GONCRETE ONTARIO

Ready Mixed Concrete Association of Ontario

COLD STRESS GUIDELINE

for the Ready Mixed Concrete Industry

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PURPOSE

The guideline for the management of "Cold Stress" is a Preferred Management Practice document. A Preferred Management Practice document describes the regulatory requirements related to the issue, the practice in the industry and the preferred practices that minimize risk to the health and safety of workers.

APPLICATION

- To any Concrete Ontario member company, management and workers that are potentially exposed to working conditions that can contribute to cold-related illnesses.
- To managing exposure to conditions that can cause hypothermia and frostbite during periods of exposure to cold, wet and/or windy weather conditions.
- To management workers involved in outside activities and workers inside unheated facilities, material recovery facilities and maintenance facilities.

TECHNICAL BACKGROUND

During the winter months (October- March), workers in the ready mixed concrete management industry can face dangerously low temperatures, wet conditions and wind-chill exposure in the workplace. Excessive cold exposure may result in workers developing cold-related illnesses.

Cold Environments and the Human Body

A cold environment is defined as an environment under which greater than normal heat losses are anticipated and compensatory thermoregulatory actions are required. Cold is a physical hazard in many construction workplaces. When the body is unable to warm itself, serious cold-related illnesses and injuries may occur, leading to permanent tissue damage and even death. In a cold environment, the human body tries to maintain an internal (core) temperature within a narrow internal temperature range of 36 to 38 degrees Celsius (°C) by reducing heat loss and increasing heat production.

When exposed to very cold temperatures, the most serious health concern is developing hypothermia or dangerous overcooling of the body. Another dangerous effect of exposure to cold temperatures is frostbite or freezing of extremities, such as the fingers, nose or ear lobes. Without immediate medical attention, these conditions could be fatal.

Factors Contributing to Heat Loss

- **Temperature** Temperatures do not have to be below freezing for cold-related illness to occur, especially in vulnerable individuals.
- **Wind-chill** also known as "equivalent chill temperature (ECT)," is the combined effect of air temperature and air movement. The wind-chill temperature is basically the air temperature that would feel the same on exposed human flesh as the given combination of air temperature and wind speed. Table 1 displays the dangers associated with various combinations of air temperatures and wind speeds.
- Humidity Water conducts heat away from the body 25 times faster than dry air. Evaporation of sweat from the skin cools the body during periods of exertion; however, wet clothing draws heat very quickly away from the body. Being wet from sweating is just as dangerous as being wet from rain or snow. High wind velocity and low humidity increases evaporation and body heat loss. If it is very cold and dry, excessive water loss through the skin and lungs may lead to dehydration (excessive fluid loss).
- Work/Rest Schedule There are no maximum exposure limits for cold working environments in Canada. However, the Saskatchewan Department of Labour has developed a "work warm-up schedule" that has

been recognized by the Canadian Centre for Occupational Health & Safety. These Threshold Limit Values (TLVs), as seen in Table 2, can be used as a guideline for cold stress.

- **Protective Clothing** Protective clothing is required when working at temperatures at or below -4°C. Clothing must be selected to suit the temperature, weather conditions and job type. If the type and amount of clothing are not properly selected, then excessive sweating may occur. This will significantly reduce the insulation value of the clothing and increase the risk of developing cold-related injuries.
- **Conduction** This is the loss of heat through direct contact with a cooler object. Heat loss is the greatest when the body is in direct contact with cold water. The body can lose approximately 25 to 30 times more heat when in contact with cold wet objects than in dry conditions.
- **Radiation** The transfer of cold to the body through air from a cold source, for example, equipment, machinery, or ice/snow. This is an important factor as heat is lost from the body.

