Workplace Health and Safety Bulletin

WORK SAFE ALBERTA

Working in the Heat

The human body works at its best within a narrow temperature range. Move $2^{O}C$ or more above or below the body's normal temperature of $37^{O}C$ and problems can start to happen. $37^{O}C$ is the body's core temperature, the temperature of the brain, heart and other organs. Skin temperature may differ from core temperature by a few degrees.

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The body controls its core temperature in a few ways. Sweating lowers the temperature; shivering raises it. Increasing blood flow to the skin helps remove heat; reducing the flow of blood helps conserve heat.

As a person works in a hot environment, their core temperature rises. To keep cool, the body sweats. The sweat then evaporates and cools the body. If the fluid lost as sweat is not replaced, the person becomes dehydrated and unable to sweat. The body then loses its ability to control its core temperature and serious heat problems can result.

The human body can adapt to hot conditions and work safely and comfortably. This is known as acclimatization. Depending on the person, acclimatization may take about four to seven days of working in hot conditions. Full heat adaptation takes up to three weeks of continued physical activity under hot conditions. Physically fit workers make this adjustment faster than unfit workers. Acclimatization is lost quickly — one week away from the hot conditions and a person loses their adaptation to the heat. A small percentage of people are unable to acclimatize at all.

The human body can adapt to hot conditions and work safely and comfortably.

Alberta HUMAN RESOURCES AND EMPLOYMENT | the people & workplace department

Factors affecting how hot we feel

Six main factors affect how hot we feel:

(1) *Air temperature* – measured with a normal thermometer, this is the temperature of the air around us. Although it is the easiest factor to measure, it is the least important under hot conditions. If air temperature is the only measurement taken, it is difficult to predict how workers will be affected by the heat.

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(2) *Humidity* – this is the amount of water in the air. Under hot conditions, people feel even hotter when the air is more humid than when it is drier. Although a person will sweat, the sweat will not evaporate as quickly if the air is filled with moisture. Less evaporation means less cooling.

(3) *Radiant heat* – this is heat given off by anything that is hot, such as the sun, molten metal, hot pipes, or a heater. It eventually heats the air, but heats people more quickly. Radiant heat affects any person working in sunlight or near a work process that radiates heat. By simply moving from sun to shade, a person can feel the difference that radiant heat makes.

(4) *Air speed* – also known as wind speed, moving air that is cooler than the skin cools a person.

(5) *Physical activity* – body temperature increases with physical activity. Under warm or hot conditions, physical activity can increase the effect of heat on a person.

(6) *Clothing* – clothing can shield a worker from radiant heat, prevent sweat from evaporating, or help to transfer heat. Protective clothing that is not appropriate under hot conditions can be a problem. This includes clothing that does not allow air or moisture to pass through it (air- or water-vapour- impermeable clothing), or multiple layers of clothing.

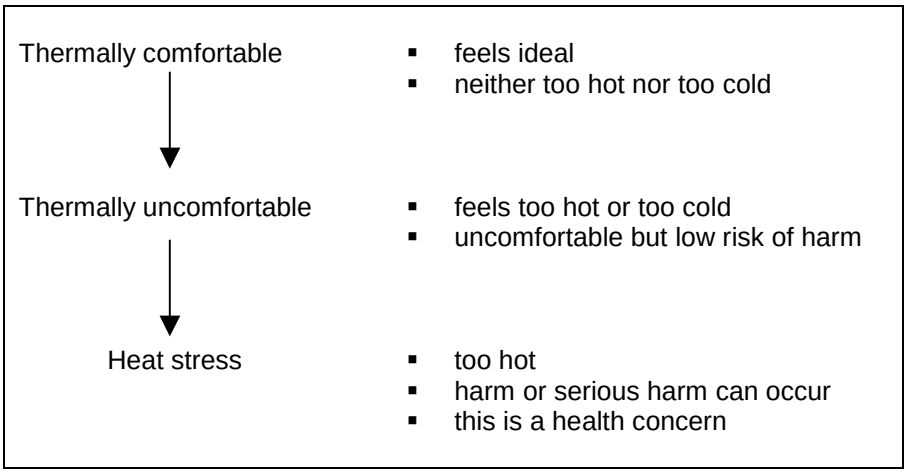
Other factors that may affect a person's ability to work in the heat include their age, health status, level of fitness, body weight, level of hydration, and their use of prescription and non-prescription drugs.

What is comfortable?

