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Cold Weather Operations Manual

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FOREWORD

This manual provides the Chief of Civil Engineers guidance regarding the command and training of Naval Construction Force (NCF) units in cold weather and extreme cold weather operations. It covers the principles of cold weather survival and operations as applied to the individual Seabee's conduct while performing NCF unit functions including construction, transportation, and camp maintenance.

This manual may be used as a source document by NCF units, particularly Naval Construction Regiments and Naval Mobile Construction Battalions, to plan basic cold weather training. Recommended changes are solicited. Send recommendations to NAVFACENGCOMHQ (Code 062).

This publication is certified as an official Command publication and has been reviewed and approved in accordance with SECNAV Instruction 5600.16, "Review of Department of the Navy (DON) Publications; Procedures Governing".

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ABSTRACT

This manual provides guidance for operations and training of Naval Construction Force units in cold weather and extreme cold weather. It covers the principles of cold weather survival and operations as applied to the individual Seabee's conduct while performing NCF unit functions including construction, transportation, and camp maintenance. Arctic and subarctic construction techniques are not covered.

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CHAPTER 1. LEADERSHIP

1.1 PRINCIPLES. The commander operating in cold weather must realize that he is confronted by two enemies: the environment and the enemy force. The cold will not go away. It must be confronted and neutralized daily. The successful commander will learn to use the cold weather environment to his advantage and will consider it his ally. Seabees respond to good leadership regardless of outside factors. Productive leadership in cold weather is based on sound judgment, developed from a knowledge of traditional leadership traits, combined with a thorough understanding of the unique problems presented by this environment. Commanders operating in this environment must become knowledgeable about the cold and develop basic skills. They must understand that everything takes longer in the cold; units will be successful if they are properly trained, confident in their abilities and allowed/required to function as small units.

1.1.1 Know Yourself.

a. Knowing yourself includes a clear assessment of your strengths and weaknesses. Learn to recognize potential weaknesses in cold weather. Most cold weather operational techniques are straightforward and use common sense. However, some require concentration and practice to become sufficiently proficient.

b. Most of the leadership challenges in cold weather are mental. The leader who cannot cope with the environment mentally will never cope with it physically, and therefore, will never have an effective unit. Almost everyone has a fear of the extreme cold. It is only when this fear is overcome that one can lead effectively.

c. For the leader to successfully lead his unit, he must work to qualify himself in cold weather techniques. This may sound like a simple enough task. The environment is working in opposition to the development of effective leadership. The cold numbs both the body and the brain, making simple decisions difficult and attacking self-motivation. The tremendous physical exertion required, simply to survive, drains the leader of his normally strong desire to see every task done right. The point to be understood here is that the cold is affecting every man in the same fashion, and if not addressed, the unit can become ineffective.

d. The leader must recognize the problems associated with cold weather and cold induced lethargy. He needs to engage his personal drive in order to spark his subordinates. He must have developed the stamina, skill and knowledge to meet the challenge of longer working hours and taking care of his men in the cold environment.

1.1.2 Be Technically Proficient

a. This translates into **know your job**. It means not only knowing a simple cold weather technique, but knowing how to apply that technique to accomplish the project in the most efficient manner. Be innovative, quick to learn and understand. Watch out for the men in the cold, get them tools, parts and materials to do their jobs well and expediently. This may require a study of both historically successful and failed cold weather operations, as well as staying current on new developments in methods and equipment.

b. Cold weather doctrine for many construction techniques is not well developed. Innovation should be a ready consideration in day-to-day operations. Study and experimentation provide the basis for competence. **Experience gained through practical application in the severest conditions possible will provide proficiency.**

1.1.3 Seek Responsibility and Take Responsibility For Your Actions. Many typical cold weather injuries such as trench foot, frostbite, dehydration, and even skiing injuries can be directly related to ineffective leadership. While these injuries might readily be identified as individual responsibilities, it has been demonstrated that a caring, knowledgeable leader can have a dramatic impact on the incidence of all types of cold weather injuries without sacrificing tactical aggressiveness. This is possible through proper training of each man in preventive medicine, the wise use of the manpower resources in harsh weather, and constant awareness of symptoms.

1.1.4 Make Sound and Timely Decisions.

a. If the impact of the cold were reduced to one sentence, it would be: **everything takes longer in the cold.** Leaders at all levels must recognize the new time requirements and plan accordingly. While some charts and equations have been devised to guide the planner, there is no formula that accounts for all the variables and no substitute for experience. The cold weather plan that depends on a rigid schedule for success will have little chance of working.

b. Flexibility must be applied in moderation. While deviation from a project CPM is certain, a prudent leader will only order a change of any kind after careful thought.

1.1.5 Set the Example. Optimism, endurance, and mental courage are qualities that a leader must have. The cold can discourage even the stout-hearted. It falls to the leader to inspire, by his optimistic outlook, any who might succumb. Fatigue, coupled with increasingly difficult physical and mental demands, can depress the esprit and make simple tasks seem monumental. The leader must have well-developed stamina to prevent fatigue from translating into fear. He must also have strong mental courage to train hard when necessary, operate to the limit of his manpower resources, yet care for his men. Mental attitude versus physical strain must not be taken lightly. This is the acid test for a leader and one reason why cold weather leadership is so challenging.

1.1.6 Know Your Seabees and Look Out For Their Welfare. The leader must know his Seabees well enough to know when they have reached their mental and physical limitations. As always, the project comes first, but in the cold, more so than in any other environment, project and personnel are inseparable. Inadequate sanitation, food, water, rest, and other support will make a unit ineffective very quickly. In the cold, the simplest necessities for survival can be hard to satisfy. Small things become important. Conserving energy by avoiding nonproductive activity, a hot drink on a frigid sentry post, and a warming tent strategically placed are but a few examples. A unit must not be driven beyond its capacity. In an environment where survival is a daily concern, knowing your Seabees and looking out for their welfare demands the attention of leaders at all levels with every decision made. A unit overextended today will be out of action tomorrow and perhaps for many days to come. A leader who knows his unit can fully appraise the project and, if necessary, negotiate changes that keep his unit operating within its capabilities.

1.1.7 Keep Your Men Informed. Only by effective communication can a leader maintain a sense of purpose within his unit. Because of the effect of heavy cold weather clothing and equipment and the deadening of the senses by the cold, communication between all personnel becomes restricted. Leaders can become distracted and noncommunicative. Physical strain limits the attention span. Leaders at all levels must consciously force information out as early as possible by the use of warning orders so that every Seabee knows the current situation and what is expected of him. Otherwise, the cocooning effect of the cold will turn each Seabee inside his parka, sleeping bag, and finally inside himself. Withdrawal from the surrounding environment is characteristic of individuals who are uninformed by their leaders. As individuals withdraw, cohesion is lost and morale suffers.

1.1.8 Develop a Sense of Responsibility in Your Subordinates.

a. Leaders at all levels must develop the skills and character traits previously discussed. Competent leaders are often reluctant to admit that the cold weather situation requires new techniques. Because the environment affects every Seabee, each one must learn survival skills for his own well-being. He must also learn to recognize cold injury symptoms in those around him. He must understand precautions to be taken with equipment in the cold to keep it operational, and he must have the sense of responsibility to take necessary action even when it is inconvenient to do so. Changing weather conditions may result in events running off schedule or in a change in orders. Whether directed to or not, leaders at all levels must have developed the ability to make adjustments.

b. Perhaps the most important trait a Seabee needs to develop in the cold is self-confidence. It must be developed based on experience in using survival skills and on knowledge of how to do the job in the cold. No Seabee will function effectively until he feels comfortable in the environment. No one likes to be cold and each Seabee must learn first how to avoid suffering because of routine exposure to the environment. This self-reliance is the first step for every man in learning to be effective in the cold.

1.1.9 Ensure Tasks are Understood, Supervised and Accomplished. This principle takes on added significance in the cold because everything takes longer and requires more effort. A job accomplished in the wrong way, to the wrong extent, or in the wrong place can be very costly in time, personnel, equipment resources, and even in casualties. Close supervision is necessary in the cold. Frequent supervisory checks of subordinates also serve the secondary purpose of combating the mental withdrawal of units or individuals from their surroundings. This type of hibernation can easily affect anyone when personal concerns outweigh the needs of the project.

1.1.10 Train Your Seabees As A Team. Teamwork is critical to success in cold weather. That is why **arctic buddies** are assigned. Every Seabee has a partner to help and to share both responsibilities and rewards. Tent routine is but one example of how a unit must work together to cope with the difficulties of the environment. The concept of teamwork needs to extend beyond assigned duties. Making a hot drink for the maintenance crew or sentry coming off duty, drying someone else's clothes before drying your own, melting snow for water for a buddy, or volunteering to go back out to help with an equipment problem on a frigid night are examples of the type of attitude that exists in a unit where teamwork is a way of life. It requires unselfishness and compassion. It also requires enough humility to stop thinking of oneself as number one. Leaders will have to teach it and then demonstrate it. **When the offers for assistance outnumber the complaints, you know you have a team.**

1.1.11 Employ Your Unit In Accordance With Its Capabilities. It is common in cold weather for leaders to underestimate the impact of the environment and overestimate the ability of the unit. This causes accidents and casualties as well as frustration. To improve knowledge levels and skills requires hard training, but working beyond current skill levels is both discouraging and dangerous. On the other hand, if a unit has trained hard and is highly competent in cold weather, it should be used to take advantage of that capability.

1.2 ATTITUDES

1.2.1 Concept. Before embarking on cold weather operations, leaders must understand that **no unit can operate successfully with an attitude of business as usual, that is, we are already good and we have nothing else to learn.** This attitude will permeate the entire unit and prevent each Seabee, including leaders, from learning the techniques necessary for success.

1.2.2 Learning with Subordinates. A problem for leaders is that they will be learning skills with their subordinates. Some younger Seabees will pick up skills much quicker than their leaders and will probably remain better skilled than their leaders. Leaders must be teachable and humble enough to learn basic skills from subordinates. Command still rests with the leader. When using an instructor to train the unit, the leader must understand that these "teachers" are to be used as any other specially skilled individual, such as a skilled local well driller or an indigenous soils engineer in a foreign country. He should use the advice of these teachers as liberally as possible, but with good judgment, always retaining responsibility for the unit's actions. In training, the slow-to-learn leader must demonstrate humility, self-esteem, a sense of humor, and persistence. Eventually the skills will come. Just as he need not necessarily be the best architect or the best structural engineer in his unit to effectively command, neither must he be the most skilled in cold weather techniques.

1.3 COMMANDER'S INTENT.

In tactical situations, subordinates must know the commander's intent and have the confidence to respond aggressively to the tactical situation. In cold weather operations, units are often isolated. Because of these conditions, reaction time is extensive. Leaders must be trained and encouraged by their commanders to react and take charge. Commanders should use unit tasking type orders that specify **what** must be done without prescribing **how** it must be done.

1.4 OPERATIONAL PRIORITIES (THE RULES).

To be successful in cold weather operations, commanders must know the following RULES.

1.4.1 Live. The cold causes far more casualties than enemy fire in the arctic. To survive is basic. We must never lose sight of the requirement for shelter, hot food, rapid medical attention, and positive leadership.

1.4.2 Build. The skills of the individuals and the right equipment provide the Seabees with the practical advantage, provided this asset is used intelligently.

1.4.3 Fight. The fundamentals of defensive combat apply. To fight in the cold, Seabees must be better trained, better disciplined, more motivated, and better led than the enemy.

CHAPTER 2. COLD WEATHER OPERATING AREAS

2.1 CHARACTERISTICS

2.1.1 Geographic Location. Cold weather operating areas of the Seabees are generally in the Northern Hemisphere; the very top is dominated by the Arctic Ocean, which is frozen in solid ice pack for most of the year. Immediately below the Arctic Ocean, between latitudes 50° and 80°, are land masses including the northern borders of the U.S.S.R., Alaska and Canada, (i.e., the Northwest Passage) and Greenland. Also located here are the Bering, Barents, Kara, and Norwegian Seas, and the Hudson and Baffin Bays. Figure 2-1, the map of North Pole area, shows these geographic locations.

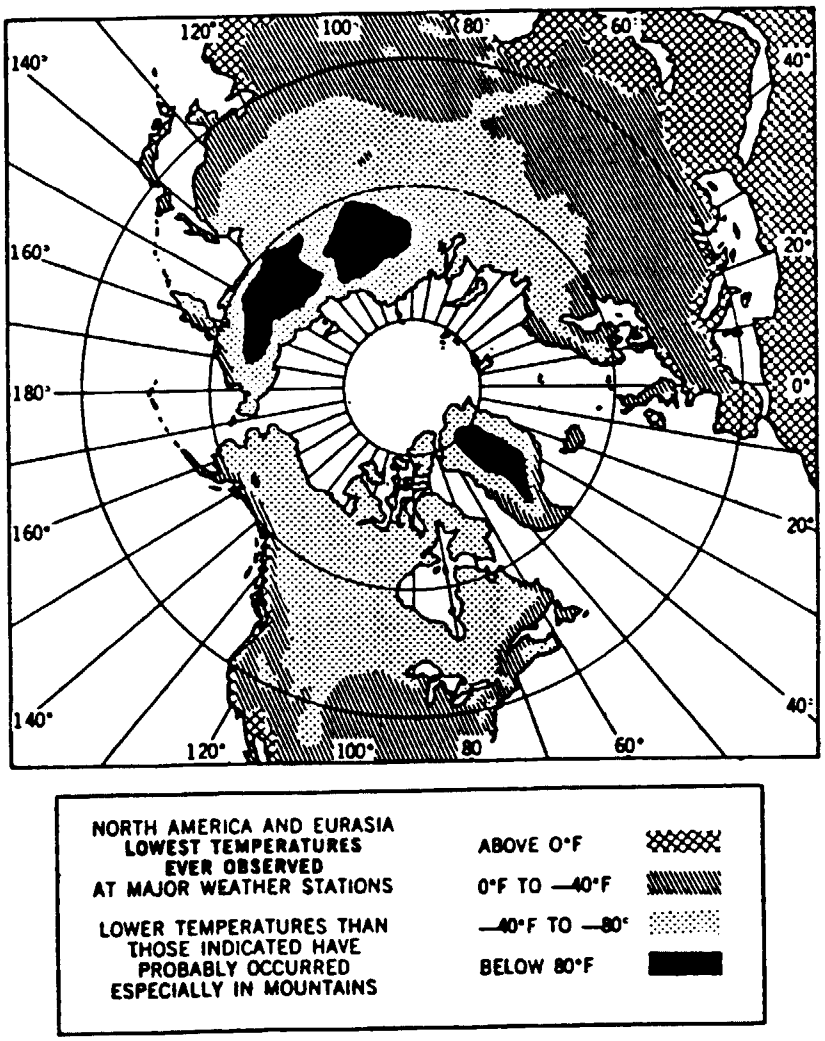

Figure 2-1, Map of the North Pole Area

2.1.2 Latitude and Temperature. Arctic areas generally lie in a region of the world where the average temperature of the warmest month is between 32° F and 50°F. These areas do not support forest vegetation and often include adjacent lakes, seas, and oceans. Higher altitudes in lower latitudes of the subarctic/temperate zone have similar temperature, wind, humidity, weather, and vegetation to those found in the lower altitudes in higher latitudes.

2.1.3 Weather and Precipitation. Arctic regions are generally places of little precipitation (i.e., snowfall and rainfall). At the head of the North Atlantic the precipitation is less than 8 inches annually, an amount similar to that of the semi-arid parts of the Western United States. Near the entrance to Franz Josef Land in Eastern Greenland, the precipitation is about the same as that found in Death Valley, California. Precipitation is developed from warm ocean currents. Amounts up to 40 inches are found on the southern coast of Greenland and up to 60 inches in the Aleutian Islands Chain and the northern Japan region. Precipitation is in the form of fine, light snow that is blown about by the wind. It always seems to be snowing. Violent local gales occur wherever high land faces open water (as in Greenland), but the polar basin is one of the least stormy areas of the world.

2.1.4 Effect of Warm Water Currents. The precipitation rate is a result of the continuous flow and circulation of warm waters from the Gulf Stream and the Japanese Current. The Gulf Stream flows out of the tropics of the Caribbean along the coast of the U.S. and across to the North Sea. The Japanese Current flows from the Philippines east of Japan beneath the Aleutian Islands Chain to the Gulf of Alaska and down the west coast of the U.S.. Where these currents intersect with cold wind currents, the turbulence created produces precipitation. Additionally, these warm water currents bring warm temperatures, which considerably influence the weather of high latitude areas.

2.1.5 Mountainous Terrain, Deep Fjords Barren Tundra. Many Arctic region coastlines are continuously broken by deep fjords and are characterized by steep mountains, which often begin below sea level and rise to heights of 5,000 feet with snow cover above 500 feet. Beaches and coastal plains are the exception. Other inland regions and many subarctic regions are characterized by barren and rolling tundra offering little or no protection from the elements.

2.2 ENVIRONMENTAL CHARACTERISTICS

2.2.1 Wind. The prevailing winds generally flow from northeast to southwest. The rugged mountainous terrain and respective gulf streams bring warmth and moisture necessary for the precipitation. Mountainous topography cools/dries the moisture laden winds, resulting in precipitation (rain or snow). The frequency and velocity of winds in the north are not as great as in the south. Stronger winds are experienced in the winter along the coast than are found in the interior at that time. These winds are the result of the turbulence developed from the contrasting temperature, which develops from the warmth of the streams reacting with the cold caused by lack of solar heating in winter.

2.2.2 Daylight/Darkness. In relation to the earth, the sun is located at the equator during Fall and Spring, moving north in the Summer and south in the Winter. This movement results in continuous periods of daylight and darkness in the high latitudes. In addition to the psychological effect on personnel, this movement creates the radiational warming and cooling of the Arctic Ocean, which develops into the weather patterns of the Northern Hemisphere.

2.2.3 Vegetation, Animal, and Insect Life. The arctic region is chiefly barren of vegetation, but animals and insects do exist there. It is windy in localized areas and its climate varies from the mildness of northern Norway to the extremes of cold and heat in northeast Siberia. The subarctic is generally below the tree line and consequently has continuous vegetation, longer summer periods, and extensive animal and insect life.

2.2.4 Seasons. The winter is changeable throughout the arctic regions, whereas the cool summer is relatively uniform. The average yearly temperatures vary from -50°F to +30°F. One author on the subject states that there are but two seasons "Winter and August". There is little water vapor in suspension in the polar atmosphere. With the low absolute humidity, there can be little precipitation, which makes the Arctic a generally arid area. In the lower latitudes the summer season is more pronounced. Spring and Fall are equated with break-up/freeze-up or mud season where trafficability is reduced to zero, particularly in areas of permafrost.

2.2.5 Fogs. There are several types of fog encountered in areas of extreme or arctic cold, classified according to their source. Most are basically ice fogs rather than moisture fogs. When moisture is released into the air from any source at low temperatures, ice crystals are formed which tend to hang in the air, especially when little or no wind is present. Human-animal fog is caused by perspiration and moisture from the breath. Water fog is caused by overflowing streams. Water products of combustion will cause town fogs, vehicle fogs, weapon fogs, or aircraft fogs. Normally these fogs appear when the temperature drops below 25°F to 30°F. Fog will form around weapons being fired and all types of combustion equipment as a result of the released moisture. These fogs affect concealment, visibility, equipment operation and other construction tasks. Fogs at warmer temperatures (25°F to 40°F) are caused by inversion effects as warm rains melt snow during break-up periods.

In areas where warm waters intersect, cold air currents and/or inversion fogs/clouds occur.

2.2.6 Arctic Whiteout. This is a condition in which an observer on the ground or aloft appears to be engulfed in a uniform white glow. The whiteout occurs when there is an unbroken snow cover and a uniformly overcast sky so that light reflected from the sky is approximately equal to that from the snow surface. The horizon cannot be distinguished, and depth perception is limited unless objects of a known size are in sight. It is impossible to tell whether a hump in the snow is a distant hill or a snow covered stone only a few feet away. Walking is awkward since it is difficult to distinguish humps from hollows or to know how far away they are. The presence of ice crystals aggravates the condition. Blowing snow can also cause whiteouts. This is an extremely dangerous condition and any movement during it should be heavily weighed against the total disorientation it creates.

2.2.7 Grayout. This condition occurs over a snow covered surface during twilight or when the sun is close to the horizon. There is an overall grayness to the surroundings, especially when looking away from the horizon, the sky is overcast with dense clouds, and there is an absence of shadows with a resulting loss of depth perception. Grayouts increase the hazard of landing, driving vehicles, towing aircraft, and even walking. This phenomenon is similar to whiteouts, however, a horizon is usually distinguishable.

2.2.8 Soils. In general, all soil types can be encountered in the Arctic and subarctic. Talik is a special class of subsoil that does not contain enough moisture to freeze and is usually characterized by sandy or well graded subsoils. Ice lenses are deposits of pure ice that may form in either talik or permafrost. (See Figure 2-2, Cross Section of Arctic Soil Structure.)

a. Permafrost. Permafrost is perennially frozen material that will thaw at the surface during the break-up/freeze-up period. Trafficability in permafrost areas is directly related to temperature. Warming temperatures will thaw the active layers of the permafrost, resulting in swamps and bogs. This quicksand-like surface will inhibit trafficability during break-up/freeze-up periods. Compare this to the periods of the year when the surface is frozen and, although rough and uneven, the permafrost is generally trafficable. If the permafrost is snow covered trafficability will be enhanced for foot troops equipped with snowshoes and oversnow vehicles.

b. Frost. In the subarctic, the ground will freeze-up in the Fall, remaining frozen until Spring. Drainage is generally good except in the Fall when swamps are filling and in the spring thaw periods. Snow is a great insulator. If snowfall occurs before the active layers are frozen, the snow will insulate the ground. Frost will not be deep and the surface may not support tracked or rubber-tired vehicles.

