Tips for Reducing Workers' Heat Load

Dealing effectively with heat stress can increase workers' comfort, safety, and productivity.

BY MEGAN TORGRUDE AND DON GARVEY

Heat stress can be a major concern in workplace environments, potentially causing irritability, low morale, absenteeism, shortcuts in procedures, and unsafe behavior. In extreme cases, heat stress, in the form of heat stroke, can be fatal. The United States Bureau of Labor Statistics data for the years 2003-2005 indicate an average of 31 worker deaths annually from exposure to "environmental heat."*

The main factors leading to heat stress include strenuous physical activity, high air temperature, high humidity, direct contact with hot materials, and radiant heat sources. Some industries with these conditions include foundries, bakeries, commercial kitchens, laundries, chemical plants, mining sites, smelters, and more.

Seasonal potential for heat stress exists in many outdoor operations, such as construction, asbestos removal, and hazardous waste activities. Many of these functions also require the use of semi-permeable or impermeable protective clothing, which adds to the heat stress burden.*

Heat Stroke Symptoms
Heat stress can lead to both heat exhaustion and heat stroke. They have differing physical signs, which are listed below.*

*Symptoms of heat exhaustion include:
- Headaches, dizziness, lightheadedness, or fainting
- Weakness
- Moist skin
- Mood changes, such as irritability or confusion
- Upset stomach or vomiting

*Symptoms of heat stroke include:
- Dry, hot skin with no sweating
- Mental confusion or losing consciousness
- Seizures or convulsions
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**Exposure Assessment**

Total heat load on a body is the combination of environmental conditions, clothing, and metabolic or workload factors. According to the American Conference of Governmental Industrial Hygienists (ACGIH), the Wet Bulb Globe Temperature (WBGT) can be useful in evaluating the environmental contribution to heat stress [ACGIH 2007]. In the indoor environment, the WBGT is a combination of wet bulb temperature (accounts for humidity) and Vernon Globe temperature (accounts for radiant heat sources). Outdoors, a dry bulb temperature (to account for solar heating) is also added. Each temperature is weighted, and they are added together using one of the following formulas:

- **WBGT Indoors** = (Wet Bulb Temp) 0.7 + (Globe Temp) 0.3
- **WBGT Outdoors** = (Wet Bulb Temp) 0.7 + (Globe Temp) 0.2 + (Dry Bulb Temp) 0.1

The WBGT can then be used with the ACGIH Heat Stress and Heat Strain Threshold Limit Value (TLV) to assess worker exposure as part of an overall heat-stress program.

The WBGT measurement may also help to identify environmental conditions that can contribute significantly to heat stress. That, in turn, may help identify ways to reduce the environmental heat load on a worker.

A heat stress monitor can quickly and easily measure WBGT. It displays the overall WBGT, as well as the individual temperatures that comprise the WBGT reading. When used in conjunction with the ACGIH Thermal Stress TLV, the monitor is a valuable tool for use in establishing and implementing a heat-stress management program.

For more information on using WBGT to assess heat stress and the risk to worker health, consult the ACGIH Heat Stress TLV.

As noted above, clothing and metabolic workload also play a significant role in determining a person’s overall heat strain. Protective clothing can increase heat load by reducing heat exchange with the environment through reduced air movement across the skin and inhibition of sweat evaporation. Use of negative pressure air-purifying respirators can increase the metabolic workload because the worker must supply the energy to draw air through the filter media.

Especially in a job that is already physically demanding, either of these examples can result in an increase in total heat load. When looking for ways to reduce worker heat load, methods to reduce each of these factors (environment, clothing, and workload) should be investigated.

**Controls**

Many workers are required to wear protective clothing, such as high-visibility apparel when working in traffic work zones, materials handling areas, etc. Wearing additional garments, such as reflective vests, can lead to increased heat burden on the worker. Comfort and visibility, however, can still be achieved by incorporating reflective materials directly into apparel such as t-shirts, rather than requiring additional garments, such as a vest, to be worn.

The design of the retro-reflective material can help to improve moisture vapor transmission, helping to keep workers drier and cooler in certain situations. In addition, workers don’t have to remember to put on their reflective apparel because it is already a part of their everyday work wear.

If respiratory protection is required, one potential solution to reduce heat load is to use a powered air-purifying respirator (PAPR) or a supplied air respirator (SAR). PAPRs use a battery and motor blower to pull air through the respirator filter or cartridge and blow it into the respirator headpiece. SARs use a supplied air hose to
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deliver compressed breathing air to the headpiece.

Both PAPRs and SARs help to reduce the extra workload caused by breathing through a non-powered respirator. They also have the benefit of blowing air across the worker’s face, which may supply a cooling effect. Hood-type head pieces typically have an inner shroud that is tucked under coveralls or outer work clothing. The shroud can channel air under the clothing, creating air movement that may increase both convective and evaporative cooling.

It should be noted, however, that PAPRs do not cool the air. If a reduction in air temperature is desired, a supplied air system with a cooling vortex is required.

Cooling devices, or vortex tubes, may be available as part of SAR systems. They are powered solely from the pressurized air of a compressor and are worn at the worker’s waist. Vortex tubes can cool breathing air by up to 50°F (28°C). Air-warming devices are also available for cold work environments. Workers can easily adjust the vortex to increase or decrease cooling according to comfort and changing work conditions.

With any respirator use, employers should implement an effective respirator program that complies with the requirements of 29 CFR 1910.134 or other local regulatory authority.

Conclusion

Excessive exposure to heat can seriously affect worker health, safety, and productivity. Accurate measurement of environmental conditions, along with use of PPE that can minimize or reduce worker heat load, can help to reduce the risk of heat strain. Heat stress monitors can help in evaluating the work environment, while reflective products and powered and supplied air respirators can help minimize the heat load on workers.

MEGAN TORGREN, MPH, is a 3M Technical Service Representative. DON GARVEY, CIH, CSP, is a 3M Technical Service Specialist.

REFERENCES: