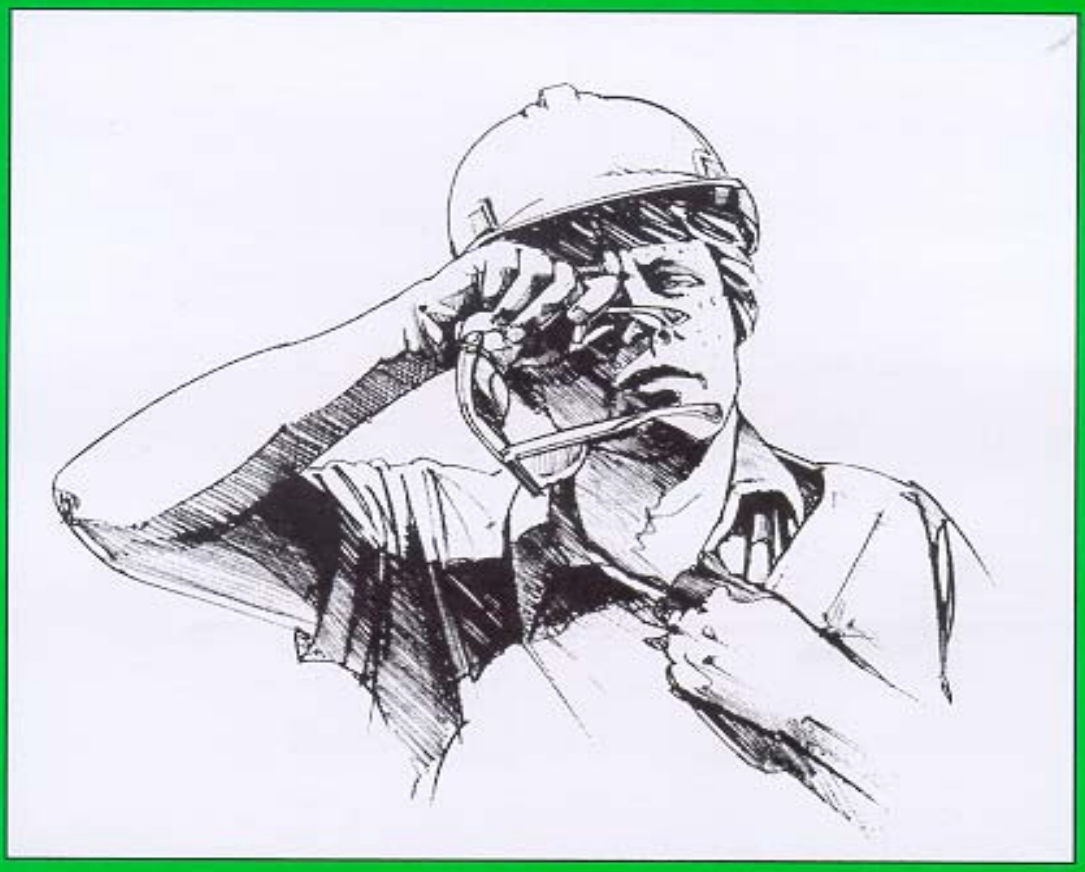
GUIDELINES FOR WORK IN HOT ENVIRONMENTS



Manitoba Labour
Workplace Safety
and Health Branch

Reprinted February 1998

INTRODUCTION

The Workplace Safety and Health Act does not specifically regulate worker exposure to hot environments. But employers are expected to deal with worker exposure to hot environments. This is part of the employer's overall responsibility under Section 4 (2) of the Act, to provide a safe and healthy workplace. As well, employers are directed to discuss the issue with their own safety and health committee, or with worker representatives. There are recommended exposure levels, as well as a number of control measures to prevent heat-related illness.

During the summer months, workers in 'hot environment jobs' can face dangerously high temperatures in their workplace. Excessive heat exposure may result in workers developing heat-related illnesses.

This booklet is intended to provide guidance for the prevention of such illnesses and to assist employers, workers, safety and health committees, and others concerned about heat-associated disorders.

The purpose of this guideline is to provide a basic understanding of the effects of heat on the body, the monitoring of heat exposure and methods of preventing heat-related illness from occurring. It is not intended to replace but rather to assist, in the development of a workplace plan to deal with individual workplaces where conditions can lead to harmful heat burdens.

HOT ENVIRONMENTS AND THE HUMAN BODY

The human body functions best within a narrow internal temperature range of 36 to 38 degrees Celsius. Above or below this range, the body's temperature control center in the brain goes to work and will cause shivering to keep warm or perspiration to keep cool. As the surrounding air warms, the body pumps more blood to the skin and increases sweat production. In this way the body loses heat, to balance the heat gain. When the heat gain becomes more than the body can lose, body temperature begins to rise and may lead to a heat-related illness.

