

18. Physical Hazards: Thermal Stress

Chapter 296-62 WAC, Part J-1

WAC 296-62-09013

1.0 Introduction

Some employees at PLU, primarily those who work outdoors, in food service, and cleaning positions may be exposed to temperatures that cause heat or cold stress. Employees who work outside of the “comfort zone” may experience decreased levels of productivity and quality of work.

The frequency of accidents also increases. Increased body temperature and physical discomfort promote irritability, anger, and other emotional states, which sometimes cause workers to overlook safety procedures or to divert attention from hazardous tasks. Working in a hot environment lowers the mental alertness and physical performance of an individual. In addition, heat tends to promote accidents due to the slipperiness of sweaty palms and dizziness. The possibility of burns from accidental contact also exists wherever there are hot surfaces.

In addition, employees may experience illness or injury as a direct result of temperature exposure. Atmospheric temperatures just above 89° F can also be dangerous, especially when humidity is high. On average, approximately 384 people a year die from heat-related illnesses.¹ Cold injuries can occur in atmospheric temperatures as high as 60° F when the body is wet. Manual dexterity drops when there is uninterrupted work for 10-20 minutes at temperatures below 61° F.

2.0 Regulation

Under Washington occupational health standards, workers who are exposed to temperature extremes, radiant heat, humidity, or air velocity combinations that are likely to cause a harmful physiological response must be protected.

3.0 Factors Associated With Thermal Stress

3.1 Cold Stress

Presence of wet clothing, contact with metals, wind-chill, and difference in temperature between the body and its surroundings directly influence the risk and extent of cold injuries. Vulnerability is increased when cardiovascular disease, diabetes, alcohol or caffeine intake, exhaustion, old age, and/or hunger impair circulation. Constrictive clothing, such as boots tied too tight, or a cramped position may also affect the occurrence of cold stress.

3.2 Heat Stress

Climatic conditions, such as temperature, humidity, and wind speed affect the amount of stress a worker faces in a hot work environment. Work demands and clothing characteristics, such as insulating ability, permeability, and ventilation are also important factors.

As with cold stress, people with health problems, such as high blood pressure or some heart conditions may be more sensitive to heat exposure. People who take diuretics (water pills) are also at risk.

¹ “We’re Having a Heat Wave...,” *Membership Advantage* Vol.2, Issue 2 (National Safety Council, April 1999)

4.0 Health Effects

Should an employee experience any of the symptoms listed below, the employee should contact their doctor or call Campus Safety at x7911.

Symptoms of Cold Stress

The following table is reproduced from the National Safety Council's Fundamentals of Industrial Hygiene, 4th edition.

Cold-Related Disorders Including the Symptoms, Signs, Causes, and Steps for First Aid

Disorder	Symptoms	Signs	Causes	First Aid
Hypothermia	Chills Pain in extremities Fatigue or drowsiness	Euphoria Slow, weak pulse Slurred speech Collapse Shivering Unconsciousness Body temperature <95 F (35 C)	Excessive exposure Exhaustion or dehydration Subnormal tolerance (genetic or acquired)	Move to warm area and remove wet clothing Modest external warming (external heat packs, blankets, etc.) Drink warm, sweet fluids if conscious Transport to hospital
Frostbite	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	Exposure to cold Vascular disease	Move to warm area and remove wet clothing External warming (e.g., warm water) Drink warm, sweet fluids, if conscious Treat as a burn, do not rub affected area Transport to hospital
Frostnip	Possible itching or pain	Skin turns white	Exposure to cold (above freezing)	Similar to frostbite
Trench Foot	Severe pain Tingling, itching	Edema Blisters Response to touch depends on depth of freezing	Exposure to cold (above freezing) and dampness	Similar to frostbite
Chilblain	Recurrent, localized itching Painful inflammation	Swelling Severe spasms	Inadequate clothing Exposure to cold and dampness Vascular disease	Remove to warm area Consult physician
Raynaud's Disorder	Fingers tingle Intermittent blanching and reddening	Fingers blanch with cold exposure	Exposure to cold and vibration Vascular disease	Remove to warm area Consult physician

Note: Hypothermia is related to systemic cold stress, and the other disorders are related to local tissue cooling.

Symptoms of Heat Stress

The following table is reproduced from the National Safety Council's Fundamentals of Industrial Hygiene, 4th edition.

