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JobHealth Highlights

Technical Information for Occupational Health and Safety Professionals

This volume of Job Health Highlights is authored by:
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Heat Stress

Introduction

Heat stress can be a major concern in workplace environments potentially causing irritability, low morale, absenteeism, short cuts in procedures and unsafe behavior.¹ 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 to 2005 indicate an average of 31 worker deaths annually from exposure to “environmental heat”.²

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 semipermeable or impermeable protective clothing which adds to the heat stress burden.³

Heat stress can lead to both heat exhaustion and heat stroke. They have differing physical signs, which are listed below.⁴

Symptoms of heat exhaustion

- * Headaches, dizziness, lightheadedness or fainting
- * Weakness
- * Moist skin
- * Mood changes such as irritability or confusion
- * Upset stomach or vomiting

Symptoms of heat stroke

- * Dry, hot skin with no sweating
- * Mental confusion or losing consciousness
- * Seizures or convulsions



Exposure Assessment

Total heat load on a body is the combination of environmental conditions, clothing and metabolic or work load 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 added together using one of the following formulas:

- a. WBGT Indoors = (Wet Bulb Temp) 0.7 + (Globe Temp) 0.3
- b. 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 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.

The 3M™ WIBGET RSS-214 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 3M™ WIBGET RSS-214 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, the ACGIH® Heat Stress TLV® should be consulted.⁵

As noted above, clothing and metabolic work load also play a significant role in determining a persons 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 work load 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 work load) 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 like reflective vests can lead to increased heat burden on the worker. Comfort and visibility however can still be achieved by incorporating reflective material like 3M™ Scotchlite™ Reflective Series 5500 Comfort Trim Material directly into apparel such as t-shirts, rather than requiring additional garments, such as a vest, be worn. The design of this retro-reflective material also helps 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; it's already a part of their every day 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 deliver compressed breathing air to the headpiece. Both PAPRs and SARs help to reduce the extra work load 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 which 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, are available as part of 3M 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 impact 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 reduce the risk of heat strain. 3M™ WIBGET RSS-214 Heat Stress Monitor can help evaluate the work environment, while 3M reflective products and powered and supplied air respirators can help minimize the heat load on workers.

References

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