National Institutes of Health

Thermal Stress Program

Division of Safety (DS)

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This document provides information and guidelines for the effective prevention of injuries or illness related to hot and cold work environments.

A. PURPOSE

The Thermal Stress Program has been developed to provide guidance and oversight for activities involving elevated or depressed temperatures during occupational activities (indoors and outdoors) at the National Institutes of Health (NIH).

B. SCOPE

The Thermal Stress Program applies to all NIH employees.

C. BACKGROUND

1. Thermal stress is a broad definition that covers personnel working in temperature extremes that can be hazardous to human health due to exposures to excessive heat and cold conditions. It describes the physical and physiological reactions of the human body to temperatures that exceeds the human body's thermal threshold. While the framework to manage heat or cold stress is similar in scope, specific actions differ by temperature extreme.

2. The overarching intent of the Thermal Stress Program is to ensure a core body temperature of individuals as close to normal (typically within 1-2° Fahrenheit) while they are working in conditions that contribute to heat or cold exposures and stressors. The program functions by limiting the amount of time an individual is exposed to extreme temperatures while completing specific categories of workload (low, medium, high). Key elements of the program involve identifying sources of thermal stress and planning measures to reduce or eliminate heat load/cold exposures where possible.

D. RESPONSIBILITIES

1. Thermal Stress Program Manager shall:

    a. Assist in the identification of potential thermal stress work areas or conditions; maintain an inventory of thermal stress work areas.

    b. Ensure proper thermal stress monitoring, analysis, and documentation for suspect and known thermal stress work areas.

    c. Ensure all equipment used for monitoring is appropriate and in proper working condition; including calibration and (if applicable) appropriate training in proper setup and use.

    d. Provide or ensure necessary NIH personnel are trained to recognize heat and cold stress, appropriate means to prevent injury or illness, and location of known thermal stress locations and/or environments.

    e. Assist in the development of localized administrative, engineering, or personal protective equipment (PPE) controls and measures to reduce or eliminate thermal stress conditions.

    f. Conduct periodic review of the NIH Thermal Stress Program to ensure it is compliant with

federal guidelines, regulations, and best practices.

2. Supervisors shall:

   a. Assist in the identification of thermal stress work areas or conditions.

   b. Notify Thermal Stress Program Manager regarding any suspect locations and/or hazardous work conditions for thermal stress conditions.

   c. Implement recommended engineering controls, instrumentation changes, or work practice changes requested to reduce thermal stress load. If these are unable to be addressed, supervisor shall notify the Thermal Stress Program Manager of this.

   d. Maintain a copy of this written program in the workplace.

   e. Ensure that employees required to work under suspect thermal stress conditions are trained in the thermal stress program. Training materials may be requested from the Thermal Stress Program Manager.

   f. Understand that tasks and activities performed under temperature extremes may take longer than under normal conditions; and incorporate extra time when planning these activities.

   g. Provide PPE where appropriate.

   h. For heat stress conditions, ensure cool drinking water is provided where fountains are not available. Ensure that a rest area (with lower ambient temperatures) is available if required.

   i. Provide appropriate rest periods for employees when indicated. NIH utilizes guidance provided by the American Conference of Government Industrial Hygienists (ACGIH) for heat stress work-rest cycles. Contact DS/Thermal Stress Program Manager for assistance in determining appropriate work/rest schedules.

   j. When working under thermal stress conditions, check employees (or have employees check each other) frequently for signs of thermal stress (see Hazard Recognition section).

   k. Ensure personnel visit the Occupational Medical Service (OMS) upon experiencing signs and symptoms of thermal stress, or injuries related to adverse heat/cold exposures.

