

Managing Heat Stress in Workplaces: The Heat Stress Toolkit



André Gauvin
Occupational Hygienist

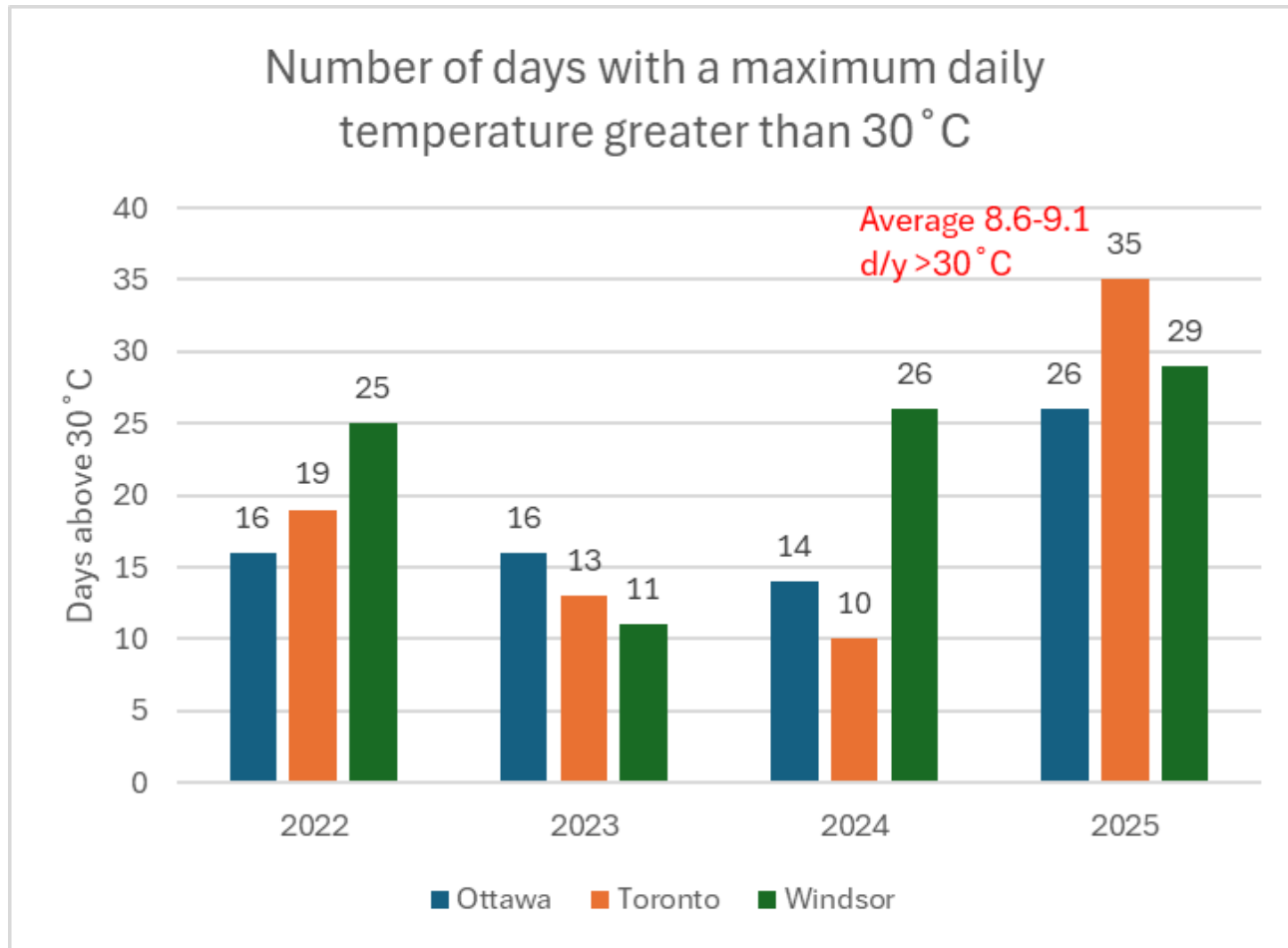


Current situation:

- MOL response to the **regulation proposal** and the **submissions provided** is to keep using **current legislation OSHA Section 25(2)(h)**, (to take every precaution reasonable in the circumstances for protection of the worker.)
- **“new” challenges:** climate change awareness, wildfire smoke, temporary foreign workers exposure conditions
- **15-20 years experience** with OHSCO Heat stress tools
- Opportunity from **MOL project funding** to update
- **Evaluations of H&S interventions** (e.g., IWH scientific reviews, HSA’s field experience, union/employer workplace experiences)



