

DRI Heat Stress Fact Sheet

Introduction

As a reminder to employees who work outside during hot weather, be mindful of the hazards this presents. High temperatures and humidity (generally not an issue in Nevada, but be mindful that field projects in other areas may occur in humid conditions) stress the body's ability to cool itself, and heat illness becomes a special concern during hot weather. According to the Centers for Disease Control (CDC) each year more people in the United States die from extreme heat exposure than from hurricanes, lightning, tornadoes, floods, and earthquakes combined. On average, approximately 300 people die each year from exposure to heat.

Four environmental factors affect the amount of stress faced by working in a hot work area: *temperature, humidity, radiant heat* (such as from the sun or a furnace) and *wind speed*. High blood pressure, some heart conditions and use of diuretics (water pills) may increase sensitivity to heat exposure. Other conditions related to risk include age (the elderly and young children), obesity, fever, dehydration, heart disease, mental illness, poor circulation, sunburn, prescription drug use, and alcohol use.

How Your Body Reacts to Hot Conditions

Heat is dissipated via three mechanisms: breathing, sweating, and change in blood flow. Initially blood flow increases in the skin, increasing skin temperature and allowing the body to give off some heat. During heavy work, muscles need more blood flow, which reduces the amount of blood available to flow to the skin and, therefore decreases efficiency in heat release in this manner.

Sweating is a mechanism that helps the body to cool off. When the humidity is high, sweat will not evaporate as quickly, preventing the body from releasing heat quickly. Fans can help the cooling process because they increase sweat evaporation.

What is the Heat Index?

The Heat Index (or apparent temperature) takes into account the combined effects of heat and ambient temperature. As humidity rises, the effects of temperature on the body increases due to the inability to lose heat through the sweat mechanism; the higher the heat index, the more dangerous the situation.

The Heat Index (HI) can be determined by looking on a table that has relative humidity on one axis and the ambient temperature on another (see <http://www.il-st-acad-sci.org/kingdom/geo1013.html> for an example of an HI Table). If you don't have access to a table, the HI can be calculated from the relative humidity and the dry air temperature using the following formula:

$$\text{Heat index (HI)} = -42.379 + 2.04901523(\text{Tf}) + 10.14333127(\text{RH}) - 0.22475541(\text{Tf})(\text{RH}) - ((6.83783 \times 10^{-3})(\text{Tf}^2) - ((5.481717 \times 10^{-2})(\text{RH}^2) + ((1.22874 \times 10^{-3})(\text{Tf}^2)(\text{RH})) + ((8.5282 \times 10^{-4})(\text{Tf})(\text{RH}^2)) - ((1.99 \times 10^{-6})(\text{Tf}^2)(\text{RH}^2))$$

There are also websites that perform this calculation for you when you plug in the dry air temperature and relative humidity. (See the reference section at the end of this fact sheet.)

DRI Heat Stress Fact Sheet

Heat Stress Disorders

When the body becomes overheated, a condition of heat stress exists. There are three major forms of heat illnesses: **heat cramps**, **heat exhaustion**, and **heat stroke**, with heat stroke being a life threatening condition. Overheating can also result in fainting (**heat syncope**) or **heat rash**, both of which are less harmful, but can indicate that engineering or administrative controls for overheating should be implemented. It is important to recognize each one and know what to do when it happens.

Heat rash, also called prickly heat, may occur in hot and humid environments where sweat cannot evaporate easily. When the rash covers a large area or if it becomes infected, it may become very uncomfortable. Heat rash may be prevented by resting in a cool place and allowing the skin to dry.

Signs and symptoms

- rash characterized by small pink or red bumps
- irritation or *prickly* sensation
- itching

What to do

- keep skin clean and dry to prevent infection
- wear loose cotton clothing
- cool baths and air conditioning are very helpful
- some over-the-counter lotions may help ease pain and itching

Fainting (Heat Syncope) usually happens to someone who is not used to working in the hot environment and is standing around. Moving around, rather than standing still, will usually reduce the likelihood of fainting.

Signs and symptoms

- Brief loss of consciousness
- Sweaty skin, normal body temperature
- No signs of heat stroke or heat exhaustion

What to do

- Lie down in a cool place
- Seek medical attention if not recovered after brief period of lying down

Heat cramps are muscle spasms which usually affect the arms, legs, or stomach that frequently don't occur until sometime later after work, at night, or when relaxing. Heat cramps are caused by heavy sweating, especially when water is replaced by drinking, but not salt or potassium lost through sweating. Tired muscles – those used for performing the work – are usually the most likely to cramp. Although heat cramps can be quite painful, they usually don't result in permanent damage.