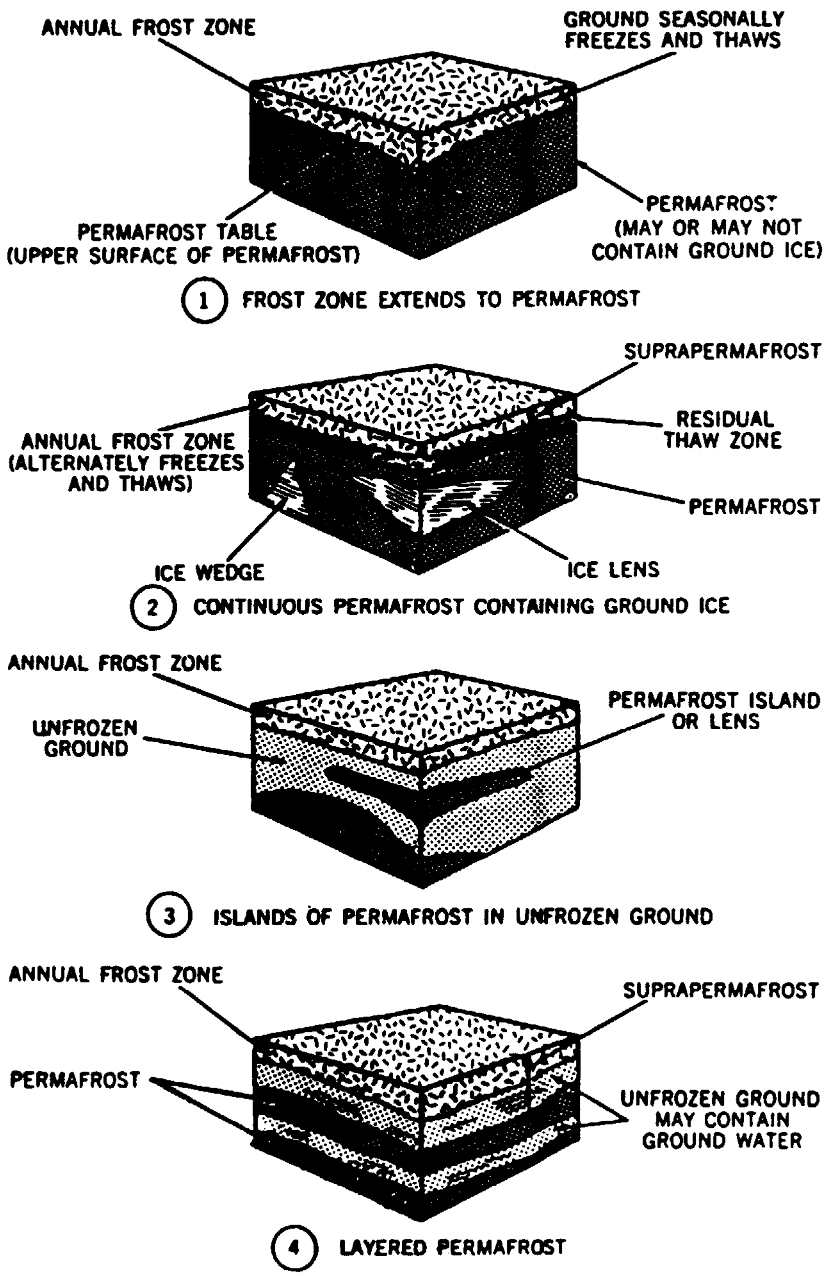

Figure 2-2, Cross-Section of Arctic Soil Structure

2.3 COLD WET/COLD DRY CONDITIONS. Cold wet/cold dry conditions are the two major terms used to describe conditions in cold and extreme cold climates. These terms are extensively used to categorize clothing, types of lubricants, types of building materials and types of ammunition etc.

2.3.1 Cold Wet. Cold wet conditions occur when temperatures hover near freezing between the temperature of 14°F to 40°F. The alternate freezing and thawing is often accompanied by rain and wet snow. This is the most difficult environment to fight in since combatants are in a constant struggle to stay dry and dry out.

2.3.2 Cold Dry. Cold dry conditions occur when average temperatures are lower than 14°F. The ground is usually frozen, providing a predictable load-bearing capability for foot troops equipped with snowshoes and over-snow vehicles. When temperatures drop below 14°F, the humidity drops to an extremely low percentage. The lower relative humidity makes the basic personal task of keeping dry easy. The snow is usually dry in the form of fine crystals. Strong winds cause low temperatures (wind chill) to seem colder and increase the need for protection of the entire body (See Figure 2-3, Cooling Power of Wind). Cold dry conditions are affected by the distance from the available moisture and warm water.

2.4. THE ARCTIC. At a glance, the Arctic regions of the world offer little apparent tactical usefulness. The extreme cold, lack of concealment, extremely limiting effects on mobility, and the enormous logistical requirement of even a small force, would seem to render it unsuitable to significant military operations. However some arctic regions touch and even dip into the U.S. and Canada and offer avenues of approach to critical resource areas of the Northern Hemisphere. Additionally, control of certain arctic regions by enemy forces could allow for interdicting vital northern sea lanes and disrupting the movement of troops and material to primary combatant areas. For these reasons, the likelihood of our commitment to an arctic construction tasking is not at all remote. In Winter, swamps, rivers and lakes become an asset to movement. From break-up to freeze-up periods, they are a liability. Detailed engineer reconnaissance is necessary to determine ice thickness for vehicle use or use as an airstrip. In Summer, insects make life miserable for troops and means of protection must be provided.

2.5 THE SUBARCTIC. Military construction operations on a large scale have been conducted in the subarctic in all seasons. The winter season and the attendant freeze-up in autumn and break-up in the Spring produce the majority of the problems in the subarctic. Military construction operations in Summer are conducted in the same manner as those in temperate regions.

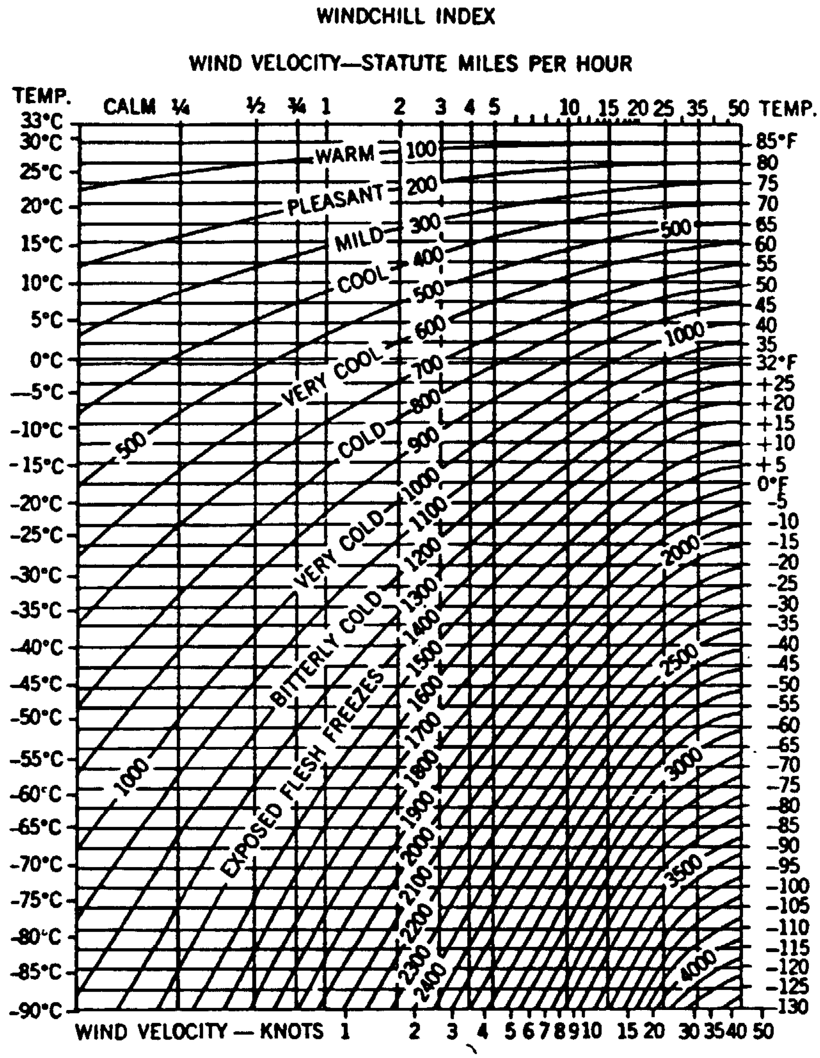

Figure 2-3, Cooling Power of Wind

The combination of forest and deep snow found in northern areas pose particular problems in subarctic winter construction operations and warfare.

2.5.1 Climate. The climate of the subarctic differs from the Arctic in the greater amount of precipitation and higher mean temperatures in all seasons. In Winter, there is abundant snowfall, (generally not less than 50 inches) and in some areas more than 200 inches. Rainfall averages 10 to 20 inches in coastal areas. The Summer is longer and mean temperatures range into the 50's and 60's, with highs occasionally in the 90's.

2.5.2 Terrain. The terrain is the major difference between the subarctic and the Arctic. Forests of spruce, alpine fir, birch, and pine trees interspersed with rivers, streams, lakes, and swamps dominate the subarctic. The relief varies from the smoothly rolling or nearly level country of the Canadian Northwest, through the mountainous relief of Norway with its deep fjords, to the mountains of British Columbia and Alaska. The forests provide cover and concealment, particularly where thick stands of spruce and fir are present. Trees can be used for constructing corduroy roads, improvised shelters, and obstacles. Forests favor the defender because it is difficult to obtain detailed information by ground or air reconnaissance. Strong defensive positions can be constructed and well-concealed; artillery and close air support are difficult; and all vehicle movement in thick forests is generally limited to roads.

2.5.3 Trafficability. Normally, few roads are available. Traffic often will be based on only one road, which may not have an all-weather surface. In Winter, keeping roads open will be a major operation requiring large Civil Engineering Support Equipment (CESE). Ground mobility in winter is based on the use of snowshoes and over-snow vehicles. Wheeled vehicles experience extreme difficulty and are normally used only on open roads.

2.5.4 Snow. The deep winter snow affects mobility in many ways. It impedes cross-country movement and on roads it blankets terrain features, hiding obstacles such as stumps, rocks, ditches, small streams, fallen trees, mine-fields and other artificial obstacles. Because the early snow cover acts as a thermal blanket retarding the freezing and thawing of the underlying ground and ice, the underlying ground and ice will remain soft and trafficability will be poor. When snow melts, it saturates the ground and makes it impassable. On roads and airfields snow must be removed or compacted. Traction on compacted snow is better during extreme cold weather. Generally, wheeled vehicles cannot travel in snow exceeding 1 foot. Tracked vehicles cannot travel through snow deeper than 2 1/2 feet. Snow crust will occasionally bear the weight of an individual or a small group on foot.

2.5.5 Break-up/Freeze-up. Mud is the dominant seasonal factor in military operations during the Spring and Autumn. With the spring thaw and break-up comes flooding and ice jams. Roads become almost unusable and operations are thus severely restricted. Ruts made during the day will freeze during cold nights. Travel over these frozen ruts can result in damage to vehicles. Once these ruts thaw during the day, vehicles bog down and movement is restricted. This condition is also present during the autumn freeze-up. Once vehicles become mired, recovery is extremely difficult and time consuming. During both spring thaw and autumn freeze-up, it normally takes 4 to 6 weeks before conditions are dry or frozen enough for normal operation. In areas where permafrost is a factor, this condition may continue right through the summer months.

CHAPTER 3. EFFECTS OF COLD WEATHER ON MILITARY OPERATIONS

3.1 GENERAL. Cold weather affects all aspects of military operations. But most importantly, the commander must realize that protecting his Seabee from physical and psychological effects can never be taken too lightly. Perhaps nothing influences the commander`s decisions more in the cold than his tactical mobility capability. He must also take extreme care to prevent the damaging effects on all ordnance. This chapter identifies all of these effects.

3.2 PERSONNEL. The effects of the cold on man fall into two categories -- physical and psychological.

3.2.1 Physical Effects (Body Heat Loss Mechanisms). See Figure 3-1, The Mechanisms of Heat Loss from the Body.

Figure 3.1, The Mechanisms of Heat Loss from the Body

a. Radiation. Loss of body heat from radiation occurs when skin is exposed directly to the outside environment. Body heat radiates off the skin due to a basic physical law, which causes heat to move rapidly from a hot source to a cooler one. The colder the outside temperature, the quicker radiation will occur. The heat provided by the furnace action of the body is carried through the body and to its extremities via the blood circulatory system. There are a vast number of blood vessels near the surface area of the head and face. The potential for loss of heat through radiation is greatly increased when those areas are not covered. Understanding this concept allows a person to safely regulate their heat loss.

b. **Respiration.** Respiration heat loss occurs during normal exhalation of breath. Warm, moist air is expelled from the lungs at a rate directly related to how hard a person is working and therefore how fast he is breathing. Evidence of respiration heat loss is a white steamy cloud being expelled from the mouth or nostrils.

c. **Evaporation.** Excess body heat is transferred from the body through sweating. When the inner body temperature becomes too high because of illness or physical exertion, this excess heat is transferred through the pores of the skin in water droplets. The process of the water drying up and allowing the heat to be released to the outside air is known as evaporation. Damp clothing found in direct contact with the skin is normally due to evaporation. Dehydration is a side effect of evaporation heat loss and can lead to heat cramps and heat exhaustion, even in the cold environment.

d. **Conduction.** In conduction, the heat is transferred directly by contact between a hot and cold surface. Heat loss by conduction most commonly occurs when an individual sits or lays down on a cold surface without adequate protection between the body and the surface. Conduction also occurs when laying in a prone position during defensive situations and during the time when an individual is sleeping. During the defense or while sleeping, the sleeping pad can be used as an insulator to slow down the process of conduction. Heat loss through conduction is a slow but deadly process because it usually occurs when an individual is unaware of it. It will lead to hypothermia. Since there are no physical signs, heat loss by conduction is extremely dangerous.

e. **Convection.** Convection or "wind chill" occurs when cold air moves against unprotected exposed skin or against and then through openings in the cold weather protective clothing. The cold air "whisks away" heat being radiated from the body. The faster the air moves against the body, the quicker the heat loss occurs. Windy conditions cause convection heat loss. These conditions can occur naturally and be quite common in the northern temperate or arctic areas, but can also be caused by normal military operations such as riding in an open vehicle, being exposed to helicopter rotor wash or to fan cooled equipment. There are no physical signs of heat loss due to convection. The greatest danger of convection is that it acts as a rapid multiplier of radiation.

3.2.2 Psychological. The psychological effects of the cold on man can be the most debilitating and hardest to prevent, let alone resolve. The only protection is obtained through realistic, thorough, and repeated training in the cold. Instructive talks about how the cold can affect mental alertness and the ability to perform should be planned for and inserted into the training program. Again, while the cold makes tasks harder and longer to do, **IT DOES NOT MAKE THEM IMPOSSIBLE.** With knowledge, equipment, and repeated training, the cold can be beaten and success achieved in training for cold weather construction and/or combat.

3.3 MOBILITY. There are three ways to move in the extreme cold and the heavy snow: by foot, by vehicle, or by helicopter. During the winter, low temperatures, snow, ice, and the problems of constructing roads and trails hinder movement on the ground. When ice thaws, it is weakened and lakes, streams, and roads may become impassable. In summer, many areas become swampy in arctic regions because the underlying permafrost prevents drainage. Wheeled vehicles are essentially roadbound. Tracked vehicle mobility (i.e. bulldozers) is limited to prepared trails and roads.

3.3.1 Snow Conditions.

a. Wet snow usually occurs in the Spring, and occasionally, in early Autumn or late Winter.

b. Moist snow is found in early Winter, but may occur in mid-Winter during warm periods.

c. Dry snow is generally found in mid-Winter, but can occur at any time during periods of low temperature. It may be packed from the action of the wind or powdery. At very low temperatures, this snow will be like sand and will have poor sliding qualities.

3.3.2 How Snow Changes. Newly fallen snow undergoes many changes on the ground. As the snow on the ground becomes denser, snow flakes consolidate and the trapped air is expelled. Snow changes because of temperature, sunlight, and prevailing wind.

a. **Temperature.** In general, the lower the temperature, the drier the snow and the less consolidation. As the temperature rises, the snow will compact more rapidly. If the temperature rises above freezing, wet snow conditions will prevail. Low night temperatures will cause wet snow to form a hard crust.

b. **Sunlight.** In spring, sunlight may melt the surface of the snow even though the air temperature is below freezing. Dry, powdery snow will be found in shaded areas and wet snow in sunny areas. Diminishing sunshine will cause the wet snow to form a crust.

c. Wind. Wind drifts and packs snow. The more constant the wind is, the harder the snow will be packed. Loose snow will drift in the wind, causing a wavy surface. Snowshoeing or even walking will usually make no impression on its surface. Below freezing temperatures and warm winds will cause an ice crust to form. Movement under these conditions is difficult.

3.3.3 Foot Mobility. The harder the snow has been packed, the greater weight per square inch it will support, making movement somewhat easier. An ice crust may have a good carrying capacity, but movement will be difficult because of the slippery surface. In most snow conditions, a Seabee's mobility can be enhanced by using snowshoes. Snow blankets the country and obscures features, making identification of terrain features difficult. It hides obstacles such as tree stumps, rocks, ditches, small streams and manmade obstacles such as mine fields and other defenses. Snow acts as an insulator retarding the early stages of the thaw. On a flat surface, it prevents effective drainage and forms deep and often almost unnegotiable slush. If snow arrives before frost, its insulating qualities will prevent the deep freezing of the underlying ground which may significantly deter off-road mobility of vehicles. Men on foot cannot move easily through fresh snow more than 8 inches deep. At depths of over 15 inches, unaided movement becomes laborious and very tiring. In such conditions troops with no over-snow capability are road-bound, unable to maneuver effectively and freely over the snow on snowshoes.

a. Snowshoeing. Snowshoes are an aid to individual over-snow movement. They enable an individual to progress at about the same pace as they would in boots on hard ground but with much greater effort. Speed will vary with the depth and consistency of the snow.

3.3.4 Vehicle Mobility. The current CESE inventory available to Seabees consists mainly of standard wheeled vehicles. These vehicles are not specifically designed or equipped for extreme cold weather or deep snow operations. Ice is also prevalent in the extreme cold. Like snow, it too enhances/limits vehicular mobility, depending on vehicle preparation (i.e., chains), and driver training. Before ice is crossed, take a load test to determine its load-bearing capacity.

a. Tracked Equipment. These vehicles benefit from their tracks by allowing some flotation over snow. This is a distinct advantage that tracked vehicles have over wheeler vehicles. Remember: Tracked equipment such as dozers and tracked loaders were not designed as marginal terrain vehicles for the arctic/cold environment and therefore have limitations. Capabilities and limitations are described below.

b. Moving Tracked Equipments. Wet snow will accumulate and pack-in underneath the tracks. Fouling of the suspension system can occur by snowpacking of the idler wheels and sprockets. Adjustments of track tension are critical during periods of extreme cold. Tracks adjusted tight in a warm shelter will contract and break when subjected to temperatures of -40°F and below. Tracks may freeze to the ground when the vehicle is parked outside in extremely cold weather. If necessary, use available tools to remove ice and snow from extremities of track blocks before moving the vehicle. To get tracks free, rock vehicle back and forth several times to avoid possible damage to track blocks. If possible, avoid parking the vehicles on low ground. Use dunnage whenever possible to form an insulating barrier between the tracks and frozen ground.

3.4 ORDNANCE. Cold weather has an adverse effect on ordnance. Great care is needed when handling cold weapons and ammunition because metal becomes very cold and bare skin may freeze to it on contact. Mittens and gloves are clumsy and there will be a temptation to remove these to make firing, clearing stoppages, etc., easier. Care must also be taken not to put the bare skin of the cheek against metal when adopting a firing position.

3.4.1 Snow and Ice. Blowing snow tends to get into everything and will cause the majority of breakages and malfunctions in small arms. Care must be taken that snow and ice do not get into the sights, barrels, magazines, or ammunition especially when moving through ice-covered woods in deep snow under combat conditions. Muzzle caps should be used when available but should be removed prior to firing. Snow and ice contaminate lubricants. To protect weapons, gun covers should be used. Charges and propellants must remain covered until used. Preventive maintenance must be constantly performed.

3.4.2 Visibility. Longer periods of darkness, snow, rain, clouds, and ice fog greatly limit visibility. Ice fog, caused when water vapor from a muzzle blast crystallizes (usually around - 30°F or lower), tends to hang over weapons and follow the path of the rounds. If the air is still, the ice fog will hover in one place and remain for some time, hindering second round engagement. Even one-round engagements will require displacement as ice fog will serve as a target acquisition aid for enemy gunners. A visibility problem can be encountered when a weapon with excessive muzzle blast is fired in temperatures below -30°F. As the round leaves the weapon, the water vapor in the air is crystallized, creating ice particles that procure ice fog and follow the path of the projectile obstructing the gunner's vision along his line of fire. When faced with this problem, fire at a slower rate and relocate to supplementary firing positions.

3.4.3 Magnetic Phenomena. Magnetic instructions will be greatly affected by increasing declination changes and by the aurora borealis. Special care must be taken when approaching and operating in the North Pole.

3.4.4 Condensation. Condensation forms on all metal surfaces when they are moved from the cold into the heat. This is called sweating After a weapon has been fired, the heat generated can cause condensation to form and freeze into ice. If a weapon is taken inside and then out into the cold again, condensation freezes into ice, adversely affecting performance. It is best to leave weapons outside when freezing temperatures exist. Weapons should be readily accessible but sheltered from ice and snow. Weapons may be taken inside for cleaning. Sweating will continue for approximately 1 hour after bringing the weapon into a warm shelter. Wait until sweating has stopped before cleaning weapons. If taken inside a warm shelter, weapons should be kept near the floor to minimize the condensation. Attempting to maintain constant temperatures of all ordnance is advised.

3.4.5 Maintenance Breakage, and Malfunction of Weapons. Weapons will function under extreme cold, causing metal and plastic to become much more brittle than normal. Breakage generally occurs early in firing while the metal is warming and rapid and unequal expansion of parts is occurring. Allowing weapons to warm up by firing at a slow rate initially will eliminate many problems. Condensation, snow, or ice in the weapon will also cause malfunction and stoppages. Never lay a weapon directly in snow or ice. The cold will triple the backblast effect of all recoilless type weapons. BACKBLAST AREAS WILL BE SIGNIFICANTLY INCREASED.

3.4.6. Lubricants. Normal temperature zone lubricants thicken in cold weather. Stoppages or sluggish action of the weapon will necessitate striping and thoroughly cleaning with cleaner, lubricant, or the preservative (CLP). CLP was introduced in 1981 and replaces bore cleaner, LSA, LAW, PL-S, and PL-M. The camming surface of the bolt should be lightly oiled with LAW. The rest of the weapon can be left dry.

3.4.7 Ammunition. Cold weather can materially affect the performance of ammunition. The ammunition should be kept at the same temperature as the weapon and should be carried in bandoleers. Additional ammunition should be carried in the pockets of the outer parka. Clips and magazines must be cleaned of all oil and preservatives and checked frequently. All ice and condensation must be removed.

a. Burning Rate. The burning rate of various types of propellent charges is affected by severe cold, weapons zeroed under temperate conditions will fire low when firing ammunition that has been exposed to the frigid temperatures. This is a result of the propellent charge burning slower due to the cold.

b. Large Caliber Ammunition. Moisture and humidity make life miserable for the mortar crews. Icing can cause misfires and damage to the pieces and injury to the crew. While the cold-dry conditions do not drastically alter the terminal effects of direct fire weapons, they dictate some additional training and planning for indirect systems, as range and burst effects drop off dramatically.

c. Bullet Penetration Table. The snow surface has a smothering effect on all types of fire. However, hard frozen bare ground or ice, when not covered with snow, greatly increases the number of ricochets and the fragmentation effects. The resistance or protection offered by snow, ice, or frozen ground against enemy fire varies greatly. The minimum thickness for protection from small arms fire and shell fragments is shown below in Figure 3-2, Bullet Penetration Table.

