Occupational Safety Program

Workplace Safety Program

Heat Stress and Heat Illness Prevention Program

Manual

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Purpose

The purpose of the procedure is to protect employees from heat-related illness caused by heat stress in the workplace.

Scope

The scope of the procedure applies to employees whose employment activities, indoor or outdoor, expose them to a heat index in the area where the employee is working that equals or exceeds 80 degrees Fahrenheit. This procedure does not apply to emergency operations and essential services (as defined below) that involve protecting life or property; incidental exposures when an employee is not required to perform work activities for more than 15 consecutive minutes per hour; or buildings, structures, and vehicles that have a mechanical ventilation system or fan that maintains the heat index below 80 degrees Fahrenheit.

Definitions

Acclimatization: The body's temporary adaptation to work in heat that occurs as a person is exposed over time.

Alternative Cooling and Control Measures: Engineering, work-practice, administrative, or other controls to manage heat, including job rotation, mechanical ventilation systems, misting equipment, cooling vests, air-cooled or water-cooled garments, and access to recreational water.

Drinking Water: Potable water that is safe to drink and cool in temperature.

Emergency Operations and Essential Service: Work in connection with an emergency that requires the involvement of law enforcement, emergency medical services, firefighting, rescue and evacuation operations, or emergency restoration of essential utilities or telecommunications.

Heat Index: A measure of how hot it feels when relative humidity is taken into account along with the actual air temperature, which can be extrapolated from temperature and relative humidity using the National Weather Service Heat Index Calculator.

High-Heat Conditions: Working conditions where the heat index of the work area equals or exceeds 90 degrees Fahrenheit.

Shade or Shaded Areas: Blockage of direct sunlight.

Responsibilities

A. Environmental Health & Safety (EHS)

1. EHS will assist in development of heat illness prevention plans.
2. EHS will provide heat illness prevention training.

B. Other Departments/Supervisors

1. Departments will develop heat illness prevention plans specific to their assigned duties.
2. Supervisors will manage and monitor employees in areas where heat stress and illness is most likely, and contact emergency services and EHS as required.
3. Supervisors will monitor temperature and humidity in aforementioned areas as required.
4. Supervisors will refer employees who require heat illness prevention training.

C. Employees

1. Employees are required to learn and understand heat illness prevention plans.
2. Employees are required to be trained in heat illness prevention.

Introduction

Workers in both outdoor and indoor work settings without adequate climate controls are at risk of hazardous heat exposure. Certain heat-generating processes, machinery, and equipment can also cause heat hazards when cooling measures are not in place. Excessive heat in the workplace can cause adverse health effects, including heat stroke and death, if not treated properly. Heat is the leading cause of death among all weather-related phenomena in the United States. Per the General Duty Clause from the OSHA Act of 1970, all employers must provide a work environment "free from recognized hazards that are causing or are likely to cause death or serious physical harm”, and the following information is intended to help workers recognize and mitigate such hazards.

Millions of U.S. workers are exposed to heat in their workplaces. Although illness from exposure to heat is preventable, every year, thousands become sick from heat exposure, and some cases are fatal. Occupational heat exposure is a combination of many factors. Body heat results from the equilibrium of heat gain, from internal work and outside addition, and heat loss, primarily from evaporative cooling, i.e., sweat evaporation. Causes of heat stress in the workplace vary dependent upon sunlight; the ambient air temperature, humidity, and movement; location and type of work; and the materials and equipment involved. Examples of heat stress sources include, but are not limited to the following:

- Areas with heat-generating appliances (kitchen, laundry, etc.)
- Equipment (furnace, power tools, heavy machinery)
- Fire-containing structures (fireplace, fire pit, chimney, kiln)
- Hot work (welding, soldering, brazing, cutting, grinding, riveting, metalworking, glassblowing, work with open flame, sparks, and flammable materials, etc.)
- Uncontrolled temperatures indoors (e.g. attic, warehouse)
- Work in confined spaces (boilers, steam tunnels, hot water/steam pipe areas, vents, etc.)

