

CHAPTER 43 – TEMPERATURE EXTREMES: COLD

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CHAPTER 43 – TEMPERATURE EXTREMES: COLD

A. INTRODUCTION

1. It is the policy of the Smithsonian Institution (SI) to control employee exposure to cold temperature extremes, protect personnel from the adverse effects of working in cold environments, and to protect personnel from possible cold-related disorders.
2. This Chapter applies to all SI operations where ambient temperatures are less than 40 degrees Fahrenheit (°F).
3. The information contained in this Chapter is based primarily on the American Conference of Governmental Industrial Hygienists (ACGIH) “Threshold Limit Values for Chemical Substances and Physical Agents, and Biological Exposure Indices,” latest edition. The “Thermal Stress” section outlines the generally accepted standards for the evaluation and control of cold stress.

B. CHAPTER-SPECIFIC ROLES AND RESPONSIBILITIES

1. Safety Coordinators shall:
 - a. Assist supervisors with monitoring ambient temperatures and conducting cold stress monitoring when the threshold temperature is reached. Refer to Section D.1 of this *Manual* for threshold temperature information.
 - b. Assist supervisors with the implementation of changes recommended by OSHM to reduce employee’s potential for developing cold-related disorders.
 - c. With assistance of OSHM medical professionals, train supervisors on the detection of early signs of cold stress and train employees on cold stress recognition, prevention, and control measures prior to working in a cold environment.
2. Supervisors shall:
 - a. Identify employees who will be potentially exposed to temperature extremes to the Safety Coordinator. Employees/activities affected by cold temperatures may include (but are not limited to):
 - (1) Construction – outdoor work or performing renovation work in areas where the heating/ventilation has been turned off;
 - (2) Maintenance- outdoor work or performing renovation or new construction in areas where there the heat/ventilation is under repair or not yet installed.
 - (3) Outdoor work (e.g., landscaping, outdoor pesticide application, animal care)

- b. Receive initial or seasonal refresher training on the detection of early signs of cold stress and first aid for initial response to cold stress disorders.
 - c. Educate employees on the symptoms of cold stress. Conduct safety briefings regarding health hazards and control measures associated with cold stress whenever conditions require the implementation of cold stress monitoring. Permit employees to interrupt their work if they demonstrate physical signs of cold stress.
 - d. In a cold-related emergency:
 - (1) Notifies local emergency medical services (EMS) transport to a local emergency room.
 - (2) Notifies OSHEM Occupational Health Services Division (OHSD) and Office of Protection Services (OPS) that EMS has been called.
 - (3) Provides cold stress disorder first aid until EMS arrives.
 - e. Monitor ambient air conditions to determine applicable work/rest regimens.
 - f. Encourage employees to notify OSHEM OHSD if the employee has an underlying medical condition or is taking medication that increases cold intolerance. OSHEM OHSD will work with SI management with a need to know to explore accommodation venues.
 - g. Permit employees to interrupt their work if they demonstrate signs of cold-related distress or extreme discomfort.
 - i. Ensure employees have access to drinking water.
3. Employees shall:
- a. Notify their supervisor if they believe they are being exposed to temperature extremes through regular work practices, or when a change in work practices increases their exposure to temperature extremes.
 - b. Consult with OSHEM OHSD's physician or physician assistant if medications are taken or an underlying medical condition develops that is adversely affected by cold. OHSD can recommend a disposition on the employee's suitability to work in a cold environment.
 - c. Receive training on cold stress recognition, prevention, and control measures prior to working in a cold environment.
 - d. Follow safe work practices to reduce cold stress as specified in this Chapter.
 - e. Wear personal protective equipment as specified in this Chapter to help prevent cold stress disorders from developing.
4. Office of Safety, Health and Environmental Management (OSHEM) shall:
- a. At the request of the Safety Coordinator or the supervisor, initially evaluate work areas/activities that may be affected by temperature extremes.

