DEPARTMENT OF THE NAVY
HEADQUARTERS UNITED STATES MARINE CORPS
WASHINGTON, DC 20380-0001

MCO 3470.1A
TDE-35
17 Feb 1987

MARINE CORPS ORDER 3470.1A

From: Commandant of the Marine Corps
To: Distribution List

Subj: Prevention of Cold Weather Injuries

Ref: (a) FM 31-70, Basic Cold Weather Manual (NOTAL)

Encl: (1) Windchill Chart Fahrenheit Scale
(2) Windchill Chart Centigrade Scale
(3) List of Films and Publications

1. Purpose. To provide information regarding the impact of cold weather on training and tactical operations and to establish guidelines for the prevention of cold weather injuries.

2. Cancellation. MCO 3470.1.

3. Background. On 45 percent of the world's land surface, conditions of cold occur which require special training, precautions, and equipment. As the Nation's amphibious force-in-readiness, the Marine Corps must be prepared to function effectively in cold weather. The cold weather environment is particularly hostile to the untrained and ill-equipped.

4. Information

a. Past Marine Corps training exercises and operations in cold weather, both outside and within the continental United States, have resulted in avoidable injuries to Marines. Proper use of simple preventive measures which are inspected and enforced will markedly reduce the incidence of cold injury. Individual and unit discipline, training, and experience are closely related in their influence upon the incidence of cold injury. Well-trained and disciplined personnel are better able to care for themselves through personal hygiene, care of feet, change of clothing, and similar measures. Among the common injuries or conditions associated with cold weather are frostbite, hypothermia, trench foot, dehydration, constipation, snow blindness, and sunburn.

PCN 102 033350 00

(1) Frostbite. Frostbite results from crystallization of tissue water in the skin and adjacent tissues, and is produced by exposure to temperatures below the freezing point. It most commonly affects the hands, feet, or face. Below 20o F, the speed at which frostbite occurs is greatly influenced by wind conditions. Enclosures (1) and (2) show the relationship between windspeed and temperature. Frostbite usually begins with an uncomfortable sensation of coldness, followed by numbness. The skin initially turns red and then becomes pale gray or white. The affected extremity is cold, pale, and may feel hard or wooden to touch. A "buddy system" of observation can be effective in providing early detection and prevention of frostbite. Frostbitten extremities should never be rewarmed in the field. Premature or partial thawing and refreezing significantly increases the severity of injury.

(2) Hypothermia. Hypothermia is the general depression of the body temperature (to 95o F, or below, in the case of young adults). Even mild hypothermia can render personnel ineffective. Severe hypothermia may cause death. Hypothermia occurs when the individual loses body heat at a rate faster than it is produced. Water, because of its heat conductivity, has a cooling power 23 times that of air. For this reason, wet or damp clothing, whether caused by water immersion, sweating, fuel spill, or other circumstances must be avoided. This is the reason for strict adherence to the basic principle of using multiple layers of dry clothing for cold weather operations. Layers of clothing are removed according to the degree of exertion to avoid sweating and getting clothes wet. As the level of activity decreases, layers of clothing are replaced. The windchill factor plays an important role in hypothermia just as it does in frostbite. The symptoms of hypothermia are nonspecific and are often disregarded because of a complacent attitude. Abnormal fatigue or weakness, mental confusion, and cessation of shivering are all signs that should alert troop leaders to the onset of hypothermia. Immediate action must be taken to forestall further heat loss and the resulting complete noneffectiveness of personnel. To diagnose hypothermia, one has to take a core temperature reading. This usually means taking the victim’s temperature rectally. Oral temperature readings are worthless in a cold weather environment.

(3) Trench Foot (Immersion Foot). Trench foot results from wet exposure for prolonged periods at temperatures above freezing, and may affect susceptible personnel in a matter of hours, if immobile. There is nerve, muscle, and blood vessel injury. Early signs are pale or blotchy skin and numbness, followed by pain and swelling in later stages. Also, blister formation and loss of pulse is common. Prevention of this disabling condition centers on keeping feet as dry as possible.

(4) Dehydration. Dehydration is one of the most insidious and physically detrimental events in cold exposure. Exposure in the cold produces significant water loss through respiration, perspiration, and urination. Early signs of dehydration include lethargy, decreased skin tone, sunken eyes, and constipation. There is often increase in the pulse rate, darkening of urine from light yellow to dark yellow to orange to brown, progressive irritability, and sleeplessness. Observation of any of these factors may indicate dehydration. All personnel exposed to cold should be encouraged to drink at least 32 to 48 ounces (1 to 1.5 liters) of water a day. This volume should be increased with increased workloads and severity of cold.