- Work outdoors (e.g. agriculture, landscaping, roofing and building construction, asphalt/road maintenance, utility work, deliveries, etc.)

The heat hazards from these sources may derive from fire, hot/humid ambient air (stagnant or blown), hot gases and exhaust air, hot or molten liquids (e.g. heated metal, fresh asphalt, tar, boiling water), hot surfaces (including reflective materials), radiant heat and light, sparks or hot particles, and steam. Other contributions to heat stress may come from strenuous physical activity; protective gear such as tight, heavy, dark, and/or synthetic clothing or personal protective equipment (PPE); and individual risk factors (e.g. pre-existing health conditions and lifestyle).

Effects of Heat Stress

The severity of heat injuries will vary based on the duration, frequency, and intensity of heat exposure and the lack of recovery and rest. The consequences of heat stress in decreasing order of severity are as follows:

- Heat stroke, the most serious form of heat-related illness, happens when the body becomes unable to regulate its core temperature. Sweating stops and the body can no longer rid itself of excess heat. Signs include confusion, loss of consciousness, and seizures. Heat stroke is a medical emergency that may result in death. Call 911 immediately.
- Heat exhaustion is the body's response to loss of water and salt from heavy sweating. Signs include headache, nausea, dizziness, weakness, irritability, thirst, and heavy sweating.
- Heat cramps are caused by the loss of body salts and fluid during sweating. Low salt levels in muscles cause painful cramps. Tired muscles—those used for performing the work—are usually the ones most affected by cramps. Cramps may occur during or after working hours.
- Heat rash, also known as prickly heat, is skin irritation caused by sweat that does not evaporate from the skin. Heat rash is the most common problem in hot work environments.

Table 1 in Appendix D shows symptoms and first aid measures to take if a worker shows signs of a heat-related illness.

Health Conditions Aggravated by Heat Stress

Some workers are more susceptible to heat-related illness. Personal risk factors include medical conditions, lack of physical fitness, previous episodes of heat-related illness, alcohol consumption, drugs, and use of certain medication. Departments should commit to preventing heat-related illness for all employees regardless of their heat tolerance levels. Measurement of heart rate, body weight, or body temperature (physiologic monitoring) can provide individualized data to aid decisions about heat controls. Some workers handle heat stress less effectively than others. Heat intolerance happens for a variety of reasons. Personal risk factors include:

- Obesity (body mass index ≥ 30 kg/m^2)
- Diabetes
- High blood pressure

- Heart disease
- Lower level of physical fitness
- Use of certain medications such as diuretics (water pills) and some psychiatric or blood pressure medicines [some medications can result in a worker's inability to feel heat conditions and/or the inability to sweat, so symptoms of heat stress may not be evident]
- Alcohol use
- Use of illicit drugs such as opioids, methamphetamine, or cocaine

The above list is not comprehensive. Other medical conditions can also predispose workers to heat-related illnesses. Employers should recognize that not all workers tolerate heat the same way. Workplace controls should focus on making jobs safe for all the employees. An occupational medical monitoring program can identify workers who are at increased risk of heat illness, while maintaining the confidentiality of workers' health information. When heat hazards are present, workers should receive training about personal factors that can make them more susceptible to heat-related illness. When in doubt, workers should talk to their healthcare provider about whether they can work safely in the heat.

Applicable Regulations

- OSH Act, § 5(a)(1) - General Duty Clause
- COMAR 09.12.32 – Heat Stress Standards