3. Non-supervisory Employees shall:

   a. Assist in the identification of thermal stress work areas or conditions.

   b. Attend required training(s) as specified by a supervisor, Thermal Stress Program Manager, or Safety Officer/Specialist.

   c. Comply with procedures as directed by the Thermal Stress Program, and all other thermal stress related guidance as deemed appropriate by a supervisor.

   d. Use all PPE as specified in prescribed training, or required by a supervisor, or Thermal Stress Program Manager.

e. Maintain adequate and proper fluid intake when working in heat stress area.

f. Set a reasonable pace for work, especially in heat stress areas.

g. Monitor own physical condition as well as that of coworkers.

h. Immediately notify a supervisor, Thermal Stress Program Manager, or Safety Office upon encountering any potentially hazardous conditions.

i. Report to OMS in the event of an injury related to thermal stress or other condition leading to injury, disease, or impairment.

4. Contractors/NIH Project Officers:

a. Contractors must comply with federal safety regulations, and any stipulations as required by their respective NIH Project Officer.

b. Contractors are required to ensure the safety of their employees working on NIH property.

c. NIH Project Officers are required to convey all hazardous conditions to contractors working in or around those locations.

d. NIH Project Officers are responsible for ensuring contractors monitor ambient temperatures and personnel exposures to excessive heat and excessive cold environments. The contractor is responsible for ensuring personnel are appropriately trained to recognize and prevent thermal stress injury or illness. Unless provided by the government, the contractor is responsible for providing appropriate PPE to their personnel.

e. The Thermal Stress Program Manager may assist Project Officer in monitoring and/or training; however, shall not direct contract employees in any activities unless there is an immediate need to take action due to extreme thermal hazard.

E. HAZARD RECOGNITION

Conditions that may cause thermal stress:

1. Weather

a. Be aware of weather reports; especially the heat stress index and wind chill factor forecasts; particularly for workers who will be outdoors under elevated thermal stress conditions.

b. Individuals are most susceptible to thermal stress during their first exposure to excessive weather conditions.

2. Workplace – regardless of environmental weather conditions

a. Heat stress may be associated with sources such as cage wash areas, furnaces, boilers, mechanical spaces, and utility plants, as well as outdoors in the summer.

b. Cold stress sources include walk-in freezers and areas where frozen materials are used

or stored. Cold stress is also a potential significant hazard when outdoors in winter.

3. Work practices that affect thermal stress

   a. Employees performing heavy work such as lifting and carrying; and those wearing impermeable personal protective equipment are more susceptible to heat stress.

   b. Wet clothing, gloves, and footwear significantly increase the chances of cold stress disorders and frostbite.

4. Initial signs of heat stress:

   a. Muscle weakness
   b. Fatigue
   c. Nausea
   d. Lightheadedness

5. Initial signs of cold stress:

   a. Uncontrollable shivering
   b. Drowsiness
   c. Loss of sensation
   d. Clumsiness

F. PROGRAMS

1. Heat Stress Safety

   a. Workers become overheated from two primary sources: 1) the environmental conditions in which they work and, 2) the internal heat generated by physical labor. Heat related illnesses occur when the body is not able to lose enough heat to balance that generated by physical work/external heat sources.

   b. One location having an increased hazard for heat stress is animal cage wash areas. These areas are suspect for elevated temperatures due to the size and type of equipment used, high relative humidity levels from the steam generated from the cage washing process, and the PPE the workers are required to wear in these areas. Cage wash areas typically reach temperatures as high as 100°F. These temperatures may be exacerbated at times by summer heat wave conditions.

   c. ACGIH Guidelines

   (1) Table 1 charts the recommended work/rest cycles and fluid intake for different types of work and under increasingly hazardous heat categories. This table assumes average, "typical" workers who have already been acclimated to working under conditions of elevated heat and humidity. Coworkers and supervisors should monitor all individuals regularly and be prepared to provide accelerated rest and increased water intake to any individual who appears to be suffering more from these conditions than his or her peers.

