WBGT–Estimate Based Heat Response Plan

What is it?

- The WBGT-Estimate plan is a simplified way of protecting workers from heat stress which is based on the 2022 ACGIH Heat Stress TLV® (Threshold Limit Value®) which uses wet bulb globe temperatures (WBGT) to estimate heat strain.
- The ACGIH prescribes an action limit (AL) based on the ability of "healthy hydrated unacclimatized workers to sustain thermal equilibrium". This limit "has a small margin of safety, and some workers may experience heat-related disorders below the AL."
- **Note:** in the estimation process some simplifications and assumptions have been made, therefore, **the plan may not be applicable in workplaces with additional sources of heat and/or humidity** (follow steps #1-5 to ensure this plan is appropriate for your workplace, if not, follow the ACGIH Heat Stress and Strain TLV®). **This plan assumes moderate, unacclimatized work**.

Effective* WBGT (°C)	Response
≤ 23.0°C	supply water to workers on an "as needed" basis
23.1 – 24.0°C	post Heat Stress Alert notice; encourage workers to drink extra water; start recording hourly temperature and relative humidity
24.1 – 25.0°C	post Heat Stress Warning notice; notify workers that they need to drink extra water; ensure workers are trained to recognize symptoms
25.1 – 26.0°C	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
26.1 – 27.0°C	work with 30 minutes relief per hour can continue in addition to the provisions listed previously
27.1 – 29.0°C	if feasible, work with 45 minutes relief per hour can continue in addition to the provisions listed above
29.1°C** or over	only medically supervised work can continue

*** "Effective" means adjusted for clothing (step #4) if the WBGT includes the globe temp**

****over 29.0°C WBGT, heat stress to be managed as per the ACGIH TLV®**

General Controls: General controls apply to all workers and include providing annual heat stress training, encouraging adequate fluid replacement, permitting self-limitation of exposure, encouraging watching out for symptoms in co-workers, and adjusting expectations for workers coming back to work after an absence. Workers doing moderate work are not considered acclimatized in Ontario unless they regularly work around significant heat and/or humidity sources (e.g., in foundries, around ovens, etc.).

Job-Specific Controls: Job-specific controls include (in addition to general controls) engineering controls to reduce physical job demands, shielding of radiant heat, increased air movement, reduction of heat and moisture emissions at the source, adjusting exposure times to allow sufficient recovery, and personal protective equipment that provides for body cooling. Apply the hierarchy of controls.

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Limitations: this table is based on work with **little or no radiant heat**, assuming wearing **regular summer clothing**; if your specific working conditions vary from these assumptions, see the steps 1-5 listed below to make adjustments

WBGT-Estimate (based on temperature & relative humidity) Heat Response Plan

Estimated Effective* WBGT	Action
29.1°C+ WBGT	only medically supervised work
27.1-29.0°C WBGT	75% relief
26.1-27.0°C WBGT	50% relief
25.1-26.0°C WBGT	25% relief
24.1-25.0°C WBGT	warning & double water
23.1-24.0°C WBGT	alert & water
≤23.0°C WBGT	water as needed

moderate metabolic rate, unacclimatized action limit

"Effective*" means adjusted for clothing

NEVER IGNORE ANYONE'S SYMPTOMS DESPITE YOUR MEASUREMENTS!