SOURCES OF HEAT GAIN AND HEAT LOSS

Metabolic heat - the body's own internal heat, generated by the breakdown of food to form energy. The greatest energy users, and therefore internal heat producers, are muscles. Hard work in a hot environment contributes to the body's heat load.

Conduction - the direct transfer of heat to the body by direct contact with a warm object. Generally, an almost insignificant source of heat when considering heat gain to the body.

Convection - the exchange of body heat with the surrounding air that comes into contact with the skin. If the moving air is cooler than the body temperature, it will cool the body; if warmer, it will increase the heat load. Air speed is an important factor in heat loss or gain.

Radiation - the transfer of heat to the body through air from a hot source, for example, a furnace, an oven, or the sun. This is an important factor as, again, heat is lost from the body only if the surrounding air is cooler than the body.

Evaporation - evaporation of sweat from the skin cools the body. As temperature, humidity and rate-of-work go up, so does the rate of sweating. At very high humidity however, sweat does not evaporate as quickly. High air speed and low humidity increases evaporation. If it is very hot and dry, excessive sweating may lead to dehydration (excessive fluid loss).

TABLE 1: HOW THE BODY RESPONDS TO EXCESSIVE HEAT

EXCESSIVE HEAT		
Skin temperature and core body temperature		
Circulation to skin surface increases	Blood supply to vital Organs is reduced	HEAT EXHAUSTION
Skin becomes moist and flushed		
Heat loss occurs by convection and radiation		
Sweating occurs		
Heat loss from body by evaporation	LOSS OF SALT	HEAT CRAMP
Fatigue of sweat glands	Loss of water	DEHYDRATION
Inadequate evaporative heat loss	Reduced sweat	Prickly heat
Body temperature rises		
Impairment of temperature regulating mechanism	Vital functions become impaired	HEAT STROKE

Table I(18K) illustrates the body's responses to heat and some of the resulting health effects.

The use of salt tablets is NOT recommended as they may cause fluid to collect in the stomach and small intestine. Salt tablets should only be taken on the advice of a physician.

Dehydration is a common problem from working in heat. As shown in Table I, it is caused by failure to replace salt and water lost from sweating. Although sweating is necessary to help cool the body, the fluid and salt loss must be replaced.

On average, one to two cups of water per hour is required to replace fluid lost from heavy sweating. Cool but not cold, fluids should be provided, in a location convenient to workers. Because the feeling of thirst may not be enough to ensure adequate fluid intake, workers in hot environments should be encouraged to drink at least one cup per hour. Too much fluid (more than two cups) should not be taken at one time since workers may develop abdominal cramps.

The use of table salt and naturally occurring salt in foods is usually enough to replace salt lost through perspiration. Fruit and vegetable juices are good sources of 'natural' salt. Workers on a salt-restricted diet should explain their working conditions to their doctor and discuss the need for extra salt.

Sugary drinks such as soda pop, and fluids containing caffeine and alcohol should be avoided.

HEAT-RELATED ILLNESSES

The body may react to excessive heat in several ways and these reactions will vary from person to person.
Table II (44K) summarizes heat-related illnesses in increasing order of severity. The table lists signs and symptoms to watch for, some predisposing factors, and also a summary of prevention and treatment.

FACTORS CONTRIBUTING TO HEAT-RELATED ILLNESSES

There are numerous factors other than the environment and work load, that influence the body's ability to acclimatize and cope with heat. These factors may contribute to the onset of a heat-related illness and should be taken into consideration when situating workers and deciding on control measures.