Procedure

A. Heat-Related Illness Prevention and Management

1. A department shall monitor the heat index throughout the work shift in areas where employees perform work using one of the following methods:
   a) Direct measurement of the temperature and humidity at the same time and location in the areas where employees perform work;
   b) Use of local weather data reported by the National Weather Service or other recognized source to determine the heat index; or
   c) Use of the National Institute for Occupational Safety and Health's (NIOSH's) Heat Safety Tool application to determine the heat index.
2. A department whose employees work in buildings and structures that do not have a mechanical ventilation system shall directly measure the temperature and humidity at the same time and location in areas where employees perform work.
3. A department shall develop, implement, and maintain an effective heat-related illness prevention and management plan in writing.
4. The heat-related illness prevention and management plan shall contain the following elements:
   a) How sufficient amounts of drinking water will be provided;
   b) How employees will be provided sufficient opportunities and encouragement to stay hydrated by drinking water;
   c) How to recognize the symptoms of heat-related illness, including heat exhaustion and heat stroke;

d) How to respond to suspected heat-related illness, including heat exhaustion and heat stroke;
e) How employees will be provided with sufficient time and space to rest in shaded or cool, climate-controlled areas to cool off;
f) How the employer will implement rest break schedules as necessary;
g) How the department will consider environmental conditions, workload, required clothing, personal protective equipment, and alternative cooling and control measures when determining rest break schedules;
h) How employees will be encouraged to take rest breaks as needed to prevent heat-related illness;
i) How employees will be trained on the hazards of heat exposure and the necessary steps to prevent heat-related illness;
j) The use and maintenance of alternative cooling and control measures used to manage heat;
k) Procedures for heat acclimatization in accordance with Step B of this section;
l) Procedures for high-heat conditions in accordance with Step E of this section; and
m) The emergency response plan in accordance with Step F of this section.
n) See OSHA Checklist - Employer Checklist for Outdoor and Indoor Heat-Related Injury and Illness Prevention (osha.gov)

5. The written plan shall be made available and accessible to:
   a) Employees; and
   b) MOSH upon request.

B. Acclimatization

1. A department shall provide for acclimatization of exposed employees for a period of up to 14 days:
   a) When an employee is newly exposed to heat in the workplace; and
   b) When an employee returns to work after 7 or more consecutive days of absence from the workplace.
2. A department shall monitor employees during the acclimatization period for signs of heat-related illness through regular communication via:
   a) Phone or radio;
   b) A buddy system; or
   c) Other effective means of observation.
3. A department shall develop and implement an acclimatization schedule which complies with one of the following:
   a) A schedule which gradually increases exposure time over a 5 — 14-day period, with a maximum 20 percent increase each day;
   b) A schedule which uses the current National Institute for Occupational Safety and Health's recommendations for acclimatization; or
   c) A schedule which uses a combination of gradual introduction and alternative cooling and control measures that acclimate an employee to the heat.
4. The acclimatization schedule shall be in writing and consider the following elements:

a) Acclimated and unacclimated employees;
b) The environmental conditions and anticipated workload;
c) The impact of required clothing and personal protective equipment to the heat burden on employees;
d) The personal risk factors that put an employee at a higher risk of heat-related illness;
e) Re-acclimatizing employees as necessary, in accordance with Step B1 of this section; and
f) The use of alternative cooling and control measures.

C. Shade Access

1. Except as provided in Step C3 and C4 in this section, a department shall provide shaded areas to exposed employees as close to the work area as practicable.
2. Shaded areas shall:
   a) Be outside, open, and exposed to air on at least three sides;
   b) Prevent contributing heat sources from reducing effectiveness;
   c) Be sufficiently sized for the number of employees utilizing the shaded area;
   d) Be arranged in a configuration that allows employees to sit in normal posture; and
   e) Accommodate the removal and storage of personal protective equipment during periods of use.
3. If creating outdoor shade is demonstrably infeasible or unsafe in the work area, the department shall implement alternative cooling and control measures that provide equivalent protection to shade.
4. A department may provide cooling with an indoor mechanical ventilation system as an alternative to outdoor shade provided that the indoor space satisfies the requirements of Step C2b-C2e of this section.

D. Drinking Water

1. A department shall:
   a) Provide drinking water at no cost to exposed employees as close to the work area as practicable; and
   b) Make available at least 32 ounces of drinking water per hour to each exposed employee per workday.
2. A department is not required to provide the entire drinking water supply at the beginning of an employee's shift but shall make drinking water available at all times while work is being performed.