T_{air} (in°C)	Relative Humidity (in%)																		T_{air} (in°C)
	100	95	90	85	80	75	70	65	60	55	50	45	40	35	30	25	20	15	10	
46																			29.6	46
45																		30.1	29.0	45
44																	30.6	29.5	28.3	44
43																31.0	29.9	28.8	27.7	43
42															31.3	30.3	29.2	28.1	27.1	42
41														31.6	30.6	29.5	28.5	27.5	26.5	41
40														30.8	29.8	28.8	27.8	26.8	25.8	40
39													31.0	30.0	29.1	28.1	27.1	26.2	25.2	39
38												31.1	30.2	29.2	28.3	27.4	26.4	25.5	24.6	38
37											31.2	30.3	29.4	28.5	27.5	26.6	25.7	24.8	23.9	37
36										31.2	30.3	29.4	28.5	27.7	26.8	25.9	25.0	24.2	23.3	36
35									31.1	30.3	29.4	28.6	27.7	26.9	26.0	25.2	24.3	23.5	22.7	35
34								31.0	30.2	29.4	28.5	27.7	26.9	26.1	25.3	24.5	23.7	22.8		34
33						31.6	30.8	30.0	29.2	28.5	27.7	26.9	26.1	25.3	24.5	23.7	23.0			33
32				31.6	31.2	30.6	29.8	29.1	28.3	27.5	26.8	26.0	25.3	24.5	23.8	23.0	22.3			32
31	31.0	31.0	30.9	30.5	30.1	29.5	28.8	28.1	27.4	26.6	25.9	25.2	24.5	23.7	23.0	22.3				31
30	30.0	30.0	29.8	29.5	29.1	28.5	27.8	27.1	26.4	25.7	25.0	24.4	23.7	23.0	22.3					30
29	29.0	29.0	28.8	28.5	28.1	27.5	26.8	26.2	25.5	24.8	24.2	23.5	22.8							29
28	28.0	28.0	27.8	27.5	27.0	26.5	25.8	25.2	24.6	23.9	23.3	22.7								28
27	27.0	27.0	26.8	26.4	26.0	25.4	24.8	24.2	23.6	23.0	22.4									27
26	26.0	26.0	25.8	25.4	24.9	24.4	23.8	23.3	22.7	22.1										26
25	25.0	25.0	24.8	24.4	23.9	23.4	22.8	22.3												25
	100	95	90	85	80	75	70	65	60	55	50	45	40	35	30	25	20	15	10	
	Relative Humidity (in%)																			

For work in direct sunlight, add 2.2°C-WBGT to the estimated WBGT from the table.

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WBGT-Estimate Based Heat Response Plan

Step #1: Training

- the WBGT-estimate plan by itself cannot guarantee that workers will not be affected by heat stress. It is absolutely essential that workers know how to recognize the early signs and symptoms of heat stress and know what to do to prevent them!
- if at all possible, workers need to be able and supported in altering their pace of work, rest breaks, and fluid intake in response to any early symptoms (240 mL or a cup of water every 20 minutes).
- the ideal heat stress response plan would let workers regulate their own pace by "listening to their body" without need for measurements.

Step #2: Select a Measurement Location

- split the workplace into heat stress zones and put a thermal hygrometer in each zone (preferably within 10 m (30') of exposed worker(s)).
- identify a representative location within the zone where measurements can be taken (if you want to base your actions on a single reading, select the highest heat stress zone).

Note: The WBGT-Estimate Heat Response Plan is **based on workplace measurements not weather station or media reports** (temperatures inside buildings **do not** usually correspond with outdoor temperatures)

Step #3: Measure Workplace Temperature & Relative Humidity

- a thermal hygrometer (usually $10-$50 at hardware or office supply stores – some even have free apps) is a simple way to measure the temperature and relative humidity in your workplace.
- once you have the temperature and humidity, use the table above to determine the corresponding estimated WBGT value and the appropriate heat stress prevention response (**remember to adjust for clothing (step #4) and radiant heat (step #5)**)
- measurements should be recorded at least hourly if the WBGT-estimate reaches 21°C WBGT.

NEVER IGNORE ANYONE'S SYMPTOMS NO MATTER WHAT THE MEASUREMENT!

Step #4: Adjust for Clothing

- evaporating sweat is the primary way the body gets rid of excess heat build-up; therefore, the best clothing is the kind that makes it easiest for sweat to evaporate. This plan assumes regular summer clothes (long-sleeved shirt & long pants, underwear, socks and shoes).
- for workers who wear cotton overalls on top of summer clothes one should add 3°C WBGT to the workplace WBGT-estimate.
- for different clothing configurations, estimate the clothing adjustment value by comparing them with cotton overalls (e.g., gloves, hard hat, apron, protective sleeves might be equivalent to a little less than half the evaporation resistance as overalls so add 1.5°C WBGT.
- if clothes do not allow sweat evaporation (encapsulated suits) heat stress should be managed by monitoring vital signs (see ACGIH TLV®)

Step #5: Adjust for Radiant Heat

- for outdoor work **in direct sunlight** between the hours of 10 am and 5 pm, add 2°C WBGT.
- for **indoor radiant heat exposures**, use common sense to judge whether the exposure of concern involves more or less radiant heat than direct sunlight and adjust the WBGT estimate by adding the appropriate proportion of the 2°C WBGT adjustment factor.

