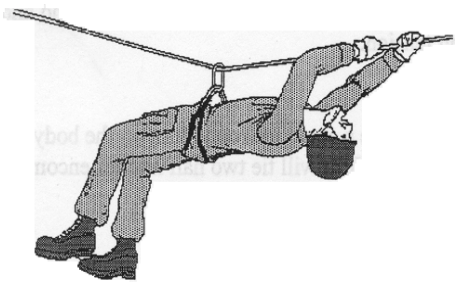
4. **CROSSING.** The method used to cross is known as a horizontal traverse. This traverse can be accomplished in the following ways.

a. Rappel Seat Method

1) The Marine ties himself into a rappel seat and inserts a large steel locking carabiner with the gate facing down and away.

2) The Marine faces the bridge with his right hand towards the near anchor to snap into the bridge, once the locking carabiner is locked onto the bridge rope, a helper flips the locking carabiner over so that the locking nut screws down. A sling rope may be girth hitched onto the bridging rope so that it forms a loop. This loop can be used by the Marines to mount the rope bridge.

3) The Marine hangs below the bridge from his rappel seat with his head pointing in the direction of the far anchor and allows his legs to hang free.



4) Progress is made by pulling with his arms.

5) This method is the safest and therefore the preferred method.

6) If the Marine must take a pack across, he may wear it with the waistband secured.
However, the preferred method is to have another carabiner (a small steel locking one is sufficient) attached to the pack frame at the top and attach this to the bridging line behind the Marine, putting his legs through the shoulder straps and pulling the pack across with him.

7) One man at a time will cross, although one can load and another can unload concurrently.

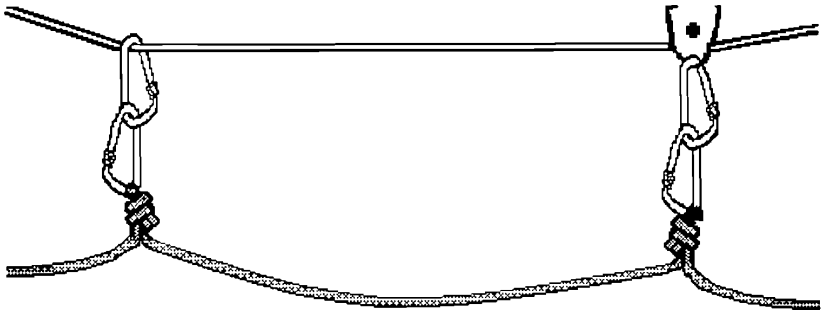
8) Weapons will be worn across the shoulder; muzzle down with a tight sling securely attached to the weapon. They should be attached to the Marine using 550 cord or other cordage during training. The slings of the weapons should always have the sling keeper either taped down or the end of the sling tied in a knot to prevent the sling coming loose from the weapon.

b. Pulley Method. This method is used when the one rope bridge is long, uphill, or speed is vital and the Marines crossing it have a lot of heavy personal equipment; M24OG's, radios, etc.

1) Equipment required. One pulley, four locking carabiners, and a hauling line twice the length of the obstacle.

2) Setting up the system. Construction of the first suspension point is done by attaching a pulley to the one rope bridge, one locking carabiner is attached to the pulley, gate down, and a second locking carabiner is attached to the first locking carabiner with the gate facing the near side bank. Into this second locking carabiner, attach the hauling rope with a figure-8 loop. The figure-8 is placed halfway along the hauling

rope and attached to the locking carabiner, which is then locked. Four feet down the line another figure-8 on a bight is placed into the second suspension point.



3) Connection. The Marine clips his locking carabiner into the lower locking carabiner, his equipment is clipped into the second locking carabiner. The mule team starts to pull.

c. Helmets will be worn for all methods of crossing the bridge. Gloves are optional.

NOTE: There are additional methods of crossing a one rope bridge such as the Commando crawl, Monkey crawl and hand over hand techniques; however, they are not used in training for safety reasons.

5. **RESCUE TECHNIOUES.** If an individual is unable to complete the crossing on the one rope bridge using the rappel seat method of crossing (i.e. injury from a fall or exhaustion), a rescue will have to be made in the following manner:

a. Reach. First try to reach the victim by using an object such as a pole, your hand, if the victim is close enough, etc.

b. Throw. If reaching the victim is impossible, try throwing a rope to the victim and have him attach the rope to himself, preferably his seat, and pull him back to the desired side of the installation.

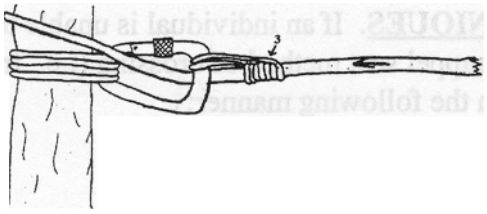
c. Tow. If the victim is unable to catch or reach a rope being thrown to him or the victim is unconscious, tie a figure-of-eight loop into the middle of the safety line and then connect the rope to the rope bridge with a steel locking carabiner. The mule team will pull the carabiner up against the victim's seat and begin towing the victim 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 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.

d. Go. If all else fails, 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 at approximately eight feet from the end of the safety line. In the end of the safety line tie a figure-of-eight loop and insert a steel locking carabiner in the end of it. Once the rescuer has made contact with the victim, he will attach the steel 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.

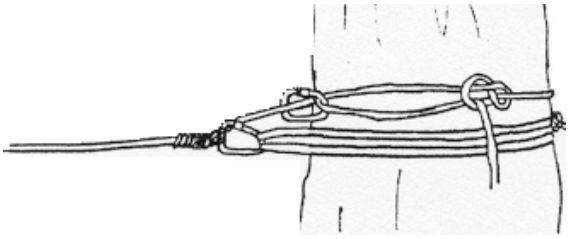
e. Cut. If while crossing the rope over water the individual goes underwater and no other rescue technique can be employed, the rope will be cut.

6. **RETRIEVING THE ONE ROPE BRIDGE**

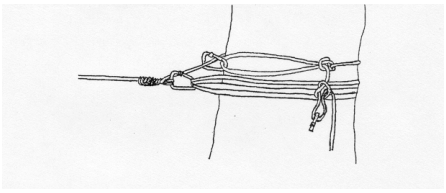
a. Before the bridge NCO sends the last Marine across, they must make the bridge retrievable.
b. The first step is to break down the mechanical advantage, ensuring the braking knot is set before doing so. The system will be broken down until the bridging line is attached only to the brake knot.



c. Now take the rope around to the back of the anchor, and tie a slip figure 8. Attach the loop of the slip 8 to the bridging line just in back of the braking knot with a locking carabiner.



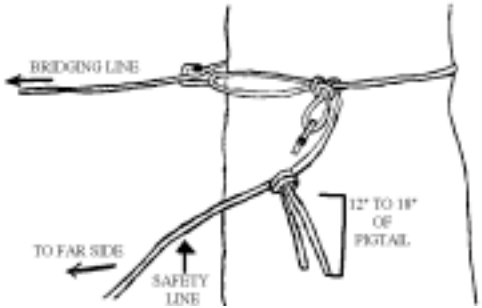
d. Now pull the running end coming out of the slip 8 until it tightens, and bites on the rope. Once the rope bites, tie a thumb knot behind the slip 8 as close to the slip figure 8 as possible.



e. The bridge NCO, with the help of another Marine, will now untie the swami wrap, until all of the tension is on the bridging line.

f. The safety line will now be brought up, and attached to the dead rope at the end of the bridging line with an overhand knot.

g. The bridge NCO and the other, Marine will now cross the bridge.



NOTE: It is possible that the bridge may lose tension after breaking the bridge down. The packs of the last two Marines across can be sent over with other Marines prior to the slip figure being tied.

h. After both Marines have crossed, the safety line will be brought up from down stream.

i. The tree wrap will now be taken off. Once the tree wrap is off, all knots and carabiners will be taken out.

j. The safety line will now be pulled, and the bridge is retrieved.

A-FRAMES. In mountain operations it is often necessary to move inexperienced Marines and equipment over steep, rocky terrain. A fixed rope installation is one method to move personnel up or down these obstacles. However, this method is not always sufficient for moving their equipment. So, the construction of a hauling system may be necessary.

1. **A-FRAME** - Definition. 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 vertical hauling line.

b. Materials. The materials required for construction of an A-Frame are:

1) Two-poles, approximately 8 feet long and not less than 3 inches 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.
2) To construct an A-Frame, 4-6 sling ropes are required. This number may vary depending on the diameter of the poles and the length of the sling ropes being used.

c. Nomenclature

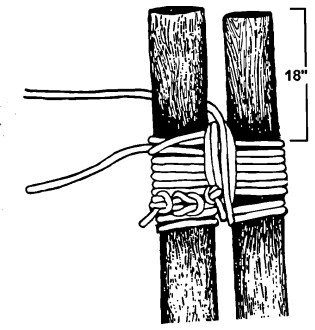
1) Apex. The point near the top of the A-Frame where the poles cross each other.

2) Butt ends. The bottom ends of the poles used in construction of the A-Frame. The butt end is larger in diameter than the end at the apex.

2. **CONSTRUCTING AN A-FRAME**

a. Place two sturdy poles of approximately the same length side by side, ensuring that the butt ends are flush together.

b. 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.



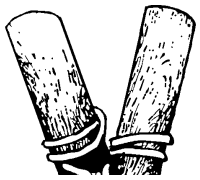
c. Wrap the sling rope 6-8 times horizontally around both poles, wrapping from the clove hitch down toward the butt ends.

1) It will be necessary to join another sling rope to the sling rope that you started with. The knot used to join the sling rope is a square knot finished with two overhand knots.

2) 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.

d. Wrap 4-6 times vertically between the poles and *around the horizontal wraps*.

e. Tie off the sling by using the 18 inch pigtail that extends from the clove hitch; tie it off by using a square knot. 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.



f. Spreader Rope (Bar)

1) 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.

2) 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.

3) Adjustment can be made to either side when needed. By adjusting the clove hitches on either butt end.

g. Anchoring the Butt Ends of the A-Frame

1) Place the butt ends of the A-Frame poles into natural or manmade pockets.

2) 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 with anchoring the A-Frame at the middle and bottom. This is done with sling ropes in order to keep the A-Frame stationary. A clove hitch and two half hitches or a round turn and two half hitches are tied to the A-Frame and anchor knots(round turn and two half hitches or round turn and a bowline) are used on the anchors.

h. Anchoring and tying-off the A-Frame. The top part of the A-frame (the Apex) is normally anchored off. There are a few different techniques used in anchoring off the A-frame. The installation being used will dictate how it is to be anchored. (This will be discussed later in *VERTICAL HAULING LINES and SUSPENSION AND TRAVERSE)*

VERTICAL HAULING LINES. In mountain operations it is often necessary to move inexperienced Marines and equipment over steep, rocky terrain. A fixed installation is one method to move personnel up or down these obstacles. However, this method is not always sufficient for moving their equipment. So, the construction of a vertical hauling line system may be necessary.

1. **VERTICAL HAULING LINE**

a. Purpose. The purpose of a vertical hauling line is to move equipment and troops over steep, rocky terrain.

b. Materials. The materials needed for a vertical hauling line are:
1) Two (2) static ropes. (An additional rope is required if using a knotted hand line)
2) Minimum of six (6) sling ropes.
3) Four (4) locking carabiners.
4) An appropriate belay device. Stitch plate, figure eight descender, (four (4) locking 82's if using a crab brake)
5) Two rescue pulleys. (Optional - these are preferred but 2 locking carabiners may be used.)
6) Two A-Frame poles, strong enough to support the load and tall enough to provide adequate clearance for the load.

2. **SITE SELECTION FOR A VERTICAL HAULING LINE.** Picking the proper site is critical to the safe and efficient operation of a vertical hauling line. The site must meet the following four criteria:

a. It must have a suitable top anchor.

b. It must have good loading and unloading platforms.

c. There must be sufficient clearance for the load at all points.

d. If using an A-Frame, you must be able to anchor the butt ends of the A-Frame.

3.**CONSTRUCTION OF A VERTICAL HAULING LINE USING AN A-FRAME.**

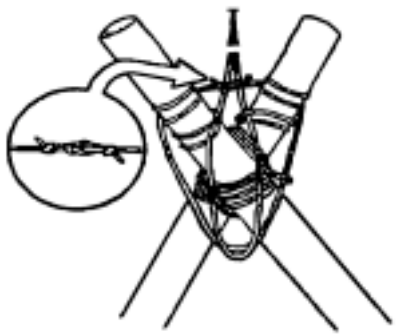
a. Construct an A-Frame that can support the load to be moved and that provides adequate clearance for the load.

b. To anchor the A-Frame, use the following procedures. One static rope will be used.
1) Double the rope and find the middle of the rope.

2) Lay the middle bight of the static rope over the apex of the A-frame, leaving an 18 inch bight over the apex. This is known as the anchor bight.
3) Tie clove hitches above the lashing on each side of the apex, ensuring that the clove hitch locking bars are facing each other and are next to the lashing. The 18 inch bight is left dangling.

4) Angle the A-Frame 30 degrees from the vertical and tie off the anchor, using a round turn and two half hitches. The rest of the rope is coiled neatly and placed out of the way.

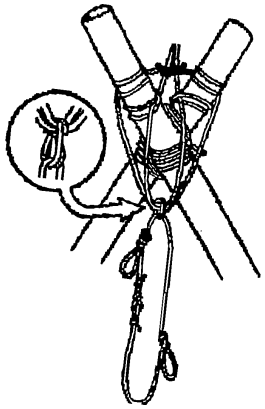
5) Construct a second 18 inch bight using a sling rope. This is known as the safety bight. Attach the sling rope to each side of the apex of the A-Frame above the first clove hitches the same manner as the anchor bight with the locking bars to the outside. Secure the



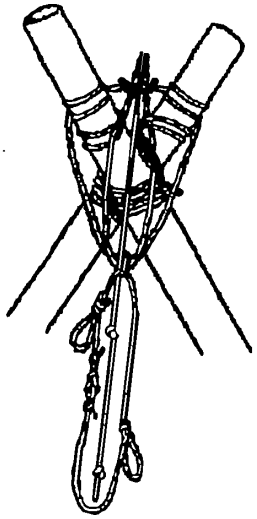
pigtails of the sling rope with a square knot and two over hands at the rear of the apex of the A-Frame.

6) Two locking carabiners with gates opposite and opposed are inserted into both bights hanging down from the apex.

c. Hauling Line. A hauling line is constructed next. Hauling lines can be constructed in two different ways. Either by using the end of the rope securing it to itself, making an endless rope.



1) For lowering and raising heavy loads and personnel. The end of the rope is used. This method is less efficient, but much safer than an endless rope. It is constructed by running one end of the rope through the carabiners/pulleys on the safety/anchor bight and tying a figure eight loop. The other end is then incorporated with an anchor (i.e. tree wrap) and an appropriate lowering/ raising system covered later.



2) If the hauling line is to be controlled from the bottom of the cliff, it is converted into an endless rope by tying the two ends together using a square knot finished with two overhand knots. Next, two directional figure-of-eight knots are tied on opposite sides of the rope, one at each loading/unloading platform.

3) After completing the hauling line, personnel at the base of the cliff should pull on the line to test it and the A-Frame simple fixed rope by any personnel ascending the vertical hauling line.

e. Additional Considerations

1) Eliminate excessive friction. Use pulleys at the apex when possible.

2) Remove any obstacles and any loose objects that could be dislodged by men or equipment.

3) Station two men at the unloading platform to operate the A-Frame during use. These operators are tied in with a safety line.

4) Use multiple anchors when establishing an A-Frame/vertical hauling line. This will prevent total system failure should one particular anchor fail.

5) A knotted handline may be used to aid individuals up a vertical hauling line and is constructed as follows: Overhand knots are be placed approximately 10-12 inches apart, ensuring that there is approximately 20 feet without knots at one end to be used to anchor. To anchor the handline, tie a round turn and a bowline finished with an overhand, around the anchor and throw the knotted handline over the apex of the A-Frame. Any personnel ascending the vertical hauling line use the knotted handline as a simple fixed rope. To assist the hauling team.

4. **OPERATION OF THE VERTICAL HAULING LINIE**

a. Personnel or equipment are secured to the hauling line and raised or lowered by a team of Marines pulling on the rope, or belaying it down.

b. If equipment and personnel are only being lowered, the hauling line can be used from the top with the same belay used with the *SUSPENSION TRAVERSE*.

c. If equipment is being raised from the bottom, an endless rope is the most efficient hauling line.

d. Marines and equipment being raised or lowered will load and unload through the center of the A-Frame, not to the sides.

e. Mule Team. If equipment and personnel can be raised from the top of the cliff, a mule team can be used there. To establish a mule team, the hauling line is run through a pulley or carabiner (preferably a pulley) at the anchor point behind the system. The line is then led away at about a 90° angle to a cleared area. A safety line should be attached to the hauling line to prevent the load from falling if the mule team drops the hauling line. This is done with an auto block/French Prussik on the carabiner or pulley on the anchor. A group of six men, (mule team) assemble on this rope on the side of the rope away from the cliff or outside the bight of the rope if on the bottom. They will haul personnel and supplies up the cliff by grasping the rope and simply walking away with it. One man monitors the auto block to ensure it does not run through the 85 carabiner (He will not wear gloves). If the mule team looses control of the line the safety man will let go of the auto block. The mule team responds to a single commander by using the following verbal/hand and arm signals.

COMMAND	MEANING	SIGNAL
*Pick up rope	Mule team picks up the rope.	N/A
Take the strain.	Take up the slack on the rope.	Arm up, palm out.
Walk away.	Walk away with the rope, lifting the load up.	Arm motion away from A-frame.
Check	Stop in place, holding the load in place.	Arm up, fist clinched.
Walk back.	Walk towards the installation, lowering the object.	Arm motion towards the A-frame.

5. **CONSTRUCTION AND OPERATION OF A BRAKING/BELAY DEVICE**

a. Because the A-Frame/vertical handing line can be a very strong, sturdy system, we often put heavy loads on it. When working with heavy loads, a braking/belay device that generates a great deal of friction is required. The most commonly used device for this purpose is the Carabiner Brake or Crab. The equipment needed is as follows:

1) Four (4) locking 82's.

2) One (1) large locking carabiner.

b. Construction

1) Insert one large carabiner into the anchor with the gate up.

2) Insert two small locking carabiners with gates facing to the right into the one large locking carabiners.

3) Pull up a bight of rope and insert it through the two small locking carabiners.

4) Clip two more small locking carabiners with the gate facing down and to the right into and through the first two small locking carabiners.

NOTE: All directions apply while facing the anchor.

c. Operation

1) More than one rope may be fed through the double crab brake.

2) As the rope flows through the crab brake, make sure that the direction of the rope (if coming in contact with the gates of the locking carabiners) is such that the rope is tightening the gates.

3) The flow of the rope through the crab brake should be constant and smooth.

4) Regardless of the type of belay device, two Marines will be required in lowering. One to operate the belay device (i.e. crab brake) and one to monitor the safety Prussik.

NOTE: The double carabiner brake/double crab is a one way brake used for lowering only and cannot be reversed under a load.

SUSPENSION TRAVERSE.

1. **DEFINITION.** A suspension traverse is a high- tension rope installation established at a suitable angle (not less than 30° and not more than 65° approximately) which allows a suspended load (no more than 250 lb. is recommended) to be moved over cliffs, ravines and rivers.

NOTE: The limit of 250 lb. has been recommended not because the suspension traverse would fail, but it is about the limit that can be safely manhandled next to a cliff edge.

2. **SITE SELECTION** The three considerations for site selection for a suspension traverse are:

a. Suitable upper and lower anchors must be available.

b. Good loading and unloading platforms.

c. Sufficient clearance for the load.

3. **CONSTRUCTION OF A SUSPENSION TRAVERSE**

a. Top to Bottom

1) When constructing the suspension traverse from top to bottom, a suitable high-tension anchor system will be placed around the top anchor point.

2) The rope will be deployed and the construction/mule team will rappel down in order to construct the bottom anchor.

3) Select a sound bottom anchor point and construct a suitable high-tension anchor system.

4) The rope is pulled to the bottom anchor and clipped through the anchor system's locking carabiners.

5) With an 18" Prussik Cord, tie a French Prussik to the rope and secure it also to the anchor system's locking carabiners. This will serve as the brake.

6) On the rope running from the far anchor point, tie a friction knot and attach a locking carabiner through it's loops.

7) Attach a second locking carabiner into the anchor system and clip the running end of the rope into it.

8) Where the rope comes out from the friction knot's locking carabiner, tie a second friction knot complete with a locking carabiner and clip the running end of the rope through it.

9) You have now made a 9:1 mechanical advantage system, with a brake attached.

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

b. Tensioning the installation.

1) Initially, the traverse is tensioned by one man. This is accomplished by pulling on the 9:1, the French Prussik is used to hold the tensioned line when the friction knots are moved.
2) When the installation has been tensioned as much as possible, it is secured by taking the standing end around the anchor point and pulling a large bight through the anchor system's locking carabiners.

SAFETYNOTE: **NO MORE THAN TWO MEN WILL TENSION THE INSTALLATION AT ANY TIME IF USING PULLEYS.**

NOTE: When two ropes are used, care should be taken to anchor the lines as close together as possible, in such a manner that the ropes do not cross each other. Also, the upper rope's securing carabiner is gate up and the lower rope's is placed gate down.

c. Bottom to Top

1) When constructing a suspension traverse from bottom to top, the lead climber will attach the traverse's ropes to the back of the harness.

2) Once the lead climber reaches the top safely, the traverse's ropes will be anchored off using a suitable high-tension anchor system. The lead climber will then bring up the number 2 climber.

3) The installation is constructed and tightened from the bottom.

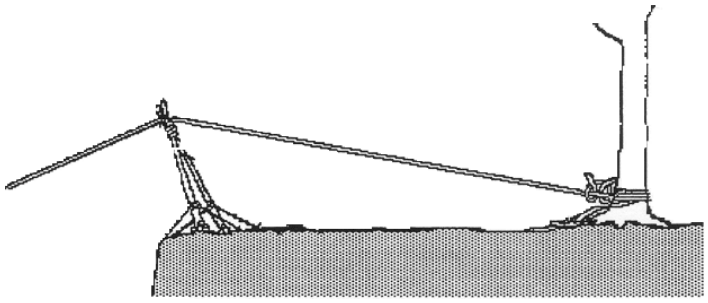
4. **USE OF AN A-FRAME**

a. Bringing up A-frame poles. If you have to gain artificial height at the top and there is no suitable tree branch/rock etc., then the A-frame logs, sling ropes and carabiners need to be moved to the top of the cliff. This can be accomplished in the following manner:

1) The A-frame logs are tied to the ropes utilizing the Timber Hitch (See ROPE MANAGEMENT). The extra sling ropes and carabiners are clipped into the rope.

2) The climbers will haul the logs to the top and construct their portion of the installation.

NOTE: The A-frame is constructed in the same manner as taught in *A-FRAMES. 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.



b. Securing the A-Frame

1) An over the object clove hitch is tied in the middle of a sling rope and placed over one pole at the apex.

2) A Prussik is tied around the suspension traverse lines with the ends of the sling rope on both sides of the A-frame. This is done before erecting the A-frame.

3) The butt ends must be anchored using a practice coil.

4) The ropes should be buffed wherever necessary.

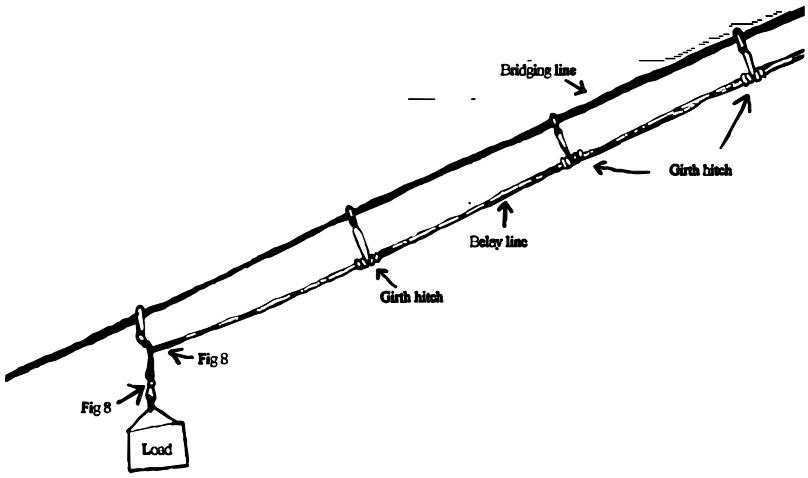
NOTE: As you can see from the figure above, the A-frame should be inclined forward on the edge of the cliff face, this is done to offset the strain on the A-frame to stop it from collapsing forwards or backwards. The approximate angle is between 45-60 degrees.