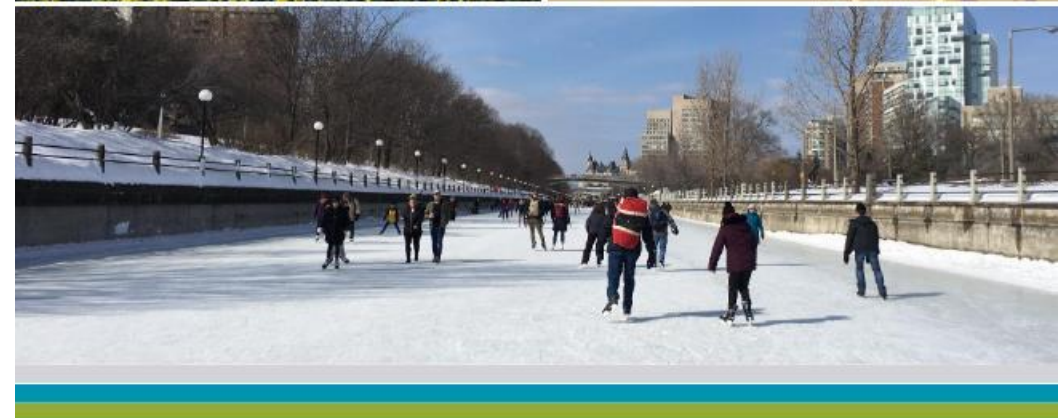
Ontario government climate change report



Ontario Provincial
Climate Change Impact
Assessment

Technical Report

January 2023

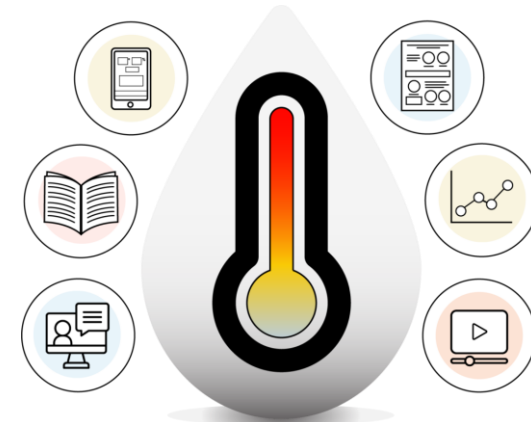


<https://www.ontario.ca/files/2023-11/mecp-ontario-provincial-climate-change-impact-assessment-en-2023-11-21.pdf>



Now Available! (2024)

- [Heat Stress Toolkit – OHCOW](#)



Target Audience:

- Who are we trying to reach and what do we want them **to do** (not just to know) (Prevention tools and Strategies guide) ?
- Direct audience: **those supporting and protecting heat exposed workers**. This includes employers, managers, supervisors, fellow workers, Joint Health & Safety Committee (JHSC) members, health and safety representatives, and workplace union representatives.
- **Unions, employer associations, and health and safety professionals** may also find this information useful.



Fundamental principles:

1. **De-technologize:** relying on expensive technical equipment to determine whether its too hot seems strange when everyone who listens to their body knows that already (in line with Brian Freeman's Coroner's Inquest recommendations)
2. **Supported Self-regulation:** ideally this would be the goal – workers able to detect signs and symptoms and have the resources/freedom to respond appropriately – although this is not always a practical option in many workplaces
3. Provide a **simplified TLV-based tools** so workplace don't need elaborate resources to manage heat stress – save the technical resources for difficult heat stress conditions
4. Recognize **self-calibration** – after a period of time of closely measuring, workers self-calibrate (unconsciously) and can accurately guess, based on how their feeling, what heat stress interventions are needed
5. **Medical monitoring:** last resort; realize this is collecting medical information require elaborate confidentiality arrangements

Ontario the Solicitor General the Chief Coroner Verdict of Coroner's Jury / Verdict du jury du coroner
Ministère du Solliciteur général Bureau du coroner en chef

Myrtle HAMILTON of Etobicoke
Elizabeth LAZZARO of North York
Robert MCVEY of Scarborough
Christopher TEMOU of Toronto
Charles WITHERELL of Etobicoke

The jury serving on the inquest into the death of / d'onten assermentés, formant le jury dans l'enquête sur le décès de:
Surname / Nom de famille Given names / Prénom
FREEMAN Brian

aged 21 years held at 15 Grosvenor Street, Toronto
Date et heure du décès qui a été menée à June 22, 23, 24, 25, 26 & 29th days of (du/au) 1992 92

by R. Isaac M.D., LL.B. Coroner for Ontario, coroner pour l'Ontario.

having been duly sworn, have inquired into and determined the following: / avons enquêté et avons déterminé ce qui suit:

Name of deceased / Nom du (de la) défunt(e) Brian Savio Freeman
Date and time of death / Date et heure du décès August 3, 1990 1:50 a.m.
Place of death / Lieu du décès Toronto Hospital - General Division
Cause of death / Cause du décès Multi-organ failure & Fungus Aspergillozia
By what means / Circonstances entourant le décès Heat induced Malignant Hyperthermic reaction causing a heat stroke. Factors: relatively inactive person, mild obesity, lack of acclimatization, alcohol consumption, no heat stress training, new job, heavy clothing, hot truck.

