

Cold Stress

1. Purpose

The purpose of this policy is to protect USPL employees and contractors from the potentially adverse effects of overexposure to cold. Although winter hazards cannot be avoided, people who work outdoors can follow simple precautions to protect themselves from the two most common dangers of cold environments: *hypothermia* and *frostbite*.

2. Scope

This policy applies to members of the USPL workforce who work for extended periods in conditions of low temperatures, especially in combination with wind or moisture.

3. Minimum Requirements

	Minimum Requirements	Supporting Documentation
1.	Members of the USPL workforce are responsible for recognizing the hazards of cold environments and mitigating the risk of cold stress.	Sections 5 and 6
2.	Members of the USPL workforce are responsible for monitoring their reaction to the cold and following basic precautions to prevent injuries related to cold stress.	Section 5
3.	Individuals within the USPL workforce who are at risk for occupational exposure to cold stress must be familiar with the causes and symptoms of cold-related injuries.	Section 6

4. Definitions

Core body temperature—The temperature in the brain, the heart, and the abdominal organs. It changes very little (normal range: 97.6–98.8°F) and is vital for the normal functioning of these organs.

Cold stress—The strain placed on the body when heat losses are greater than normal and compensatory thermoregulatory mechanisms are required to maintain normal body temperature. The main factors that contribute to cold stress are environmental: cold air temperatures, high-velocity air movement, dampness of the air, and contact with cold water or surfaces. Other factors include age, weight, fitness level, acclimatization to cold, fatigue, use of medications, and use of alcohol or nicotine. Cold-related injuries are either localized (frostnip, frostbite) or generalized (hypothermia).

Equivalent Chill Temperature (ECT)—The air temperature that would produce the same cooling effect on exposed flesh as a given combination of air temperature and air movement. Commonly called the wind chill index, it is a useful tool in determining the clothing requirements and potential hazards of different air temperatures and wind speeds.

Frostbite—The freezing of tissues in some part of the body as a result of exposure to extreme cold or contact with cold objects. Blood circulation may cease in the affected areas, and blood vessels can be irreparably damaged. In milder cases, the symptoms include a patchy inflammation of the skin, accompanied by slight pain. In more severe cases, there is often tissue damage without pain. Frostbitten skin is susceptible to infection and gangrene. There are three stages of frostbite:

- Frostnip—the affected body parts begin to feel cold and stiff with a prickling pain; the skin is usually white and blotchy.
- Superficial frostbite—ice crystals form in the skin cells, causing the area to feel hard and waxy. The skin looks purplish, and blisters may appear. Nerve endings, blood vessels, and muscle tissue are damaged, so the affected area becomes numb and sensations of cold and pain go away.
- Deep frostbite—tissue is frozen through to the bone, causing blood clots and gangrene. If the victim receives medical attention soon enough, the frozen limb may be saved from amputation.

Hypothermia—A decrease in the core body temperature that impairs normal metabolic, muscular, and cerebral functions. This condition occurs when the body loses heat faster than it is replaced. Symptoms begin when the core body temperature drops below 95°F; if it falls below 90°F, the condition is critical and eventually fatal. Hypothermia is a threat when an individual is exposed to water temperatures below 60°F or air temperatures below 50°F. Symptoms include intense shivering, muscle tension, fatigue, feelings of cold or numbness, slurred speech, stumbling, lethargy, erratic behavior, or irritability.

Trench foot—An injury to nerve and muscle tissue in the feet after they have been wet and cold (but not frozen) for a prolonged period. Also known as “immersion foot.”

5. Roles and Responsibilities

- A. All workforce members are responsible for the following:
1. Recognizing the hazards of working in cold environments (see Appendix I).
 2. Mitigating the risk of cold stress by establishing and enforcing engineering controls, appropriate work practices, and protective clothing guidelines.
 3. Watching for signs of cold stress and ensuring that employees interrupt their work with adequate warming periods.