SNOW DENSITY (lb/sq ft)	PROJECTILES	MUZZLE VELOCITY	PENETRATION (feet)	REQUIRED MINIMUM THICKNESS
18.0-25.0	Grenade frag (HE)	2.0		3.0
11.2-13.0	5.56 mm	3,250	3.8	4.4
17.4-23.7	5.56 mm	3,250	2.3	2.6
11.2-13.1	7.62 mm	2,750	13.0	15.0
17.4-23.7	7.62 mm	2,750	5.2	6.0
25.5-28.7	7.62 mm	2,750	5.0	5.8
19.9-24.9	12.7 mm	2,910	6.4	7.4
	14.5 mm		6.0	8.0
28.1-31.2	70 mm HEAT	900	14.0	17.5
31.2-34.9	70 mm HEAT	900	8.7-10.0	13.0
27.5-34.9	90 mm HEAT	700	9.5-11.2	14.5

Figure 3-2, Bullet Penetration Table

d. Grenades. Fragmentation grenades suffer a reduced effective casualty radius (ECR) due to energy dissipation in the snow and the slower burning rate of powder. The ECR of fragmentation grenades over frozen surfaces without snow cover is excellent, as was demonstrated in Korea. Smoke grenades are useless unless placed in a container to prevent them from sinking below the snow cover. (Note: An arctic smoke grenade has been developed with numerous flanges that open from the canister on detonation.) Hand gear must be dry when handling grenades to prevent freezing to the grenade.

e. LAAW. The penetration of the rounds will remain the same as in a temperate environment. However, some reduced range may occur due to the slower burning rate of powder in cold weather. Hangfires may be more numerous in cold weather and the backblast area will triple. Wearing the arctic mitten set may present some problems, however some type of hand protection must be worn. Face and eye protection for the gunners is **MANDATORY.**

f. 60mm/81mm Mortar. Mortar ammunition, due to incomplete burning of propellants, can expect a decrease in achieved range versus the plotted range. This decrease may be as much as 10 percent at -10°F. and 20 percent at -40°F. The ammunition and tube must be kept dry. Open only rounds required for the current fire mission and use the tube cover provided. Tube must be swabbed after every tenth round or after every fire-for-effect. When firing into snow, attempt to obtain an airburst. Snow decreases the effects of WP and fragmentation rounds dramatically. When firing at low temperatures, misfire wait times should be doubled due to the possibility of delayed ignition. The new 60mm and 81mm mortars employ a trigger mechanism, which allows the firing pin to be recocked and fired. Consequently, with these mortars misfire times do not have to be increased. Even though the M-16 plotting board may become warped at temperatures below -40°F, fire direction procedures may still be performed.

g. Mines. Mine warfare in cold weather takes special precaution and constant attention to be successful. As little as 6 inches of snow can virtually negate the effects of M-18A1 Claymore antipersonnel and anti-armor mines. Digging them in becomes impossible on frozen surfaces. Mines placed out in light snow in the evening may be covered with another 8-10 inches by morning, further negating their effectiveness. Marking of minefields is crucial in case they must be recovered. Marking of minefields will also affect the decision of whether they should be booby-trapped and how. When placing mines in deep snow, branches or crossed sticks must be placed under the mines, giving them a "snowshoe" effect, or they may be simply pushed deeper into the snow by the passage of the enemy rather than detonated. Care must be taken when placing mines in the changing temperatures, for upon recovery, the mines may be frozen to the ground. The Family Of Scatterable Mines (FASCAM) is severely inhibited by snow. In addition to the decreased blast effects, the self-orientation characteristic of the mines are upset because it is hard for them to determine "up" in the soft snow. Further, the trip wires may only be ejected 1-3 inches from the mines, thereby negating that capability.

h. Demolitions. Trinitrotoluene (TNT) is a preferred over the plastic explosive C-4 because the initiating device couplers are built into the blocks. C-4 becomes very hard, making the insertion of an initiating device impossible unless done indoors. At temperatures of -40°F and colder, C-4 has been known to shatter from the explosion of its initiating device rather than detonate. Military dynamite or TNT blocks are excellent for use in the cold regions for things like hasty fighting or firing positions. In cold weather, shaped charges do not penetrate as far as indicated in FM 5-25, Explosives and Demolitions. Detonation cord becomes stiff in the cold and will not tie as easily as in temperate zones. It will also break easily. Time fuse tends to maintain its curl in the cold and will break if uncurling is attempted except inside warm shelters. Static electricity, which easily develops as a result of the cold dry conditions, leads one to prefer non-electrical detonation techniques rather than electrical ones.

CHAPTER 4. PREVENTION AND TREATMENT OF COLD WEATHER INJURIES

4.1 BACKGROUND. History has shown that in combat operations, cold weather produces more casualties than actual combat. Cold weather is an unrelenting enemy that has presented a continuing problem to military forces from earliest recorded history. In the beginning of the fourth century B.C., Xenophon's army was decimated by mountains of Asia minor. George Washington's army lost unknown numbers of men to cold weather injuries during the Revolutionary War. Napoleon, in his campaigns, lost 250,000 men to cold weather injuries and deaths. Soviet estimates of German military losses during World War II from cold alone were three million men. In a single two-month period, 100,000 German Army cold injuries resulted in 15,000 amputations. Cold injuries accounted for 10 percent of U.S. Forces' casualties in the Korean War; almost all of these casualties were incurred within a three month period of a three year war. In the 1980's, British forces sustained significant casualties due to nonfreezing cold injuries in the Falkland Islands War. More than 2,000 years of military experience have failed to solve the problems of fighting in cold weather.

4.2 FACTORS CONTRIBUTING TO COLD WEATHER INJURIES

4.2.1 Physical Activity: Too Little or Too Much. Normal physical activity increases blood circulation; generates body heat, and warms body parts distant from the body's core, i.e., the head, hands; and cools the extremities both varying degrees of impairment in blood circulation. Thus a Seabee is susceptible to frostbite or other cold injury. Heavy physical activity increases heat loss through perspiration, which is trapped in the clothing and reduces its insulating capacities. Physical activity to the point of exhaustion causes apathy and loss of the will to take precautions against cold injury. Seabees may become so tired that respite is their only consideration. A Seabee may lapse into a state of hypothermia and die while sleeping. A healthy Seabee will always wake up before reaching a serious state of hypothermia. Commanders should make a conscious effort to provide his Seabees with moderate activity and adequate rest.

4.2.2 Inadequate Nutrition. The primary source of body heat is food consumed, not external heat sources such as a fire or a heater. External heat sources only help the body conserve heat in the cold. In the cold, about 75 percent of caloric intake is used to create body heat. Therefore, a Seabee must increase his caloric intake significantly. See paragraph 5.1, Caloric Intake, and paragraph 5.2, Rations.

4.2.3 Dehydration. In the medical sense, dehydration is a condition resulting from an excessive loss of body water, either from too little intake or too much output, or a combination of both. Cold weather injuries will always be more severe in a dehydrated individual. The danger of dehydration is almost as great in cold environments as it is in hot dry regions. Even at rest, Seabees must drink a minimum of 4 quarts of liquid per day.

4.2.4 Poorly Fitted Clothing and Footwear. Clothing and footwear must be fitted so they do not bind and restrict blood circulation. Unrestricted circulation is absolutely essential in prevention of cold injuries. Clothing should also be loose enough to permit air circulation, thus increasing insulation efficiency. A major problem exists in the fitting of boots, which is often not done well. Do not fit boots to a Seabee at rest and then expect him to carry a heavy load without his feet changing size in both width and length. When this happens, circulation to his toes is impaired and frostbite is more likely to occur. The key is to fit boots with the Seabee wearing his socks and loaded pack in place.

4.2.5 Smoking. Authorities on cold weather medicine all agree that smokers are clearly at risk to cold weather injury because nicotine significantly diminishes blood flow to the extremities. Medical history has proven that cold injuries will occur more frequently and the injuries will be significantly more severe among smokers than among non-smokers. Since nicotine is the offending substance, users of other forms of tobacco, such as snuff and chewing tobacco, share the same risks.

4.3 PREVENTIVE MEASURES

4.3.1 Leadership. The key to survival is preventing cold weather injuries. Prevention is achieved through training and leadership. Success or failure is a direct reflection on the quality of the commander's leadership and his ability to deal with cold weather injuries. Commanders must be dedicated. Continuous, aggressive, and positive leadership and supervision, especially at the small unit level, are mandatory to prevent cold weather injury. Leaders must know the capabilities of their Seabees and not over-extend them.

4.3.2 The Buddy System. The buddy system must be maintained. Two Seabees are assigned to each other, never separated, and responsible for everything the other does or fails to do, in order to prevent becoming a cold weather casualty. Buddies must often check each other for signs of cold weather injuries.

4.3.3 Training and Discipline. The best trained and disciplined individuals will be able to prevent cold weather injuries. This self-discipline creates units that will be able to recognize the potential onset of cold weather injuries and treat those injuries before they become disabling.

4.3.4 Physical Fitness. Seabees must maintain a higher level of physical fitness in the cold than in any other environment.

4.3.5 Nutrition. An adequate diet is absolutely essential to survival in cold weather operations. Commanders must ensure that mess officers are aware of the requirement for additional caloric consumption so that they plan for the proper amount of food. The additional food will have to be budgeted for, and its source of supply and resupply will have to be logistically feasible.

4.3.6 Activity. Personnel should be in one of two modes, active or at rest in-shelter.

a. Active. Personnel should be on the march; wiggling toes and fingers; walking, jumping, or running in place; or working. The large muscles must be exercised for the body to generate heat.

b. In-Shelter. If a unit is going to be stationary for 30 minutes or more, have the Seabees erect shelter. They may not be in it long, but the activity of setting up and taking down the shelter will keep them from becoming inactive and cold.

4.4 PERSONAL HYGIENE

4.4.1 Importance of Cleanliness. A practical view of facilities, capabilities, and the environment itself quickly reveals the need for modification of normal hygienic habits. Things once taken for granted now become unobtainable luxuries and extremely important to health and well-being. In the cold Seabees will become resistant to all but the most essential tasks. Commanders must exert strong, aggressive, and positive leadership to ensure they maintain the same standard of personal hygiene as in any other environment. If commanders allow their personal hygiene to deteriorate, they will sense that normal standards are more relaxed in this environment, and the deterioration of discipline will soon follow.

4.4.2 Mouth Care. Teeth must be brushed and flossed at least once daily.

4.4.3 Shaving. Shaving with a blade, when combined with wind and cold, may cause severe skin irritation. Skin creams containing alcohol should not be used because alcohol dries the skin. When possible, shave in the tent before sleeping so that the face may recover its natural oils before exposure to the wind and cold.

4.4.4 Bathing. In a cold weather combat scenario, a full body bath will rarely be possible. However, the commander should provide general bathing facilities when the situation permits. There is much disagreement as to how frequent body baths should be taken in the cold. As a minimum, the following should be done: wash armpits, crotch, and anal area daily, if possible, but no less than twice weekly.

4.4.5 Foot Care. Foot care is a daily practice. The vapor barrier boots have eliminated most frostbite problems. However, these boots keep the feet in a constant damp condition. The feet should be taken out of the vapor barrier boot, dried, massaged, put into dry socks, and aired at least three times daily. Foot powder must be rubbed on and left for a short time and then brushed off. This procedure will prevent trench/immersion foot and fungus infections. Seabees should not sleep in their sleeping bags with their vapor barrier boots on. When in the tent, the boot socks should be worn, allowing the feet to dry and circulation to be restored. If the situation precludes daily washing, feet should be at least cleaned by other means and dried.

4.4.6 Clothing. Clothing will stay unusually clean in the cold. However, commanders must devise methods to provide clean changes of clothing for their personnel when necessary.

4.5 GROUP HYGIENE

4.5.1 Trash. Tight control must be maintained over garbage and its collection. A useful technique is to affix a garbage bag to a central location within the tent, such as the center pole or snow hole, so that it is accessible and visible. All trash should be either moved out with a unit or consolidated and moved according to unit standard operating procedures (SOP).

4.5.2 Human Waste

a. Urinals. A specific object (tree, rock, stick, or a hole) must be designated as a urinal. This designated location will prevent the growth of contaminated snow throughout the camp area/bivouac. It will also enable the tent group leader to periodically check the color of the urine in the snow for signs of dehydration (i.e., darker).

b. Heads. Heads must be accessible so that Seabees will use them. They should be comfortable and provide shelter from the cold weather. Depending on the location of tents, two or more tents can share the same head provided that it is close to all of the served tents. Units may be required to use plastic lined heads that will improve sanitation and enable the retrograde of wastes.

4.6 COLD WEATHER INJURIES

4.6.1 Categories. Cold injuries are referred to by a number of terms, such as chilblains, frostnip, frostbite, dehydration, trench foot, immersion foot, and hypothermia. Most military cold casualties may be described under the categories of immersion foot, frostbite, and hypothermia. Severity of injury may vary greatly within these three categories.

4.6.2 Dehydration. The main medical problem confronting the commander and the logistician in cold weather operations is dehydration. The more strenuous the work, the greater the loss of water. When personnel are bundled in layers of clothing in the cold, it is hard to realize they are sweating. Perspiration is quickly absorbed by the heavy clothing or evaporates in the air. A great deal of water is lost during respiration in the cold.

a. Causes. Perspiration and overheating resulting from increased activity or excess clothing; respiratory evaporation that removes remarkable amounts of fluids from the body in the dry arctic environment; and dehydrated meals when eaten dry; cause dehydration. The inadequacy of water supply consistently makes hydration a problem. For example, when units rely on melting snow as their sole water source, they often do not stop long enough to melt snow. Cold weather operations or training demands that personnel consume at least 4 quarts of liquid daily. This creates a logistic problem of carrying enough water, keeping it from freezing, and/or carrying fuel/stoves to melt snow.

b. Symptoms. Dark urine is the most obvious symptom observed by squad/crew leaders who monitor the color of "snow flowers." Fatigue, irritability, constipation, and headache are other positive symptoms. Thirst is an unreliable symptom because the body inhibits the thirst mechanism so Seabees do not feel thirsty even though they are dehydrated.

c. Prevention and Treatment. Forced drinking is necessary for proper hydration. Every effort should be made to provide hot drinks for fluid replacement. Leaders must ensure proper preparation of meals, particularly dehydrated meals. Leaders should ensure proper wearing of clothes with adequate ventilation to avoid overheating and dehydration. Severe cases must be evacuated.

4.6.3 Hypothermia. Hypothermia is general body cooling with a body core temperature of 95°F or less. The medical profession has learned a great deal about hypothermia within the past few years. Experts have discovered that people can survive long terms of hypothermia even in the absence of respiration. Experts also feel that a person can be without heartbeat for more than 3 hours and still be resuscitated. New discoveries on hypothermia may tremendously affect military units sent to cold weather regions of the world.

a. Causes. In the military, the important causes are poor physical condition, dehydration, inadequate nutrition, exhaustion, and loss of heat due to wind, rain, snow, and water. It must be emphasized that hypothermia is not necessarily a danger in severe cold only. Most deaths from hypothermia occur in air temperatures between 30°F and 50°F. The effects of water immersion are extremely important. The human body cools 26 times faster in water than in air of the same temperature. Wet clothing loses up to 90% of its potential insulation value. A person immersed in water of 50°F or below will rapidly go into a state of hypothermia. Hemorrhage due to hostile fire or accident will dramatically increase the danger of hypothermia.

b. Symptoms. In the cold where body heat is being lost faster than the body's "central furnace" can replace it, the body automatically acts to protect its vital organs. Only a slight drop in body core temperature will trigger a reduction of blood circulation to the extremities as the blood is drawn back into the deep vessels of the torso. A reflex action causes shivering, which increases muscular activity in an effort to generate more heat. This is usually the first visible sign of approaching hypothermia. At this point, the core temperature is down a bit, but is probably no lower than 95°F. Shivering is an important warning sign! At approximately 95°F, the muscles used in speech are affected and the person may sound as if he has a mouth full of mush. This may be followed by diminished shivering, muscular rigidity, mental confusion, and decreased visual acuity or impaired vision. As core temperature approaches 88°F, the person will go into a semi-coma, progressing to a coma state. Below this level, the body's metabolic needs are so diminished that life can still continue, even though there may be little or no outward signs of life. A person may remain in this "metabolic icebox" state for 12 to 24 hours, or maybe longer. Whether or not cardiovascular death occurs will depend upon rescue and effective resuscitative procedures.

c. Prevention

(1) Maintain a moderate level of activity, emphasizing exercise of hands and feet.

(2) Maintain adequate nutrition and fluid intake.

(3) Wear clothing appropriate for weather and work conditions. Whenever possible, wear mittens and footwear over an extended period. Cover the ears and as much of the face as possible.

(4) Use the buddy system. Buddies must constantly check each other for signs of hypothermia.

d. Treatment. Early recognition and immediately stabilizing the victim by preventing further heat loss are the key factors of treatment. If a Seabee can be stabilized while he is still conscious and coherent, there is an excellent chance of returning him to normal activities within a few hours.

(1) Check body core temperature. Take a rectal temperature using a low temperature thermometer to determine body core temperature and to establish a starting point. Check core temperature periodically. If you have not succeeded in restoring normal temperature within a few hours, the victim will require evacuation. If the core temperature continues to drop despite stabilizing efforts, the victim must be treated as a medical emergency and evacuation arranged as quickly as possible.

(2) Dry the victim. Remove wet clothing and insulate the victim from further heat loss. Place in a sleeping bag with another warm and dry individual.

(3) Replace fluids. Remember that as people cool, they lose fluids and dehydrate. Start replacing these fluids by giving the victim warm liquids to drink if the victim is able to drink. Add some sugar for energy.

(4) Evacuate the unconscious or comatose victim. The unconscious or comatose patient is a problem that cannot be handled in the field. When an individual reaches this level of hypothermia, significant changes take place in the body's electrolyte balance, pH (acidity/alkalinity) balance, and enzyme system. These personnel must be closely controlled during the rewarming process or they will almost certainly die from cardiac failure or other complications. A fairly sophisticated medical facility is required to manage resuscitation of these personnel. The comatose hypothermic individual must be treated as a very fragile patient and handled with great care. It is best not to attempt any resuscitative procedures. Do not allow anyone to pound on the chest or attempt external cardiac massage. This could destroy any life that may remain. Remove wet clothing, thoroughly insulate the patient, and arrange medical evacuation as quickly as possible.

(5) The question of how to determine if a person is truly dead is very difficult to answer. The first thing to be done is using a low-reading rectal thermometer to read body core temperature. (This is the only way to get a correct reading. All medical personnel operating in the cold should carry this thermometer (NSN is 6515-00-139-4593.) If the core temperature is 30°F and the temperature of the environment is 30°F, then the person is obviously dead. However, where the body's core temperature is significantly above that of the environment, the person may still be alive. Every effort must be made to resuscitate the hypothermia victim. The body must be rewarmed before being pronounced dead.

4.6.4 Frostbite. Frostbite is a freezing injury caused by the formation of ice crystals in the tissues. The body parts that most often are injured are body parts that protrude, e.g., hands, feet, the nose, ears, and anything else exposed for any length of time. Frostbite varies in severity. Severity is directly determined by the length of exposure and the degree of temperature responsible for the injury. The first warning sign of frostbite is usually an uncomfortable sensation of coldness followed by numbness. There may be tingling, stinging, or aching. Progression from superficial to deep frostbite can be quite rapid, depending on air temperature, wind chill, and effectiveness of protective clothing. Seabees with superficial frostbite can usually continue their normal duties without significant interruption. Seabees suffering deep frostbite will always require evacuation and prolonged treatment.

a. Superficial Frostbite. Superficial frostbite is tissue damage involving only the skin and no more than the immediate tissue beneath it. The skin first turns red, and as freezing occurs, becomes pale or waxy white. The skin is resilient and moves freely over joints and facial bones. Superficial frostbite is fairly common and serves as a warning. If thawing is done at this time and the frostbitten parts are protected from refreezing, there are usually no serious consequences and no need to remove the Seabee from a duty status. If no action is taken and the freezing process continues, deep frostbite will probably result.

b. Deep Frostbite. Deep frostbite is tissue damage involving not only the skin and subcutaneous tissue, but deeper layers extending to the bone. The skin usually becomes translucent, takes on a pallid, yellowish color, is solid to the touch, and DOES NOT move freely over joints or bones. The affected body part loses any sensation of pain. This is a serious injury and will require expert medical attention. IT IS IMPERATIVE THAT THE FIELD COMMANDER UNDERSTAND THAT IN CASES OF DEEP FROSTBITE OF THE FEET, THE CASUALTY BECOMES A STRETCHER CASE IMMEDIATELY UPON THAWING OF THE FROZEN PARTS. This is true no matter whether thawing is deliberate or spontaneous. A casualty can continue to walk on frozen feet, but he cannot walk once the frozen parts are thawed. Furthermore, any frozen body part that is thawed and then refrozen will be lost at the level of the second freezing. In other words, toes that are frozen, thawed, and then refrozen will invariably require amputation.

c. Prevention and Treatment. Preventive measures are essentially the same as for hypothermia, but with stronger emphasis on early recognition of symptoms, training for all levels of the unit, and STRICT ADHERENCE to the buddy system. All cases or suspected cases should be treated with the 15 minute rule. Place the affected body part in a warm place (under an arm, in the groin, pocket, etc.). If the affected part is a foot, then place it against the warm part of a buddy. Leave in this position for 15 minutes. After 15 minutes check for capillary refill, movement, feeling, and normal function. If the affected part is not normal, treat as deep frostbite and conduct an emergency MEDEVAC. Note: Once warming has begun, if the casualty does not indicate recovery at the end of the 15 minutes, deep frostbite must be assumed and the warmth continually applied to the affected body part throughout the entire MEDEVAC chain.

d. Medical Treatment of Frostbite. The following is provided for the commander's information but applies to medical staffs only:

(1) Superficial Frostbite. Minor cases of superficial frostbite require little treatment. In most cases, no treatment other than rewarming is necessary. If a shelter is not available for rewarming, the frostbitten parts can be rewarmed by body heat. Nose, ears, cheeks, and forehead can be rewarmed by holding a warm hand or mitten over the areas. Hands can be placed in the armpits, against the abdomen, or between the thighs. Feet and toes can be rewarmed against the abdomen of a companion. In some cases, small blisters will occur in the outer skin layer in about 24 hours. These should not be broken. They will usually dry up, become hard, and heal without treatment. Large blisters with significant swelling of the area indicate that the original frostbite may have been more severe than superficial. Such cases should be referred to a physician for evaluation.

(2) Deep Frostbite. This is always a serious injury, but it is not a life-threatening condition. The first priority of treatment is treating immediate life-threatening or severe trauma conditions, such as hemorrhage, shock, wounds, fractures, etc. Before considering field treatment of deep frostbite cases, a comprehensive evaluation of the unit's tactical situation, in addition to the patient's needs, is necessary. Seabees with frozen extremities are able to walk. Once thawing has occurred, these Seabees become medically-dependent litter cases. If there is a chance that thawed body parts may be refrozen at any time in the process of evacuation, the frozen injury should not be thawed in the field. If a decision is made to thaw the injury, this is best done in a carefully controlled water bath at a temperature of 100°F to 105°F. Immerse the frozen parts in the water only until the tips of the tissues flush. Once thawing has occurred, either naturally or as a medical procedure, the injured area must be protected from further trauma or freezing. The injured area is best left open, but a light dressing may be applied for protection. Ointments or creams should not be used. Thawed injuries quickly become quite painful. The casualty should be given medication to relieve pain.

e. Outdated Methods. Some of the "old time" methods of thawing frozen extremities or other tissues have proven to be extremely damaging. A person suffering from deep frostbite of the hands could put his hands into water near the boiling point and feel no pain. Countless fingers, toes, and feet have been needlessly lost through ignorance of a few simple rules. The following cautions must be followed:

(1) Do not rub frozen tissues with snow. This damages tissues and causes a more severe injury.

(2) Do not rub or manipulate a still frozen extremity or another frozen area. This breaks blood vessels, which leads to swelling, internal pressure, and impaired circulation with an end result of possible amputation.

(3) Do not use excessive heat to thaw extremities. Devastating injuries have been caused by holding extremities over a fire or a stove, in front of vehicle exhaust, jet engine exhaust, or on a vehicle radiator.