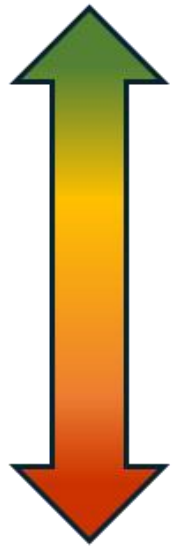
We wish to make the following recommendations:





Prevention Tools and Strategies – Layered approach

Simpler/
More frequent



More complex/
Less frequent

Supported
Self-management

**Humidex/WBGT Estimate-based
Heat Response Plan**

Screening TLV (ACGIH)
/ Detailed TLV

TLV Physiological
Monitoring

- Layers are supposed blend together with the **optimal** being support self-management if feasible



Supported Self-Management

Knowledgeable workers who have demonstrated they are able to recognize early signs & symptoms and, supported by their supervisors, are provided the latitude to manage their work rate and their fluid intake. **Caution!! This level of heat stress management cannot be followed without proper heat stress awareness and prevention training.**

supported
self-management

Humidex/WBGT Estimate-based
heat response plan

screening TLV (ACGIH)
/detailed TLV

TLV physiological
monitoring

Humidex/WBGT Estimate Based Heat Respond Plan (Simplified TLV)

Humidex-based heat response plan a simplified version of the ACGIH TLV guidelines based on direct measurements of temperature and relative humidity. The measurements are converted to Humidex (or WBGT estimates) prescribing preventive actions. This approach is designed for workplaces without process heat/humidity sources and regular work clothing

Screening TLV / Detailed TLV (ACGIH)

Using the “official” **screening WBGT** measurements and appropriate application of work-rest regimens to prevent heat stress. For complex and unusual exposures there is also the option to follow the technically challenging “**TLV Analysis**” method outlined in the ACGIH TLV documentation. **A WBGT meter is needed for these methods.**

TLV Physiological Monitoring

may be required to manage exposures above the ACGIH TLV criteria (for tough to manage exposures). Physiological self-monitoring using smart watches or apps is another “unofficial” approach which should be viewed with caution (accuracy & validity problems).



Supported Self-management

Training

- Train workers and supervisors to recognize early signs and symptoms of heat stress.
- Ensure workers can show demonstration of knowledge.
 - Practice (aware and skilled using HSMP)

Supported by supervisors/employers.

- Give workers access to a cool or shaded rest area
- Take breaks as needed
- Manage your own work rate and fluid intake
- Co-worker observation (buddy system) with verbal cues.
- Have a hot-weather plan (such as the Humidex).

Caution!! This level of heat stress management cannot be followed without proper heat stress awareness and prevention training.

Low tech tools: hydration urine colour chart

1	Good
2	Good
3	Fair
4	Dehydrated
5	Dehydrated
6	Very dehydrated
7	Severely dehydrated



SUPPORTED SELF-MANAGEMENT OF HEAT STRAIN (Optimal Situation)

supported self-management

Humidex/WBGT Estimate-based heat response plan

screening TLV (ACGIH) /detailed TLV

TLV physiological monitoring

Supported self-management in heat stress management necessitates specific prerequisites to ensure workers' optimal performance and well-being under heat stress conditions. Here are the key requirements:

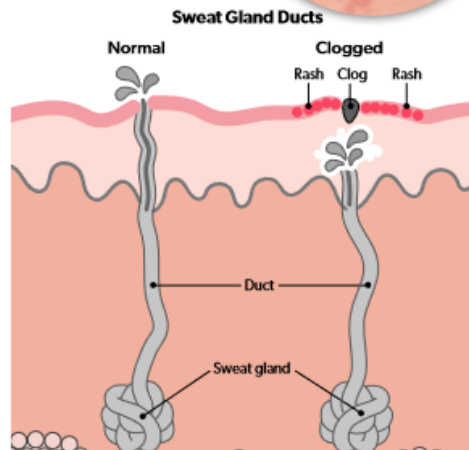
1. A solid understanding of heat strain symptoms and remedies is crucial to prevent health risks related to overheating. This knowledge helps individuals identify warning signs and address heat-related issues promptly.
2. **Supervisory support** in the ability to set your own work pace and take necessary breaks is essential for self-management, allowing individuals to recharge, rehydrate, and prevent heat strain.
3. Access to an ample water supply for hydration is fundamental for physical performance, and overall well-being.
4. Availability of other cooling options like air conditioning, shaded rest areas, and supporting effective self-management practices.

By meeting these key requirements and receiving leadership support, a workplace can implement supported self-management of heat strain.

Health Effects (training essentials):

Heat Rash

Skin becomes reddened and may itch, feel prickly or hurt. Practice good personal hygiene; keep the skin clean and the pores unclogged, allow skin to dry, wear loose clothing, see doctor if rash persists. Often happens early in heat stress season (first heat wave) when skin is unacclimatized.



Supported Self-Management

Training

Health Effects and First Aid:

Heat Edema

Heat Rash

Heat Syncope (fainting)

Heat Cramps



Temperature

Together, our findings indicate that strenuous work in the heat may compromise thermoregulatory function and elevate the risk of heat-illness in older workers on the next workday, particularly during moderate-to-high intensity work.

<https://www.tandfonline.com/doi/full/10.1080/23328940.2018.1512830>

ISSN: 2332-8940 (Print) 2332-8959 (Online) Journal homepage: www.tandfonline.com/journals/ktmp20



Cumulative effects of successive workdays in the heat on thermoregulatory function in the aging worker

Sean R. Notley, Robert D. Meade, Andrew W. D'Souza, Gregory W. McGarr & Glen P. Kenny

To cite this article: Sean R. Notley, Robert D. Meade, Andrew W. D'Souza, Gregory W. McGarr & Glen P. Kenny (2018) Cumulative effects of successive workdays in the heat on thermoregulatory function in the aging worker, *Temperature*, 5:4, 293-295, DOI:

What factors can we measure for heat stress?