(5) Constipation. This is a syndrome brought on by the individual voluntarily postponing defecation as long as possible to avoid exposure to the cold. Dehydration can also contribute to constipation. Prevention measures include drinking plenty of liquids and regular elimination of solid body waste.

(6) Snow Blindness. Snow blindness occurs when the sun is shining brightly on an expanse of snow, and is caused by the reflection of ultraviolet rays. It is more likely to occur after a fall of snow, and in most cases, is caused by negligence or failure to wear sunglasses. Symptoms of snow blindness are a sensation of grit in the eyes with pain in and over the eyes made worse by eyeball movement, watering, redness, headache, and increased pain on exposure to light. To prevent snow blindness, personnel should wear sunglasses when snow blindness conditions exist. First-aid measures consist of blindfolding or covering the eyes with a damp cloth. The condition heals in a few days without permanent damage once unprotected exposure to sunlight is stopped.

(7) Sunburn. Personnel can be sunburned even when the temperature of the air is below freezing. On snow, ice, and water the sun’s rays reflect from all directions and angles. Sunlight reflected from bright surfaces and from all directions can strike personnel where the skin is very sensitive around the lips, nostrils, and eyelids. Sunburn cream and lip balm should be carried and, to prevent sunburn, applied to the parts of the body exposed to direct or reflected sunlight. Blistered areas caused by sunburn should be cared for to prevent infection.

b. The incidence and seriousness of cold weather related injuries can be reduced significantly by anticipating and preparing for the climatic threat to personnel safety and effectiveness. Individual confidence and unit morale are important factors in the Marine’s ability to adapt to extreme

weather conditions. Personnel must be trained, mentally and physically prepared, and properly equipped for normal and exceptional weather conditions which may be encountered in an operational or training area. Strong, effective small unit leadership and a high state of discipline and control are necessary to ensure that individuals perform as they have been trained. Cold injury results from the interaction of the individual, the environment, and clothing.

(1) The Individual

(a) Age. There is no indication that within the age range of military populations there is a wide difference in susceptibility. The very young are more resistant and the very old are more susceptible.

(b) Grade/Duty Assignment. Trench foot and frostbite are more likely to occur in the case of front line riflemen and other personnel who spend more time in the cold. These personnel are more likely to be of the lower grades.

(c) Previous Cold Injury. A previous cold injury definitely increases the individual's risk of subsequent cold injury, not necessarily involving the part previously injured. Minor degrees of superficial cold injury, when completely healed, do not predispose to subsequent injury sufficiently to require restriction of assignment.

(d) Fatigue. Mental weariness may cause apathy leading to neglect of acts vital to survival. Frequent rotation of individuals from exposure to extreme cold for even short periods lessens the influence of fatigue.

(e) Additional Injury. Injuries which are not cold related but which result in significant blood loss or shock reduce effective blood flow to extremities and predispose to cold injury.

(f) Psychosocial Factors. Cold injuries are more often associated with passive individuals, or those less physically active. Others may have adverse reactions to external stresses, such as cold, which may impede their taking preventive measures. Still others may perspire excessively, thereby decreasing the insulating qualities of their clothing.

(g) Geographic/Racial Origin. Individuals from warm climates, where the mean minimum January temperature is above 14o F, appear to be predisposed to cold injury. The basic factor involved, however, rather than geographic, may be psychosocial and educational. It has been established that black personnel are at a greater risk of cold injury than Caucasians and therefore need to take extra precautions with hand/foot care in cold climates.

(h) Nutrition. Starvation or semistarvation predisposes to cold injury. Adequately clothed and protected individuals in cold environments do not require more than the normal daily military ration of 3,600 to 4,600 calories. The increased exercise requirements imposed by heavy clothing and equipment, and the difficulty of movement in snow covered terrain can increase caloric requirements to 7,000 calories per day. For example, cross-country skiing can require expenditure of between 600 to 1,200 calories per hour.

(i) Activity. Too great or too little activity may contribute to cold injury. Over activity can cause loss of large amounts of body heat by perspiration, which becomes trapped in excess clothing, markedly reducing the clothing's insulation quality. Immobility causes decreased heat production and the danger of resultant body cooling, especially of extremities and pressure areas of the body.

(j) Drugs and Medication. Physicians should advise their patients of adverse effects on peripheral circulation or sweating when prescribing drugs and medications in cold climates. Morphine is an important example of a drug with significant effects on cutaneous circulation and therefore on body heat balance.