4.6.5 Shock. Shock will usually develop more rapidly and progress more deeply in the cold than it will in normal temperatures. Shock is caused by the reduction of effective circulating blood volume. It can also be caused by severe injuries, loss of blood, pain, and many other factors. The normal reaction of the body to hypothermia is very similar in its reaction to shock. Therefore, the symptoms are very similar. This is because of the physical and psychological stress that the Seabee is experiencing as a result of the cold. (Casualties must be treated quicker in the cold than in other climates if they are to survive.) To treat shock:

a. When possible, treat casualties in a heated shelter.

b. Slightly elevate the legs and keep the casualty comfortable.

4.6.6 Snow Blindness. Snow blindness is sunburn of the eye. It is caused from excessive exposure of the surface of the eye to ultraviolet rays. Most snow blindness occurs on overcast days, because one is unaware of the ultraviolet rays and allows his eyes to become overexposed. In bright sunlight, an individual will squint to protect his eyes.

a. **Symptoms.** Initially there will be an irritating, gritty feeling in the eyes. Severe pain in and over the eyes and excessive tearing follow. The eyes become sensitive to light. Finally, the vision is blurred.

b. **Prevention.** Prevention of snow blindness is simply to wear eye protection such as sunglasses, especially on overcast days.

c. **Treatment.** Apply light-proof bandage, from individual's first aid kit, over the victims eyes. Evacuate if possible. If unable to evacuate, place the victim in a shelter for 12 hours or until symptoms subside. Keep the light-proof bandage on for the entire 12 hours.

4.6.7 Immersion Foot/Trench Foot. Immersion foot is a non-freezing cold injury. It starts with tingling pain, followed by inflammation, discoloration, swelling, ulcers, and finally, a stabbing pain. It is caused by wet feet and prolonged exposure to cold of "warmer" temperatures that freeze tissues. This does not mean that it cannot occur when temperatures are below freezing. A Seabee may suffer immersion foot in sub-freezing temperatures if he is wearing vapor-barrier (VB) boots and his feet have become wet from perspiration or water running into his boots. The VB boot has prevented uncounted cases of frostbite. However, because VB boots keep the feet constantly wet, they make them susceptible to immersion foot. This injury is insidious and is most likely to cause the largest number of casualties. Immersion foot is normally associated with cold rain, mud, and slush. In warmer climates, immersion is called trench foot. The injury is the same.

a. Symptoms. Pruned, white skin develops. Blisters or blood blisters will appear later. A very noticeable smell or stink will be evident, especially in an enclosed shelter when the feet are removed from the boots.

b. Prevention. Because the early stages are only mildly uncomfortable, Seabees must be constantly alert to conditions that cause immersion foot. Preventing immersion foot is an exercise in avoiding the circumstances that produce it. If it is possible for troops to dry their feet at intervals during a 24-hour period, immersion foot will be negligible. If no other means are available, the wet socks may be dried by placing them under the clothing next to the body. Seabees should carry at least three pairs of socks for frequent changing.

c. Treatment. The pain immersion foot produces does not respond to normal pain medications. It hurts and nothing stops it. Degree of injury may vary from minimal to severe. In minimal and mild cases, tissue and nerve damage is reversible, and recovery time may be from only days to weeks. In severe cases, tissue and nerve damage will be irreversible, and convalescence will be weeks to months. The most severe cases will almost certainly result in some degree of permanent disability. An immersion foot injury that does not respond to drying and routine foot care within 24 hours must be referred to the nearest medical treatment facility for further evaluation and care.

4.6.8 Sunburn and Wind Chapping. Seabees can get sunburned even though the temperature of the air is below freezing. On snow, ice, and water, the sun's rays are reflected with more intensity from all angles. They attack where the skin is sensitive around the lips, nostrils, and eyelids. Seabees get sunburned especially at higher altitudes in the spring as the days get longer and the sun reflects up off the snow, increasing its intensity. Sunscreen gives effective protection. Soap or shaving lotions with a high alcoholic content should not be used since they remove natural oils that protect the skin from the sun. If the skin blisters, apply a disinfectant and cover. This will prevent infection. Chapping due to cold and wind is rarely serious. Any greasy substance can be used for treatment except those that have a water base, which can freeze on the skin. Chapstick should be carried by all personnel. Personnel who become sunburned must drink plenty of liquids to promote healing and replace fluid loss from damaged skin.

4.6.9 Carbon Monoxide Poisoning. Carbon monoxide is a deadly gas, even in low concentrations, and is particularly dangerous because it is odorless. It is not the same as "fumes." Carbon monoxide can be present when there are no fumes, and fumes can be strong when there is no carbon monoxide. The most common sources of carbon monoxide are engine exhausts and coal stoves. Although tests reveal there is less danger of carbon monoxide poisoning from gasoline stoves or lamps, this cannot be taken for granted. Ventilation must constantly be checked. Carbon monoxide collects around parked vehicles that have their engines running. No individual should be allowed to sleep in a vehicle. The temptation to start up the vehicle for warmth is too great. Carbon monoxide is produced by any combustion that produces carbon or uses carbon in combustion.

a. Symptoms. The following symptoms may be present: headache, dizziness, impaired vision, mental confusion, yawning, weariness, nausea, a ringing in the ears, and bright pink lips and eyelids. Later on, the heart may begin to flutter or throb. Normally, the gas will strike without warning and a Seabee may not know anything is wrong until his knees buckle.

b. Treatment. Move the casualty into the fresh air at once. Keep the casualty warm! The casualty should not be exercised since this increases his need for oxygen. If a casualty stops breathing or breathes only in gasps, artificial respiration should be started immediately. Carbon monoxide poisoning is serious, and a casualty who survives it must be kept absolutely quiet and warm for at least 1 day in a well-ventilated place.

4.6.10 Fume Irritation/Tent Eye. This is irritated eyes caused by fumes from stoves, lamps, cigars, or cigarettes in poorly ventilated tents. It is prevented by keeping the stoves and lamps clean and not allowing smoking inside the tents. Eye drops may be used for treatment.

4.6.11 Constipation. Constipation is a general blockage of the bowel. This is a significant problem in cold weather. Seabees are already subjected to a great deal of stress from the environment. Constipation can make them either ineffective or casualties that must be evacuated. Seabees can cause constipation by self-induced, conscious efforts to avoid normal bowel movement because of the cold. Leaders must ensure that this attitude does not prevail and that Seabees are having a daily bowel movement. Dehydration also causes constipation. Certain dehydrated meals, such as long-range rations or portions of MRE's, can be eaten without hydrating them properly. When this is done, the meal has insufficient liquid in it to enable complete digestion. As a result, constipation occurs.

a. Symptoms. The victim has cramps, stomach ache, headache, and is lethargic. He is unable to perform a normal bowel movement. Stools are small, tight, and dark.

b. **Treatment.** Force in more water to aid in digestion. In moderate cases, administer a standard laxative or warm water enema. Severe cases will require evacuation to an aid station where removal of stools by hand will be performed.

4.6.12 Blisters. Blisters are a nuisance in cold weather operations. However, they can be serious enough to require medical evacuation. VB boots, the bindings from snowshoes and the heavy loads carried and towed will make blisters a greater problem in the cold environment. VB boots must fit properly and ample moleskin should be on hand. Nonwater based lubricants can also be used to prevent blisters. (Water-based lubricants can freeze on the skin and cause frostbite.)

4.6.13 Burns. The potential for burns is a problem in cold weather because of the requirement to heat shelters with stoves. Fire safety and tent evacuation procedures must be followed. (See chapter 11, Bivouac Routine.)

4.6.14 Altitude Sickness. Some Seabees are affected profoundly by altitude sickness while others are hardly affected at all. This is not a cold weather peculiar problem. However, commanders must ensure that their Seabees can recognize and deal with altitude sickness. Altitude sickness rarely occurs below 8,000 feet. The degree of a Seabee's physical fitness appears to have no bearing on how he will react to the altitude.

a. **Symptoms.** The effects of altitude sickness can range from minor headaches and nausea to a pneumonia-like congestion of the lungs that can cause death.

b. **Prevention.** If time allows, a gradual altitude acclimatization period will normally take care of most problems. Often the affected Seabee will display symptoms of dehydration. Altitude sickness may be more a symptom of dehydration than anything else. Forced drinking is a good preventive measure if a unit is to operate at altitudes.

c. **Treatment.** Descent is the best and often the only treatment for altitude sickness.

4.6.15 Bronchitis and Pneumonia. The stress placed on the body by the cold and the drying and irritating effect of cold air on the respiratory system places the body's immune system in a more overtaxed state than in other environments. This will further increase the chances of contracting respiratory infections. Increasing moisture in the air in sleeping areas and mess tents will help prevent colds and bronchitis.

4.7 MEDICAL EVACUATION

4.7.1 General. The most significant difference between handling the wounded in cold weather as opposed to other climates is that eventually almost all wounded will be evacuated in cold weather. This includes wounded that would have been functional and required little or no treatment in other climates. Shock, damage to blood vessels and arteries, and the damage to protective clothing will require that almost all wounded Seabees be evacuated. Wounds bleed easily because the low temperature keeps the blood from clotting and the increased bleeding increases the likelihood of shock. Wounds freeze quickly with the body losing heat in the area around the injury because shock restricts circulation. Shock usually develops more rapidly and advances more deeply in the cold than it will in normal temperatures. Early first aid and immediate, well-coordinated MEDEVAC procedures become even more important at lower temperatures. Unit training should include MEDEVAC, buddy-aid, and basic first aid training.

4.7.2 Buddy-Aid Training. Buddy aid is provided to augment the efforts of hospital corpsmen. (Corpsmen will very likely be overwhelmed on the cold weather battlefield.) Casualties will need immediate attention if they are expected to survive even minor wounds in the cold. Buddy aid should be provided under the direction of the unit leader.

4.7.3 Dedicated Vehicles. Unit commanders must make conscious decisions to dedicate unit support vehicles for MEDEVAC. Drivers must realize that specifically identified vehicles will jettison normal loads and assume the MEDEVAC role. Special equipment may be stored on the designated vehicles. Unit SOP's on vehicle use must be established and constantly and consistently rehearsed in training.

4.7.4 Ambulance Exchange Points. The unit must coordinate closely with the medical element or medical treatment facility on the establishment of a rendezvous point to be used as an ambulance exchange point (AXP). These points should be located as close to the front lines as possible to reduce the distance a victim is moved by litter bearers, or dedicated MEDEVAC vehicles.

4.7.5 Litter Bearer Training. Training must be provided to litter bearers on casualty assessment techniques, basic first aid, and preventing frostbite. All Seabees should be trained to apply basic first aid, i.e., splints, pressure bandages, etc., and to protect the victim from the cold. The victim must be placed in a casualty evacuation bag, if available, or a sleeping bag. The litters should be insulated on the bottom or underneath the sleeping bag with an isopore mat (an egg crate mat is a good alternate). Shock, frostbite, and hypothermia must be primary concerns because of the strict immobility of the victim while he is being handled. The feet must have added protection from frostbite during evacuation. External heat sources (e.g., body warmers) should be provided. Litter bearers should avoid unnecessary handling of the victim and select the easiest route for traveling. Send scouts ahead if possible to break trail. If the route is long and arduous, relay points and warming stations must be set up with medical personnel at the warming stations for emergency treatment of shock, hemorrhage, or conditions that may arise. Evaluate the victim's condition constantly. If he develops increased signs of shock or other symptoms during the evacuation, he may be retained at emergency stations until determined "stable." Normal litter bearer teams must be augmented in arduous terrain. Specific goals should be given to the litter bearer teams. (This job is extremely tiring, both physically and mentally.) Leaders must ensure that the victim and members of the litter bearer team are not separated from their survival gear.

4.7.6 Transportation Methods.

a. Ahkio Litter. The standard ahkio sled can be readily used as a litter. Pad the bottom with sleeping mat and bag. Use assistants to prevent the ahkio from overturning. Lash the victim securely, but not too tightly. Place the victim's head to the rear, slightly elevated, unless the evacuation is down a slope; if down a slope, the head is placed uphill. The ahkio is the preferred litter because it can be manhandled, pulled by a snowmobile, or loaded into a helicopter. It is large enough to accommodate a victim and most of his survival gear. See Appendix B.

b. Hjelper Sled. A hjelper sled can be made using the injured Seabee's skis and poles. While requiring some time to properly construct, the hjelper sled is energy efficient and can be pulled across the snow with less effort than other litters. Care must be taken to place the load away from the front.

c. Litter Travois. A litter travois can be made for use over relatively smooth slopes. Two poles, approximately 3 meters x 8 centimeters, are secured to a standard litter by tying the small ends to the stirrups at the foot of the litter with wire or cord. (A poncho or tent sheet can be used if a litter is not available.) The butt ends extend past the head of the litter approximately 1 to 2 meters. The poles are secured to the stirrups at the head of the litter. The travois is then dragged across the snow by one or more litter bearers. For all litters, tape slings worn diagonally across the bearer's shoulders and secured to the litter can free the hands for balance and aid.

4.7.7. Decision Making. The decision to evacuate a casualty must be made carefully. In a training situation, evacuate all casualties that require attention. In a combat situation, the decision to evacuate a casualty is much more complicated.

a. Training Situations. Helicopters are the best way to evacuate a casualty because of their speed. The next best method is by ambulance and other vehicles. If the unit is located away from plowed roads, tracked vehicles are more efficient. The least desirable method of evacuating a casualty is by sled. However, terrain and weather conditions can prevent a vehicle from reaching the casualty. The decision must be made whether to risk further harm to the casualty and possible injury to a sled team by attempting an evacuation on foot, or to keep the casualty in place and obtain medical advice by radio until an evacuation vehicle can be moved into position.

b. Combat Situations. In a combat situation, transportation methods are not the only consideration. Commanders must consider:

(1) The danger of enemy ground fire to helicopters.

(2) The danger of helicopters disclosing the position.

(3) The potential loss of combat power of a squad for each casualty moved by sled. (Four Seabees are needed for pulling the sled, four for relief, at least two to break trail and provide security in the front, and one for rear security. In very deep snow, more personnel will be needed to break trail.)

4.8 CARE OF MEDICAL SUPPLIES

4.8.1 Preventing Freezing. Cold temperatures will freeze some medical supplies. Liquids, pastes, or gels need to be kept in heated containers or spaces. Plasma units will freeze and must be given at body core temperature. Specially designed heated containers and cold weather medical kits have been developed to prevent freezing.

4.8.2 Expedient Measures. When special equipment is not available, expedient measures must be taken. Medical supplies can be kept beneath the clothing, next to the skin, or in the cabs of vehicles that have their engines running. Corpsmen can distribute medical supplies throughout the unit to be carried under clothing. Plasma units can be carried under clothing to augment individual first aid packets. Corpsman may wear survival vests beneath their clothing to carry Unit-1 items.

4.8.3 Special Items of Equipment. Commanders will need to make decisions to dedicate vehicles specifically for transporting and protecting medical supplies and MEDEVACs, which support the aid stations. Body warmer units have been developed to keep MEDEVACs warm during transport to the rear. Commanders must remember to include warming tents during the MEDEVAC procedure.

CHAPTER 5. SUBSISTENCE IN COLD WEATHER OPERATIONS

5.1. CALORIC INTAKE. A daily intake of 5,500 to 6,000 calories will sustain a Seabee during extended construction operations. The primary source of body heat is the food we eat, and not external sources such as a fire or a heater. External heat sources only help the body conserve heat in the cold. In the cold, about 75 percent of caloric intake is used to create body heat. Seabees must actually force feed themselves. If a Seabee feels hungry during a cold weather operation, he is probably below the caloric intake level. Seabees who are unable to sleep due to shivering may not be getting enough calories to sustain adequate body temperature. Sleep loss will make Seabees weary very quickly. Snacks should be made available as food supplements. Leaders should ensure that each member is consuming at least a full ration every day, even if he doesn't feel hungry.

5.2 FIELD RATIONS. Proper caloric intake depends on the entire ration being consumed during the course of a 24 hour period. Planning must include time to prepare meals and melt snow for water. Lethargy induced by the cold, combined with the difficulty and inconvenience of cooking, may tempt Seabees to skimp on or miss meals. Seabees must be educated on the importance of preparing hot meals and consuming all of their rations. Although many of the meal packages may be eaten without hydrating and heating, leaders must closely supervise their Seabees to ensure proper preparation is accomplished. Cold meals will rob calories and cause other health problems. There are four different types of field rations available:

5.2.1 Meal Ready to Eat (MRE). MRE's can freeze in the cold. Personnel should carry them in inside pockets to prevent freezing. MRE's contain 1,300 calories and may be eaten without dehydration. Eating MRE's dry will increase dehydration problems. Four or more MRE's will provide the minimum daily caloric intake.

5.2.2 Long Range Patrol Rations (LRPR) This lightweight ration can be easily prepared in hot water. The LRPR must be hydrated before eaten. Four LRPR's or more per day are needed to provide the minimum daily caloric intake.

5.2.3 Arctic Ration. Arctic ration provides the proper mix of carbohydrates, fat, and protein and the 4,500 daily caloric intake which has been established as the minimum daily requirement. It comes in two pouches. The ration decreases weight and cube requirements by one half which further decreases the bulk that must be carried and the amount of trash that must be disposed. It provides two hot meals and easy to eat high energy snacks. The ingredients for numerous hot drinks are also included in this ration. No liquid containing food items are contained in this ration. The freeze-dried items can be eaten dry but should be rehydrated with hot water to prevent dehydration.

5.2.4 Tray Pack Meals. Tray-pack meals are particularly useful in the cold. They consist of prepared meals in aluminum trays that can be stored without refrigeration and a heating system that uses vehicle electrical systems, diesel fired burners, or external electrical generators to heat a water bath. Tray packs are immersed in the hot water bath and heated to serving temperature. They are then opened and the meal is served on paper trays using plastic eating utensils. Each storage tray contains enough of an entree, vegetable, or dessert to feed a squad-sized unit. Hot drinks are also prepared using the heater system.

5.3 LIQUIDS. The body loses liquid at an exceptional rate in the cold. The heavy exertion of performing construction work or simply moving on foot in the snow extracts its toll in sweat and loss of moisture in the breath. These liquids must be replaced. Hot drinks with sugar (because they add calories) are the best. Every Seabee must drink the required amount of water daily to prevent dehydration. Seabees in sedentary activities must drink 2 to 4 quarts daily, active personnel 3 to 5 quarts daily, and highly active personnel performing heavy work 4 to 6 quarts daily. Dehydrated rations add to the water requirement for all Seabees. Water is usually available from streams, lakes, or by melting ice or snow. Water from lakes and streams needs to be boiled or purified with water sterilizing tablets. The problem is the time and amount of fuel it takes to melt snow and ice. Whenever possible, water should be obtained from running streams or from a lake. If a hole is cut in the ice to obtain water, the hole should be covered by a snow block, board, or poncho to keep it from refreezing. The hole should be clearly marked. If no free water is available, ice or snow must be melted. Ice produces more water in less time than snow. This water should also be purified by boiling or using water sterilizing tablets.

5.3.1 Hot Drinks and Sweetened Supplements. The daily intake of water should be hot drinks of soups, cocoa, etc., and sweetened supplements. This will encourage Seabees to drink the required amount of water daily. No one likes to drink ice water during cold weather operations. Sweetened supplements will also increase caloric intake. Main meals should begin with hot soup and between meal snacks should include a hot drink.

5.3.2 Alcohol. Alcohol should never be consumed in the cold. It causes blood vessels nearest to the skin to open and waste body heat. The temporary feeling of warmth produced by alcohol is quickly replaced by chilling. Alcohol also causes the body to lose liquid because of a more frequent need to urinate. The effect alcohol has on judgement is particularly dangerous because brief lapses of poor judgement can result in serious injury or death. Alcohol does not freeze at 32°F. A Seabee drinking alcohol cooled below freezing can freeze his esophagus and die.

CHAPTER 6. COLD WEATHER CLOTHING AND EQUIPMENT

6.1 COLD WEATHER CLOTHING. Military cold weather clothing systems are designed to provide personnel with the flexibility to tailor the system to their needs. The clothing systems allow personnel to be warm in the coldest temperatures they are likely to encounter. By varying the parts of the clothing system, personnel can be comfortable when performing vigorous activities.

6.1.1 Principles of Design. All Seabees should understand the design principles of Military cold weather clothing systems. These principles are: insulate, layer, and ventilate. A good rule of thumb is: "Start Cool" before moving off; and take a vent stop after the first 15 to 30 minutes or when troops begin to sweat, to remove unnecessary layers and vent the neck, waist, and under arms.

a. Insulate. Insulation material reduces the amount of body heat lost to the environment. By regulating the amount of insulation, a Seabee can regulate the amount of body heat lost or retained. The cold weather clothing systems provide several layers of insulation. If proper clothing is not available, stuff clothes with newspaper, pine needles, dry grass, or leaves, all of which will trap dead air.

b. Layer. Several layers of clothing provide more insulation and flexibility than one heavy garment, even if the heavy garment is as thick as the combined layers. The secret is "dead air space" in the insulating layers. The more dead air space, the greater the insulating value. Layers can be added as it gets colder and taken away if it warms up or work increases.

c. Ventilate. Ventilation helps maintain a comfortable body temperature by allowing the wearer to rid himself of excess heat and body moisture. Seabees should ventilate by either opening their clothing or removing insulating layers any time they start to sweat from a change in temperature or vigorous activity.

6.1.2 How To Keep Warm (COLD). There are four important considerations in making the Military cold weather clothing systems work: keep it CLEAN, avoid OVERHEATING, wear it LOOSE and in LAYERS, and keep it DRY. By remembering the acronym COLD, a Seabee can quickly check his adherence to the cold weather clothing principles, see Figure 6-1, C-O-L-D.

THE KEY TO KEEPING WARM IN COLD CLIMATE IS THE WORD

C.O.L.D

keep it - C lean
avoid - O verheating
wear it - L oose
keep it - D ry

Figure. 6-1. C-O-L-D.

6.1.3 Cold Wet Versus Cold Dry.

a. Cold Wet. Temperatures which are constantly above 14°F are considered to produce cold wet conditions. Cold wet conditions usually involve a freeze/thaw cycle, often accompanied by rain or wet snow. This type of weather is the most difficult to dress for since each man must fight a continuing battle against the elements to keep dry.

b. Cold Dry. Temperatures consistently below 14°F will cause cold dry conditions. During cold dry conditions, the ground is usually frozen and the snow is dry in the form of fine crystals. Although the temperatures during cold dry conditions may be much lower that during cold wet conditions, it is often easier to stay warm because it is easier to stay dry. See Figure 6-2.

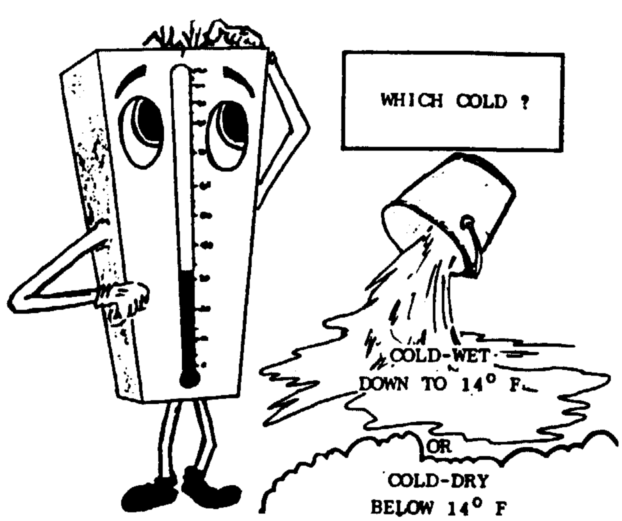

Figure 6-2. Wet Cold or Dry Cold?.

