RiskTopics

Helping Prevent Heat Stress

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Heat stress in the workplace can cause reduced productivity and, at its worst, serious illness if you don't take proper precautions through education and prevention.

Introduction

Heat stress is an on-going health problem for both indoor and outdoor workers. Its seriousness can range from severe thirst to a feeling of weakness and exhaustion or even uncontrolled heat stroke and death.

Any workplace may represent a heat stress exposure if high temperatures and strenuous work are present. The following list of industries represents those with a recognized risk:

- Construction
- Agriculture
- Landscaping/Forestry
- Foundries, Smelting and Forging
- Manufacturing (including Food Processing)
- General Warehousing
- Energy (Oil/Gas Drilling/Servicing and Mining)

It is important to be watchful of any industry or work situation that is outdoors during hot weather or may be subject to high indoor temperatures as potential heat stress environments.

Discussion

Heat-induced occupational illnesses and injuries can occur when the total heat load, environment (outside) and metabolic heat (heat generated in the body by physical activity) exceeds the capacity of the body to maintain normal body functions without strain.

Heat Stress Disorders. The following descriptions outline various heat disorders.[1] Common symptoms of heat stress may be gradual**,** such as severe thirst but excessive and uncontrolled heat stress can lead to death. It is important for employees and supervisors to understand the symptoms of these disorders so at risk employees can be identified and treated in a timely manner. Prompt recognition and action may be critical depending on the situation. The common heat stress disorders are displayed in order of increasing seriousness. In particular, the final two, Heat Exhaustion and Heat Stroke, are serious conditions that require immediate medical attention.

Heat fatigue: People with this condition exhibit reduced performance capacity, a lowered standard of social behavior, and an inability to concentrate. Heat fatigue is usually caused by moving from a tepid environment to a very hot environment. Usually, when those affected get back to a cooler environment, the heat fatigue subsides. An orientation or gradual introduction to the hot environment can help workers avoid this condition.

Skin Eruptions: Employees who wear impermeable protective clothing are prone to skin eruptions caused by exposure to high humidity and a hot environment. Under these conditions, the skin is continuously wet with sweat, but the moisture cannot evaporate. The sweat ducts become plugged, sweat is retained, and an inflammatory reaction occurs. Heat rash can be helped by resting in cooler areas, frequent bathing, and allowing the skin to dry. Wearing loose fitting clothing can also help. Another type of skin condition is anhydrotic heat exhaustion which may occur when large areas of skin do not perspire when exposed to heat. The skin takes on a goose- flesh appearance. This condition may occur when someone with a previous history of extensive heat rash and sunburn has constant exposure to heat. Usually, recovery of sweating occurs gradually on return to cooler climates.

Heat syncope: This condition, (fainting while standing erect and immobile in the heat), is generally caused by a pooling of blood in the lower extremities along with dilated vessels of the skin. It leads to hypotension (low blood pressure) and results in sudden unconsciousness. To prevent heat syncope, employees should not be required to stand in the heat for a long period. Treatment requires removal of the affected person to a cool, shaded area and keeping them in a recumbent position.

Heat cramps: Cramps are extremely painful spasms of the larger muscles used during work (i.e., muscles of arms, legs, abdomen, or back). They generally last less than two or three minutes. The predisposing factor to heat cramps is heavy prolonged sweating and an electrolyte imbalance. If there is an electrolyte deficit and prolonged sweat loss, once a fluid loss of 5 percent of body weight is reached, an electrolyte liquid replacement should be used.[2] Athletic drinks containing electrolytes leave the stomach slowly, produce a sensation of fullness, and may discourage people from ingesting the water needed to replace critical fluid losses. Thirst is not a sensitive or reliable indicator of the need to drink fluids. Cool water should be provided, and employees should be encouraged to drink at regular intervals, (approximately every 20 minutes) even though they may not be thirsty. People on diuretics, salt-restricted diets, or other medications that alter hydration should be educated about the causes of heat cramps and review the need for salt. Some employers used to provide salt tablets in the workplace in order to help people acclimate to heat, but so much salt is contained in the average diet that most people have sufficient salt intake. Salt tablets can be difficult for some people to digest, causing stomach irritation and other illnesses, so they are no longer recommended.

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[1] "Heat Stress and Strain." *2009 TLVs and BEIs: Based on the Documentation of the Threshold Limit Values for Chemical Substances and Physical Agents & Biological Exposure Indices*. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, 2009. N. pages 1-37. Print.
[2] Ibid

Heat exhaustion: Heat exhaustion is one of the more serious types of heat-related disorders. Common symptoms are fatigue, headache, giddiness, diarrhea, nausea, and clammy and moist skin. The worker may be disoriented, and treatment is usually symptomatic. Rest in a cool area, fluid replacement under observation, and possibly the application of cold towels to the groin, armpits, and forehead may be indicated. Medical care should be sought to discover the cause of the heat exhaustion and prevent its recurrence.

