

## INTRODUCTION

At a conference on heat stress, a manager asks: "Why should I put efforts into a heat stress program when I have not seen a single heat stress injury report over the past nine years?" When this manager was asked if he looked for trends relating the number of accidents and injuries to the heat, he admitted that he had not. Reflecting on this, the manager began to show a deeper interest in the topic. **Why? The potential for accidents and injuries to occur as a result of heat-induced disorders can represent a greater risk of loss than the heat-induced disorder itself. A single worker experiencing a heat-induced disorder can put the safety of an entire work crew, plant or community at risk.**



## HEALTH & OTHER RISKS

Heat tends to promote accidents due to dizziness, the slipperiness of sweaty palms, or the fogging of safety glasses. Aside from these more obvious dangers, the frequency of accidents, in general appears to be higher in hot environments than in more moderate environmental conditions. One reason is that working in a hot environment lowers the mental alertness and physical performance of an individual. Increased body temperature and physical discomfort promote irritability, anger, and other emotional states, which sometimes cause workers to overlook safety procedures or to divert attention from hazardous tasks. Heat stroke, exhaustion, cramps, collapse, rashes and fatigue are all forms of heat-induced disorders that are either serious health risks themselves or can lead to serious compromises in safety.

## ROOT CAUSES

Operations involving high air temperatures, radiant heat sources, high humidity, direct physical contact with hot objects, or strenuous physical activities have a high potential for inducing heat stress in employees engaged in such operations. Such places include: iron and steel foundries, nonferrous foundries, brick-firing and ceramic plants, glass products facilities, rubber products factories, electrical utilities (particularly boiler rooms), bakeries, confectioneries, commercial kitchens, laundries, food canneries, chemical plants, mining sites, smelters, and steam tunnels.

Outdoor operations conducted in hot weather, such as construction, refining, asbestos removal, and hazardous waste site activities, especially those that require workers to wear semi-permeable or impermeable protective clothing, are also likely to cause heat stress among exposed workers.

**Heat stroke** occurs when the body's system of temperature regulation fails and body temperature rises to critical levels. This condition is caused by a combination of highly variable factors, and its occurrence is difficult to predict. Heat stroke is a medical emergency. The primary signs and symptoms of heat stroke are confusion; irrational behavior; loss of consciousness; convulsions; a lack of sweating (usually); hot, dry skin; and an abnormally high body temperature, e.g., a rectal temperature of 41 °C (105.8 °F). If body temperature is too high, it causes death. The elevated metabolic temperatures caused by a combination of work load and environmental heat load, both of which contribute to heat stroke, are also highly variable and difficult to predict.

If a worker shows signs of possible heat stroke, professional medical treatment should be obtained immediately. The worker should be placed in a shady area and the outer clothing should be removed. The worker's skin should be wetted and air movement around the worker should be increased to improve evaporative cooling until professional methods of cooling are initiated and the seriousness of the condition can be assessed. Fluids should be replaced as soon as possible. The medical outcome of an episode of heat stroke depends on the victim's physical fitness and the timing and effectiveness of first aid treatment. Regardless of the worker's protests, no employee suspected of being ill from heat stroke should be sent home or left unattended unless a physician has specifically approved such an order.

The signs and symptoms of **heat exhaustion** are headache, nausea, vertigo, weakness, thirst, and giddiness. Fortunately, this condition responds readily to prompt treatment. Heat exhaustion should not be dismissed lightly, however, for several reasons. One is that the fainting associated with heat exhaustion can be dangerous because the victim may be operating machinery or controlling an operation that should not be left unattended; moreover, the victim may be injured when he or she faints. Also, the signs and symptoms seen in heat exhaustion are similar to those of heat stroke, a medical emergency.

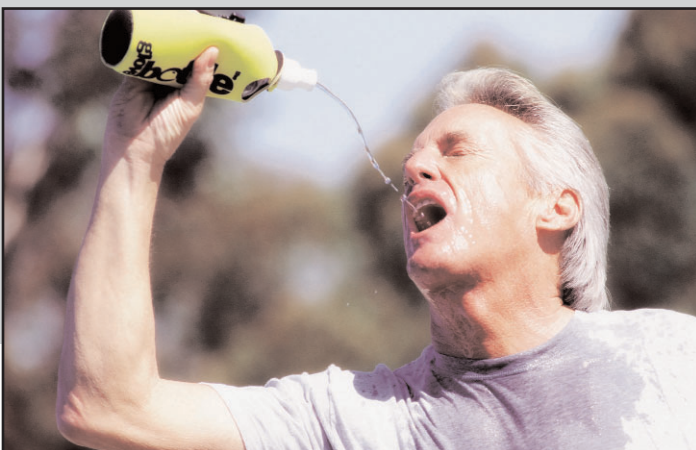
Workers suffering from heat exhaustion should be removed from the hot environment and given fluid replacement. They should also be encouraged to get adequate rest.

Performing hard physical labor in a hot environment usually causes **heat cramps**. These cramps have been attributed to an electrolyte imbalance caused by sweating. It is important to understand that cramps can be caused by both too much and too little salt. Cramps appear to be caused by the lack of water replenishment. Because sweat is a hypotonic solution ( $\pm 0.3\%$  NaCl), excess salt can build up in the body if the water lost through sweating is not replaced. Thirst cannot be relied on as a guide to the need for water; instead, water must be taken every 15 to 20 minutes in hot environments.

Under extreme conditions, such as working for 6 to 8 hours in heavy protective gear, a loss of sodium may occur. Recent studies have shown that drinking commercially available carbohydrate-electrolyte replacement liquids is effective in minimizing physiological disturbances during recovery.