	5		WIN	ID CHI	LL CHA	RT			
	Ambient Temperature oC								
	4	-1	-7	-12	-18	-23	-29	-34	-40
Wind Speed km/h	km/h Equivalent Chill Temperature oC								
0	4	-1	-7	-12	-18	-23	-29	-34	-40
8	3	-3	-9	-14	-21	-26	-32	-38	-44
16	-2	-9	-16	-23	-30	-35	-43	-50	-57
24	-6	-13	-20	-28	-36	-43	-50	-58	-65
32	-8	-16	-23	-32	-39	-47	-55	-63	-71
40	-9	-18	-26	-34	-42	-51	-59	-67	-76
48	-10	-19	-27	-36	-44	-53	-62	-70	-78
56	-11	-20	-29	-37	-46	-55	-63	-72	-81
64	-12	-21	-29	-38	-47	-56	-65	-73	-82
Adapted from Threshold Limit Values (TLV) and Biological Exposure Indices (BEI) booklet: published by ACGIH, Cincinnati, Ohio, 2008.	LITTLE DANGER			INCREASING DANGER			GREAT DANGER		
	In less than 1 hr with dry skin. Maximum danger of false sense of security.			Danger from freezing of explosed flesh within 1 minute			Flesh may freeze within 30 seconds		
	Ens	ure dry clothing v	worn	Continuous work not permitted					

Table 1. Wind Chill Chart¹

¹ Canadian Centre for Occupational Health & Safety (2008). Cold Environments – Working in the Cold

THRESHOLD LIMIT VALUES WORK/WARM-UP SCHEDULE FOR FOUR-HOUR SHIFT														
Air Tem Sunn	perature y Sky	No noticeable wind		8 km/h wind		16 km/h wind		24 km/h wind		32 km/h wind				
°C (approx)	°F (approx)	Max. Work Period (min.)	No. of Breaks	Max. Work Period (min.)	No. of Breaks	Max. Work Period (min.)	No. of Breaks	Max. Work Period (min.)	No. of Breaks	Max. Work Period (min.)	No. of Breaks			
-26 to	-15 to		•				55	3	40	4				
-28	-19	(Normal Breaks) 1		(Normal Breaks) 1		75					2			
-29 to	-20 to	(Normal Breaks) 1					_		_		_			
-31	-24			/5	2	55	3	40	4	30	5			
-32 to	-25 to								_					
-34	-29	75	75	/5	75	2	55	3	40	4	30	5		
-35 to	-30 to			10	4	30	_							
-37	-34	55	3	40			5							
-38 to	-35 to													
-39	-39	40	4	30	5			Non-emergency work should cease						
-40 to	-40 to							work should cease						
-42	-42	30	30 5		Non-emergency		Non-emergency work should cease							
-43 and below	-43 and below	Non-eme work shou	rgency ld cease	work should cease										

² Canadian Centre for Occupational Health & Safety (2008). Cold Environments – Working in the Cold. Adapted from Threshold Limit Values (TLV) and Biological Exposure Indices (BEI) booklet: published by ACGIH, Cincinnati, Ohio, 2008.

RECOGNIZING COLD STRESS ILLNESSES

Cold stress illnesses range from the following minor discomforts to life-threatening conditions:

- Respiratory damage
- Hypothermia
- Frostnip
- Frostbite
- Chilblains

NOTE: Workers in the presence of a person with symptoms of cold stress or cold-related illness should provide on-site care in the form of warm liquids and heat while awaiting medical assistance. A competent person with a valid first aid certificate, EMS personnel or a physician should administer treatment for all cold stress and illness.

RESPIRATORY DAMAGE

Exposure to very cold temperatures can result in respiratory damage as the inhalation of cold air cools or even freezes the mucous membranes of the upper respiratory tract.

Symptoms:

- Discomfort in breathing or difficulty with breathing.
- Irritation, inflammation or spasms in the upper respiratory tract.

Treatment:

Limit time exposure to very cold temperatures and prevent exposure by covering the mouth and nose with a warm, porous material and avoiding deep, rapid breathing. Minor irritations and discomforts should disappear when removed from cold temperature exposure. More serious or persistent symptoms may require medical attention.

HYPOTHERMIA

Hypothermia (literally "low-heat") is a condition marked by an abnormally low internal body temperature. It develops when the body cannot maintain a normal core temperature, and body heat is lost to a cold environment faster than it can be replaced. Hypothermia can be called a "silent killer" as many victims are not aware of the threat. Wind, physical exhaustion, and wet clothing all make a person more prone to hypothermia.

