UNIVERSITY OF MINNESOTA
University Health and Safety

Heat Stress

Effective Date: 3/28/2022

I. PURPOSE

The purpose of this program is to reduce the risk of injury, illness, or death for those individuals on campus who may work in hot indoor or outdoor environments and are susceptible to heat related illnesses.

II. SCOPE

This program applies to all employees, staff, and faculty associated with the University of Minnesota whose work requires them to be in hot indoor or outdoor environments.

III. DEFINITIONS

Heat Cramps: Painful muscle spasms because of exposure to excess heat. This occurs when a worker drinks a lot of water but does not replace salts lost from sweating.

Heat Exhaustion: A condition usually caused by loss of body water because of exposure to excess heat and characterized by body temperatures above 100.4 °F. Symptoms include headache, fatigue, nausea, and sometimes fainting.

Heat Rash: Skin irritation caused by excessive sweating during hot, humid weather.

Heat Stress: The net heat load to which a worker is exposed. Physical exertion, environmental factors, and clothing worn all contribute to heat stress.

Heat Stroke: A serious heat-related illness and should be treated as a medical emergency. It occurs when the body becomes unable to control its temperature: the body's temperature rises rapidly, the sweating mechanism fails, and the body is unable to cool down.

Heat Syncope: Weakness, fatigue, and fainting due to loss of salt and water in sweat and exercise in the heat.

Natural wet bulb (NWB): Temperature is measure by exposing a wet sensor, such as a cotton wick fitted over the bulb of a thermometer, to the effects of evaporation and convection. The term natural refers to the movement of air around the sensor.

IV. RESPONSIBILITIES

University Health and Safety (UHS)

- Ensure the Heat Stress program is followed and revised periodically.
- Assist supervisors in determining appropriate engineering and administrative controls to minimize heat load on employees.
- Provide training to employees on heat risk exposure and heat related illnesses if requested by departments.
- Upon request, evaluate the workplace for heat stress risk and recommend ways to manage exposure.
- Investigate heat related incidents.

Supervisors

- Recognize heat stress and risk factors.
- Provide access to fluid replacement for employees working under hot conditions.
- Identify specific areas in which workers are exposed to or likely to experience significantly hot environments.
- Determine tasks and activities that require extensive physical activity in hot environments.
- Identify workers whose job duties place them at risk for heat-related illness.
- Identify personal protective equipment (PPE) or specialized clothing that may increase the heat load on workers.
- Review the use of engineering controls such as ventilation systems, cool rest areas, or other controls that can reduce the heat load on workers.
- Review the use of work practice controls such as periodic rest breaks, work scheduling, or other practices that can reduce the heat load on workers.
- Provide training for all employees who work under hot conditions.

Employees

- Participate in heat stress training and learn the signs and symptoms of heat stress as well as risk factors.
- Follow all instructions given to reduce risk of heat-related injury.
- Monitor themselves and coworkers for signs of heat-related illnesses.
- Report any known or suspected unsafe conditions or unsafe procedures to their supervisor.

V. PROCEDURE

A. Recognizing and Characterizing Heat Hazards

Heat related illnesses are influenced by many personal factors such as age, weight, gender, fitness level, medical condition(s), metabolic heat, water and salt balance, and medications.

Environment, work effort, and clothing risk factors for heat stress are summarized in Table 1 below.

The human body regulates high temperatures by first increasing circulation of blood to the skin, then sweating to give off excess heat by evaporation. Heat stress occurs when the body is unable to release excess heat through these methods and the core body temperature rises. Signs and symptoms associated with heat stress are summarized in Table 2 below.

Supervisors and employees can use available tools such as heat stress temperature/humidity charts to anticipate and protect from heat stress hazards. OSHA-NIOSH has a Heat Safety Tool app for smartphones that can be a helpful resource for planning outdoor work activities based on location and the calculated heat index for that area.

Use of biometric detectors can be helpful in determining heat stress to employees but should not be relied on solely without considering all factors of heat stress laid out in this program. Use of biometric detectors to waive or modify any controls required within this plan must be approved by UHS.