- b. Recommend changes to the work environment, as needed, to reduce employees' potential for developing cold-related disorders.
- c. On request from the supervisor or employee, determine an employee's fitness for working in cold environments, considering risk factors including (but not limited to): general health, age, acclimatization, degree of hydration or water intake, alcohol/caffeine consumption, obesity, low physical work capacity, recent blood donation, pregnancy, and medications, if known. OSHEM OHSD will work with SI management with a need to know to explore accommodation venues.
- d. When requested, OSHEM OHSD advises supervisor of medical determination. Decision to accommodate employee's condition lies with coordination of SI management official (s) with a need to know.
- e. Provides emergency room interface after hospital evaluation.

C. HAZARD IDENTIFICATION

1. General

- a. Supervisors will evaluate, with the assistance of the Safety Coordinator, work operations to determine employee exposure to cold temperature extremes, as part of the Job Hazard Analysis (JHA, refer to [Chapter 4, "Safety Risk Management Program"](#), of this *Manual*).
- b. When the body is unable to warm itself, cold stress disorders may result, including tissue damage and possibly death. Four environmental factors affect the amount of cold stress employees may face in a cold work area. The following factors are to be considered in the evaluation:
 - (1) Wind velocity;
 - (2) High humidity at low temperatures causes condensation lowering body temperatures
 - (3) Dampness; and
 - (4) Contact with cold water or cold surfaces.
- c. Major Risk Factors for Cold Stress
 - (1) Personal risk factors that may affect the amount of stress employees may face in a cold work area include:
 - (a) Wearing inadequate or wet clothing increases the effects of cold on the body.
 - (b) Taking certain drugs or medications such as alcohol, nicotine, caffeine, and medication that inhibits the body's response to the cold or impairs judgment.

- (c) Having an upper respiratory infection, or certain chronic diseases, such as diabetes, heart, vascular, and thyroid problems, may make an individual more susceptible to cold environments.
 - (d) Being a male; men experience greater death rates due to cold exposure than women (possibly due to inherent risk-taking activities, body-fat composition, or other physiological differences).
 - (e) Becoming exhausted or immobilized, especially due to injury or entrapment, may speed up the effects of cold temperatures.
 - (f) Older/elderly persons are more susceptible to the effects of cold stress.
2. Recognition of Cold Related Disorders. Cold body parts are tricky to warm gently to prevent further harm. Symptoms must be readily identifiable and prompt first aid or referral made to gently increase the temperature and promote warmed blood flow to prevent the death of tissue or the need for amputation. The following information must be clear and readily accessible to those needing immediate first aid/referral directions to prevent severe frostbite.
- a. A cold environment forces the body to work harder to maintain its temperature. Cold air, water, and snow all draw heat from the body. Wind chill, which is a combination of temperature and velocity, is an important factor to evaluate when working outside. A dangerous situation of rapid heat loss may arise for any individual exposed to high winds and cold temperatures.
 - b. Cold-induced occupational illnesses, injuries, and reduced productivity may occur with excessive exposure to a cold work environment. When in a cold environment, most of the body's energy is used to keep the body cavity warm. Over time, the body will begin to shift blood flow from the extremities (hands, feet, arms, and legs) and outer skin to the core (chest and abdomen), allowing exposed skin and extremities to cool rapidly and increasing the risk of frostbite and hypothermia. Trench foot may also be a problem where cold water is present within a cold working environment. Cold-induced disorders include:
 - c. The cold stress disorders outlined below are listed from the least to the most serious disorder; death is possible if the person is not removed from the cold stress situation.
 - (1) Trench Foot - caused by long, continuous exposure to a wet, cold environment, or actual immersion in water. Symptoms include a tingling and/or itching sensation, burning, pain, and swelling; sometimes blisters form in more extreme cases.
 - (2) Chilblain-Red swollen skin which is tender, hot to the touch and may itch. Condition may worsen to aching/prickly sensation to actual numbness.