Heat Category	WBGT	Light Work		Moderate Work		Heavy Work	
Describes the significance of the thermal conditions	Temperature Range in Degrees Fahrenheit (°F)	Work/Rest Cycle (in minutes/ hour)	Water Intake in ounces/ hour (oz/hr)	Work/Rest Cycle	Water Intake oz/hr	Work/Rest Cycle	Water Intake oz/hr
Caution	77.0 – 86.9	No limit	16	45/15	24	40/20	24
Danger	87.0 – 89.9	No Limit	24	30/30	24	20/40	32*
Extreme Danger	Above 90	50/10	32*	15/45	32*	10/50	32*

(1) **Table 1. Heat Stress Work/Rest and Fluid Intake Guidelines for Acclimatized Workers**

This table provides the administrative method for ensuring that "typical" individuals do not over-exceed a stress level that might trigger a hazardous physiological response to elevated temperatures. Table 1 requires the use of a Wet Globe Bulb Thermometer (WBGT) to integrate various measures of heat load.

WORK/REST GUIDELINES IN INDUSTRIAL ENVIRONMENTS

** Water intake recommendations are general guidance. For individuals with certain health conditions, it may be contraindicated to rehydrate at amounts greater than 24 ounces of water/hour.*

(2) **Table 2 Examples of Types of Work When Considering Work/Rest Cycles**

This table provides information describing typical work processes that define "light", "moderate", and "heavy" work.

Work Type	Light (up to 200 kcal/hr)	Moderate (200-350 kcal/hr)	Heavy (350-500 kcal/hr)
Activity Examples	• Sitting (light manual work) • Standing with some light arm work/occasional walking • Lifting: - 10 lbs; fewer than 8 times per minute - 25 lbs; fewer than 4 times per minute	• Sustained hand and arm work (painting with a brush/roller) • Sustained arm and leg work • Pushing and pulling carts, wheelbarrows, etc. • Walking at average pace • Lifting: - 10 lbs; 10 times per minute - 25 lbs; 6 times per minute	• Intense arm and trunk work (sledgehammer work) • Carrying, shoveling • Pushing or pulling heavy loads • Walking at a fast pace • Lifting: - 10 lbs; 14 or more times per minute - 25 lbs; 10 or more times per minute

(3) Clothing and PPE also affect the body's response to heat stress. Simply speaking, the more one wears, the greater the effect heat and humidity have on the body's physiological response. When evaluating an area for heat stress; work/rest cycles and fluid intake, take into consideration the work clothing that is worn in the performance of duties. Many of the references cited at the end of this instruction provide various multipliers depending on

clothing/PPE type.

(4) It may not be possible to reduce PPE requirements to combat heat stress.

(5) If possible, employees working under heat stress conditions should wear light-colored, loose fitting, natural-fiber clothing.

(6) Outdoor workers may also be affected by the amount of sunlight shining onto the work area. Even under similar temperatures and humidity, bright sunny days pose a greater heat stress threat than overcast days. Individuals who are sunburned have a reduced work capacity whether working inside or outdoors.

(7) Oral rehydration should be accomplished through regularly – to the extent possible – drinking fluids (i.e. frequent, small sips rather than great gulps at one time) throughout the exposure period. To ensure sufficient hydration, recommended water intake is identified in Table 1. Be advised that water intake recommendations are general guidance. For individuals with certain health conditions, it may be contraindicated to rehydrate at amounts greater than 24 ounces of water/hour. These oral rehydration volumes are marked with an asterisk (*) in Table 1.

(8) Employees should avoid alcohol, caffeine and decongestants when working in excessive heat, as these substances, by themselves, cause dehydration. Over-the-counter allergy medicines and certain high blood pressure medications may negatively affect and individual's tolerance to heat. Any employee with a medical condition or who is taking prescription medications should inform his/her supervisor or OMS prior to beginning work under heat stress conditions.

d. Acclimatization of Workers:

(1) Acclimatization is the result of beneficial physiological adaptations (e.g., increased sweating efficiency, etc.) that occur after gradual increased exposure to a hot environment. Employers should ensure that workers are acclimatized before they work in a hot environment.

(2) Gradually increase workers' time in hot conditions over 7 to 14 days.

(a) For new workers: The schedule should be no more than 20% of the usual duration of work in the heat on day 1 and no more than 20% increase on each additional day.

(b) For workers with previous experience: The schedule should be no more than 50% of the usual duration of work in the heat on day 1, 60% on day 2, 80% on day 3, and 100% on day 4.

