WCB
Workers Compensation Board of Manitoba

Thermal Stress Guide

December 2025

SAFE WORK MANITOBA™
A division of the WCB

The Workers Compensation Board of Manitoba serves workers and employers through a no-fault insurance system integral to the Manitoba economy. Funded by employers, the WCB promotes safe and healthy workplaces, facilitates recovery and return to work, delivers supportive compensation services, and ensures responsible stewardship of Manitoba's workers compensation system.

SAFE Work Manitoba, a division of the WCB, is dedicated to preventing workplace injury and illness. Working with safety partners, we provide prevention education, safety programming, consulting, and strategic direction to create a culture of safety for all Manitobans.

This guide's content was created in partnership with the Government of Manitoba's Workplace Safety and Health department.

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INTRODUCTION

This guideline will help you develop and implement a thermal stress management program in your workplace to protect workers in both hot and cold environments.

Workplace Safety and Health Regulation requirements

General Workplace Requirements, Part 4, addresses thermal stress as follows:

> **4.12** When a workplace or work process exposes a worker to conditions that may create a risk to the worker's safety or health because of heat or cold, an employer must implement safe work procedures and control measures to ensure that
>
> **a)** the threshold limit values for thermal stress established by ACGIH in its publication, 2019 *Threshold Limit Value for Chemical Substances & Physical Agents and Biological Indices*, are followed; and
>
> **b)** the worker is provided with information, instruction and training in the symptoms of thermal stress and the precautions to be taken to avoid injury from thermal stress.

Workplace program for hot or cold conditions

A workplace or work site with potential heat or cold-related concerns must have a program in place to address these situations as they arise. The program should include procedures for monitoring and educating workers. It should also have a plan for providing first aid to affected workers.

Prevention is the key. Many factors that contribute to heat or cold-related illnesses or injuries can be controlled to reduce the potential for harm.

Training

Employers must make sure workers exposed to safety or health risks because of hot or cold conditions at the workplace are provided with information, instruction and training on recognizing and avoiding injury or illness from thermal stress.

Provide effective supervision

Employers must make sure that all supervisors know about heat and cold-related illnesses, symptoms, prevention and treatment. Supervisors must be able to recognize unsafe conditions and take corrective action immediately.

Promote internal responsibility

Employers should involve the workplace safety and health committee or representative, managers/supervisors and workers in identifying heat and cold-stress symptoms and taking required action immediately.

Also under General Workplace Requirements, Part 4, the following provision addresses general thermal conditions at an indoor workplace as follows:

> **4.13** Subject to subsection 4.12, an employer must establish and maintain thermal conditions,including air temperature, radiant temperature, humidity and air movement, in an indoor workplace that are appropriate to the nature of the work being done.

Extreme thermal environments and the human body

The human body functions best within a narrow internal temperature range of 36 to 38 degrees Celsius. Below this range, the body's temperature control center in the brain goes to work, directing more blood to vital internal organs and causing shivering to help keep the body warm. Above the target range, more blood is directed toward the skin surface and perspiration increases to help cool the body. When heat loss or gain becomes more than the body can balance, internal systems will begin to fail and may shut down, leading to illness and possibly death.

Sources of heat gain and heat loss

The environment is the main source of thermal stresses to the body. Stress arises due the difference between the external thermal conditions and the temperature target needed by the body for best performance. Strain is a measure of the efforts made by the body to compensate for the thermal stress and maintain the thermal target.

Thermal energy, or heat, is transferred from one body to another by the mechanisms of:

- conduction, through direct contact
- convection, through a moving medium such as air or water
- radiant heat, through space over a distance

Each component of the system evaluated will experience a net gain or loss of heat. The heat load evaluation considers environmental heat transfers with the body and includes the heat generated within the body itself.

Heat is continuously produced within the body because of metabolic activity. Muscular work contributes to the production of internal body heat with more heat produced as more work is performed.

The skin is the organ of the body which directly interfaces with the environment and includes sensory elements to detect conditions, and responsive elements such as muscles and glands. Covering the skin may shield the body from thermal extremes but will also limit the ability for the natural response mechanisms to perform effectively.

HOT ENVIRONMENTS

Definitions (for the purpose of this document, the following definitions apply):

Acclimatization

Is a gradual process in which the body becomes accustomed to temperature extremes.

Conduction

The transfer of heat to the body by direct contact with a warm object. This is a relatively insignificant source of heat when considering heat gain in the body.