Heat Stroke: Heat stroke occurs when the body's system of temperature regulation fails and body temperature rises to critical levels. Heat stroke can be life threatening. Symptoms include: the absence of sweating; hot, dry skin; confusion; loss of consciousness and/or convulsions. Heat stroke is a serious medical emergency and should be treated as such. It is prudent to seek emergency services support (such as paramedics) in cases of suspected heat stroke. Hospitalization is recommended for anyone suffering heat stroke. At least 24-hour observation is common.

Several conditions influence the heat equilibrium, including skin temperature, amount of evaporated sweat and the type, amount and characteristics of the clothing worn.

Analyzing Conditions: In analyzing any work situation, the following concepts should be considered.

- Conduction of heat to and from solid objects is usually not an issue in the workplace since workers generally are not in direct contact with surfaces hotter than normal body temperatures for any sustained length of time. Heat loss by conduction to air occurs when the air in contact with the skin is below body temperature. Conversely, heat gain by conduction from air occurs when air temperature exceeds body temperature, as it would in a hot chamber or a warehouse during the summer months.

- Convective heat exchange occurs by radiation. A body loses heat when the surrounding objects have surface temperatures lower than the temperature of the body surface and conversely gain heat by radiation when the temperature of the surrounding surfaces is above body surface temperature (i.e., steam pipes and blast furnaces). Radiant heat exchange is independent of air motion.

- Evaporation of sweat is generally the mechanism most used by the body for the dissipation of large amounts of heat generated by working muscles. The Recommended Standard for Occupational Exposure to Heat and Hot Environments (NIOSH) explains in detail the interaction between gaining heat and controlling heat along with the importance of worker acclimitization.

Risk assessment: The body's natural reaction and cooling mechanism to heat stress is to increase blood flow to the skin surface and by sweating. Since predicting heat stress is often difficult, a risk assessment is an important part of prevention. In addition to a person's sensitivity and susceptibility to heat stress, other key risk factors include, work rate, working climate and work clothing.

Examples of risk factors affecting a person's susceptibility and sensitivity to heat stress can include, age, weight, build, physical fitness, metabolism, medical condition (high blood pressure, organic diseases of the heart or vascular system, coronary artery, or cerebral vascular and peripheral artery disease, workers with active lung disease, skin disease, chronic liver, renal, and endocrine and digestive diseases) and use of drugs or alcohol. Drug and alcohol abuse physiologically alters the body's thermal regulatory functions and is a risk factor for heat stress. An older person has reduced metabolism and generally has a lower tolerance to heat

stress. Obese people who exceed standard weight by 15 percent have a lower tolerance to heat than leaner individuals do.[3] A person's prior history of heat stress increases the susceptibility.

Working climate factors include ambient air temperature, humidity, air movement and work in proximity to a heat source. Hard physical work produces greater body heat. Since sweating is the body's natural cooling mechanism, impermeable and protective work clothing may interfere with body's natural temperature regulation

The human body has an incredible capacity to adjust to hot weather conditions in just a few days, which is why acclimatization is a very important step in avoiding heat exposure. To acclimatize workers, the National Institute for Occupational Safety and Health (NIOSH) recommends that the beginning worker or one returning from vacation or illness should work at least two hours a day in the heat for one week and gradually increase workloads from half to full capacity during those days. As the worker becomes accustomed to the heat, body temperature will drop, and the pulse rate will decrease. As the body gets used to the heat, the physical work will become easier.

Based on the risk assessment, effective heat stress prevention can be initiated.

Guidance

Heat-induced occupational illnesses and injuries can occur in situations in which the total heat load exceeds the capacities of the body to maintain normal body functions without strain.

A preventative workplace program should be initiated in order to prevent heat stress disorders. The program should include alerts to employees when the weather is hot enough to induce heat stress, a review of work areas or work practices to accommodate the hot environment and providing fluids and cool areas to assist employees.

An education program or a heat stress disorder prevention program should discuss at a minimum the following:

- Heat transfer
- The body's reaction to heat
- Practical matters, such as clothing and pacing or work
- Fluid replacement
- Diet and salt intake
- Acclimatization
- Impact of prescription medications on heat disorders
- Life style issues, i.e. alcohol consumption, drug abuse, extra jobs, adequate sleep, health status.
- Signs and symptoms of heat stress disorders

[3] "Heat Stress and Strain." *2009 TLVs and BEIs: Based on the Documentation of the Threshold Limit Values for Chemical Substances and Physical Agents & Biological Exposure Indices*. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, 2009. N. pages 1-37. Print.