Symptoms: (Based on the stage of hypothermia)³

	Core							
Stage	Temperature	Signs and Symptoms						
Mild Hypothermia	37.2 - 36.1°C	Normal shivering may begin						
	(99 - 97°F)							
	36.1 - 35°C	Cold sensation, goose bumps, unable to perform complex tasks with hand						
	(97 - 95°F)	shivering can be mild to severe, hands numb.						
	35 - 33.9°C	Shivering, intense, muscle in-coordination becomes apparent, movements						
Moderate Hypothermia	(95 - 93°F)	sobriety test, if unable to walk a 9 meter (30 foot) straight line, the person is						
		hypothermic.						
	33.9 - 32.2°C	Violent shivering persists, difficulty speaking, sluggish thinking, amnesia starts						
	(93 - 90°F)	frequently, difficulty speaking, signs of depression, withdrawn.						
	32.2 - 30°C	Shivering stops, exposed skin blue or puffy, muscle coordination very poor,						
	(90 - 86°F)	to maintain posture and appearance of awareness						
	30 - 27.8°C	Muscle rigidity, semiconscious, stupor, loss of awareness of others, pulse ar respiration rate decrease, possible heart fibrillation.						
Severe Hypothermia	(86 - 82°F)							
	27.8 - 25.6°C	Unconscious, a heart beat and respiration erratic, a pulse may not be obvious.						
	(82 - 78°F)							
	25.6 - 23.9°C	Pulmonary edema, cardiac and respiratory failure, death. Death may occur before this temperature is reached.						
	(78 - 75°F)							

³ Canadian Centre for Occupational Health & Safety (2008). Cold Environments – Working in the Cold.

Treatment:

- If not treated promptly, hypothermia can lead to death. Unconscious persons with severe hypothermia should be treated aggressively by experienced medical personnel and transported to a hospital. If no pulse is detected, CPR should be administered immediately until help arrives.
- Call 911.
- Carefully remove casualty to shelter, avoiding sudden movement or rough handling which can upset heart rhythm.
- Keep the victim awake.
- Get the victim out of frozen, wet or tight clothes.
- Mild hypothermia in young and otherwise healthy persons can be treated by re-warming the person in a warm bed or bath with warm packs, warm dry clothes, or blankets.
- Apply direct body heat or use safe heating devices.
- Re-warm neck, chest, abdomen and groin but not extremities.
- Have the victim drink something warm (if conscious), but do not give caffeine or alcohol. NEVER give anything by mouth to someone who is unconscious.

FROSTNIP

Frostnip occurs when the face or extremities are exposed to cold wind (wind-chill) which causes the skin to turn white.

Symptoms:

- Firm, cold, white areas on the face, ears, or extremities.
- Peeling or blistering that may appear similar to sunburn.
- A mild, persistent hypersensitivity to cold

Treatment:

- The affected area should be treated by re-warming with an unaffected hand or a warm object.
- Do not use hot water.

FROSTBITE

Frostbite occurs when there is freezing of the skin and/or body tissue. It can occur without hypothermia when the body extremities do not receive sufficient heat from the body core because of inadequate clothing or circulation. The most vulnerable parts of the body are the nose, cheeks, ears, fingers, and toes. Damage from frostbite can be serious; scarring, tissue death, and amputation are all possible, as is permanent loss of movement in the affected body parts. Local tissue damage ("white finger") may be triggered by exposure to cold after prolonged exposures to vibration from hand held power tools.

Symptoms:

- A sharp, prickling sensation in the affected area (pain may be absent).
- The skin is waxy and feels numb.
- The affected area is cold, hard, white and anesthetic.
- On warming, the affected area becomes blotchy red, swollen and painful with blisters that may take ten days to heal.
- Depending on the extent of the injury, the area may recover normally, or deteriorate to gangrene.
- Once damaged, tissue will be more susceptible to frostbite in the future.

Treatment:

- Call 911.
- Remove restrictive clothing or jewellery near the affected area or body part.
- Gradually warm and exercise the frozen part, but don't walk on frostbitten feet.
- Warm the frozen part quickly with sheets, blankets and warm water.
- Remove wet clothing from the affected area and gently dry the affected part.
- Place the affected part next to a warm part of the body if warm water is not available.
- Don't rub the affected areas or break any blisters.
- Don't apply a heat lamp or very hot water bottle.
- Don't go near a hot stove.
- Don't drink caffeine or alcohol to treat for hypothermia or frostbite.
- Don't re-warm the frozen tissue if tissue refreezing is a possibility.
- Don't use hot water (use warm water only).