Health Effects of Heat Stress*

Health Effect	Symptoms	Treatment
Heat Rash	Bumps on skin with severe itching caused by hot humid environments and plugged sweat glands.	Change into dry clothes often and avoid hot environments. Rinse skin with cool water. Wash regularly to keep skin clean and dry.
Fainting (Syncope)	Sudden fainting after at least two hours of work; cool moist skin; weak pulse.	**GET MEDICAL ATTENTION**. Move to a cool area; loosen clothing; lie down; if awake, sip some cool water.
Heat Cramps	Heat cramps are painful, involuntary muscle spasms that usually occur during heavy exercise in hot environments. Inadequate fluid intake often contributes to this problem. The spasms may be more intense and more prolonged than typical nocturnal leg cramps. Muscles most often affected include the calves, arms, abdomen, and back – although the cramps may involve any muscle group involved in the exercise.	**If you suspect heat cramps:** Rest briefly and cool down. Drink water or an electrolyte-containing sports drink. Practice gentle, range-of-motion stretching and gentle massage of the affected muscle group. If the cramps are severe or don't go away after drinking a beverage with electrolytes, **get medical help right away.**
Heat Exhaustion	Signs and symptoms of heat exhaustion often begin suddenly, sometimes after excessive exercise, perspiration and inadequate fluid intake. Features resemble shock and include: feeling faint, nausea, ashen appearance, rapid heartbeat, low blood pressure, hot, dry or sweaty skin, low-grade fever, generally less than 40°C.	**If you suspect heat exhaustion:** Get the person out of the sun and into a shady or an air-conditioned location. Lay the person down and elevate the feet slightly. Loosen or remove the individual's clothing. Have the person drink cold water, not iced, or a sports drink containing electrolytes. Cool the person by spraying him or her with cool water and fanning. Monitor the person carefully. Heat exhaustion can quickly become heatstroke. **If fever — especially greater than 40°C — fainting, confusion or seizures may occur, CALL FOR EMERGENCY MEDICAL ASSISTANCE.**
Heat Stroke	The main sign of heatstroke is a markedly elevated temperature — generally greater than 40°C — with hot, dry skin and changes in mental status ranging from personality changes to confusion and coma. Other signs may include: rapid heartbeat, rapid and shallow breathing, elevated or lowered blood pressure, cessation of sweating, irritability, confusion or unconsciousness, fainting, which can be the first sign in older adults.	**If you suspect heatstroke:** Move the person out of the sun and into a shady or an air-conditioned space. Dial 911 or **CALL FOR EMERGENCY MEDICAL ASSISTANCE**. Cool the person by covering him or her with damp sheets or by spraying with cool water. Direct air onto the person with a fan or newspaper.

 Heat Rash and Fainting adapted from Ontario Ministry of Labour Heat Stress Guideline: http://www.labour.gov.on.ca/english/hs/pubs/gl_heat.php (accessed Jan/21 & Nov/23).

Vulnerability to Heat Stress: There are many permanent or temporary conditions (e.g., age, heart or lung conditions, dehydration, fatigue, some medications, etc.) that can make a person more vulnerable to heat strain. Despite these conditions, workers may be able to cope given adequate knowledge of the signs and symptoms of heat stress and, given the latitude to make the appropriate adjustments to their pace of work. It is more often the young, fit workers who may think they are invincible who succumb to heat strain. Some workers may need medical advice about what accommodations they might need.

****Acclimatization & Moderate Metabolic Rate:** In the past the MOL heat stress guideline stated that "hot spells in Ontario seldom last long enough for workers to acclimatize". Workers performing "moderate" work (e.g., work with some pushing, lifting) would also not be assumed to be acclimatized by the same criteria, unless there is significant radiant heat associated with the work. Since the TLV® is based on data derived from 20-year-old males weighing an average of 154 lbs., "real" workers probably burn up more calories than the TLV® light category assumes. Selecting the "moderate" work category will account to some extent for workers who are somewhat dehydrated, older (e.g., over 40), not male, are heavier than 154 lbs and perhaps have additional risk factors compromising their heat stress response.