5. **CONSTRUCTION OF THE BELAY LINE.** The belay rope is used to attach personnel and equipment to the bridging line and belay system. It is tied as follows:

a. Ensure that the belay line is established at the top of the bridge with an adequate anchor, braking system, and a safety Prussik.

b. Tie a figure eight loop at the end of the belay line, and attach it with a carabiner to the load.

c. Twelve to eighteen inches from the end of the belay line tie another figure eight loop and attach this loop to the bridging line with a carabiner.



d. Using web runners and aluminum carabiners girth hitch the web runners to the belay line, and clip into the bridging line at intervals of approximately 15 feet. This is to ensure that the belay line doesn't sag excessively and tangle in trees or on rocks.

6. **OPERATION OF A SUSPENSION TRAVERSE.** A suspension traverse is used for the transportation of men and equipment up and down a vertical obstacle. The operating procedure is as follows:

a. Point NCOIC. The Point NCOIC has overall responsibilities for the operation of the suspension traverse. The Point NCOIC duties include:

1) Supervision of the construction of the installation.

2) Control of the load being lowered and raised.

3) Deploys wed runners on the belay line.

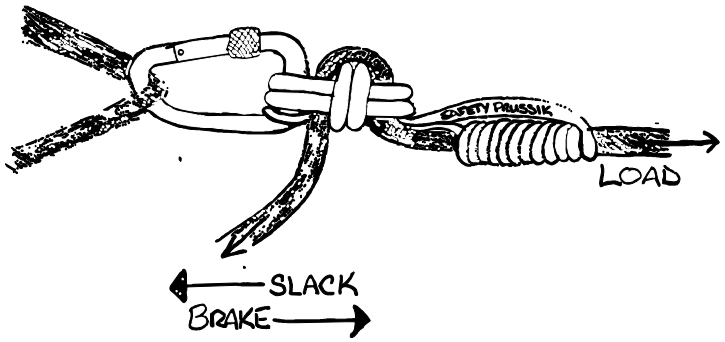
4) Ensure that the brakes are employed properly.

5) In command of the mule team.

b. Lowering. Whenever a load is lowered down a suspension traverse, a belayer and a belay line are used to control the load. Ideally the belay man should observe the load being lowered. If this isn't possible, the belay man will receive his commands from the Point NCOIC.

1) Carabiner Brake

a) To make the single carabiner brake, two small carabiners (82's) are hooked 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 and right.



b) If the gates were against the ropes, the rope action would in time unlock the carabiners, with dangerous consequences.

c) To place tension or brake the rope, the belay man simply pulls the rope against the carabiners, towards the load, which creates more friction on the rope.

d) The carabiner brake is a good method for lowering a load due to lots of friction and good control, but the carabiner brake does not make for a good raising system because of the large amount of friction. This will make unnecessary work for the mule team.

NOTE: If the loads require more or less friction, you can add or take away the carabiners, which are placed across the body.

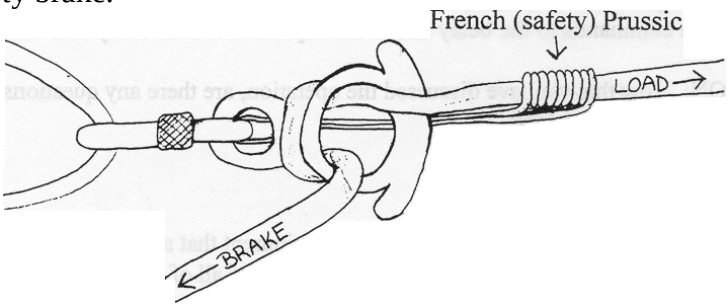
2) Figure 8. The Figure 8 rappel device is the easiest method for belaying a load.

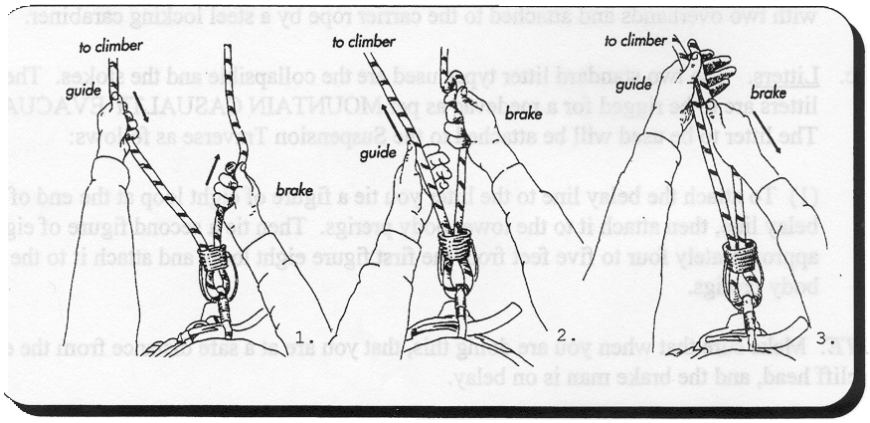
a) Thread a bight of the belay line through the large "O" ring and pull it over the small "O".
b) Clip a locking carabiner through the small "O" ring and attach it to an anchor point.
c) Braking is conducted in the same fashion as in rappelling.

3) Munter Hitch. The Munter Hitch is a good brake because of the minimal gear required. Use with heavy loads.

4) Stitch Plate. The stitch plate is a user friendly device that offers quick attachment and removal. Unlike some other belay techniques, the stitch plate has no rope on rope friction. This system can be used for all load sizes.

5) 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 it's own anchor point. One man is tasked with the operation of the safety brake.





7. **GENERAL LOAD CONSIDERATIONS.** The type of equipment that needs to be lowered or raised will range from weapons to ammunition, personnel to litters, all of which need to be handled differently.

a. Weapons. Normally the types of weapons that would have to be raised or lowered are the crew served weapons organic to a rifle battalion, i.e. 81mm Mortar, 50 caliber machine gun, dragon etc. 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 of eight is then tied into the ends and attached to the suspension traverse. The belay line is now attached to the load.

b. Ammunition/Equipment . The articles to be moved are to be secured through bundling or banding them together. A rope is then taken and 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 will be crossed and wrapped around the remainder of the bundle (90° to the previous wrap). This is then secured by using a square knot with two over hands and attached to the carrier rope by a steel locking carabiner.

c. Litters. The two standard litter types used are the collapsible and the stokes. These litters are to be rigged for a medevac as per MOUNTAIN CASUALTY EVACUATION. The litter to be used will be attached to the Suspension Traverse as follows:

1) To attach the belay line to the litter you tie a figure of eight loop at the end of the belay line, then attach it to the lower body pre-rigs. Then tie a second figure of eight loop approximately four to five feet from the first figure eight loop, and attach it to the upper body pre-rigs.

NOTE: Make sure that when you are doing this, that you are at a safe distance from the edge of the cliff head, and the brakeman is on belay.

2) At this stage it is worth checking and adjusting the length of the pre-rigs, to ensure that the casualty's head is higher than his feet. Once all that is done and checked, the belay line is taken tight 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.

3) Before you start to lower, a last minute safety check is essential to ensure that carabiners are locked, knots are secure, casualty is secure, that the brake man is on the brake and the safety man is manning the Prussik. Now you can commence lowering or raising the casualty.

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

NOTE: If you lower the load without some means of keeping the lowering line from sagging, then there is a good possibility that the lowering line will get snagged. The easiest way around this is to have 8-10; three to six foot web runners with carabiners handy. When the load is being lowered you can girth hitch the web to the lowering line and snap the carabiner into the main line. This will keep the lowering line from getting snagged.

8. **RAISING A 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 we can use. Because part of the weight of the supplies to be lifted will be carried by the static line. This is not true in a vertical hauling line where all the weight is suspended vertically. The main method of raising supplies is by utilizing a "Mule Team". This is a group of men 6 or more who will do the lifting.

a. Mule Team.

1) To establish a mule team, the belay/haul line is run through a pulley or a steel locking carabiner at the top of the system, just as for lowering.

NOTE: This is why choosing a belay device that is suitable for the load and can be removed quickly is so important.

2) If the cliff head does not afford an open area for the mule team to operate directly back, the haul/belay line can be re-directed. The line is then led away at an angle to a cleared area.

3) Six or more men 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. This uses leg muscles and can be maintained for long periods of time. The mule team responds to a single commander by using the following verbal/hand and arm signals:

COMMAND	MEANING	SIGNAL
*Pick up the rope.	Mule team picks up the rope	None
Take the strain.	Take up the slack on 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 clenched.
Walk back.	Walk towards the A-Frame holding the load.	Arm motion towards the installation.

* The rope should be held unless specifically ordered to lay it down. Also the use of the Prussik braking system on the belay rope is necessary, in the event that the mule team lose control of the rope.

* As with all installations requiring commands, some form of tactical commands need to be established. Those can be established by unit SOP.

CONCLUSION: The Suspension and Traverse is the primary means of moving equipment up a vertical face in this environment. As an Assault Climber/ Mountain Leader you will be tasked with building these systems. But ensure that other personnel are trained in its use and maintenance.

CHAPTER 7
MOUNTAIN CASUALTY EVACUATIONS

Precipitous terrain and adverse weather conditions are inherent to a mountainous environment. Under these conditions personnel with relatively minor injuries can become casualties which require evacuation. By using the techniques and equipment outlined here, these casualties can be evacuated safely and efficiently.

1. GENERAL CONSIDERATIONS. The general considerations are a set of guidelines that can be used no matter how serious the casualty is. They are remembered by a simple acronym, **A PASS NGG**.
   a. Apply Essential First Aid. (i.e. splints, pressure bandage, etc.)

   b. Protect the Patient from the Elements. Provide the casualty with proper insulation from the ground. Ensure that he is warm and dry. If there are any natural hazards (i.e. rock fall, lighting, etc.) either move the casualty as quickly as possible or ensure that he is well protected.

   c. Avoid Unnecessary Handling of Patient. Especially true in cold environments or with hypothermia cases where rough handling can shock the heart and other organs.

   d. Select Easiest Route. Send scouts ahead if possible to break trail. Remember the best trail may not always be the shortest route.

   e. Set Up Relay Points and Warming Stations. If the route is long and arduous, set up relay points and warming stations with minimum amount of medical personnel at warming stations to:

      1) Permit emergency treatment. Treat for shock, hemorrhage, or other conditions that may arise.
      2) Reevaluate the patient constantly. If patient develops increased signs of shock or other symptoms during the evacuation, he may be retained at an emergency station until stable.

   f. Normal Litter Teams Must Be Augmented in Arduous Terrain. While it takes two to four to evacuate a patient in average terrain, it could take up to eight Marines in mountainous terrain, because of irregular drop-offs, streams, etc.

   g. Give Litter Teams Specific Goals. The litter teams' job is extremely tiring, both physically and mentally. The litter teams must be given realistic goals to work towards.

   h. Gear. Ensure all of the patient’s personal gear is kept with him throughout the evacuation. Even if you do not expect the Marine to be back in the fight he will need his sleeping bag and a change of socks for example.

2. ONE-MAN CARRIES.
   a. Sling Rope Carry. The sling rope carry requires two men and a 15-foot sling rope. One as the bearer, the second an assistant to help in securing the casualty to the bearer. Conscious or unconscious casualties may be transported in this manner:

1) Bearer kneels on all fours and the assistant places casualty face down on bearer's back ensuring the casualty's armpits are even with the bearer's shoulders.

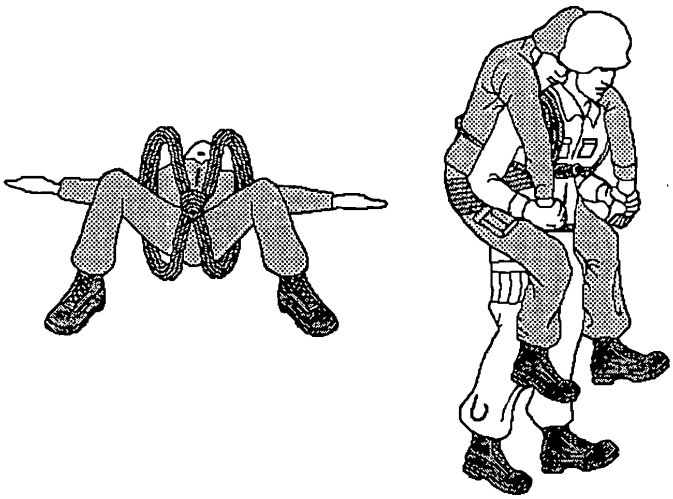
2) He then finds the middle of the sling rope and places it between the casualty's shoulders and the ends of the sling rope are run under the casualties armpits, crossed and over the bearer's shoulders and under his arms.

3) Then the ropes are run between the casualty's legs, around his thighs, and tied with a square knot with two overhands just above the bearer's belt buckle.

4) Ensure the rope is tight. Padding, when available, should be placed where the rope passes over the bearer's shoulders and under the casualties thighs.

b. <u>The Rope Coil Carry.</u> This requires a bearer and a rope coil. It can be used to carry a conscious or unconscious casualty.

1) Position the casualty on their back.



2) Separate the loops of the mountain coil into two approximately equal groups.

3) Slip 1/2 of the coil over the casualty's left leg and 1/2 over his right leg so that the wraps holding the coil are in the casualty's crotch, the loops extending upward the armpits.

4) The bearer lies on his back between the casualty's leg and slips his arms through the loops. He then moves forward until the coil is extended. When using the rope coil the bearer ties the coil to himself vice slipping his arms through the loops.

5) Grasping the casualty's right or left arm, the bearer rolls over, rolling to the casualty's uninjured side, pulling casualty onto the bearer’s back.

6) Holding the casualty's wrists, the bearer carefully stands, using his legs to lift up and keeping his back as straight as possible.

NOTE: The length of the coils on the rope coil and the height of the bearer are to be considered. If the coils are too long and the bearer happens to be a shorter person, it will require the coils to be uncoiled and shortened. If this is not done, then the casualty will hang too low on the bearer's back and make it a very cumbersome

evacuation. A sling rope harness can be used around the victim's back and the bearer's chest, which will free the bearer's hands.

3. TWO-MAN CARRY.

a. Pole Carry. The pole carry method is a field expedient method and should be considered as a last resort only, especially when narrow ledges must be traversed or when vegetation limits the bearers to a narrow trail. This method is difficult for the bearers and uncomfortable for the casualty. Two bearers, four sling ropes and a 12 foot pole - 3 inches in diameter, are required for this carry.

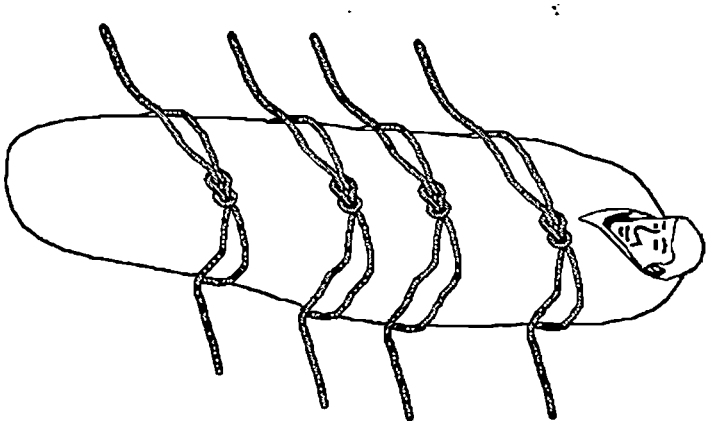
1) The casualty is placed on his back in a sleeping bag or wrapped in a poncho or blanket, then placed on an insulated pad.

2) One sling rope is placed under the casualty below the armpits and tied with a square knot across the casualty’s chest.

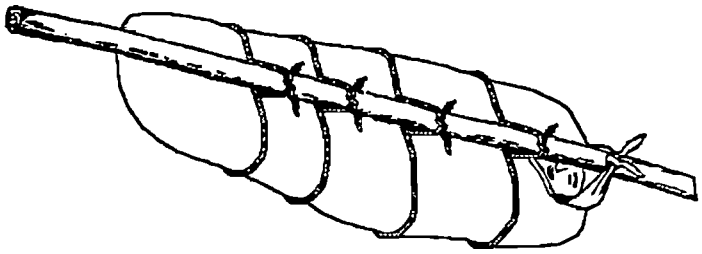
3) The second sling rope is tied in the same manner at the casualty's waist.

4) The third sling rope is placed at the casualty's legs below the knee.

5) The fourth sling rope is tied around the ankles.



6) The pole is placed along the casualty's length and secured using square knots with two overhands with the ends of the sling ropes. The square knots should be so tight that the overhands are tied onto themselves



7) The casualty should hang below the pole, as close to the pole as possible, to prevent swinging during movement.

8) The casualty's head may be supported using a triangular bandage or a cartridge belt passed around the pole.

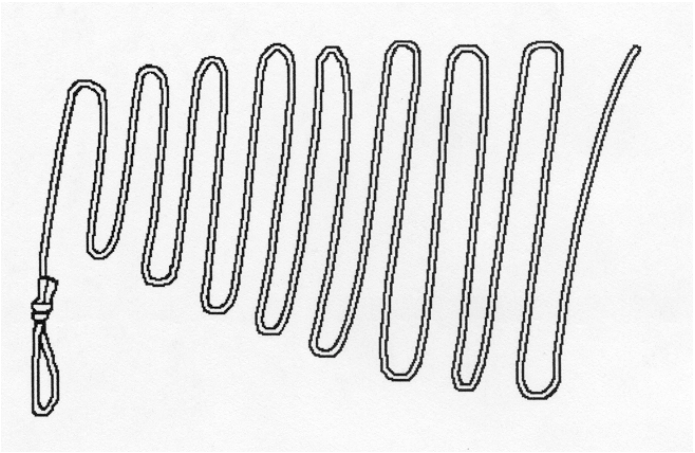
9) For additional support and ease of movement, two additional bearers may be required, as well as a mountain coil.
   a) Mountain coil is split into two equal coils.

   b) Place knot of mountain coil under casualty's lower back.

   c) Additional bearers slip into each half of the hasty coil one on each side of casualty, aiding in support and movement of the casualty.

4. EXPEDIENT LITTERS. The two types of expedient litters that we will talk about are the alpine basket and the poncho litter.

a. Alpine Basket. A climbing rope is also used for the construction of the alpine basket. The alpine basket takes less time to construct, approximately 10 to 15 minutes, but this litter is not suitable for evacuating seriously injured people.



1) Construction of the Alpine Basket:

a) Start by making the same amount of bights as in the rope litter, but start from one end and tie a figure-of-eight loop to run the first bight through.

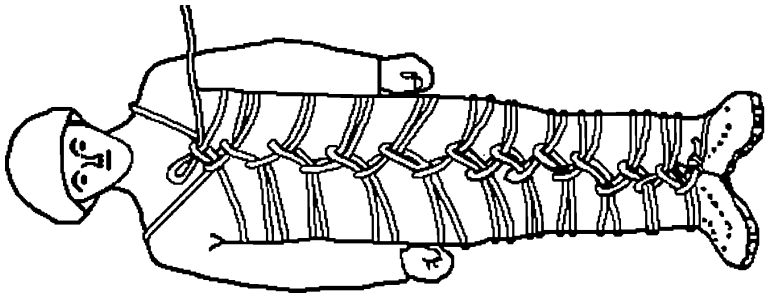
b) Place padding i.e., isopor mat, on top of the bights and then lay the casualty on the padding and bights.

c) Start at the casualty's feet and pull the first bight up around the casualty's ankles and through the figure-of-eight loop tied into the starting end of the rope.

d) Go to the opposite side of the casualty and pull up the second bight and pull it through the loop formed by the bight that was pulled through the figure-of-eight.

e) Continue until you get to the casualty's armpits, bring the second to the last bight up over the casualty's shoulder and into the bight and then bring the last bight up over the casualty's other shoulder and into the last bight formed.

f) Secure the end of the bight with an appropriate anchor knot.



b. Poncho Litter. A poncho, poncho liner, bivy bag, or similar piece of material may be used. In addition you will need six individuals with sling ropes.

1) Lay the poncho litter flat on the ground.

2) Select six rocks about the size of a golf ball. Place one rock in each of the corners and one on each side in the middle of the litter. The rocks are placed on the underside of the poncho or like material. If a bivy bag is used the casualty should be zipped inside the bivy bag. The rocks should then be arranged in the same manner only on the inside below the zipper.

3) Tie the sling rope in an endless loop with an overhand knot. Take the middle of the rope and secure it around the rock with a clove hitch.

4) An isomat may be laid on the poncho to help make the litter firmer.

5) The casualty is then placed in the litter. The sling ropes are adjusted by feeding the pigtails of the over hand knot through itself to adjust for length. The loop is then put over the inboard shoulder of the carriers. Insure that the casualty is carried level.

5. LITTERS. There are two kinds of litters that are used for casualty evacuations in moderate to vertical terrain the SKED and the Stokes litters. Each has a variation of procedures for securing a casualty and rigging the litters for either raising or lowering. Let’s first look at the SKED litter.

a. The SKED Litter. The SKED litter is constructed of a highly durable plastic that comes equipped with four body straps, two feet straps, four carrying handles, a pull strap, and various grommets. The SKED also comes with various accessories for its different uses. The litter can be rolled and stored inside its carrying bag that can be worn as a pack or secured to a pack. The approximate weight of the litter and its accessories is 10 to 12 pounds. For cervical spine injuries the SKED comes equipped with an Oregon Spine Splint. The additional weight of the splint is 3 to 5 pounds.

1) Securing a Casualty to the SKED.

a) First unroll the litter. The litter must be re-rolled the opposite way to allow the litter to lay flat. Then lay the litter next to the casualty.

b) If the casualty has any possibility of a spinal injury the Oregon Spine Splint must be used. Secure the splint to the casualty by use of the color-coded buckles. Experienced medical personal are recommended if spinal immobilization is necessary.

c) Once the casualty is on the SKED use the four body straps to secure the casualty to the litter. Unless injuries prevent it, the casualty's arms should be at his sides to prevent further injuries to himself or the rescuers.

d) Once the casualty is secured with the body straps, the feet straps must be secured. The feet straps are secured last to ensure the casualty is in the proper position on the SKED. The feet can be positioned in three ways. The first position is feet together with the straps running on the outside of the feet. The second position is feet apart with the straps running on the inside of the feet. The last position is the feet stacked. This is the most uncomfortable position and not recommended for casualties with possible spinal injury. This position is formed by placing the heel of one foot on top of the toes of the other. This position will only be used for a casualty in confined spaces. Once the feet are positioned the feet straps must be secured. Start by bending the feet end of the SKED to form a platform for the feet. Then loop the feet straps through the second grommets on each side.

e) The last thing to do is to form the head end to protect the casualty's head. If possible, the casualty should wear his helmet. Form the head end by tying the pull strap up and secure it to the first body straps.

2) Medical evacuation of a Casualty. There are many ways to move the casualty once in the SKED. However the medevac team must keep the following general considerations in mind. The two methods that we will talk about next are the simplest and require the least amount of additional rigging.

a) The first way is to drag the casualty by the drag strap located at the head end of the SKED. You can also use the SKED's carrying bag as a harness in conjunction with the pull strap and towing harness. If additional people are required, cordage can be added to the pull strap or the front carrying handles.

b) The second way is to carry the casualty using the carrying handles. By using the set of four removable webbing, the litter team can be augmented. To do this, each piece of webbing is tied to

make an endless loop. Then pass a bight of the loop through one of the grommets to create additional handles.

3) Rigging the SKED for Vertical Terrain. For vertical terrain, special requirements must be taken to raise or lower a casualty in the SKED.

a) Rigging the SKED for a Vertical Employment. A vertical raise or lower is used when moving a casualty on steep earth to avoid any further injury to the casualty. On vertical terrain, the vertical raise or lower can be used if the terrain is not uniformed or there is a chance of rock fall. Ensure that the casualty's head is always above his feet.

(1) Identify the 30-foot piece of cordage that comes with the SKED. Then tie a figure eight in the middle of the rope. If the rope is worn or missing, the same process can be done with two sling ropes.

(2) Next pass each end of the rope through the grommets at the head of the SKED. Leaving approximately 1-2 feet of rope between the stretcher and the knot.

(3) Continue to feed each end through the grommets and the carrying handles towards the foot end of the SKED. Pass the ends of the rope through the last grommets at the foot end and secure the two ends with a square knot without over hands.

(4) Bring the pigtails up and over the casualty's feet and pass the ends through the carrying handles towards the middle of the casualty. Then tie a square knot with two over hands.

a) Rigging the SKED for a Horizontal Employment. A horizontal raise or lower is preferred on uniformed vertical terrain. The horizontal employment allows the rescuer to assist the casualty on either a raise or lower. It also allows the rescuer the ability to monitor the casualty's condition and can easily treat the casualty if the need arises.