What are you measuring?

- Humidex plan (Temp & RH%)
- ACGIH TLV ($WBGT_{eff}$)
- Physiological monitoring (HR, skin temp, core temp, complex heat stress program)



ACGIH Heat Stress & Strain TLV Documentation

ACGIH® © 2022

11DOC-658-NPA Heat Stress and Strain TLV – page 1

HEAT STRESS AND STRAIN

the “Gold Standard”

TLV®

Warning: The TLV is based on the ability of most healthy hydrated acclimatized workers to sustain thermal equilibrium. The Action Limit (AL) is similarly prescribed for healthy hydrated unacclimatized workers. This TLV has a small margin of safety, and some workers may experience heat-related disorders below the TLV or AL.

Introduction: The goal of the TLV is to limit heat stress exposures to those that may be sustained for hours; that is, where healthy acclimatized individuals can achieve and maintain thermal equilibrium. The Action Limit (AL) describes conditions where most healthy unacclimatized workers can achieve thermal equilibrium. If thermal equilibrium cannot be sustained, there is an increasing likelihood of heat exhaustion or heat stroke. While not considered for the TLV, there is also an increased likelihood of errors in judgement, acute injury, and adverse incidents with increasing heat stress. Furthermore, the TLV assumes complete recovery from a previous heat stress exposure.

excerpt from: [ACGIH® © 2022 11DOC-658-NPA Heat Stress and Strain TLV p.1](#)



Evidence based:

- American Conference of Governmental Industrial Hygienist (**ACGIH**) Heat Stress/Heat Strain Threshold Limit Value (**TLV**[®]) Documentation (last updated 2022)
- Contains a **detailed literature summary**; explanation of derivation of TLV values; **instructions** on how to properly apply
- Considered **minimal** professional practice standard
- Been in use since 1974 and constantly updated – internationally referenced by regulations and in practice guides

2024

TLVs[®] and BEIs[®]

Based on the Documentation of the

Threshold Limit
Values

for Chemical Substances
and Physical Agents

&

Biological Exposure
Indices



GLOBALLY PROTECTING WORKER HEALTH

• SIGNATURE PUBLICATIONS •





Acclimatization Argument

- The 2022 TLV[®] uses the following **measurable criteria**:
““Acclimatization requires physical activity under heat stress conditions like those anticipated for the work. With a recent history of heat stress exposures of at least **2 continuous hours for 5 of the last 7 days**, a worker may be considered acclimatized for the purposes of the TLV. Acclimatization declines when activity under heat stress conditions is discontinued. A noticeable loss occurs after 4 days and may be completely lost in 3 weeks. A person may not be fully acclimatized to a sudden or episodic higher level of heat stress.” (*pages 3-4 emphasis added*)
- Our experience was that employers just assumed everyone was acclimatized, so we removed that option – **if heat stress conditions allow for acclimatization the workplace should follow the TLV[®]**