TABLE II: HEAT-RELATED ILLNESSES
SYMPTOMS, PREVENTION AND TREATMENT

SIGNS & SYMPTOMS	CAUSES	PREVENTION	TREATMENT
HEAT FATIGUE Irritability, tiredness, loss of skill for fine or precision work. Lower Ability to concentrate. No change in body temperature.	Lack of acclimatization. Other emotional or psychological stresses. Discom-fort in heat.	Proper acclimatization. Rest breaks.	None necessary unless other heat illness present. Removal may be necess-ary if acclimatization in-effective.
HEAT RASH Prickling sensation during heat exposure. Itchy, tiny red spots on skin covered by clothing. A result of plugged sweat glands.	Skin continuously wet from sweat. Humid heat.	Shower to keep skin clean. Apply powder and mild drying lotions (e.g. calamine).	Keep skin dry. Rest in cool place. May take several days to sunbside.
HEAT SYNCOPE Giddiness and fainting while standing in hot environment.	Pooling of blood in legs causing drop in blood pressure. Lack of acclima-tization. Loss of body fluid from sweating.	Moving from time to time. Proper acclimatization. Drink extra fluids.	Rest in cool area. Recovery usually fast. May need to see physician.
HEAT CRAMPS Sharp pains in muscles of arms, legs or abdominal muscles. May occur during or after work.	Heavy sweating causing loss of salt. Drinking large amounts of water without salt replacement.	Add salt to foods. Drink fluids naturally containing salt (e.g. fruit and vegetable juices).	Move to cool place. Give salted fluids. If severe, may need to see physician.
HEAT EXHAUSTION Headache, nausea, dizziness, weakness, intense thirst. Skin moist and clammy. Rapid, weak pulse.	Loss of water and salt from heavy sweating. Lowered volume of circulating blood. Lack of acclimati-zation. Sustained Exertion in high temperatures.	Drink cool fluids often. Take extra salt in food. Drink fruit juices. Proper acclimatization.	Rest lying down in cool area. Replace body fluids and salt. If vomiting refer to physician.
HEAT STROKE OR HEAT HYPER-PYREXIA Nausea, headache, dizziness. Hot dry skin (moist in hyper-pyrexia). Body temperature 40 ^{0}.c	Failure of central control of sweating. Prolonged work in hot environment. Unfit, unacclimatized workers. High humidity. Pre-	Medical assessment prior to hot work. Acclimatization. Monitoring of workers during periods of work in heat. Work-rest regimes. Adequate	Immediate medical attention! Immediate first aid-remove clothing, spray with cool water, fanning, cool wet sheets.

or over. Rapid. Strong pulse. Convulsions, coma may occur.	existing medical conditions, use of medications, high alcohol intake.	fluid/salt replacement.	

Workers should ask a health professional whether any drugs being taken, may increase the risk of heat illnesses.

Age generally brings a decrease in efficiency of sweat glands, heart and lungs (after age 45).

Gender is an influencing factor since men tend to have a higher sweat rate and larger oxygen intake, and therefore tend to acclimatize better than women. Fitness, size and other factors affect the differences in people's ability to acclimatize.

FACTS ABOUT ACCLIMATIZATION
Physically fit, healthy individuals generally acclimatize more quickly.

Acclimatization will last for about one week if away from the heat and will disappear completely in three weeks.

Drinking extra fluids hastens the acclimatization process.

Lack of Acclimatization-the body has not had sufficient time to adjust, or other factors prevent the body from adjusting to the heat

General state of health - the following medical conditions may be a factor in causing heat illness, or may be aggravated by heat:

a) Skin disorders may limit sweating. Dermatitis, for example, when aggravated by heat/moisture.

b) Heart and lung diseases may limit ability to cope with heat and may be aggravated by it.

c) Diabetes, poorly controlled, may contribute to dehydration and may be aggravated by excessive heat.

d) Diarrhea may contribute to dehydration.

e) Obesity requires increased energy to move around and the extra insulation reduces heat loss - both contributing to the body's overall heat gain.

Medication/drugs - can affect the body's responses to heat, and may affect acclimatization. Different medications/drugs may affect different parts of the body:

a) the brain's 'thermostat' affected by ASA, phenothiazines

b) the sweating function affected by pilocarpine, hyoscine, other anticholinergic drugs

c) the circulatory system affected by antihypertensives, antiarrhythmics, diuretics, alcohol, 'street' drugs

d) the metabolic rate affected by thyroxin, alcohol, street' drugs.

TABLE III: TRESHOLD LIMIT VALUES (TLV s) FOR HEAT EXPOSURE RECOMMENDED BY THE ACGIH

Work/Rest Regimen	Wet Bulb Globe Thermometer (^{0}C) for Different Workloads*		
(Hourly)	Light	Moderate	Heavy
Continuous Work	30.0	26.7	25.0
45 min. work-15 min. rest	30.6	28.0	25.9
30 min. work-30 min. rest	31.4	29.4	27.9
15 min. work-45 min. rest	32.2	31.1	30.0

- Examples of Workloads
  Light work-sitting or standing at desk or bench, typing, light assembly.
  Moderate work moving about, moderate lifting and pushing, sheet metal work, grass cutting, nailing.
  Heavy work-pick and shovel work, digging, tending hot furnaces, tree felling.

The values in Table III are based on healthy, acclimatized workers wearing one layer of customary work clothing. Variations from this norm, (note factors discussed in Section 2 and 4) require modification of the TLV. See Table IV for suggested modifications.

TABLE IV: SUGGESTED MODIFICATIONS TO TLV'S

Situation	Suggested change to TLV ^{0}C
Unacclimatized and/or physical unconditioned	Subtract 2^{0}C
Obese or elderly	Subtract 1^0 to 2^{0}C
Female	Subtract 1^{0}C
Air velocity over 1.5 m/s (5.4 Km/hour)	Add 2^{0}C
Clothing-light, shorts	Add 2^{0}C
-body armor, impermeable jacket	Subtract 2^{0}C
-firefighter's coat, full length coat	Subtract 4^{0}C
-enclosed suit	Subtract 5^{0}C

When recommended levels of WBGT are exceeded, it is the employer's responsibility to implement control measures to reduce the levels.