(3) Closely supervise new employees for the first 14 days or until they are fully acclimatized.

(4) Non-physically fit workers require more time to fully acclimatize.

(5) Acclimatization can be maintained for a few days of non-heat exposure.

(6) Taking breaks in air conditioning will not affect acclimatization.

e. Monitoring

(1) Upon notification of potential heat stress conditions in a workspace or environment, the Thermal Stress Program Manager will evaluate and, if needed, perform heat stress monitoring of suspect location(s).

(2) To complete monitoring the Thermal Stress Program Manager will:

(a) Work with a knowledgeable individual from the work area who can adequately describe the perceived sources of heat load and time periods that are both typical and worst case for the suspect location.

(b) Set up the WBGT in the suspect location and run the meter for an appropriate period of time to adequately capture the heat intensity that is created by either natural environmental conditions or equipment/instrumentation that adds heat load.

(c) Provide technical feedback to the Supervisor or representative of the work area to allow an immediate response to ensure the safety of personnel.

(d) For work groups where long-term monitoring will take place, provide a copy of Appendix A – Heat Stress Monitoring Sheet a means of them recording data. A copy of this shall be kept as a historical record.

- At least one person per shift shall be trained on the use of the WBGT and how to read and record data on this record.
- A formal report containing heat stress data, results, and recommendations may also be issued, and retained for any monitoring evaluation.

f. Heat stress risk management measures for employees:

(1) Administratively rotating the workload among workers,

(2) Shortening the duration of exposure,

(3) Assigning tasks in pairs (buddy system) so that they can monitor each other for signs of heat stress.

(4) Increasing rest time or frequency of rest periods (rest periods should be in a cooler shaded area in relation to the work area),

(5) Utilizing air-conditioned rest areas,

(6) Minimizing direct heat sources by insulation or installing reflective screening,

(7) Using additional fans in the work area,

(8) Providing cool drinking water and encouraging employees to continually drink and not to consume water all at once.

g. Heat Stress Safety Training:

(1) All supervisors of employees who work in elevated heat areas should ensure that heat stress training is available. Types of training include a formal presentation by the Thermal Stress Program Manager, DS personnel, or OMS personnel; "Toolbox talks" led by the supervisor and/or the Thermal Stress Program Manager; or computer – based training.

(2) Training should incorporate both identifying heat related conditions and measures; and methods to overcome elevated heat conditions.

(3) Training should also include who to contact should workplace heat stress evaluation and monitoring be needed.

2. Cold Stress Safety

a. Anyone working in a cold environment may be at risk of cold stress. Some workers may be required to work outdoors in cold environments and for extended periods. Examples include (but are not limited to): snow cleanup crews, sanitation workers, police officers and emergency response. Some people who work indoors may also be subject to cold stress (e.g. researchers working in cold rooms). In general, a cold environment forces the body to work harder to maintain its optimum temperature. Whenever temperatures drop below "normal", heat can leave the body more rapidly. Injury risk is elevated when heat leaves the body at a faster rate than that body's metabolism can replace it. Cold stress occurs by driving down the skin temperature and eventually the internal body temperature (core temperature). This can cause significant health problems; and may cause tissue damage and possible death. Extremities such as fingers, toes, noses, ears, are at a greater risk of experiencing cold stress and potential tissue damage. Cold stress can also result in other types of work-related injuries as exposures to cold temperatures can slow reaction times; and can also affect certain cognitive processes.

b. Just as with heat stress, acclimatization is a factor in determining levels of cold stress.

c. A cold environment challenges the worker in three ways: air temperature, air movement (i.e. wind speed) and humidity (wetness).

d. Risk Factors

(1) In a cold environment, most of the body's energy is used to keep the internal core temperature warm. Over time, the body will begin to shift blood flow from the extremities (hands, feet, tips of ears and nose) and outer skin to the body's core (chest and abdomen). This shift allows the exposed skin and extremities to cool rapidly and increases the risk of frostbite. Hypothermia occurs when the body's internal core temperature is reduced enough to compromise vital functions required to sustain life. Combine cold temperatures with exposure to a wet environment and conditions such as trench foot may also occur.