E. High-Heat Procedures

1. A department shall implement high-heat procedures when the heat index reaches or exceeds 90 degrees Fahrenheit in the area where the work is being performed.
2. The high-heat procedures shall include a work and rest schedule to protect employees from heat-related illness that is adjusted for environmental conditions, workload, and impact of required clothing or personal protective equipment.

3. Except as provided in Step E4 of this section, the high-heat procedures shall include:
    a) Both:
        i. A minimum rest period of 10 minutes for every 2 hours worked where employees are exposed to a heat index above 90 and below 100 degrees Fahrenheit; and
        ii. A minimum rest period of 15 minutes for every hour worked where employees are exposed to a heat index above 100 degrees Fahrenheit; or
    b) A rest period as provided for in the current National Institute for Occupational Safety and Health (NIOSH) recommendations for work and rest schedules to manage heat exposures.
4. If a department can demonstrate effective heat management and protection from heat-related illness through alternative cooling and control measures, the work and rest schedules set forth in Step E3 of this section may not be required.
5. If a department utilizes alternative cooling and control measures under Step E4 of this section, the measures:
    a) Shall be readily available and accessible to employees at all times work is being performed;
    b) Shall be documented in writing; and
    c) May not supersede any other requirements of this procedure.
6. A department may coincide rest periods with a scheduled rest or meal period.
7. Rest periods shall be taken in the shade in accordance with Step C of this procedure.
8. A department may not discourage employees from taking rest breaks as needed to prevent heat-related illness.
9. When high-heat procedures are in effect, a department shall monitor exposed employees for signs of heat-related illness with regular communication via:
    a) Phone or radio;
    b) A buddy system; or
    c) Other effective means of observation.
10. A department shall make high-heat procedures available in writing in a language and manner that all employees can understand.

F. Emergency Response

1. Departments shall implement an emergency response plan that includes procedures for:
    a) Ensuring effective and accessible means of communication at all times at the worksite to enable an employee to contact a supervisor or emergency medical services;
    b) Responding to signs and symptoms of possible heat-related illness in employees;
    c) Monitoring and providing care to employees who are exhibiting symptoms of heat-related illness; and
    d) Contacting emergency medical services and, if necessary, transporting employees to a location accessible to emergency medical services.

G. Training

1. Any worker subjected to conditions where heat stress is a hazard shall receive training. Training shall be offered by EHS to employees, including supervisors, as needed. The training requirements are as follows:
    a) Initial heat stress training to affected employees and supervisors prior to an employee's first exposure to heat;
    b) Retrain employees and supervisors at least:
        i. Annually prior to exposure; and
        ii. Immediately following any incident at the worksite involving a suspected or confirmed heat-related illness;
    c) Present training in a language and manner that all employees and supervisors can understand;
    d) Ensure that training includes at least:
        i. The work and environmental conditions that affect heat-related illness;
        ii. The personal risk factors that affect heat-related illness;
        iii. The concept, importance, and methods of acclimatization;
        iv. The importance of frequent consumption of water and rest breaks in preventing heatrelated illness;
        v. The types of heat-related illness, signs and symptoms of heat-related illness, and the appropriate first aid and emergency response measures;
        vi. The importance of and procedures for employees immediately reporting to the employer signs and symptoms of heat-related illness; and
        vii. The employer's procedures and the requirements for compliance; and
    e) Maintain training records for one year from the date on which the training occurred.

2. The training records required by this regulation shall include:
    a) The names of the persons trained;
    b) The dates of the training sessions; and
    c) A summary or outline of the content of the training sessions.

3. The training records shall be made available to MOSH upon request.
4. Training will be assigned virtually through Vector Solutions SafeColleges found at the following URL: https://towsonehs-md.safecolleges.com/training/home. Workers shall request training by emailing safety@towson.edu or by calling the Environmental Health & Safety (EHS) office at 410-704-2949.