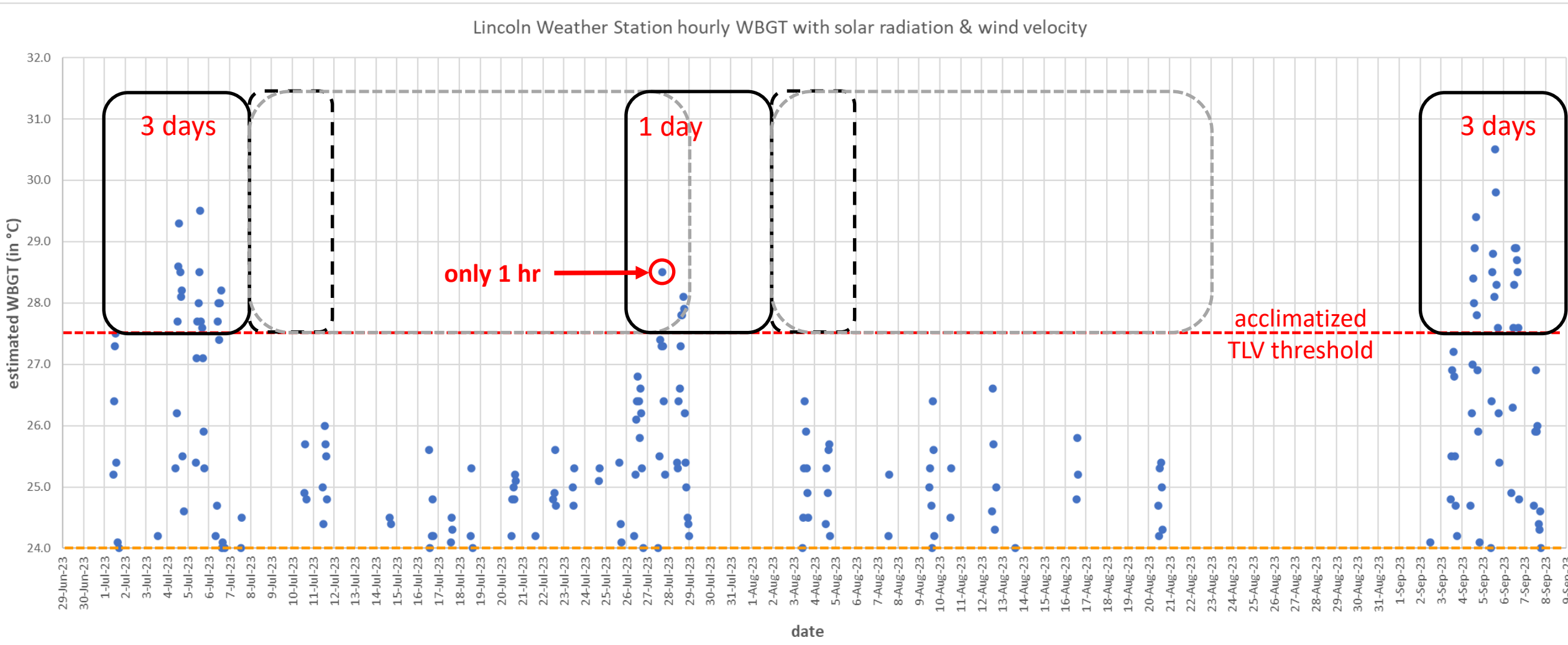


Acclimatization determination (with hourly solar radiation & wind data)

ACGIH acclimatization rule of thumb:

- 2 hr/day for 5 of 7 days window
- after 4 days noticeable loss
- after 3 weeks complete loss

Conclusion: no acclimatization even with solar radiation & wind velocity incorporated into the WBGT



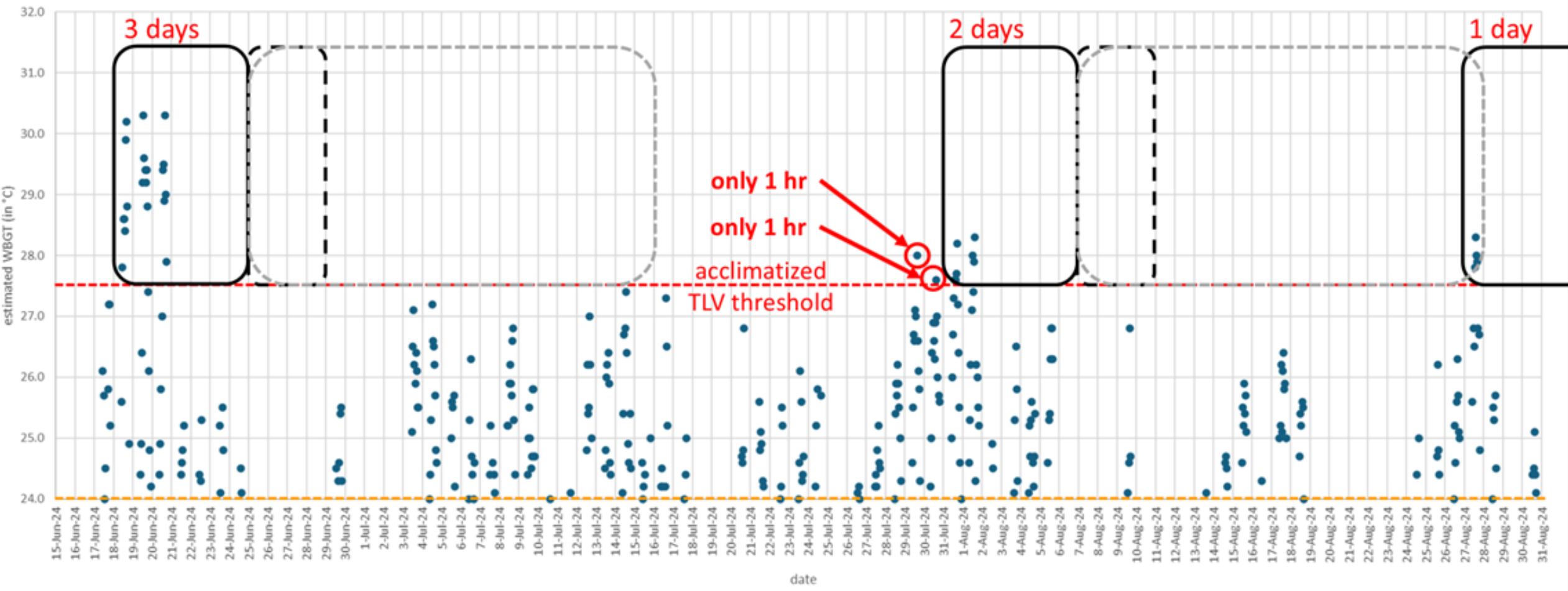
Acclimatization determination 2024 (with hourly solar radiation & wind data)

ACGIH acclimatization rule of thumb:

- 2 hr/day for 5 of 7 days window
- after 4 days noticeable loss
- after 3 weeks complete loss

Conclusion: no acclimatization even with solar radiation & wind velocity incorporated into the WBGT

Lincoln Weather Station hourly WBGT with solar radiation and wind speed (June 15 - Aug 31, 2024)