Convection

The exchange of body heat with the surrounding air. If the moving air is cooler than the body temperature, it will cool the body; if warmer, it will increase the heat load. Air speed is an important factor in heat loss or gain.

Evaporation

Evaporation of perspiration from the skin is usually the main method of heat removal from the body. As temperature, humidity and rate-of-work go up, so does the rate of perspiration. At very high ambient humidity, sweat does not evaporate very quickly, however, high air speed and low humidity increases the rate of sweat evaporation. If it is very hot and dry, excessive perspiration may lead to dehydration (excessive fluid loss from the body).

Heat stress

The heat load that a worker may be exposed to come from a combination of metabolic heat while working, clothing requirements and environmental factors, e.g., air temperature, humidity, air movement and radiant heat exchange. Mild or moderate heat stress may cause discomfort and may negatively affect performance and safety. As the heat stress increases, the risk of heat related health disorders increases.

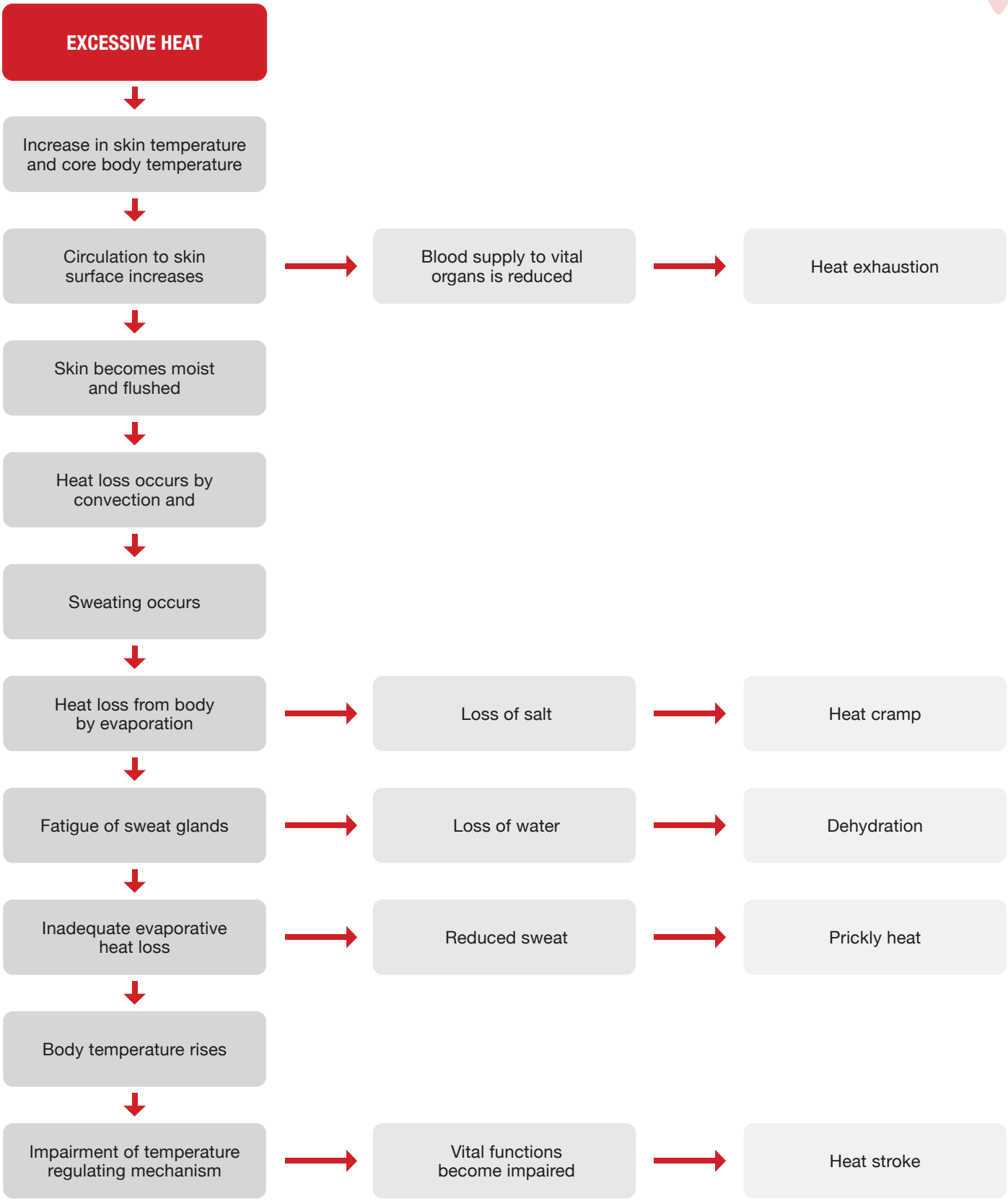
Heat strain

Describes the body's individual response system to cope with heat stress and indicators include elevated heart rate and core body temperature.