Resources

To request documents, reviews for procedures, processes, or equipment, or general inquiries, contact EHS by emailing safety@towson.edu or by calling the Environmental Health & Safety (EHS) office at 410-704-2949.

- OSHA
  https://www.osha.gov/heat/worker-information

- MOSH
  https://www.labor.maryland.gov/labor/mosh/moshheatstress.shtml

Appendix A: Heat Stress Standard

COMAR 09.12.32: Heat Stress Standards
https://www.labor.maryland.gov/labor/mosh/09.12.32.pdf

Appendix B: Hierarchy of Hazard Controls for Heat Stress

A. Elimination

1. The best hazard control is elimination of the heat hazard. Two heat sources contribute to the risk of heat-related illness:
   - Environmental heat is produced by warm or hot surroundings, and
   - Metabolic heat, generated by the body, is related to workload and physical activity.

   Avoiding the use of heat-producing equipment or performing work in an environment that has favorable ambient conditions such as moderate to low temperatures and humidity is optimal. This, however, is not always possible to accomplish tasks outdoors, those that require the use of heat or fire, or those that are labor-intense or strenuous.

B. Substitution

1. Substitution in hazard control for heat may involve the use of machinery or equipment which produces little or no heat. Devices that are energy efficient or which require less power will produce less heat. Upgrading mechanical equipment may assist here.
2. Wearing clothing that retains less heat (light-colored or white, less bulky, loose fitting, breathable fabrics) may also be beneficial, dependent upon the task and regulatory requirements.

C. Engineering Controls

1. The best engineering controls to prevent heat-related illness is to make the work environment cooler and to reduce manual workload with mechanization. A variety of engineering controls can reduce workers' exposure to heat:
   - Air conditioning (such as air-conditioned vehicles, air conditioning in break rooms)
   - Increased general ventilation and air circulation
   - Cooling fans or chillers
   - Local exhaust ventilation at points of high heat production or moisture
   - Barriers or reflective shields to redirect/avoid direct, radiant heat or heat exposure (e.g. walls)
   - Insulation of hot surfaces
   - Elimination of steam leaks
   - Cooled seats or benches for rest breaks
   - Mechanical equipment/automation to reduce manual work or heat exposure
   - Covers, canopies, or other shelter to provide shade access
   - Misting fans that produce a spray of fine water droplets

D. Administrative Controls/Work Practices

1. Some work sites cannot be cooled by engineering controls. At those locations, employers should modify work practices when heat stress is too high to work safely. Consider the following activity modifications:
    - Modify a work process to reduce or eliminate heat exposure where possible.
    - Modify work schedules and activities for new workers in warm environments.
    - Schedule shorter shifts for newly hired workers and unacclimatized existing workers. Gradually increase shift length over the first 1-2 weeks.
    - Require mandatory rest breaks in a cooler environment (i.e. a shady location or an air-conditioned building). The duration and frequency of the rest breaks should increase as heat stress rises.
    - Seek shelter or shade on hot, sunny days.
    - Consider scheduling work at a cooler time of day, such as early morning or late afternoon.
    - Reduce physical demands as much as possible by planning the work to minimize manual effort (i.e. delivering material to the point of use so that manual handling is minimized).
    - Rotate job functions among workers to help minimize exertion and heat exposure.
    - Ensure that workers drink an adequate amount of water or electrolyte-containing fluids. Employees should be permitted to drink water and cool liquids (e.g. sports drinks) at liberty.
    - Have an emergency plan that specifies what to do if a worker has signs of heat-related illness.
    - Ensure that medical services are available if needed.
    - Employees should monitor and watch out for each other for signs and symptoms of heat-related illness and be prepared to administer appropriate first aid to anyone who is developing a heat-related illness.
    - Administer appropriate first aid to any worker who is developing a heat-related illness [See Table 1 in Appendix D].
    - In some situations, employers may need to conduct physiological monitoring of workers.
    - Implement a buddy system for new workers and in heat stress environments.
    - Avoid drinking hot beverages during lunch and afternoon breaks.
    - Work at a slower pace or reduce heavy workloads to minimize exhaustion or overheating.
    - Wear sunscreen with SPF 30 or higher.
    - Practices that decrease the likelihood of dehydration or burns.