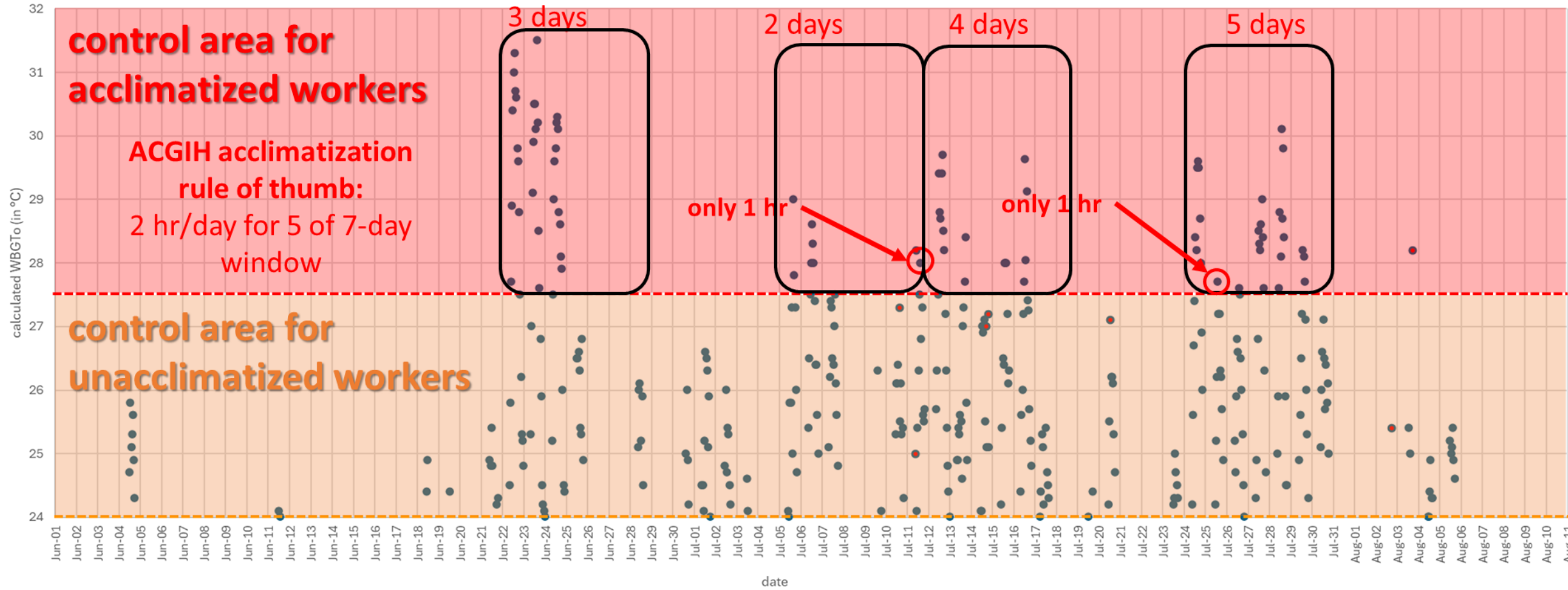
Acclimatization determination 2025 (with hourly solar radiation & wind data)

ACGIH acclimatization rule of thumb:

- 2 hr/day for 5 of 7 days window
- after 4 days noticeable loss
- after 3 weeks complete loss

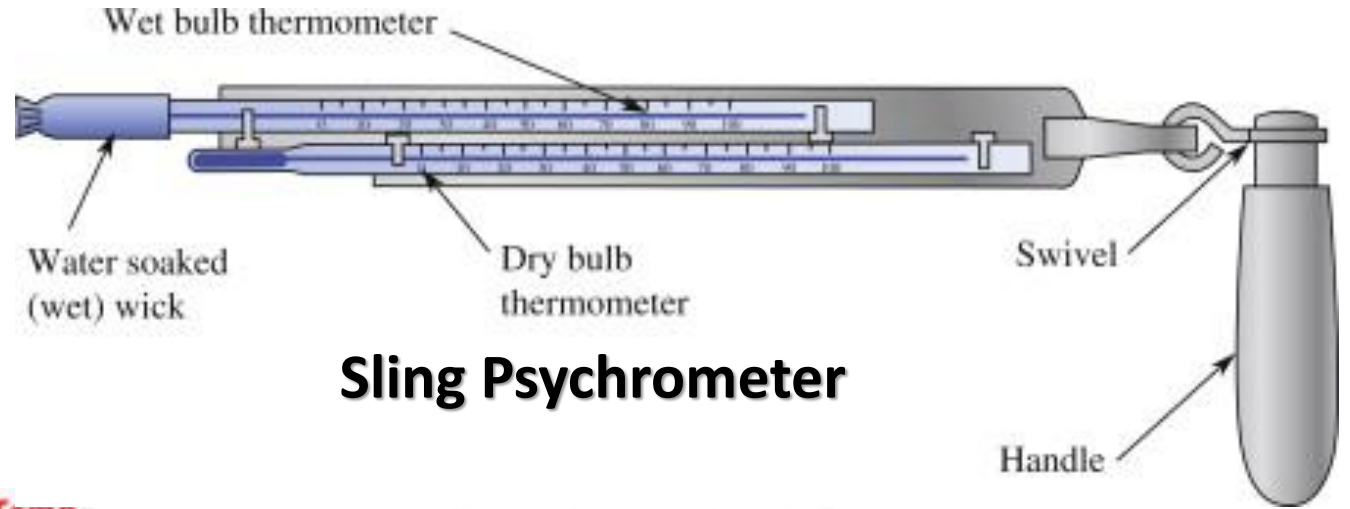
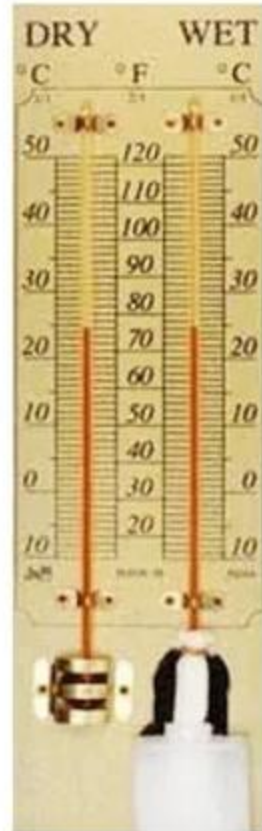
Conclusion: no acclimatization even with solar radiation & wind velocity incorporated into the WBGT