6.2 THE CLOTHING SYSTEMS. There is one clothing system currently in use in the NCF Cold Wet/Cold Dry seven layer system.

6.3 HAND WEAR. The standard hand wear items are: glove inserts, gloves, mitten inserts, mitten shells (cold weather and snow camouflage), and mitten set.

6.3.1 OD Knitted Glove. The knitted OD glove insert is the standard insert that Seabees are issued as organizational equipment.

a. **Description of Item.** The olive drab glove inserts can be worn on either hand. All parts of the glove, except the cuff, are seamless knit. The cuff is a true rib knit.

b. **Concept of Use.** The glove inserts are to be worn for added warmth with light duty gloves.

6.3.2 Black Field Gloves. The black gloves (Gloves, Men's and Women's, Light Duty) are the standard field gloves normally issued to Seabees as organizational equipment.

a. **Description of item.** The gloves are black, slip-on style, all leather, with a buckle strap of black tape on back of glove for wrist closure. The gloves are either a one-piece back and front or a two-piece back design.

b **Concept of Use.** The gloves are used for light work duty. They may be worn alone or, for additional warmth in cold conditions, may be worn with the cold weather glove inserts.

6.3.3 OD Mitten Insert. The knitted OD mitten inserts (Mitten Inserts, Cold Weather w/Trigger Finger) are available through the Navy Supply System.

a. **Description of Item.** The mitten inserts can be worn on either hand and have separate sections for the thumb and index finger.

b. **Concept of Use.** The mitten inserts are used as an insulating layer under cold weather mitten shell.

6.3.4 Mitten Shells, Cold Weather w/Trigger Finger. The cold weather mitten shells (Mitten Shells, Cold Weather w/Trigger Finger) are available through the Navy Supply System.

a. **Description of Item.** The color of the leather is saddle brown. The mittens are slip-on style with trigger finger. The mitten has an elastic webbing and tape loop (for suspension cord) at the cuff opening and an adjustable wrist strap on the back of the mitten shell. The back of the thumb, hand, and trigger finger down to the cuff of the mitten is lined with insulation for added protection.

b. Concept of Use. The trigger finger mittens are to be worn with or without the wool/nylon mitten inserts and in areas too cold for leather gloves and not sufficiently cold for arctic mittens.

6.4 ACCESSORY ITEMS.

6.4.1 Suspenders.

a. Description of Item. The olive drab suspender straps are scissor-back style (cross over in the back). The suspenders have two slide buckles and two hooks which attach to the trousers.

6.4.2 Head over Scarf. The head over scarf (Scarf, Headover) is an item borrowed from our NATO allies. This item enables Seabees to regulate their body temperature.

a. Description of Item. The head over scarf is a circular knitted wool tube 2 feet long and 9 inches wide laid flat, open at both ends, with the face of the fabric lightly brushed.

b. Concept of Use. The head over scarf is to be wrapped around the neck, pulled over the head and ears, or pulled down over the neck and lower face.

6.5 FOOTWEAR. USN footwear consists of three items: the cushion-sole wool socks, and the extreme cold weather boots (black or white). The boots used by the U.S. Armed Forces for cold weather operations are vapor barrier VB boots. These boots use an inner and an outer boot made of rubber and filled with either wool fleece or closed cell foam (neoprene) insulation. The rubber acts to stop the movement of moisture from the feet. Heat is transferred quickly by the moisture in the air. By trapping the moisture, the boots trap heat. The boots also act to keep moisture out. It is imperative that Seabees carry dry socks and change socks at least 3 times a day when wearing VB boots. When possible, the VB boots should be removed for at least a few hours a day to allow the feet to "breathe" and dry out. NOTE: Because of dangers of frostbite, steel toe boots will not be worn in extreme cold climates.

6.5.1 Vapor Barrier Boots. There are two types of VB boots:

a. Boots, Cold Weather (Type 1, Black). These boots are worn in the "cold wet" environment and protect feet down to 20°F.

b. Boots, Extreme Cold Weather (Type 2, White). These boots are worn in the "cold dry" environment and provide protection down to 50°F.

6.6 COLD WEATHER PERSONAL EQUIPMENT. Personal equipment for use in cold weather environments is especially designed to provide protection and be as lightweight as possible.

6.6.1 Sleeping System. The sleeping system consists of a sleeping bag, an insulated sleeping mat, and a waterproof bag. There are two current types of sleeping bags:

a. Sleeping bag, type I, intermediate cold, for temperature down to +10°F, used polyester batting for insulation and weighs 7.5 lbs.

b. Sleeping bag, type II, extreme cold, for temperatures down to 50°F, uses waterfowl feathers, down, and polyester batting for insulation, weighs 9.5 lbs.

c. The Sleeping Mat provides excellent insulation from ground cold and can be used for tactical positions when personnel must lie prone for long periods of time.

d. The Waterproof bag is used to protect the sleeping bags from getting wet. Both bags are difficult to dry once wet and care should be taken to keep them as dry as possible.

6.6.2 Load Carrying Equipment. Commanders must ensure that Seabees are equipped with the large ALICE pack (mountain ruck) for use in cold weather environments. Organization of the items in the pack are a concern in cold weather as Seabees will need to have quick access to certain items of mission and survival equipment. A typical pack arrangement is as follows:

a. **Small External Pockets.** Small high energy foods to be eaten on the move.

b. **Large External Pockets.** Rations for morning and evening meals. Extra socks, scarf, spare cap.

c. **External Attachment Points.** Sleeping mat attached to bottom of pack or under top flap.

d. **Top Flap.** Camouflage overwhites and pack cover.

e. **Main Compartment.** Sleeping bag in bottom of pack. Spare clothes in top where they can be easily reached.

6.6.3 **Miscellaneous Equipment.**

a. **Sunglasses.** Snow blindness, painful and very real problem in snow covered terrain, requires bed rest to treat. The snow blind Seabee is a liability to the unit. Snow blindness is preventable if leaders ensure Seabees have and use their sunglasses even on overcast days.

b. **NBC Protective Mask.** There is a cold weather kit for the NBC Protective mask. Leaders must ensure that the NBC protective mask is winterized prior to the cold weather operations/exercises.

c. **Canteens.** Plastic canteens will freeze very quickly in cold weather. If used, they must be carried in the interior of the clothing or deep in the pack wrapped in spare clothing. The two quart, collapsible canteen is useful in cold weather operations, but also must be carried next to the body. One quart, stainless steel vacuum bottles are insulated canteens for cold weather use. They will keep water from freezing but are difficult to use.

d. **Personal Survival Kit.** A Seabee separated from his gear can soon become a casualty and is not effective to his unit. Above that, even during training operations, the cold can easily kill an unprepared Seabee. Each Seabee should carry his survival kit on his person at all times in the cold weather environment. Some NCF units frequently assigned to cold weather operations have made the most of the contents of this suggested kit. Each Seabee must carry food and water gathering materials, fire starting and signaling materials. A suggested list, not all inclusive, includes the following items: a small sharp knife; matches in a waterproof container; five meters of strong line; a small flashlight; sunburn preventive cream; chapstick; a candle; sunglasses; a small brush; a whistle; thermos bottle; emergency rations (MRE, 1300 Calories); and space blanket.

6.7 TENT GROUP EQUIPMENT

6.7.1 Command Post/General Purpose (CP/GP) Tent with Tent Liner. These are the standard CP/GP tents used throughout the US Navy. The arctic liners are ordered as a separate item with a separate NSN, via normal supply channels. The tents are normally heated by the M-1941 stove. The command post tent can be heated with the M-1951 Yukon Stove. The tents are supplied with vent holes for venting the stoves. If they are kept in place for a period of time, commanders will generally attempt to provide hard backs.

6.8 STOVES. Stoves in cold weather operations are a source of comfort as well as a constant source of danger. Nothing is more dangerous in cold weather operations/training than a tent fire which will not only injure the tents occupants with serious burns, but may result in the destruction of a tent teams equipment that is necessary for the team to survive.

6.8.1 Yukon Stove.

a. **General.** The Yukon stove is an excellent, liquid or solid fuel stove of simple design for combat units to heat the ten-man, five-man, and GP small tents. The top surface of the stove and the area beneath the stove may be used to cook rations or heat water. The standard fuel for the Yukon stove is standard leaded motor fuel. Kerosene, light fuel oil, naphtha, or JP-4 fuel can also be used without modification. The stove will burn five gallons of gasoline every 8 to 12 hours. Solid fuels (wood, coal, or charcoal) may also be burned. To burn solids, the stove must be modified by removing the oil burner from the top of the stove, closing the opening where the burner was installed, and turning over the fire grate so that there is space below the grate for draft and ashes. A piece of plywood (covered with aluminum foil) slightly larger than the base of the stove should be carried as part of the tent group equipment to provide a firm base for the stove and to prevent it from melting into the snow. All stove parts conveniently fit into the body of the stove which weighs approximately 33 pounds.

b. **Drafting Procedures.** A draft diverter (component part of the stove) shields the top of the stovepipe from the wind and prevents a backdraft from forcing smoke or gases into the stove and tent. Three 4.5-meter (15') guy lines tied to the draft diverter serve to anchor the stovepipe in strong winds. These guy lines must be anchored to the tent or tent ropes, not to the ground or nearby trees.

c. **Fuel Can.** A tripod can be erected for the fuel can by obtaining three poles about 2 meters (6") in length; the poles are tied about two-thirds of the way up and then spread out to form a tripod (See Figure 6-3). The fuel can should be at least 3 feet higher than the stove. The lowest part of the inverted gasoline can must be a minimum of 1 foot above the level of the needle valve of the Yukon stove. It should not be higher than 4.5 feet for the valve to operate smoothly. The fuel can must be tilted so that air is trapped in the uppermost corner and should be tied to the tripod for additional protection.

d. **Precautions.** When using liquid fuels, personnel must be trained in proper lighting procedures. The stove should never be left unattended. The burner must be cool before relighting the burner. If the stove is lit before the burner is cool, the fuel will vaporize prior to ignition, causing an explosion. All fuel supplies must be kept outside the tent. With solid fuels, proper ventilation of the tent is required to prevent carbon-monoxide poisoning.

6.8.2 Squad Stoves. Seabees may utilize small squad stove (M-1950, Optimus 8R or 111B) when operating in tent sheets and/or 5 and 10 man tents (low silhouette will retain maximum heat), giving the unit more flexibility in all types of operations it might be assigned. As was indicated when discussing types of shelters, individuals and/or units cannot be separated too far from shelter or a source of heat. These stoves are a cooking and heating unit for a group of from two to five men and can be utilized to melt snow/ice for water. They are used when operating in an isolated or forward area where the use of heavier equipment is not practical. These stoves are small, compact, and light, and will operate on either white or leaded gasoline. The initial pressure for operation may be generated by a few strokes on the hand pump, thereafter the pressure is generated by heat from the burner evaporating the fuel in the stove tank. In the near future the only fuels on the battle field will be either diesel or jet fuel. Research is currently being conducted developing a squad stove to meet this need.

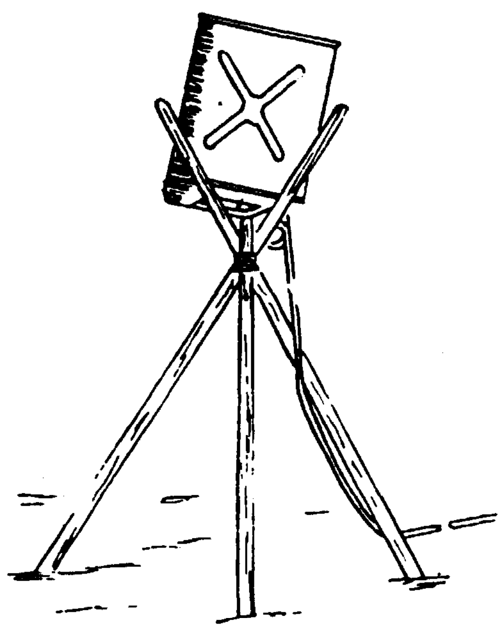

Figure 6-3. Tripod with Fuel Can.

6.8.3 Pot Bellied Stove. The 1941 stove is a gasoline fired carbonator operated pot belly stove of relatively simple design, which develops 50,000 BTUs. This stove is also capable of burning solid fuels. Because the only fuel on the battle field in the 1990s will be diesel or jet fuel, current modifications are being developed to adapt this stove to diesel. This stove will require constant preventative maintenance to keep it firing efficiently. A sand filled box should be constructed to set the stove in and the operator should constantly be aware of carbon/soot buildup in the exhaust pipe.

CHAPTER 7. CIVIL ENGINEER SUPPORT EQUIPMENT (CESE)

7.1 GENERAL The doctrine, techniques and procedure for equipment operations are contained in the NAVFAC P-404, NCF Equipment Management Manual. Providing support for the NCF during cold weather operations will require the full capability of CESE assets, and the planning and training of all personnel. Additional training will need to be provided to Equipment Operators (EOs) and Construction Mechanics (CMs) on: basic survival, vehicle recovery principles, tire chain installation, cold weather preparation and maintenance, and driving under ice and snow conditions.

7.2 VEHICLE MOBILITY

7.2.1 Vehicle Acclimatization. Most vehicles that are designed to operate in temperate climates must undergo acclimatization in order to function properly in cold climates. Tires, batteries, cooling systems, and lubricating/fluid systems must receive special attention in extreme weather. If possible, acclimatization should be accomplished before deployment.

a. **Tires.** Tires are a critical item in keeping motor transport units operating. In frigid temperatures, (e.g., below -50°F), tires have a tendency to become very brittle, develop flat spots from parking, or go flat. Units operating in cold weather zones should plan for high replacement rates on tires.

b. **Batteries.** Standard 12-volt batteries have a fairly high replacement factor in temperate climates and lose cranking power rapidly as temperatures drop below freezing. Battery blanket warmers are available in the supply system, however they must be requested. If electrical power sources will be available, vehicle heaters can be installed, which will keep batteries warm while remaining in vehicles. Keep batteries fully charged. Wet cell batteries freeze easier as the charge gets weaker. (Fully charged batteries freeze at -95°F; one third charged batteries at -18°F).

c. **Heaters.** Units should ensure that all vehicles have effective personnel compartment heaters and engine block heaters for maintenance tents.

7.3 SNOW REMOVAL. Snow, whether fresh or packed, should be expected in every cold region area during winter months. Because snow can quickly become an obstacle, units should plan for efficient and timely snow removal. Some areas can receive two to three feet of snow in a 24 hour period. Snow removal storage areas must be preplanned in all cold weather operations.

7.4 DRIVER TRAINING. During cold weather driver training operations, the following recommendations will help promote successful operations:

a. Drivers must have practice driving in snow conditions before driving in heavy traffic or difficult terrain.

b. Drivers must begin pumping brakes at least 40 meters before coming to a complete stop.

7.5 VEHICLE OPERATIONS. In cold temperatures, vehicle operation is more difficult and the reliability of vehicles decreases as temperatures get colder. In extremely low temperatures, vehicles must be operated and exercised periodically to prevent cold soaking of engines, power trains and axles.

7.5.1 Freeze In. Vehicles should be parked on dunnage to prevent the tires from freezing to the surface. Evergreens, boards, salvage canvas, etc., are good for this purpose. If tires do freeze to the ground, do not pop the clutch to break loose (which will only result in ripping the tires).

7.5.2 Starting. Vehicles should always be parked where they can be assisted easily. Back them into position so that the slave receptacle is close to where another vehicle can drive. Be certain that the vehicle can be conveniently towed.

7.5.3 Brakes. Chock blocks should be used for wheels when parking; not the emergency brake which, when wet, can freeze in the "on" position.

7.5.4 Starting and Pre-heating Engines.

a. For vehicles equipped with engine heaters, the heaters should be plugged in while the engine is hot. Engine heaters require 4-8 hours of operation to warm a "cold soaked" engine to a temperature sufficient to allow starting without damage to the engine. If leaving a vehicle for an extended period of time, plug in the heater while the engine is still hot.

b. For vehicles not equipped with engine heaters, these vehicles can be allowed to run around the clock in extreme cold conditions. Shut down the engine every 4 hours to check the oil and fuel levels and drain the air tanks.

c. When starting "cold soaked" vehicles, use caution when starting vehicles that are extremely cold without first heating the engine. A cold engine may turn over by the battery or jump starting, however, if the engine oil will not flow through the engine journals, damage to the engine will occur. Engines can be heated by running a hose from the exhaust line of a running vehicle into the engine compartment of the cold vehicle or by using portable forced air heaters.

7.5.5 Collateral Equipment. Collateral equipment will be installed on vehicles during cold weather operations. Accountability must be maintained. Drivers will inventory and accept custody for collateral equipment, along with vehicle custody. Equipment listed in the following matrix is the minimum acceptable for cold weather operations.

	JACK & LUG WRENCH	SHOVEL	TOW CHAINS	CHOCK BLOCKS	JERRY CAN W/FUEL	WHEEL CHAINS
JEEP	X		X		X	X
WEPS	X	X	X		X	X
CARGO TRUCKS	X	X	X	X	X	X
DUMP TRUCKS	X	X	X	X	X	X
T & T	X	X	X	X	X	X
WRECKER	X	X	X	X	X	X
AMBULANCE	X	X	X	X	X	X
FUEL TRUCK	X					

Figure 7.1 Minimum Acceptable Equipment

7.6 VEHICLE MAINTENANCE.

7.6.1 Winterization. Every piece of equipment used in cold weather operations is affected by the cold and must be maintained in the best possible mechanical condition. All equipment must be completely winterized in accordance with the manual referenced in 7.1. Adequate maintenance shelters are necessary and a larger number of experienced maintenance personnel must be available than are normally provided by staffing guidance. Efficiency of the individual and unit equipment varies directly with the temperature. It may become extremely difficult, due to lack of facilities, for units to perform organizational maintenance when engaged in combat operations. Under these conditions, the equipment officer must recommend to the Commander ways and means of solving the preventive maintenance problems.

7.6.2 Pre-start Checks. Pre-start checks are of vital concern when operations in cold weather are involved. The cold affects rubber on items such as fan belts, radiator hoses, heater hoses, and tires. Engine seals and drive train seals are stressed to the limit. Electrical components, drive-trains, and even freeze plugs must be inspected prior to vehicle use.

7.6.3 Maintenance Cycle. The three categories of equipment maintenance are affected by cold weather.

a. Operators maintenance is the driver's responsibility and must be an integral part of the unit's cold weather workup.

b. Preventive maintenance is associated with the maintenance cycle required in the equipment's maintenance manual. The difficulties associated with conducting maintenance in cold weather will make adhering to a maintenance schedule difficult. The acquisition of shelter for maintenance must be aggressively planned for and pursued throughout the operation. Adequate shelter will only reduce, not do away with unit maintenance problems.

c. Interim repairs, while common in cold weather, may not be the result of poor operator or preventive maintenance. However, a lack of preventive maintenance will definitely cause an increase in corrective maintenance. Corrective maintenance must be planned for, maintenance shelters must be erected, and heated and maintenance repair parts readily available.

7.7 SAFETY/SURVIVAL

7.7.1 Safety.

a. Personnel must not be allowed to sleep under vehicles or trailers for protection from the elements for, if the vehicle is moved while personnel are sleeping under it, they may be injured. Also, personnel must not be allowed to sleep in vehicles. The temptation is too great to run the engine for heat, which can cause death by carbon monoxide poisoning.

b. Bare skin to metal contact. Personnel must be cautioned not to touch bare metal with bare skin for it will stick to the frozen metal. Anti-contact gloves should always be used around vehicles and tools. Personnel must be constantly checked for cold weather injuries.

c. Mechanics are relatively immobile while working on equipment, so their bodies do not generate adequate heat to cope with the cold. They must be put in a warm shelter occasionally and given hot drinks and hot food. If possible, a heated shelter should be provided for the maintenance.

d. Caution must be exercised when fueling equipment, as fuel spilled on flesh will result in a rapid heat loss and frostbite can occur almost instantly. Uniforms that become soaked with fuel or oil conduct heat away from the body rapidly and are a fire hazard around heat sources. They must be replaced or cleaned immediately.

e. Carbon Monoxide Poisoning. Carbon monoxide is a deadly gas, even in low concentrations, and is particularly dangerous because it is odorless. It is not the same as "fumes." Carbon monoxide can be present when there are no fumes, and fumes can be strong when there is no carbon monoxide. The most common sources of carbon monoxide are engine exhausts and coal stoves. Although tests reveal there is less danger of carbon monoxide poisoning from gasoline stoves or lamps, this cannot be taken for granted. Ventilation must constantly be checked. Carbon monoxide collects around parked vehicles that have their engines running. No individual should be allowed to sleep in a vehicle. The temptation to start up the vehicle for warmth is too great. Carbon monoxide is produced by any combustion that produces carbon or uses carbon in combustion.

f. Symptoms. The following symptoms may be present: headache, dizziness, impaired vision, mental confusion, yawning, weariness, nausea, a ringing in the ears, and bright pink lips and eyelids. Later, the heart may begin to flutter or throb. Normally, the gas will strike without warning and a Seabee may not know anything is wrong until his knees buckle.

g. Treatment. Move the casualty into the fresh air at once. Keep the casualty warm! The casualty should not be exercised since this increases his need for oxygen. If a casualty stops breathing or breathes only in gasps, artificial respiration should be started immediately. Carbon monoxide poisoning is serious and a casualty who survives it must be kept absolutely quiet and warm for at least one day in a well-ventilated place.

7.7.2 Survival Training.

a. Cold weather survival training is necessary for all operators. There are a variety of situations that can cause personnel to find themselves suddenly in a survival situation. Whenever a vehicle is dispatched, the crew should be provided with radios, emergency radio frequency, and/or emergency telephone numbers.

b. Drivers. The buddy system must be maintained with drivers. This concept is particularly important on extended trips. If a Seabee is injured in an accident, he must have immediate help if he is to survive either the injury or the cold. Units should be notified of the destination departure time and estimated time of vehicles arrival. This will reduce the reaction time when an enroute emergency occurs.

7.8 USE OF CHAINS. Each rubber-tired vehicle should have chains for the drive wheels and one set per side for rear wheels. The chains should be the heavy duty type of the cleated or studded variety, which provide the best traction on glare ice. Chains are a part of the collateral equipage for some vehicles. They provide added traction on snow and ice, but they are not without their drawbacks. The installation of chains on a military tire is difficult, especially with cold hands, and the techniques should be practiced in training. Chains become damaged or destroyed when used on hard surfaced roads. This happens most often when the vehicle moves on and off both unimproved and hard-surfaced roads, and the driver cannot or does not want to take the time to frequently remove and reinstall chains. Damaged and loose chains can cause major damage to the vehicle such as puncturing the fuel tank. Time must be taken to remove/replace tire chains on an "as needed" basis. Chained wheels used on the deck of a ship create a dangerous situation. During the ship-to-shore movement, chained vehicles must be moved with caution. The chains can become snagged, which can shred the chain or bend or break an axle.

7.8.1 Alternatives to Using Chains. The best way to avoid the use of tire chains is to install studded tires on all vehicles. If studded tires are not available depending on the road, snow, and ice conditions, it may be more advantageous to lower the air pressure in the tires and/or remove the inner dual on the vehicle.

7.8.2 SOP When Using Chains. Key points to remember when using chains are as follows:

a. Use chain tighteners to keep the chains tight.

b. Never apply chains to only one side of an axle.

c. Chains on at least the front and rear tires of the six wheel drive vehicles are a must.

d. Trailer with brakes must have chains when operating on ice.

e. Coat chains with lubricant prior to storage.