6. Prevention

- A. Supervisors shall adopt work schedules and work practices that help protect employees from the effects of cold stress. Guidelines include, but are not limited to, the following:
1. Monitor current weather conditions.
Note: See the table in Appendix II for the effects of wind speed on air temperatures.
 2. Establish a work/warm-up cycle.
Note: See Appendix III, “Scheduling Work in Extreme Cold.”
 3. Schedule work at the warmest times.
 4. Move work to warmer areas.
 5. Assign additional workers to the job to shorten its duration.
 6. Encourage self-pacing and extra breaks in warm dry shelters, if required.
 7. Establish a buddy system, emphasizing mutual observation.
 8. Allow for reduced efficiency and productivity when employees are wearing protective clothing.
 9. Urge employees to drink warm, sweet fluids (sugar water, sports-type drinks) before beginning work and during breaks. Avoid drinks with caffeine (coffee, tea, sodas, or hot chocolate).

10. Include a thermometer and chemical hot packs in first aid kits.
- B. Employees who are at risk for occupational exposure to cold stress must be familiar with the causes and symptoms of cold-related injuries (see Appendix I).
- C. Personnel working in cold conditions should follow recognized procedures for controlling cold stress.
 1. Eat a well-balanced diet.

Note: Energy bars and dried fruits are good sources of quick energy. Nuts, seeds, and other proteins provide longer-lasting energy. Caffeine and nicotine, which can restrict circulation or accelerate heat loss, should be avoided.
 2. Stay hydrated.

Note: Working in cold, dry air can cause significant water loss through the skin and lungs. Increased fluid intake prevents dehydration, which puts the extremities at greater risk of damage due to decreased blood flow.
 3. Wear appropriate protective FRC clothing that keeps the extremities warm and dry.
 - a) Dress in layers. Wear clothes that are snug but not tight. This allows insulating air between the clothes and your skin. Layers can be adjusted to changing conditions.
 - b) Wear underwear that wicks moisture away from the skin.
 - c) Cover as much of the head, face, and neck as possible without restricting vision.
 - d) If working in rain, snow, or extreme wind, wear an outer layer of waterproof or windproof FRC garments that allow water vapor created by perspiration to escape.
 - e) Wear insulated boots and socks with insulating properties.
 - f) Wear gloves if the air temperature is below 60°F; if the temperature is 0°F or less, wear mittens.
 - g) Change out of wet clothing as soon as possible.
 - h) Wear tinted eye protection, if needed, when working in snow- or ice-covered terrain.
 4. Take regular breaks and go indoors or to a dry, heated area to warm up.
 5. Never touch cold metal objects with exposed skin.
 6. At the first sign of overexposure, stop work and go indoors or to a dry, heated area to warm up. Don't push yourself to finish a task.

7. Treatment

7.1. Frostbite

The sooner a frostbite victim gets help, the better the chances for saving the affected body part.

- A. Personnel administering first aid for frostbite must observe the following procedures to avoid making the situation worse.
 1. Get the victim to a warm dry area. Remove any wet clothing or tight clothing that may cut off blood flow to the affected area.
 2. Take the victim to a hospital emergency room. If the victim cannot be moved, call for an ambulance.
 3. Warm the affected area by the following methods:

- a) Skin-to-skin contact. *Don't rub or massage frostbitten skin as that can cause damage to the skin and tissue.*
Examples: Use your armpits or abdomen to warm frostbitten hands or feet; cover ears, nose, or cheeks with your hands.
- b) Immersion in lukewarm (105°F) water: Gently place the affected area in a lukewarm water bath and monitor the water temperature to slowly warm the tissue. Don't pour warm water directly on the affected area because it will warm the tissue too fast, causing tissue damage.
- c) *Don't use hot water. Don't apply direct heat to the area. Never warm the area with dry or radiant heat.*

Note: Warming can take up to one hour.

4. Raise the affected area above the level of the victim's chest to relieve swelling or pain.
5. Dry the area and cover with blankets.
6. Give the victim warm, sweet fluids to drink, such as sugar water or sports-type drinks. Avoid drinks with caffeine (coffee, tea, sodas, or hot chocolate).

7.2. Hypothermia

All cases of hypothermia should be regarded as life-threatening because it affects the individual's core body temperature.

- A. Personnel administering first aid for hypothermia must observe the following procedures.
 1. Get the victim to shelter and remove any wet clothing.
 2. Take the victim to a hospital emergency room. If the victim cannot be moved, call for an ambulance.