- (3) Frostbite - occurs when skin tissue actually freezes, causing ice crystals to form between cells and draw water from them, which leads to cellular dehydration. Although frostbite typically occurs at temperatures below 30°F, wind chill effects may cause frostbite at above-freezing temperatures (see [Attachment 3](#)).
 - (a) Initial effects of frostbite include uncomfortable sensations of coldness; tingling, stinging, or aching of the exposed area followed by numbness. Ears, fingers, toes, cheeks, and noses are primarily affected. Frostbitten areas appear white and cold to the touch. The appearance of frostbite varies depending on whether re-warming has occurred.
 - (b) Deeper frostbite involves freezing of deeper tissues (e.g., muscles, tendons, etc.), causing exposed areas to become numb, painless, and hard to the touch.
- (4) General Hypothermia - occurs when your body temperature falls to a level where normal muscle and brain functions may be impaired. While hypothermia is generally associated with freezing temperatures, it may occur in any climate where a person's body temperature falls below normal.
 - (a) The first symptoms of mild hypothermia, such as shivering, an inability to perform complex motor functions, lethargy, and mild confusion, occur as the core body temperature decreases to approximately 95°F.
 - (b) As body temperature continues to fall, hypothermia becomes more severe. The individual falls into a state of dazed consciousness, failing to complete even simple motor functions. The victim's speech becomes slurred and their behavior may become irrational.
 - (c) The most severe state of hypothermia occurs when body temperature falls below 90°F. The body moves into a state of hibernation, slowing the heart rate, blood flow, and breathing. Unconsciousness and heart failure may occur in a severely hypothermic state.

D. Hazard Control. The risk of developing cold related injuries will be reduced by using one or more of a selection of engineering controls, work practices, employee training, and exposure (cold stress) monitoring.

- 1. Exposure Monitoring. The supervisor shall conduct cold stress monitoring (ambient temperature monitoring) when the work environment temperature is less than 40°F. Initial monitoring will be conducted to determine the first warm-up break, measuring air temperatures and estimating wind velocity (for outdoor operations), as follows:

- a. Establish the work/warm-up schedule for properly clothed employees using the Threshold Limit Values (TLVs) outlined in [Attachment 1](#), "TLVs Work/Warm-Up Schedule for a 4-Hour Shift."
 - b. For exposed skin, continuous exposure shall not be permitted when the air speed and temperature result in an equivalent chill temperature of -25°F. Refer to the National Weather Service's (NWS), "[Wind Chill Factor Chart](#)" for information on making an exposure determination. (See [Attachment 2](#)).
 - c. At air temperatures of 40°F or less, employees who become immersed in water, or whose clothing has become wet, should immediately change their clothing and be treated for any symptoms of hypothermia (refer to Section C.2.c.(4) of this Chapter for hypothermia symptoms).
2. Engineering Controls will be implemented to reduce risk, when feasible, and will include such measures as:
 - a. Use an on-site source of heat (e.g., air jets, radiant heaters, or contact warm plates).
 - b. Shield work areas from drafty or windy conditions.
 - c. Provide a heated shelter for employees who experience prolonged exposure to equivalent wind-chill temperatures of 20°F or less.
 - d. Use thermal insulating material on equipment handles when temperatures drop below 30°F.
 3. Safe work practices will be implemented to combat the effects of cold temperatures extremes, such as changes in work schedules and practices will help combat the effects of exceedingly cold weather. This can include:
 - a. Allowing employees a period of adjustment to the cold before scheduling a full work shift in a cold work area.
 - b. Permitting employees to interrupt their work if they demonstrate signs of cold-related disorders or extreme discomfort.
 - c. Establishing work periods and rest periods in a warm area. If work is performed continuously in the cold at or below an equivalent chill temperature of 20 °F, heated warming shelters should be made available nearby. Employees shall be encouraged to use these shelters at regular intervals. When entering a warming shelter, employees should remove their outer layer of clothing, and loosen the remainder of clothing to permit sweat evaporation.
 - d. Reducing the number of activities performed in cold environments as much as possible. When employees must work outside in cold temperatures, supervisors shall select the warmest hours of the day. Arrange work tasks to minimize sitting or standing still for long periods of time.
 - e. Protecting employees from drafts to the greatest extent possible.

