



UNIVERSITY OF MINNESOTA
University Health and Safety

Cold Stress Program

Effective Date: June 25th, 2021

I. PURPOSE

This program is to protect employees who are exposed to excessive cold or who work in cold environments while at work. Various factors can contribute to cold stress such as low air temperature, high winds, dampness, and cold water.

II. SCOPE

This program applies to all University of Minnesota employees who are exposed or may become exposed to excessive cold during the course of performing their job duties.

III. DEFINITIONS

Acclimation – Acclimation is when the physical processes of an employee’s body adjust to the environment over a period of time (usually 5-7 days up to 3 weeks, depending on the individual and work environment).

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 (frostbite) or generalized (hypothermia).

Chilblain – A painful, itching swelling on the skin, typically on a hand or foot, caused by poor circulation in the skin when exposed to cold.

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 two stages of frostbite:

- **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.”

IV. RESPONSIBILITIES

Employee Responsibilities

1. Work in accordance with the provisions of this program.
2. Understand the signs and symptoms of cold-related illnesses. An overview of these signs and symptoms can be found in Appendix A.
3. Notify supervisor if conditions exist that may lead to a cold-related illness or if they experience symptoms of a cold-related illnesses.

Departmental and Supervisor Responsibilities

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 B for the effects of wind speed on air temperatures.
2. Establish a work/warm-up cycle.
Note: See Appendix C, “Scheduling Work in Extreme Cold.”
3. Schedule work at the warmest times of the day whenever possible.
4. Move work to warmer areas whenever possible.
5. Assign additional workers to the job to shorten its duration.
6. Encourage self-pacing and extra breaks in warm dry locations, if required.
7. Establish a buddy system, emphasizing mutual observation.

8. 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).

Facilities Management/Facilities Project Services Responsibilities

1. Notify affected parties when shutdowns or maintenance to heating systems will be conducted.
2. Provide emergency heat when necessary.
3. Maintain indoor work temperatures in accordance with MN Rule 5205.0110 Indoor Ventilation and Temperature in Places of Employment.
 - Indoor places where heavy work is performed shall maintain a minimum air temperature of 60 degrees.
 - Indoor places where light to moderate work is performed shall maintain a minimum air temperature of 65 degrees.

V. PROCEDURE

Prevention

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 clothing that keeps 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 under layers 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 garments that allow water vapor created by perspiration to escape.
 - e. Wear insulated boots, socks, and gloves.
 - f. Change out of wet clothing as soon as possible.
 - g. 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. As the first sign of overexposure, stop work and go indoors or to a dry, heated area to warm up. Do not push yourself to finish a task.

First Aid Treatment and Emergency Response

Frostbite

The sooner a frostbite victim gets help, the better the chances for saving the affected body part. Personnel administering first aid for frostbite must observe the following procedures to avoid making the situation worse.

- a. 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.
- b. Take the victim to a hospital emergency room. If the victim cannot be moved, call 911.
- c. Warm the affected area by the following methods:
 - i. Skin-to-skin contact. Do not rub or massage frostbitten skin as that can cause damage to skin and tissue.
 - ii. Immersion in lukewarm (105°F) water: Gently place the affected area in a lukewarm water bath. Do not pour warm water directly on the affected area because it will warm the tissue too fast, causing tissue damage.
 - iii. Do not use hot water. Do not apply direct heat to the area. Never warm the area with dry or radiant heat.
- d. Raise the affected area above the level of the victim's chest to relieve swelling or pain.
- e. Dry the area and cover with blankets.
- f. 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).

Hypothermia

All cases of hypothermia should be regarded as life-threatening because it affects the individual's core body temperature. Personnel administering first aid for hypothermia must observe the following procedures.

- a. Get the victim to shelter and remove any wet clothing.
- b. Take the victim to a hospital emergency room. If the victim cannot be moved, call for an ambulance.

Trench Foot

Trench foot, also known as immersion foot, is an injury of the feet resulting from prolonged exposure to wet and cold conditions. Personnel administering first aid for trench foot must observe the following procedures.

- a. Soak feet in warm water, then wrap with dry cloth bandages.
- b. Give the victim warm, sweet fluids to drink.

VI. REFERENCES

- American Conference of Governmental Industrial Hygienists (ACGIH) TLV's and BEI's 2019
- MN Rule 5205.0110 Indoor Ventilation and Temperature in Places of Employment
- OSHA, Department of Labor, Fact Sheet OSHA 98-55, "Protecting Workers in Cold Environments."
- OSHA, Department of Labor, OSHA Publication 3156, "The Cold Stress Equation."
- CDC, Department of Health and Human Services, "Cold Stress."

APPENDIX A

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 B

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)

| Est. 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 | -49 | -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 C

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 locations, 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 Temp (°F) with Sunny Sky | Wind Speed* | | | | | | | | | |
|------------------------------|---------------------------------|---------------|---------------------------------|---------------|---------------------------------|---------------|---------------------------------|---------------|---------------------------------|---------------|
| | Calm | | 5 mph | | 10 mph | | 15 mph | | 20 mph | |
| | 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 | | | | |
| -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 | | | | | | | |
| -45 and below | 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 B 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, 2012).