Heat Stress: cool solutions

Version 4.0

Global climate change demands many responses. Few now argue against their absolute necessity. As Ontarians experience increasingly hot summers though, the need for some responses seems more immediate than others. Workers certainly require increased protection to prevent occupational heat stress.

The shock of one bakery worker's death galvanized health and safety activists on this issue. Kim Douglas Warner, 44, died from heat stroke in Barrie, Ontario during a 12-hour day shift where temperatures were estimated at 49°Celsius. Lack of water and rest breaks also contributed to the fatality. Warner's core body temperature rose to a staggering 42.5°C at time of death. The employer was fined $215,000 under the *Occupational Health and Safety Act*.

What is heat stress?

Heat stress is our body's biochemical response to extreme heat or to a hot environment. Heat comes from hot working environments, but it also comes from within the body itself. The harder the work, the more metabolic heat is generated inside the worker's body.

It is this combination of hot working environments and heavy manual work that poses the greatest health threat.

Heat transfer

In order to stay healthy, the body must maintain a constant core temperature of approximately 36°C to 38°C regardless of external conditions. The body does this by gaining heat from food (calories) and muscular work or losing it through radiation and sweating. Rates of heat gain and heat loss must balance to maintain this constant body temperature.

Most people feel comfortable when the air temperature ranges from 22°C to 25°C and the relative humidity is about 45 per cent. This range is neither too hot nor too cold.

As the body warms up after exposure to heat and/or exertion, blood is circulated to the skin, which increases skin temperature and allows the body to give off its excess heat through the skin as sweat. Evaporation of sweat cools the skin, eliminating large amounts of heat. Unfortunately, sweating does not cool the body unless the moisture is removed from the skin. Under conditions of high humidity, the evaporation of sweat is decreased and the body's efforts to maintain an acceptable core temperature may be significantly impaired. Maintaining an acceptable core temperature is also difficult for workers exposed to excessive radiant heat (e.g. from a furnace or the sun), or those workers required to perform extremely physical work. Either way, when this happens we say the individual is experiencing "heat stress."

Who is at risk?

Kim Warner's death is not an isolated incident. His is but one of an estimated 220 workers in Canada and the United States who die annually from occupational heat stress. Moreover, scientists tell us the worst is yet to come. A study released by Toronto Public Health and Environment Canada predicts heat-related deaths will double by 2050 and triple by 2080 as a result of global warming.

Workers most at risk include those employed in bakeries, food processing, canneries, restaurants, laundries, mines, smelters and foundries, where temperatures can rise to extreme levels, particularly in the summer months. Outdoor workers, such as roofers, road crews, farm workers, parks and recreation, landscapers, and surface miners are also susceptible to heat stress during the summer.

Even workers employed in Ontario schools can be confronted by heat stress at the close and opening of the school year. Poorly ventilated, aging classrooms with no access to air conditioning have seen indoor temperatures rise to hazardous levels.

Older workers, those with medical conditions and individuals taking certain types of drugs are also at higher risk. For example, workers who take medications for blood pressure control may have problems when exposed to high temperatures.

What are the health effects?

Too much exposure in a very hot work environment can cause a variety of **acute health effects.** They include the following:

- ***Heat stroke*** is the most serious consequence. It occurs when a person's own temperature-regulating system fails, and sweating becomes inadequate to keep the body temperature within normal range. The body's core temperature rises. Signs and symptoms include hot and unusual dry skin that is red or spotted, a temperature above 41°C, mental confusion, delirium, convulsions or unconsciousness. If heat stroke is not treated immediately, permanent damage to organs (such as the heart, brain, kidneys) or even death can occur, as in the case of Warner.
- ***Heat exhaustion*** is caused by the loss of large amounts of fluids by sweating (and sometimes excessive loss of salt) from continuous work in high temperatures. A worker suffering from heat exhaustion still sweats, but experiences some or all of these symptoms: extreme weakness, dizziness, headache, nausea, vomiting, muscle cramps, breathlessness and numbness of the hands or feet.
- ***Heat cramps*** are sharp muscle spasms that occur in those who sweat copiously in heat, drink plenty of water, but do not adequately replace the body's loss of salt.
- ***Fainting, heat rash and transient heat fatigue*** are also consequences of prolonged exposure to hot conditions. 'Transient' heat fatigue is a short and temporary state of physical and mental/emotional discomfort, and can cause a decline in performance, alertness and safe working habits.