Heat-Related Disorders Including the Symptoms, Signs, Causes, and Steps for First Aid and Prevention

Disorder	Symptoms	Signs	Cause	First Aid	Prevention
Heat Stroke	Chills Restlessness Irritability	Euphoria, Red face, Disorientation, Hot, dry skin (usually, but not always), Erratic behavior, Collapse, Shivering, Unconsciousness, Convulsions, Body temp. ≥ 104 F (40 C)	Excessive exposure; subnormal heat tolerance (genetic or acquired), Drug /alcohol abuse	Immediate, aggressive, effective cooling. Transport to hospital. Take body temperature.	Self-determination of heat stress exposure. Maintain a healthy life-style. Acclimation
Heat Exhaustion	Fatigue Weakness Blurred vision Dizziness, headache	High pulse rate, Profuse sweating , Low blood pressure, Insecure gait Pale face Collapse Body Temp: Normal-slightly increased	Dehydration (caused by sweating, diarrhea, vomiting) Distribution of blood to the periphery Low level of acclimation Low level of fitness	Lie down flat on back in cool environment Drink water Loosen clothing	Drink water or other fluids frequently Add salt to food Acclimation
Dehydration	No early symptoms Fatigue / weakness Dry mouth	Loss of work capacity Increased response time	Excessive fluid loss caused by sweating, illness (vomiting or diarrhea), alcohol consumption	Fluid and salt replacement	Drink water or other fluids frequently Add salt to food
Heat Syncope	Blurred vision (grey-out) Fainting (brief black out) Normal temperature	Brief fainting or near-fainting behavior	Pooling of blood in the legs and skin from prolonged static posture & heat exposure	Lie on back in cool environment Drink water	Flex leg muscles several times before moving Stand or sit up slowly.
Heat Cramps	Painful muscle cramps, especially in abdominal or fatigued muscles	Incapacitating pain in muscle	Electrolyte Imbalance caused by prolonged sweating without adequate fluid and salt intake	Rest in cool environment Drink salted water (0.5% salt solution) Massage muscles	If hard physical work is part of the job, workers should add extra salt to their food
Heat Rash (prickly heat)	Itching skin Skin eruptions Reduced sweating	Skin eruptions	Prolonged, uninterrupted sweating Inadequate hygiene practices	Keep skin clean and dry. Reduce heat exposure.	Keep skin clean and periodically allow the skin to dry

Note: Salting foods are encouraged as both treatment and prevention of some heat-related disorders. Workers on salt-restricted diets must consult their personal physicians.

5.0 Thermal Safety Program

5.1 Purpose

This program will establish guidelines and procedures for protecting exposed employees from temperature related injuries. While it applies to all PLU employees, those who work outdoors and in food service are most affected.

5.2 Policy

PLU will protect the health of its employees by recognizing the risks of temperature related injuries and illnesses and controlling those risks through a combination of employee education, administrative, engineering, and protective equipment controls. The use of these controls will vary based on the work environment and needs of the employees.

5.3 Responsibilities

Environmental Health & Safety Manager

Provide technical assistance to supervisors in implementing this program.

Supervisors

- Identify risk factors in various work environments.
- Implement work practices and other controls that minimize employee exposure.
- Train employees to recognize the risks, symptoms, and controls of temperature exposure, and to use self-determination to reduce their own risk.

Employees

- Occupationally exposed employees shall attend training when offered
- Employees shall monitor their own work environment for temperature risks and take appropriate action to protect themselves.

6.0 Cold Stress

There are a number of methods to protect against cold stress. Supervisors should use a combination of methods, including training, to manage the effects of cold stress on employees.

6.1 Training

Supervisors should inform employees of cold stress hazards when employees work in air temperatures below 41° F.² Employees exposed to cold stress shall be trained in the following.

- Description of cold stress: Environment, clothing, and physiological responses
- Recognition of cold-related disorders and first aid measures
- Cold stress hygiene practices and self-determination
- Overview of this program

6.2 Hygiene Practices and Self-Determination

Dehydration places a person at greater risk of cold stress. Employees should drink warm, sweet, and non-caffeine containing drinks to remain hydrated.

It is also important to eat a normal, well-balanced diet.

² Thomas E. Bernard, PhD, CIH, "Thermal Stress," *Fundamentals of Industrial Hygiene, 4th ed.* (National Safety Council, 1996) pp. 319-345.

Employees who experience extreme discomfort or symptoms of cold stress should stop work and seek a place to warm themselves. Employees should replace wet clothing immediately.