DRI Heat Stress Fact Sheet

Signs and symptoms:

- Cramping or spasms of muscles
- May occur during or after the work

What to do

- Drink electrolyte solutions (sports drink) such as Gatorade in addition to water during the work day and try eating more fruits high in potassium, such as bananas and kiwi.
- If the cramps are severe or not relieved by drinking a sports drink, seek medical attention at one of the approved worker's compensation clinics.

Heat exhaustion is more serious than heat cramps and is the most common heat-related ailment. It occurs when the body's internal air-conditioning system is overworked, but hasn't completely shut down. In heat exhaustion, the surface blood vessels and capillaries which originally enlarged to cool the blood collapse from loss of body fluids and necessary minerals, which occurs when a worker sweats a lot and does not drink enough fluids or take in enough salt or both. The simple way to describe the worker is wet, white and weak.

Signs and symptoms

- Headache, heavy sweating, intense thirst
- Weak or tired, dizzy, coordination loss, impaired judgment, possibly giddy
- Nausea, loss of appetite
- Hyperventilation, anxiety
- Tingling in hands or feet
- Rapid, weak pulse (120-200 bpm) and low to normal blood pressure
- Normal or slightly higher body temperature
- Pale, clammy skin (sometimes flushed)

What to do

- Rest in a cool place, such as a shaded area or air-conditioned building
- Drink an electrolyte solution, such as Gatorade or another sports drink. Avoid caffeinated beverages such as colas, iced tea or coffee.
- Lie down with feet slightly elevated. Loosen clothing, apply cool, wet cloths or fan them.
- Victims of heat exhaustion should avoid strenuous activity for at least a day, and they should continue to drink water to replace lost body fluids.
- In severe cases involving vomiting or fainting, call seek immediate medical attention.

Heat stroke is the most serious heat related health problem, and though it is not very common it is a life threatening illness with a high death rate. It occurs when the body has depleted its supply of water and salt, and the victim's body temperature rises to deadly levels resulting in a failure of the body to regulate its core temperature. A heat stroke victim may first suffer heat cramps and/or the heat exhaustion before progressing into the heat stroke stage, but this is not always the case. It should be noted that, on the job, heat stroke is sometimes mistaken for heart attack. It is therefore very important to be able to recognize the signs and symptoms of heat stroke - and to check for them anytime an employee collapses while working in a hot environment.

DRI Heat Stress Fact Sheet

Signs and symptoms

- The early symptoms of heat stroke include a high body temperature (103 degrees F); a distinct absence of sweating (usually); hot red or flushed dry skin; rapid pulse; difficulty breathing; constricted pupils; any/all the signs or symptoms of heat exhaustion but more severe; bizarre behavior; and high blood pressure.
- Advance symptoms may be seizure or convulsions, collapse, loss of consciousness, and a body temperature of over 108° F.

What to do

- Call 911 immediately and request an ambulance
- Move victim to a cool area
- Soak the victim with cool water
- Fan the victim vigorously to increase cooling
- Apply cold packs if available

Preventing Heat Stress

The risk of developing heat stress can be reduced by planning and implementing controls.

Administrative Controls include the following

- schedule work for the cool part of the day
- rotate workers in and out of the job (thereby shortening work hours in the heat)
- require frequent rest breaks

Engineering Controls that can help reduce heat exposure include:

- general and local exhaust ventilation in areas of high heat
- shield radiant heat sources, such as furnaces or hot machinery
- elimination of steam leaks
- use cooling fans or personal cooling devices, such as cooling vests
- use power tools to reduce manual labor
- provide shaded rest areas

Work Practices to control heat related illness include:

- Clothing: Wear loose-fitting, lightweight clothing, such as cotton, to allow sweat to evaporate. Light colors absorb less heat than dark colors. When working outside, wear a lightweight hat with a wide brim to keep the sun off your head and face, wear sunglasses, and put on sun screen of SPF 15 or higher (the most effective products say "broad spectrum" or "UVA/UVB protection" on their labels).
- Drinking: Drink plenty of liquids, especially if your urine is dark yellow, to replace the fluids you lose from sweating, which can be as much as one quart per hour may be necessary. Do not wait until you are thirsty because thirst is not a reliable sign that your body needs fluids so by the time you are thirsty there is a good chance you are already be dehydrated. Water and/or sports drinks are recommended. Caffeine is a diuretic, so avoid caffeinated beverages such as cola, iced tea and coffee. Never drink alcoholic beverages to quench thirst. Avoid very cold drinks, because they can cause

DRI Heat Stress Fact Sheet

stomach cramps. When doing heavy work, it is better to sip rather than gulp the liquids.