(2) Some of the risk factors that contribute to cold stress are:

(a) Wetness/dampness of clothing

(b) Wet/damp environmental/working conditions

(c) Dressing improperly

(d) Fatigue and exhaustion

(e) Predisposing health conditions such as hypertension, hypothyroidism, and diabetes

(f) Poor physical conditioning

e. Cold Stress Prevention

(1) Although OSHA does not have a specific standard that covers working in cold environments, employers have a responsibility to provide workers with employment and a place of employment which are free from recognized hazards, including cold stress, which are causing or likely to cause death or serious physical harm to them (the "General Duty Clause"; Section 5(a)(1) of the Occupational Safety and Health Act of 1970).

(2) Employers should train workers on how to prevent and recognize cold stress illnesses and injuries and how to apply first aid treatment. Workers should be trained on the appropriate engineering controls, personal protective equipment, and work practices to reduce the risk of cold stress. The NIH Thermal Stress Program Manager can assist with cold stress training.

(3) Employers should provide engineering controls. For example, radiant heaters may be used to warm workers in outdoor stations. If possible, shield work areas from drafts or wind to reduce wind chill. Metal handles and bars can be covered by thermal insulating materials. Machines and tools can be designed so that they can be operated without having to remove mittens/gloves.

(4) Employers should use safe work practices; and incorporate the below items into a relevant health and safety plan for the workplace. These practices, aimed at protecting workers from cold-stress injuries, illnesses, and fatalities, include:

(a) It is possible to become dehydrated in cold weather. Employers can, therefore, provide or ensure that workers are drinking plenty of warm liquids and avoiding alcoholic drinks and strongly caffeinated beverages. Caffeinated drinks, besides contributing to dehydration (as mentioned in the heat stress section above, also increased blood flow at the skin, which can increase the loss of body heat. Similarly, alcohol should be avoided when working in cold condition as it causes expansion of blood vessels at the skin and impairs the body's ability to regulate temperature (i.e. it adversely affects shivering; a body's mechanism to increase body temperature).

(b) Employers can assign tasks in pairs (buddy system) so that they can monitor each other for signs of cold stress.

(c) Workers can be allowed to interrupt their work if they are extremely uncomfortable.

(d) Employees should avoid touching cold metal surfaces with bare skin.

(e) Provide workers with the proper tools and equipment to do their jobs.

(f) Develop work plans that identify potential hazards, and the safety measures used to

protect workers.

(g) Schedule maintenance and repair jobs for warmer months.

(h) Schedule routine jobs that expose workers to the cold weather in the warmer part of the day.

- Avoid exposure to extremely cold temperatures whenever possible.
- Limit the amount of time spent outdoors on extremely cold days.
- Use relief workers to fill in during long, demanding jobs.
- Provide warm areas for use during break periods.

(i) Monitor workers who are at risk of cold stress.

(j) Monitor the weather conditions during a winter storm; have a reliable means of communicating with workers; and be able to stop work or evacuate when necessary.

(k) Acclimatize new workers and those returning after time away from work by gradually increasing their workload, and allow more frequent breaks in warm areas, as they build up tolerance for working in the cold environment.

(l) Have a means of communicating with workers, especially those in remote areas.

(m) Know how the community warns the public about severe weather.

(n) Dressing properly is extremely important to preventing cold stress. The type of fabric worn makes a significant difference. Cotton loses its insulation value when it becomes wet. Wool, silk, and most synthetics, retain their insulating properties, even when wet. The following are recommended for working in cold environments.

(o) Wear at least three layers of loose-fitting clothing. Layering provides better insulation as the air between clothing actually provides better insulation than the clothing itself. Do not wear tight-fitting clothing. Tight clothing reduces blood circulation. Successive outer layers should be larger than the inner layer, otherwise the outer layers will compress the inner layers and decrease the insulative properties of the clothing.