E. Personal Protective Equipment

1. In most cases, heat stress should be reduced by engineering controls or work practice modifications. However, in some limited situations, special cooling devices can protect workers in hot environments:
    - Insulated suits

- Reflective clothing
- Infrared reflecting face shields
- Cooling neck wraps

2. In extremely hot conditions, the following thermally conditioned clothing might be used:
    - Vests that receive cooled air from a vortex tube connected to an external compressed air source.
    - Jackets or vests with reusable ice packs or phase change cooling packs in the pockets.
    - Workers should be aware that use of certain personal protective equipment (e.g., certain types of respirators, impermeable clothing, and head coverings) can increase the risk of heat-related illness.

Appendix C: OSHA Guidance on Heat Illness Prevention

Creation of a Heat Illness Prevention Plan

Departments shall create a written plan to prevent heat-related illness. OSHA tools can assist in creating a plan. Important elements to consider when creating the heat plan are:

- Who will provide oversight on a daily basis?
- How will new workers gradually develop heat tolerance?
- Temporary workers may be more susceptible to heat and require closer supervision.
- Workers returning from extended leave (typically defined as more than two weeks) may also be at increased risk.
- How will the employer ensure that first aid is adequate and the protocol for summoning medical assistance in situations beyond first-aid is effective?
- What engineering controls and work practices will be used to reduce heat stress?
- How will heat stress be measured?
- How to respond when the National Weather Service issues a heat advisory or heat warning?
- How will we determine if the total heat stress is hazardous?
- What training will be provided to workers and supervisors?

Day-to-Day Supervision

Heat conditions can change rapidly and management commitment to adjusting heat stress controls is critical to prevent heat illness. An individual at the worksite should be responsible for monitoring conditions and implementing the department's heat plan ***throughout the workday***. This individual can be a foreman, worksite supervisor, plant manager, safety director, or anyone else with the proper training. Proper training includes knowing how to:

- identify and control heat hazards;
- recognize early symptoms of heat stress;
- administer first aid for heat-related illnesses; and
- activate emergency medical services quickly when needed.

Ideally, the individual who is responsible for the heat management plan should be on-site, where the workers are. On-site monitoring allows accurate determination of heat stress. In some industries with a widely distributed workforce, such as mail and package delivery, on-site monitoring might not be feasible. In those cases, the responsible individual at the site should be fully trained on the means and methods to contact and report to the employer any adverse heat related conditions that may develop on the site as well as any signs and symptoms of heat related illness experienced by any of the workers. The responsible individual in a central location should estimate heat stress using the best available methods for remote estimation.

In a warm environment, especially when physically active, the human body relies on its ability to get rid of excess heat (i.e., heat dissipation) to maintain a healthy internal body temperature. Heat dissipation happens naturally through sweating and increased blood flow to the skin. Workers cool down more rapidly if the external (environmental) heat and physical activity (metabolic heat) are reduced. If heat dissipation does not happen quickly enough, the internal

body temperature keeps rising and the worker may experience symptoms that include thirst, irritability, a rash, cramping, heat exhaustion, or heat stroke.

Departments and workers should become familiar with the heat symptoms. When any of these symptoms is present, promptly provide first aid. Do not try to diagnose which illness is occurring. Diagnosis is often difficult because signs and symptoms of multiple heat-related illnesses can occur together. Time is of the essence. These conditions can worsen quickly and result in fatalities.

- Take the affected worker to a cooler area (e.g., shade or air conditioning).
- Cool the worker immediately. Use active cooling techniques such as:
    - Immerse the worker in cold water or an ice bath. Create the ice bath by placing all of the available ice into a large container with water, standard practice in sports. **This is the best method to cool workers rapidly in an emergency**.
    - Remove outer layers of clothing, especially heavy protective clothing.
    - Place ice or cold wet towels on the head, neck, trunk, armpits, and groin.
    - Use fans to circulate air around the worker.
- Never leave a worker with heat-related illness alone. The illness can rapidly become worse. Stay with the worker.
- When in doubt, call 911!

