

Heat Stress

HIGHLIGHTS:

- Types of heat-related illnesses and how you protect against them
- Toxic effects and minor heat-related conditions
- Signs and symptoms
- Exposure guidelines
- Controls for heat stress

Heat stress is a combination of environmental conditions, work demands and clothing requirements that are likely to increase body temperature, along with heart rate and sweating. The tendency for increased body temperature increases with heat demand.

Indoor operations that may have a high heat stress potential include foundries, smelters, brick-firing and ceramic plants, as well as other commercial businesses such as laundries, restaurant kitchens and food processors.

Outdoor operations conducted in hot weather such as agriculture, construction, or hazardous waste remediation also have the potential to cause heat stress among exposed workers.

Toxic Effects

Three major illnesses can occur as a result of the body's inability to cope with excess heat load:

1. **Heat stroke:** the most serious of the heat illnesses, is a medical emergency. It is caused by the body's inability to regulate its core temperature: sweating stops and the body can no longer rid itself of excess heat. If an individual's deep body temperature approaches 41.1°C (106°F), heat stroke is inevitable. Heat stroke may be fatal unless treated promptly and adequately.
2. **Heat exhaustion:** less severe than heat stroke, results from dehydration caused by failure to drink enough fluids, electrolytes or both. An individual who is already experiencing heat exhaustion has the potential to develop heat stroke with additional exposure to a hot environment and without adequate rehydration. Heat exhaustion most often occurs in individuals with a low level of cardiovascular fitness or those not acclimatized to heat.
3. **Heat cramps:** the least serious of the three heat-related illnesses, usually occur in individuals who sweat profusely during heavy work without replacing salt losses. Resting in a cool place and drinking water or an electrolyte drink will usually result in rapid recovery. Note: persons on a low-sodium diet should consult with a physician about what to do under these conditions.

Minor heat-related conditions:

- **Heat syncope** (fainting) may occur when an unacclimated worker stands still in a hot environment. Fainting occurs due to blood pooling in the lower extremities, resulting in insufficient blood flowing to the brain.
- **Heat rash** (prickly heat) may occur in hot and humid environments when sweat cannot be easily removed from the skin by evaporation. When the skin remains wet most of the time, the sweat ducts become plugged and skin rash appears.
- **Transient heat fatigue** is a temporary state of discomfort, mental or physiologic strain resulting from prolonged heat exposure. Unacclimated workers can suffer to varying degrees, including a decline in task performance, coordination, alertness and vigilance. Gradual heat acclimatization can ease the severity of transient heat fatigue.

Signs and Symptoms

Heat stroke may be associated with mental confusion; delirium; loss of consciousness; convulsions or coma; dry, pale skin with no sweating; or hot, red skin that looks sunburned; and an abnormally high body temperature (e.g., 41.1°C, or 106°F). Early recognition and treatment of heat stroke are the only means of preventing permanent brain damage or death.

Heat exhaustion may be associated with clammy moist skin, extreme weakness or fatigue, nausea or vomiting, headache, dizziness or lightheadedness, low blood pressure and normal or slightly elevated body temperature. Collapse can occur without immediate treatment.

Heat cramps involve painful spasms in one or more of the skeletal muscles. The legs, arms and abdominal muscles are the most commonly affected muscle groups. Tired muscles are more susceptible to heat cramps.

Persons who have experienced previous heat injury are more susceptible to a subsequent injury and should be given more protection such as more frequent or longer rest periods.

Exposure Limits

Screening Criteria for TLV® and Action Limit for Heat Stress Exposures¹

Allocation of Work in a Cycle of Work and Recovery.	TLV (WBGT values in °F)				Action Limit (WBGT values in °F)			
	Light	Moderate	Heavy	Very Heavy	Light	Moderate	Heavy	Very Heavy
75% to 100%	87.8	82.4	—	—	82.4	77.0	—	—
50% to 75%	87.8	84.2	81.5	—	83.3	78.8	75.2	—
25% to 50%	89.6	86.0	84.2	82.4	85.1	80.6	77.9	76.1
0 to 25%	90.5	88.7	86.9	86	86.0	84.2	82.4	80.6

¹2009 TLVs and BEIs Based on the Documentation of the Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices. Published by the ACGIH.