Radiation

The transfer of heat energy to a body, over a distance, from a hot source, such as a furnace, an oven or the sun. It is important to note that heat energy may be lost from the body as radiant heat if the surrounding air is cooler than the body.

The body's response to excessive heat



The body's response to heat

Dehydration is a common concern when working in a hot environment. As shown in the illustration on page 7, it is caused by failure to replace the salt and water lost through perspiration. Although perspiring helps the body cool, it is necessary to replace lost fluid and salt.

On average, one to two cups of water per hour are required to replace fluid lost from heavy perspiration. Sugary drinks such as soda pop, and fluids containing caffeine and alcohol should be avoided. Cool, but not cold, water should be provided in a location convenient to workers. Because the feeling of thirst may not be enough to ensure adequate water intake, workers in hot environments should be encouraged to drink at least one cup per hour. Too much water (more than two cups) should not be taken at one time since workers may develop abdominal cramps.

Most people consume enough salt as table salt and as naturally occurring salt in foods. Fruit and vegetable juices can be good sources of natural salt. Encourage workers on salt-restricted diets to discuss salt needs with their doctor. Salt tablets should only be taken on a doctor's advice.

Heat-related illnesses

The table on page 9 summarizes heat-related illnesses in increasing order of severity. It lists signs and symptoms to watch for; factors that influence heat-related illnesses; and a summary of prevention and treatment.

Factors other than the environment and workload can influence the body's ability to acclimatize and cope with heat. To avoid heat-related illness, such factors should be taken into consideration when assigning worker tasks and deciding on control measures.

Workers should ask a health professional whether any drugs being taken may increase the risk of heat illnesses. Age generally brings a decrease in efficiency of sweat glands, heart and lungs (after age 45). Gender is an influencing factor since men tend to have a higher sweat rate and larger oxygen intake, and therefore tend to acclimatize faster than women. Fitness, size and other factors influence the variations in people's ability to acclimatize.

Heat-related illnesses symptoms, prevention and treatment

SIGNS AND SYMPTOMS	CAUSES	PREVENTION	TREATMENT
HEAT FATIGUE • irritability, tiredness, loss of skill for fine or precision work • lower ability to concentrate. • no change in body temperature	• lack of acclimatization • other emotional or psychological stresses • discomfort in heat	• proper acclimatization • rest breaks	• not necessary unless other heat illness present • removal may be necessary if acclimatization ineffective
HEAT RASH • prickling sensation during heat exposure • itchy, tiny red spots on skin covered by clothing (a result of plugged sweat glands)	• skin continuously wet from sweat • humid heat	• shower to keep skin clean • apply powder and mild drying lotions,e.g.,calamine	• keep skin dry • rest in cool place • may take several days to subside
HEAT SYNCOPE • giddiness and fainting while standing in hot environment	• pooling of blood in legs causing drop in blood pressure • lack of acclimatization • loss of body fluid from sweating	• moving from time to time • proper acclimatization • drink extra fluids	• rest in cool area • recovery usually fast • may need to see physician
HEAT CRAMPS • sharp pains in muscles of arms, legs or abdominal muscles • may occur during or after work	• heavy sweating causing loss of salt • drinking large amounts of water without salt replacement	• add salt to foods • drink fluids naturally containing salt, e.g., fruit and vegetable juices	• move to cool place • give salted fluids • if severe, may need to see physician
HEAT EXHAUSTION • headache, nausea, dizziness, weakness, intense thirst • skin moist and clammy • rapid, weak pulse	• loss of water and salt from heavy sweating • lowered volume of circulating blood • lack of acclimatization • sustained exertion in high temperatures	• drink cool fluids often • take extra salt in food • drink fruit juices • proper acclimatization	• rest lying down in cool area • replace body fluids and salt • if vomiting, refer to physician
HEAT STROKE OR HEAT HYPERPYREXIA • nausea, headache, dizziness • hot dry skin (moist in hyperpyrexia) • body temperature 40 C or over • rapid strong pulse. • convulsions, coma may occur	• failure of central control of sweating • prolonged work in hot environment • unfit, unacclimatized workers • high humidity • pre-existing medical conditions, use of medications, high alcohol intake	• medical assessment prior to hot work • acclimatization • monitoring of workers during periods of work in heat • work-rest regimes • adequate fluid/salt replacement	• immediate medical attention! • immediate first aid-remove clothing, spray with cool water, fanning, cool wet sheets