Our perception of temperature is very complex. Under ideal temperature conditions, persons are unaware of being too hot or too cold. This is when they feel "thermally comfortable" (see Figure 1).

Workers should be made as comfortable as possible under hot conditions.

Figure 1 Range of comfort



A person feeling "thermally uncomfortable" will feel too hot but will not suffer harm as a direct result. However, being too hot may make the person feel tired and irritable. The person may also be less productive and may make more mistakes that could result in an accident.

Workers should be made as comfortable as possible under hot conditions. At many workplaces, some degree of thermal discomfort may be unavoidable. Although the temperature conditions for workers working outside cannot be controlled, clothing, physical activity and the timing of the work can. If workers experience discomfort for only a few days a year, it may not be reasonable to spend a lot of resources to control the thermal environment. Administrative controls may be more appropriate.

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Heat stress

Heat stress happens when hot working conditions have the potential to harm a worker. This harm is of two types:

- Non life threatening – includes conditions such as dehydration and heat exhaustion

- Life threatening – heat stroke, a condition during which the body is unable to regulate its temperature.

All workers who work or supervise work in hot conditions should be trained to recognize the symptoms of these problems, particularly the more serious ones. Table 1 summarizes heat exposure problems, including their treatment and prevention.

All workers who work or supervise work in hot conditions should be trained to recognize the symptoms.

Heat stress is unlikely for a person wearing the appropriate clothing, performing light to moderate physical activity, and with the sun being the only heat source. Heat stress is possible if, in addition to the weather (or sometimes on its own), the work involves one or more of the following factors:

- high radiant heat – e.g. from a dryer, oven, furnace, or molten metal
- high humidity – e.g. from a kitchen or laundry
- intense physical activity
- clothing – e.g. including protective clothing, that reduces the rate at which sweat evaporates and cools a person

Controlling hot conditions

Each of the six factors affecting how hot a person feels can be controlled to some extent. Here are some suggestions:

(1) Lower the temperature
- Air conditioning
- Ventilation – a good ventilation system can remove hot air from a work area or building.
- If possible, open windows and doors to allow air to circulate.

(2) Lower the humidity
- Ventilation – a good ventilation system can remove humid air. If the work process allows it, try to capture as much of the humidity at its source with air evacuation units.
- Dehumidifiers – these can remove moisture from the air.
- Where possible, wear clothing that allows sweat to evaporate easily.

Table 1 Health problems resulting from heat exposure

Problem and Symptoms	Treatment	Prevention
Heat rash (prickly heat) Tingling and burning of the skin, red itchy rash. Sweat glands plugged due to prolonged exposure of skin to heat, humidity, sweat	▪ thorough drying ▪ cool showers ▪ calamine lotion	▪ keep the skin as dry as possible ▪ rest in a cool place ▪ shower often ▪ change clothes frequently ▪ keep skin clean
Heat cramps Painful spasms of muscles that do the hardest work i.e. in the arms, legs, and abdomen	▪ massage the muscle(s) ▪ eat salt-containing foods (unless to be avoided for medical reasons)	▪ warm up muscles before heavy work ▪ take rest breaks ▪ eat a normal, healthy diet
Fainting Increased flow of blood to the skin to get rid of heat means less blood to the brain	▪ lie down in a cool place ▪ drink cool fluids to lower body temperature ▪ see a doctor if fainting recurs	▪ drink plenty of fluids at regular intervals ▪ avoid standing still in one position – move around
Heat exhaustion Tired, weak, dizzy, clammy skin, slow weak pulse. Pale or flushed skin colour. Higher than normal heart rate (160 to 180 beats/min)	▪ lie down with knees raised ▪ drink cool, not cold, fluids ▪ contact a doctor if condition does not improve quickly	▪ take four to seven days to adjust (acclimatize) to the heat ▪ drink plenty of fluids at regular intervals ▪ take rest breaks in a cool place
Heat stroke Person usually stops sweating, body core temperature is high (40^{O} – 43^{O}C), skin is hot and dry. Person experiences headache, dizziness, confusion, may lose consciousness or have fits. Fatal if treatment is delayed	▪ this is a medical emergency. Person must be taken to hospital as quickly as possible ▪ move worker to a cool or shaded area, remove clothing, wrap in wet sheet, pour on chilled water and fan vigorously. Avoid overcooling. Treat for shock once temperature is lowered	▪ take four to seven days to adjust (acclimatize) to the heat ▪ drink plenty of fluids at regular intervals ▪ take rest breaks in a cool place ▪ wear clothing appropriate for the conditions ▪ follow a work/rest schedule

(3) Reduce worker exposure to radiant heat
- Provide workers with shade from the sun or move the work to a shaded location.
- Shield workers from any hot process or relocate equipment that gives off heat.
- Use blinds, curtains, or reflective coatings on windows to reduce direct sunlight.
- In buildings such as prefabricated metal ones, insulate the walls and ceiling.
- Rotate workers into tasks and areas that expose them to less radiant heat.