- **Eating:** Salts (electrolytes) are lost through sweating. To replace them drink diluted sports drinks or eat a salty snack. Eat less protein since high protein meals can increase metabolic heat production and increase water loss as part of the normal digestion process.
- **Work Schedule:** If possible, heavy work should be scheduled during the cooler parts of the day. Otherwise, alternate heavy work in the heat with lighter work or work in cooler areas. When the temperature humidity index is between 84 and 93 (Warning Zone), try to minimize the amount of time working in the heat such that approximately half of each hour is spent doing heavy work in the heat. When the temperature humidity index is 94 or higher (Danger Zone), this should be further minimized to approximately one quarter of each hour spent doing heavy work in the extreme heat. Plan out the work using local weather forecasts as much as possible. Call back to the office if you do not have access to forecasts for your area.
- **Body Weighing:** Workers may be at greater risk of heat stress if they lose more than 1.5% of their body weight in a single day from sweating.
- **Acclimatization:** New employees and workers returning from an absence of two weeks or more should have 5 days to get used to the heat. Begin with 50 percent of the normal workload and time exposure the first day and gradually build up to 100 percent on the fifth day.
- **Shade:** If you work in one area for an extended period of time in the sun, then consider bringing a shade provider with you if natural shade is not available. For example, put up a tarp or canopy in your work area.
- **Supervisory responsibility:** Supervisors should watch for signs of heat stress and allow workers to interrupt their work if they are extremely uncomfortable. Supervisors should also ensure that work schedules allow appropriate rest periods and ensure liquids are available. They should use appropriate engineering controls, personal protective equipment and work practices to reduce the risk of heat stress.

Personal Protective Equipment In cases where someone will be working in excess heat for an extended portion of the work day, personal cooling systems may help reduce the risk of heat stress. There are several systems available through health and safety catalogs, including the following:

- Heat reflective clothing may alleviate the problem of radiant heat sources, such as furnaces. However, if the worker is fully covered, he or she will have trouble evaporating sweat.
- Ice vests or cooling vests remove heat from the skin. They are relatively inexpensive and allow freedom of movement.
- Liquid cooling systems also remove heat from the skin. Cool liquid flows in the suit around the body and carries the heat away.

Personal Habits can affect a person's reaction to extreme heat. To minimize the chance of an adverse reaction stemming from personal habits:

- Take cool baths or showers.
- Get enough sleep at night.
- Avoid alcoholic beverages before working in extreme heat as they are dehydrating.
- Take a break if you notice you're getting a headache or you start feeling overheated.
- Take advantage of fans and air-conditioners to cool off before going back to work.

DRI Heat Stress Fact Sheet

- Cut down on exercise before and after work in the heat.
- Limit your outdoor activity to morning and evening hours.

Training

Employees and supervisors need to be trained to be able to detect early signs of heat stress. Employees must understand the need to replace fluids and salt from sweat and recognize the signs of dehydration, fainting, heat cramps, heat exhaustion, and heat stroke.

DRI EH&S has several training programs that can be checked out for use in employee education (see <http://safety.dri.edu/Training/training.html>).

Additional References

A Listing of Heat Stress Related URLs is available at <http://www.baesg.org/heatlist.htm>

A few of many sites selling cooling products like portable evaporative coolers, cooling vests, etc.
<http://www.jimssupplies.com/waycool.htm>
http://www.advancedmistingsystems.com/evaporative_cooling.htm (retrofit an existing fan)
<http://www.coolsport.net/index2.html>
<http://www.texascoolvest.com/>

Heat stress calculations

http://www.pphsa.on.ca/OccHealth/HeatStress/heat_stress_calculator.htm
http://www.dnr.sc.gov/climate/sco/drought/heat_index.html

Dangers of Heat and Humidity

<http://www.qra.org/training/wheat1.html>

Heat Index

<http://www.il-st-acad-sci.org/kingdom/geo1013.html>

Weather Forecasts

<http://www.weather.gov/>
<http://www.weather.gov/view/states.php>