7.3. Cold Water Immersion – Immersion Hypothermia

Cold water immersion creates a specific condition known as immersion hypothermia. It develops much more quickly than standard hypothermia because water conducts heat away from the body 25 times faster than air. Hypothermia can occur in any water temperature below 70°F.

- A. Personnel administering first aid for immersion hypothermia must observe the following procedures.
 1. Call for emergency help.
 2. Get the victim out of the water and into a warm environment.
 3. Mild hypothermia victims who show only symptoms of shivering and are capable of rational conversation may only require removal of wet clothes and replacement with dry clothes or blankets.
 4. For more severe cases where the victim is semi-conscious:
 - a) Remove the clothing only if it can be done with minimum movement of the victim's body. Do not massage the extremities.
 - b) Lay the semi-conscious person face up, with the head slightly lowered, unless vomiting occurs. The head down position allows more blood to flow to the brain.
 - c) Immediately attempt to rewarm the victim's body core. If available, place the person in a bath of hot water at a temperature of 105 to 110 degrees. It is important that the victim's arms and legs be kept out of the water to prevent "after-drop". After-drop occurs when the cold blood from the limbs is forced back into the body resulting in further lowering of the core temperature. After-drop can be fatal.

7.4. Trench Foot

Trench foot, also known as immersion foot, is an injury of the feet resulting from prolonged exposure to wet and cold conditions.

- A. Personnel administering first aid for trench foot must observe the following procedures.
1. Soak feet in warm water, then wrap with dry cloth bandages.
 2. Give the victim warm, sweet fluids to drink.

8. References

1. OSHA, Department of Labor, Fact Sheet OSHA 98-55, "Protecting Workers in Cold Environments."
2. OSHA, Department of Labor, OSHA Publication 3156, "The Cold Stress Equation."
3. CDC, Department of Health and Human Services, "Cold Stress."
4. US SAR Task Force, Department of Homeland Security, "Cold Water Survival."

Appendix I

Cold-Stress Disorders

The body's first response to cold stress is to conserve body heat by reducing blood circulation through the skin. This effectively makes the skin an insulating layer. A second physiological response is shivering, which increases the rate of metabolism. Shivering is a reliable sign that cold stress is significant and hypothermia may be present. However, these responses are relatively weak as a protection mechanism. Behavior is the primary human response to preventing excessive exposure to cold. These include increasing clothing insulation, increasing activities, and seeking warm locations.

Insulation is a critical characteristic of clothing designed to be worn in cold conditions. Clothing materials used for their insulation characteristics include cotton, wool, silk, nylon, down, and polyester. Better insulation is usually achieved by layering clothes rather than wearing one garment. Another advantage of layers is that a person can add or remove layers to adjust for differing insulation needs during the work period.

The insulating value of clothing is greatly diminished by moisture, either in the work environment or in the form of sweat. Once clothing is wet, it should be replaced immediately with dry clothing.

Overview of Cold-Stress Disorders: Causes, Symptoms, Prevention, and First Aid Treatment

	Causes	Symptoms	Prevention	First Aid
Hypothermia	Overexposure, exhaustion, or dehydration; low tolerance (genetic or acquired); drug and alcohol use	Chills, pain in extremities, fatigue or drowsiness, euphoria, slow and weak pulse, slurred speech, collapse, shivering, loss of consciousness, core body temperature below 95°F	Wear layered clothing; avoid moisture and stay dry; bring along extra dry clothes; carry blankets, matches, first aid kit; use buddy system if possible.	Move to warm area and remove any wet clothing; apply modest external warmth (external heat packs, blankets, etc.); drink warm, sweet fluids if conscious; transport to hospital.
Frostbite	Exposure to cold; vascular disease	Burning sensation at first, coldness, numbness, tingling; skin color white or grayish yellow to reddish violet to black, blisters; response to touch depends on depth of freezing	Wear layered clothing; protect the face, ears, nose, fingers, toes; avoid moisture and stay dry; wiggle toes and fingers if they begin to lose feeling or tingle; go inside and warm up.	Move to warm area and remove any wet clothing; apply modest external warmth (external heat packs, blankets, etc.); drink warm, sweet fluids if conscious; treat as a burn (do not rub the affected area); transport to hospital.
Frostnip	Exposure to cold (above freezing)	Possible itching or pain; skin turns white	Similar to Frostbite	Similar to Frostbite
Trench Foot	Exposure to cold (above freezing) and dampness	Severe pain, tingling, itching; edema, blisters; response to touch depends on depth of freezing	Similar to Frostbite	Similar to Frostbite
Chilblain	Inadequate clothing; exposure to cold and dampness; vascular disease	Recurrent, localized itching; painful inflammation; swelling; severe spasms	Similar to Frostbite	Remove to warm area and seek medical attention.
Raynaud's disease	Exposure to cold and vibrations; vascular disease	Fingers tingle; intermittent blanching and reddening; fingers blanch with cold exposure	Similar to Frostbite	Remove to warm area and seek medical attention.