(4) Increase air speed or move air
- Increase air speed without creating an uncomfortable draught.
- Use fans or air blowers to circulate air.
- Increase the number of air changes per hour. This also helps to remove hot air and humidity.

(5) Control physical activity
- Have workers do less physically intense activities.
- If possible to choose a time of day to carry out physical tasks, do them in the early morning or once it is cooler in the evening. Avoid intense physical activity during the hottest period of the industrial process or day.
- Use additional workers for the job.
- Select physically fit workers capable of doing the work under hot conditions.
- Rotate workers to less demanding activities.
- Reduce the pace of work.
- Implement a schedule of work and rest intervals. Provide cooled rest areas.

(6) Wear appropriate clothing
- If possible, wear loose-fitting clothing that is light in weight.
- Try to wear clothing made of fabrics that wick sweat away from the skin and allows the sweat to evaporate.
- Aluminized reflective clothing near sources of radiant heat such as hot furnaces.
- Insulated or cooled clothing such as cooling vests may be necessary.
- Sunglasses and sunscreen may be needed to reduce sun exposure.

Drink plenty of fluids

A person who does not drink enough fluids becomes dehydrated and less able to function in the heat. Dangerous levels of dehydration (more than 10 percent of body weight) can occur quickly under very hot working conditions. Two signs of dehydration that a worker can watch for are dark-coloured urine and having to urinate less often in smaller quantities. A worker noticing either of these signs should drink more fluids.

Dangerous levels of dehydration can occur quickly under very hot working conditions.

Don't rely on thirst as an indicator of when to drink. By the time a person feels thirsty, he or she is well past the point at which more fluids should have been drank. While the preferred fluid is water (cool, not cold), other recommended fluids include *diluted* fruit juice, tea or lemon tea. An electrolyte replacement drink, diluted to half strength with water, is also a good choice.

Don't rely on thirst as an indicator of when to drink.

Avoid alcohol and drinks containing large amounts of caffeine such as coffee, colas, and other carbonated drinks. The caffeine acts as a diuretic, causing the body to produce more urine at a time that fluids need to be conserved.

Fluids should be located at or near where the work is being done. Workers should be able to get a drink at any time during the workday without going too far from their work area. In some cases a portable hydration system may be helpful. Looking like a small backpack, it can hold up to four litres of fluid and is worn on the back. The wearer takes a drink using the attached long drinking tube and mouthpiece. As a rough guide, workers working under hot conditions should drink approximately 250 ml (1 cup) of fluid every 20 minutes.

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Salt pills are rarely required and their use is not recommended (a person can have too much salt). The normal salt content of the diet, including salt as a seasoning, is usually enough to replace salt lost through sweating. If salt replacement is a concern, try one of the electrolyte replacement drinks diluted to half strength with water.

Working outdoors and skin cancer

According to the Alberta Cancer Board, skin cancer is the most common form of cancer in Alberta and rates of skin cancer are increasing. In 2000, over 4,500 new cases of skin cancer were diagnosed in Alberta.

Repeated exposure to ultraviolet (UV) radiation from the sun is the main factor in the development of skin cancer. In the short term, too much sun can cause sunburn. Over the long term, UV radiation can cause premature aging of the skin, skin cancer, cataracts, and other forms of eye damage, and may weaken the immune system.

People who work outdoors are at an increased risk of developing skin cancer

People who work outdoors are at an increased risk of developing skin cancer. Most skin cancers are curable if treated early and can be prevented by reducing exposure to UV radiation. For information about how to protect workers from sun exposure, and how to prepare a company's sun safety policy, refer to the following publication:

www.cancerboard.ab.ca/pdf/cancer_prevention/eps_sunright_outdoor_policy.pdf
Sun Safety Policy Guide for Outdoor Workers

Is it too hot to work?

Air temperature, measured with a normal thermometer, is the least important factor in both calculations.

Scientists have developed several methods of determining if conditions are too hot for workers to work. These include heart rate monitoring, measuring body core temperature, and measuring sweat rate. The most popular and widely used method measures the "wet bulb globe temperature" (WBGT). This method uses a portable device called a heat stress monitor to measure heat stress on a worker.