CHAPTER 8. COMMUNICATIONS IN COLD WEATHER

8.1 GENERAL. In cold weather, units may operate in separated areas. They may be beyond the range of mutual support and at considerable distances from higher headquarters. Because of this dispersion, a greater use must be made of radio communications at a longer range. One of the keys to success is a reliable, secure, rapid, and flexible communication system. This is particularly true in a cold weather environment where Seabee units face the problems of survival from the elements and mission accomplishment. It is important that commanders understand the effects of cold weather environment on communications equipment and personnel.

8.2 PLANNING.

8.2.1 General. Communications tasks are more difficult in the cold and the toll on personnel is tremendous. The communications officer must conduct reconnaissance and plan frequencies within ranges that will work. Communication planning functions must consider:

a. Communications equipment.

b. Communication maintenance and supplies.

c. Safety.

d. Communication personnel equipment load.

e. Communication plans.

f. Command group communication system configurations.

8.2.2 Site Selection. Locating the antenna field near/within the command post area will reduce wire and cable problems, but will render the command post more vulnerable to direction finding. This will dictate that command post sites be selected in good positions from which communications can be conducted and still be protected from detection.

8.2.3 Redundancy. Communication in low temperatures is very difficult. Leaders should plan on utilizing all available communications assets and see to it that back up capabilities are always available.

8.3 RADIOS. Several problems radios are subject to in cold weather are decreased battery power and failure of materials. The construction of snow caves, igloos, and shelter halves/tent sheets around the radios will protect them from the environment and will raise the ambient temperature around the radios. Flexible cables and some metal parts become brittle at low temperatures. Cables must be handled carefully. Power connections and cables can easily be broken by rough handling. Before connecting cables, they should be warmed so that they can easily be manipulated without damage. If a radio is dropped or jarred when very cold, it will likely become damaged internally. Moving parts may become stiff and frozen because of condensation or may jam because of varying contraction of different metallic parts.

8.3.1 Battery Power. Batteries of all types give less power at low temperatures, and the conventional dry cell battery loses efficiency very rapidly as the temperature falls. Dry cell batteries should be stored at a temperature above 10°F and should be gently warmed before use. They should then not be exposed to extreme cold until needed, and during use should be kept as warm as is feasible. Man-pack radio sets should be taken into shelters overnight. However, if an operator is going into a shelter for a short time to eat or rest, he should take the batteries with him, leaving the radio outside to avoid unnecessary condensation which, over a short period, will not dry off.

a. Use cold weather batteries. Most batteries have a cold weather counterpart. Ensure that supply personnel do not substitute with batteries prescribed for normal use in warmer temperatures. On resupply, require a one-for-one exchange of batteries.

b. Lithium batteries are far superior to magnesium batteries in cold weather because they are lighter and last longer. Batteries perform best and last longer when kept cool, rather than cold or freezing. The most favorable storage temperature is 35°F or slightly colder, but not freezing.

c. The radio operator should carry one set of spare batteries in a parka or pack and rotate the batteries every 8 hours.

d. Keep log entries when batteries are changed. Mark the battery with the time of usage and the date and time the battery was depleted.

e. KEEP BATTERIES OFF THE BARE OR SNOW COVERED GROUND. Insulate batteries against the cold by whatever means available. Store batteries inside a shelter. The plastic connectors on some batteries become particularly brittle when cold and must be handled gently.

8.3.2 Common Equipment Problems. When temperatures are below 10°F, radio equipment materials become brittle and are very susceptible to breakage. The following recommendations should be considered:

a. Spare antennas and handsets should be made available to radio operators.

b. Coaxial cable, connectors and antenna elements should be coated with a thin film of silicone lubricant (RC-292 or equivalent).

c. Moisture from the breath will freeze onto handsets and quickly coat them in ice and the button or switch may also become ice covered. Handsets should be protected by covers that can be improvised from plastic battery bags and tape. Ordinary electrical tape loses its grip in cold weather, therefore, low temperature tape should be used.

d. Keep radios, radio remote sets and cryptographic equipment off the ice and snow. If snow covers the pressure release cover, ice may form and restrict the radio battery box from air exchange.

e. Remove frost from equipment before bringing it into a tent or heated shelter. Warm equipment gradually to prevent damage from sudden temperature changes.

f. Do not turn radios off at night when temperatures are below 10 degrees F if needed for operation in the morning.

8.3.3 Condensation is a particular problem when temperatures fluctuate between freezing and thawing (25°F to 40°F). Radio equipment is susceptible to the same dangers from condensation as are weapons, with the added problem of internal condensation (caused by battery heat), which may take a long time to dry and may cause short circuits and damage. Additional radio equipment items must be anticipated in cold weather operations due to condensation problems. Communicators should anticipate a requirement for additional time/labor in drying out equipment.

8.3.4 Antennas may be difficult to erect in deep, soft snow and on frozen ground. They are likely to become iced up and are susceptible to a phenomenon called precipitation static. Antennas, and particularly the support wires, should be jarred frequently to dislodge any ice. Wire antennas should be erected so that the wire is attached to one post by string of a thickness that will break before the antenna does under the weight of ice build-up.

a. In snow, anchor guys using the deadman technique. Tie off guys to stationary objects such as trees where available, but do not use fewer guys than the antenna TM calls for. Icing and high winds will tax guy lines heavily.

b. Ice also reduces antenna radiating ranges and poses a safety hazard. Inspect antennas and clean off ice regularly. Keep ceramic insulator bowls dry and free of ice and handle them carefully, as cold makes the ceramic brittle. Keep antenna mast and whip sections dry and free of dirt. Apply a light film of silicon lubricant to each joint. Be gentle when coiling or uncoiling antenna coaxial cables, as cold weather makes them brittle. If possible, warm cables inside before.

8.4 WIRE (TELEPHONE). Wire is the preferred type of communication in the cold because there are fewer problems with actual communication. Installing and maintaining the network can create several problems. There are three primary considerations to counteract the effects of cold on wire communications: battery power, material failure, and wire laying techniques. When planning, consideration must also be given to the personnel necessary to perform the mission and the drain of the vitality of the individual from the effects of the cold. Like radio equipment, telephone equipment and materials become brittle and are very susceptible to breakage when temperatures are below 10°F.

8.4.1 Wire Laying Techniques. Laying the wire may be done in a variety of ways using standard methods. The wire will normally be laid above the snow surface whenever possible to prevent losing sight of the wire and for ease of laying and retrieving. When laying wire across roads, the recommended procedure is to elevate the wire above the road. If the wire must be placed on the road, special care must be taken to ensure the wire is well below the running surface. If there is an absence of snow and the frozen ground prevents burying the wire, an alternative means of covering the wire must be planned for.

a. The use of host nation cable systems, when possible, will conserve wire, cable and labor. Host nation cable systems are usually underground, which will provide better quality lines with less impact from the weather.

b. If cable must be installed, mark each of the cable connecters in the event snowfall covers them. This technique will aid in trouble-shooting and cable recovery.

c. Personnel. Because of the same problems associated with radio operations in cold weather/mountain operations, wiremen will find the task exceptionally tough. Additional personnel should be requested. All wiremen should be knowledgeable of expedient shelters and survival techniques.

8.5 MAINTENANCE. Performance of preventive maintenance is essential to ensure the proper operation of communication equipment. The communication teams should have additional maintenance personnel assigned and a sufficient amount of pre-expended bin items and supplies, such as handsets, coaxial cable, connectors, whip and base antennas.

8.6 SAFETY. The following safety precautions are to be followed in operating communications equipment in cold weather:

a. If temperatures are below 10°F, do not touch metal parts with bare hands.

b. Construct antennas to be secure against blowing wind.

CHAPTER 9. CONSTRUCTION OPERATIONS

9.1 GENERAL. As with all operations in cold weather, construction operations are influenced by the amount of exposure personnel can stand, psychological factors (pronounced fear of the cold), and the loss of work efficiency from reduced freedom of movement (use of hands, feet, etc.) caused from wearing essential cold weather clothing. Additionally, the reduction of overall efficiency of personnel, increased equipment maintenance time, and the reduction of productive efficiency have a particular effect on construction operations. These problem areas can be reduced by psychologically preparing personnel for cold weather operations, proper use of special and standard items of equipment and supplies, a high state of technical training, and aggressive leadership.

9.1.1 Missions. NCF units in cold weather operations carry out their normal construction and construction support missions. Environmental factors increase the volume and scope of Seabee activities and the difficulties attendant to execution of these activities. The scarcity of trails, roads and airfields increases the need for construction effort. At the same time, the effect of the extreme variations in climate increases the manpower and equipment effort required for both construction and maintenance. The numerous streams, swamps, and lakes require increased quantities of stream crossing equipment and correspondingly increased effort for its installation and maintenance. Cross-country movement of large forces requires augmentation of NCF units. The problems confronted in the construction of conventional field work are magnified, as are the problems of installation of field fortifications. While water sources are normally adequate, the difficulties of supplying potable water by conventional methods are increased.

9.1.2 Training and Equipment. NCF units accustomed to operating in warm weather can be prepared for winter conditions by modification of organizational equipment, issue of special-purpose equipment, and proper training.

9.2 SITE RECONNAISSANCE. Reconnaissance teams will often require augmentation in cold weather operations to verify the capability of roads, landing zones, beaches, etc.

9.2.1 Ground Reconnaissance. The purpose of ground reconnaissance is to verify all information previously collected, to obtain data not otherwise available, and to select the best site/route if more than one potential site/route is available. Ground reconnaissance includes observations of soil, snow cover, vegetation, ground water, surface water, local sources of construction material, and other pertinent information.

9.3 LOGISTICAL IMPORTANCE. The logistical value of local materials and transportation facilities in conserving transport assets is most important. A knowledge of local resources permits ready identification of materials useful for the speedy initiation and completion of construction projects. It also can do much to prevent delays arising from transport priorities and interruptions. The location of suitable sources of rock or rock deposits, gravel and sand for aggregate, and stands of timber is essential.

9.3.1 Timber. In the sub-arctic, timber is usually available within a range of 50 to 100 miles. Available timber can be used for arctic construction in the same way it is used in temperate climates. In the Arctic, native timber is generally not available, but can be transported and therefore planned for.

9.3.2 Soils. In the Arctic, soils that can be used for construction vary in accessibility. To a large extent, their availability depends on the season. Various sources are:

a. Glacial deposits. Subsurface deposits of sand and gravel are of fairly frequent occurrence in arctic and sub-arctic areas.

b. River and lake deposits. Sand and gravel may also be found along the seacoast and the shores of lakes, and the backwaters and meandering channels of rivers. These deposits may not be of as good quality as the glacial deposits, being frequently mixed with silt and vegetable matter.

c. Uses for sand and gravel. As in temperate zones, sand and gravel are used in the arctic for fills and base courses and as aggregate for bituminous pavements and concrete.

9.3.3 Permafrost. Knowledge of the extent and nature of the permafrost where ice segregation occurs is important. It is necessary to determine the depth of the annual frost zone, and the nature of the soils present in the permafrost and suprapermafrost zones.

9.3.4 Transportation Facilities. The availability of existing commercial and military ground, water, and air routes for transportation of personnel and materials, as well as prospective sites for such facilities, must be determined. Information on existing or abandoned roads should be obtained.

9.4 SNOW AND ICE. In a country in which known resources are rare, those which are known must not be neglected. Man must work with nature to use snow and ice to his advantage.

9.4.1 **Obvious Properties.**

a. Snow and ice are incidental products of cold climates. Atmospheric moisture precipitates and remains on the ground as snow. Ice forms on water surfaces and, as the exposure continues, penetrates such surfaces until it is deep enough to support vehicles across areas impassable in summer.

b. Falling snow is light and fluffy and is a partial insulator.

c. The strength and load bearing capacity of ice depends on its thickness and temperature.

d. Windblown drifted snow and snow that has been weathered in place tends to be well compacted, providing good passability for low ground pressure vehicles.

9.4.2 Snow and Ice as Building Materials.

a. Structures. Eskimos have used snow blocks for the construction of igloos for centuries. Russian engineers have used ice to construct cold-storage warehouses that have lasted for several years, and have built railroads on ice.

b. Roads. Satisfactory procedures for the construction of snow and ice roads have been developed.

c. Airfields. Winter road construction principles have been applied to the construction of snow and ice runways for aircraft.

9.4.3 Strength of Ice. The strength of ice is dependent on its structure, the purity of the water from which it was formed, the process of the formation and the alternate cycles of freezing and thawing, its crystal orientation, the temperature, its thickness, the snow cover, the water currents, the underside support and its age. Its strength increases rapidly as the temperature drops from the freezing point to about 0°F; the strength remains fairly constant for temperatures below 0°F. Fresh water ice is generally more uniform and stronger than sea ice. Young sea ice must be one and two thirds the thickness of old sea ice to carry the same load. The freezing and thawing process produces ice of poor quality which is often described as "green" or "blue" ice because of its appearance. Ice that is cloudy or milky is not as strong as clear ice. The cloudiness is caused by gas or air trapped within the ice. Ice may separate into vertical prisms when thawing; this leaves an extremely weak structure, irrespective of thickness. Often called "candle-ice" or "honeycombing," its development can be retarded by an insulating snow cover. Candle ice generally occurs on lakes and is less common on rivers because the surface flow of warm runoff water and ice movement contribute to the ice breakup. Thawing or deteriorating ice becomes dull, chalky, and brittle and loses its loadbearing capacity. "Rotten" ice, generally found in the top and bottom of clear ice, should not be considered when taking an ice measurement.

9.4.4 Density of Snow. The density of the snow is the ratio of its water-equivalent to its volume. Density of snow is one of its most important physical and mechanical properties because all other properties are related. Snow density is an important index for the possible use of snow for transportation and construction. For pedestrian traffic, densities in the order of 20 to 22 pounds per cubic foot are required. Truck traffic will require density of 31 to 37 pounds per cubic foot. Supporting power is calculated at 32°F. Supporting power will change greatly above 32°F as the moisture content increases.

9.4.5 Thickness. The thickness attained by ice in a single season depends on snow cover, water temperature and depth, velocity of the current, wind and wave action, and latitude. With slow moving or current-free water, the ice thickness is the greatest where the snow depth is the least. In general, the ice thickness varies inversely with the depth of the snow cover. The insulating property of snow retards the rate and extent of ice formation and also minimizes the melting effects of the sun during ice deterioration. Normally, fresh water does not freeze to a thickness of more than 8 feet in a single season. In lakes, the normal ice depths to be expected by late March are 3-1/2 to 6 feet, depending on the latitude. Under certain conditions, the ice may form 4 to 5 inches thick during the first 48 hours. After this thickness is reached, the rate of formation is much slower and it may be some time after the initial freeze-up before the ice is safe for crossings.

9.4.6 Load Capacity. A thickness of 14 to 20 inches of water borne freshwater ice is necessary for safe passage of heavy equipment. A safe rule of thumb for ice thickness required for armored vehicles is: 16 inches of waterborne ice can support 16 tons, and each additional inch can support an additional ton. This applies only for increasing loads and does not hold in the reverse order.

9.5 ROADS AND TRAILS. Rivers form water highways in the summer and ice roads in the winter. In the spring and fall, off road travel virtually ceases. Full utilization of all intelligence available through map, ground, aerial and space reconnaissance is mandatory to assure proper route selection and avoid needless construction efforts. Route selection criteria vary by season. Summer routes are selected for ground bearing (in most instances, areas with deciduous trees offer best trafficability), whereas terrain grades generally dictate winter routes because of the difficulties encountered in earth moving during sub-zero weather. Tracked vehicles do not eliminate the need for roads, regardless of the season. The vast roadless areas become, under summer conditions, even more difficult for overland vehicular movement than during the winter months when the ground and waterways are frozen.

9.6 SNOW REMOVAL. Snow removal, including control of snow drifting, is a maintenance measure. It begins as soon as the first snow falls and does not end until the last drifting halts in early spring. Snow on roads and runways is either compacted in place or removed by use of motorized snow-handling equipment. The compaction of snow, performed by special equipment designed for that purpose, is a matter both of maintenance and of new construction. Compaction is often prescribed as the best method for treating newly constructed, macadam-surfaced roads and runways in sub-arctic interior regions where the weather progresses steadily from warm to extremely cold temperatures, and back to warm temperatures.

9.7 AIRFIELD AND HELICOPTER LANDING ZONES.

9.7.1 Selection Factors. Selection factors for forward aviation sites such as size, approaches and exits, takeoff and landing direction, and security are the same as for normal operations. Helicopter landing sites can be prepared in winter by packing the snow with troops on skis or snowshoes or with tracked vehicles. Helicopter landing sites of compacted snow will minimize the problem of blowing snow.

9.7.2 Construction of Winter Airfields. After ice reconnaissance similar to that for roads and the selection of a site, the airstrip is leveled with dozers and graders. Deep depressions and holes are leveled by pumping water into them and allowing them to freeze; or by filling them with layers of compacted snow. The entire surface is covered with a layer of compacted snow. Site selection for airstrips should always include locations for alternate runways in case large cracks appear in the primary location during operations.

9.8 AIRFIELD SURFACING. Various types of prefabricated steel mats may be successfully laid over bare, frozen ground, over compacted snow, and over ice. However, their use creates problems of handling at cold temperatures. It is more economical to use the abundant snow and ice in all cases of temporary winter airfield surfacing than to transport mats to remote arctic or sub-arctic localities at the beginning of construction operations.

9.9 AIRFIELD MAINTENANCE.

9.9.1 Effect of Bombing. Experiments have shown that a 1,000 pound bomb dropped on sea ice 4 1/2 feet thick produces a hole roughly 100 feet in diameter. It scatters blocks of ice up to 5 feet square over an area 180 feet in diameter. These blocks quickly freeze to the surface ice, forming a complete obstacle to aircraft landing. Several days elapsed before the ice was strong enough to carry equipment necessary to restore the surface.

9.9.2 Thawing Temperatures. Runways constructed in winter will become non-operational as soon as thawing temperatures begin to melt the compacted snow surface. They will be an operational hazard at any time when the temperature of the air, combined with the heat of the sun, raises the runway surface temperature to 32°F or higher. Then the surface becomes "slick as ice."

9.9.3 Snow Removal. To provide space for removed snow, at least 150 feet of clear space should remain open between the near edges of parallel runways and taxiways.

9.9.4 Ground Water. Because of ground water, it is generally better to locate the parking aprons and attendant facilities on the side of the runway toward which the permafrost table slopes.

9.9.5 Runways. Runways to be used by the heavy aircraft now in use must usually be kept as free as possible of snow, and completely free of ice.

9.9.6 Artificial Snow Fences.

a. Types of Snow Fences. Commercial snow fences are commonly used, and consist of metal posts and wooden laths or metal pickets about 5 feet long woven together with wire. In some cases snow fences as high as 10 feet may be required.

b. Location. Before winter begins, reconnaissance is made to determine where snow fences will be needed to control the drifting of snow.

c. Placement. Snow fences are placed on the windward side of the runway/roadway, as determined from the prevailing winds (See Figures. 9-1 to 9-3). The height of the fence determines the distance it is to be placed from the traveled way. Generally, 15 times the height of the top of the fence is the proper distance.

d. Erection. Snow fences are built before the ground is frozen. Metal posts are driven into the ground, with fencing wired to the windward side. In regions of heavy snow, the use of long posts allows the fencing to be raised on the posts as the season progresses to increase snow storage to the leeward. Fencing is initially installed with the bottom about 6 inches above ground level to prevent the ends of pickets from freezing fast. Such freezing makes it difficult to raise the fence and may cause the pickets to break off when swayed by the wind. End posts are braced according to the wind velocities anticipated.

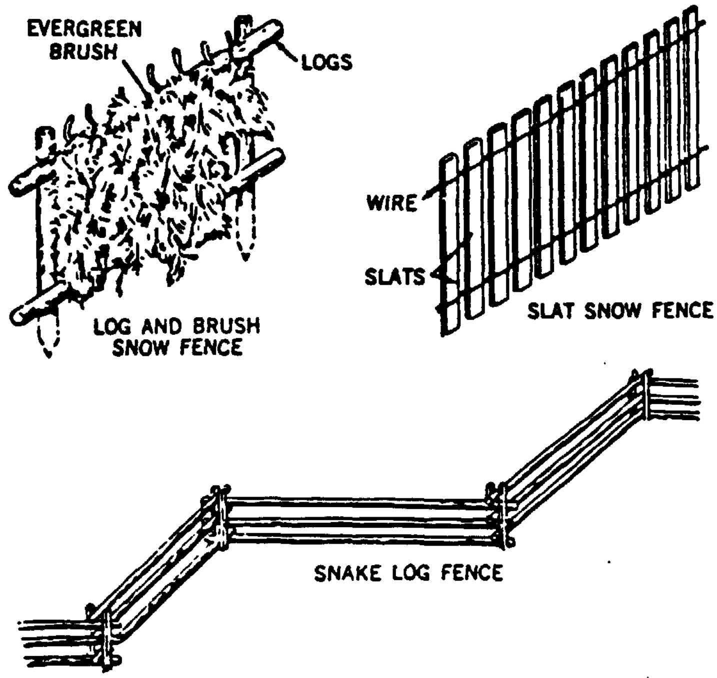

Figure 9-1. Types of Snow Fences

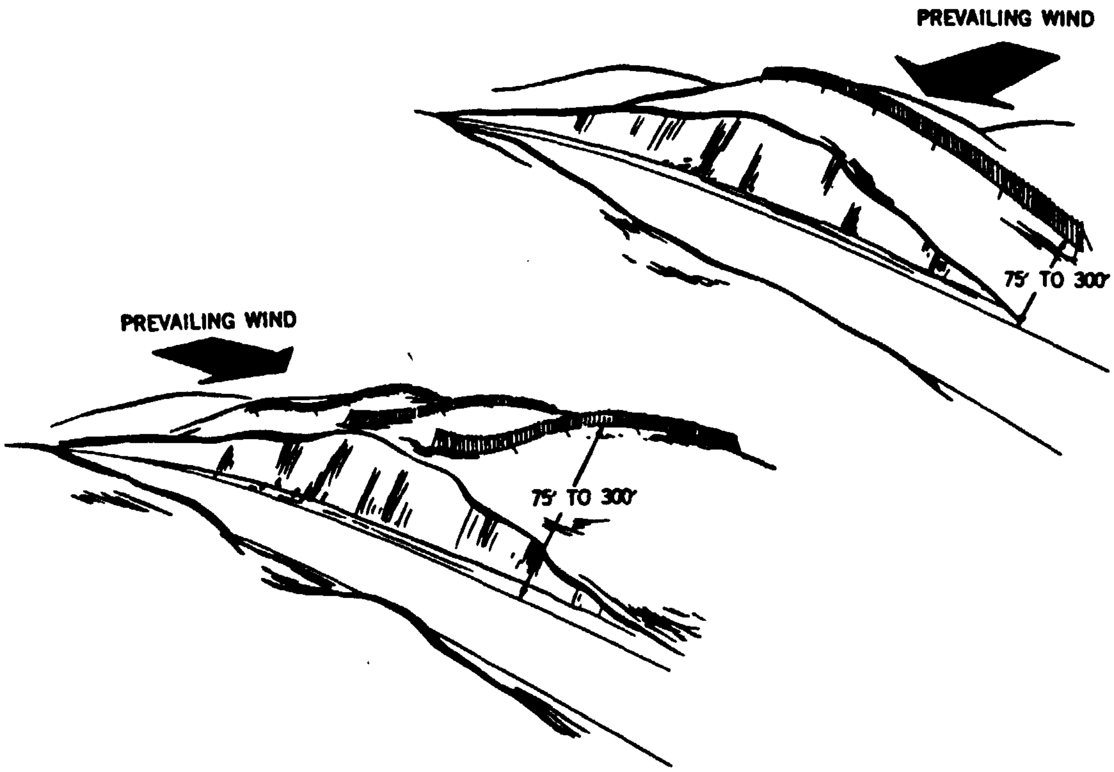

Figure 9-2. Placement of Snow Fences

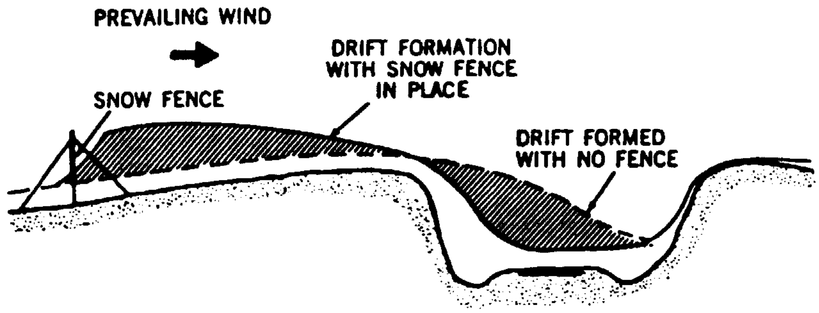

Figure 9-3. Control of Drift by Snow Fencing

9.10 USE OF EXPLOSIVES IN THE ARCTIC.

9.10.1 Explosive Requirements. In arctic/sub-arctic regions, requirements for explosives vary from those normally found in temperate climates. Explosives are in greater demand for use in construction work and for tasks that in temperate zones are normally done by machinery such as earth augers or ditchers. Explosives are used in quarry and sidehill cutting in mountainous terrain. At the outset of any operation, requirements for explosives must be carefully calculated with arctic conditions in mind.