(1) Identify the two 4 inch nylon straps. They should be two lengths; one four inches shorter than the other. The shorter strap should be marked HEAD STRAPS.

(2) Insert one end of the head strap into a slot near the head of the litter. Then wrap the rest of the straps under the SKED and pass the other end through the opposing slot. Do the same at the foot end of the SKED with the other strap. Ensure that the strap runs smoothly under the SKED.

(3) Connect the strap ends with the large locking carabiner that comes with the SKED. If the carabiner is worn or missing, opposing 85 locking carabiners will suffice.

b. STOKES LITTER. . The stokes litter is a litter that is constructed of metal tubing with a plastic covering. The litter is formed in a rectangular basket shape with mesh attached to the frame. Using the stokes for an evacuation (as with any evacuation) it should be padded for the casualty.

1) Securing the casualty to the stokes litter. In the event that the "seat belts" are missing from the stokes litter, sling ropes can be used to the lash the casualty. The steps involved are:

a) Tie two sling ropes together using square knots and two overhands.

b) Tie a stirrup hitch around ankles and feet, feed the two pigtails through the right angles of the stokes. Do not cross the ropes at the ankles.

c) Lace the sling rope towards the casualty's head by passing the rope through the right angles (not over the top of the rails of the stokes).

d) Secure the ends of the sling ropes by tying a clove hitch with two half hitches on the fat vertical bar located by the victim's shoulder.

6. YOSEMITE PRE-RIG. The title of this method, pre-rig implies the meaning ready to use, but in this case the rig must be constructed. Its purpose is for attaching a belay line to a litter and to make the litter easily adjusted. This is the one method that is used to secure a litter to a belay line.

a. Construction. This method normally requires four sling ropes. The steps are:

1) Using one sling rope, tie a figure-of-eight loop with one tail.

2) Take the remaining tail and run it through the window of the stokes litter or in the stirrups of the collapsible litter.

3) Tie a kragur knot onto the same sling rope.

4) Repeat steps (1), (2), and (3) with the three remaining sling ropes.

(5) Suspend the litter to ensure that the comers are balanced.

7. ASCENTS OR DESCENT OVER STEEP TO MODERATE SLOPES. When the litter team is ascending or descending a slope they must think of the potential for further injury to the casualty or to themselves. If the risk of injury is high, a belay line may be used to decrease injury to the casualty and the rescuers.

a. Preparing Casualty for Ascents or Decent over Steep to Moderate Terrain. This procedure will be depending on several things. Initially, site selection should contain the following features.

1) Suitable anchor points.

2) Clearance for the casualty along the route

3) Loading and unloading points.

b. Additional considerations.

1) The casualty will always be rigged for vertical employment when on steep to moderate terrain.

2) The smoothest possible route must be selected.

3) Ensure that the casualty's head are above his feet.

c. Rescuers positions. There are two methods that can be used for the rescuers for moving a casualty in steep to moderate terrain.

1) Two to four men will position themselves on each side of the litter. They can then carry the litter by the carrying handles. In steep terrain a second belay line may be used to assist the rescuers. We will discuses the belay line later in the chapter.

2) The Caterpillar method will require as many personnel as possible. The personnel will split in half and position themselves on each side of the litter forming a tunnel. As the litter is raised or lowered each member will hand the litter to the next member in the tunnel. As the litter passes each person in the tunnel, he will peel off and assume the lead either at the top or bottom of the tunnel, depending on the direction of movement. This will continue until the litter reaches its desired destination.

d. Belay Line. For belaying a casualty, one rope from the top will be used, using one of two methods depending on the application.

1) Body Belay. This method should only be used over moderate terrain. The belay man will establish a sitting position behind a suitable anchor (i.e., rock, tree, etc.) and pass the standing end of the rope behind his back. The running end of the rope will feed out from the belay man's right side. A figure of eight loop is tied to the end of the running end of the rope. It is then attached to the litter's figure eight loop with a locking carabiner. The belay man will then remove all of the slack between himself and the litter. The standing end of the rope should be stacked on the belay man's left side and run through his left side. As the casualty is lowered, the belay man will feed the rope from behind his back allowing it to run through his right hand. If the belay man needs to stop the casualty, he will clench the rope in his left hand, and bring the rope to the center of his chest.

2) Direct Belay. This method is the safest for either raising or lowering a casualty in either moderate to steep terrain.

a. To Lower a Casualty. First a swami wrap will be tied around a suitable anchor point. Two locking carabiners will be clipped into all of the wraps of the swami wraps, gates up. A figure of eight loop is tied into the end of the static rope and attached to the litter with a locking carabiner. After all the slack has been taken up between the litter and the anchor, the rope must be tied through an appropriate belay device. The belay device is attached to the anchor through one of the two locking carabiners on the anchor. A safety (French) prussic will be tied to the running end of the rope and clipped into the second locking carabiner on the anchor. While the casualty is being lowered, one person will control the rope running through the belay device. The safety prussic will be controlled by a second person. Should the primary belay man lose control, the person operating the safety prussic simply lets go and the prussic will bind onto the rope, stopping the casualty.

b. To Raise a Casualty. The anchors will be established in the same manner as discussed in lowering the casualty with one minor change. The one change is that instead of running the rope through a belay device, the rope will only run through a locking carabiner. The load will be raised by the use of a mule team. The mule team should consist of as many people as possible. The mule team will raise the load in as straight a line from the anchor as possible. If the space does not permit, a ninety-degree angle away from the anchor is also an option. The mule team will walk backward until the last man reaches his limit of advance. Once he reaches that limit he will peel off the end and return to the front of the mule team. This process is continued until the casualty reaches the top. If the load becomes unmanageable, the safety prussic will be allowed to bind on the rope while the mule team repositions themselves. If the person operating the safety prussic can not see the casualty, a Point NCO will be in charge of communicating with the mule team.

c. To Belay the Rescuers. If the route is too steep or the footing is poor, the rescuers may need some assistance either on the raising or lowering of a casualty. If this is the case, a separate belay line will be established for the rescuers. The anchor and the belay line are established in the same manner. The same anchor can be used if it is suitable for the load. The rescuers will then tie either around the chest bowlines or swami wraps. A figure eight loop will be tied into the end of the static rope and connected to the bottom rescuer with a locking carabiner. The other rescuers will connect themselves to the same rope with middle of the line prussic. They will be connected in this manner so that they can adjust their position to the casualty.

8. BARROW-BOY. A barrow-boy is no more than an assistant to the litter on vertical to near vertical cliff faces. The barrow-boy can be used for either the Stokes or the SKED litters. For this situation the Stokes litter should only be used in the horizontal position. However the SKED can be employed in either the horizontal or the vertical positions.

a. Rigging the Barrow-Boy.

1) First the rescuer must ensure that a suitable anchor has been established, a proper belay has been constructed, and that a safety prussic has been constructed.

2) Then the rescuer must ensure that if an A-frame is used, that it has been constructed and anchored properly.

3) Next the rescuer will tie a rappel seat on. (a sit harness can also be used) Then he will ensure that an around the body bowline is tied onto the casualty. A figure eight will be tied on to the end to act as the casualty's safety.

4) After running the running end of the rope though the carabiners or pulley of the A-frame he will tie a figure eight loop at the end of the static rope. He will then attach the figure eight loop to his hard point with a locking carabiner. Then he will tie a middle of the line prussic above the figure eight and attach it to the same locking carabiner in his hard point. This is called the adjustment prussic. It is used to adjust the position of the Barrow-Boy in relation to the litter. Next he will take six to eight feet of slack from the end of the line figure eight and tie a directional figure of eight with

direction of pull down. (Note: the prussic should be between the end of the line figure of eight and the directional figure of eight.) The directional figure of eight is the attaching point for the litter and the casualty's safety.

5) Once the rescuer and the litter are secured, the belay man must take all the slack out of the system. The rescuers will the maneuver the litter through the apex of the A-frame with the help of the point NCO.

6) Once onto the cliff face the rescuer will then position him self with his adjustment prussic so that he can be of most assistance to the litter on the raise or lower. The rescuer will pull the litter out away from the cliff face so that the casualty rides smoothly up or down the cliff face.

7) The Point NCO will be in charge of the belay men or the mule team. He will also communicate with the rescuer about the rate of speed, if the rescuer need to be stopped along the route, and when he reaches the top or bottom of the cliff.

9. TANDEM LOWERING. The tandem lowering system can be used for the walking wounded, POW's, or more serious casualties when situation would not permit using the barrow-boy.

a. The assistant to the casualty should first tie a rappel seat on himself and then assist the casualty with his.

b. The assistant will take only one belay line and tie a end of the line figure 8 loop, and clip this into his rappel seat.

c. A directional figure of eight will be tied 12 to 18 inches up the rope from the figure eight loop with a direction of pull down. This will be clipped into the casualty's hard point.

b. A middle of the line safety prussic will be tied between the figure of eight loop and the directional figure of eight. This will be attached into the same locking carabiner as the end of the line figure eight loop. The prussic will be used so that the rescuer can position him self to render the most support to the casualty.

10. OTHER CONSIDERSTIONS. All of the techniques we have discussed for the evacuation of a casualty from top to bottom can also be used on a suspension traverse or rope bridge, with a slight variation in the belay line. Two belay lines may be used for rope bridges and the suspension traverse, if they are available. No matter what type of litter is used, the individuals involved in the evacuation must ensure that the head is always uphill or not lower than the feet.

CONCLUSION: Medevacs while not wanted, are a regular part of combat as well as training. These techniques must be well rehearsed and understood if you expect to execute them successfully in an actual situation when lives are at stake.

CHAPTER 8
UNIT MOVEMENT

STREAM CROSSING: Anywhere in the world a mountain stream swollen by melting snow runoff poses a formidable obstacle to movement and can also be a hazard to your Marines.

1. **SITE SELECTION -** Mountain streams and rivers are military obstacles and therefore are danger areas for units crossing them. In order to reduce the time in the vicinity of the danger area, a Reconnaissance team should precede the main body and select the best crossing site. The site selection for a stream crossing should include these eight considerations:

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

2. **SAFETY PRECAUTIONS.** The following two safety precautions must be taken while conducting stream crossings.

a. There must be a safety line at a 45° angle downstream across the stream. This is for anyone who slips and is swept downstream to grab so that he is capable to stopping himself

b. There must be safety swimmers downstream. These are strong swimmers who are positioned downstream to help anyone who is swept downstream. The safety swimmers will use throw bags.

NOTE: The safety line, as well as any other lines that must be taken across the stream, will be taken across by using the lead swimmer method taught in *ONE-ROPE BRIDGE.*

3. **INDIVIDUAL CROSSING PREPARATIONS.** Prior to crossing a stream, there are certain preparations that each individual should take. The five preparations are as follows:

a. Wear the pack with shoulder straps fastened snugly. Waterproof the pack for buoyancy if possible.

b. Weapons will be slung diagonally over the shoulder with the weapon being between the pack and the individual's back.

c. Button all pockets and remove blousing garters. This prevents the water from creating added drag against the individual.

d. Wear boots to protect the feet, but remove socks and insoles to keep them dry.

e. Wear the minimum amount of clothing. This reduces the amount of clothing that must be dried after the crossing.

f. Wear a helmet only in slow moving, shallow water. In swift water the current can catch on the inside of the helmet and drown a Marine.

NOTE: If you are in a tactical situation, the actual situation will dictate which of the above precautions will be taken.

4. **INDIVIDUAL CROSSING METHODS.** There are three individual methods that may be used.

a. Staff Method. A strong staff or pole about 6 feet long is used as a crossing aid. It should be strong enough to support the Marines weight and trimmed clean of any branches. Placing both hands on the pole, the Marine should place the staff just upstream of his intended path. He should use the staff as the third leg of a tripod and should move only one leg or the staff at a time. He should face upstream using the staff to retain his balance. The staff is also used as a probe to discover bottom irregularities which could trip the Marine. The Marine should drag his feet instead of picking them up.

b. Swimming. This is an obvious method, if your Marines are good swimmers. However, this is not always the case, so usually this method is not a preferred one.

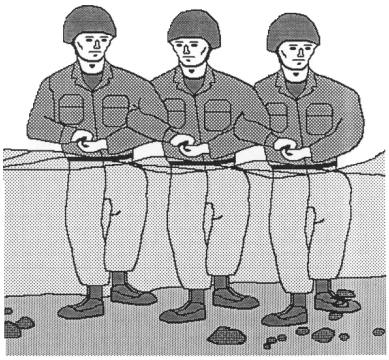
1) In fast, shallow water, the Marine should angle across on his back with his feet downstream and his head up. He should use his hands to tread water and his feet to fend off obstructions.

2) In fast, deep water, the Marine should angle across the stream on his stomach with his head upstream, to establish a proper ferry angle. Ferry angle is accomplished by simply entering the water upstream of the point you want exit at. Depending on how swift the current is the farther up stream you will need to enter the water.

c. Belay Method. In chest deep water or water with a strong current, a rope can assist greatly. A rope will be secured from bank to bank, with the far anchor slightly downstream from the near anchor. The rope will be anchored off so that it lays at a minimum of 45°. The Marine attaches himself to the rope by using a sling rope as safety line, tying a bowline around his waist and a figure-of-eight loop with a locking carabiner inserted. ***This carabiner should not be locked for ease of removal on the far side***. This is one of the few times you will not lock down a carabiner. He then attaches the carabiner to the crossing line, at the same time another Marine will attach the pack to the line in front of the Marine that is crossing. The Marine will enter the water downstream of the line pushing his pack in front of him. He now crosses using

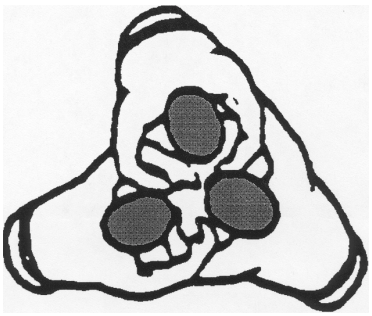
the current and doing a side stroke to assist him. Marines will not grab the line as a finger can get caught in a carabiner causing many problems.

5. **TEAM CROSSING METHODS.**



a. Line Abreast . Small units (squad to platoon) can cross in moderate currents up to chest deep, by lining up in a line abreast or chain method. The largest man 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 man of the chain will control the groups movement and give the command when to step. Hands must remain interlocked as shown in the diagram to the left.

b. Line Astern Method. Three or more men can line up facing the current. The upstream man, who should be the largest man in the group, breaks the current while the downstream men hold him steady. The upstream man may use a staff, similar to the individual staff method, to steady himself All men side step at the same time with one man calling the cadence.



c. Huddle Method. Between three and eight men can face inboard as in a football huddle. They will wrap their arms around each other, like the line abreast method, and cross the stream in this formation. The upstream man should change position as they cross because the entire formation will rotate. This prevents one man from becoming exhausted in the upstream position.

CONCLUSION: While you will normally not need these methods on a patrol. They will help to ensure there will be no lost gear or personnel and will be essential in the spring when mountain streams are at their peak, and there is very little training needed to perform these methods.

FIXED ROPE INSTALATIONS: In a mountainous environment, battle field gaps or soft spots in an enemy defense are usually cliffs or steep slopes. These gaps can be easily exploited by the use of fixed rope installations. Fixed ropes also aid the heavily laden troops in ascending steep to moderate slopes.

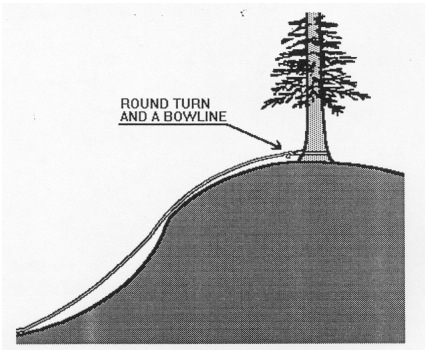
1. **SITE SELECTION.** Fixed ropes should be used to protect routes where a fall may result in injury, choose routes that will allow a Marine to be ready to fight upon reaching the top. The two factors to determine difficulty of route are:

a. Climbing units experience and ability.

b. Climbing units load.

2. **<u>TYPES OF FLXED ROPES</u>.** There are two types of fixed rope installations that we will cover in this class: Simple fixed ropes and fixed ropes.

a. <u>Simple Fixed Ropes.</u> This type of rope installation is primarily designed to aid heavily laden Marines in the ascent or descent of a steep to moderately steep slope. It is defined as being anchored at one end of a climbing rope. The rope can be used for all desired aid when climbing. A knotted hand line may be used for this purpose.



1) The #1 climber will pull the static rope up the route. Once at a suitable anchor he will anchor the static line. The #2 climber ascends the route and ensures the simple fixed rope is on the correct route.

2) The last man up will retrieve the rope and coil it.

3) Ascending or descending a simple fixed rope.

a) Ascending a simple fixed rope is accomplished by straddling the rope with your legs and walking up the slope while pulling yourself up the rope with your hands. Gloves will not be worn as they may give you a false grip on the rope.

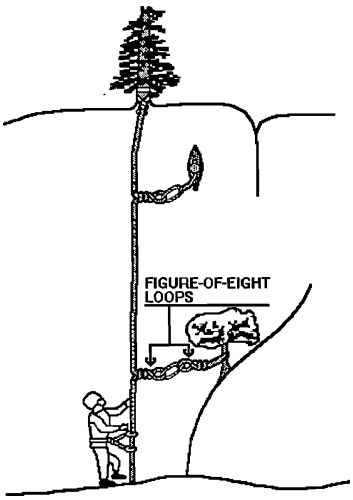
b) Descending a simple fixed rope will be accomplished in the same manner as a hasty or body rappel, whichever is appropriate, as covered in *ESTABLISHMENT OF RAPPEL POINTS AND RAPPELLING.* Gloves will be worn to prevent rope burn to your hands.

b. <u>Fixed Ropes.</u> This type of rope installation is primarily designed to protect heavily laden troops while negotiating difficult scrambles, traverses, or slopes where balance climbing may be hazardous. Types of terrain where this would apply: narrow chutes, dry waterways, steep talus slopes, etc. Fixed ropes differ from simple fixed ropes and are defined as being anchored at both top and bottom and having several intermediate anchors points along the route. Establishment of the fixed rope is as follows:

1) The assault climber picks a route and the climbing team sets up for a normal two party climb.

2) Before the #1 climber begins to climb he will flake out a static rope and tie one end of the static rope into the back of his harness with a figure of eight loop.

3) The #1 climber begins climbing and placing pro as in any two party climb keeping in mind that other less skilled climbers will ascend his route. With this in mind



he should position the rope in relationship to the other climbers in the following manner:

a) The rope is positioned approximately waist high. For the climbers to use as a handrail.

b) The climber should not be forced to cross the rope at any point once it is tightened. To avoid Marines tripping over the line or their gear getting caught on the line possibly causing injury.

4) The #1 climber should clip his climbing rope into the intermediate anchors as in regular two party climbing.

5) Once on top, the #1 climber will remove the static rope from his harness and anchor it off using an appropriate anchor system. He will then tie himself off, or move further than 10 feet away from the cliff face. The #1 climber is now “off climb”.

6) When the #2 climber gets the "off climb" signal or command from his partner he will then break down the anchor system and untie from the dynamic climbing rope. At this point the #1 climber will pull up the dynamic rope and coil it. Once the dynamic rope is coiled the #1 climber will go to a good position and set in topside security.

7) The #2 climber will find the end of the static rope and tie a figure of eight knot in it. The rope will then be attached to the first piece of pro not more than waist high.

8) A prussik knot will be attached to the static rope with a four or six finger prussik knot. The running end of the prussik will be attached to the climber with a locking carabiner.

9) The #2 climber now begins to climb the route, sliding his prussik up the rope as he climbs to protect himself in case of a fall.

10) Intermediate anchor points will be attached to the fixed (static) rope with a carabiner. The knot tied in the fixed rope can be a slip figure eight, clove hitch, or a figure of eight loop. There should be no slack in between any of the anchor points.

NOTE: The No.2 man must use good judgement while setting in the fixed line. He can remove or place more intermediate points if he feels it is necessary. The key to remember is to protect in areas where your average Marine could take a dangerous fall, and less protection in the easy sections of the climb.

11) At natural anchor points, a round turn and bowline finished with an overhand, will be tied around the anchor with one end of a sling rope. A figure of eight loop will be tied to the running end of the static rope with a carabiner attached to the loop. This may now be used as a normal piece of protection.

12) When the #2 climber reaches the top, all slack should be taken out at the anchor, and the static rope should be as tight as possible.

13) By anchoring the rope at intermediate anchor points, each section of rope is made independent of the others. Should one sections fail, the other sections remain intact. If this happens, it should be reported immediately to the installing unit and fixed.

14) An alternate method that can be used when speed is essential is the assault lane. This is established in the same manner as a fixed rope, but the intermediate anchors are just clipped in and the lead climber tensions the rope from above or below depending on the anchor availability.

a) The advantages of this method are the speed of installation and recovery and the flexibility of the second climber' position at the cliff base. Now the No. 2 climber can remain at the bottom to assist other teams, set in control features or control personnel as they reach the cliff.

b) The disadvantage is the lack of a hard knot at the intermediate anchors. That will not prevent a long fall should a piece of protection come out.

3. **MAINTENANCE OF A FIXED ROPE.** There are two considerations in the maintenance of fixed ropes:

a. The rope should be buffed at all points of abrasion.

b. The rope should be periodically checked for the security of anchors. All discrepancies should be reported immediately to the installing unit.

4. **ASCENDING A FIXED ROPE.** To attach yourself to the rope:

a. Tie a bowline around the chest using a sling rope.

b. There should be one arms length or more of pigtail left. Tie a figure-of-eight knot with a large loop, (three fists**),** at arms length on the pigtail. Place two carabiners in the figure-of-eight loop. (Locking or non-locking).

c. Clip both carabiners on the fixed rope between the first and second anchor points. Start climbing.

d. Upon reaching the second anchor point, unclip one of the carabiners from the climbing rope and reattach it to the climbing rope above the second anchor point you will do the same thing with the second carabiner. (If a fall should occur the climber is always attached to the rope when climbing in this manner).

e. Special instructions:

1) Keep a section of rope between Marines climbing on the fixed rope. A section being the rope between two pieces of protection.

2) Prior to beginning the ascent the ascending unit should set up commands or signals.

5. **CLEAR THE ROUTE.** Once all Marines have ascended the cliff, it becomes necessary to dismantle the fixed rope to retrieve the equipment and rope. Various methods may be used to dismantle the fixed rope. Here are the easiest and most preferred:

a. Rappel Method:

(1) The climbing team establishes a rappel line.

(2) The climber will hook up to the rappel line, and use a safety prussik.(see RAPPELLING)

(3) The climber will then begin rappelling. As he reaches the intermediate anchor points he will hang on the prussik and untie the fixed rope. He will also collect the protection.

(4) The climber will clear the entire lane in this manner.

(5) If the climber needs to ascend the cliff, he may be top roped on one of the two lines he now has.

b. Prussik Method:

(1) The #2 climber will move to the base of the fixed rope. (He may rappel or down climb the fixed rope).

(2) The #2 climber removes the rope from the first runner**,** unties the knot and retrieves any protection.

(3) The #2 climber will attach a prussik to his harness and a prussik knot secured with a bowline to the fixed line.

(4) As the #2 climber starts climbing he will have to slide his prussik up the fixed rope.

(5) The #2 climber will clear the route ensuring he retrieves all gear.

c. Top Rope Method:

(1) The climbing team establishes a top rope.

(2) The #2 climber clears the route while the #1 climber belays him.

6. **LONG PITCHES.** For longer pitches it will be necessary to use two ropes. The procedures for establishing the second rope is as follows:

a. The first pitch is negotiated in the established manner.

b. The #2 climber climbs to the top of the first pitch, while being belayed by the No.1 climber, tightening the fixed rope and tying into intermediate anchors points, he will carry an extra static line on his back.

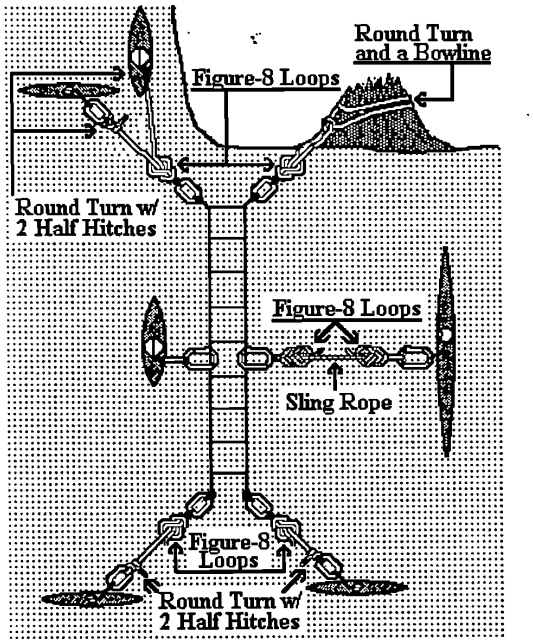
c. At the top of the first pitch, the #1 climber establishes a belay and belays the #2 climber who negotiates the second pitch establishing intermediate anchors.

d. Once on top, the #2 climber goes through the same procedures as the #l climber of a single pitch fixed rope. The #1 climber will tie the ends of the two static ropes together and carry out the same procedures of the #2 climber for a single pitch fixed rope.