Employees with chronic illnesses or risk factors, such as cardiovascular disease or diabetes, should consult their physician regarding their exposure to cold at work. The employee shall provide his/her supervisor with written documentation from the physician indicating any limitations necessary to conduct their work safely.

6.3 Engineering Controls

Portable outdoor heaters are acceptable warming devices when used in accordance with equipment instructions. Gas-fired heaters must not be used in an enclosed area to reduce the possibility of exhaust gas poisoning. Heaters that are “on” must be attended at all times and must be turned off when unattended to limit fire hazard. They may not be used under conditions that could cause a heater to tip over, such as while driving.

Use insulated or non-metal tools. Steel conducts heat away from the body faster than water.

6.4 Administrative Controls

When the risk of cold exposure is high, supervisors should encourage frequent breaks in the work routine. Breaks are an opportunity to warm up the body in a temperature-regulated environment.

Whenever possible, supervisors should schedule outdoor or cold work during the warmest periods of the day. Avoid or limit periods of sedentary work effort.

Encourage employees to self-pace and to monitor their own health. Encourage them to leave the cold environment when feeling symptoms of cold stress.

6.5 Protective Clothing

Employees should wear dry, layered clothing to keep the body warm. Moisture conducts heat away from the body 25 times faster than air, increasing the potential for cold stress. Employees should prepare to change wet clothing during the workday.

Prevent clothing from becoming externally wet by using rain gear, to shed moisture. Waterproof footwear is also essential for protecting against the cold.

Sweat may also cause the body’s temperature to decrease. Clothing, including those made from polypropylene materials, that pull moisture away from the skin is recommended.

Wear a hat. Up to 50% of heat loss is through the head, ears and back of neck.

Cover all exposed skin to prevent chilblain (permanently damaged red and itchy skin) injuries. Wear gloves when the air temperature is less than 61° F for light work. Mittens are even better when manual dexterity is not required.

It is the employee’s responsibility to provide clothing that is “personal in nature and may be used by workers off the job”³. This includes waterproof footwear or cold-weather wear. Supervisors must provide other personal protective equipment.

7.0 Heat Stress Program

Requirements apply to outdoor work environments from May 1 through September 30, annually, when employees are exposed to outdoor heat at or above an applicable temperature listed in Table 1.

To determine which temperature applies to each worksite, select the temperature associated with the general type of clothing or personal protective equipment (PPE) each employee is required to wear.

³ Michael Wood, “WISHA Interim Interpretive Memorandum #96-9-C Personal Protective Equipment Assessment, Training & Payment,” (September 27, 1996).

Table 1 - Outdoor Temperature Action Levels

All other clothing	89°
Double-layer woven clothes including coveralls, jackets and sweatshirts	77°
Nonbreathing clothes including vapor barrier clothing or PPE such as chemical resistant suits	52°

Supervisors should implement a combination of administrative, engineering, and protective equipment controls to minimize heat related injuries. They should also train employees to protect themselves against heat stress.

7.1 Training

Employees at risk of heat stress shall be trained in the following topics.

- Description of heat stress: Environment, work demands, clothing, and physiological responses, including acclimation
- Recognition of heat-related disorders and first aid measures
- Heat stress hygiene practices and personal responsibility
- Overview of this program

7.2 Hygiene Practices and Self Determination

Dehydration is associated with heat stress. Employees should drink about one cup of fluids every 20 minutes. Cool water, artificially flavored lemonade, or commercial fluid-replacement drinks are suitable. Avoid alcohol, coffee, tea, and soft drinks containing caffeine as they may cause dehydration.

Employees should eat healthy, light meals at breaks and get adequate sleep to decrease the effects of heat stress.

It is the employee's responsibility to stop the work or leave the heated environment at the first symptom of a heat-related disorder. The employee must also carry out a pace of work that reduces the effects of heat stress.

Employees with chronic illnesses, such as heart, lung, kidney, or liver disease should consult their physician regarding their exposure to heat at work. The employee shall provide his/her supervisor with written documentation from the physician indicating any limitations necessary to conduct their work safely.

Employees should protect their skin from injury by using a sunscreen. Sunburn makes the body's job of heat dissipation much more difficult.

7.3 Engineering Controls

Whenever possible, departments will substitute power tools or other processes to reduce employee physical exertion or work demand.

Use personal fans to increase airflow. Good airflow evaporates sweat, which cools the skin. However air movement in environments more than 104° F may actually increase overall heat stress.