Acclimatization

So far in this guideline, we have shown the consequences of lack of acclimatization. This section will show methods to achieve acclimatization and prevent these consequences. Acclimatization is the process by which the body becomes accustomed to heat. During first exposures to a hot environment, workers often feel very tired, irritable and 'too hot'. Body temperatures often rise. After repeated exposures these symptoms decrease or disappear. When this occurs a person is considered to be acclimatized. This period of 'repeated exposure' is not the same for everyone. Just as many factors may lead to heat illness, there are differences in people that affect the rate at which people acclimatize.

Acclimatization Schedule

As a general rule, acclimatization will take from 5 to 7 days for a healthy worker. New workers with no recent heat exposure should be started on their first day with 50% of the workload. This may be increased by 10% each day until the full workload is reached. Workers may be assigned to work in cooler areas for portions of the day until fully acclimatized. The added workload will need to be varied if any of the factors mentioned earlier are present. Employers may consider additional workload every second day for some workers. As well, adequate fluids must be provided and encouraged for all workers, but especially new or returning workers. Workers who have been off the job for a week should be re-acclimatized for two to three days.

Measurement of Occupational Heat Exposure

Workplace Safety and Health Act and Regulations do not specify a maximum temperature above which work must cease. Rather, the combination of environmental conditions must be measured and evaluated against a set of exposure limits recommended by the American Conference of Governmental Industrial Hygienists (ACGIH). These exposure limits or threshold limit values (TLV s), are published annually in a booklet entitled Threshold Limit Values and Biological Exposure Indices. Copies are sold by the ACGIH.

Measuring occupational heat exposure requires combining the environmental factors that contribute to heat load, as discussed earlier. The most common method involves the wet bulb globe thermometer (WBGT) or a direct-reading meter, commercially available. These instruments calculate temperature, air movement, radiant heat and evaporation, indoors or out. The WBGT index most closely relates to the body's response to heat over an 8 hour period. These readings should be obtained from a qualified professional either in-house or from an outside consultant. The ACGIH booklet outlines technical detail about monitoring and calculations to obtain the WBGT and time-weighted averages (TWA) for heat exposure. Information may also be obtained by

contacting the Occupational Hygiene Unit of the Workplace Safety and Support Services Division at 945-3446.

Heat Exposure Limits

ACGIH prescribes allowable temperatures for light, moderate or heavy work. Recommendations are made for rest breaks when these temperatures are exceeded. See Table III (34K) for a examples of what is meant by these workloads, and for the recommended work-rest schedule when the WBGT temperatures increase.

Prevention and Control Measures

The risk of heat-related illnesses can be reduced by preventive and control measures:

a) Engineering controls to provide a cooler workplace.

b) Administrative controls to reduce exposure and recognize symptoms of heat-related illness.

c) Personal protective equipment when necessary for further limiting of exposure.

Engineering Controls

The most effective means of reducing occupational heat exposure, engineering controls include the following:

- Planning during the construction and setting up of a workplace if a hot environment is anticipated.

- Control heat at source through insulating and reflective barriers.

- Exhaust hot air and steam to the outside.

- Reduce temperature and humidity through ventilation, air-conditioning.

- Provide cooled observation booths and/or air-conditioned rest areas.

- Increase air movement if temperature is less than skin temperature (approximately 36 degrees C)

- Reduce air movement if air temperature is greater than skin temperature.

- Reduce physical exertion through mechanical assistance.

Administrative Controls

Administrative controls are things that can be done for or by the worker directly. These could include the following:

- Implement a schedule for heat acclimatization.

- Increase the frequency and duration of rest breaks.

- Schedule hot jobs to cooler times of the day.

- Provide cool drinking water near the work location and
- encouraged workers to drink even if not feeling thirst.

- Slow down work pace or assign additional workers to decrease workload.

- Educate workers to recognize signs and symptoms of heat-related illnesses.

- Use nearby air-conditioned areas for rest areas.

Personal Protective Equipment

Where engineering or administrative controls are not feasible or practicable, occasional use of personal protective equipment may be necessary.

- Wear insulated or cooled clothing for short term exposure such as a maintenance job.

- Wear clothing that allows free movement of airflow.

- Wear reflective clothing near heat sources such as a hot furnace.

- Wear light-filtering eye protection when work involves hot objects such as molten metals.

- Use sunscreen and sun block when working out doors.

- Wear a hat and light clothing to protect skin when working in the sun.

Workplace Plan for Hot Conditions

Any workplace having the potential for heat-related problems should have a plan in place to deal with such problems if they arise. The plan should include procedures for acclimatization, monitoring and education of workers, as well as procedures for providing first aid to affected workers.