Table 1: Risk Factors for Heat Stress

Factor	Low Risk	Medium Risk	High Risk	Very High Risk
Cloud Cover	Cloudy	Mostly Cloudy	Partly Cloudy	Sunny
Clothing Worn	Standard cotton shirt/pants and coveralls	Coveralls, suits, and aprons of engineered fibers (Tyvek, polypropylene, etc.)	Dual-layer clothing	Vapor-barrier coveralls (chemical protective suits, turn-out gear)
Work Effort	Light (sitting, standing, light arm/hand work, walking)	Moderate (normal walking, moderate lifting)	Heavy (heavy material handling, walking at fast pace)	Very heavy (pick and shovel work)
Heat Index	<91°F	91-103°F	103-115°F	>115°F
Humidity	0-30%	30-50%	50-60%	60+%
Air Movement	Breezy or actively ventilated with large fans or HVAC	Mild wind or small fans	Limited air movement, natural ventilation	No circulating air

Table 2: Signs and Symptoms Associated with Heat Stress
The table below illustrates some of the signs and symptoms associated with heat stress. If an employee experiences any of these symptoms, they should be taken for medical treatment immediately.

Condition	Signs/Symptoms	First Aid
Heat Cramps	Painful muscle spasms Heavy sweating	Increase water/electrolyte intake Rest in shade/cool environment
Heat Syncope	Brief fainting Blurred vision	Increase water intake Rest in shade/cool environment
Dehydration	Fatigue Reduced movement	Increase water intake Rest in shade/cool environment
Heat Exhaustion	Pale, clammy skin Possible fainting Weakness, fatigue Nausea Dizziness Heavy sweating Blurred vision Body temp. slightly elevated	Lie down in cool environment Water intake Loosen clothing Call 911 if symptoms continue once in cool environment
Heat Stroke	Sweating has stopped Skin hot and dry Red face High body temperature Unconsciousness Collapse Convulsions Confusion or erratic behavior Life threatening condition	Medical Emergency Call 911 immediately Move victim carefully to shade, immerse in water

B. Control of Heat Hazards

1. Engineering Controls

Heat may be controlled through general ventilation and spot cooling by local exhaust ventilation (LEV) at the point of high heat production. Shielding may be needed for protection against radiant heat sources. Other control measures include opening windows or using fans to create airflow. Outdoor work areas need to have a shaded area accessible to the employees.

2. Administrative Controls

Acclimatization

Employees need to adapt to new temperatures gradually. This adaptation period is usually 7-14 days but can vary. New employees and employees returning from an absence of two weeks or more should have at least a week long period of acclimatization. This period should begin with 50% of the normal workload the first day and gradually build up to 100% on the last day.

Clothing

During work in hot environments, workers should use the lightest weight or breathable protective garments that give adequate protection. This may include wearing short if this does not create a hazard for the legs. The clothing should be light colored.

Fluid Intake

Fluids such as water or electrolyte replacement drinks, need to be conveniently available to workers so they can drink about 8 oz. of liquids every 20 minutes. For remote outdoor work locations, a cooler of liquids and ice should be provided to employees. Alcohol, coffee, tea, and caffeinated sodas should be avoided as this will increase dehydration.

Training

Employees who may be exposed to hot environments (steam tunnels, greenhouses, non-airconditioned spaces, fieldwork, etc.) are required to receive Heat Stress training annually. This training can be received through Hazard Communication training module in Training Hub or in-person training provided by UHS.

Weather Conditions

Check weather conditions frequently during the day and adjust the work schedule. It might be appropriate to change the actual hours of work to minimize working during the heat of the summer months. Heavy work should be scheduled for the cooler hours of the day. Non-essential tasks should be postponed when there is a heat warning issued.

Work/Rest Cycles

Heavy and minimal work activities should be alternated. Tasks should be rotated among workers when possible. Employees should be allowed sufficient breaks in a cool area to avoid heat strain and promote recovery. Shade or an air-conditioned break room should be provided. A guideline to work/rest cycles can be found in Appendix A.

Other Administrative Controls

The following administrative controls can be used to reduce heat stress:

1. Reduce the physical demands of work, e.g., excessive lifting or digging

2. Provide recovery areas, e.g., air-conditioned enclosures and rooms
3. Use shifts, e.g., early morning, cooler parts of the day
4. Use intermittent rest periods with water breaks
5. Use relief workers and use the buddy system
6. Slow down the pace of work, if needed
7. Assign extra workers and limit worker occupancy, or the number of workers present, especially in confined or enclosed spaces
8. Consider a worker's physical condition when determining fitness to work in hot environments. Taking certain medications, lack of conditioning, obesity, pregnancy, and inadequate rest can increase susceptibility to heat stress.

