Heat Stress Considerations

Heat stress can be a major concern in workplace environments potentially causing irritability, low morale, absenteeism, short cuts in procedures and unsafe behaviour. In extreme cases heat stress, in the form of heat stroke, can be fatal. The Australian Safety and Compensation Council database indicates there are hundreds of reported injuries and a number of deaths in Australian workplaces every year from exposure to “environmental heat.”

Introduction

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

Exposure Assessment

Total heat load on a body is the combination of environmental conditions, clothing and metabolic or work load factors. The Australian Institute of Occupational Hygienists (AIOH) has released a useful reference work dealing with the whole issue of Heat Stress.

The Wet Bulb Globe Temperature (WBGT) can be useful in evaluating the environmental contribution to heat stress. 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) WGBT Indoors = (Wet Bulb Temp) 0.7 + (Globe Temp) 0.3

b) WGBT Outdoors = (Wet Bulb Temp) 0.7 + (Globe Temp) 0.2 + (Dry Bulb Temp) 0.1

Symptoms of heat exhaustion
- Headaches, dizziness, light-headedness 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
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The WBGT can then be used to assess worker exposure as part of an overall heat stress program. It 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 QUESTemp™ 32 Thermal Environment Monitor can quickly and easily measure WBGT. It measures and displays the overall WBGT as well as relative Humidity. When used in conjunction with the ACGIH™ Thermal Stress TLV™, the QUESTemp™ 32 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 AIOH Heat Stress Standard document or ACGIH Heat Stress TLV should be consulted.

Personal measurements on an individual can be made using the QUESTemp™ II Personal Heat Stress Monitor which logs core temperature of the external auditory canal near the tympanic membrane of the ear. Temperature data is monitored and recorded and user-selected alarm trip points provide an audio alert to the worker experiencing elevated core temperatures. This device was created to work in conjunction with a well-managed heat stress safety program. Recorded data may also be used to evaluate worker response to heat stress loads and assist in developing preventive measures.

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 though the filter media. Especially in a job that is already physically demanding, environment, clothing and work load can result in an increase in total heat load and should be investigated when looking for ways to reduce worker heat load.

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 the new “breathable” 3M™ Scotchlite™ Reflective Trim Series Material directly into apparel such as work shirts, rather than requiring additional garments, such as a vest, be worn. The design of this retro-reflective material also helps improve moisture vapour transmission, helping to keep workers drier and cooler in certain
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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, there are some features and equipment that can help. For disposable masks, use of a valved product allows the workers hot, sweaty breath to escape from the mask quickly, thereby reducing heat build up inside the mask and keeping the wearer cooler.

Another potential solution to reduce heat load is to use a powered air purifying respirator (PAPR) or a supplied air respirator (SAR). PAPR’s use a battery and motor blower to pull air through the respirator filter or cartridge and blow it into the respirator headpiece. SAR’s use a supplied air hose to deliver compressed breathing air to the headpiece. Both PAPR’s and SAR’s 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 PAPR’s 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 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 AS/NZS175.

Conclusion

Excessive exposure to heat can seriously impact worker health, safety and productivity. Accurate measurement of environmental conditions and use of PPE that can minimize worker heat load can help to reduce heat strain. The 3M™ QuestTemp™ 0 32 Thermal Environment Monitor and the QuestTemp™ II Personal Heat Stress Monitor can help evaluate the work environment and the individual worker, while 3M reflective products and powered and supplied air respirators can help minimize the heat load on workers.
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References