Heat Stress Assessment

In addition to a thermometer, use these resources to assess heat stress:

- Use an on-site wet bulb globe temperature (WBGT) meter - the most accurate way (Morris 2018) to measure environmental heat impact on body temperature. WBGT incorporates temperature, humidity, sunlight, and air movement into a single measurement. See OSHA's guidance for using and interpreting WBGT.

Download the NIOSH/OSHA Heat App [iOS | Android] to access a simple heat calculator on your device. Remember that the Heat App provides only heat index (HI), not WBGT, although it does also provide workload guidance.

There are many factors that have a role in creating an occupational heat stress risk to workers. These factors include:

- Environmental conditions (such as air temperature, humidity, sunlight, and air speed), especially on sequential days, and the presence of heat sources (e.g., furnaces) in the work area.
- Level of physical activity, i.e., the workload leading to body heat production.
- Use of clothing or protective gear that can reduce the body's ability to lose excess heat.
- Individual/personal risk factors.

Workload considerations are described at length in the OSHA Technical Manual. Common values given for categories of work are included in the table on Workload. You should consider the above factors when evaluating heat stress risk to workers. Heat-related illness prevention starts by determining if a heat hazard is present in the workplace. Two heat sources contribute to the risk of heat-related illness:

1. Environmental heat is produced by warm or hot surroundings.

2. Metabolic heat, generated by the body, is related to workload (physical activity).

To determine workers' total heat stress, employers must assess both of the above heat sources. Employers should compare the total heat stress to published occupational heat guidance. This step allows employers to determine if the work conditions are too hot. Employers should be aware of any heat advisories from the National Weather Service. They should know that workers may experience heat stress at temperatures much lower than public heat advisories. Remember: Physical labor increases the heat experienced by workers. Sports physiologists recognize that heat-related illness may occur, surprisingly, at low to moderate temperatures, including below 65°F when workload is very heavy (Armstrong 2007).

Environmental Heat

Environmental heat is more than just temperature. Four factors contribute to heat stress in workers:

1. Air temperature.
2. Humidity. High relative humidity makes it difficult for the body to cool itself through sweating.
3. Radiant heat from sunlight or artificial heat sources such as furnaces.
4. Air movement. In most situations, wind helps workers cool off.

An environmental heat assessment should account for all of these factors. OSHA recommends the use of wet bulb globe temperature (WBGT) monitor to measure workplace environmental heat. WBGT devices contain three different thermometers:

- A dry bulb thermometer to measure the ambient air temperature.
- A natural wet bulb thermometer to measure the potential for evaporative cooling.
- A black globe thermometer to measure radiant heat.

The WBGT instrument should be placed close to the work location. For example, if the work is in direct sunlight, then the WBGT instrument should be in the sun. Employers should always follow the WBGT manufacturer's instructions about setup, calibration, and use.

WBGT has important advantages over other environmental heat measurements. One major advantage is that WBGT accounts for *all four* major environmental heat factors — temperature, humidity, radiant heat, and wind. In contrast, standard thermometers only assess one factor (air temperature). Heat Index is another common way to measure heat stress. It is measured in the shade and combines air temperature and relative humidity to represent how hot the conditions feel at rest. The heat index does not account for the effects of wind, sunlight, radiant heat sources, or workload. Air (dry bulb) temperature also ignore relative humidity. All these factors can influence the total heat stress experienced by workers.

Workplace environmental heat should be measured on-site using WBGT meters. Use of heat index is a less desirable substitute. While local weather reports based on meteorological data from observation stations can be useful, the readings from these stations may not reflect the conditions at the specific worksite. Heat conditions at the worksite may be different for multiple reasons, from cloud cover and humidity to local heat sinks. The potential error increases with distance from the weather station.