Factors contributing to heat-related illnesses

General state of health – the following medical conditions may be a factor contributing to development of heat illness or may be aggravated by excessive heat:

a. Skin disorders may limit sweating, e.g., dermatitis, when aggravated by heat/moisture.

b. Heart and lung diseases may limit ability to cope with heat and may be aggravated by it.

c. Diabetes, poorly controlled, may contribute to dehydration and may be aggravated by excessive heat.

d. Diarrhea may contribute to dehydration.

e. Obesity requires increased energy to move around, and the extra insulation reduces heat loss — both contribute to the body's overall heat gain.requirements and environmental factors, e.g., air temperature, humidity, air movement and radiant heat exchange. Mild or moderate heat stress may cause discomfort and may negatively affect performance and safety. As the heat stress increases, the risk of heat related health disorders increases.

Medication/drugs – can affect the body's responses to heat and may affect acclimatization. Different medications/ drugs may affect different parts of the body:

a. The brain's thermostat is affected by ASA, phenothiazines.

b. The sweating function is affected by pilocarpine, and anticholinergic drugs such as hyoscine.

c. The circulatory system is affected by antihypertensives, antiarrhythmics, diuretics, alcohol and street drugs.

d. The metabolic rate is affected by thyroxin, alcohol and street drugs.

Lack of acclimatization – The body has not had enough time to adjust, or other factors prevent the body from adjusting to better tolerate the heat.

About acclimatization – Acclimatization is an important part of working in heat extremes. The following section outlines how employers can help workers achieve heat acclimatization.

Physically fit, healthy individuals generally will acclimatize more quickly. Drinking extra fluids hastens the acclimatization process. Acclimatization will last for about one week if away from the heat and will disappear completely in three weeks.

Acclimatization

Acclimatization is a gradual process in which the body becomes accustomed to temperature extremes.

During initial exposures to a hot environment, workers often feel very tired, irritable and too hot. Body temperatures often rise. After repeated exposures, these symptoms decrease or disappear. When this occurs, a person is considered acclimatized. Full physiological acclimatization involves a number of body systems, and some will take about a month to adjust. In the same way that many factors may lead to heat illness, there are differences in people that affect the rate at which they acclimatize.

In the acclimatized body, there is increased blood volume, a decreased body temperature and reduced salt concentrations in sweat and urine. The onset of sweating in response to heat stress occurs quicker, and the heart rate is better able to remain within acceptable limits.

Acclimatization schedule

As a rule, acclimatization may take from five to seven days for a healthy worker. The work environment should occur for at least two hours each day. New workers with no recent heat exposure should be started (on their first day) with 50 per cent of a normal workload. This may be increased by 10 per cent each day until a full workload is reached. Workers may be assigned to work in cooler areas for portions of the day until fully acclimatized. The added workload will need to be varied if other factors that contribute to heat-related illness are present. Also, adequate fluids must be provided and encouraged for all workers, especially new or returning workers. Workers who have been off the job for a week should be re-acclimatized for two to three days.

Measurement of occupational heat exposure

The Workplace Safety and Health Act (WSH Act) or regulations do not specify a maximum temperature above which work must stop. Rather, the combination of work and environmental conditions must be measured and evaluated against a set of screening criteria recommended by the American Conference of Governmental Industrial Hygienists (ACGIH). The exposure limits or threshold limit values (TLV) are published annually in a booklet titled, *Threshold Limit Value for Chemical Substances and Physical Agents and Biological Indices.*

To measure occupational heat exposure, combine the environmental factors that contribute to heat load, as discussed earlier. The most common method involves the wet bulb globe thermometer (WBGT) or a direct-reading thermal environment meter, available commercially. These instruments measure and calculate an effective temperature value which considers air temperature, air movement, radiant heat and effect of evaporation, and provides a value for indoors or outdoors.

WBGT readings are widely used to estimate the effect of ambient temperature, humidity, air movement and radiant energy sources on the body over time.

The WBGT is composed of three separate temperatures:

1. The air (shade) temperature (Tdb) consists of a dry thermometer shielded from the solar radiation. It is the standard ambient air temperature commonly measured and normally given in weather observations and forecasts.