7. **CABLE LADDERS.** The cable ladder used is a caving ladder, consisting of two long side pieces made of cable with eyes on each end of the cable connected by aluminum crosspieces at suitable distances. These crosspieces form steps by which personnel can ascend or descend obstacles.

a. Site Selection. When selecting a ladder site consider these four factors:

1) There must be good anchors at the top and bottom of the ladder.
2) You must be able to anchor the ladder along the route to keep it from swaying.
3) There must be suitable loading and unloading platforms.
4) The ladder should be placed in a book, chimney, or on an overhang.



b. Ladder Installation.

1) If using a natural anchor as a primary, use a sting rope and tie a round turn and a bowline finished off with an overhand on the anchor point.

2) With the other end of the sling rope, tie a round turn and two half hitches onto a carabiner attached to the eye of the ladder.

3) Each eye on the ladder will have its own independent anchor and will be pulled tight so there will be no slack between the eye and the anchor.

4) The ladder should be tightened from the top or the bottom so it is rigid.

5) If intermediate anchors are needed on the route of the ladder, make sure each side of the ladder has equal tension.

6) If artificial anchors are used, each eye will have two anchoring systems. A sling rope will be attached to the ladder eye with a figure of eight loop and then the two ends of the sling rope are anchored to the protection with appropriate anchor knots, such as a round turn and two half hitches.

8. **ASCEND THE CABLE LADDER.** This is done by one, or a combination of several, of the following techniques:

a. Climb the device as in climbing any ladder.

b. Climb the device so that one arm and one leg are on the side of the ladder nearest to the obstacle being climbed, and one arm and one leg are on the side of the ladder farthest from the obstacle. The hands will be placed in the underhand positions and the feet will be placed in the rungs via the heels being turned in and placing the arch of the boot on the rungs.

c. Climb the device with hands using the rungs for aid and the feet being placed on the obstacle being climbed (i.e. friction on foot holds.).

d. Safety being a main concern, the climber must be protected as he ascends. This may be accomplished by:

(1) A top rope system.

(2) A fixed rope running parallel to the ladder. The climber will use the same method to ascend as described earlier in the outline, but now will have the aid of a cable ladder.

(3) A semi fixed rope system running parallel to the cable ladder. This rope system is anchored at the top and the bottom with suitable anchor systems, with no intermediate anchor points. The climber is attached to the safety line by tying an around the chest bowline with a figure eight loop in the pigtail using a sling rope. Then using a short prussik cord, he will attach the cord to the safety line using a middle of the line prussik, that he will slide along beside him as he ascends. The prussik will be attached to the figure of eight loop in the end of his sling rope.

NOTE: The top anchor for any of the methods of protecting the climber will be separate from that of the top anchor of the ladder.

CONCLUSION: Fixed ropes and caving ladders should be used as the primary means of movement up a vertical to near vertical obstacle. They are used not only on cliffs but also to move in alpine areas and on glaciers.

STEEP EARTH CLIMBING: Like the Cliff Assault, Steep Earth is another obstacle that we as Mountain Leaders and Assault Climbers must be able to negotiate and move a Marine Infantry Company up and over.

1. **Equipment Needed:**
   a. Each climber will need the following equipment:
      1) Climbing harness.
      2) Mountaineering boots with half or full shank. If mountaineering boots are not available then the Marine Combat Boot can be substituted.
      3) Helmet.
      4) Gloves.
      5) 165 feet of climbing rope per rope team.

6) Earth ax, commonly referred to as an ice ax. The earth ax should be between 50 and 65 centimeters in length, if a short model is not available then a longer version can be substituted. The earth ax and alpine hammer are used in the same manner as for glacier and ice climbing. The picks of the two axes are driven into the earth and the axes are then used as handholds. The earth ax can also be used to cut handholds or footholds for follow on climbers. The use of 550 cord to secure the tools to the climber is highly recommended.

7) Alpine hammer, Northwall style hammer, or a heavy wall type hammer. If possible, use an alpine hammer as it has a hammer on one end and an ice ax pick on the other. The alpine hammer gives the climber a second tool when it is needed; the other types of hammers do not.

8) Set of twelve point crampons. It must be noted that there are numerous types of crampons available, all are suitable as long as they have twelve points. The reason for this is that twelve point crampons provide a more secure foot placement in the sometimes loose and unpredictable soil.

9) Sling ropes.

10) Snow stake.

11) Pieces of rebar optional. The rebar should be between 24 and 36 inches in length with one end bent around to form an eyelet. This eyelet can be used to clip a carabiner into or thread the rope through for an anchor similar to the snow stake.

b. The number two climber will carry a grappling hook (five point hand grapnel with 25 feet of knotted 7mm cord and a 165 foot knotted static rope. It must be kept in mind that more than one 165 foot knotted static rope maybe needed, depending on the length of the climb. The use of this system will be explained later in the text.

c. Each climbing team will carry a small rack of rock protection. This is because a large majority of steep earth climbs have a mixture of dirt and rock. The presence of rock will enable the climber to place secure protection in the event that he takes a fall. The rack should consist of at minimum:

1) (1) set of stoppers
2) (1) set of SLCD's up to 2 inches
3) (5) quickdraws
4) (5) double length runners
5) (10) non-locking carabiners
6) (5) locking carabiners

2. **<u>Climbing procedures</u>**:

a. <u>Route Reconnaissance</u>.- The route is visually inspected for steepness, soil composition, rock outcroppings, ice and snow patches, and availability of suitable anchors to include top, bottom and intermediate anchors. Based on this reconnaissance, the climbers choose a route and appropriate gear to complete the climb.

b. If possible normal belay procedures are used. The belayer establishes the bottom anchor utilizing his snow stakes, rebar, and earth axes or natural anchor points. The belayer ties into the rope and then ties into the anchor point for security. A bottom anchor is preferred, but it may not always be possible to setup. In this situation the belayer will act as the bottom anchor, using his body weight as the anchor.

c. Once the belay is established, the #1 climber ties into the rope and begins the climb. He will cut steps with the adze of his earth ax for footholds, if needed. If possible the climber will place a piece of intermediate protection as soon as possible after starting the climb. This protection may be a form of steep earth anchor or rock protection if possible. The climber must always remember that any protection placed in steep earth climbing is questionable, the best choice would be rock protection if available. There may be times when the lead climber is unable to place intermediate protection, if this happens, then the climber

must decide whether to choose a new route or continue with the route and take the chance of a severe fall. The tactical situation and availability of better-protected routes will determine the decision that is made.

d. If the climb can be completed in a single pitch, then once the lead climber has reach the top he will establish a top anchor using either the snow stake, rebar, a natural anchor, rock protection or a combination of the four. If the climb cannot be completed in a single pitch then the lead climber will need to set up a hanging belay. He will first dig a small belay platform using his earth ax. Next, the climber must establish an anchor using the snow stake, rebar, natural anchor, rock protection or a combination of the four. Once the anchor is established, the climber will tie into it and belay up the #2 climber.

e. The #2 climber will climb up to the #1 climber, taking out any intermediate pieces of protection that were placed. When the #2 climber reaches the belay stance, he will collect any unused gear from the #1 climber and continue the climb. If necessary the #2 climber will establish a belay stance and belay the #1 climber up and repeat the process. If the #2 climber reaches the top he will set up a top anchor in the same manner as mentioned for the #1 climber.

3. **Use of the Grappling Hook.** (five point hand grapnel):

a. The five-point grapnel, with its 25 feet of cord can be used in steep earth climbing. It can provide handholds where there may otherwise be none i.e.… short sheer faces and overhangs are just a few of the places where a grapnel can be used.

b. The use of the grapnel is fairly simple, yet does require practice to become proficient at using. First, the climber unwinds the cord and secures it to his body. Next, the climber must throw the grapnel up and over or around the obstacle in his path. Care must be taken to throw the grapnel to one side of the climber to prevent the grapnel from falling back onto the climber in the event that it does not hook on an object. Once the grapnel has been thrown, the climber slowly pulls on it until it hooks onto an object and is secure.

c. The climber now climbs up the difficult section using the assistance of the grapnel line. Since the grapnel relies on a steady downward pull to remain secure, the climber must be careful not to unnecessarily pull in any direction but down. A palms down with thumbs down grip is best used to climb the grapnel line.

d. Once at the top the climber checks the security of the grapnel and changes its position, if needed. He then establishes a belay and the #2 climber climbs up the difficult section, using the grapnel line as necessary.

4. **Duties Once on the Top:**

a. Security

1) The first man to the top conducts a hasty recon of the area before belaying the #2 climber up to the top.

2) As soon as the #2 climber is at the top, he provides security. The #1 climber looks for a suitable location to set up the climbing lane for the follow on Marines. Keep in mind that the actual climbing lane may be different from where the initial route was established. This site should have the following criteria:

a) Good natural anchors, these may have to be multiple small shrubs or bush type anchors. They may also be sturdier objects such as rock or a tree.
b) Artificial anchors i.e.…snow stakes, rebar, and rock protection or a combination of the three.
c) Ensure that the rope reaches the bottom of the cliff. It maybe necessary to tie two ropes together in order for the rope to reach the bottom. If this were the case, then the preferred knot used to join the two ropes would be either the square knot with two overhands or the double fisherman's knot.
d) There must be a minimum of loose rock and dirt.

3) The knotted hand line should be pre-knotted to save time and carried by the number 2 climber. There are two knots which can be used in the knotted hand line:

a) Overhand knots placed approximately 24 to 36 inches apart.
    (1) Uses less rope.
    (2) More difficult to tie
b) Directional figure of eight's placed approximately 24 to 36 inches apart with the direction of pull being towards the bottom of the cliff.
    (1) Loops are easier to grasp and can be made large enough to be used as footholds.
    (2) Uses more rope.
    (3) Easier and quicker to tie.

4) Steep earth climbing anchors: There are many types of anchors which can be constructed using the snow stakes, rebar, earth ax, rock protection and natural anchors, if available. The following are just a few that can be constructed:

a) Snow stakes and rebar:
    (1) If the ground is solid enough, then a single stake can be driven into the ground and the rope attached using a locking carabiner. The stake should be driven into the ground so that all but 2 to 4 inches are imbedded. Using a locking carabiner, attach the rope to the stake.
    (2) A two-point anchor system can be used if the ground is questionable. In order to construct a two point system; first drive two stakes into the ground approximately 12 inches apart, no closer. Next attach a non- locking carabiner to each stake. After that is completed, take a double length runner and clip it into the two carabiners. Next, pull the runner towards you and put a twist into one leg of the runner and clip your locking carabiner into the two loops formed by the twist. Lastly, clip your rope into the locking carabiner.
    (3) If the ground is loose or sandy, then a three picket hold fast (refer to climbing anchors) can be used. Keep in mind that this system uses three stakes.
    (4) In extremely loose or unstable soil a T-trenched stake maybe necessary. To build this system, first use your earth ax to dig a trench parallel to the cliff head. The depth of the trench will depend on the stability of the soil. The more unstable the soil the deeper the trench. Next dig a trench perpendicular to the first trench forming a T, with the bottom of the T pointing towards the cliffhead. Once that is completed, take a double length runner and girth hitch (refer to climbing knot) it around the center of the stake. Next place the stake into the trench with the runner coming out of the trench which forms the bottom of the T. Using the dirt that climber dug out of the trenches, fill the trenches in and pack the soil down. Lastly connect the rope to the runner using a locking carabiner. This method can also be constructed using an earth ax.
    (5) Earth axes can be used in place of the snow stake and rebar and are considered to be just as strong and secure.
    (6) Natural anchors, if available, are the preferred method to be utilized. The types of natural anchors and the methods of using them are covered in climbing anchors. They can be put to use in the same manner for steep earth climbing as they can be for rock climbing.
    (7) If there are rock outcroppings at the top of the cliff, then the rock protection can be used to set up the top anchors. (refer to climbing anchors)

(8) These anchors can be used alone or in combination with each other. The type of soil encountered and available anchor materials the climbers brought with them will dictate the anchors that will be constructed. If the climber is ever in doubt about the type stability of the soil or the strength of the anchor, then he should back it up with a secondary anchor and a third if necessary.

VERTICAL ASSAULT. For a Marine, there is almost no such thing as impossible terrain. Even cliffs can be surmounted, and military operations can be conducted if the techniques are properly learned. Techniques for cliff assaults were developed and refined by the Royal Marine Commandos during World War II for amphibious raids; but the principles apply to any cliff. This will introduce you to the principles of cliff assault.

1. **TACTICAL CONSIDERATIONS**. The aim of a vertical assault is to move a military force from the bottom of a cliff face to the top with minimum of disorganization, in order to carry out a military operation. The four tactical considerations that the planner must take into account are:

a. Surprise is paramount and silence must be kept to attain surprise.

b. Speed is essential, and all ropes must be used.

c. The cliff head must be well organized.

d. Initially, the raiding party is very vulnerable.

2. **AMPHIBIOUS CONSIDERATIONS.** Some of the amphibious considerations are:

a. Advance force reconnaissance operations should be employed.

b. Hydrographic surveys/confirmatory beach reports should be conducted.

c. All landing vehicles/crafts must be spread loaded.

d. Debarkation must be done quickly.

3. **PLANNING**

a. The most experienced Assault Climber/ Mountain Leader is responsible for organizing the unit's movement from the beach master's position across the vertical obstacle to the CONTROL POINT NCO.

b. Reconnaissance. Recon teams, when able, must take an experienced assault climber team with them on insertion to ensure that:

1) Climbing points can be established on the vertical obstacle that are within the units ability.

2) Suitable top and bottom anchors.

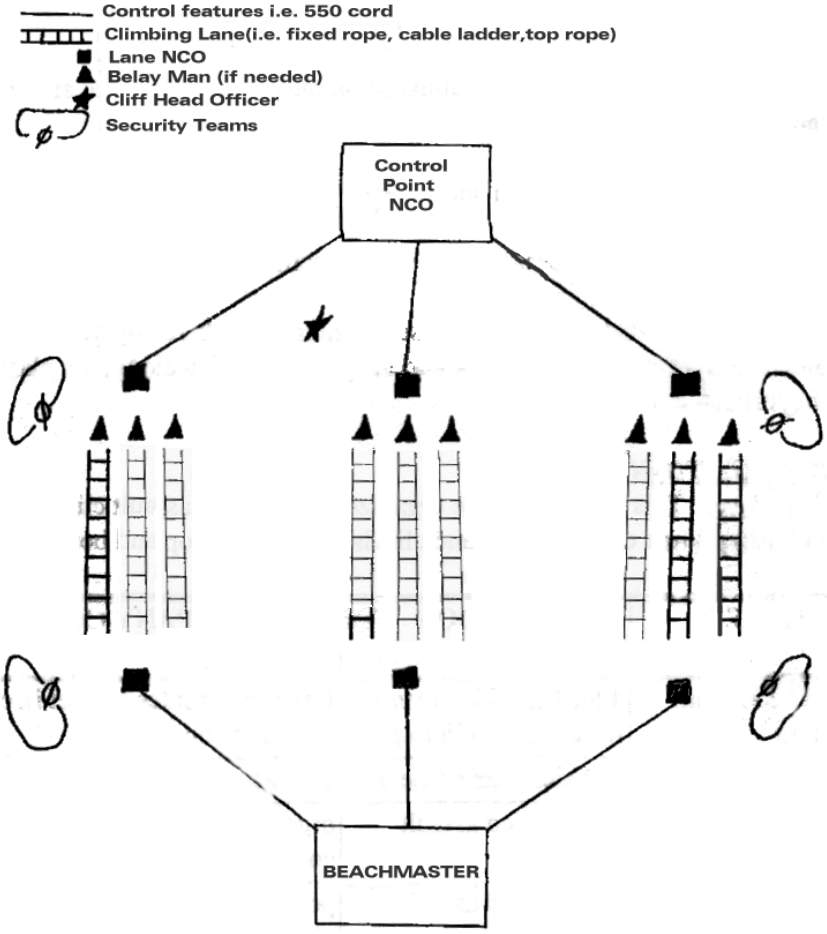
3) Be able to direct assault climbers to specific routes upon arrival.

4. **ORGANIZATION.**

a. 1stWave. This wave would be organized with l8-24 assault climbers (depending on size of unit), plt/unit commanders, and cliff head security (top and bottom).

BILLET	PLATOON COUNTERPART	COMPANY COUNTERPART
#1 and #2 Assault Climbers	4 lead climbing teams from assault climb plt.	lead climb routes and set in climbing points for follow on force
Unit commander	HQ elements of the unit	complete plan through visual recon
control point NCO	experienced assault climber	organize top of obstacle, set up control features, coordinate with MACO
Cliff Head Officer	experienced assault climber	position security at bottom and top of vertical obstacle, aware of all actions between beach master and control point
Beach Master	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	experienced assault climber	one per climbing lane, assist beach master and control point NCO in setting up control features, physically places individuals from climbing lanes to climbing points.

NOTE: Additionally within the first wave, a company-sized unit may want to designate a vertical hauling line/suspension traverse team to establish these installations on top for heavy equipment.



b. 2nd Wave. This would constitute the remainder of the task-organized units, the assault force and the reserves. The XO is delegated in command of the second wave and will stay at the base of the vertical obstacle until the unit has negotiated the vertical face.

1. 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).

5. **TECHNIOUES.** The actual techniques used to negotiate personnel and equipment up the vertical obstacle may vary depending on a variety of factors: level of training, type of vertical obstacle to be negotiated, and/or equipment available. The following four techniques, or any combination of them may be used:

a. Two party climb for assault climbers, all other personnel top rope.

b. Two party climb for assault climbers, all other personnel go up fixed rope installations.

c. Two party climb for assault climbers, all other personnel/equipment utilize vertical hauling line and/or suspension traverse.

d. Two party climb for assault climbers, all other personnel utilize cable ladders.

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6. **ASSAULT SEOUENCE**

a. Assault climber platoon links up with recon teams and move to the base of the vertical obstacle and begin to establish climbing points.

b. Cliff head officer sets in bottom security.

c. Beach Master establishes control features at the base of the vertical obstacle.

d. As the first climbing points are established, the cliff head officer, unit commander, control point NCO, top security elements, and the remainder of the assault climbers will move to the top of the vertical obstacle. Remember speed is essential the most vulnerable time of the cliff assault begins now.

e. Cliff head officer selects the top cliff security positions while the control point NCO runs control features from the control point to the climbing points.

f. Cliff head officers radio operator brings up wire line from the beach master. This is preferred as they are a more secure means of communicating and are lighter and easier to carry up the vertical obstacle. Caution must be used to avoid climbers getting caught in the communication wire in the dark, also in an amphibious assault the shock effect can be felt if wires become caught in the surf.

g. Vertical hauling line and/or suspension traverse will be established if required.

h. Once the top of the vertical obstacle is secured. The 2nd wave moves to base of obstacle, deploys and ascends up climbing points. Have the unit prepared and flexible enough so that if all lanes are not ready the Marines can go up a separate lane. (I.E. no cable ladders are ready but the two top ropes are.) This requires maximum communication between the Cliff Head Officer, Beach Master, and the Senior Assault Climber.

i. Once they are on top of the obstacle and all of their personnel are accounted for. Unit leaders report readiness.

j. Once the entire unit has passed the control point NCO, control features are retrieved.

k. Cliff head officer organizes for defense/security.

l. Beach Master party provides base security.

7. **WITHDRAWAL**

a. Tactical situation. If the unit is compromised before the mission has been completed, then the tactical situation will dictate how the withdrawal will be made. Control must be exercised by the unit commanders to ensure that personnel do not “rush” the rappel lanes and that some security is maintained. Obviously in this situation the ropes have the lowest priority, and all lanes should remain up to get maximum personnel down. Then if possible the senior Assault Climber can cast them off or destroy them, if time is available, in the end.

b. Principles. If the unit is not discovered, or in close contact, then the principles are the same as any normal withdrawal.

(1) The perimeter integrity is maintained as the diameter decreases.

(2) A high proportion of leaders remains to ensure close control.

(3) A preponderance of automatic weapons is maintained until the last moment.

(4) Pre-planned fires from supporting arms are planned for, if available.

c. The standard procedure is as follows:

(1) The unit returns and forms a 180° defensive perimeter in its original position. If control tape is required to remark the rope sites, it is laid now.

(2) The unit commander then gives the signal to "Withdraw", and the beach master and his party prepare to receive the descending troops. In an amphibious raid, he would call the landing craft/vehicles.

(3) Company XO rappels down.

(4) #1/#2 assault climbers control their ropes.

(5) 50-75% of the machine guns are left in the defensive perimeter until the final moment of withdrawal.

(6) Squads thin their positions with the squad leader descending last. He reports his squad’s departure to the Control Point NCO.

(7) The unit commander descends after the main body has descended down.

(8) Security teams descend down.

(9) Cliff head officer/messenger rappels down and assist the beach master. In an amphibious assault, they would assist in back-loading. In mountains, control features can be used to control organization following descent.

(10) The #2 Assault Climbers cast off their ropes and rappel down #1 ropes.

(11) The senior #1 Assault Climber all remaining #1 Assault Climbers a retrievable rappel lane, then rappels down, recovers the rope and reports to the unit commander that the vertical obstacle is cleared.

(12) In an amphibious raid, the beach is checked to ensure no equipment is left behind, and the unit commander embarks last.

d. If your mission was a raid, you would want to leave no trace of your route! This requires self-discipline by each Marine and close supervision by all unit leaders.

CONCLUSION: The vertical assault is one of the hardest operations to conduct. Even in a training environment Marines are often not accounted for and lanes not properly utilized wasting time and exposing the unit for extended periods at the edge of a cliff. Only a good plan, rehearsals, and reliance on junior leaders will enable a good execution of the vertical assault.

CHAPTER 9
ALPINE MOVEMENT

GEOLOGY AND GLACIOLOGY.

1.THE EARTH'S COMPOSITION

a. Geology is the study of the Earth. At the macro level, the Earth is divided into three distinct layers:

1) Crust. The only portion of the earth that man has direct knowledge of is the crust, the outer 1% of its radius. The crust is 5-40 miles thick, being thinnest under the oceans, and thickest under the mountains.

2) Mantle. This layer, about 1,800 miles thick, separates the crust from the core. Scientists are unsure as to the exact appearance, consistency, density, or temperature of the mantle, though they have agreed that it is probably made up of solid matter. The most interesting thing about the mantle, from the standpoint of physical geography, is that despite the overall solid character, it contains layers or zones of differing strength and rigidity. The upper most layer of the mantle combines with crust to form the lithosphere, which is divided into units or plates. Located immediately beneath the lithosphere is a thick layer of weak plastic-like mantle called the atmosphere. Many earth scientists now believe that the major source of energy for tectonic forces comes from movement within the atmosphere produced by thermal or convection currents originating deep within the mantle.

3) Core. The core of the earth is believed to be composed primarily of nickel and iron, and hence the material of the core is sometimes called Nife (Ni is the chemical symbol for nickel and Fe is for iron). The core material is under enormous pressure, probably as much as three to four million times the atmospheric pressure at sea level. Through the transmission of seismic waves into the structure of the earth, we discovered that the earth's core is molten. However, because increased pressure can change the melting points of elements, the innermost core of the earth appears to be solid.

2. **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, we have basically three types of rock classifications: Igneous, sedimentary, and metamorphic.

a. Igneous.*These are 'fire-formed" rocks which have solidified from a hot liquid melt, called magma.* Examples are granite and basalt.

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

2) The cores of most major mountain ranges in the world is granite, and, in general, the older the mountains, the more granite rock has been exposed at the surface and the better the climbing.

3) When magma rises too close to the earth's surface, the molten rock may either flow onto the surface and cool or be ejected in a volcanic explosion as ash and lava. These igneous rocks are termed extrusive, as they cool and solidify in the atmosphere. Extrusive rocks, which are ejected by volcanic action, have very little strength or cohesion and are very difficult for climbing. Extrusive rocks which cool more slowly, such as basalt, can be almost as good for climbing as granite, but such rocks rarely make up the major portion of a mountain range.

b. Sedimentary. *Rocks which are deposited by the action of water, wind, and/or ice, or chemically precipitated from water*. Sandstone, shale, and coal are sedimentary rocks usually deposited by rivers and oceans, whereas limestone is precipitated from sea water.

c. Metamorphic. *These "changed" rocks were originally igneous or sedimentary rocks which, due to temperature and/or pressure within the earth, have been altered physically and/or chemically.* Examples of metamorphic rocks are slate from shale, marble from limestone, and gneiss from granite.