Safety problems

Heat stress can also trigger safety problems, including incidents resulting from fogging of safety glasses, sweaty palms and dizziness. Mental alertness and physical competency also may suffer as the temperature goes up, with increased discomfort promoting anger, irritability and other negative emotions that can spark incidents.

Chronic health effects

Heat stress can also have long-term chronic health effects. Workers who have suffered heat stroke or exhaustion are often less able to tolerate heat, sometimes for the rest of their lives. After labouring for long periods in a hot environment, some workers will experience chronic heat exhaustion, while others may suffer from hypertension (high blood pressure), heart muscle damage, reduced libido, or sexual impotence.

What is the law?

Ontario does not have specific regulations governing heat exposure and resulting heat stress under the *Occupational Health and Safety Act*. In the absence of an enforceable, standalone regulation, the Ministry of Labour, Immigration, Training and Skills Development (MLITSD) relies upon Threshold Limit Values (TLVs for heat stress set by the American Conference of Governmental Industrial Hygienists (ACGIH). MLITSD inspectors use these TLVs as a guideline for enforcing the legislation's general duty clause, which requires employers to take every precaution reasonable to protect workers' health and safety. The ACGIH specifies both a TLV and an action limit to prevent unacclimatized workers' core body temperatures from rising above 38°C (38.5°C for acclimatized workers).

The heat stress TLVs refer to conditions under which it is believed that nearly all workers may be repeatedly exposed without adverse health effects. Unfortunately, the limits do not address thermal discomfort, a significant and unaddressed issue for many workers.

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The TLVs assume all workers are fully clothed (e.g., lightweight pants and shirt), with adequate water and salt intake. They also differentiate between acclimatized and unacclimatized workers.

These assumptions are problematic at best. A number of personal factors can make a person more vulnerable to heat stress. Few workers become acclimatized. Acclimatization is a series of measurable physiological changes a person undergoes over a period of about five to 10 days that supposedly enables the body to rid itself of excess heat. Once acclimatized, the body begins to sweat at lower skin and body temperatures, and that will result in a lower accumulated heat load — and less stress. According to the MLITSD though, "hot spells in Ontario seldom last long enough for most workers to acclimatize." Those workers performing "heavy work" (e.g., shoveling dry sand) or exposed to significant radiant heat (e.g., working in a foundry) could possibly be considered acclimatized once the warm weather season arrives. Given that TLVs are based upon data derived from 20-year-old male workers weighing 154 lbs., they also fail to reflect a majority of the workforce, including the differences between how male and female workers' bodies manage heat stress.

Also problematic, ACGIH TLVs rely on the Wet Bulb Globe Temperature Index (WBGT), which requires use of a black globe thermometer, a natural (static) wet bulb thermometer and a dry-bulb thermometer. Using these instruments can be confusing, expensive, and time-consuming.

What can be done?

With rising global temperatures, hot spells are becoming more frequent. A report from Canada's federal and provincial auditor's general states by 2100, the number of days above 30°C is expected to double in Canadian cities. Workers need greater protection now.

Offering a simplified approach which focuses on the more relatable Humidex, a combination of temperature and relative humidity measurements, the Occupational Health Clinics for Ontario Workers (OHCOW) devised a ***Humidex-Based Heat Response Plan*** based on ACGIH TLVs. Adopted by many workplaces, the plan among other things, consists of a Heat Stress Calculator and a table listing Humidex measurements with corresponding recommended response measures. To arrive at the Humidex, OHCOW recommends using a thermal hygrometer (type of thermometer) which costs $10 to $50 in a hardware store.