2. The natural wet-bulb temperature (Tnwb) is measured by a thermometer with its bulb covered with a wet cotton wick. The cotton wick is always wet, allowing continuous evaporative cooling of the thermometer's bulb, simulating the evaporation of sweat. This temperature reading represents the combined effect of ambient temperature, humidity and air movement.

3. The black globe thermometer (Tg) consists of a black globe with a thermometer located in the center. This temperature reading represents the effect of radiant heat sources including solar radiation.

WBGT values are calculated as follows:

With direct exposure to sunlight:

$$WBGT_{out} = 0.7T_{nwb} + 0.2T_g + 0.1T_{db}$$

Without direct exposure to the sun:

$$WBGT_{in} = 0.7T_{nwb} + 0.3T_g$$

WBGT is the measurement of the environmental conditions before adjustment.

Heat exposure evaluation

The screening criteria values are shown in Table 1 and the value selected for comparison to an adjusted measurement is based on the work schedule and rate given for light, moderate, heavy or very heavy work. See Table 2 for examples of what is meant by these indicated work rates.

TABLE 1
Screening criteria to evaluate heat stress

	WBGT values in degrees Celsius							
	Acclimatized worker				Unacclimatized worker			
Allocation of work in a cycle of work and recovery	Light	Moderate	Heavy	Very heavy	Light	Moderate	Heavy	Very heavy
75% to 100%	31.0	28.0	–	–	28.0	25.0	–	–
50% to 75%	31.0	29.0	27.5	–	28.5	26.0	24.0	–
25% to 50%	32.0	30.0	27.5	28.0	29.5	27.0	25.5	24.5
0% to 25%	32.5	31.5	30.5	30.0	30.0	29.0	28.0	27.0

Heat exposure evaluation

The screening criteria values in Table 1 are based on healthy workers wearing one layer of customary work clothing. Water-vapour-impermeable, air-impermeable, thermally insulating clothing, multiple layers of clothing and encapsulating suits severely restrict heat transfer mechanisms. Variations from the customary clothing may require an adjustment to the measured value. See Table 3 for some suggested adjustments.

The effective temperature is a measured environment value adjusted if necessary for the clothing worn. When these effective temperatures are exceeding the criteria value selected, risk is confirmed, and a more detailed analysis is required. If the work and rest environment differ, a time weighted average estimate may be considered.

To address the scenario when the WBGT temperatures are exceeding the screening criteria, adjustments to the work-rest schedule and/or the rate of work are commonly considered control measures.

Example:

Work is performed at a moderate pace, generally at an indoor construction project. There may be occasional tasks that are classified as heavy work.

The working day includes a midday lunch and a short break every few hours. The break environment is the same as the work environment. This schedule represents a 75 to100 per cent work allocation, and the workers are generally not acclimatized to working in an extreme heat environment.

The WBGT measurement in the workplace is 24 C

No clothing adjustment is required as workers wear conventional single-layer clothing.

Screening value is not exceeded for moderate work suggesting a low risk of excessive heat stress, but heavy work should not be performed at this time as the measurement suggests there may be risk.

	WBGT values in degrees Celsius							
	Acclimatized worker				Unacclimatized worker			
Allocation of work in a cycle of work and recovery	Light	Moderate	Heavy	Very heavy	Light	Moderate	Heavy	Very heavy
75% to 100%	31.0	28.0	–	–	28.0	25.0	–	–
50% to 75%	31.0	29.0	27.5	–	28.5	26.0	24.0	–
25% to 50%	32.0	30.0	27.5	28.0	29.5	27.0	25.5	24.5
0% to 25%	32.5	31.5	30.5	30.0	30.0	29.0	28.0	27.0

TABLE 2
Classification of rate of work

Resting	• sitting quietly, sitting with moderate arm movements
Light	• sitting with moderate arm and leg movements • standing with light work at machine or bench, while using mostly arms and/or some walking • using a table saw
Moderate	• walking about with moderate pushing or lifting • walking on level at six kilometres per hour while carrying three kilograms • scrubbing in a standing position
Heavy	• carpenter sawing by hand • intermittent heavy lifting with pushing or pulling, e.g., shovel and pick work • shovelling dry sand • heavy assembly work on a non-continuous basis
Very heavy	• shovelling wet sand