- f. Establishing a “buddy system” while working in cold climates/temperatures, so employees can monitor each other for signs of cold stress.
 - g. Encouraging employees to remain hydrated; provide drinking water.
 - h. Adaptation of work schedules should help prevent cold-related disorders from occurring.
4. Personal Protective Equipment (PPE). If work is performed in an environment at or below 40°F, employees are to wear appropriate clothing and adequate layers of insulation to prevent cold stress. These are to include, but are not limited to:
- a. An outer wind-breaker layer that allows some ventilation (e.g., Gore-Tex, nylon);
 - b. A middle layer of wool or synthetic fabric that absorbs sweat and retains insulation in a damp environment; and
 - c. An inner layer of cotton or synthetic weave fabric that allows ventilation.
 - d. Insulated protection for feet, hands, face, and head (hat and gloves, as a minimum), to protect against cold and dampness. Up to 40 percent of body heat may be lost when the head is exposed.
 - e. A change of clothing is to be kept available and changed into immediately if work clothes become wet (to prevent hypothermia).
5. Emergency First-Aid Procedures. When in urban areas where Emergency Services personnel are readily available to transport victims of cold related disorders to a hospital facility, minimum manipulation and first aid interventions are necessary. Hospital facilities have current protocols, procedures and equipment for effective, gentle warming of cold induced injuries. In most cases only removing wet clothing and covering affected area with blankets or towels should suffice until EMS arrives. Applying too much heat or warming too quickly can result in further injury.
- a. Trench Foot
 - (1) Move employee to a warm, dry area. Gently dry off foot and cover with a dry cloth/ blanket.
 - (2) Carefully soak foot in warm (not hot) water gradually raising temperature of water above current temperature of foot. Only warm in gradual temperature increments so as not to burn the areas. Temperature recognition will be impaired.
 - (3) Dry, re-warm, and elevate affected tissue.
 - (4) Seek medical assistance as soon as possible.
 - b. Chilblain
 - (1) Remove from cold.

- (2) Remove wet or constrictive clothing.
 - (3) Gently wash area.
 - (4) Cover with loose warm clothes and allow gradual, natural re-warming.
- c. Frostbite
- (1) If there is suspicion of frostbite, seek medical assistance immediately. Hypothermia should be treated first (See hypothermia below).
 - (2) Take measures to prevent further cold injury.
 - (3) Cover frostbitten parts with dry, sterile gauze or soft, clean cloth bandages.
 - (4) Do not massage frostbitten tissue because it may cause greater injury.
 - (5) Severe cases may require hospitalization.
 - (6) If professional medical treatment will be delayed, consult with a medical professional for guidance on re-warming techniques. If there is a chance that the affected part will become cold again, then do not warm it. Warming and re-cooling may cause severe tissue damage.
- d. Hypothermia
- (1) DO NOT attempt to re-warm a severely hypothermic victim; re-warming may cause the development of an irregular heart beat. Severe hypothermia is a medical emergency, and the victim must be transported to the hospital immediately. Seek immediate medical assistance for persons suspected of being moderately or severely hypothermic.
 - (2) Treat hypothermic victims very gently due to the increased irritability of a cold heart; rough handling may induce an irregular heart beat.
 - (3) Reduce further heat loss by obtaining shelter, removing wet clothing, and adding layers of dry clothing and/or blankets.
 - (4) For mildly hypothermic cases, apply external re-warming, such as body-to-body contact, chemical heat packs, and/or insulated hot water bottles. The best areas to place these packs are the armpits, neck, chest, and groin. Only warm in gradual temperature increments so as not to burn the areas. Temperature recognition will be impaired.
 - (5) Give mildly hypothermic victims warm fluids orally gradually increasing the temperature with care, but avoid beverages containing alcohol or caffeine.

E. TRAINING

1. On request employees shall be trained by OSHEM OHSD in cold stress recognition, prevention, and control measures prior to working in a cold

environment. Employee training is important so that employees can recognize cold stress disorders and understand how to prevent them.

2. Supervisors who task employees in extremes of cold shall be trained by OSHEM to monitor ambient temperatures and to be aware of early signs of cold stress in employees and conduct cold stress monitoring.
3. Supervisors shall conduct safety briefings regarding health hazards and control measures associated with cold stress whenever conditions require the implementation of cold stress monitoring.
4. Include supervisor and employee initial and seasonal refresher training as well as supervisor monitoring for cold stress in the Job Hazard Analysis (JHA).

F. RECORDS AND REPORTS

1. Records of training are to be maintained for 5 years, per [Chapter 8, "Program Reporting and Recordkeeping Procedures"](#), of this *Manual*.
2. Employee health monitoring results should be maintained in the electronic medical record database.
3. Include supervisor and employee training as well as supervisor monitoring for cold stress in the Job Hazard Analysis (JHA).