3. Personal Protective Equipment (PPE)

Depending on the work tasks, specialized PPE may be necessary to reduce the severity of heat exposure. Examples include water and air cooled garments, cooling vests, wetted overgarments, and heat reflective clothing. It is important to understand that wearing PPE such as polyolefin coveralls or respiratory protection will increase your risk for heat-related illnesses.

C. Workplace Evaluation of Heat Stress

Determine WBGT

UHS can use a WBGT (wet bulb globe thermometer) to evaluate heat stress using the following equations:

Indoor measurement

$$WBGT = 0.7NWB + 0.3GT$$

Outdoor measurement with solar load

$$WBGT = 0.7NWB + 0.2GT + 0.1DB$$

Where:

WBGT = Wet Bulb Globe Temperature Index
NWB = Natural Wet-Bulb Temperature
DB = Dry-Bulb (air) Temperature
GT = Globe Thermometer Temperature

The determination of WBGT requires the use of a black globe thermometer, a natural (static) wet-bulb thermometer, and a dry-bulb thermometer. The measurement of

environmental factors shall be performed following the operational guide of the WBGT. The WBGT must be placed in the measured environment for at least 10 minutes to allow for sensor stabilization.

Once the WBGT has been estimated, UHS can estimate workers' metabolic heat load and use the ACGIH TLV book to determine the appropriate work/rest regiment, clothing, and equipment needed to control the heat exposures of workers in their facilities.

VI. Indoor Temperature Requirements

Minnesota rule 5205.0110 *Indoor Ventilation and Temperature in Places of Employment* requires that employees shall not be exposed to indoor environmental heat conditions in excess of the values listed in Table 3. If these temperatures cannot be maintained below the WBGT value for the respective work occurring in the indoor space, the following must occur:

- Work is discontinued in the space until temperatures can be maintained below respective WBGT value for work activity occurring in the space.
- UHS recommends a work-rest cycle based on WBGT measurement and ACGIH TLV guidelines if the work is deemed essential (i.e., steam tunnel work, potential damage or loss of research and equipment).

Table 3: Two-hour time-weighted average permissible heat exposure limits.

Work Activity	WBGT °F
Heavy work	77
Moderate work	80
Light work	86

Heavy work: 350 or higher kcal/hr (kilocalories per hour), such as heavy lifting and pushing, shovel work.
Moderate work: 200-350 kcal/hr such as walking with moderate lifting and pushing.
Light work: 200 kcal/hr such as sitting or standing performing light hand or arm work.

VII. REFERENCES

2022 ACGIH TLVs for Chemical and Physical Agents & BEIs
Minnesota Administrative Rules 5205.0110 Indoor Ventilation and Temperature in Places of Employment
NIOSH Criteria for a Recommended Standard: Occupational Exposure to Heat and Hot Environments
OSHA Technical Manual (OTM) Section III: Chapter 4 Heat Stress

Appendix A: Work/Rest Times and Fluid Replacement Guide

This is a recommended guideline for a work/rest cycle based on WBGT values and work effort of a fit, acclimated worker. Workers that do not fit that category may require longer rest times and increased hydration.

	Light Work		Moderate Work		Heavy Work	
WBGT (°F)	**Work/Rest (minutes)**	**Fluid Intake (quarts/hr)**	**Work/Rest (minutes)**	**Fluid Intake (quarts/hr)**	**Work/Rest (minutes)**	**Fluid Intake (quarts/hr)**
78 - 81.9 °F	No Limit	½	No Limit	¾	40/20	¾
82 - 84.9 °F	No Limit	½	50/10	¾	30/30	1
85 - 87.9 °F	No Limit	¾	40/20	¾	30/30	1
88 – 89.9 °F	No Limit	¾	30/30	¾	20/40	1
>90 °F	50/10	1	20/40	1	10/50	1

Fluid needs and worker performance can vary based on individual differences and environmental exposure conditions. Rest means minimal physical activity (sitting or standing) in the shade if possible. PPE and heavy clothing must be considered when assessing work/rest cycles. If you are unsure, contact UHS for further guidance.

Caution: Hourly fluid intake should not exceed 1 ½ qts. Daily fluid intake should not exceed 12 qts.

Work Load Definitions

Category	Examples
Light	Sitting with light manual work with hands or hands and arms, and driving. Standing with some light arm work and occasional walking.
Moderate	Sustained moderate hand and arm work, moderate arm and leg work, moderate arm and trunk work, or light pushing and pulling. Normal walking.
Heavy	Intense arm and trunk work, carrying, shoveling, manual sawing; pushing and pulling heavy loads; and walking at a fast pace.