7.4 Administrative Controls

Whenever possible, supervisors should schedule the heaviest or hottest work during the cooler parts of the day and encourage short, frequent work-rest cycles to allow employees to drink and cool down. Encourage employees to take breaks in cooled environments whenever possible.

Supervisors should also pace the assignment of work so that the rate of metabolism, which contributes to heat stress, is maintained at a healthy level. Assign work to be shared by workers. Monitor workers for signs and symptoms of heat stress.

Encourage employees to utilize self-determination to control heat stress. They should monitor their own health and remove themselves from the environment as needed.

For new employees or employees returning from time off, implement a work schedule that allows the individual to build up a tolerance to hot conditions.

Heat Acclimation Schedules

The following acclimation schedules are reproduced from the National Safety Council’s Fundamentals of Industrial Hygiene, 4th edition.

Basic Acclimation Schedule

Basic Acclimation Schedule		
Day	Activity (% of full work assignment)	
	<i>Experienced</i>	<i>New</i>
Day 1	50%	20%
Day 2	60%	40%
Day 3	80%	60%
Day 4	100%	80%
Day 5		100%

Schedule for Re-acclimation after Periods Away from Heat Stress Exposures Due to Routine Absence or Illness

Re-Acclimation Schedule

Days Away from Heat-Related Schedule			Exposure Sequence (% of full work assignment)			
<i>Routine Absence</i>	Illness	Day 1	Day 2	Day 3	Day 4	
<4	-	100%				
4-5	1-3	R/E*	100%			
6-12	4-5	80	100%			
12-20	6-8	60	80	100%		
>20	>8	50	60	80		100%

* Reduce expectations, some diminished capacity

7.5 Protective Clothing

Employees should wear light-colored, lightweight, loose-fitting, natural fiber clothing. Select clothing that is permeable, does not insulate, and allows vapor movement.

There are also personal protective equipment products that can be worn to reduce the effects of heat. Try a reflective vest when working in the sun or near a heat source or ice/water-cooled bandanas or vests.

As with cold stress protective clothing, it is the employees responsibility to provide clothing that is “personal in nature and may be used by workers off the job”. Supervisors must provide other personal protective equipment.

Refrain from wearing frayed, torn, or loose-fitting clothing, jewelry, thong-type sandals, athletic/sport shoes, or long unrestrained hair near moving machinery or other potential sources of entanglement, or around electrical equipment.

HEAT EXHAUSTION

What happens to the body:

Headaches, dizziness, or light-headedness, weakness, mood changes, irritability or confusion, feeling sick to your stomach, vomiting, fainting, decreased and dark-colored urine, and pale, clammy skin.

What should be done:

- Move the person to a cool, shaded area. Don't leave the person alone. If the person is dizzy or light-headed, lay him on his back and raise his legs about 6-8 inches. If the person is sick to his stomach, lay him on his side.
- Loosen and remove heavy clothing.
- Have the person drink some cool water (a small cup every 15 minutes) if he is not feeling sick to his stomach.
- Try to cool the person by fanning him. Cool the skin with a cool spray mist of water or wet cloth.
- If the person does not feel better in a few minutes call for emergency help (ambulance or 911.)

If heat exhaustion is not treated, the illness may advance to heat stroke.

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HEAT STROKE - A Medical Emergency

What happens to the body:

Dry, pale skin, sweating may still be present, hot, red skin (looks like a sunburn); mood changes; irritability, confusion, and not making any sense; seizures or fits, and collapse (will not respond).

What should be done:

- Call for emergency help (ambulance or 911.)
- Move the person to a cool, shaded area. Don't leave the person alone. Lay him on his back and if the person is having seizures, remove objects close to him so he won't hit them. If the person is sick to his stomach, lay him on his side.
- Remove heavy and outer clothing.
- Have the person drink small amounts of cool water if he is alert enough to drink anything and not feeling sick to his stomach.
- Try to cool the person by fanning him or her. Cool the skin with a cool spray mist of water, wet cloth, or wet sheet.
- If ice is available, place ice packs in armpits and groin area.

PREVENTING HEAT-RELATED ILLNESS

- Drink a lot of water, about 1 cup every 15 minutes.
- Know the signs/symptoms of heat-related illness; monitor yourself and co-workers.
- Block out direct sun or other heat sources.
- Use cooling fans/air-conditioning; rest regularly.
- Wear lightweight, light colored, loose-fitting clothes.
- Avoid alcohol, caffeinated drinks, or heavy meals.



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Labor & Industries
Division of Occupational Safety and Health