The tool assumes the work to be moderate, with little or no radiant heat (although instructions for adjusting the Humidex value for radiant heat indoors and outdoors are provided), and that workers are wearing regular summer clothing, in good physical health and are unacclimatized. General and job-specific controls should be provided for all workers in either Humidex category. Never ignore any worker's heat stress symptoms.

What more can be done?

Like many other dangers, indoor heat stress hazards can be controlled at the source, along the path, and at the worker. Controls at the source of the hazard are the best way to reduce or eliminate heat stressors. Better building design and air-cooling systems using renewable energy sources reduce worker risk and hot weather-promoting greenhouse gas emissions. Air-cooling systems can help reduce the compounding problem of humidity. Dehumidifiers and the elimination of open hot water baths, drains, and leaky steam valves can similarly help. Mechanizing or automating some work procedures and installing better insulation on stoves and furnaces, are two more ways to curb heat stress.

Exhausting hot air and steam produced by operations, and installing fans will help address heat issues along the path. However, fans have little benefit when relative humidity levels rise above 70 per cent, as very little evaporation occurs. Further, if air and skin temperatures are the same (36°C) or higher, moving air may heat up the body, especially if humidity is high.

When it comes to outdoor workers much can be done too. These controls include:

- Administrative controls that schedule heavy work during the coolest time of day, avoidance where possible of work in direct sunlight, assign extra workers to heavy tasks, slow the pace of work, postpone nonessential work altogether.
- Allowing workers to pace their work, take frequent breaks in cool, shaded locations or in nearby air-conditioned buildings or vehicles;
- Loose-fitting, light clothing in less extreme heat, water-cooled jackets and air-cooled space suits for extreme heat, and reflective clothing in high radiant heat situations, and
- Provision of readily accessible cool drinking water (slightly salted water in extreme heat) especially in response to early symptoms of heat stress.

In the case of firefighters, a Workplace Safety and Insurance Board (WSIB)-funded study and many since have also found forearm submersion in water 18°C or cooler to be an effective intervention during rest periods.

All interventions should be identified in a formal heat stress monitoring and control plan developed by the joint health and safety committee (JHSC), ideally in advance of a heat wave. To perform their essential role JHSCs must be trained to identify, assess sources of heat stress and understand what makes for a proper heat stress policy and program. **Worker training, including training on the signs and symptoms of heat stress and a buddy system to help identify them is also essential.**

In the absence of proper heat stress controls and lack of response to expressed concerns, as a last resort, workers should exercise their right to **refuse unsafe work** under the *Occupational Health and Safety Act*. This isn't just good advice — it may literally save lives.

NOTE: The Workers Health & Safety Centre offers training on heat stress and its control. To learn more visit **www.whsc.on.ca** or contact a Training Services Representative near you. Special thanks to the staff of OHCOW's Hamilton office for their assistance in preparing this bulletin. OHCOW's Humidex-based Heat Stress Calculator and Plan are available on their website: **https://www.ohcow.on.ca/resources/apps-tools-calculators/humidex-based-heat-stress-calculator-plan/.**

Humidex 1	Response	Humidex 2
25 – 29	supply water to workers on an "as needed" basis	32 – 35
30 – 33	post Heat Stress Alert notice; encourage workers to drink extra water; start recording hourly temperature and relative humidity	36 – 39
34 – 37	post Heat Stress Warning notice; notify workers that they need to drink extra water; ensure workers are trained to recognize symptoms	40 – 42
38 – 39	work with 15 minutes relief per hour can continue; provide adequate cool (10-15°C) water; at least 1 cup (240 mL) of water every 20 minutes worker with symptoms should seek medical attention	43 – 44
40 – 41	work with 30 minutes relief per hour can continue in addition to the provisions listed previously	45 – 46*
42 – 44	if feasible, work with 45 minutes relief per hour can continue in addition to the provisions listed above	47 – 49*
45 or over	only medically supervised work can continue	50* or over

Humidex calculator: http://www.ohcow.on.ca/edit/files/general_handouts/heat-stress-calculator.html

*at Humidex exposures above 45, heat stress should be managed as per the ACGIH TLV®

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