Companies should review the various types of heat illness and first aid with their employees and hold a discussion about the countermeasures that can be used on site to prevent heat disorders. The policies of the company on work in hot environments should also be explained.

Work practice modifications can be beneficial in avoiding heat stress. Examples include having more frequent short exposures rather than few longer exposures, starting earlier in the day when it is cooler, increased rest times and restricted overtime.

Job tasks and the work environment should be reviewed in conjunction with weather conditions to determine if steps need to be taken to minimize the chances of heat related disorders.

These steps may include:

- Instituting a work – rest regime based on the ambient conditions (temperature, humidity) and the pace and type of work. Guidelines for work – rest regimes are shown in Reference 1.
- Providing cool, air-conditioned or shaded areas close to the work area for the rest breaks.
- Providing workers with an adequate supply of cool water in convenient, visible locations close to the work area and promote frequent fluid intake beginning before thirst is noted (i.e., at least once per hour).
- As possible, increasing air flow to promote cooling by using fans or other air movement devices
- Allow workers to acclimate to heat conditions by gradually increasing exposure over a five-day work period and by implementing more frequent breaks during the first week of work in those conditions.
- Reschedule strenuous jobs occurring during times of high heat exposure to cooler times of the day.
- Encourage employees to wear or provide employees with light weight, light-colored and permeable clothing.

Determining when to institute controls can be challenging. OSHA suggests using heat index as a way to monitor the potential risk of heat disorders. The following table outlines suggested risk and control levels based on heat index.[4]

Heat Index	Risk Level	Protective Measures
Less than 91°F	Lower (Caution)	Basic heat safety and planning
91°F to 103°F	Moderate	Implement precautions and heighten awareness
103°F to 115°F	High	Additional precautions to protect workers
Greater than 115°F	Very High to Extreme	Triggers even more aggressive protective measures

For additional information on the specific protective measures suggested for each risk level, see Appendix A.

In addition, OSHA has developed a "Heat Safety Tool" app that works on both iOS and Android operating systems. The OSHA "Heat Safety Tool" app uses the local temperature and relative humidity to identify the risk level as noted above. The app also directs the user to possible protective measures and precautions that

[4] "UNITED STATES DEPARTMENT OF LABOR."*OSHA's Campaign to Prevent Heat Illness in Outdoor Workers*. US DOL/OSHA, 2013. Web. 10 May 2016. https://www.osha.gov/SLTC/heatillness/heat_index/index.html .

are suggested for a given heat index level. This app may be useful for workers and supervisory staff to help monitor changing hot work conditions and in instituting controls.

The heat stress exposure guidelines established by the American Conference of Governmental Industrial Hygienists can also be used to interpret heat stress and when to institute controls including a work/rest regimen. See Appendix B for more information.

Conclusion

Hot environments and heat stress can present a significant challenge to companies and their workers. Understanding the causes of heat disorders and being alert for the symptoms can help minimize adverse effects among employees. Companies can take the steps noted earlier to educate employees, monitor and address heat stress conditions in order to help minimize the impact on employees and business operations.

References

1. "*Heat Stress and Strain."2009 TLVs and BEIs: Based on the Documentation of the Threshold Limit Values for Chemical Substances and Physical Agents & Biological Exposure Indices. Cincinnati, OH: American Conference of Governmental Industrial Hygienists, 2009. N. pages 1- 37. Print.*

2. "UNITED STATES DEPARTMENT OF LABOR."*OSHA's Campaign to Prevent Heat Illness in Outdoor Workers*. US DOL/OSHA, 2013. Web. 10 May 2016. https://www.osha.gov/SLTC/heatillness/heat_index/index.html .

3. "UNITED STATES DEPARTMENT OF LABOR."*OSHA Technical Manual (OTM)* Section III: Chapter 4- Heat Stress. US DOL/OSHA, 20 Jan. 1999. Web. 10 May 2016. https://www.osha.gov/dts/osta/otm/otm_iii/otm_iii_4.html

Appendices

Appendix A

The following table is taken from the OSHA Fact Sheet on Occupational Heat Exposure and outlines suggested potential risk level and suggested protective measures by heat index level (https://www.osha.gov/SLTC/heatillness/heat_index/index.html).