9.10.2 Effects of Climate. The use of explosives under arctic conditions is complicated because low temperatures affect both explosives and crews. Explosives tend to detonate with reduced force, and personnel are severely chilled by extreme cold and handicapped by bulky clothing. Explosive storage problems arise primarily from the need for cold storage in spots which are isolated but accessible even during heavy winter snow conditions.

9.10.3 Camouflage. Special problems arise regarding the coloring of mines, wires, marking equipment, and other accessories. The colors of such objects should be adapted for arctic camouflage in winter snow or in summer vegetation.

9.11 FIELD FORTIFICATIONS. Fighting positions can be constructed of ice and snow; however in event of thaw, these positions lose strength, and are wet and difficult to fight from. Snow and ice will break down under sustained fire.

9.11.1 Survivability Support. Constructing fortifications and protective positions in frozen ground is difficult. Heavy earthmoving equipment requires longer digging time in frozen ground, and traction is reduced. Expedient techniques can be used to build positions above ground using snow. Some aspects to consider are that snow, if compacted, will stop or slow projectiles and fragments; is easier to move than the lightest unfrozen soil; and can be a satisfactory material for constructing shelters.

a. Dry snow can be easily compacted to a density of 25 pounds per cubic foot with a few blows of a snow shovel.

b. **Hasty Firing Positions.** Hastily made firing positions and trenches are built in the snow and reinforced with readily obtainable materials such as ice, wood, or branches. A minimum of 6 1/2 feet of solidly packed snow is required for adequate protection from small arms fire. If possible, positions are dug into the ground. Shelter is built simultaneously with the construction of positions.

c. **Artificial Barriers.** Weak spots in the defense should be reinforced with artificial barriers. Places where there is little snow or which are easily traversed by the enemy require barriers such as wire entanglements, pitfalls, minefields and iced slopes.

d. In forested areas, measures should be taken to protect defensive positions against deliberately set forest fires.

e. Dummy positions, which are especially effective in winter, are used extensively to mislead both ground and air observation.

f. Wire barriers are practical, but because they require continual surveillance tend to lose their usefulness as the depth of snow increases.

g. A breastwork of snow can be built if time is short. Sandbags filled with sand or snow are effective in the silent and speedy construction of defensive positions in frozen ground. Water poured on the bags freezes and improves their protective qualities for the duration of the cold weather.

h. Tunnels. If the snow is deep enough, tunnels can be constructed. They do not provide effective protection against artillery fire, but do afford complete concealment and effectively eliminate infrared signature.

9.11.2 Construction Materials.

a. **Snow.** Dry snow is less suitable for expedient construction than wet snow because it does not pack as well. Snow piled at road edges after clearing equipment has passed condenses and begins to harden within hours after disturbance, even at very low temperatures.

b. Ice. The initial projectile stopping capability of ice is better than snow or frozen soil; however, under sustained fire, ice rapidly cracks and collapses.

c. Icecrete. Water is also used to form icecrete. This is a mixture of sand, soil, chipped ice or gravel, and water. Mixing is done either by hand or in a concrete mixer.

d. Frozen/Unfrozen Soil. Frozen soil is three to five times stronger than ice, and increases in strength with lower temperatures. Frozen soil has much better resistance to impact and explosion than to steadily acting loads (an especially valuable feature for position construction purposes). Unfrozen soil from beneath the frozen layer is sometimes used to construct a position quickly before the soil freezes. Material made of gravel, sand or silt aggregate wetted to saturation and poured like portland cement concrete is also suitable for constructing positions. After freezing, the material has the properties of concrete. See Figure 9.4 for Penetration of small arms projectiles into frozen materials.

SNOW DENSITY (lb/sq ft)	PROJECTILES	MUZZLE VELOCITY	PENETRATION (feet)	REQUIRED MINIMUM THICKNESS
18.0-25.0	Grenade frag (HE)	2.0		3.0
11.2-13.0	5.56 mm	3,250	3.8	4.4
17.4-23.7	5.56 mm	3,250	2.3	2.6
11.2-13.1	7.62 mm	2,750	13.0	15.0
17.4-23.7	7.62 mm	2,750	5.2	6.0
25.5-28.7	7.62 mm	2,750	5.0	5.8
19.9-24.9	12.7 mm	2,910	6.4	7.4
	14.5 mm		6.0	8.0
28.1-31.2	70 mm HEAT	900	14.0	17.5
31.2-34.9	70 mm HEAT	900	8.7-10.0	13.0
27.5-34.9	90 mm HEAT	700	9.5-11.2	14.5

Figure. 9-4. .Snow Wall Construction for Protection From Grenades, Small Caliber Fire, and HEAT Projectiles

Notes: These materials degrade under sustained fire. Penetrations given for 12.7 mm or smaller are for sustained fire (30 continuous firings into a 1 by 1 foot area).

Penetration characteristics of Warsaw Pact ammunition does not differ significantly from US counterparts.

Figures given for HEAT weapons are for Soviet RPG-7 (70 mm) and US M67 (90 mm) fired into machine-packed snow.

High explosive grenades produce small, high velocity fragments which stop in about 2 feet of packed snow. Effective protection from direct fire is independent of delivery method, including newer machine guns like the Soviet AGS-17 (30 mm) or US MK 19/M75 (40 mm). Only armor penetrating rounds are effective.

9.12 BRIDGING.

9.12.1 General Stream Crossing. The many lakes, swamps, and streams require increased quantities of stream crossing equipment, to include ferries and fixed and floating bridges. As a result, there is an increased requirement for troops, bridge installation, and maintenance. Drainage throughout the sub-arctic is complicated and inefficient. Rivers flow north and the ice starts to melt in the south, thus causing overflow and flooding until the river mouths are thawed.

9.12.2 Bridge Construction. Bridge construction methods employed in temperate areas are suitable for use in the arctic, if special precautions to deal with arctic conditions are taken. Consideration must be given to logistical support, construction seasons, and the special bridging requirements brought about by stream characteristics, permafrost, and ice conditions.

9.13 POTABLE WATER. The major sources of water supply in order of efficiency and economy are: drawing water from under river or lake ice, melting ice, melting snow, and drilling wells. Melting of ice or snow in quantities required for unit needs is impractical and is primarily an emergency method. Heated shelters may be necessary for operation of water purification units. If water is not available under river or lake ice, special or improvised ice melting equipment can be used to melt the ice in place. For cutting holes through thick ice to prepare a water hole, shaped charges are far superior to hand tools. The development of an adequate water supply system usually requires: selecting a water supply site; developing the source; constructing water storage facilities; treating the water; and constructing a water distribution system.

9.13.1 Choice of Site. Choice of water sites is based on the water supply data obtained from reconnaissance and from site surveys.

9.13.2 Development of Source.

a. Rivers and Lakes. Rivers and lakes so deep that they do not freeze to the bottom in winter can be developed as water supply sources by constructing offshore collecting basins, channels, or intakes.

b. Wells. Wells are easily located and constructed in glacial gravel till areas found extensively throughout the arctic and sub-arctic regions. Even in extremely rough and rocky terrain, the water table lies near or in the permafrost zone. Operation of these wells requires special attention to prevent freezing of the water at the permafrost level. Large units will require many shallow outlying wells, due to shallow confined aquifers.

c. Storage. Storage facilities are a necessary part of any water supply system. They provide a reserve for peak loads and emergencies such as fire fighting, and against breakdown of pumping equipment.

d. Water Treatment and Purification. The water treatment required depends primarily on the quality of the source. All water for drinking must be chlorinated. Surface water from streams generally requires filtration. Ground water seldom needs filtration, but generally needs treatment to remove dissolved minerals. Water obtained directly from melted snow or ice by either natural run off or artificially induced melting requires very little treatment.

e. Distribution. Water distribution systems, particularly buried pipelines, present special construction problems in permafrost regions. Adequate measures must be taken to prevent water from freezing in pipelines and to avoid disturbing the supporting adjacent ground.

9.14 HYGIENE SERVICES. Bath and laundry units should be established immediately adjacent to rivers or lakes to reduce the problem of the water freezing between the source of supply and the point of use. Detailed consideration must be given to the disposal of waste water. If a moving water source is utilized, adjacent downstream discharge of runoff is desirable, friendly units downstream considered. When utilizing a stationary water source, an adjacent runoff containment area is needed. The size of what will become an iced over area, and the results when thawing conditions occur must be considered. These facilities are not always within reasonable distances of major units.

9.15 STORAGE. During summer seasons, well drained ground is selected for storage sites. All supplies stored in the open should be stacked on pallets or dunnage to prevent freezing to the ground. Special fuzes, batteries, and other items subject to damage by freezing are stocked in heated shelter. Tents warmed by high BTU blower type heaters may be employed.

CHAPTER 10. CHEMICAL, BIOLOGICAL, AND RADIOLOGICAL (CBR) DEFENSE IN COLD WEATHER OPERATIONS

10.1 GENERAL. CBR defense in a cold weather environment is more difficult because protective equipment requires constant attention and maintenance. Commanders need to be aware that the cold adversely affects the rubber, plastic, and filters that make up the individual protective equipment. Monitoring and surveying, decontamination, and unit protection will all be more difficult. Commanders must aggressively incorporate CBR training into the cold weather training schedule. It must be emphasized that threat doctrine calls for tactical methods in cold weather not much different from those for other seasons. The confirmed experimentation and use of a variety of agents in recent conflicts by the threat leaves no question of their capability and intention.

10.2 COLD WEATHER EFFECTS ON NUCLEAR DETONATIONS.

10.2.1 Blast. Primary and reflected blast waves and ground shock from detonation of even small yield nuclear weapons may cause avalanches and rock slides as far as 30 kilometers or more away from ground zero. Variations in terrain and weather influence the blast as follows:

a. Unfrozen Muskeg/Tundra. Unfrozen muskeg and tundra provide an average blast reflecting surface with no appreciable difference in characteristics.

b Hard Frozen Ground/Thin Layer of Packed Snow. Hard frozen ground or ground with a thin layer of packed snow provide good blast reflecting surface. The shock wave transmitted through the ground will be appreciably greater, and dug-in defenses will be particularly liable to damage.

c. Newly Fallen, Loose Snow. Newly fallen, loose snow provides a poor blast reflecting surface with a decrease in overall effects.

d. Significant Secondary Effects. Secondary effects caused by the blast are temporary snowstorms, avalanches, quick thaws, and ice break-up on lakes and rivers.

e. Sub-zero Temperatures. In sub-zero temperatures, damage radius to material targets is increased up to 20 percent. The disturbance in permafrost may restrict or disrupt movement. Frozen tree trunks and branches are broken into many projectiles moving at high speeds.

10.2.2 Thermal. Clear, cold air and reflection from the snow greatly increase heat and light radiation. This increases minimum safe distances as much as

50 percent. A higher incidence of eye injuries will be experienced at greater distances from ground zero as a result of the brilliant flash, especially at night. Burn casualties will be reduced by the added clothing required by cooler temperatures at high latitudes, and by the low absorption properties of pale colors (camouflage over whites). Variations in terrain and weather affect thermal characteristics as follows:

a. **Muskeg, Tundra, Wet Terrain.** These are average reflecting surfaces which reduce the effectiveness of thermal radiation.

b. **Snow.** Snow is a good reflecting surface which increases the effectiveness of thermal radiation.

c. **Ice Fog/Snow Cloud Cover.** Ice fog creates unfavorable conditions and snow cloud cover reduces effectiveness if the device is detonated as an air burst.

d. **Cold Temperatures, Snow, Ice, or Frost Coverings.** This combination of conditions will inhibit thermal effects on combustible materials. Subsurface fires may be experienced in heavy tundra.

10.2.3. Radiation. Weather plays an important part in radioactive fallout patterns. At extremely low temperatures, the increased density of the atmosphere may reduce the distances of initial radioactivity by as much as 25 percent. Fallout will normally be extended in a particular direction, following local wind patterns, however, contaminated snow can still spread. The deposition is erratic because of rapidly changing winds. Levels of local radiation can change quickly in windy conditions. This can lead to "hot spots" far removed from ground zero and very low intensity areas near it.

a. The amount of induced radioactivity in the soil is reduced by the presence of ice and snow, and may even be prevented by deep snow.

b. Poorly drained areas such as meadows, limit natural flushing of radioactive contaminants.

c. For the individual, the heavy cold weather clothing provides excellent protection from fallout particles. Removal of radioactive particles is done primarily by rigorous shaking and brushing of outer garments.

10.2.4 Electromagnetic Pulse (EMP) The effects of EMP are expected to be the same as in temperate zones.

10.3. COLD WEATHER EFFECTS ON CHEMICAL AGENTS.

10.3.1 Prevalent US View. The American chemical defense community generally considers there to be little threat from chemical agents in extreme cold because of the low vapor hazards of agents at low temperatures. The "pick up" hazard of solid chemicals is a major hazard.

10.4. COLD WEATHER EFFECTS ON BIOLOGICAL AGENTS.

10.4.1 Effects of the Cold. Cold weather discourages the use of vectorborne agents since they can't survive, and aerosolizing live biological agents becomes more difficult in this environment. At extremely cold temperatures, only some spore forming bacteria and certain viruses survive. Layers of snow and reduced sunlight in the northern regions, lengthens the hazard period for biological agents by allowing the organism to remain alive but dormant. Therefore, the only effective means of biological warfare in cold weather is by delivery of live organisms by covert means.

10.4.2 Effects on Personnel. If a biological agent has been disseminated, contamination may be encountered at sites far removed from the source. Personnel are more susceptible to biological agents. The body's immune system does not function as well in cold weather. Rapid rate diseases spread in the crowded conditions and the effects become more pronounced because of difficulties encountered in maintaining personal hygiene, good eating habits, and normal body functions. For this reason, special attention must be paid to maintaining a high degree of personal hygiene. Insure troops consume only purified, approved water.

10.5 COLD WEATHER CBR PROTECTION. To defend against the effects of CBR weapons, four fundamentals must be applied. They are detection, contamination avoidance, protection, and decontamination. In a mountainous/cold weather environment, the first three fundamentals become extremely important as decontamination quickly becomes a logistical nightmare.

10.5.1 Detection. The first fundamental of CBR Defense is detection. The following are some considerations:

a. Identification. All personnel have the responsibility to identify biological and chemical agents suspected or known to be in their sectors.

b. Survey Teams. They should be trained and basically equipped to conduct CBR detection when the area under reconnaissance is suspected of contamination.

CHAPTER 11. BIVOUAC ROUTINE

11.1. FIELD SANITATION.

11.1.1 Garbage Pits. Whenever possible, all garbage should be disposed of in garbage pits, and either burned or buried before departure from the bivouac site. There should be a pit for each tent group. Patrols should never leave any evidence of their presence behind them. All waste must be carried until it can be disposed of without trace.

11.1.2 Heads. There will normally be a central head if dispersion within the camp is not too great. One head will usually serve the needs of three to four shelters or a unit of platoon size. It must be placed downwind of the campsite, but not so far from the shelters as to encourage people to break sanitary discipline. A pit or cross tree type head is the usual type, windproofed by branches, snowblocks, ponchos, or any other available material, and properly camouflaged. Urinals are cut into the snow walls around tents or shelters, or arranged around a tree which will hide the discolored snow.

11.2 SECURITY. A bivouac must be properly protected by a system of listening posts, sentries, and warning devices appropriate to the proximity of the enemy, the length of time for which it is to be occupied and the tactical situation. A bivouac which is an integral part of a defensive position will get its protection within the overall defense plan. Under very cold conditions, sentries can only remain alert for very short periods. They cannot look into the wind for long, and in spite of frequent reliefs can hear and see little.

11.2.1. Tactical Bivouac. A tactical bivouac should be protected by establishing listening posts and such warning devices as can be positioned quickly:

a. Listening posts should be deployed on likely enemy lines of approach.

b. Trip wires and night observation devices should be set up.

c. All posts and devices set up outside the perimeter should be approached from a flank so that an enemy patrol that stumbles on the tracks is not led straight to the bivouac site.

d. If a bivouac is close to the enemy or vulnerable to attack, troops not on post should rest in their sleeping bags, fully clothed, with the zipper open and their boots on.

e. Lights in tents should be kept to a minimum to preserve night vision.

11.2.2 Alarms. An alarm system must be devised enabling each tent commander to be alerted. When the alarm is given, the occupants of a tent should prepare to move, but no one should leave until all are ready.

11.2.3 Sentries. Commanders must use their judgment on how long an individual can be on duty outside (this time will vary with the temperature, degree of windchill and visibility). The following are some solutions that may fit different circumstances:

a. A number of combined living and fighting positions can be established on likely enemy approaches to provide for small standing patrols, with a warning system to give those in the main position notice of any enemy approach.

b. One complete sub-unit can be used to provide all sentries, allowing the remainder an extended period of time out of the cold for rest and warmth.

c. Double all guards so that one man is on guard and one is acting as fire guard in a shelter. Their positions can then be changed every 30 minutes or more often if necessary, with the fire guard going out to relieve the sentry on the post. Both men should be relieved at staggered intervals.

11.3. RECONNAISSANCE OF THE BIVOUAC SITE. If the bivouac site is to be tactical, the commander must be careful about his site selection. Some types of country offer better bivouac than others, and these should be selected if there is any choice:

11.3.1 Forested Areas. Forests provide excellent sites; camouflage is easy and building materials, firewood, and wood for insulation are readily available. Pine and spruce grow on well drained soil, and coniferous forests are therefore better than deciduous.

11.3.2 Marshy Ground. In winter, frozen swampy areas can offer good sites, as do the banks of rivers and shores of lakes. Deep valleys should be avoided, as cold air gathers in such places.

11.3.3 Open Country. Open country should be avoided because it is exposed to strong winds and drifting snow and also provides poor concealment. If this is not possible, then shelters should be pitched in the lee of natural windbreaks. These are normally found in depressions or behind pressure ridges of ice on lakes and glaciers. If no natural windbreaks exist, then shelters must be dug deep into the snow, and snow blocks used to construct windbreaks.

11.3.4 Mountainous Areas. These are usually open, especially above the tree line, and offer little shelter. When there is a high wind, pockets of relatively still air occur in the shelter of a lee slope, and such positions should be sought. Avalanches can occur on steep slopes, and their likely path must be avoided.

11.3.5 Likely Enemy Contact. When contact with the enemy is likely, the following factors should be taken into account when selecting the site of a tactical bivouac:

a. The proximity of the enemy.

b. Enemy patrol habits.

c. The air threat.

d. Dominating features from which an attack could develop.

e. The wind direction which may carry sounds of movement (the bivouac should be downwind of likely enemy approach routes particularly when wind speeds are low).

f. Routes out in the event of a hurried move.

g. Availability of camouflage material.

h. State of moon and weather. In good weather or bright moonlight, the bivouac must be in an area of deep shadow; e.g., in the middle of a wood or on the northern slope of a ridge.

11.3.6 Site Selection. The commander must precede the main body with a reconnaissance party whose task it is to lay out the bivouac site and then receive incoming troops. They must:

a. Site the bivouac and a dummy, if necessary.

b. Establish a track plan.

c. Select defensive positions.

d. Mark individual tent sites.

e. Select areas for cutting brushwood.

f. Act as guides for the main body on their arrival.

g. Protect the position during occupation by the main body.

APPENDIX A . SURVIVAL SHELTERS

A.1 GENERAL. Construction of survival shelters is dependent upon the materials found in the survival site, and the imagination and capability of the personnel building the shelter. In the military area, an important consideration is the camouflage of the shelter and how it blends into the surrounding area. This consideration of course would include track discipline of the survival site. The bivouac must provide shelter from the elements and warmth.

A.2 BRUSHWOOD BIVOUACS. Brushwood bivouacs take longer to build than erecting a tent but they can be effectively camouflaged and sometimes more easily incorporated into a defensive layout. There are five main types which are described in this section, but there is opportunity for personal enterprise and initiative that can improve comfort and enable a shelter to be devised with a variety of materials and to suit different tactical needs.

A.2.1 The Single Lean-To Shelter. This shelter should be built with its back to the wind or it will be cold and smoke-filled. The snow should be cleared down to ground level if possible and the main poles positioned in the manner shown (See Figure A-1). The top crossbar should then be placed at about shoulder height. Twenty-four inches of width should be allowed for each inhabitant. Figure A-1 shows a lean-to that is just over 2 meters deep, allowing enough space for men to lie with their packs behind their heads. Good strong timbers should be used for the main structure. The top crossbar should be 4-6 inches in diameter. The lean-to is completed with the building of a fire and reflecting wall. This wall should be about 1.5 meters from the front of the lean-to, and extend the full length of it. The fire should also extend the full length so that every man has an opportunity to warm himself. It is important to build a good base for the fire if it is on snow. Enough logs should be cut to keep the fire going all night.

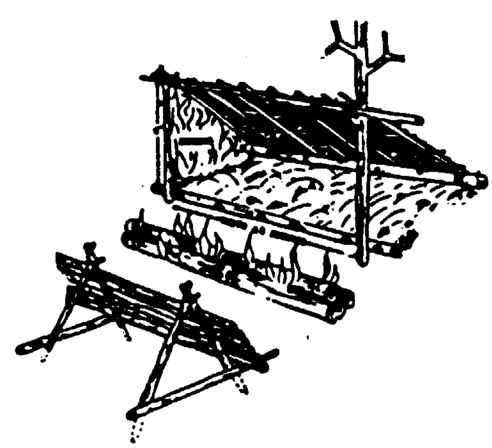

Figure A-1. The Single Lean-To Shelter.

A.2.2 The Double Lean-To Shelter. The double lean-to is built in the same way as two single lean-to's facing each other. The arrangements of the two structures are shown in figure A-2. This shelter is economical, since only one fire is built for two bivouacs, and no reflector walls are needed. However, the layout is not very satisfactory in windy weather since the occupants of one shelter will be troubled by smoke.

Figure A-2. The Double Lean-To Shelter.