TABLE 3
Clothing-adjustment factors for some clothing ensembles

Clothing type	Addition to WBGT [°C]
Work clothes (long-sleeve shirt and pants)	**0**
Short sleeves and woven pants	**-1.0**
Cloth (woven material) coveralls	**0**
Double-layer woven clothing	**3**
SMS polypropylene coveralls	**0.5**
Polyolefin coveralls	**1**
Limited-use vapor-barrier coveralls	**11**
Add a hood (full head and neck covered, not face)	**1.0**

Prevention and control measures

The risk of heat-related illnesses can be reduced by preventive and control measures, including:

a. engineering controls to provide a cooler workplace

b. administrative controls to reduce exposure and to ensure workers are able to recognize symptoms of heat-related illness

c. personal protective equipment, when necessary, to further limit exposure

Employers need to have a workplace program that includes training, environmental monitoring and responsive actions planned in association with established triggering measurements or reported values.

Engineering controls

Engineering controls are the most effective means of reducing occupational heat exposure, including:

- planning during the workplace construction if a hot environment is anticipated
- shielding the radiant heat at the source through insulation and reflective barriers
- exhausting heat and water-vapour (steam) to the outside
- reducing temperature and humidity through ventilation or air-conditioning
- providing cooled observation booths or air-conditioned rest areas
- increasing general air movement if temperature is less than skin temperature (approximately 36 C)
- reducing air movement if air temperature is greater than skin temperature
- reducing physical exertion by changing processes or using machines designed to assist

Administrative controls

Administrative controls are often the easiest to put in place, for or by the worker:

- apply a work schedule to allow for heat acclimatization
- increase frequency and length of rest breaks
- schedule hot jobs during cooler times of day
- provide cool drinking water near the work location and encourage workers to drink even if not feeling thirsty
- slow down work pace or assign additional workers to decrease workload
- allow for self-limitation of exposures and encourage co-workers to observe signs and symptoms of heat stress in each other
- provide workers with accurate written and verbal instructions, frequent training programs and other information on heat stress
- consider requiring that, as a condition of hiring, prospective employees provide medical evidence that they are not susceptible to systemic heat-related illness
- use air-conditioned rest areas

Personal protective equipment

Where engineering or administrative controls are not feasible or practical, occasional use of personal protective equipment may be necessary, including:

- wear insulated or cooled clothing for short-term exposure such as maintenance jobs
- wear clothing that allows free movement of airflow
- wear heat reflective clothing near heat sources such as a hot furnace
- wear light-filtering eye protection when work involves hot objects such as molten metals
- use sunscreen and sun block when working outdoors
- wear a hat and light clothing to protect skin when working in the sun

COLD ENVIRONMENTS

Cold environments and the human body

Cold can be a serious occupational hazard for many workers. Construction, oil and gas extraction, trucking, firefighting, police work, farming/ranching, fishing, logging and other outdoor jobs are examples of occupations where the potential for serious cold injury exists. Fatal exposures to cold have, most commonly, resulted from accidental exposures involving immersion in low-temperature water and failure to escape from low-air-temperature environments.

Workers do not need to be exposed to below-zero temperatures to experience cold-related conditions such as hypothermia. Indoor workers in refrigerated rooms or unheated buildings can also be at risk. Frostbite and hypothermia are two conditions of particular concern.

Cold stress exposure charts can help protect workers from the severest effects of cold stress and cold injury. They describe cold working conditions most workers can handle repeatedly without adverse health effects. They can help workers prevent cold injuries by determining when the risk is too high.

Definitions:

Frostbite happens when tissue freezes. Any exposed skin is subject to frostbite when air temperatures fall below freezing. Frostbite can lead to scarring, permanent tissue damage, possible amputation and disability. Symptoms of frostbite vary according to severity. Mild cases may produce prickling or burning sensations. Severe frostbite can produce extreme pain or no pain at all if nerve tissues are affected. Supercooled materials, including liquids and conductive solids, may cause frostbite on contact with bare skin.

Hypothermia occurs when the core body temperature drops below a level that allows it to maintain normal metabolic function, often only one or two degrees. Initial symptoms include a sensation of cold, followed by pain. As exposure time increases, the sensation of pain is reduced, and overall numbness develops. Additional symptoms may include muscle weakness, confusion, slurred speech and drowsiness. Hypothermia can rapidly progress to coma and death.

Wind chill cooling rate is the heat loss from a body, often expressed in watts per square meter. This rate is a function of air temperature and wind velocity.