Heat Index	***Risk Level***	***Protective Measures***
<91°F	***Lower (Caution)***	▪ *Provide drinking water* ▪ *Ensure that adequate medical services are available* ▪ *Plan ahead for times when heat index is higher, including worker heat safety training* ▪ *Encourage workers to wear sunscreen* ***If workers must wear heavy protective clothing, perform strenuous activity or work in the direct sun, additional precautions are recommended to protect workers from heat-related illness.******
91°F to 103°F	***Moderate***	***In addition to the steps listed above:*** ▪ *Remind workers to drink water often (about 4 cups/hour)***

		▪ *Review heat-related illness topics with workers: how to recognize heat-related illness, how to prevent it, and what to do if someone gets sick* ▪ *Schedule frequent breaks in cool, shaded area* ▪ *Acclimatize workers* ▪ *Set up buddy system/instruct supervisors to watch workers for signs of heat-related illness* ***If workers must wear heavy protective clothing, perform strenuous activity or work in the direct sun, additional precautions are recommended to protect workers from heat-related illness.**** ▪ ***Schedule activities at a time when the heat index is lower*** ▪ ***Develop work/rest schedules*** ▪ ***Monitor workers closely***
103°F to 115°F	***High***	***In addition to the steps listed above:*** ▪ *Alert workers of high risk conditions* ▪ *Actively encourage workers to drink plenty of water (about 4 cups/hour)*** ▪ *Limit physical exertion (e.g. use mechanical lifts)* ▪ *Have a knowledgeable person at the worksite who is well-informed about heat-related illness and able to determine appropriate work/rest schedules* ▪ *Establish and enforce work/rest schedules* ▪ *Adjust work activities (e.g., reschedule work, pace/rotate jobs)* ▪ *Use cooling techniques* ▪ *Watch/communicate with workers at all times* ***When possible, reschedule activities to a time when heat index is lower***
>115°F	***Very High to Extreme***	***Reschedule non-essential activity for days with a reduced heat index or to a time when the heat index is lower*** ***Move essential work tasks to the coolest part of the work shift; consider earlier start times, split shifts, or evening and night shifts. Strenuous work tasks and those requiring the use of heavy or non-breathable clothing or impermeable chemical protective clothing should not be conducted when the heat index is at or above 115°F.*** ***If essential work must be done, in addition to the steps listed above:*** ▪ *Alert workers of extreme heat hazards* ▪ *Establish water drinking schedule (about 4 cups/hour)*** ▪ *Develop and enforce protective work/rest schedules* ▪ *Conduct physiological monitoring (e.g., pulse, temperature, etc.)* ▪ *Stop work if essential control methods are inadequate or unavailable.*

**The heat index is a simple tool and a useful guide for employers making decisions about protecting workers in hot weather. It does not account for certain conditions that contribute additional risk, such as physical exertion. Consider taking the steps at the next highest risk level to protect workers from the added risks posed by:*

- *Working in the direct sun (can add up to 15°F to the heat index value)*
- *Wearing heavy clothing or protective gear*

***Under most circumstances, fluid intake should not exceed 6 cups per hour or 12 quarts per day. This makes it particularly*

important to reduce work rates, reschedule work, or enforce work/rest schedules.

Source: OSHA - https://www.osha.gov/SLTC/heatillness/heat_index/index.html

Appendix B

The heat stress exposure guidelines established by the American Conference of Governmental Industrial Hygienists (ACGIH) are generally intended to represent working conditions under which most employees will not suffer adverse effects. The Wet Bulb Globe Temperature Index (WBGT) is used to quantify environmental factors, including air temperature, humidity, air movement and radiant heat using wet bulb, globe temperature, and dry bulb factors according to the following relationships:

WGBT = 0.7 WB + 0.2 GT + 0.1 DB (Outdoors with Solar Load)

WGBT = 0.7 WB + 0.3 GT (Indoors or Outdoors with no Solar Load)

Where,

WB = Wet bulb temperature

GT = Globe temperature

DB = Dry bulb temperature

The exposure guidelines specify a percentage allocation of work per hour (or a work-rest regimen) based on the derived WBGT and the workload associated with a task. These guidelines do not apply when heavy protective clothing is worn.

For example, during times of light work (standing, walking, light movement of arms), work – rest regimens as suggested by the ACGIH can vary from 100% work per hour for WBGT temperatures of 31° C to work only 25% of the time for WBGT temperatures greater than 32.5° C. Typically, heavy work (intense arm, leg, trunk movements, shovelling, sawing) will require frequent rest breaks (e.g., working only 25 – 50% per hour) when the WBGT temperature exceeds 27° C.

Adherence to the work – rest regimen criteria outlined in the ACGIH TLV should allow most acclimatized, fully clothed workers with adequate water and electrolyte intake to function under the given work-rest schedule without exceeding a deep core body temperature of 38°C. It is believed that maintenance of body core temperature at or below this level will not result in adverse health effects for most employees. Some employees may still have problems. Refer to Reference 1 for greater detail.

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