- An inner layer of wool, silk or synthetic to keep moisture away from the body.
- A middle layer of wool or synthetic to provide insulation, even when wet.
- An outer wind and rain/snow protection layer that allows some ventilation to prevent overheating.
- Having several layers of clothing provides the option to open or remove a layer should exertion or temperature levels get high enough to induce sweating and to accommodate changing temperatures and weather conditions.
- Wear a hat or hood to keep the whole-body warmer. Hats reduce the amount of body heat that escapes through the head. Consider a hat that covers the ears as well.
- Use a knit mask to cover the face and mouth (if needed).
- Use insulated gloves to protect the hands (water resistant if necessary). Even

better, if the work task allows, and fine manual dexterity is not required, wear mittens.

- Wear insulated and waterproof boots (or other similar footwear). While some materials, such as leather allow the boots to "breathe" and let perspiration evaporate, any work involving standing in water or slush should be done in waterproof boots. Just keep in mind that socks and insulating materials will become wet (primarily from perspiration) more quickly in waterproof boots; this can increase the risk of frostbite. If waterproof boots are necessary, bring along an extra change of socks and switch when necessary.
- Workers should keep extra clothing (including underwear) handy in case the original clothing gets wet, and the employee needs to change into dry cloths.
- Clothing should be kept clean since dirt fills air cells in fibers and destroys the garment's insulating ability.

f. Employers' Responsibilities for Providing Protective Clothing That Provides Warmth.

(1) Employers must provide personal protective equipment when required by OSHA standards to protect worker safety and health. However, in limited cases (specified in the standard section 29 CFR 1910.132), there may be exceptions to the requirement for employers to provide PPE to workers.

(2) There is no requirement for employers to provide workers with *ordinary* clothing, skin creams, or other items, used solely for protection from weather, such as winter coats, jackets, gloves, parkas, rubber boots, hats, raincoats, ordinary sunglasses, and sunscreen. It is at the discretion of the employer to choose whether or not to provide winter weather gear such as winter coats and gloves.

(3) Employers should train (or provide training) on cold stress to include (at a minimum):

(a) How to recognize the symptoms of cold stress, prevent cold stress injuries and illnesses.

(b) The importance of self-monitoring and monitoring coworkers for symptoms.

(c) First aid and how to call for additional medical assistance in an emergency.

(d) How to select the proper clothing for cold, wet, and windy conditions.

(e) How workers will be protected: engineering controls, safe work practices and selection of equipment, including PPE.

G. NIH THERMAL STRESS ACTION LIMIT PROCEDURES

1. NIH Heat Stress Alert Procedure: conduct WBGT temperature monitoring.

a. The first action limit is reached at WBGT 78°F (calculated index, not apparent temperature):

(1) Provide replacement fluids (water) for workers performing moderate to heavy work (the default workload, if specific workload information is absent, use "moderate" work levels).

(2) Workers should drink 1 cup of fluid every 20 minutes. This corresponds to the 0.75

quarts each hour in Table 1 above.

b. The second action limit is reached at WBGT 87°F (calculated index):

(1) Supervisors shall arrange work schedules to limit the worker's exposures to heat stress conditions. Work/rest regimens for any moderate and heavy work are recommended at this action limit (and above 90°F for light work) at this action limit. Table 1 shows recommended work/rest cycles.

(2) Contact DS, Thermal Stress Program Manager for any situations or circumstances (such as impermeable PPE requirements, or outdoor work) where work/rest cycles may need to be amended.

(3) Provide (or continue) fluid replacement and monitoring of such for workers.

(4) NIH Cold Stress Alert Procedure: the objective is to prevent any cold stress disorder or injury.

c. Below 20°F Wind Chill Index (WCI):

(1) Make warming shelters available if performing extended outdoor work.

(2) Ensure employees are wearing cold weather PPE.

d. At or below 11°F WCI:

(1) Workers may become disoriented when experiencing cold stress. Use the "buddy system" when working in these conditions.

(a) Wear insulated clothing or layers as described in Section F.2.e.(4)(o) above.