Appendix II Effects of Wind Speed and Temperature

Air temperature and air speed play important roles in cold stress. The following table illustrates the effects of air temperature and air speed on exposed flesh, expressed as Equivalent Chill Temperature (ECT), also known as the wind chill index.

Cooling Power of Wind on Exposed Flesh, Expressed as Equivalent Chill Temperature (ECT)

Estimated Wind Speed (mph)	Actual Temperature (°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	-24	-33	-46	-58	-70	-83	-95
15	36	22	9	-5	-18	-32	-45	-58	-72	-85	-99	-112
20	32	18	4	-10	-25	-39	-53	-67	-82	-96	-110	-121
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	-51	-67	-82	-98	-113	-129	-145
40	26	10	-6	-21	-37	-53	-69	-85	-100	-116	-132	-148
(Wind speeds above 40 mph have little additional effect.)	Little danger in one-hour period with dry skin. Maximum danger is false sense of security.				Increasing Danger Danger from freezing of exposed flesh within one minute.				Great Danger Flesh may freeze within 30 seconds.			
Trench foot (immersion foot) may occur at any point on this chart.												

Source: Developed by U.S. Army Research Institute of Environmental Medicine, Natick, Mass.

Note: These ECT values assume that a person is wearing dry clothes.

Appendix III Scheduling Work in Extreme Cold

The schedules shown in the following table are advised for any four-hour work period with moderate to heavy work activity, with warm-up periods of ten minutes in a warm location, and with lunch or another type of extended break at the end of the four-hour work period in a warm location. For light to moderate work activity (limited physical movement), apply the schedule one step below the row indicated for current conditions. Maximum work periods apply only for workers in dry clothing.

Air Temperature (°F) with Sunny Sky	Wind Speed*									
	Calm		5 mph		10 mph		15 mph		20 mph	
	Max. Work Period	No. of Breaks	Max. Work Period	No. of Breaks	Max. Work Period	No. of Breaks	Max. Work Period	No. of Breaks	Max. Work Period	No. of Breaks
-15 to -19	normal breaks	1	normal breaks	1	75 min.	2	55 min.	3	40 min.	4
-20 to -24	normal breaks	1	75 min.	2	55 min.	3	40 min.	4	30 min.	5
-25 to -29	75 min.	2	55 min.	3	40 min.	4	30 min.	5	Non-emergency work should cease	
-30 to -34	55 min.	3	40 min.	4	30 min.	5	Non-emergency work should cease			
-35 to -39	40 min.	4	30 min.	5	Non-emergency work should cease		Non-emergency work should cease			
-40 to -44	30 min.	5	Non-emergency work should cease		Non-emergency work should cease		Non-emergency work should cease			
-45 and below	Non-emergency work should cease		Non-emergency work should cease		Non-emergency work should cease		Non-emergency work should cease			

*Guidelines for estimating wind speed: 5 mph—light flag moves; 10 mph—light flag fully extended; 15 mph—raises newspaper sheet; 20 mph—blowing and drifting snow.

Note: If air temperatures are above -15° F, account for the wind speed by using the chart in Appendix II to determine the equivalent chill temperature. Then use the equivalent chill temperature on the Scheduling Work in Extreme Cold chart instead of the Air Temperature with Sunny Sky, and use just the first column of this chart as though wind speeds were calm.

Source: *Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices* (ACGIH, 2006). Adapted from the Occupational Safety and Health Division, Saskatchewan Department of Labour.