1) Sedimentary and metamorphic rocks are, in general, not as good for climbing as are igneous, as they tend to be much more friable (breakable or "rotten"). Exceptions are:

a) Some types of sandstone in very arid (dry) regions where there is little water to weaken the rock's cementing agents.

b) Some granite-like metamorphic rocks called gneiss. Often, too, sedimentary and metamorphic rocks contain high concentrations of clay-like minerals, which become very soft and slippery when wet.

3. **FORMATION MECHANICS**

a. Mountains. Most mountain ranges are the result of interior stresses in the earth's interior. In order to relieve these stresses, thick sections of the crust slowly bend (fold) or fault (break). The resultant surface relief caused by folding and faulting is then often magnified by the processes of erosion.

b. Plains/Plateau. In semi-arid regions, extreme erosion of basically flat-lying rock layers can produce a typical badlands topography that is impassable to vehicles and may require mountaineering techniques. Examples of this type of topography are the Grand Canyon area and the Black Hills and Badlands of the Dakotas.

1) Fault Block Mountains. Fault block mountains are bounded on one or more sides by faults, dividing the crust into up and down thrown blocks. The Tetons of Wyoming and the Sierra Nevada's are some examples.

2) Folded Mountains. Folded mountains, such as the Appalachians, have numerous faults but the principal structures are large scale folds, which are again modified by erosion.

3) Domal Mountains. Domal mountains are usually the result of the upward movement of magma and the supplement folding of the rock layers overhead. Erosion may strip away the overlying layers, exposing the central igneous core. Examples are Stone Mountain in Georgia and the Ozark Mountains.

4) Volcanic Mountains. Volcanic mountains are an exception to the rule that folding/faulting are needed to form mountains. The mountains of the Hawaiian Islands and Japan are good examples of this type.

4. **WEATHERING AND EROSION.** Once mountains have been built, the forces of nature begin a relentless task of tearing them down. As soon as land is raised above the sea and exposed to wind and running water, the forces of weathering and erosion begin to act.

a. Basically, 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.

b. The most important type of weathering in mountainous regions is called frost wedging. This 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 which 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 certain techniques.

5. **GLACIERS.** Glaciers are the world's greatest earth movers. 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. They may move from several inches to several hundred feet a year, and when the snow melt rate exceeds the rate of snowfall, a glacier can actually retreat back up the valley. Movement is usually caused by gravity, by basal slippage over the bedrock, or internal flow in the ice.

a. Formation of Glacial Ice. Glaciers can occur in any mountainous terrain where the annual snowfall exceeds snow melt, and the terrain permits deep deposits of snow. Once the snow depths exceed 10 feet or more, the weight of the underlying snow is compacted into firm snow, or neve snow (10 feet of snow makes 1 foot of firm snow). This is re-crystallized into firm ice and then into glacial ice. The region of the glacier where the snow accumulation exceeds the melt year-round 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 called the firm line.

b. Glacier Classifications

1) Alpine: Glaciers that form in high mountain bowls by the year round accumulation of snow over a long period of time.

2) Ice Sheet or Ice Cap. The second and larger type of glacier is the ice sheet or ice cap. The ice cap, a far more significant formation than the alpine glacier, usually covers hundreds of thousands of square

miles, though uncommon today, at one time covered as much as 30% of the land. They still blanket Greenland and Antarctica, and smaller ice caps are still present in many highlands.

c. Types of Glaciers

1) Cirque glacier.Does not advance beyond the bowl in which it is formed.

2) Hanging glacier. A glacier which is forced out of its origin area and over a cliff or precipice, so that it breaks off at the snout and tumbles down as an ice avalanche.

3) Valley glacier. A glacier which advances down a valley. Glaciers form U-Shaped valleys, while rivers form V-Shaped valleys.

4) Piedmont glacier. A glacier which moves out of its valley origins onto an open plain, or into the sea forming a fan-like pattern.

d. Glacial Features. Glaciers are treacherous places, with many features that can impede your travel across them. The following is a list of them.

1) Moraines. The most common features of a glacier are moraines. These are piles of rock and other debris which have either fallen onto the glacier, or been pried loose by the glacier as it moves along. There are four basic types:

a) Lateral moraine. This is the rock debris along the valley wall.

b) Medial moraine. This is formed when two glaciers come together and the lateral moraines are forced out into the middle of the glacier.

c) Terminal moraine. This is the rock debris at the snout of the glacier which is being dredged up and pushed down the valley. Many times a glacial stream will also flow out from under the terminal moraine.

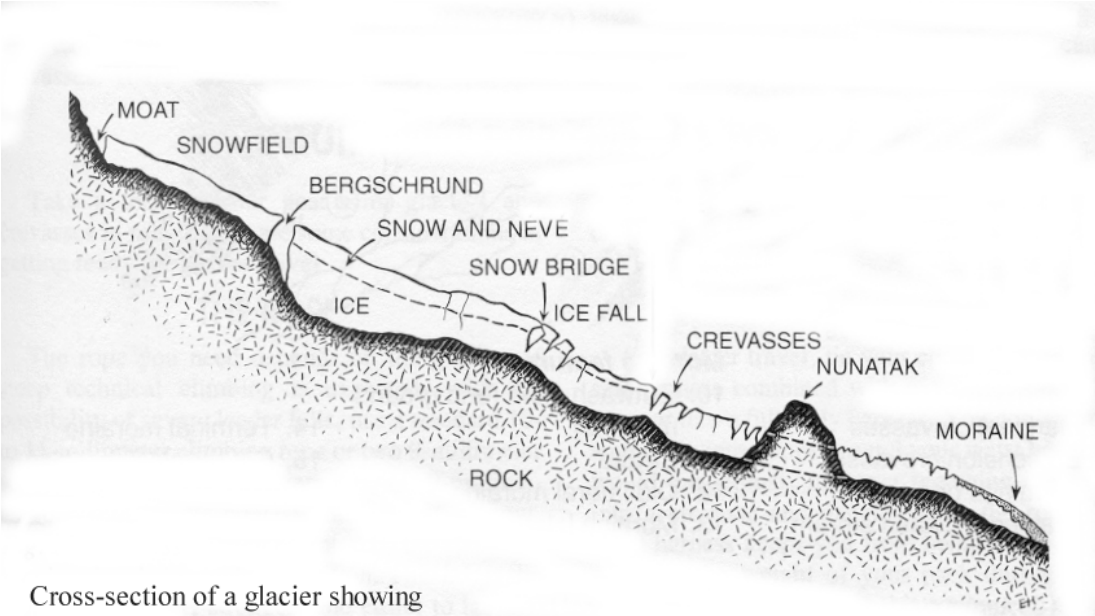
d) Ground moraine. If the glacier stops and then begins to recede, the rocks and debris under the glacier can be exposed. This is called ground moraine. Generally, the outside of a moraine wall is stable, but the side facing the glacier can be steep and loose and should be avoided. A moraine may be your only path, but it can be awkward and tiring due to the jumbled rocks. There are also other features that are found on glaciers.

2) Crevasses

a) These 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 between 40-100 feet in depth. Crevasses are hindrances in 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. These bridges

must be tested before crossing, and can give way without warning. In summer, the ice is usually not covered with snow leaving most crevasses exposed. However they can still be hazardous at night or during reduced visibility.

b) Bergschrund. A special crevasse is the bergschrund. This is the separation of the glacial ice at the point where the glacier transitions from the neve snow/ice on the steep mountain sides to the valley floor. Where this crevasse separates the glacier from a rock wall, it is technically not a bergschrund, but a randluft. 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 mountain sides.



Cross-section of a glacier showing principal features.

3) Seracs. These are ice walls and towers that have been forced upward due to pressure within the glacier. They are unstable and can fall unexpectedly. This is another hazard and your route planning should give them a wide berth when possible.

4) Icefalls. These 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.

5) Nunatak. This is bedrock that protrudes up through the glacier creating an obstacle to glacial movement. This can create pressures in the ice and help to bring about some of the hazards that we have mentioned earlier; crevasses, seracs and icefalls.

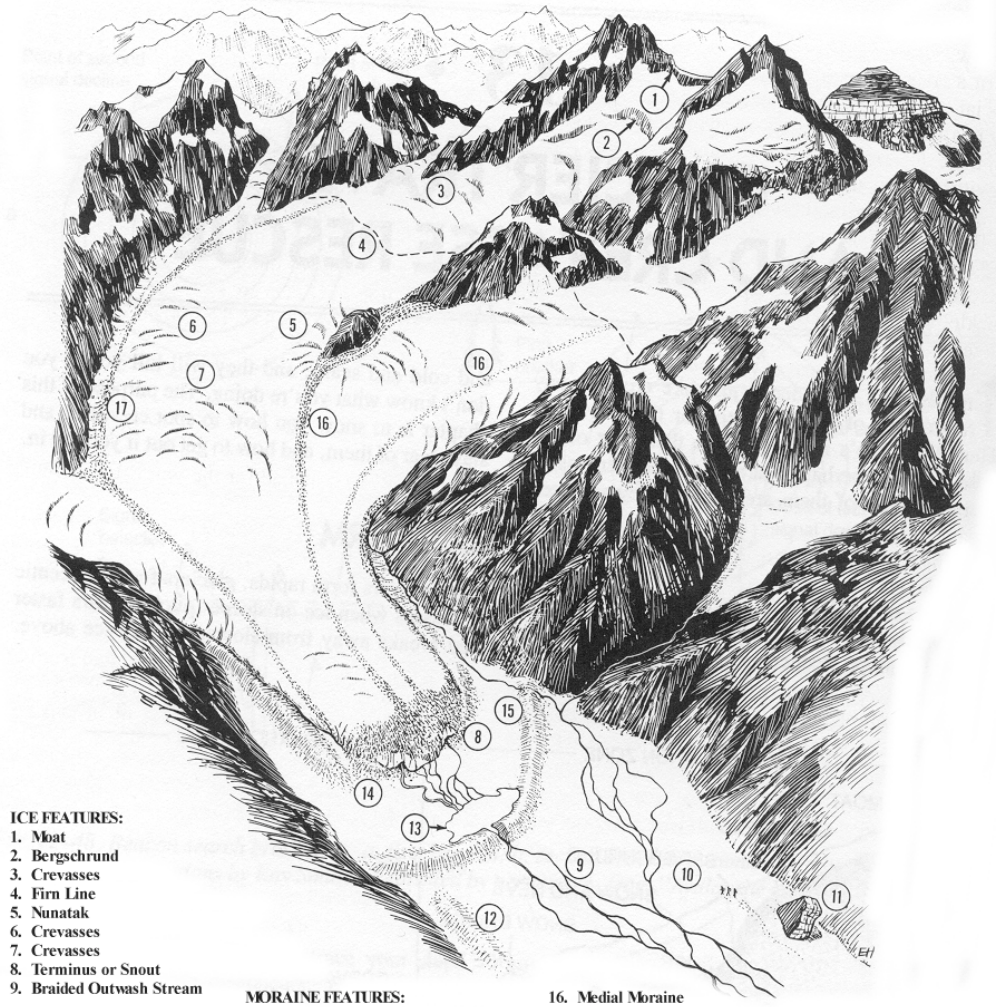
6) Rock and ice avalanches. These can occur when seracs and blocks of ice come loose and cascade onto the glacier. These are dangerous when traveling near the valley walls, or under a hanging glacier. Detour around these areas when possible.

7) Water hazards. This is a mountain or glacier mill. Melt-water from the glacier has found a crevasse and is moving to the ground below the ice. It would be very dangerous to fall into this! 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 Marine. In summer, glacial thaw water can form in troughs, freeze at night, and form glacial swamps. These should also be approached with care.

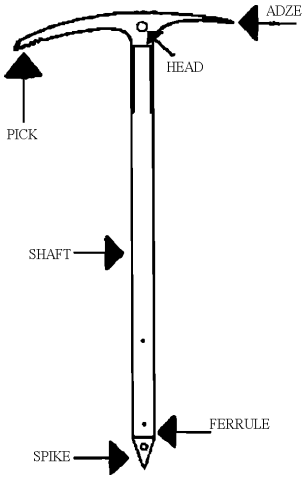
CONCLUSION: With mountains and glaciers undergoing these constant changes they can pose a great danger to anyone moving in these areas. Knowing and understanding these factors can only serve to increase our safety and survivability in these areas, and therefore it is imperative that we learn the proper techniques for moving across these ever changing landscapes.

SNOW AND ICE EQUIPMENT: This equipment is going to be essential in an Alpine Environment. Even in



the hottest parts of summer, snow fields and glaciers exist around the world that may need to be negotiated for the conduct of an attack.

1. **Ice Axes.** There are a number of different ice axes on the market that can be purchased. The differences being; the type of materials used in construction and the intended use.
    a. Materials.
        1) Metal.
        2) Fiberglass
        3) Wood
        4) Carbon fiber
        5) Combinations of the above.
    b. Intended use
        1) Glacier travel
        2) Steep ice climbing
        3) Steep earth climbing
    c. Nomenclature: All materials have their own characteristics, but each has its own purpose. The length of the shaft and type of pick will vary depending on the intended use. However, all ice axes do have the same general nomenclature.
        1) Pick.- the pick is curved so that it follows the natural swing of the arm when in use. The teeth on the under side prevent it from being pulled out. There are different types of picks depending on the type of climbing that is going to be done. Below are a few of the different types of picks.
            (a) Classic- general mountaineering
            (b) Alaska- all around use
            (c) Singer- steep ice and technical climbing



2) Adze.- the adze is the blade, which forms a right angle to the shaft, used in crusty snow and for cutting steps or digging belay ledges.
3) Head.- This is the top portion of the ax, which includes the pick and adze; some axes have a hole in the center of the head for attaching a wrist loop or a carabiner.
4)Shaft.- This is the handle of the ax. The length of the shaft varies with the intended use, in general mountaineering and glacier travel a longer shaft is desired, in steep ice climbing or technical snow climbing a shorter shaft is desired.
5) Ferrule.- The ferrule is the point just above the spike, on some axes it is a separate band of metal.
6) Spike.- this is the point of the axe located at the base of the ax. It often has a hole to attach carabiner for anchors and belays. The spike is also important in glissading.

    d. Attaching the Ice Ax.
        1) A sliding wrist clasp is manufactured which attaches to the shaft of the ax. It is a metal ring that has a screw on it which allows you to move it up/down the length of the shaft thus enabling you to have access to quick adjustment if necessary.

2) A short wrist loop can be tied to the eye (hole) of the head of the ax. To provide a better grip the wrist loop can be tied to the shaft or even wrapped around it.

NOTE: The purpose of wrist loops is to provide support to a climber who is negotiating high angle ice. With a wrist loop the climber does not have to grip the shaft as tightly. This reduces the chance of getting frostbite. The wrist loops should be made of ½ inch nylon tubular webbing.

3) A long sling to the body can be used in conjunction with the sliding wrist clasp of the wrist loop, it is a good idea to use one in the event that the ax is dropped.
4) There are holsters available for the ice axe, however these should only be used by experienced climbers.
5) A long runner can also be used during glacier travel, by girth hitching it to the hole in the head of the ax and connecting it to the hard point of the climber's harness with a carabiner. This leaves the hands more available if needed, and makes the transfer of the ax between hands quicker on a slope. This is not intended for use on vertical ice.

2. Care and Maintenance of the Ice Axe.

a. Check the shaft for splits or cracks and apply linseed oil to wooden shafts.
b. Ensure the shaft is rough so that a good grip can be maintained.
c. Inspect the webbing and its knots for cuts.
d. Ensure that the pick and adze are sharp.

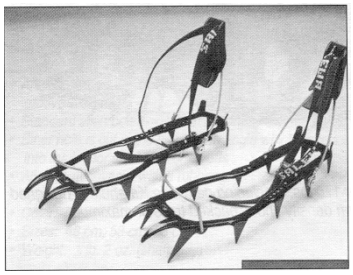
NOTE: Do not use electrical grinders to sharpen the pick or the adze as they may remove the teeth of the pick and greatly weaken the tool. The pick should be sharpened from the sides toward the tip with a file held at 20°. The adze should be sharpened from the underside only. The spike should never be sharpened.

e. Rubber protectors should be placed on the pick and the spike when not in use to prevent unnecessary damage.

2. **Ice Hammers.** These are a combination of a pick and a piton hammer. They are used to insert ice piton/screws. They again differ in length depending on their intended use.

3. **Crampons.** There are two kinds of crampons, 10 and 12 point; they can also be either rigid or flexible. Crampons provide traction in ice or harder snow conditions. The crampon that the Marine Corps uses is the 12 point crampon. It has been designed with two projecting front points which can be used to climb very step snow or ice. They can adjust to a large number of boot sizes, are easy to walk in and can be used in front pointing techniques. We will breakdown the crampon into two groups: Flexible and rigid.

a. Flexible Crampons. These crampons have two sections.
1) Toe Section.
2) Heel Section.
a) These sections have the following:
(1) Crampon teeth or points.
(2) Strap post with ring.
(3) Flexible adjusting bar and screws.



(4) Leather straps with buckles.

NOTE: On new crampons, the adjustment bar may have to be sawed to a shorter length to adjust to a particular boot size.

b. Rigid Crampons.

1) Unlike flexible crampons, rigid crampons have a left and a right crampon.

2) Each rigid crampon comes in four pieces.
a) Right half toe piece.
b) Left half toe piece.
c) Right half heel piece.
d) Left half heel piece.

3) The nomenclature is the same for the rigid crampon as for the flexible ones, with the exception of the flexible adjusting bar. The rigid one has a solid piece of metal.

c. Adjustment of the Crampons. You will make the adjustments to your crampons by using a crampon repair kit. In the repair kit you will need the following items:
   1) Allen Wrench.
   2) Screwdriver.
   3) Heavy Gauge Wire.
   4) Pliers.
   5) File.
   6) Spare straps and nuts and bolts.

d. Adjustment of Flexible Crampons.
   1) Place boot on the crampon and with a screwdriver, loosen the flexible adjusting bar.
   2) Slide the heel piece from the toe piece until heel of boot is even.
   3) Then place on so that the piece on the crampon and the toe of the boot covers the two front points leaving ½ - ¾ inches of the front points exposed.
   4) Now take an allen wrench and make your width adjustments by taking out the screws on your toe piece and heel piece.
   5) Slide in or out until the sole of your boot is snug.
   6) Line up the holes for the screws and tighten (boot should stay in crampon without leather straps).

e. Adjustment of Rigid Crampons.
   1) Rigid crampons are shaped just like boots. You have a left and a right crampon. All you will use is an allen wrench.
   2) Just like the flexible crampon you loosen screws; adjust for length first, then width. The adjustment procedures are the same as for the flexible crampons.

f. Fitting of Crampons.
   1) Select and use a stiff-soled boot.
   2) Ensure that the heel strap is long enough to go around the ankle once.
   3) The toe strap must be secured so that it does not slip over the toe of the boot.
   4) To avoid unnecessary damage to your crampons and other equipment, cover the points and place inside your pack.

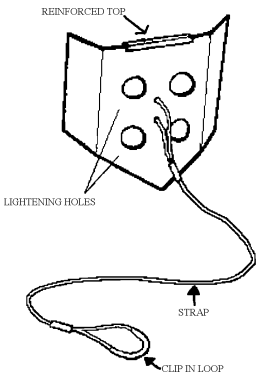
g. Types of Crampons.
   1) Flexible Crampons.
      a) Used for climbing moderately steep snow and ice covered slopes (such as glacial fields).
      b) Used also for steep slopes and front pointing.
   2) Rigid Crampons.- Used for climbing steep snow and ice covered slopes.(Such as couloirs extending from glacial fields to the peak of the mountains.)

h. Maintenance of the Crampons.
   1) Keep the front points sharp. Use on ice can dull and wear down the points. Careful filing will sharpen the crampons and reduce the possibility of a slip or a fall. Lightly file down the top of

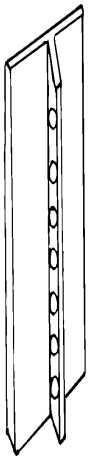
the front points. File down on the other points from the rear only. Do not use power tools to sharpen your crampons as this may cause the metal to weaken.

2) The adjustment nuts should be checked frequently and re-tightened as necessary.
3) Check all rivets, straps and buckles. Replace or repair as necessary.
4) A piece of plastic can be taped to the underside of the crampon to help prevent snow buildup.

4. **Ice Pitons.** There are two basic types of ice pitons. Drive-in, screw out, types such as the "Wart-Hog". The second type is the screw-in, screw-out type such as a "Hollow Salewa Tubular Ice Screw".
   a. No matter what type of piton you use, always attach a nylon tape and carabiner to it. In case of a fall the load will come from below the piton enabling it to be more secure.
   b. Care and Maintenance of Ice Pitons.
      1) Keep the points of your ice pitons sharp.
      2) When not in use apply a light coat of oil to prevent rusting.



5. **Dead Man and Dead Boy.** These are aluminum plates with a pointed base and reinforced top. The dead man has holes in the plate designed to make it lighter. Both have a wire cable from the center.
   a. Characteristics.
      1) Dead Man, 11"x 7 ½", 24 inch length of cable wire.
      2) Dead Boy, 8"x 5", 24" length of cable wire.
   b. Specific Use. They are designed to be used as an anchor in soft/hard snow. If they are correctly placed when weight is applied to them they will bury themselves deeper into the snow. The reliability depends on the structure of the snow. They should always be used in conjunction with a nylon tape and two locking carabiners.



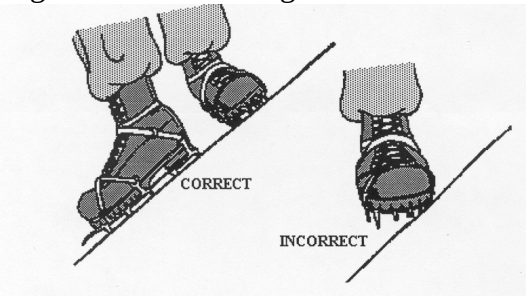
6. **Picket/Coyote.** Aluminum pickets are found in different styles, including round or oval tubes and angled or T-section stakes.
   a. Characteristics. 18 to 36 inches in length.
   b. Specific Uses. They are designed to work in snow too firm for a dead man but too soft for ice screws. Attach a carabiner or runner to the picket at the snow line.
   c. A Picket should be driven into the deck using the same side each time.

CRAMPON TECHNIQUES. When walking on crampons, you use the same basic fundamentals that are used in mountain walking, except that when a leg is advanced it is swung in an outboard arc to prevent the crampons from locking into one another.

1. Donning Crampons. Put crampons on while still on easy ground, many climbers make the simple and dangerous mistake of getting half way up a route before attempting to put on crampons on some dangerously steep slope.

2. Crampon Technique. There are three basic crampon techniques.
   a. The French technique or flat-footed method. This technique is the easiest and most efficient method of climbing gentle to steep ice/hard snow, once you learn how to do it. Good French technique demands balance, rhythm, and the confident use of crampons and axe. French climbers developed the flat-footed technique, thus their terminology is commonly used. Terms using the

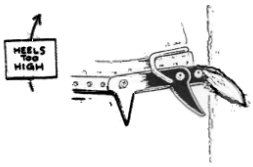
French word "*pied*" refers to the feet; using "*piolet*" refers to the ice axe. Pied a plat, is French for flat footing. This outline will give French and English translations.

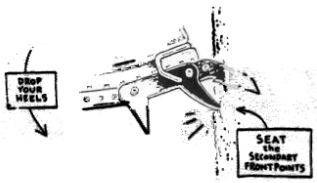


1) For the Feet. Below is an abbreviated directory of terms with the approximate steepness of slope for each type.