(b) Minimize exposure time and air flow conditions in the work area.

(c) Avoid bare skin contact with uninsulated or conductive surfaces.

(d) Provide warm fluids and a warm rest area for workers.

H. REFERENCES

1. TED 01-00-015, (*OSHA) OSHA Technical Manual, Chapter III: Heat Stress*

2. 29 CFR 1910.132, *Personal protective equipment*

3. U.S. Army Corps of Engineers: Safety and Health Requirements Manual*, Inclement Weather and Heat/Cold Stress Management*

4. The National Institute for Occupational Safety and Health (NIOSH), Workplace Safety and Health Topics, *Cold Stress* and *Heat Stress*

5. United States Council of Governmental Industrial Hygienists (ACGIH), *TLV for Chemical Substances and Physical Agents and Biological Exposure Indices, 2012*

6. Canadian Centre for Occupational Health and Safety, Fact Sheets, *Cold Environments – Working in the Cold*

7. National Oceanic and Atmospheric Administration, National Weather Service, Winter Resources, *Windchill Chart*

8. United States Department of Labor, Occupational Safety and Health Administration, *Winter Weather; Plan, Equip, Train*

9. United States Department of Labor, Occupational Safety and Health Administration, *Cold Stress Guide*

I. DEFINITIONS

Acclimatization- A physiologic adjustment process occurring when a healthy worker accustomed to a temperate environment begins to work in a hot environment. These adjustments may occur over a period of days to several weeks. During this time period time spent in an area may be gradually increased.

Action Limit – In evaluating thermal stress at the NIH, Action Limits are used. These are temperature thresholds, or temperature index thresholds which, when reached, require a supervisor to initiate action to prevent thermal illness or injury. (See Appendix B – Thermal Hazard Assessment)

American Conference of Government Industrial Hygienists (ACGIH) – A professional society consisting of government employees and academia. This organization has developed the Wet Bulb Globe Temperature (WBGT) Index as a threshold limit value which is used to establish guidelines for working under heat stress conditions. In cold stress situations, the ACGIH wind chill index can be used. The NIH uses these values to determine appropriate action limits.

Apparent Temperature – A measure of relative discomfort due to combined heat and high humidity. It was developed by R.G. Steadman (1979) and is based on physiological studies of evaporative skin cooling for various combinations of ambient temperature and humidity.

Evaporative Cooling – Takes place when sweat evaporates from the skin. High humidity reduces the rate of evaporation and thus reduces the effectiveness of the body's primary cooling mechanism. Air from fans can provide evaporative cooling to the human body (even if they do not lower ambient air temperatures). Above certain temperatures (around 95°F and higher) the ambient air temperatures are too high for fans to provide evaporative cooling.

Heat Index – The heat index is a specialized temperature/humidity index. It is also called the apparent temperature; and is a measure of how hot weather is perceived by the average person at varying temperatures and relative humidity. Heat Index may prompt further evaluation using WBGT; but should not be used to determine heat stress risk in any environment.

Heat Wave – A heat wave is a prolonged period of excessively hot weather, which may be accompanied by high humidity. It is measured relative to the usual weather in the area and normal temperatures for the season.

Thermoregulation – The process that allows the human body to maintain a constant internal body temperature independent of the environmental temperature.

Wet Globe Bulb Temperature (WBGT) – Type of apparent temperature used to estimate the effect of temperature, humidity, wind speed (wind chill), and visible and infrared radiation (usually sunlight) on humans. This differs from "apparent temperature" or "heat index" as they only account for temperature and humidity and are a more subjective indication of how the hot weather is perceived by a human. WBGT is the industry (and OSHA-adopted) standard for measuring and determining heat stress risk in an indoor or outdoor environment.

Wind Chill Index – Developed by the National Weather Service, the Wind Chill Index (WCI) is the perceived decrease in air temperature felt by the body on exposed skin due to the flow of air. Wind chill temperature is the apparent temperature felt on the exposed human body owing to the combination of temperature and wind speed.