CHILBLAINS

Chilblains are caused by prolonged, continuous exposure to cold temperatures without freezing, combined with persistent dampness or actual immersion in water. When this affects the feet it is called "trenchfoot".

Symptoms:

- Swelling, tingling, itching and severe pains.
- Possibly blistering, tissue death and ulceration.
- Pale, clammy cold skin that is swollen and numb.
- Infection is likely, and sensitivity to temperature may persist for years.

Treatment:

• Treatment for chilblains is the same as for frostbite (see above).

FACTORS CONTRIBUTING TO COLD-RELATED ILLNESSES

There are numerous factors other than the environment that influence the body's ability to acclimatize and cope with cold environments. These factors may contribute to the susceptibility of a worker to cold-related illness and should be taken into consideration when situating workers and deciding on control measures.

- Dehydration Dehydration is a common problem from working in heat and cold. It is caused by failure to replace salt (electrolytes) and water lost through the skin and lungs as a result of the dryness of the air. The fluid and salt loss must be replaced. Increased fluid intake is essential to prevent dehydration that can increase the risk of damage to the extremities since blood flow is decreased. Warm, sweet drinks (but not caffeinated) or soups should be consumed.
- The naturally occurring salt in foods is usually enough to replace salt lost through perspiration. Fruit and vegetable juices are good sources of 'natural' salt. The direct use of salt or salt tablets is no longer a recommended method of replacing salt, as this form of salt does not enter the body as easily or rapidly as water or other fluids.
- Lack of acclimatization the body has not had sufficient time to adjust, or other factors prevent the body from adjusting to the cold.
- Acclimatization is the process by which the body becomes accustomed to cold. Workers exposed to the cold should be physically fit, without any circulatory, metabolic, or neurologic diseases that may place them at increased risk for hypothermia. A new employee should not be required to work in the cold full time during the first days of employment until they become adjusted to the working conditions and required protective clothing. New workers should be introduced to the work schedule slowly and be trained accordingly.
- General state of health The following medical conditions may be a factor in contributing to cold-related illness, or may be aggravated by cold:
 - Asthma and bronchitis may increase the risk of cold air damage to the respiratory tract
 - Heart conditions may limit the ability to cope with the cold and may be aggravated by it
 - Diabetes, poorly controlled, may contribute to dehydration and may be aggravated by excessive cold
 - Diarrhea may contribute to dehydration
 - Get proper rest fatigue makes the body more vulnerable to subnormal cold
 - Cold may increase blood pressure, acute or chronically (persons with circulatory diseases are more susceptible and prone to suffer from cold exposures)
 - o Tall thin persons are more susceptible to frostbite than persons of "stocky" build
- **Diet** it is very important for persons who work in cold environments to eat a well-balanced diet. Eat nutritious foods and exercise moderately- proper diet and physical conditioning help protect against abnormal cold.

Workers should avoid smoking or alcohol use since these can restrict circulation in the vital organs and to the arms and legs increasing the susceptibility to frostbite.

- *Medication/drugs* Medication and drugs can affect the body's responses to cold, and may affect acclimatization. Different medications/drugs may affect different parts of the body:
 - the brain's "thermostat" affected by acetylsalicylic acid (aspirin) and phenothiazines
 - o the sweating function affected by pilocarpine, hyoscine, or other anticholinergic drugs

- $\circ\,$ the circulatory system affected by antihypertensives, antiarrhythmics, diuretics, alcohol, or "street" drugs
- o the metabolic rate affected by thyroxins, alcohol, "street" drugs

***Note:** If a worker is coherent and can provide information regarding drugs taken, record responses to assist with medical treatment.