(k) Alcohol. The effects of alcohol on peripheral blood flow increase body heat loss. Its impact on glucose metabolism, its suppression of shivering, and its influence on judgment should preclude its use in cold environment. The dangers of hypothermia and frostbite are increased greatly under its influence.

(l) Duration of Exposure

1 Duration of exposure resulting in immersion foot varies according to the ambient air temperature and the temperature of the water, and, therefore, with season and latitude. Immersion of the torso and extremities in cold water, as in the northern latitudes, may result in total physical impairment in less than 1 hour. Death may occur within a few hours at very low water temperatures because of excess lowering of core temperature (hypothermia).

2 The average duration of exposure resulting in trench foot is 3 days in a temperature range of 32o F to 50o F with a time range from a few hours to 14 days.

3 The average duration of exposure resulting in frostbite is 10 hours with usual time range of 1 to 20 hours, but this varies for different types of activity. High exercise levels require a longer time to produce risks, whereas sedentary tasks may bring danger in a short time. Decrease in physical activity decreases the time it takes to produce cold injury.

(2) The Environment

(a) Temperature, humidity, precipitation, and wind interact to increase body heat loss. Low temperatures and wind tend to favor frostbite, whereas nonfreezing temperatures with moisture favor trench foot and hypothermia. The windchill charts, enclosures (1) and (2), describe this cooling effect on bare skin. If moisture is added, rapid body cooling can occur.

(b) The type of combat and method of deployment are important in producing cold injury. Rear area or standdown position situations produce few cold injuries. As exposure increases with combat, so do the numbers and seriousness of cold injury. Long periods of immobility, forced facing into the wind, moving a base camp during combat, inadequate rewarming facilities, and sudden changes in weather have caused major outbreaks of cold injury.

(3) The Clothing

(a) Adequate clothing, properly worn, is essential to welfare and survival. Clothing for cold weather is designed to be worn as an ensemble for protection of head, torso, and extremities. Failure to wear the total ensemble influences cold injury. The ensemble depends on the layering principle to conserve body heat. Loose layers of clothing with air space between them, under an outer wind- and water-resistant garment, provide maximum protection. Learning to adjust these layers to decrease or increase ventilation is the key to proper use of clothing. Reference (a) describes basic cold weather clothing, provides information concerning proper use under different cold weather conditions, and defines the categories of cold which affect the use of cold weather clothing. These categories are:

1 Wet Cold. Wet cold conditions occur near freezing when temperature variations cause alternate freezing and thawing. Clothing should consist of a water-repellent, wind-resistant outer layer and inner layers with sufficient insulation to provide protection in moderately cold weather.

2 Dry Cold. Dry cold conditions occur when average temperatures are lower than 14o F. The ground is usually frozen and snow is usually dry. The effect of windchill, as indicated at enclosures (1) and (2), increases the need for protection and may require additional insulating layers of clothing.

(b) A standard number of layers of clothing cannot be prescribed for universal wear in cold weather. Certain basic principles are important, including ventilation of the body, cleanliness and repair of clothing, and avoidance of constriction.

(c) In cold areas, personnel must be equipped with and trained in the use of suitable protective footwear. A cold/dry climate requires multiple layers of loose fitting insulation material with a solid, waterproof outer shell. In a cold/wet environment, it is advisable to wear water impermeable overshoes over combat boots. It is essential to keep feet as dry as possible.

(d) In all types of footgear, feet perspire more and are generally less ventilated than other parts of the body. Moisture accumulates in socks, decreasing their insulation quality. Special foot and sock care is essential. All personnel should carry extra socks. Socks damp from perspiration should be changed daily and washed whenever the opportunity permits. Socks can be hung outside the ALICE pack during a march so that perspiration will freeze and the frost can be beaten out of the socks.

(e) Sleeping bags should provide head cover without drawing the face inside the bag. Breathing into the insulation layer reduces the insulation value and will induce chilling and shivering, leading to sleeplessness and fatigue. The bag should be insulated from the ground with a pad, an air mattress, or boughs.

c. Physical fitness is a major factor in the ability of an individual to adapt and function effectively in a cold weather environment. The human body consumes tremendous amounts of energy in maintaining and adjusting body functions such as temperature, blood pressure, and oxygen consumption. Physical conditioning is a deterrent to illness and injury.

d. The importance of involving medical personnel in the initial stages of planning for training exercises or deployments to cold weather areas cannot be overemphasized. While medical considerations should be an essential part of planning for any exercise or deployment, the medical implications of cold weather operations are such that early and thorough planning is even more vital. It may literally be a matter of life or death.

e. The list of films and publications located at enclosure (3) is not all inclusive but is provided to assist commanders towards the goal of preparing for cold weather operations and preventing cold weather injuries.