Lincoln Weather Station WBGT (outdoors) from calculator (Jun 1 - Aug 5, 2025)



Measure the temperature & relative humidity

Thermal Hygrometer



Sling Psychrometer

Air Temp.
↓

Relative Humidity (%)

Dry-Bulb Temperature (°C)	Difference Between Wet-Bulb and Dry-Bulb Temperatures (°C)															
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
10	100	88	76	65	54	43	33	24	13	4						
12	100	88	78	67	57	48	38	28	19	10	2					
14	100	89	79	69	60	50	41	33	25	16	8	1				
16	100	90	80	71	62	54	45	37	29	21	14	7	1			
18	100	91	81	72	64	56	48	40	33	26	19	12	6			
20	100	91	82	74	66	58	51	44	36	30	23	17	11	5		
22	100	92	83	75	68	60	53	46	40	33	27	21	15	10	4	
24	100	92	84	76	69	62	55	49	42	36	30	25	20	14	9	4
26	100	92	85	77	70	64	57	51	45	39	34	28	23	18	13	9
28	100	93	86	78	71	65	59	53	47	42	36	31	26	21	17	12
30	100	93	86	79	72	66	61	55	49	44	39	34	29	25	20	16



Can we estimate the WBGT from temperature and relative humidity (easily available)?

- Thomas Bernard has a table on a website (“Estimation of WBGT from Dry Bulb Temperature and Dew Point or Relative Humidity” https://health.usf.edu/-/media/v3/usf-health/COPH/Thomas-Bernard/Heat-Stress/Tables_WBGT_from_DP_or_RH21.ashx) where he provides **estimates of the WBGT based on temperature and relative humidity**. We used this table (converted to a set of equations) to estimate the indoor WBGT.
- For outdoor WBGT estimates, Bernard suggests **adding 2°C WBGT** to the table value to adjust for work in direct sunlight.
- Better yet, using a calculator available online (<https://www.climatechip.org/excel-wbgt-calculator>) the air temperature, **solar radiation**, relative humidity and **wind speed** were entered to supply an estimate of the outdoor WBGT



Calculation WBGT & UTCI

Version 2

<https://www.climatechip.org/excel-wbgt-calculator>

Input Data:

Ambient temperature(C)	<input type="text" value="30.0"/>	←		
Globe temperature (C)	<input type="text"/>	or Solar Radiation (w/m ²)	<input type="text" value="700"/>	←
Dew point (C)	<input type="text"/>	or Relative Humidity (%)	<input type="text" value="60"/>	←
Wind Speed (m/s)	<input type="text" value="1.0"/>	←		

Output:

UTCI	<input type="text" value="40.6"/>	Needs ambient temperature, globe temperature OR solar radiation, dew point OR relative humidity and wind speed.
WBGT(outdoors)	<input type="text" value="29.7"/>	Needs ambient temperature, globe temperature OR Solar radiation, dew point OR relative humidity and wind speed.
WBGT(indoors)	<input type="text" value="25.9"/>	Needs ambient temperature, dew point OR relative humidity and wind speed.
Mean Radiant Temperature	<input type="text" value="68.0"/>	

References:

Ramsey JD, Bernard TE (2000) Heat Stress in R Harris (ed) Patty's Industrial Hygiene and Toxicology vol 2 New York: John Wiley & Sons

Bernard TE, Pourmoghani M (1999) "Prediction of Workplace Wet Bulb Global Temperature." Applied Occupational and Environmental Hygiene 14: 126-134

Brice T, Hall T (2009) Wet-bulb calculator <http://www.srh.noaa.gov/epz/?n=wxcalc>

Liljegren J, Carhart R, Lawday P, Tschopp S, Sharp R (2008) "Modeling Wet Bulb Globe Temperature using Standard Meteorological Measurements" Journal of Occupational and Environmental Hygiene 5: 645-655

Thorsson S, Lindberg F, Eliasson I, Holmer B (2006) "MEASUREMENTS OF MEAN RADIANT TEMPERATURE IN DIFFERENT URBAN STRUCTURES" SIXTH INTERNATIONAL CONFERENCE ON URBAN CLIMATE p687



HUMIDEX-BASED HEAT RESPONSE PLAN

supported self-management

Humidex/WBGT Estimate-based heat response plan

screening TLV (ACGIH) /detailed TLV

TLV physiological monitoring

The Humidex 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 moderate unacclimatized WBGT's were translated into Humidex or WBGT estimate (see Appendix 1 for the Humidex-based Heat Response Plan). The following steps must be followed when using the Humidex based heat response plan. To use the WBGT estimate, see Appendix 1.