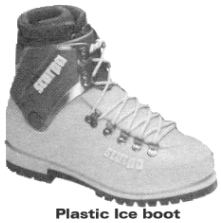
*PIED MARCHE	MARCHING	Gentle 0-15°
*PIED EN CANARD	DUCK WALK	Gentle 15-30°
*PIED A PLAT	FLAT FOOTING	Moderate steep 30-60°

2) Marching While Wearing Crampons. Walk more or less as normal. You will soon become accustomed to being an inch or two taller and your boot soles being in effective an inch or two deeper. Remember that you will have at least 10 downward facing points- the more you are able to use, the greater security you gain. Instead of edging your feet as you would without crampons, allow your ankles to roll out from the slope so that the soles of your boots lie at the same angle as the slope and all 10 points are allowed to bite.
   a) As the slope steepens slightly, it will become awkward to keep your feet facing forward. So turn them outward, duck fashion (pied en canard).
   b) As the slope continues to get steeper, duck walk will also begin to get awkward by causing severe ankle strain. Then it is time to turn sideways to the slope and ascend diagonally for a more relaxed step. The feet at this stage are kept flat (pied a plat), with all bottom crampon points stamped into the ice. Do not try to edge with crampons, it does not work.
   c) As the slope steepens (while traversing) you will find it easier to rotate your feet downhill to keep them flat on the ice. On very steep slopes your feet may point downhill.
3) Rest Position. The French have a rest position- called (pied assis) that gives leg muscles a rest and provides more security for replanting the ax. From a position of balance, bring your downhill foot up and beneath your buttocks, with that boot (flat as always) pointing straight downhill. Now sit down on that foot.





b. The German Technique, front pointing. Front pointing uses not only the front two points of each crampon, but also the two vertical points immediately behind them. Synthetic plastic boots and/or rigid crampons are mandatory for this technique.


Plastic Ice boot

1) The best placement of the crampon is straight into the ice; you need to avoid splaying your feet, as that tends to rotate the outside front points out of the ice. Boot heels need to be just above the horizontal. You need to resist the temptation to raise your heels higher, as this will only bring the rear two stabilizing points out

of the ice, therefore endangering placement of the front points and tiring your calf muscles. Your heels will normally feel lower than they actually are when in fact they are in the correct position.

2) This is especially important when coming over the top of steep ice onto gentler terrain, where the natural tendency is to raise your heels, relax your level of concentration, and hurry.

The American Technique. This is a combination of the two techniques listed above. One foot is placed flat on the snow/ice using all points, on the other foot, only the front points are used. This technique can be used on snow/ ice ranging from steep to extremely steep slopes (55° +). It has the advantage of allowing the muscles to relax by alternating techniques and is also a useful rest position while front pointing.

3. The Descent. In going down, just like going up, technique is determined mainly by the hardness and angle of the snow. In soft snow on a moderate slope, simply face outward and walk down. With harder snow or a stepper slope the plunge step can be used.

a. Plunge Step. The plunge step is a confident, aggressive move. Face outward; step assertively away from the slope and land solidly on your heel with your leg vertical, transferring weight solidly to the new position. Avoid leaning back into the slope, which can result in a glancing blow step, which can result in an unplanned glissade. When plunge stepping, keep the knees bent a bit, not locked, to maintain balance.

b. Flat Foot. To descend gently sloping ice/hard snow, simply face directly downhill, bend the knees slightly, and walk downward (pied marche). Plant all bottom crampon points into the ice with each step. The ax is held in the cane position. As the descent angle steepens, bend your knees more and spread them apart, ensuring your body weight is over your crampons.

CONCLUSION: All of these methods need to be practiced on various snow and ice conditions. Training should be progressive from easier too harder conditions and shallow to steeper terrain. At all times there should be no one below the climber in case of a fall. Time and repetitions are the keys to mastering these techniques.

ICE AX TECHNIQUES: In order for us to move in the mountains we must be aware of all obstacles, and have the knowledge necessary to overcome them. Movement over snow/ice is only one of the many obstacles that can be encountered. In order to efficiently move over snow/ice we must first learn how to use ice axes to ascend snow/ice obstacles.

1. **STOWAGE OF THE ICE AX/ICE HAMMER:**

a. The ice ax can be carried on the outside of the pack (some packs have loops provided). The head of the ax should be down 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 with the picks facing inboard.

b. Ice axes can be placed through a carabiner that is attached to the shoulder strap of the pack. 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.

c. The ax/hammer can be carried in hip holsters that are attached to the waist harness. This technique can be very cumbersome and awkward, but the ax is readily available for use if needed.

2. **CARRIAGE AND USE OF THE ICE AX:**

a. Using the ice ax while moving over snow or ice covered terrain will provide a third (and sometimes, a fourth) point of contact with the ground. To achieve this, there are various methods in which the ax (or axes) can be used. Regardless of the methods used, the ice ax or hammer should be secured to the climber by means of a wrist leash. Or it can be attached using a runner to the harness of the climber making the transfer of the ax between hands easier.

1) Cane Position. The cane position is used for the majority of time while crossing glaciers and ascending slopes up to 50-60°. The ax is carried in the uphill hand, with the hand grasping the head, the pick facing to the front or the rear. As you walk along the ax is used as a cane, and is ideally used to maintain your balance.

2) Cross-body. For this position the ax is held perpendicular to the angle of the slope, one hand grasping the head, the other holding the shaft. The ax will cross diagonally in front of you, with the pick facing forward. Most of the weight will be on the shaft, while the hand on the head will stabilize the ax. Your feet move up as in the cane position.

3) Stake position. At some point as the slope steepens, you the climber will want to change to a more secure method of movement. This method of movement is used when going directly uphill at an angle of over 45°. Before moving upward the ax is planted into the snow with both hands grasping the head, you then take a step upwards, and repeat the movement.

NOTE: Diagonal ascent. On a diagonal ascent with a slope of between 40-45° the axe usually works fine in the cane position. As the slope steepens it is time to change to cross-body position. Diagonal ascents will often mean many changes of direction and care must be taken. Your balance is maintained by stopping in a stable position, planting the axe in front of you in the stake position. Once secure you need to turn your feet to point in the new direction and then the axe is transferred to the new uphill hand.

4) Support Position (Banister)

a) Method: The support position may, at first, seem awkward but it provides a surprising amount of stability. The ax is used as a handrail; the pick is placed into the snow with the shaft pointed uphill. The hand slides down the shaft as the climber, feet flat on the face and facing downhill, walks down. After a few steps the climber stops, pulls out the ax and replaces it downhill, he then repeats the procedure.

b) This is used for a descent on moderate to steep slopes.

5) Brace Position

a) Method : The ax is held in the port arms position. The spike is planted into the snow/ice by pressure from the uphill hand. It is used with the French method (Piolet) of cramponing.

b) This technique is used on slopes that range from 40° to 50° and acts as an extra security measure.

6) Anchor Position

a) Method: The pick is firmly planted into the snow with the uphill hand held over the top of the ax. The other hand holds onto the shaft near the spike. In crusted snow, it may be wise to reverse the pick and use the adze. In this position the ax is again ready for any self-arrests that may be needed. In snow, it is used in conjunction with step kicking on crampons and the French or American methods.

b) Utilized on slopes steeper than 50°.

c) When anchoring on steeper slopes, you will find yourself almost going backwards. It is nearly time to turn square-on and front-point.

7) Shaft Dagger

a) Method: The shaft is held like a dagger and thrust into the snow. Remember to grip the shaft where it meets the snow to avoid an upward leverage. To overcome a bulge or cornice, a climber can push his shaft into the snow and use this to mantle onto or over the obstacle.

b) This can be used on steep slopes where the snow is not firm enough to support the pick of the ax.

3. **VERTICAL ICE POSITIONS**

a. Dagger Position

1) High dagger method: This technique is used on steep, hard snow slopes (50° to 90° slopes). The hands are held below the heads of the axes, with the fingers holding on to the top of the pick. The pick is placed in at head height. Pressure is then placed on the pick. This technique can be used almost anywhere on a steep snow slope, in good hard neve conditions it is a very efficient method.

2) Low dagger method: This technique is used on steep, soft to firm snow slopes (50° to 60° slopes). The hands are above the adze, the pick is inserted at waist level. The main body weight is used to press the pick into the slope. This is also a very efficient method of ascending reasonably steep snow slopes.

b. Hammer/Two tool Position

1) Method 1. The axes are inserted into the ice at full reach above the climber's head. The climber moves up by pulling on both arms until his shoulders are level with the lower part of the ax shaft. First, one ax is extracted and reinserted above the climber's head. The weight is shifted onto the ax and then the other ax can be removed and placed along side the first.

2) Method 2. One ax is inserted into the ice at full reach above the climbers head, the other ax is then placed in about halfway distance between your shoulders and the pick of the other ax. You now continue the movement with one ax above the other. Both of these methods are used in conjunction with the front pointing or American techniques of cramponing. This technique is normally used with the two ice axes, one being a pick and one an ax. It is normally used on slopes of snow/ice from 60° to overhanging.

CONCLUSION: As a Mountain Leader these techniques are the least used or practiced and availability of good training areas is very limited around the world. Ice ax placement and other work can be improvised on earth slopes or a soft wooden surface in lieu of ice.

GLACIER TRAVEL. Movement in the mountains carries with it the potential of grave danger. There is nothing one can do to completely eliminate these dangers no matter how much experience or savvy one may possess. However, an understanding of other types of hazards likely to be encountered when traveling in the mountains makes it possible to minimize the dangers and improve the chances of success.

1. **UNDERSTANDING THE MOUNTAIN.** The first and most important fact a climber must realize is that mountains undergo constant and relentless change. The process of mountain building and decay is wholly dynamic and very violent. The climber is himself in the midst of this change. At issue is the question of control; that is, how much control the climber can exert over his situation. An individual has little or no control over the weather or snow conditions that influence avalanche activity. He cannot know which rocks may loosen through the effects of frost wedging and hurtle down upon him. On the other hand, a climber aware of the forces at play around him may be able to establish a pattern of events that helps him predict when the danger is most serious and when travel may be conducted in relative safety. Only experience and study can produce the judgment required to intelligently minimize the risks.

2. **OBJECTIVE HAZARDS VS. SUBJECTIVE HAZARDS**

a. Objective Hazards: The Mountain environment. These are the natural processes that exist whether humans are involved or not. Darkness storms, lightning, cold, precipitation, high altitude, avalanches, rockfalls, cornices, ice fall, crevasses, wind, fog and whiteouts are all examples of objective hazards.

b. Subjective Hazards: The climber. The human factor shares the blame for many accidents.

1) Knowledge- A climber with inadequate knowledge can mean danger to a climbing party.

2) Skill- The climbers' skill level should match the difficulty of the climb.

3) Judgment- Good judgment is the quality of using knowledge gained from study and experience to make sound decisions.

3. **BASIC SAFETY RULES**

a. There are four basic safety rules for glacier travel. These are as follows:

1) Always rope up with one or more climbers.

2) The belayer must have the knowledge to be able to anchor the rope if his partner falls into a crevasse.

3) The fallen climber must have the knowledge, and the means available to get himself out of a crevasse.

4) The belayer must know how to extricate an injured or unconscious victim.

4. **ROPING-UP TECHNIQUE.**Crevasses and snow bridges have never shown much respect for mountaineers and may open up beneath even the best mountaineers. Roping up is not an onerous task and with only a little practice takes but a few minutes. Since most alpine/glacier routes are climbed as a party of two, we will look at them first. There are half a dozen or so different practicable ways of roping up. The one mentioned here is the most common.

a. In glacier crossing it is mandatory that the rope between the two climbers is shortened to a manageable length. The length of rope between climbers depends on terrain and the amount of climbers on a rope, a two-man team would ideally have a third of the rope between them and a three-man team would have a quarter of the rope between them. The remainder of the rope would be coiled and carried by the end men. Here is how it is done.

1) Method. Climbers should be spaced along the rope about 30 ft apart (this distance will be greater if there are especially wide crevasses around).

a) With the sit harness on, tie into the end of the rope with a retrace figure 8-knot, keep the knot dressed down as close to the harness as possible.

b) Take 12-14 coils around the body and over one shoulder. These should be fairly snug under the arm, though not so snug that they constrict or are uncomfortable.

e) The coils can be taken either under the arm and over the shoulder or the other way round.

d) When you judge that you have taken sufficient rope (12-14 coils are normal on a rope of two), you then reach under the coils and pull through a bight of the live rope, the piece running to your partner. The length of this bight is important, as it should just reach the locking carabiner on the harness strong point.

e) Using the bight, tie an overhand. Embracing the live rope, clip it to the carabiner and lock it up. You're now tied in.

NOTE: THIRD MAN. If the team is a three-man team, the third man will pull up a bight in the middle of the rope. Take about a six-foot length and tie an overhand in the rope. With the bight he has now created, tie a figure of 8 loop and clip that into his harness.

b. Rigging for Glacier Travel. In addition to the harness with locking carabiner and rope already mentioned, the following items of equipment are also needed:

1) Helmet.

2) Crampons.

3) Ice ax.

4) Two 12" prussic loops/ ascender could be used to substitute for one of these.

5) One Texas kick prussic.

6) 2 pieces of snow/ice protection.

7) 4 free carabiners.

8) 1 double length tape.

9) 3 pulleys or 3 extra carabiners.

c. Attachment of the Prussic to the Climbing Rope. No matter which method is used to shorten the rope this procedure will be the same.

1) Attach one of the 12” prussic loops to the climbing rope using a French prussic with a locking carabiner attached and clipped to one of the loose body coils. This is used to hold the rope while moving and as your waist prussic if you have to Texas kick out of a crevasse.

2) Pre-rig your Texas kick by tying a figure-of-eight approximately 12" down from the middle of the prussic cord and place it in your pocket or attach it to your harness until needed.

3) Wearing a pack: If you are carrying a pack you need to attach a runner/cord to a sturdy part of the pack using a girth hitch. Ensure that the runner/cord is long enough to be slack while wearing the pack. This "hook up" will allow the climber to drop his pack if a fall occurs, acting as a counter weight to hold the rope taut while prussicing.

5. MOVEMENT TECHNIQUES

a. The lead man on the rope should be the one most experienced in detecting and avoiding crevasses. But, when they are thoroughly masked, an alternative policy is for the lightest member of the party to lead, followed by the climber most skillful at belays and arrests.

b. The basic aim of glacier travelers is to complete the trip without falling into a crevasse. Should they fail in this, it is even more fundamental that remaining members of a team must not fall into the same crevasse.

c. Each member of the party should be adequately dressed to allow for proper protection from the abrasive nature of ice and the effects of lengthy exposure to the cold. Whenever possible, the team crosses the visible or suspected crevasse at right angles. When the route precludes such a course, the echelon formation is used.

d. A common error is for the party to cluster close together at rest stops. A number of alpine tragedies have resulted from this instinct when a chosen rendezvous proved to be the bridge over an unseen slot. Although strong enough to support one or two climber at most, the bridge may give way on the third or fourth climber. Skis and snowshoes distribute weight wider than when stomping about on boots, and they place less strain on snow bridges.

e. If safe areas cannot be found, the rope must be kept extended during rests just as during travel. A party establishing camp on a snow covered glacier remains roped for a long period. Probing the surface thoroughly before establishing a bivouac site is a must.

f. During glacial movement it may be necessary to protect a traverse on a steep section of snow/ice. This can be done in a number of ways.

1) A running belay is used to protect a traverse or a steep ascent on hard pack snow or ice. It is a movement technique in which both climbers are roped up and move simultaneously with intermediate points of snow/ice protection between them. This method is similar to a party climb but both Marines are moving. When the number one climber runs out of snow/ice protection he stops, sets up an anchor and belays the No. 2 man up to his position where they change over the lead. If one Marine slips or falls then the other one self-arrests until the fallen climber or both climbers come onto the intermediate protection and stop.

2) Another method to protect climbers ascending or traversing steep slopes safely is fixed ropes. This is discussed in *FIXED ROPE INSTALLATION*. Ascending fixed ropes on snow or ice can be accomplished by using a French prussic or an ascender with runner and carabiner attached to the climber's hard point. An additional runner girth hitched to the climbers hard point with a non-lock carabiner is used to protect the climber as he reaches the intermediate points of protection.

6.**CREVASSE RESCUE**

a. Actions of the Belayer

1) Upon realizing your partner has broken through a snow bridge into a crevasse, your first reaction should be to go into the self-arrest position. Once you have arrested the fall, call out to determine your partners condition then continue with the following steps:
   a) Place one piece of protection and clip your French prussic to the chosen anchor. (This is much more difficult than it sounds)
   b) Let the tension of the fallen climber be taken fully onto the French prussic. Making sure the anchor will hold.
   c) Place a second piece of protection no closer than 18 inches from the first, and equalize it to the first piece of pro with a long runner and an overhand or a daisy chain.

d) Tie a figure of 8 loop into the rope behind the French prussic and clip it to another locking carabiner to back up the French prussic.

e) Next, attach your Texas kick to your hard point and to the rope with a six-finger prussic. Now, move down the rope to the edge of the crevasse to check on your partner (probe the snow enroute). You may have to untie your retrace figure of 8 to reach the edge of the crevasse.

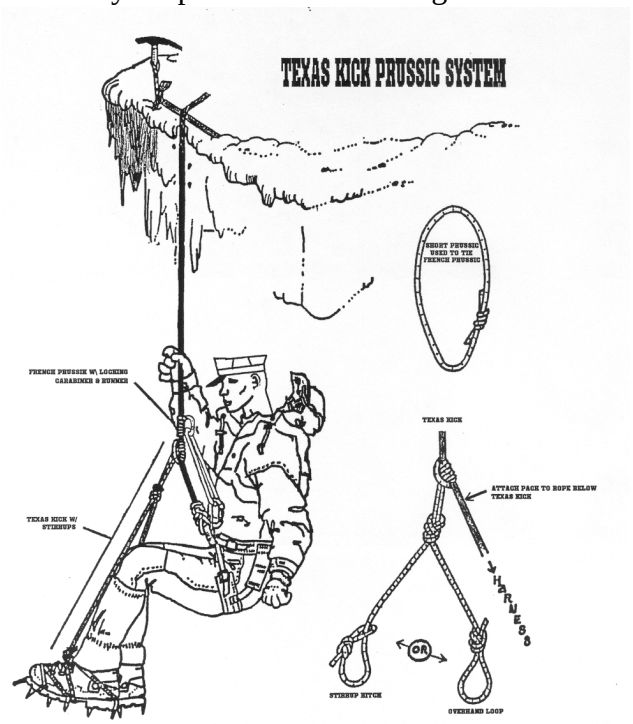
f) Clear the snow from the edge of the crevasse down to the rope level. Then pad the lip with your pack or a tool to stop it from cutting in any further.

NOTE: While the belayer is doing all this, the fallen climber needs to keep still until the anchor is secured. Once the anchor is secure then his actions are as follows.

b. <u>Actions of a victim in the Crevasse</u>

1) Since his pack is either pulling him over backwards or has actually succeeded in turning him upside down, his first and correct instinct is to get rid of it along with the extra coils taken up earlier. (This may have to be done before the anchor is set, if so then all movements must be very deliberate so as no additional shock is loaded onto the belayer) After clipping the pack into the climbing rope, you then slip out of it. This will lower your center of gravity so that you are upright.

2) At this point, the French prussic connected to the locking carabiner is unclipped from the body coils and a daisy chain or a runner is girth hitched into the harness strong point and then clipped into that locking carabiner. The French prussic is then pushed up within arms reach to take some of the load. The Texas kick is removed from your pocket and a six-finger middle of the line prussic is tied with the bight end onto the rope between the hard point and the French prussic. The pigtails of the Texas kick are then tied into overhand loops with a bight passed through it creating a stirrup hitch. These loops may be adjusted for maximum efficiency with the Texas kick.



3) Now you begin to prussic out, the initial moves are quite awkward, but once you are past them it is only mildly strenuous. If you cannot make the initial moves, then to make it easier you need to untie the overhand holding the coils together. Once you have done that, you release them to fall beneath you. You can now prussic out.

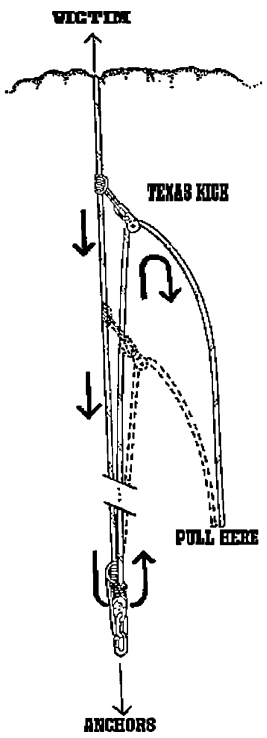
NOTE: An ascender can be used instead of a French prussic knot. In the case of the Texas kick, the bight of rope where the prussic would be made can be clipped into a carabiner on the ascender.

4) If the victim in the crevasse is capable of self -rescue as described above, the belayer need not do any more than to assist the victim as necessary and monitor and/or improve his anchor system. However, if the fallen climber is injured or unconscious, the belayer will then need to establish a mechanical advantage system in order to extricate the victim. The procedure for this is as follows:

c. Actions of the belayer if the fallen is injured or unconscious.

1) Ensure that the victim is not being strangled by ropes, submerged in water and or in need of immediate first aid. If this is the case, a rappel by the belayer into the crevasse to correct the situation may be necessary. Once the victim is stabilized, the belayer will prussic out the same as a self rescue out of crevasse, now the belayer is ready to establish a Z or a Z-C pulley system to retrieve the victim.

2) Establishing a Z system once you have performed actions of the belayer.



a) Once you've moved back away from the crevasse to a safe position, using the Texas kick that you used to check out your partner with.

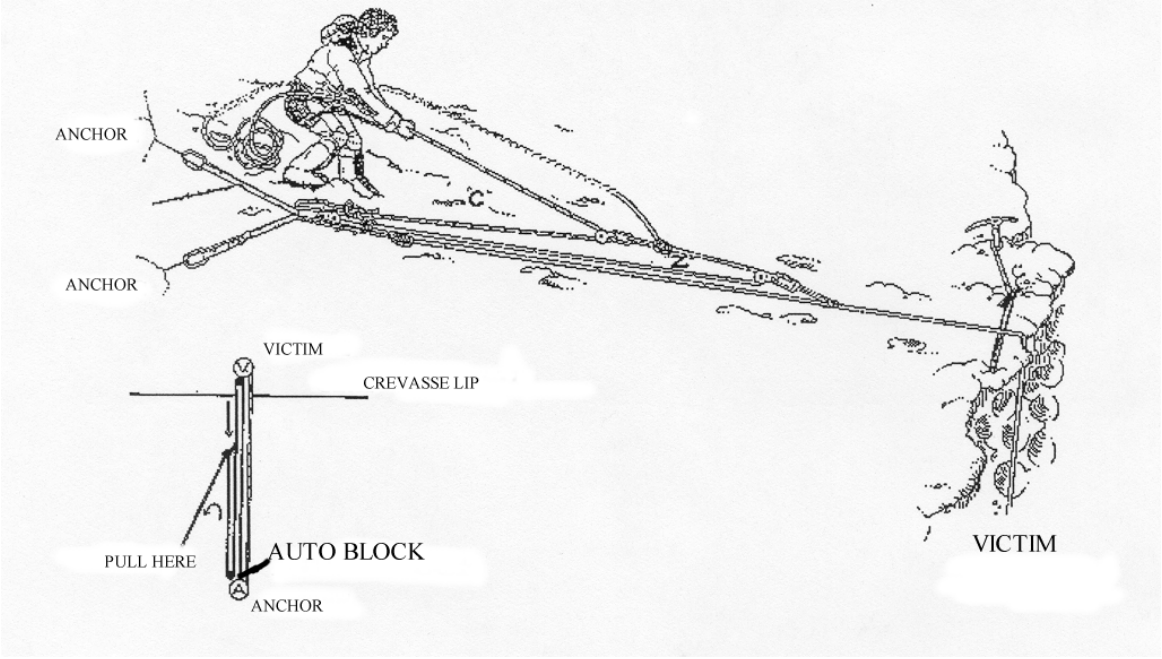
b) Unclip from the Texas kick and clip a non-lock carabiner into the loop created by the figure 8 and the 6-finger prussic. Clip the loose rope into this carabiner (or a pulley if you have one) and run it back to the anchor.

c) Remove the figure 8 loop back-up from the anchor, clipping it through a locking carabiner on the anchor.

(d) Attempt to pull your partner out using the "Z" pulley system. If unable to achieve enough Mechanical advantage, establish a Z-C Pulley system.

4) Establishing the "ZC" system:

a) Clip the end of the rope into the MAC or into a third piece of protection (ax, picket, screw etc.) slightly offset and to the rear of the anchor, depending on the soundness of the existing anchor.



b) Taking a bight from the now anchored end of the rope, connect it to the tail of the Z with a French prussic and a non-locking carabiner.

e) Pull on the slack end of the rope to retrieve the victim. The prussics will periodically require adjustment by sliding them towards the edge of the crevasse.

7. **MUSCLE METHOD.** If more than two/three men are moving across a glacier, then the above techniques become redundant. If someone drops into a crevasse, the other climbers, who are still roped up and a good distance apart, attach themselves to a belayer. Then using muscle power turn and walk 180° away from the crevasse site. Four or more men WILL lift any man out of a crevasse.