Appendix A – Heat Stress Monitoring Sheet

Location:_____ Date:_____

WORK/REST GUIDELINES IN INDUSTRIAL ENVIRONMENTS

Heat Category	WBGT	Light Work		Moderate Work		Heavy Work	
Describes the significance of the thermal conditions	Temperature Range in Degrees Fahrenheit (°F)	Work/Rest Cycle (Min./Hour)	Water Intake in ounces/hour (Oz/Hour)	Work/Rest Cycle in (Min./Hour)	Water Intake (Oz/Hour)	Work/Rest Cycle (Min./Hour)	Water Intake (Oz/Hour)
Caution	77.0 – 86.9	No limit	16	45/15	24	40/20	24
Danger	87.0 – 89.9	No Limit	24	30/30	24	20/40	32*
Extreme Danger	Above 90	50/10	32*	15/45	32*	10/50	32*

NOTE: *Follow the guidelines for (choose either light/moderate/heavy) Work/Rest Cycles*

** Be advised that water intake recommendations are general guidance. For individuals with certain health conditions, it may be contraindicated to rehydrate at amounts greater than 24 ounces of water/hour.*

Temperatures should be read hourly starting at the beginning of shift and commence at the end of shift

WBGT Temperature_____ Heat Category_____ Time_____ Initials_____
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Appendix B – Thermal Hazard Assessment

This appendix presents hazard assessment factors for thermal stress and some control mechanisms which may be used by Supervisors to aid in thermal stress management.

Hazard Assessment – the most important thermal indicators to assess are:

- Air Temperature
- Radiant Heat
- Humidity
- Air Movement
- Workload

At a minimum, temperature and humidity assessments should be performed when assessing a heat stress environment. When assessing a cold stress environment, temperature and air movement shall be assessed.

Certain areas, such as cage-wash rooms maintain temperature/humidity sensors. During times of heat stress, these readouts should be regularly monitored and DS contacted to perform a formal monitoring when action thresholds are reached.

Monitoring equipment is maintained by DS and the Thermal Stress Program Manager. Contact the DS Technical Assistance Branch at 301-496-3353 for assistance. Equipment maintained by DS includes:

- Temperature Monitor: measures the wet bulb temperature, dry bulb temperature, radiant heat and calculates the Web Bulb Globe Temperature (WBGT) index.

- Velometer: measures the air speed (air movement affects convective heat and sweat evaporation.

Heat Stress Safety Controls – measures that can reduce worker heat stress potential:

- Engineering controls include anything that:
    - Increases air velocity
    - Uses reflective or heat absorbing shielding or barriers
    - Reduces steam leaks, wet floors, or humidity
- Mechanize as many tasks as possible
- Provide cool drinking water
- Share the workload among workers, especially during peak heat periods
- Shorten the duration of exposure
- Increase rest time, or frequency of rest periods
- Schedule tasks in the morning hours, or evening hours when ambient temperature conditions are usually lower than those during mid-day
- Allow workers to self-limit exposure according to signs and symptoms – use the “buddy” system where workers observe each other for signs of heat intolerance
- Utilize air-conditioned rest areas
- Use additional fans in the work area

Note: fans do not actually lower temperatures in the area. Fans work to promote evaporative cooling of perspiration. Fans are not effective at this when ambient air temperature is above 95°F.

Cold Stress Safety Controls – measures that can reduce the risk of cold stress incidents, illnesses, and injuries:

- Plan ahead:
    - Schedule cold jobs for the warmer parts of the day
    - Defer maintenance and non-urgent repairs for warmer times of the year
- Monitor workers at risk of cold stress – use the "buddy" system
- Provide warm liquids to workers
- Provide warm areas for use during break periods
- Use relief workers, or assign extra workers for long demanding jobs
- To protect hands:
    - If temperatures are below 60°F for more than 10 minutes, use portable heaters
    - If temperature is below 32°F, use thermally insulated tools and wear gloves
- Preventing frostbite:
    - If cold surfaces are below 19°F, prevent inadvertent contact with exposed skin
    - If air temperatures are below 0°F, gloves must be worn when performing work