OSHA has no established standards for heat stress. The American Conference of Governmental Industrial Hygienists has adopted threshold limit values (TLVs) for heat stress, listed in the table above. The TLV refers to heat stress conditions under which it is believed that nearly all workers may be repeatedly exposed without adverse health effects. These TLVs are based on the assumption that nearly all acclimatized, fully clothed (e.g., lightweight pants and shirt) workers with adequate water and salt intake should be able to function effectively under the given work conditions without exceeding a deep body temperature of 38°C (100.4°F). The action limit (AL) is similarly protective of unacclimatized workers and represents conditions for which a heat stress management program should be considered. This exposure guidance is not a fine line between safe and dangerous levels.

A measurement of environmental factors that correlates closely with deep body temperature is needed to determine specific heat stress exposure for comparison to the TLV. The Wet Bulb Globe Temperature (WBGT) is the simplest and most suitable technique to measure environmental factors. A determination of WBGT requires the use of dry-bulb, natural wet-bulb, and black globe thermometers.

The WBGT index is then calculated using these equations:

Outdoors with Direct Exposure to Sunlight

$$\text{WBGT} = 0.7 \text{ NWB} + 0.2 \text{ GT} + 0.1 \text{ DB}$$

Without Direct Exposure to Sunlight

$$\text{WBGT} = 0.7 \text{ NWB} + 0.3 \text{ GT}$$

Where:

WBGT = Wet Bulb Globe Temperature Index

NWB = Natural Wet Bulb Temperature

DB = Dry Bulb Temperature

GT = Globe Temperature

The amount of physical work performed by the individual is divided into four categories: light, moderate, heavy or very heavy.

Examples of these workloads are as follows:

- A **light** workload might consist of sitting or standing to control machines or performing light hand or arm work.
- A **moderate** workload may be walking about with moderate lifting and pushing.
- A **heavy** workload might be characterized by intermittent heavy lifting with pushing or pulling (activities such as pick or shovel work).
- A **very heavy** workload would be characterized by shoveling wet sand.

Since WBGT is only an index of the environment, the screening criteria must be corrected for jobs that require protection against other harmful substances, and/or the use of additional personal protective clothing and equipment. A more thorough discussion of heat stress evaluation can be found in the documentation of the TLV.

Controls for Heat Stress

Heat stress can diminish work performance and adversely affect worker health and safety. Heat-related conditions can be prevented through a heat stress management program that includes engineering and procedural modifications in the facilities, equipment and/or work practices.

Engineering Modifications

- Substitute a high heat generating process with one that generates less heat.
- Provide power tools that decrease manual labor demands or reduce physical workload.
- Reduce heat in the work area by isolating, enclosing, ventilating or shielding workers from the heat source.
- Cool the work space with evaporative coolers or air conditioners, or spot cool by using portable air conditioners or spot cooling systems at high heat production points.

Procedural Controls

- Let workers use a cooler rest area or control station intermittently throughout the workday.
- Provide water and encourage frequent drinking of small amounts (a cup of cool water about every 15 to 20 minutes).

Administrative Controls

- Acclimatize individual workers by gradually increasing time spent in the hot work environment.
- Schedule heavy work during the coolest part of the day.
- Properly select employees based on medical history and physical condition.
- Train employees and supervisors to recognize the signs and symptoms of heat-related disorders and appropriate first aid measures.

- Train employees in good heat stress hygiene practices, such as the importance of fluid and electrolyte replacement, diet, lifestyle and health issues. Workers with heart problems or those on low sodium diets who work in hot environments should consult with their physicians about treatment options for heat exhaustion and heat cramps. Some medications increase the risk of heat-related stress conditions.

Personal Protective Equipment

- Provide specific personal protection for individual workers as needed, such as circulating air or water systems, cooling vests, or reflective garments.

Biological Monitoring

There are no chemical techniques for measuring biological responses to heat stress. Diagnosis of a heat-related illness depends on the association between the occupational exposure, presenting signs and symptoms, and findings from the medical examination.

References

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