STEP KICKING AND CUTTING: Crampons are generally used on technical snow and ice routes, however, many mountain routes are of a mixed nature, i.e. rock sections with snow or ice sections that are interspersed. Sometimes on this type of climb crampons are not used, either because the snow and ice pitches are short or they are not of a very severe nature. By step kicking, of which there are three techniques, we can ascend, descend, or traverse a slope without the aid of crampons. Also, there may be conditions where the snow is classified as too hard for kicking steps into (when more than one solid kick is necessary to gain a good position). For this type of condition the climber may use the method of step cutting.

1. **STEP KICKING IN SNOW.** There are three methods that we may use to move in crampons and, when done properly, without them.

a. Diagonal Ascent.

1) Steps are kicked, using the side of the boot. The serrated edge of a lugged-sole boot, i.e., Vibram, should be used as saw teeth and the step should be made with a forward motion of the foot, not by pressing down. The sole of the boot should be kept at the horizontal position.

2) The ice ax is used as a third leg in the support position on moderate slopes. On easier terrain, the ax may be carried in the self-arrest position.

b. Straight Ascent.

1) The climber must face square to the slope and kick the toe of the boot in at a right angle.
2) If an ax is not carried, handholds may be made by punching a clenched fist into the snow at about shoulder height.
3) On moderate slopes the ax may be used in the anchor position and on easier terrain the ax should be carried in the support position.

c. Descent.

1) To descend, face out from the slope and drive a straightened leg and the heel into the slope, exerting full weight on each heel alternatively. This movement is enhanced by adding a little jump to gain more momentum in penetrating the heel into the snow.
2) The ankle is held as rigid as possible to ensure that the heel remains at a sharp angle and drives into the slope. This technique is called plunge stepping.
3) The ice ax is used in the "banister", position on moderate to steep slopes. On easier slopes, hold the ax in the self-arrest position.

2. **STEP CUTTING IN SNOW.** Normally, it is unnecessary to cut steps into the snow if all the members of a patrol are wearing crampons. However, in the event that everyone is not using crampons, you may have to prepare a route for mountain troops by cutting steps. Step cutting is a slow and tiring task in comparison to kicking steps, but with practice, the technique can be carried out reasonably well and quickly by using either hand (inside cuts on easier slopes, outside on steeper ones). The essence of good step cutting includes conservation of energy, a good balanced position, and a powerful rhythmic swing of the arm. The weight of the ax will assist you in the work. The type of steps to be cut in the snow are:

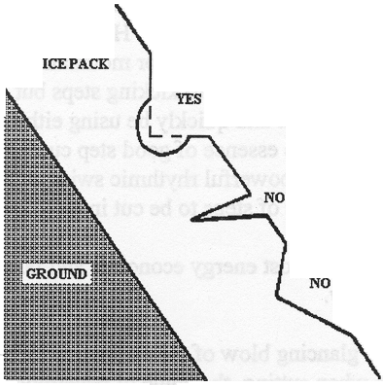
a. Slash Step. The slash step is the most energy conserving and fastest way of cutting steps but it can only be used on snow.

1) The step is cut with one glancing blow of the ax about 6 inches long. It is important to be in the proper position when cutting, the angle of penetration must not be too steep or the adze will stick into the snow. Also, the blow must not be too shallow or it may glance off or miss the snow surface all together.

2) The slash step is quick and can be used in diagonal ascents and descents of snow covered slopes.

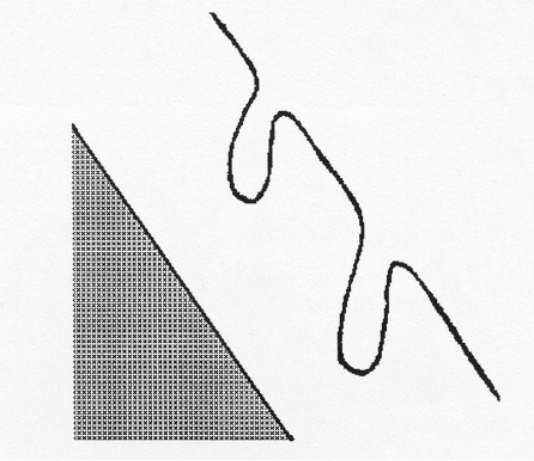
a. Side Step. The side step is most often used when a more secure cut is needed to enable the whole boot to fit.

1) The cutting position and principals are the same as the slash step. Usually, three blows are sufficient to make a good step. The step should be sloped in toward the slope angle. Also, there is no reason to waste energy by trying to clear the debris from the steps because the Marines feet will pack them down as they cross.



c. 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.

1) A horizontal slit is made with the pick of the ice ax and then another slit is cut at a 45 ° angle to form a "V", pointing to the climber. The adze is then used to cut out the center of the "V", leaving a triangular step with a flat base.



d. Pigeon Hole. This technique is used for both a handhold and a foothold when ascending steep snow.

1) 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.

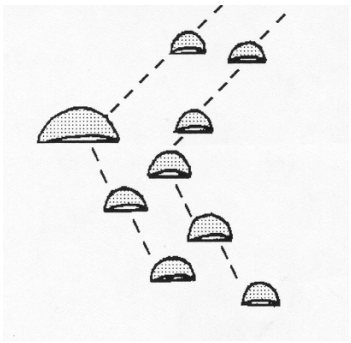
3. **STEP CUTTING IN ICE.** Step cutting in ice is very arduous work, therefore it is important to have a relief frequently to conserve energy.

a. Side Step. The same method of cutting this 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.

b. Pigeon Hole. A pigeonhole is cut into the ice in the same way as in snow with the exception that the pick will have to be used. The adze may be used to finish up the hole and to make a more pronounced lip for a good handhold.

c. Ice Knicks/Finger Holds. It is not always necessary to cut a large step in ice. A small knick can be made for a finger hold and can be fashioned with one or two blows of the ice ax. Crampons on thin or brittle ice can be placed on these ice knicks to allow them (the crampons) to work more effectively.

4. **STEP PATTERNS.** There are three basic patterns that can be used while on a snow/ice-covered slope. They are the single diagonal line, double diagonal line and the straight up pattern.



a. Single and Double Diagonal Line Patterns. Both these techniques are used in conjunction with the slash step or the side step. 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 your position. The single diagonal line step is quicker to cut due to the fewer number of steps that are needed, but it requires great care while moving from one step to another. The double diagonal line 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.

b. Straight Up Pattern. The third pattern that can be used when climbing steep slopes is the straight up method. This technique is used in conjunction with the pigeon hole step. A set pattern of pigeonhole steps that are spaced at regular intervals will look like the rungs on a ladder. It is important to cut the holes well ahead of your position using this pattern and never climb up to the top steps without already establishing handholds above you for security.

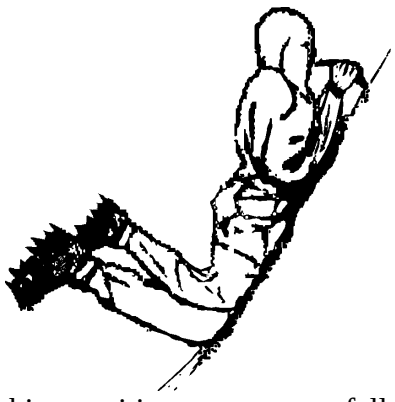
SELF ARREST AND GLISSADING: The battery of self-arrest techniques using the ice ax is of the utmost importance for those Mountain Leaders operating in a snow/ice covered mountainous environment. After a slip or a fall, self-arrest is the first movement that needs to be executed to prevent serious injury or even death. If you are roped up as a rope team, the self-arrest will prevent you and your climbing partner(s) from falling into a crevasse. Also of great importance is the ability to move down a slope quickly but in control. The technique for that is called glissading which is basically skiing on your boots.

1. **ICE AXES.** The ice ax should always be carried and ready to be used when on snow/ice covered slopes. In the event of a fall, it must be brought into the self-arrest position immediately. Let us now discuss how to use the different types of brakes.

2.**BRAKING POSITIONS**

a. Shoulder Brake. The shoulder brake is done by bringing the ax head into the shoulder with the shaft running parallel to the body. With one hand, grasp the shaft near the ferrule and spike. The pick is gradually depressed into the snow by allowing your body weight to slowly descend onto it. If you were to brake immediately, forcing all of your weight onto the pick, it could possibly jerk right out of your hands. The body should be arched slightly to concentrate the body weight onto the head of the ice ax, and the legs should be spread to allow for more stability.

b. Chest brake. The chest brake is the most commonly used brake for a self-arrest. The ice ax is held diagonally across the chest with one hand grasping the adze of the ice ax while the other grips the ferrule at the hip. The body, as in the shoulder brake, should be arched and the legs spread. There are three stages to the chest brake, they are as follows:



1) The climber assumes the braking position as soon as a fall is felt.

2) The climber will then assume a "half braking position" by initiating a full body rotation toward the head of the ice ax; this is done by throwing your opposite leg across. Caution must be used when

doing this so that the climber does not roll onto the ferrule, if he does the spike may enter the snow and be ripped from the grasp of the climber. Pressure is now gradually applied to the ice ax.

3) The full braking position is obtained by continuing the rotation until the climber is in the face down position on the slope. Once again the body should be arched with the legs spread and the chest can be pressed onto the ice ax.

c. Thigh brake. The thigh brake is usually used in very powdery type snow conditions, when the pick or adze will not grab into the snow. It is used when the shoulder or chest brake does not produce enough resistance to check your speed.

1) Get into sitting position. Feet in a wide triangular position.

2) Place your ice ax shaft under your strong side thigh, the spike will be pointing slightly uphill, and the head of the ax will be down by your knees.

3) As you slide, you can simply pull back on the head of the ax.

4) This will force the shaft to penetrate deeper into the snow thereby slowing your unplanned descent.

d. General Rules

1) The feet may be used to help the brake. However, if crampons are worn, the feet must be elevated to prevent the teeth from digging into the snow and flipping you over.
2) In soft snow, the adze can be used instead of the pick
3) The self-arrest should be used even if you are roped up, or are being belayed.
4) Wrist straps of some sort should always be used to help prevent loosing the ice ax.

3. **TRAINING.** Training and practice are vital if the self-arrest is to be mastered.

a. Terrain. The terrain should be fairly steep; it should be concave and free of obstacles and hazards. There should be a good, clear run to the bottom of the slope, with a safe run out zone.

b. Snow Conditions. Ideally, a hard pack should be used as a soft slope ensures a slower speed and allows for easy braking, which can give a false sense of security.

c. Equipment. The equipment used in preliminary training sessions should be minimal. Packs, crampons and auxiliary equipment are removed; a full Gore-Tex suit, helmet, gloves, and an ice ax will be sufficient.

d. Progression . The novice should be introduced to the simplest forms of self-arrest. A suggested progression is as follows:

Shoulder brake
Chest brake
Thigh brake

Do these drills with the students gradually sliding further and further, before self-arresting. Once they are competent then you can introduce various positions that they could find themselves in.

On their back, feet first.
On their back, head first.
On their chest, feet first**.**
On their chest, head down.
A forward roll.
A backward roll.

All of these drills should be practiced without crampons first and then with crampons.

c. Stages of Body Positions. The first thing that should be done is to have a safe platform made. This can be done by cutting out a ledge on the slope at the beginning of the run.

1) Feet first on back. Climber sits on the ledge feet downhill with his ice ax in the braking position. He will then push himself off and slide down the hill on his back. He will now conduct a self-arrest by coming into the full braking position. This is done in the following manner;

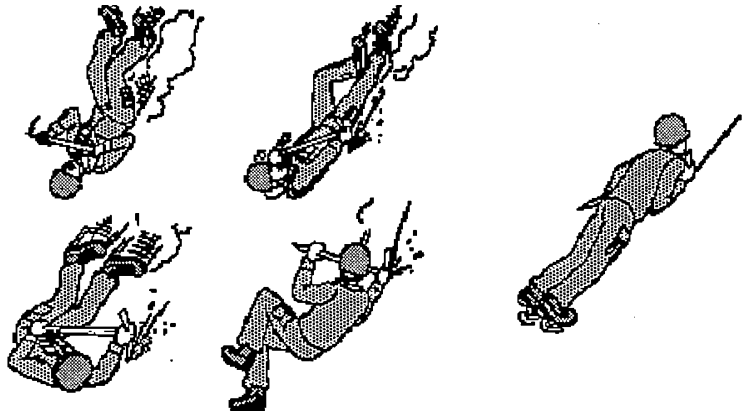
a) Roll towards the hand that is holding the ax head and apply pressure with the pick gradually so that the ax is not snatched from your grasp. You must ensure that the spike is kept out of the snow, as it will be ripped out of your hand. This is done by grasping the ferule of the ice ax with your other hand, and keeping it out of the snow.

b) It is advisable to keep your feet off the snow surface, especially if you are wearing crampons when applying the brake, unless it is very soft snow. And in soft snow you will not fall far anyway.

2) Head First on Stomach. The climber will lay down on the ledge on his stomach, facing down the slope. He will then push off and begin his descent. The ice ax is already in the self-arrest position. He will grasp the ice ax above the head and place the pick into the snow gradually; the

pick should be slightly offset to ensure that the climber does not hit his own ax. The body will then rotate around the ax. Once this is accomplished the ice ax can be brought into a full brake position.

a) Your first action is to get into a head uphill position.
b) To do this you need to reach out horizontally with the pick as far as you can on the same side as the arm, which is holding the ax head. Bring the pick to the snow and the braking effect on that side will cause your body to swing around past the ax into a head uphill position. This needs to be done as soon as possible after you fall. The faster you are moving, the more violent your body will swing around your ax.
c) Immediately arch your back, and pull yourself up and over the ax, and place it below your shoulder to brake as before. So that the ax is underneath your chest.



3) Head first on back.
a) Insert the pick close to your hip and on the same side as the arm which is holding the ice ax head.
b) Dig the pick in and at the same time pull yourself into a sitting position.
c) Bring your knees up towards your chest, then swing your legs away from the ax head and allow them to fall into a position with your head uphill, from which a normal arrest can be made.

4) Forward roll. A forward roll usually occurs when a climber trips over his own crampons or he fails to self-arrest himself and his crampons catch on the snow/ice and flip him over. It is the most difficult to arrest and is also the most dangerous. This should be practiced with care, as there is a possibility of injury from the ice ax. The position is adopted by crouching on the ledge with the ice ax head off to one side; one forward roll is taken to start with. As the body comes out of the roll the legs and arms are opened to help prevent further rolling. The arrest procedure for feet first is then followed. As you become more proficient, more than one roll can be conducted.

4.**GLISSADES.** The term comes from the French, meaning to slide. There are basically three types of glissades that we can use; sitting, squatting, and standing. ***Crampons will never be worn while glissading!***

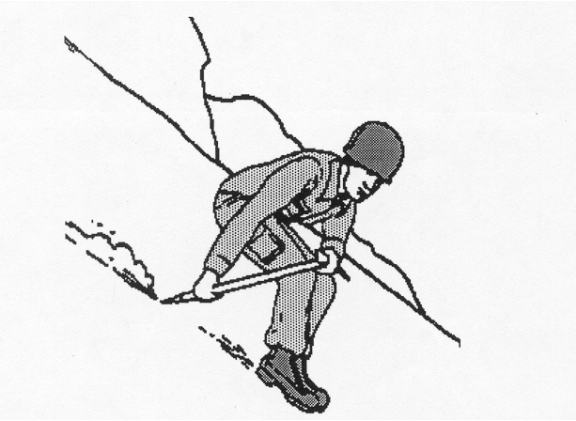
a. Sitting Glissade. To use the sitting glissade, the glissader must of course sit on the snow surface, his legs will be flat on the snow with his heels lifted off the slope and he will not be wearing crampons. The feet will point down the slope. The ice ax is grasped with one hand on the head, pick outboard, the other hand is on the shaft. In this manner, downward pressure can be applied to the ax, which will be used to control your descent. The hand that is on the shaft

should be locked into your side at the hip; the spike of the ice ax should be in the snow.

NOTE: The spike of the ice axe should never leave the snow surface.

1) Waterproof trousers should be expressly worn for this type of glissade, as you will be sitting in the snow. The wearing of the waterproof trousers will also increase the speed of your descent.

2) To begin the glissade, push yourself down the slope either by throwing your weight forward or by pushing off with the ice ax. As you descend the slope, use the spike of the ice ax as a rudder to control your direction and speed. Ensure that your speed is kept to a level at which you can control it.



b. Squatting Glissade. This method is done by placing the body in a semi crouched position with both knees bent and the body weight directly over the feet. The ax is grasped in the same manner as the sitting glissade, with the exception that the hand holding the ice ax is not locked into the side at the hip. The ax will act as a third point of contact.

c. Standing Glissade. For this method the glissader assumes a well, balanced standing position with his arms outstretched for balance. The ice ax is carried so that it can be quickly brought into the self-arrest position. The boots are used like skis and are the sole means of direction and control.

5. **SAFETY**

a. As a rule, crampons should not be worn while glissading because of the fact that the points may get stuck into the snow and cause the glissader to trip and fall out of control.
b. While glissading if you pick up too much speed or the terrain is becoming too steep, immediately self-arrest.

b. Never glissade roped to another glissader.

c. Before you glissade YOU MUST be able to see the runout. Failure to see or ignorance has led to more than one experienced mountaineer being killed falling into a crevasse or falling off even a short cliff.

d. Selecting a site to train may sometimes be a problem, i.e. concave slopes, bad run out zones, etc. A safety line may be utilized to help you when working on a problem site:

1) Take a 150 foot coil and anchor it by the loading platform.

2) Take the rope down and anchor it off at the bottom. The rope should form a "J" down at the bottom anchor.

3) Using a sling rope, take one end and tie a bowline around the chest, with the other end tie a figure-of-eight loop, place a non-locking carabiner into the loop and hook into the 150 foot climbing rope. If the student looses control, he will stop when he comes to the bottom anchor.

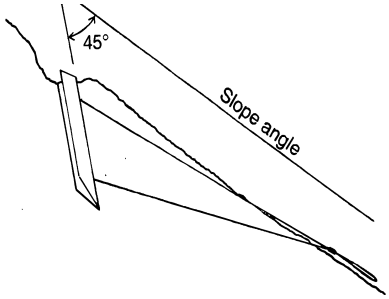
7. **SNOW CONDITIONS.** The ideal snow for glissading is a well packed slope with a soft-top surface, such as a slope that has been warmed by the early afternoon sun. It should be reasonably uniform and free of protruding obstacles. Steep, icy slopes should be avoided due to the lack of control they allow.

PLACING PROTECTION ON SNOW AND ICE: When a climbing team is climbing on snow or ice and the angle increases, the team needs the ability to place protection or establish belays in order to protect each other. Belays placed in snow and ice are not always secure; due to the lack of stability in the snow pack and ice pack. In the event of a fall, a climber could possibly drag his partner to his death if an anchor failed. It is important to have the knowledge of placing good solid anchors on snow and ice, and be able to choose the appropriate belay for the environment.

1. Deadman/Deadboy. This is an aluminum plate with a metal cable attached to the middle. They come in various sizes, and their holding power generally increases with size. The large one is known as a deadman and the small one is a deadboy. They come in different configurations as well, some have angled flanges, and some have holes in them. Another common name for them is flukes.
   a. Serviceability Checks of Deadmen/ Deadboy.
      1) The body of the deadman/deadboy should be checked for fractures and obvious deformities.
      2) The cable attached to the body should be checked for any cuts or frays.

NOTE: On the deadboy, the brass fitting on the cable should be inspected and should equalize the cables when stretched.

2. Emplacement of Deadman/Deadboy.
   a. The first thing is to cut a T-slot into the slope. It should be the width of your adze at the top, and the width of your pick at the base.
   b. Place the deadman at a 45° angle down the slope. The deadman is now pushed or hammered in as far as possible, making sure that the cable runs down the T-slot and is fully stretched with no slack in the cable.



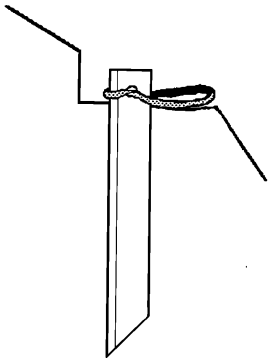
   c. To seat the deadman properly, pull the cable in its intended direction of pull. This will allow the deadman to burrow even deeper into the snowpack.
   d. Once the deadman has been seated, cover the T-slot with snow.
   e. Next cut a sitting ledge below the exit point of the cable. This is where you will belay from. It may become necessary to attach a runner to the cable to lengthen the distance from the belay to the anchor.
   f. In theory, the deadman serves as a dynamic anchor, burrowing deeper into the snowpack when subjected to a load. In practice, it can fail if placed at an angle less than or greater than 45, or if the load is pulled

from one side or the other, rather than straight down the fall line. Deadmen are the least reliable when placed in snow of varying density.

b. Snow Stake. This is an aluminum stake, T shaped along its long axis, with holes down the side for clipping into. The snow stake ranges in length, but is commonly three feet long.

1) Serviceability Checks of the Snow Stake . The snow stake should be inspected for any fractures and any obvious deformities.

2) Emplacement of the Snow Stake



a) The snow stake is a relatively easy piece of gear to place in snow. Place the snow stake between 45-55 degrees to the slope. Next, hammer the snow stake in as far as possible. Another 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 the step. The base of the T with the holes is to be placed facing the direction of the fall line.

b) Now either attach a carabiner directly to one of the holes on the snow stake closest to the surface of the snow, or girth hitch a web runner through the hole.

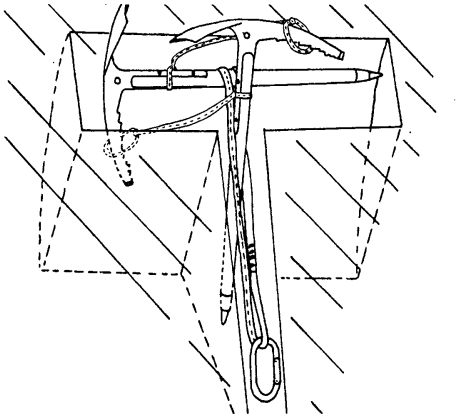
c) A sitting ledge may be cut below the anchor in which you can belay from.

d) This is to be used as a dynamic anchor.

c. Ice Tool Anchor. This anchor is constructed by placing two ice tools at 90 degree angles to each other.

1) Serviceability Checks of the Ice Tools . Use the same considerations as covered in *SPECIFIC SNOWAND ICE EQUIPMENT.*

2) Employment of the Ice Tool Anchor.



a) Once again, cut a T-slot into the snow. Tie a long web runner around the shaft of the first ice tool using a clove hitch. Place the ice tool into the top of the T-slot horizontally.

b) Place the second ice tool vertically into the top of the T-slot, below the first ice tool, and incorporate the second ice tool into the web runner loop. This system should be backed up by looping the slings around the other ice tools adze.

c) The web runner should extend down and out through the bottom of the T-slot. This is what you will use as the anchor point.

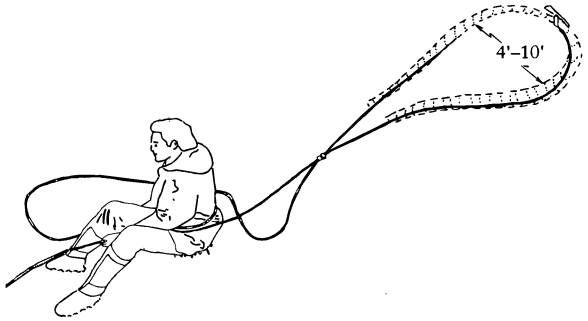
d) A single ice tool anchor may be used in the same fashion as the snow stake anchor, with a web runner vice a carabiner.

d. Snow Bollard. This is a natural anchor that is very useful and utilizes the snow pack itself. It should only be used on very hard snow pack.

1) Construction of a Snow Bollard

a) Begin by removing the snow where you intend to set up your belay stance, but leave the center area undisturbed. This will be your snow bollard anchor when complete. The minimum dimensions of a snow bollard are 6-8 feet wide, 12-15 feet long and 18 inches deep. It should resemble an inverted teardrop shape, with the large area up slope and the small end down slope.

b) Insure that the back and sides of the snow bollard are undercut several inches to prevent the rope from slipping off.



c) The rope is placed around the bollard only once (not in a round turn), and secured
d) The bollard can be backed up, by placing a piece of protection up slope from the bollard, and attaching it to the rope with a web runner.
e) A sitting ledge may be cut below the bollard to belay from.

NOTE: This makes a suitable rappel anchor since there is no artificial pro left behind to retrieve. Use of a pack to buff the bollard, so the rope does not cut into the bollard, until the last Marine rappels down is preferred.

2. **PLACEMENT OF PROTECTION ON ICE**

a. Ice Screws. There are two basic types of ice screws (Refer to *SPECIFIC SNOWAND ICE EQUIPMENT),* the drive-in/screw-out type, and the screw-in/screw-out type.