- **Clothing and Personal Protective Equipment (PPE)** Select protective clothing to suit the climate, the job, and the level of physical activity.
 - Wear adequate insulating, dry clothing to maintain body core temperatures above 37 degrees Celsius.
 - Clothing should resist snow, rain and wind, but also allow water vapor generated by perspiration to escape. If conditions are wet as well as cold, ensure that the outer clothing worn is waterproof or at least water-repellent. Wind-resistant fabrics may also be required under some conditions
 - Do not wear constrictive garments. Instead, wear several layers of loose-fitting clothes that can be added or removed as needed to aid in evaporation of sweat. Air captured between the layers of clothes acts as an insulator. Suspenders may be used instead of belts, which can constrict and reduce circulation
 - Wear thin cotton fabric or synthetic fabrics such as polypropylene next to the skin since it helps evaporate sweat. Wear a cotton T-shirt and shorts under cotton or wool thermal underwear and wool or thermal trousers
 - Wear socks with high wool content and insulated boots. When two pairs of socks are worn, the inside pair should be smaller and made of cotton. Tight-fitting footwear restricts blood flow.
 Footwear should be large enough to allow wearing either one thick or two thin pairs of socks
 - Wear a hat or hood to prevent heat loss from the head and to protect ears. You lose up to 40
 percent of body heat if your head is not covered
 - Gloves should be worn below 5 degrees Celsius. Mittens should be used when the air temperature is 0 degrees Celsius or less
 - Wear a facemask and/or scarf if it is windy or extremely cold, and cover your mouth to protect your lungs
- Workload The body generates more heat during heavy physical work. Continued motion and work activity is advised during cold periods to maintain body heat. However, over exertion can lead to excess perspiration/moisture.

MANAGING COLD STRESS

The benefits of managing cold stress are:

- Protecting health Illness can be prevented or treated while symptoms are still mild.
- Improving safety Workers are less liable to develop a cold-related illness and have an accident. Cold stress often creeps up without warning.
- Increasing productivity Workers feel more comfortable and are likely to be more productive as a result.

Cold stress can be controlled through training and education, engineering, and work procedures.

• Training and Education

Cold stress employee training should cover the following components:

• Knowledge of cold stress hazards

- Recognition of risk factors, danger signs, and symptoms
- Awareness of first-aid procedures for, and potential health effects of cold-related illnesses
- Safe work practices
- Proper clothing and equipment
- o Guidelines for proper eating and drinking
- Employee responsibilities in avoiding cold stress
- Dangers of using alcohol and/or drugs (including prescription drugs) in cold work environments.
- o Knowledge of body heat and moisture affects

• Engineering Controls

- For work performed continuously in the cold, allow rest and warm-up breaks
- Workers showing signs of shivering, frostbite, fatigue, drowsiness, irritability, or euphoria should immediately be placed in a warm area
- Workers entering warm areas should remove their outer layer of clothing and loosen other clothing to let sweat evaporate
- In some cases, a change of clothing may be necessary
- Given the constantly changing nature of construction activities and environmental conditions, engineering controls are not usually feasible or practical for workers engaged in outside activities such concrete delivery
- Proper work procedures are therefore required to prevent cold stress illnesses

Work Procedures

• The risks of working in cold construction environments can be diminished if workers and management cooperate to help control cold stress

<u>Management:</u>

The employer should implement a cold stress prevention program that establishes:

- Employee training in the hazards, health effects and prevention of cold related illness
- Criteria or monitoring method (i.e. the plan should go into effect when there are wind chill warnings or cold alert notices given by environment Canada)
- Responses or preventative measures (i.e. dressing in proper layers of clothing, establishing a warm-up schedule, providing warm shelter, etc.)
- First aid and emergency responses
- Generally in Ontario, cold stress prevention programs should be in place between October 1st and April 30th of each year

EMPLOYEES

- Follow company policies and procedures related to cold stress and utilize all company provided safety equipment.
- Wear appropriate clothing that protects the body from cold temperatures and wind exposure.
- Drink small amounts of warm sweet drinks and consume adequate amounts of high-caloric foods when working in cold environments.
- Avoid beverages such as tea, coffee, or alcohol that increase water loss and blood flow to extremities.
- Open jackets but keep hats and gloves on if hot from physical exertion.
- Report any cold-related symptoms, illnesses or incidents immediately.
- Do not operate vehicles or equipment if exhibiting symptoms of moderate or severe hypothermia.

RELEVANT LEGISLATION/REGULATION

- Ontario Occupational Health and Safety Act (OHSA) Employers have a duty under section 25(2)(h) and supervisors under section 27(2)(c) to take every precaution reasonable in the circumstances for the protection of a worker. This includes developing and implementing hot and cold environment policies and procedures.
- OHSA Industrial Establishments Regulation

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