In addition to possible distance-based errors, weather reports can be inaccurate if the worksite has features that affect heat conditions. These features include:

- Indoor work — A weather report cannot gauge conditions inside a building.
- Direct sunlight — Weather services measure temperature and Heat Index in the shade. Work in the sun may be considerably hotter. Direct sunlight can increase Heat Index by up to 13.5°F (7.5°C).
- Heat sources — Weather reports cannot account for the heat generated by fires, hot tar or other materials, ovens, or other hot equipment, or heat-absorbing surfaces such as roads and roof surfaces.
- Wind blockage — Some worksites may be hotter than surrounding areas because of structures that block air movement. Examples include trenches and bowl-shaped athletic stadiums.
- Reflective material — Water, metal, or other materials can reflect sunlight onto workers.

Physiologic Monitoring

Workers' bodies produce automatic responses to cope with heat stress. Heart rate increases. Sweating becomes more profuse. Eventually skin temperature and core body temperature rise. These physiologic responses can be measured by workers or employers. Physiologic monitoring has several advantages over other methods of monitoring heat stress:

- Physiologic responses provide a direct and individualized measurement of each worker's response to heat stress.
- Physiologic measurements can be used to monitor the worker's level of heat tolerance. Impermeable clothing, such as chemical protective suits, prevents cooling by sweating and may contribute to heat illness at lower temperatures. Environmental monitoring (i.e., WBGT) does not give an accurate indication of these workers' heat stress. Physiologic monitoring, such as heart rate measurement, should be used to determine whether their heat stress is too high.

Heart rate is the easiest physiologic parameter to measure. A timepiece is the only required equipment. Workers can be trained to count their pulse. More sophisticated devices, such as heart rate monitor wristwatches, are also available. Some employers also monitor weight changes during a work shift as a measure of water loss from sweating. Body temperature can be measured by thermometers. Oral, skin, and aural (eardrum) thermometers are less invasive than core body temperature measurements. Caution should be used when interpreting temperature measurements, because environmental heat might affect some thermometers.

Appendix D: Heat-Related Illnesses and First Aid (OSHA)

Table 1. Heat-Related Illnesses & First Aid (OSHA). The table features illnesses due to heat stress, signs and symptoms which workers should monitor, and appropriate steps to take in providing first aid to workers.

Illness	Symptoms	First Aid*
Heat Stroke	• Confusion • Fainting • Seizures • Excessive sweating or red, hot, dry skin • Very high body temperature	• Call 911 While waiting for help: • Place worker in shady, cool area • Loosen clothing, remove outer clothing • Fan air on worker; cold packs in armpits • Wet worker with cool water; apply ice packs, cool compresses, or ice, if available • Provide fluids (preferably water) as soon as possible • Stay with worker until help arrives
Heat Exhaustion	• Cool, moist skin • Heavy sweating • Headache • Nausea or vomiting • Dizziness • Lightheadedness • Weakness • Thirst • Irritability • Fast heartbeat	• Have worker sit or lie down in a cool, shady area • Give worker plenty of water or other cool beverages to drink • Cool worker with cold compresses/ice packs • Take to clinic or emergency room for medical evaluation or treatment, if signs or symptoms worsen or do not improve within 60 minutes. • Do not return to work that day
Heat Cramps	• Muscle spasms • Pain • Usually in abdomen, arms, or legs	• Have worker rest in shady, cool area • Worker should drink water or other cool beverages • Wait a few hours before allowing worker to return to strenuous work • Have worker seek medical attention, if cramps don't go away
Heat Rash	• Clusters of red bumps on skin • Often appears on neck, upper chest, folds of skin	• Try to work in a cooler, less humid environment when possible • Keep the affected area dry
Rhabdomyolysis (muscle breakdown)	• Muscle pain • Dark urine or reduced urine output • Weakness	• Call 911 • Have worker sit or lie down in a cool, shady area • Provide fluids (preferably water) as soon as possible • Stay with worker until help arrives

* Remember, if you are not a medical professional, use this information as a guide only to help workers in need.