Wind chill temperature (WCT) is the “feels like” temperature combining the ambient temperature with the wind effect. It provides an equivalent ambient temperature in calm conditions. Wind chill temperature is reported to the public by Environment Canada.

Factors that contribute to the risk of cold injury:

- temperature
- wind speed
- moisture (perspiration, rain or working near water)
- exposure duration
- type of clothing
- work/rest schedule
- type of work performed
- use of certain medications
- experience (previous exposure to the cold)
- age and physical state of the worker

Older workers or workers with circulation problems

Older workers or workers with circulation problems require special precautionary protection against cold injury, including the use of extra insulating clothing and/or reduced exposure time. Precautionary actions should be individually determined with the advice of a physician.

Adequate insulating dry clothing

Workers must wear adequate insulating dry clothing if work is performed in air temperatures below 4 C to maintain the core body temperature. The cooling power of air and the wind chill cooling rate are critical factors. The lower the air temperature and the higher the wind speed, the greater the insulation value of the clothing must be to maintain worker comfort. The combined effect of temperature and wind speed, as shown in Table 4, should be used in determining the requirements.

Typical cold weather clothing consists of multiple layers and functions to reduce heat loss through the insulation provided by the clothing directly as well as the trapped air within and between the clothing layers.

- Inner layer that is in direct contact with the skin should not absorb moisture but rather wicks moisture away from the skin to allow for evaporation through to the outer layers.
- Middle layer is the primary insulating layer and is adjusted to be appropriate to the ambient temperature for comfort.
- Outer layer is providing a barrier to the environment repelling water and resisting wind but is vented to allow for the evaporation of moisture that may arise due to sweating during work activities.

Workers must be aware of the importance of remaining dry in cold conditions as wet skin will increase the risk of developing hypothermia. The outer clothing layer is typically removed for performance of moderate to heavy work, unless needed for wind/rain, and then donned for rest periods.

Contact with cold surfaces with bare hands should be avoided below -7 C. Hands should be protected with mittens below -17.5 C.

Workplace monitoring

1. Suitable thermometers should be available where the air temperature is below 16 C.
2. When the air temperature falls below -1 C, a dry bulb temperature should be measured and recorded every four hours.
3. Indoor environments: wind speed should be recorded every four hours, whenever air movement exceeds two meters per second (~5mph).
4. Outdoor work: wind speed should be measured and recorded whenever the air temperature is below -1 C.
5. Equivalent wind chill temperature (WCT) should be obtained when air movement measurements are required and recorded whenever WCT is below -7 C (see Table 4).

TABLE 4
The cooling power of wind (°C)

WIND CHILL CHART

V_{10} \ T_{air}	Air Temperature (°C)												
Wind Speed (km/h)	0	-5	-10	-15	-20	-25	-30	-35	-40	-45	-50	-55
5	-2	-7	-13	-19	-24	-30	-36	-41	-47	-53	-58	-58
10	-3	-9	-15	-21	-27	-33	-39	-45	-51	-57	-63	-63
15	-4	-11	-17	-23	-29	-35	-41	-48	-54	-60	-66	-66
20	-5	-12	-18	-24	-30	-37	-43	-49	-56	-62	-68	-68
25	-6	-12	-19	-25	-32	-38	-44	-51	-57	-64	-70	-70
30	-6	-13	-20	-26	-33	-39	-46	-52	-59	-65	-72	-72
35	-7	-14	-20	-27	-33	-40	-47	-53	-60	-66	-73	-73
40	-7	-14	-21	-27	-34	-41	-48	-54	-61	-68	-74	-74
45	-8	-15	-21	-28	-35	-42	-48	-55	-62	-69	-75	-75
50	-8	-15	-22	-29	-35	-42	-49	-56	-63	-69	-76	-76
55	-8	-15	-22	-29	-36	-43	-50	-57	-63	-70	-77	-77
60	-9	-16	-23	-30	-36	-43	-50	-57	-64	-71	-78	-78
65	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-79
70	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-80	-80
75	-10	-17	-24	-31	-38	-45	-52	-59	-66	-73	-80	-80
80	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-81

Chart from Environment Canada

- **White (0 to -27):** Low risk of frostbite
- **Light Blue (-28 to -39):** Moderate risk
- **Medium Blue (-40 to -47):** High risk in 30 minutes of exposure
- **Dark Blue (-48 to -54):** Very high risk in 5 to 10 minutes of exposure
- **Purple (-55 to -59):** Severe risk in 2 to 5 minutes of exposure
- **Dark Purple (-60 and below):** Extreme risk in 2 minutes or less of exposure

(V_{10}) Wind Speed measured 10 metres above ground level

Warm-up periods

When continuous work in a wind chill temperature (WCT) at or below -7 C is required, heated shelters (cabins, tents, rest rooms etc.) should be available nearby. These shelters should be used as frequently as required, depending on the severity of the cold conditions.