5. Action. Commanders preparing for operations or training in a cold weather environment will:

a. Ensure adequate predeployment training, to include medical and small unit leadership aspects of cold weather operations.

b. Coordinate with host commands to ensure that unit predeployment training fulfills host command requirements.

c. Place required emphasis on physical fitness to develop a higher level of resistance to cold injury and illness.

d. Ensure that medical support personnel are included in all phases of planning and preparation for cold weather operations.

e. Establish an effective clothing supply program that provides for daily needs of the farthest forward combat personnel.

f. Establish and maintain a high level of foot and clothing discipline for individuals and units.

g. Establish a policy under which individuals and units exposed to cold are rotated into a protected environment according to the degree of exposure and within the limits of the cold injury incubation period. Only the most critical combat situations should be permitted to interfere with the practice of rotation.

h. Establish effective provisions in the forward area for evacuation and/or treatment of personnel suffering from cold trauma.

6. Reserve Applicability. This Order is applicable to the Marine Corps Reserve.

F. E. SISLEY
Deputy Chief of Staff
for Training

DISTRIBUTION: A less 7352007, 019, 040, 049/7801010/8180016, 026

Copy to: 8145001

WINDCHILL CHART FAHRENHEIT SCALE

1. Figure 1 of this enclosure shows only the cooling power of wind on exposed flesh, giving the equivalent temperature (under calm conditions) as compared to that which would be experienced under calm conditions at the lower temperature. No matter how great the wind velocity, exposed flesh will not freeze as long as the temperature of the skin remains above freezing. This statement applies only to dry skin, since moisture introduces the added factor of cooling by evaporation.

2. The human body is continually producing and losing heat. Wind increases the loss of heat by reducing the thin layer of warm air next to the skin. This loss increases as the wind speed increases. When the temperature of the air is below freezing and the wind is such that it removes the heat faster than the body can replace it, frostbite may occur. Thus, decreasing the ambient air temperature or increasing the wind speed act to increase the danger of frostbite. The combined effect of wind and temperature is expressed in figure 1 of this enclosure as an equivalent temperature. This denotes the effective temperature acting upon exposed flesh.

3. Any movement of air past the body has the same cooling effect as wind. This may be produced by walking, running, skiing, or riding in open vehicles. The speed of movement must be considered, in addition to natural wind, when using figure 1 of this enclosure.

4. It is emphasized that figure 1 of this enclosure is of value only in predicting frostbite to exposed flesh. Any clothing or material which stops or reduces the wind will give a degree of protection to the covered area. No attempt should be made to estimate this protection in the use of the chart. Wet clothing or boots have little insulation value and result in heat loss nearly equal to that of exposed flesh.

5. To use figure 1 of this enclosure, find the estimated or actual wind speed in the left-hand column and the actual temperature in degrees Fahrenheit in the top row. The equivalent temperature is found where these two intersect. The description below the column indicates the comparative danger of exposed flesh under these conditions. For example, at a temperature of -10o F under calm conditions, rate of heat loss from exposed flesh is that of the ambient temperature, that is, -10o F, and the danger of frostbite to a properly clothed person is slight. If the wind increase to only 20 miles per hour, or if the person is riding in an open vehicle which is being drive at 20 miles per hour, the rate of heat loss of exposed flesh increases to that which would be experienced at an ambient temperature of -53o F. This lies within the zone of increasing danger of frostbite, indicating that protective measures must be taken. For figures intermediate to those shown, use interpolation.

WINDCHILL CHART CENTIGRADE SCALE

1. Figure 1 of this enclosure shows only the cooling power of wind on exposed flesh, giving the equivalent temperature (under calm conditions) as compared to that which would be experienced under calm conditions at the lower temperature. No matter how great the wind velocity, exposed flesh will not freeze as long as the temperature of the skin remains above freezing. This statement applies only to dry skin, since moisture introduce the added factor of cooling by evaporation.