In **heat collapse** (fainting), the brain does not receive enough oxygen because blood pools in the extremities. As a result, the exposed individual may lose consciousness. This reaction is similar to that of heat exhaustion and does not affect the body's heat balance. However, the onset of heat collapse is rapid and unpredictable. To prevent heat collapse, the worker should gradually become acclimatized to the hot environment.

**Heat rashes** are the most common problem in hot work environments. Prickly heat is manifested as red papules and usually appears in areas where the clothing is restrictive. As sweating increases, these papules give rise to a prickling sensation. Prickly heat occurs in skin that is persistently wetted by unevaporated sweat, and heat rash papules may become infected if they are not treated. In most cases, heat rashes will disappear when the affected individual returns to a cool environment.



A factor that predisposes an individual to **heat fatigue** is lack of acclimatization. The use of a program of acclimatization and training for work in hot environments is advisable. The signs and symptoms of heat fatigue include impaired performance of skilled sensorimotor, mental, or vigilance jobs. There is no treatment for heat fatigue except to remove the heat stress before a more serious heat-related condition develops.

## SOLUTION

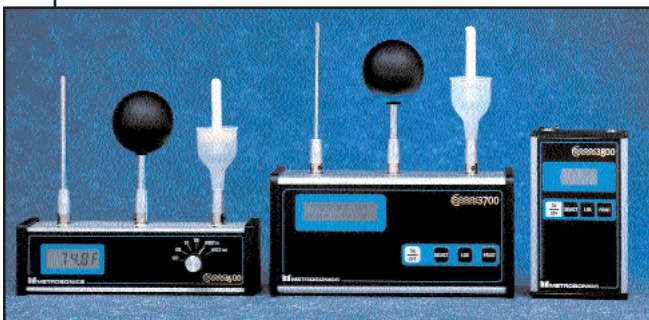
Heat stress injuries can be prevented through the implementation of an effective heat stress program. A good place to turn for information on setting up a heat stress program is the 2001 TLVs<sup>®</sup> and BEIs<sup>®</sup> handbook from the American Conference of Governmental Industrial Hygienists (ACGIH). Updated in the year 2000 publication, the Heat Stress and Heat Strain guidelines describe a comprehensive program covering topics from monitoring to controls.

Described in the ACGIH handbook, the Wet Bulb Globe Temperature (WBGT) is used to evaluate the environment. The WBGT is a temperature measurement derived from three sensors influenced by temperature, humidity, radiant heat, and air flow. A WBGT Index gives work/rest regimens based on the WBGT and the metabolic rate of the worker. Instruments, like Quest Technologies' QUESTemp<sup>®</sup> 36, automatically calculate the WBGT and display work/rest regimens for each of four metabolic work categories.



Some companies rely primarily on the WBGT Index and work/rest regimens for their heat stress program but for other companies, additional or alternative approaches are needed. When jobs require wearing impermeable clothing, like chemical protective clothing, the WBGT does not indicate what the workers are experiencing inside the clothing. In such situations, directly monitoring individual heat strain provides more useful information. In other jobs, such as working in the oil refineries in the hot and humid Gulf Coast, the summer heat exceeds the WBGT but the work needs to continue. Here, the WBGT Index is used as a first-order screening and other approaches such as personal heat strain monitoring come into effect once the index is exceeded.

The ACGIH guidelines identify several measurable indicators of excessive heat strain for healthy working adults. Body core temperature should not exceed 38°C for unacclimatized workers or 38.5°C for medically selected acclimatized workers. Sustained heart rate should not exceed 180 beats per minute (bpm) minus the worker's age and the one-minute recovery heart rate should not exceed 110 bpm. Weight loss from sweating should not exceed 1.5% of body weight. Other non-measurable indicators include severe fatigue, nausea, dizziness, or lightheadedness.



Periodic measurements of heat strain may include oral temperature, weight loss, or pulse. While useful, this method leaves room for injury between measurement intervals. Continuous personal monitoring provides a solution for some. The Metrosonics hs-3800 continually monitors both temperature and heart rate alarming the worker if limits are exceeded. The QUESTemp<sup>®</sup> II continually monitors body core temperature in the ear canal and provides an audible alarm if the limit is exceeded.

An effective heat stress program does not begin and end with measurements. Sound industrial hygiene practice includes worker training and site-specific controls. All managers and workers working in the hot environments need to be trained on the signs and symptoms of heat stress, how to recognize problems with themselves and coworkers, how to prevent heat injuries, and what first aid should be administered.

General and job-specific controls can be implemented once the job demands and constraints are understood. General controls may include: medical screening for fitness; acclimating workers to the heat; allowing self-limited exposures; encouraging healthy diets and lifestyles; and providing cool water or electrolyte replacement drinks to encourage frequent drinking. Job specific and engineering controls may include: limiting exposure times; moving the most strenuous tasks to cooler times of the day; reducing workloads through the use of machinery and tools; using cooling vests; shielding the heat source or providing a sun shade; or increasing the air flow using fans.

Preventing on the job heat stress injuries and heat stroke is a daunting task for those who work and live in the southern heat but at least they tend to be aware of heat stress and how to deal with it. Those who work and live in the cooler northern climates need to be prepared for the sudden summer heat waves that catch workers unacclimated and unprepared.

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## FOR MORE INFORMATION

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## PERTINENT WEBSITE LINKS

OSHA Technical Manual (Heat Stress)

[http://www.osha-slc.gov/dts/osta/otm/otm\\_iii/otm\\_iii\\_4.html](http://www.osha-slc.gov/dts/osta/otm/otm_iii/otm_iii_4.html)

Ontario Ministry of Labour

<http://www.gov.on.ca/LAB/ohs/heate.htm>

NIOSH: Working in Hot Environments

<http://www.cdc.gov/niosh/hotenvt.html>

American Conference of Governmental  
Industrial Hygienists

<http://www.acgih.org>

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