A.2.3 The Wigwam. The wigwam is the warmest and most draft free of all brush-wood bivouac types. It is, however, tall, and unless it is well concealed among standing trees, it tends to present a conspicuous silhouette. Very big wigwams can be built that can house up to ten men but one for four men is most usual, and is shown in figure A-3.

Figure A-3. The Wigwam.

A.2.4 The Tree-Pit Bivouac. Where there is deep snow in a wooded area, a very quick bivouac can be made using the lower branches of a tree as a roof. A shelter of this type is very easy to conceal. It can be made for up to four men, but above this size is unsatisfactory as few fir trees have a wide enough spread to provide cover. The two-man size is most common.

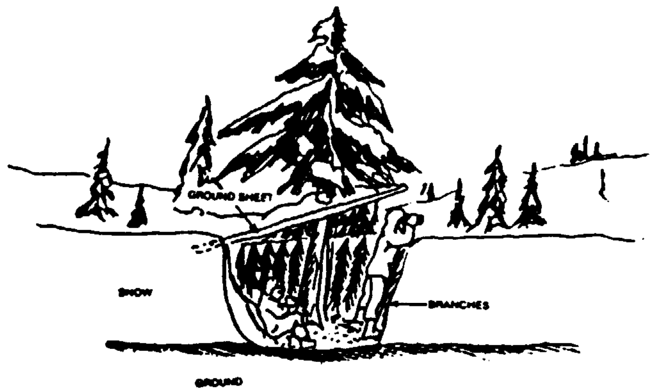

Fig A-4. The Tree-Pit Bivouac.

A.2.5 The Fallen Tree Bivouac. Another easily concealed and quickly made shelter uses a cut or fallen tree. If a tree has to be cut, one with plenty of green branches should be selected and felled at such a height that, when the snow is dug down to ground level underneath the fallen tree, there will be about 1 to 1-1/2 meters head-room. The inside limbs are trimmed off; these can be used to thicken up the sides. Figure A-5, shows a fallen tree shelter for two men. Bigger ones can seldom be made satisfactorily. Once the sidewalls have been packed with branches, snow can be piled up to prevent drafts, and a good bed of brushwood laid on the floor. A fire base can be built in the front with a reflector wall beyond it within the same limitations as those for the tree-pit bivouac.

Fig. A-5. The Fallen Tree Bivouac.

A.3 SNOW SHELTERS. Snow shelters are relatively easy to build, provided there is enough snow of the proper quality available. They can be more easily concealed than tents or brushwood bivouacs, are very warm, and because of their white reflective walls, easily illuminated. Building snow shelters follows no firm rules. The depth and condition of the snow will vary and the tactical needs may dictate the type and the degree of comfort that can be achieved. They are often tactically used as expeditious shelters for pickets or reconnaissance type units. Snow shelters are easily camouflaged, and once the inside glazes with ice they give off a very limited IR signature. Once constructed they provide excellent warmth. A few of the basic types are described in this section.

A.3.1 General Considerations. There are a few important principles to observe when constructing snow shelters:

a. Air Trap. The top of the entrance should be lower than the sleeping bench. This will ensure that warm air is trapped around the occupants.

b. Smooth Ceiling. The ceiling should be arched and smooth to prevent dripping. Ceilings will melt back with age and the internal dimensions of the shelter increase.

c. Snow Shovel. At least one snow shovel should be kept inside every snow shelter so that men can dig themselves out if it collapses. Another shovel should be kept outside the entrance.

d. Vent Hole. Every snow shelter must have a permanently open ventilation hole in the roof or walls; a hole made with a ski pole is very suitable for this purpose.

e. Maintaining Dryness. When constructing snow shelters, Seabees must be careful to stay dry. They should strip down to the minimum amount of clothing necessary and, if possible, wear their rain suit or ECWCS clothing. While snow shelters are warm and well insulated from the cold, they are cramped and difficult to dry clothing in.

A.3.2 The Snow Cave. The snow cave is simple to build, comfortable, easy to conceal, and very warm. It requires a large snow bank or drift. It is important to choose carefully and estimate the depth of snow before starting work. Examination of the ground behind the snow bank, protruding saplings, windblown ridges, and exposed moss surfaces or rock are often a useful guide. For a two or four-man cave a drift 3 meters wide and 2 meters deep is needed. Bigger caves require proportionately bigger drifts. A snow cave can be built either by tunneling or by building it up with blocks of snow.

a. The Tunnel Method. A tunnel is made into the snowbank. Initially, only one man can work, but later, two can be employed. The front man tunnels, while the second clears the excavated snow away from the entrance. Having dug in about 2 meters, the location of the sleeping bench must be determined. If there appears to be plenty of snow, it is probably best to have a sleeping bench on either side of the tunnel lying along the axis. If the snow bank is narrow, it may be necessary to have the sleeping bench at right angles to the tunnel, figure A-6. A snow block can be used to seal up the entrance to the tunnel, but care must be taken to ensure that a ventilation hole remains open.

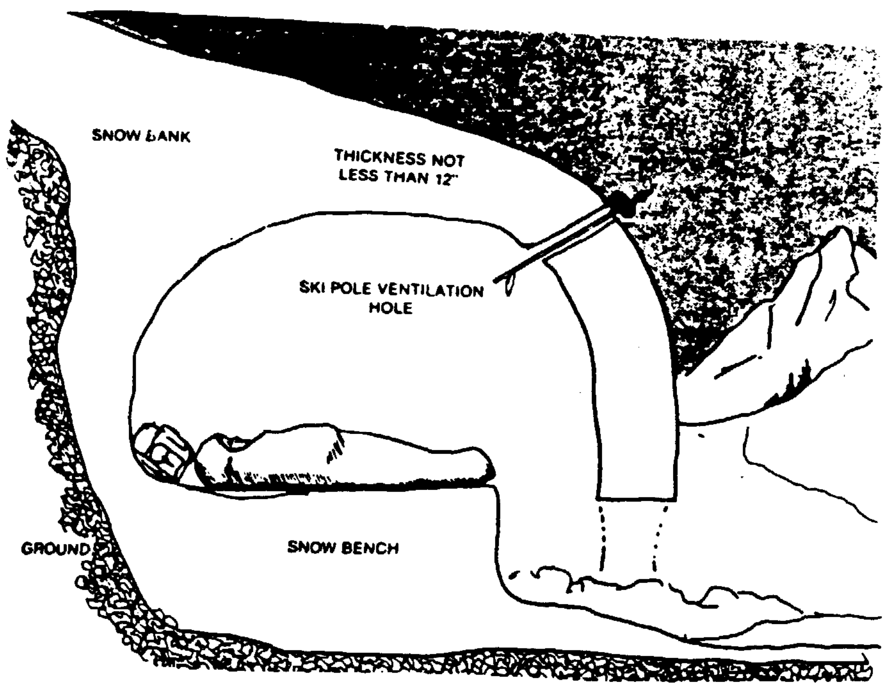

Figure A-6. A Tunnel Snow Cave

b. The Block and Cave Method. If the snow is easy to cut into blocks, the block and cave method should be used. The principles for deciding the internal layout of a snow cave using this building method are the same as those used in tunneling. Having decided upon the total internal width of the snow hole, one can dig straight into the snowdrift all along this width. There is plenty of room to work and several men can work together while one man digs the entrance tunnel to the side of the main excavation. Once the snow hole is completed and sleeping benches and a stove position are established, the cave can be sealed with snow blocks. These blocks are best cut during the last stages of excavation since the snow is usually more densely packed inside a drift. Also by using snow blocks from this area, the minimum amount of snow moving is necessary. An example can be seen in figure A-7.

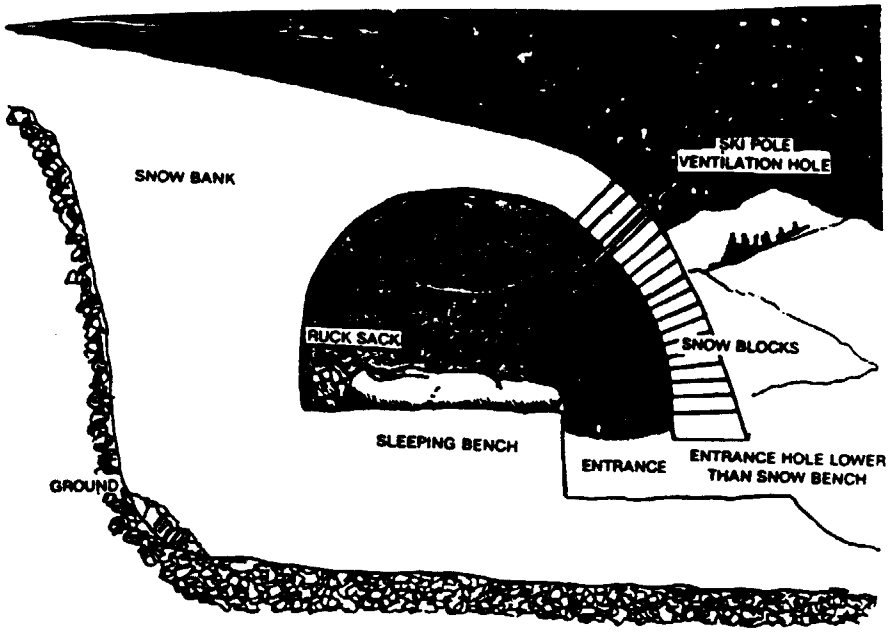

Fig. A-7. A Block and Cave Snow Hole.

A.3.3 The Quin-zee. The quin-zee is a modified snow cave constructed after first developing an adequate snow quarry from which the shelter can be built (tunneled into). This snow shelter can be constructed with the minimal amounts of available snow. If the snow is granular or powdery this shelter can still be built, however longer time must be allocated for the snow to "set up." The snow is first piled up to about 8 to 10 feet diameter and about 7 to 8 feet high. The snow is packed and allowed to set up (generally 1 to 2 hours). The shelter is then hollowed out. The door is the weakest part of the shelter and should be beveled upward and kept as small as possible for heat retention. Walls should be about 18 inches thick. Snow that is removed from the inside can be piled on the outside to increase the insulation and reduce light/IR signature. A vent hole is necessary and the inside walls need to be smoothed. A sleeping step should be constructed under personnel and equipment and the inside of the shelter ditched to prevent the condensation which will move down the walls from puddling under personnel and equipment. In extreme cold/wind conditions a wind block/tunnel will need to be constructed at the opening.

A.3.4 The Snow Trench. The snow trench is a trench dug in the snow and covered to provide protection. It is the easiest and quickest snow shelter to build, easily concealed, and gives good protection. It is not particularly comfortable, since it is cramped, and entry and exit can be difficult.

a. To build a snow trench, at least 3 feet of snow is needed. First mark out an area about 8 feet by 2 feet, then dig out the trench. Snow spoil should be laid to one side of the trench for use on the roof later. If ground is reached before the trench reaches shoulder height, snow walls can be built to gain the extra height. If two men are to use snow trench it should be widened toward the bottom to make a sleeping bench 4 feet wide. The top must not be too wide, or bridging it for a roof may present problems.

b. Before the roof is put on, packs should be moved inside since it may be difficult to do this later. If it is possible to insulate the floor with brushwood, scrub or moss, this should also be done at this stage. Now dig an entrance tunnel. Putting on the roof can be done several ways. Providing the snow is reasonably compact, blocks can be cut and laid across the top of the trench. Once these are in place, loose snow can be thrown on top to increase the depth of the roof and improve the camouflage. If it is not possible to roof in with snow blocks, the trench should be covered with branches or brushwood, a tent sheet or, in extreme cases where shelter is vital for survival, skis and ski sticks. If skis have to be used, they should be placed with the bindings downward so that these do not freeze. Snow can be piled on top of any of these structures (See figure. A-8).

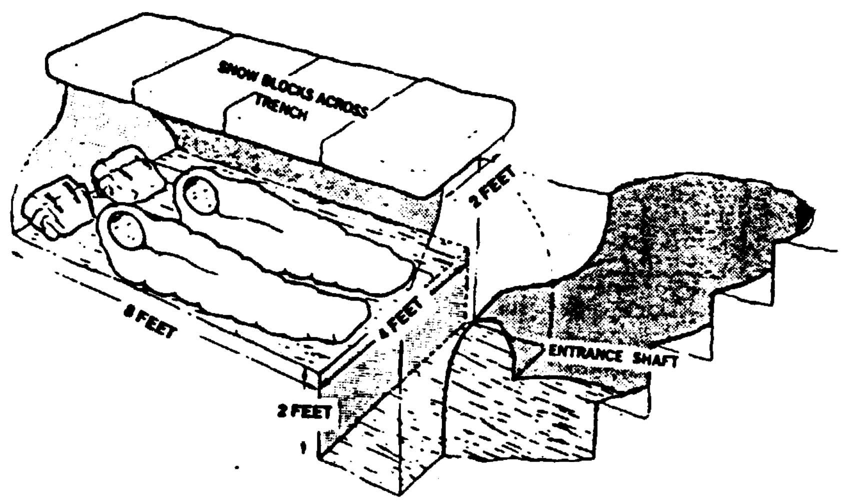

Figure A-8. The Snow Trench.

A.3.5 The Snow House or Igloo. The snow house or igloo provides greater protection from the weather and is warmer and stronger than any other snow shelter. Its construction requires experience, practice, and good quality snow from which blocks can be cut. It can be constructed from a snow quarry, however, powdery and granular snow are generally useless, and the poorer the quality of the snow, the smaller must be the igloo. Igloos can be made for any number of men up to ten.

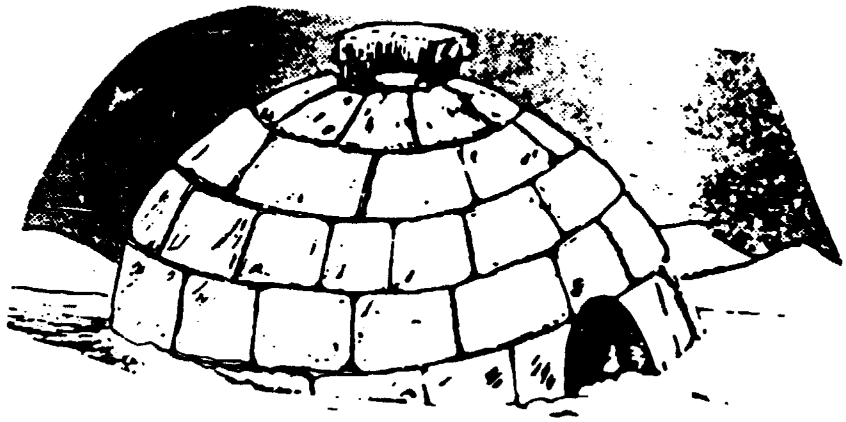

Figure A-9. The Snow House or Igloo

A.3.6 **A Snow Wall.** If there is little time available, a snow wall can provide some shelter quickly. Snow bricks are cut and laid in a semicircle with the open side away from the wind. The snow is then banked against the outer, windward side. A wall built like this provides protection from the wind and driven snow for cooking a meal and sleeping (See Figure A-10).

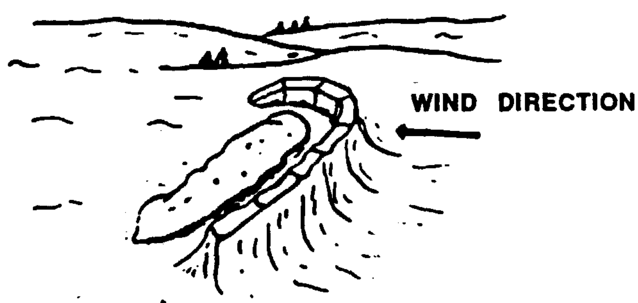

Figure A-10. Snow Wall.

APPENDIX B. THE AHKIO SQUAD SLED

B.1 GENERAL. Two Hundred-Pound Sled (Ahkio). Combat operations in cold weather in snow require considerably more equipment at the squad/section level than is necessary in temperate climates. This excess weight can easily exceed 200 pounds. It is not practical to man pack this extra equipment, considering that each Seabee is carrying a 70-pound load. To move this extra equipment, the ahkio sled must be employed.

B.2 TECHNICAL DESCRIPTION. Characteristics of the ahkio are: weight, 38 pounds; length, 88 inches (223.5 cm); and width, 24 inches (61 cm).

B.3 CAPABILITIES. The ahkio is a tub-shaped sled capable of carrying a load of 200 pounds over difficult terrain. The sled is equipped with tents, stoves, fuel, rations, and other necessary items. The sled may be used as a firing platform for crew served weapons in deep snow and is very useful for evacuating casualties.

B.4 SLED COMPONENTS

a. Four web-belt harnesses with quick-release buckles and adjustable shoulder straps.

b. Four 9 ft. traces (tow lines) with snap buckles at each end.

c. One 27 ft. trace with snap/buckle at one end and "O" ring at the other.

d. White canvas cover.

B.5 CARE. Because of its ability to carry large loads over almost any snow-covered terrain, the ahkio is a valuable piece of equipment and, as such, should be cared for. When in bivouac or other static position, the sled should be placed on a rack to prevent freezing to the snow. When not in use, ensure that the cover is kept closed to prevent snow from accumulating inside the ahkio. When pushing the ahkio, do not use ski poles or any other sharp object that may puncture or tear the canvas cover.

B.6 AHKIO EQUIPMENT AND PACKING.

B.6.1 Ahkio Equipment. To ensure swift and easy movement of all required gear, the ahkio must be complete and in good working order. The ahkio should not have any cracks or holes in either the fiberglass bottom or the canvas cover. The ropes used for tightening should be long enough and be free of any breaks. The ahkio hooks and D-rings should be tightly secured around the sides of the ahkio. The following is the normal load for the ahkio.

a. Five/Ten-Man Arctic Tent.

b. M-1950 Yukon Stove.

c. Five-Gallon Gas Can. To provide fuel, a gas can is included in the ahkio. It should have a proper fitting cap with an extra rubber gasket.

d. Shovels, Axe, and Saw. To aid in movement of the ahkio in wooded areas, and to help speed up the construction of the bivouac site and defensive positions, one saw, three machetes, one axe and two shovels are included in the ahkio. The axe should be well sharpened to ensure a clean cut. Check to make sure that the head of the axe is tight fitting on the hardwood handle. The saw and machetes should also be sharp to aid cutting of timber.

e. Miscellaneous Gear. A few other items that could also be carried in the ahkio are as follows: one or more cook sets, one case of emergency rations, stove board, 5-gallon water can, extra snowshoe/ski bindings, candles, and plastic bags. The gear mentioned so far will make the individual Seabee comfortable and increase effectiveness in combat if correctly used. Squad stoves, lanterns, and appropriate fuel, if they can be packed, also will greatly enhance the morale of the Seabees in the tent groups.

f. Ropes. The Seabee must also ensure that the proper gear for moving the ahkio is present and usable. Contained with the ahkio is one 120-foot mountain coil. The coil can be used for movement behind tracked vehicles or for belaying the ahkio up or down steep slopes. The coil should be free of cuts or frays. For foot movement over snow-covered terrain, one 27-foot rope and four 9-foot ropes are used. These ropes should also be free of any cuts or frays.

g. Harnesses. To be able to move the ahkio by foot, four harnesses should be used. The harnesses attach to the different length ropes. To prevent any injury due to the ahkio getting out of control, the quick release on each harness should be checked for proper functioning.

B.6.2 Packing. A general rule of thumb is that heavier items go to the bottom and slightly to the rear and lighter items to the top and front.ensure maximum space for packing, the ahkio should be clear of snow and debris. The ahkio can be packed securely when the 5/10-man tent is folded up and wrapped in its canvas cover. The telescopic tent pole is placed in the center of the ahkio. Next place the tent on top of the tent pole, just to the rear of center. In the front of the tent place the Yukon stove with any C-ration cases.

The available space in front can accommodate squad stoves, cook sets, candles, and miscellaneous gear. To the rear of the tent, place the gas and water cans. The tent pins and any other small gear can now be stored to the rear of the cans. A case of MREs can be laid out on top of the tent along with axe, saw, machetes, and both shovels. Now the ahkio can be secured by folding the two ends inboard first, then folding the sides with one side overlapping. Now place the hooks across the top and onto the ahkio ropes on the opposite side of the ahkio. Tighten down by starting at one end and working to the other.

B.6.3 Sled-Pulling Techniques. Pulling an ahkio is hard work, requiring both teamwork and technique. It is difficult to effectively tow an ahkio while on skis. Ahkios should be towed by Seabees wearing snowshoes. However, the number and formation of pullers will change depending on terrain, weight of the load, type of movement, and mission.

B.6.4 Preparation for Sled Pulling. The traces are laid out and fastened by snap buckles in tandem system. The sled harnesses are adjusted to fit loosely on the pullers. Before moving out, check the sled for proper loading to ensure the lowest possible center of gravity.

B.6.5 Pulling Technique. When pulling a sled over flat terrain, skiers normally use the one-step ski technique. When crossing small ditches, stop the sled in the ditch while the pullers go as far as the tow ropes allow. Then all together pull the sled out of the ditch. To change direction in the woods, continue to move straight forward until the sled comes to the desired turning point. Then move in the new direction with the turn being controlled by the brake man. When the forest is dense, and space does not allow the men to move far enough ahead before the turn is made, start the turn by gradually making as gentle a curve as possible while the two men nearest the sled (in front and behind) guide, lift, and otherwise assist in turning the sled.

a. Uphill Climbing. To accomplish an uphill maneuver, use the following techniques:

(1) On short, gentle slopes the herringbone can be used.

(2) On a steep, short slope the pullers can use the sidestep. In this case, the rear man moves to the front and side of the sled, and while sidestepping, assists in pulling the sled by using the rope fastened to the front end.

(3) On very gentle slopes, an uphill traverse may be used. Climbing skins are used if the length of the slope justifies the time required to put them on.

(4) In difficult terrain, use a belay technique when the necessary equipment is available. A 120-foot climbing rope or similar item, is fastened to the sled. The pullers then climb uphill as far as the rope allows. While they stand in place, the sled is pulled up to their position. This procedure is repeated as many times as is necessary to reach the top. Care is taken to ensure that the sled is well anchored each time the pullers move up, thus avoiding a runaway sled. Where steep slopes must be ascended for considerable distances, less energy will be expended if the sleds are left behind and the sled load backpacked to the top.

b. Downhill Movement.

(1) It is necessary to control the speed to prevent the sled from overrunning the pullers. The rear man can help by braking the sled, although usually very little braking will be needed.

(2) A short, steep slope can be descended by sideslipping, or sidestepping. If necessary, the rear man is helped in the braking action by one or more members of the team. During short descents in wooded areas, the brake man may position himself behind a tree for added stability in lowering the sled. If necessary, a succession of position moves are made.

(3) On long moderate slopes, if more braking is necessary than can be applied by the rear man, he is assisted by the puller closest to the sled, who moves to one side or removes his rope and refastens it to the rear of the sled.

(4) The whole team is needed to brake the sled when going down a long, steep slope. Fasten all tow ropes to the rear of the sled. All men brake from the rear and one Seabee controls the sled by straddling its front. The puller nearest the sled and the rear man remain above the sled and as far from it as the ropes allow. From this position, they can prevent the sled from sideslipping.

(5) In very steep terrain, a long rope can be used to lower the sled straight down the slope. This procedure is the reverse of the uphill-relay method described earlier and is good for evacuating wounded.

c. Traversing Slopes. When traversing slopes, the ahkio tends to roll over often. To prevent this, one man hooks a 9-foot rope over the ahkio to the downhill side D-ring and positions himself on the uphill side of the ahkio. He moves with the akhio keeping the rope tight to prevent the ahkio from rolling.

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