WBGT takes into account air temperature, humidity, radiant heating from the sun or other sources, and air movement. Air temperature is measured using a normal thermometer called a dry bulb thermometer. A black metal ball or "globe" that absorbs heat and has a thermometer inside it measures radiant heat. The "wet bulb" portion of the heat stress monitor measures the effect of evaporation and air movement. It consists of a regular thermometer bulb wrapped in a wick moistened with water. Heat stress monitors begin at a cost of about $2000.00.

The monitor uses these measurements to calculate the WBGT temperature. For outdoor workplaces with direct sunlight, the calculation is:

WBGT = 70% of the wet bulb temperature
+ 20% of the black globe reading
+ 10% of the air temperature

For workplaces without direct sunlight, the calculation is:

WBGT = 70% of the wet bulb temperature
+ 30% of the black globe reading

Note that air temperature, measured with a normal thermometer, is the least important factor in both calculations.

To help assess heat stress, the American Conference of Government Industrial Hygienists (ACGIH) has prepared limits known as threshold limit values or TLVs (see Table 2). These take into account the WBGT reading, the intensity of the work being done (see Table 3), whether or not the worker is acclimatized, and the type of clothing the worker is wearing. To compensate for clothing, the following rules apply: for workers wearing double-cloth overalls, add $5^{O}C$ to the WBGT reading; for workers wearing cloth (woven material) overalls, add $3.5^{O}C$; and for workers wearing a long-sleeved shirt and pants, no correction is necessary.

The recommended intervals assume that the rest area has the same WBGT reading as the work area.

Combined, this information recommends what portion of each working hour a worker should be resting so that they do not suffer heat stress.

To use Table 2, consider the following example:

- workers perform moderate activity i.e. walking about and doing moderate lifting and pushing
- workers have been working in the heat for the past week and are considered to be acclimatized
- workers are required to wear double-cloth overalls, requiring a $+5^{O}C$ correction to the WBGT reading of the heat stress monitor
- the heat stress monitor gives a WBGT reading of 26 (meaning that the air temperature is probably in the mid to high 30s)

Referring to Table 2, "Acclimatized" column, "Moderate" work intensity, WBGT temperature of 31^{O}C (26 + 5), the work/rest interval should be "25% work/75% rest". This means that under these conditions, workers should work 15 minutes of each hour (25% of 60 minutes) and rest for the other 45 minutes of the hour (75% of 60 minutes). The recommended intervals assume that the rest area has the same WBGT reading as the work area.

"Rest" does not have to mean that no work is done. It may be acceptable to have workers work in a cooler area doing tasks of equal or lesser intensity.

Table 2 Threshold Limit Values (TLVs) for heat exposure

	Acclimatized				Not Acclimatized			
Work/rest Schedule	Light	Moderate	Heavy	Very Heavy	Light	Moderate	Heavy	Very Heavy
100% Work	29.5	27.5	26		27.5	25	22.5	
75% Work / 25% Rest	30.5	28.5	27.5		29	26.5	24.5	
50% Work / 50% Rest	31.5	29.5	28.5	27.5	30	28	26.5	25
25% Work / 75% Rest	32.5	31	30	29.5	31	29	28	26.5

Reference: ACGIH 2002; p.173

Notes:

- Table 2 assumes 8-hour workdays in a 5-day work week with conventional breaks.
- The TLVs assume that workers exposed to these conditions are adequately hydrated, are not taking any medication, are wearing lightweight clothing, and are in generally good health.
- Because of the strain associated with very heavy work among less fit workers regardless of WBGT, several values are not given. Other types of physiological monitoring should be used in these cases.

Table 3 Categories of work and example activities

Work Category	Examples of physical activities in this category
Resting	▪ sitting quietly ▪ sitting with moderate arm movements
Light	▪ sitting with moderate arm and leg movements ▪ standing with light work at machine or bench while using mostly arms ▪ using a table saw ▪ standing with light or moderate work at machine or bench and some walking about
Moderate	▪ scrubbing in a standing position ▪ walking about with moderate lifting or pushing ▪ walking on level at 6 km/hr while carrying a 3 kg weight load
Heavy	▪ carpenter sawing by hand ▪ shovelling dry sand ▪ heavy assembly work on a non-continuous basis ▪ intermittent heavy lifting with pushing or pulling e.g. pick and shovel work
Very Heavy Work	▪ shovelling wet sand

Reference: ACGIH 2002; p.174

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