G. REFERENCES

1. American Conference of Governmental Industrial Hygienists ([ACGIH](#)), "Threshold Limit Values for Chemical Substances and Physical Agents, and Biological Exposure Indices," "Physical Agents - Thermal Stress." 2006.
2. "[Protecting Workers in Cold Environments](#)," OSHA Fact Sheet No. 98-55. 12/22/1998.
3. OSHA, "[Emergency Preparedness and Response: Safety and Health Guidelines – Cold Stress](#)." February 23, 2005.
4. "[OSHA Offers Tips to Protect Workers in Cold Environments](#)," OSHA Trade News Release. January 8, 2002.
5. "[Warehousing – Freezer/Cooler Hazardous Situation and Possible Solutions](#)," OSHA Poultry Processing Industry eTool. 2007

Attachment 1

Work / Warm-up Schedule for a 4-hour Shift

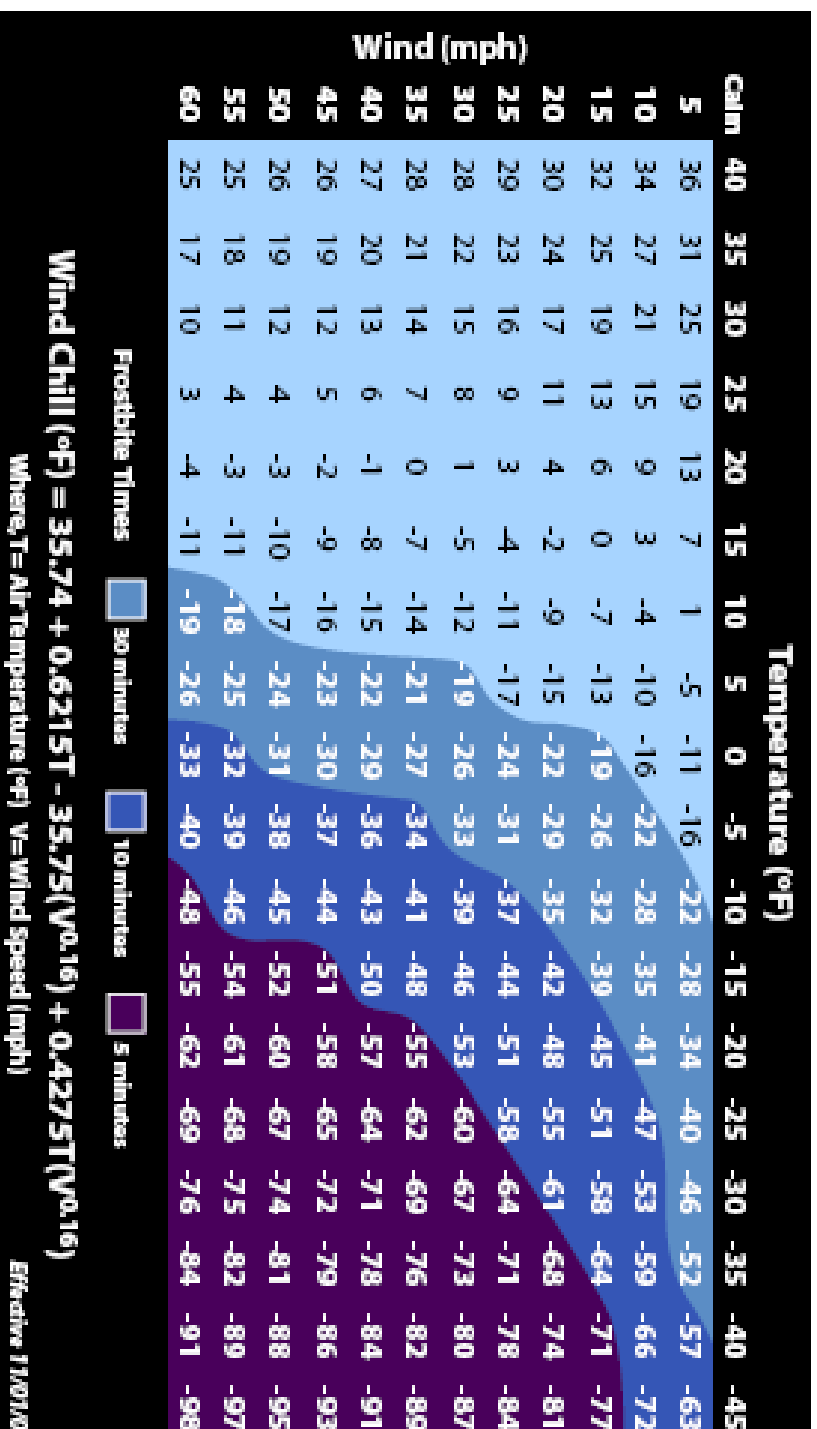
Air Temperature—Sunny Sky		No Noticeable Wind		5 mph Wind		10 mph Wind		15 mph Wind		20 mph Wind	
°C (approx.)	°F (approx.)	Max. Work Period	No. of Breaks	Max. Work Period	No. of Breaks	Max. Work Period	No. of Breaks	Max. Work Period	No. of Breaks	Max. Work Period	No. of Breaks
-26° to -28°	-15° to -19°	(Norm. Breaks) 1		(Norm. Breaks) 1		75 min	2	55 min	3	40 min	4
-29° to -31°	-20° to -24°	(Norm. Breaks) 1		75 min	2	55 min	3	40 min	4	30 min	5
-32° to -34°	-25° to -29°	75 min	2	55 min	3	40 min	4	30 min	5	Non-emergency work should cease	
-35° to -37°	-30° to -34°	55 min	3	40 min	4	30 min	5	Non-emergency work should cease			
-38° to -39°	-35° to -39°	40 min	4	30 min	5	Non-emergency work should cease		Non-emergency work should cease		Non-emergency work should cease	
-40° to -42°	-40° to -44°	30 min	5	Non-emergency work should cease		Non-emergency work should cease		Non-emergency work should cease			
-43° & below	-45° & below	Non-emergency work should cease		Non-emergency work should cease		Non-emergency work should cease		Non-emergency work should cease		Non-emergency work should cease	