Immediate use of the shelter is required by workers with the onset of heavy shivering, minor frostbite, excessive fatigue, irritability, drowsiness or euphoria.

When entering a heated shelter, the worker should remove the outer layer of clothing and loosen the remainder of the clothing to allow sweat evaporation. Warm, sweet drinks and soups should be provided for caloric intake and fluid volume. The intake of coffee should be limited.

The following table is provided as a guide that may be used to determine the appropriate warm up to work periods.

TABLE 5
Work/warm-up schedule for four-hour shifts and moderate to heavy work activity*

	No noticeable wind		8 km/h wind		16 km/h wind		24 km/h wind		32 km/h wind	
Air temperature °C (sunny skies)	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	Normal	1	Normal	1	75 mins.	2	55 mins.	3	40 mins.	4
-29 to -31	Normal	1	75 mins.	2	55 mins.	3	40 mins.	4	30 mins.	5
-32 to -34	75 mins.	2	55 mins.	3	40 mins.	4	30 mins.	5		
-35 to -37	55 mins.	3	40 mins.	4	30 mins.	5				
-38 to -39	40 mins.	4	30 mins.	5						
-40 to -42	30 mins.	5								
-43 and below										

In all shaded areas non-emergency work should cease

This schedule applies to moderate-to-heavy work with breaks of ten minutes in a warm location to allow workers to warm up. For light-to-moderate work (little physical movement), apply the schedule one step lower.

For example, at -35 C with no noticeable wind, a worker at a job with little physical movement should have a maximum work period of 40 minutes with four breaks in a 4-hour shift instead of 55-minute work periods and three breaks.

* Adapted from Occupational Health & Safety, Saskatchewan Department of Labour

Prevention and control measures

Frostbite cannot occur if air temperature is above 0 C.

The wind chill estimate provides an estimate of the cooling power of the environment. Wind does not cause an exposed object to become cooler than the ambient temperature, rather wind causes them to cool more rapidly than without wind.

Wet skin exposed to the wind will cool even faster. If the skin is wet and exposed to wind then the ambient temperature selected will be 10 degrees less than the actual, when using this chart (see chart on page 16).

Instantaneous frostbite can occur when the skin contacts super cooled liquids, such as petroleum products, oil, fuel, antifreeze and alcohol, all of which remain liquid at temperatures of -40 C.

Contact frostbite can occur by touching cold objects with bare skin, particularly cold metal or stone.

When working in conditions at or below -12 C WCT, the following measures should be in place:

1. A buddy system or constant supervision of workers.
2. Limit the amount of heavy work (to avoid heavy perspiration).
3. Allow new workers to become accustomed to the cold working conditions and with required protective clothing by limiting exposure times for a few days.
4. All work performance (including weights to be lifted by the worker) should take into consideration the bulkiness and weight of workers' clothing.
5. Encourage continuous body movement (minimize sitting or standing still) in cold environments, and protect workers from drafts.
6. The training program for workers should include at a minimum:
   - proper clothing practices
   - proper eating and drinking habits
   - safe work practices
   - proper re-warming procedures and first aid
   - signs and symptoms of impending frostbite
   - signs and symptoms of impending hypothermia

Particular attention needs to be given to the hands and the need for manual dexterity in the performance of work as both gloves and cold temperatures may negatively impact manual dexterity.

If fine work is performed with bare hands for more than 10-20 minutes in an environment below -16 C there should be previsions to keeping the workers hands warm.

Metal handles of tools and control bars should be covered by insulating materials at temperatures below -1 C. If dexterity is not important, then the worker should wear gloves in cool weather.

PPE such as hard hats need to have thermal layers that are approved by the manufacturer. In temperatures below -18 C, specific boots for this environment are needed.

Continuous skin exposure should not be permitted when air speed and temperature results in an equivalent chill temperature of -32 C. Deep tissue freezing will occur only at temperatures below -1 C, regardless of wind speed.

At air temperatures of 2 C or less, workers who become immersed in water, or whose clothing becomes wet, must change into dry clothing and be treated for hypothermia.