1) Serviceability Checks of Ice Screws

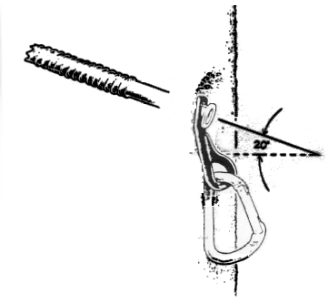
a) Inspect the shaft of the ice screw for any fractures and for any visible signs of deformities.

b) Inspect the threads of the screw for serviceability. Look for sharpness and excessive dents or dings.

c) Inspect teeth on the bottom that they are as sharp as possible. You may sharpen them with a hand file. *DO NOT SHARPEN WITH A POWER SHARPENING DEVICE. THIS WILL HEAT UP AND WEAKEN THE METAL.*

d) Inspect the hanger or eyelet of the screw for serviceability.

e) Inspect the ratchet and ensure that it operates properly.



2) Emplacement of Ice Screws

a) Ice screws are inserted at an angle of 90° to the slope and then tilted down 15-20°.
b) If you are unable to screw or drive in the length of the screw through the ice, then a hero's loop can be tied to the screw. (Refer to *PARTY CLIMBING).*
c) If there is any unstable surface ice, it should be cut away so that the screw can be inserted into solid ice.
d) If, when inserting the screw, you see the ice "starring", or cracking, the ice screw should be removed and placed in another area. These signs would indicate that the ice is unstable, therefore unsatisfactory for a secure anchor point.
e) Whenever the ice screw emplacement is doubtful use two or more ice screws which should be linked together to create a stronger anchor point.
f) Once you have established the desired anchor with your ice screw, the next step is to cover your screws up with ice and snow. To help prevent them pulling out.
g) Use an ax for leverage while inserting or extracting an ice-screw.

(1) On insertion, it is usually possible to turn by hand for about half the length of the screw.

(2) On extraction, the ax is usually only needed as a lever for the first few turns, after which it should be possible to unscrew by hand.

NOTE: Place the ice protection in as far as possible to ensure a stronger anchor point.

3) Self Equalized Ice Screw Anchor. This anchor is similar to artificial anchors on rock, but instead it is being placed on ice.

a) Place two ice screws approximately 18 inches apart. Ensure that the ice screws are placed horizontally in relation to the direction of the belay.

b) Attach a web runner (approximately 24 inches in length) to the ice screw.

c) Bring the web runner down and equalize it out. After it has been equalized, tie an overhand loop into the runner and attach a carabiner into the overhand loop.

d) The anchor is now prepared to perform either a direct or indirect belay.

NOTE: Ice tools can be used to back up ice screws. When placing the tools, be sure to put them a safe distance from the ice screws so as not to affect the stability of the ice surrounding the protection.

b. Natural Anchors. Natural ice anchors such as ice pillars/ice pinnacles can provide a very secure anchor point for a belay position. If there are no natural ice archers available, ice can be cut and shaped in order to provide you with a solid anchor point.

1) Ice bollard. It is very similar to the snow bollard, the only exception being that it is cut out of ice instead of snow.

a) The 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, this will help keep the rope in place.

b) Then the belayer will place the rope around the bollard and he will then tie himself off approximately 6-8 feet below the bollard.

c) If there is any "starring" or opaqueness in the center of the bollard, remove the belay and place it in another area. These signs would indicate that the ice is unstable and therefore unsatisfactory for a safe anchor point.

NOTE: You may also 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.

3.**BELAYING ON SNOW**

a. Once the desired anchor is established, (i.e.. equalized, or self equalized) it is now time to figure out what type of belay to use.

1) A stitch plate may be used to belay the person up.

2) A munter hitch may be used.

3) A body belay may be used, but it is not highly recommended.

4) A satins hitch may be used. This is accomplished by taking a bight in the rope and making 4-5 twists into the rope. Then take the original bight and clip it into the carabiner.

NOTE: The satins hitch can only be used on an anchor that has no runners attached or no cables (i.e.. a snow stake with a carabiner attached straight to the stake).

5) A boot/ice tool belay may be utilized by placing a bight around the shaft of the tool and placing the tool into the snow. Now, place a boot in front of your tool and take the belay line and running end over your boot. To brake, take the belay line around the side of your ankle to the back of your calf.

NOTE: Ensure that your ice tool is placed solid. Always place your free hand over the top of your ice tool to keep it from popping out of the snow.

4.**BELAYING ON ICE**

a. A stitch plate may be used to belay the person up.

b. A munter hitch may be used.

c. A body belay may be used, but it is not highly recommended.

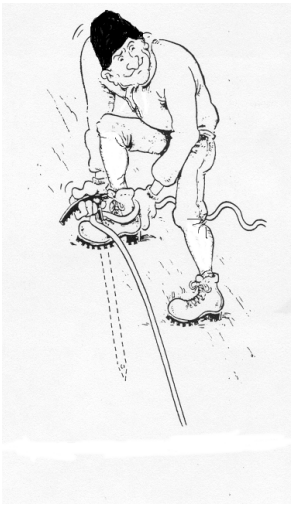
d. A satins hitch may be used. This is accomplished by taking a bight in the rope and making 4-5 twists into the rope. Then take the original bight and clip it into the carabiner.

NOTE: The satins hitch can only be used on an anchor that has no runners attached or no cables (i.e.. an ice screw with a carabiner attached straight to the hanger).

5. **TYPES OF BODY BELAYS**

a. Ice Piton Foot Brake. This method of belaying can be used on flat or gentle ice slopes.

1) Two steps are cut in the ice, one just above the other so that the belayer can stand comfortably.
2) An ice piton is placed into the back of the upper step and one carabiner is attached.
3) A cramponed boot is then placed carefully over the piton and carabiner.
4) The rope is then run through the carabiner and passed over the arch of the boot and around the heel. The rope is fed out with both hands.



5) In case of a fall the rope is allowed to run through the hands, as more friction is needed, the rope will wrap itself around the heel to arrest the climber.

b. Boot Ax Belay. (New Zealand Footbrake)
As a quick belay when a high force fall is not expected. It is especially useful when belaying a weaker climber from above on a steep snow climb.
1. Stamp or chop a stable platform in the snow.
2. Jam shaft of ice axe into snow at a 10-15 degree upslope angle. The pick should be perpendicular to the fall line.
3. Stand at a right angle to the fall line, facing you climber's route. Place uphill boot next to ice axe so that it is touching on the downhill side. Most of your bodyweight should be on uphill leg. Downhill leg should be straight and well braced.
4. Run rope from lower climber over the toe, around uphill side of axe and across front of ankle to the downhill side of your boot.
5. Uphill hand leans on axe and takes in rope as climber moves up.
6. Downhill hand is the brake hand, which must never leave the rope. In case of a fall bring the rope behind your uphill boot forming an S curve in the rope.

Carabiner/Ice Axe Belay (stomper belay)
Same level of security but is quicker to set up and easier rope handling characteristics. To set up, have a twelve inch runner girth hitched around shaft near head of axe. Clip a carabiner into it. You could also use your wrist leash where it is tied onto the head of the ice axe. In the event of a fall, the belayer is pulled more firmly into his stance. Follow steps 1 thru 3 as above.
4. Run the sling with the carabiner under your uphill foot, be careful if wearing crampons.
5. Run rope through carabiner up to downhill hip, around body to an uphill hand brake. A carabiner on the belayers hard point could be used as a directional.
6. Downhill hand is guide hand and uphill hand is the brake hand.

This method can also be used by standing directly on the axe with both feet, running the carabiner between your feet. You will actually be facing downslope, otherwise it is the same as above.

CONCLUSION: Just as in party climbing belaying your partner is probably the most important duty you can have. Learning not only how to use them, but also what snow conditions are the best for the use of a particular belay.

GLOSSARY

PURPOSE: This will give the independent Mountain Leader a reference of terms that will be used when discussing mountaineering with others in and out of the military.

Aid Climbing: Climbing assisted with out the use of anything beyond the rock or what's naturally there.

Alpine Style (Climbing): An approach to multi-day climbs in which a team progresses toward the summit in one continuous push, using neither stocked camps or fixed ropes in the assent. 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 you 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.

Beta: Information about the route.

Bergschrund: Also simply ‘shrund. A broad crevasse or series of crevasses occurring at the head of a glacier where moving ice separates from static ice or rock.

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, "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 you to clip into the rock with a quickdraw.

Bomber: A very secure point or anchor. A hold of large size. Also called “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 non-fixed 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.

Crevase: 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. Conductive 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 you 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 you slide your hand into a crack and twist or otherwise change the shape of your 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 you 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 an 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.

Haul Bag : Large and robust bbag 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 you wedge your 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.

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 pro 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 you 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 pro. Slings can be as short as two feet or as long as needed for hanging portaledges, handling haul bags, etc.

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 you extend an arm or leg to create outward opposing forces.

TCU: Tri-Cam Unit. A piece of equipment used for protection in larger sized cracks.

Thin: A climb or hold of relatively featureless character. As in 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.

Undercling: A hold that requires you to hold with palm facing up.

YDS: Yosemite Decimal System - A method of rating climbs used in North America.

Z-Pulley System: Complicated rope setup that allows you to hoist heavy weights with relatively little force. Excellent for rescues or hauling bags

Zipper: To pull out protection sequentially through a fall.

APPENDIX I

MOUNTAINS OF THE WORLD.

ALL ELAVATIONS ARE IN METERS. COUNTRIES THAT SHARE A PEAK ARE LISTED.

SOUTH AMERICA AND THE CARIBBEAN

ARGENTINA- Aconcagua 6,959 (22,831 ft) (Highest mountain outside the Himalayas) , Bonete 6,872, Mercedario 6,770 Argentina/Chile, El Libertador 6,720 Llullaillaco 6,723Argentina/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 3,441Argentina/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, Parinacota 6,330, Pomerape 6,240, Huayna Potosi 6,194, Aucanquilcha 6,200Bolivia/Chile, Chearoco 6,127, Chachacumani 6,094, Guallatiri 6,060 Chachani 6,057, Acotango 6,050, Tacora 5,988, Licancabur 5,921Bolivia/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 6,300Chile/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, 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 6,162Peru, 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, 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, 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

FAEROE ISLANDS- Sleaettaratindur 882

GERMANY- Zugspitze 2,962 Germany/Austria

GREECE-Mytikas Peak 2.917, Mt Smolikas2.637, 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

NORWAY- Galdhϕpiggen 2,469, Glittertinden 2,465, Store Skagastϕlstind 2,403, Surtningshui, ϕ-1 2,302, Tverratind, M 2,302, Over 50 peaks between 2,500m and 2,000m.

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

RUSSLAND- El brus 5,642 (18,510 ft), Rustiveli 5.201, Dykh-Tau 5.198, Kazbek5.047, Klyuchevskaya 4,750, Ushba 4,710, Krestovski 4,030, Ushkovski 3,930, Ostri Tolbachik 3,682, Kamen 3,460

SPAIN-Mulhac,n 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, Fluchthorn 3,399 Switzerland/Austria, Calderas 3397, 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, 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

YUGOSLAVIA- Triglav 2,863, Titov Vrh 2,748, Bobotov Kuk 2,523

ASIA

AFGANISTAN-Shah Fuladi 5,143,

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 – I 6,600, Bremeh 6,575,

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, 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 (29,028 ft) (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, Batura7,785, Saltoro Kangri 7,742, Trivor 7,720, Tirich Mir 7,690, Chogolisa 7,654, Shispar 7,619, Haramosh 7,406, 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(17,063 ft), 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

NAMBIA- 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 (19,563 ft) (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, 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 Pulu4,862, Kerintji 3,809, Rinjani 3,727, Semeru 3,677 Arjuno 3,340, Raung 3,334, Lawu 3,265, Welirang 3,200, Merbabu 3,142, Agung3.142, Merapi 2,919, Merapi 2,891, 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

PAPA NEW GUINEA- Mt Wilhelm 4,510, Giluwe4,368, Mt Hagen 3,778

PHILIPPINES- Mt Pulog 2,930, Volcan Mayon 2,462

NORTH AMERICA

CANADA-Logan 5,951 (19,524 ft), 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 (16,4040 ft), 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 (20,321 ft.) (Highest point in North America), Foraker 5,303, Mt Blackburn5,037, 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 Mt 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, 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, Francs Peak 4,006 Mt Owens 3,946, Trout Peak 3,733,

APPENDIX II
Glaciers and Glaciology

Approximate Worldwide Area Covered by Glaciers (square kilometers)

Anartica	13,586,000km
Greenland	1,700,000km
Canada	200,000km
Central Asia	109,000km
Russia	82,000km
United States	75,000km
China and Tibet	33,000km
South America	26,000km
Iceland	12,000km
Scandinavia	3,100km
Alps	2,900km
New Zealand	1,000km
New Guinea	15km
Africa	12km

Glacier Facts.

- 10% of all land is covered by glaciers.
- North America's longest glacier is the Bering Glacier in Alaska, mesuring 204 km long.
- The Malaspina Glacier in Alaska is the world's largest piedmont glacier. Covering over 8,000km and over 193 km across at its widest point.

Appendix III

CLIMBING RATING SYSTEM. Climb Rating Systems Rock, Ice, Mixed.
The grade of a climb is a subjective indication of its severity, at least in the US. In the UK, the word grade is also used to indicate the technical difficulty of the climb, what is called rating in the US. Some grading systems measure the average length of a climb, others consider the general safety of the climb, etc. Below are some of the more popular grading systems. These generally cover both free and aid climbing, but not ice climbing.

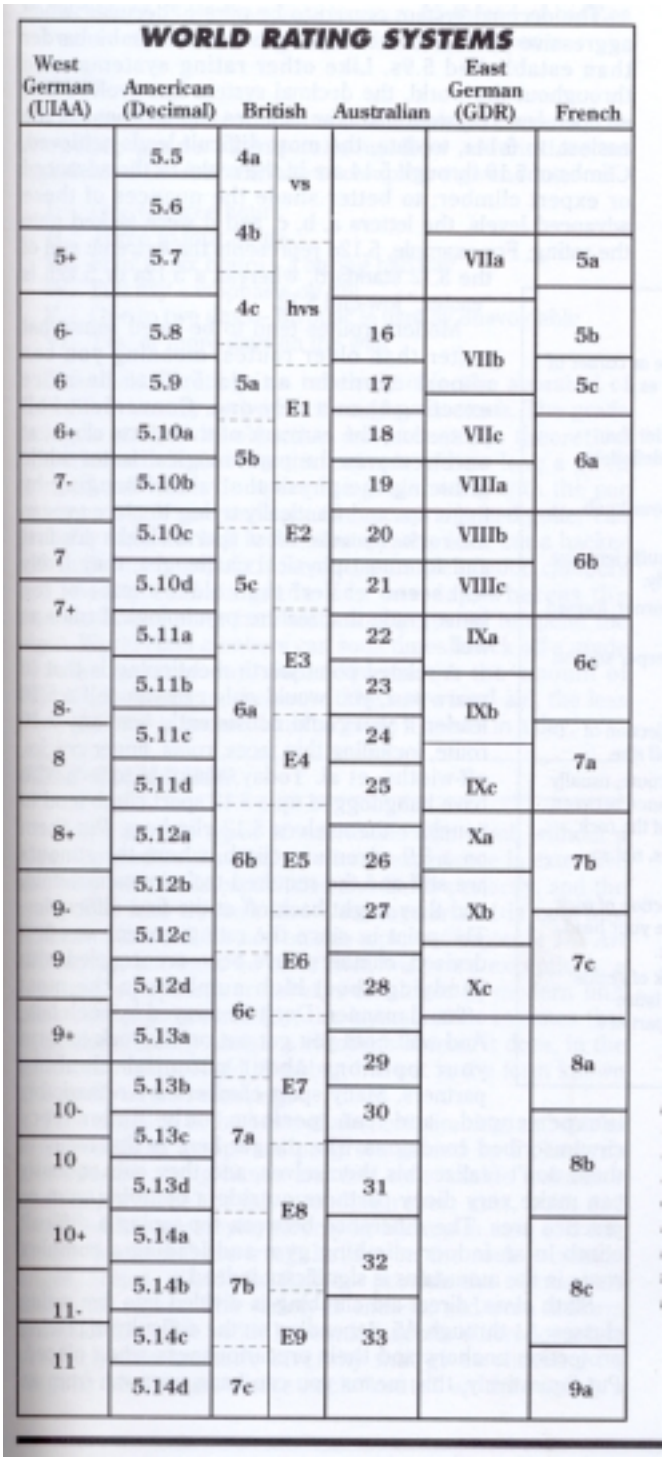
The North American Grading System
In North America, grades denote the normal amount of time required to complete a route. This time is based on a team of average climbers using normal techniques. And is shown in front of the difficulty rating. Ex. III 5.9 A2: Climb requires most of a day free climbing of 5.9 or lower and Direct aid sections of A2 or lower on the route. If a climb only shows a ratting off of the American Decimal system (see chart below) or an equivalent it can be assumed that the climb is a class I or II and will only take a few hours.

Class I - Requires 1-2 hours
Class II - Requires half a day
Class III - Requires most of a day
Class IV - Requires a very long day
Class V - Requires an overnight stay on the route
Class VI - Requires a few days
Class VII - Expedition

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 says something about 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, the objective dangers, etc. The grading system uses letters (derived from the french words - in parenthesis) 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 or Ernsthaftigkeitsgrad of a climb. This grading scale considers all aspects of the climb which have nothing to do with the technical difficulty: average runout distance, quality of the

protection placements, objective dangers, quality of the rock, etc. The scale goes from E0 to E5. E0 is a normal route, with solid fixed protection and ample opportunities for placing protection. E5, at the other end of the scale, stands for a largely unprotected and un-protectable route with weak piton placement and poor rock. On an E5 climb, falling is generally a lethal result. In most European maps, routes with an Ernsthaftigkeitsgrad above E0 are marked as such.



WORLD RATING SYSTEMS

West German (UIAA)	American (Decimal)	British		Australian	East German (GDR)	French
	5.5	4a	vs			
	5.6	4b				
5+	5.7		hvs		VIIa	5a
6-	5.8	4c		16	VIIb	5b
6	5.9	5a		17		5c
6+	5.10a		E1	18	VIIc	6a
7-	5.10b	5b		19	VIIIa	
7	5.10c		E2	20	VIIIb	6b
	5.10d	5c		21	VIIIc	
7+	5.11a			22	IXa	6c
8-	5.11b		E3	23	IXb	
	5.11c	6a		24		7a
8	5.11d		E4	25	IXc	
8+	5.12a				Xa	7b
	5.12b	6b	E5	26		
9-	5.12c			27	Xb	7c
9	5.12d		E6	28	Xc	
9+	5.13a	6c		29		8a
10-	5.13b		E7	30		
	5.13c	7a				8b
10	5.13d		E8	31		
10+	5.14a			32		8c
11-	5.14b	7b				
11	5.14c		E9	33		9a
	5.14d	7c				

A Few Words on Ratings and Grades - 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. It will all depend on where and when that first ascent was made.

For most purposes, the following - general - aid rating scale will do:

A1: All placements are rock 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 (60 ft) or more of body placements in a row.

In Europe, where most aid climbs were made long ago, this scale may be adjusted downward. Put simply, A3 placements are difficult, but will hold a short fall. A4 will involve some body weight placements, but not necessarily many in a row. And A5 is just unheard of. In Europe, A0 is used to indicate that fixed (and solid) pro is in place.

In the USA, modern equipment and the un-relentless drive to climb ever bigger and more difficult Big Walls or multi-pitch climbs, has pushed aid climbing to limits that were unimaginable a few decades ago. This has also changed the interpretation of the rating scales. This is how John Long and John Middendorf interpret the modern aid climbing ratings it in their 'Big Wall' book:

A0: Hanging from gear, stepping on pitons, pulling up on nuts, etc. Everything that doesn't require aiders and can't be honestly called 'free climbing'. Also known as "french free".

A1: Easy aid. Placements are easy and bomber. Each piece should hold a fall.

A2: Moderate aid. Solid but often awkward and strenuous placements. Maybe a difficult placement or two above good protection. Falls pose no danger.

A2+: Moderate aid, but with more tenuous placements above good protection. There is a potential for serious falls, but these will generally be otherwise uneventful.

A3: Hard aid. Requires many tenuous placements in a row and pieces need to be tested before weighting them. There should be solid placements within the pitch, but they are rather few and far between. During a fall, up to eight pieces of protection may rip out, but there generally is little serious danger. Takes several hours to complete a pitch.

A3+: A3, but with a dangerous fall potential.

A4: Serious aid. Most placements hold little less than body weight and falls are serious affairs. Being 10 to 15 meters (30 to 50 ft) above the last solid piece is not uncommon.

A4+: Very serious aid. Placements are often very marginal and pitches require many hours to complete.

A5: Extreme aid. No piece in the whole pitch can be trusted to hold a fall. No bolts or rivets in A5 pitches.

A6: A5 with poor belays that won't hold a fall. The leader pops and the whole team is airborne. No one sane has ever done this, and no one insane who tried came back to tell us about it.

APPENDIX IV
METRIC CONVERSIONS

Metric Conversion System Measuring Units Conversion Tables

Three temperature scales are commonly used in science and industry. Two of them are SI metric:

The degrees Celsius (°C) 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 (°F) non-metric 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.

Temperature conversions between the temperature scales:

degree Fahrenheit / degree Celsius conversions (exact):

* degrees F = degrees C x 1.8 + 32.
* degrees C = (degrees F - 32.) / 1.8

Some baseline temperatures in the two 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 / melting point of water / ice

0. °C

32.°F

A degrees Celsius memory device:

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!

Notes: 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 now transmitted in degrees Celsius.*

All upper-air (non-surface) temperatures have always been measured and reported in degrees Celsius by all countries.

The tables below provide for conversion from/to metric and imperial and US measurement systems.

1 millimetre [mm] = 0.0394 in	1 inch [in] = 2.54 cm
1 centimetre [cm] = 10 mm = 0.3937 in	1 yard [yd] = 3 ft = 0.9144 m
1 metre [m] = 100 cm = 1.0936 yd	1 mile = 1760 yd = 1.6093 km
1 kilometre [km] = 1000 m = 0.6214 mile	1 int nautical mile = 2025.4 yd = 1.852 km

APPENDIX V
WIND CHILL CHART

WIND SPEED		COOLING POWER OF WIMD EXPRESSED AS "EQUIVALENT CHILL TEMPERATURE"																				
KNOTS	MPH	TEMPERATURE °F																				
CALM		40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45	-50	-55	-60
		EQUIVELENT 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	-	-	-
16-19	20	20	10	5	0	-10	-15	-25	-30	-35	-45	-50	-60	-65	-75	-80	-85	-95	-	-	-	-
20-23	25	15	10	0	-5	-15	-20	-30	-35	-45	-50	-60	-65	-75	-80	-90	-95	-	-	-	-	-
24-28	30	10	5	0	-10	-20	-25	-30	-40	-50	-55	-65	-70	-80	-85	-95	-	-	-	-	-	-
29-32	35	10	5	-5	-10	-20	-30	-35	-40	-50	-60	-65	-75	-80	-90	-	-	-	-	-	-	-
33-36	40	10	0	-5	-10	-20	-30	-35	-45	-55	-60	-70	-75	-85	-95	-	-	-	-	-	-	-
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***									

APPENDIX VII
WARFIGHTING LOAD REQUIREMENTS

Seven Pocket Items- These items should be carried in the pockets of a Marine's utility unifrorm.
1) Pocket Knife 2) Whistle 3) Pressure Bandage 4) Chapstick and sunscreen 5) Sunglasses 6) Survival Kit and Rations 7) Notebook with pen /pencil

Survival Kit- These are the six requirements for a survival kit and an example of each.
1) Fire Starting Material: Lighter, flint and steel. 2) Water Gathering Material: Plastic Bag 3) Signaling Device: Mirror, Whistle. An audio and visual are needed. Also plan for night and day. 4) Food Gathering: Fishing Hooks and lures, snare building material. 5) Shelter Material: 550 Cord, finger saw. 6) 1st Aid items: pressure bandages, iodine.

Assault Load- Carried in a Marine's LBV, and using his pack system.
1) Extra insulating layer. 2) Protective layer. 3) LBV with 2 quarts of water and first aid kit. 4) Helmet. 5) Rations for the time away from bivuac. 6) Cold weather hat or balacalava. 7) Individual Mountaineering gear.(Sling rope, carabiners, rappel gloves). 8) Specialized mountaineering equipment. 9) Mission essential gear.

Combat Load- These are in addition to the Assault load. For missions of longer duration.
1) Sleeping Bag. 2) Isopor Mat. 3) Stove. 4) Fuel Bottle. 5) Thermos. 6) Poncho.

Existence Load- Is packed for long duration operations, when it will be necessary to replace worn out items. To include but not limited to, uniforms, boots, personal hygiene gear.

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