NOTES for Table 3:

1. Schedule applies to any 4-hour work period with moderate to heavy work activity, with warm-up periods of ten (10) minutes in a warm location and with an extended break (e.g., lunch) at the end of the 4-hour work period in a warm location. For Light-to-Moderate Work (limited physical movement): apply the schedule one step lower. For example, at -35°C (-30°F) with no noticeable wind (Step 4), a worker at a job with little physical movement should have a maximum work period of 40 minutes with 4 breaks in a 4-hour period (Step 5).
2. The following is suggested as a guide for estimating wind velocity if accurate information is not available:
5 mph: light flag moves; 10 mph: light flag fully extended; 15 mph: raises newspaper sheet; 20 mph: blowing and drifting snow.
3. If only the wind chill cooling rate is available, a rough rule of thumb for applying it rather than the temperature and wind velocity factors given above would be: 1) special warm-up breaks should be initiated at a wind chill cooling rate of about 1750 W/m²; 2) all non-emergency work should have ceased at or before a wind chill of 2250 W/m². In general, the warmup schedule provided above slightly under-compensates for the wind at the warmer temperatures, assuming acclimatization and clothing appropriate for winter work. On the other hand, the chart slightly over-compensates for the actual temperatures in the colder ranges because windy conditions rarely prevail at extremely low temperatures.
4. TLVs® apply only for workers in dry clothing.

☆ Adapted from Occupational Health & Safety Division, Saskatchewan Department of Labour.

Wind Chill Factor Chart



Effects On Skin In Contact With Surfaces At Different Temperatures

<u>Temperature (°F)</u>	<u>Sensation or Effect</u>
212	Second degree burn on 15-second contact
180	Second degree burn on 30-second contact
160	Second degree burn on 60-second contact
140	Pain; tissue damage (burns)
120	Pain; "burning heat"
91 (+ or - 4)	Warm; "neutral" (physiological zero)
54	Cool
37	"Cool heat"
32	Pain
Below 32	Pain; tissue damage (freezing)