2. The human body is continually producing and losing heat. Wind increases the loss of heat by reducing the thin layer of warm air next to the skin. This loss increases as the wind speed increases. When the temperature of the air is below freezing and the wind is such that it removes the heat faster than the body can replace it, frostbite may occur. Thus, decreasing the ambient air temperature or increasing the wind speed act to increase the danger of frostbite. The combined effect of wind and temperature is expressed in figure 1 of this enclosure as an equivalent temperature. This denotes the effective temperature acting upon exposed flesh.

3. Any movement of air past the body has the same cooling effect as wind. This may be produced by walking, running, skiing, or riding in open vehicles. The speed of movement must be considered, in addition to natural wind, when using figure 1 of this enclosure.

4. It is emphasized that figure 1 of this enclosure is of value only in predicting frostbite to exposed flesh. Any clothing or material which stops or reduces the wind will give a degree of protection to the covered area. No attempt should be made to estimate this protection in the use of the chart. Wet clothing or boots have little insulating value and result in heat loss nearly equal to that of exposed flesh.

5. To use figure 1 of this enclosure, find the estimated or actual wind speed in the left-hand column and the actual temperature in degrees centigrade in the top row. The equivalent temperature is found where these two intersect. The description below the column indicates the comparative danger of exposed flesh under these conditions. For example, at a temperature of -25o C, under calm conditions, rate of heat loss from exposed flesh is that of the ambient temperature, that is -25o C, and the danger of frostbite to a properly clothed person is slight. If the wind increase to only 20 kilometers per hour, or if the person is riding in an open vehicle which is being driven at 20 kilometers per hour, the rate of heat loss of exposed flesh increases to that which would be experienced at an ambient temperature of -42o C. This lies within the zone of increasing danger of frostbite, indicating that protective measures must be taken. For figures intermediate to those shown, use interpolation.

ENCLOSURE (2)

WINDCHILL CHART

Cooling Power of Wind on Exposed Flesh Expressed as an Equivalent Temperature (under calm conditions)

Estimated Windspeed MPH	ACTUAL THERMOMETER READING (°F)											
	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
	EQUIVALENT CHILL TEMPERATURE (°F)											
Calm	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
5	48	37	27	16	6	-5	-15	-26	-36	-47	-57	-68
10	40	28	16	4	-9	-21	-33	-46	-58	-70	-83	-95
15	36	22	9	-5	-18	-36	-45	-58	-72	-85	-99	-112
20	32	18	4	-10	-25	-39	-53	-67	-82	-96	-110	-124
25	30	16	0	-15	-29	-44	-59	-74	-88	-104	-118	-133
30	28	13	-2	-18	-33	-48	-63	-79	-94	-109	-125	-140
35	27	11	-4	-20	-35	-49	-67	-82	-98	-113	-129	-145
40	26	10	-6	-21	-37	-53	-69	-85	-100	-116	-132	-148

Little Danger
In less than 5 hours with dry skin. Maximum danger from false sense of security.

Increasing Danger
Danger from freezing of exposed flesh within 1 minute.

Great Danger
Flesh may freeze within 30 seconds.

* Wind greater than 40 MPH has little additional effect.

Figure 1

LIST OF FILMS AND PUBLICATIONS

1. Films

    a. Prevention of Cold Injuries, U.S. Army TFB-4879.

    b. Cold Can Kill, A-2467, British Ministry of Defense.

    c. Northern Flank, D-023, NATO.

2. Publications

    a. FMFM 8-1, Special Operations.

    b. FM 31-70, Basic Cold Weather Manual.

    c. FM 31-71, Northern Operations.

    d. FM 90-6, Mountain Operations.

    e. MCB, Camp Pendleton Base Order 5400.18, Instructions and Procedures for the use of the Marine Corps Mountain Warfare Training Center (MCMWTC).

    f. Handbook on Desert Environment and Survival, Marine Corps Base, Twentynine Palms, California.

    g. TC 21-3, Department of the Army, Soldiers Handbook for Individual Operations and Survival in Cold Weather Areas.

    h. NAVMED P-5052-29, Cold Injury.

    i. Arctic Mobility Study, VTU 12-50, USMCR, June 1976.

    j. MCO 3501.10, Marine Corps Combat Readiness Evaluation System, Vol IX, Special Operations.

    k. FM 9-207, Operations and Maintenance of Ordnance Material in Cold Weather (0 to -65 F).

    l. The Polar Manual by E. E. HEDBLOM.

    m. TC 21-3, Soldiers Handbook for Individual Operations and Survival in Cold Weather Areas.

    n. TC 90-11-1, Military Skiing.

    o. OH 5-3.1, Cold Weather Helicopter Operations.

    p. OH 8-5, Cold Weather Operational Handbook.