Step 1: Training

The Humidex plan by itself cannot guarantee that workers will not be affected by heat stress. It is important that all workers can recognize the early signs and symptoms of heat stress to prevent more serious heat illnesses. Workers need to adjust their work pace, take frequent breaks in shaded or cooler areas, and stay hydrated by drinking water regularly. Supervisors also need to be able to recognize when a worker is experiencing heat-related symptoms and know what to do to support them. 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

The Humidex Heat Stress Response Plan is based on workplace measurements not weather station or media reports. Temperatures inside buildings do not usually correspond with outdoor temperatures. Therefore it is important to identify a representative location within the zone where measurements can be taken, within 10m (30 ft) of the exposed worker

Step 3: Measure Workplace Humidex

For work areas where there is significant process radiant heat and/or humidity sources (steam, circulation of large quantities of water) the preferred measurements are Wet Bulb Globe Temperature (WBGT) measurements taken within 10m (30') of the exposure (the closer to the exposed worker the better). For workstations where weather conditions are the main source of external heat exposure temperature and relative humidity measurements taken within the work zone are sufficient. Measurements should be taken at least once per hour during heat stress conditions and be recorded. A thermal hygrometer a simple way to measure the temperature and relative humidity

WBGT Estimate Plan

Estimated WBGT version (based on temp & RH)

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	Estimated Effective* WBGT		Action										NEVER IGNORE ANYONE'S SYMPTOMS DESPITE YOUR MEASUREMENTS!						30.1	29.0	45											
44	29.1°C+ WBGT		only medically supervised work																30.6	29.5	28.3	44										
43	27.1-29.0°C WBGT		75% relief																31.0	29.9	28.8	27.7	43									
42	26.1-27.0°C WBGT		50% relief																31.3	30.3	29.2	28.1	27.1	42								
41	25.1-26.0°C WBGT		25% relief																31.6	30.6	29.5	28.5	27.5	26.5	41							
40	24.1-25.0°C WBGT		warning & double water																30.8	29.8	28.8	27.8	26.8	25.8	40							
39	23.1-24.0°C WBGT		alert & water																31.0	30.0	29.1	28.1	27.1	26.2	25.2	39						
38	≤23.0°C WBGT		water as needed																31.1	30.2	29.2	28.3	27.4	26.4	25.5	24.6	38					
37	moderate metabolic rate, unacclimatized action limit																		31.2	30.3	29.4	28.5	27.5	26.6	25.7	24.8	23.9	37				
36	"Effective**" means adjusted for clothing																		31.2	30.3	29.4	28.5	27.7	26.9	26.0	25.2	24.3	23.5	22.7	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.

both units,
side by side

Adjusted* Humidex	Response	Effective** WBGT (°C)
25 - 29	supply water to workers on an "as needed" basis	← 23.0°C
30 - 33	post Heat Stress Alert notice; encourage workers to drink extra water; start recording hourly temperature and relative humidity	23.1 – 24.0°C
34 - 37	post Heat Stress Warning notice; notify workers that they need to drink extra water; ensure workers are trained to recognize symptoms	24.1 – 25.0°C
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	25.1 – 26.0°C
40 - 41	work with 30 minutes relief per hour can continue in addition to the provisions listed previously	26.1 – 27.0°C
42 - 44	if feasible, work with 45 minutes relief per hour can continue in addition to the provisions listed above	27.1 – 29.0°C
45*** or over	only medically supervised work can continue	29.1°C*** or over

* "adjusted" means adjusted for additional clothing and radiant heat (see steps #4 & #5)

**at Humidex exposures above 45 (WBGT 29.1°C), heat stress should be managed as per the ACGIH TLV®

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



SCREENING AND DETAILED TLV (ACGIH)

ACGIH Screening Criteria Based on WBGT_{eff}

supported
self-management

Humidex/WBGT Estimate-based
heat response plan

screening TLV (ACGIH)
/detailed TLV

TLV physiological
monitoring

From Humidex to WBGT

Jamila works in a mid-sized factory producing shaped cardboard containers. The cardboard is shaped when wet and the dried in kilns, so the factory process emits both heat and humidity. At first the plant tried to use the Humidex plan, but heat stress conditions were more complicated than the Humidex plan assumes, so they decided to purchase machines that would measure the wet-bulb globe temperature (WBGT). The employer installed 4 fixed sets of sensors which were programmed to notify supervisors beginning when the conditions in these for areas exceed 20°C WBGT. There are also hand-held measuring units which can be used for following up specific heat stress concerns.

The Health & Safety department liked the simplicity of the Humidex plan so they worked out a correlation between Humidex and WBGT measurements so they could convert the Humidex table into WBGT units. The WBGT measurements take into consideration the radiant heat from the kilns and extra humidity from the wet processes in the plant. Jobs were classified by ergonomic consultants into "light" and "moderate" categories. It was also noted which jobs had access to air-conditioned break rooms for relief and which jobs did not. Engineering controls included ventilation with chillers to control the level of humidity in the plant (for the stability of the cardboard product), ergonomic changes were made to reduce the amount of energy workers have to expend to do their work, and evaporative cooling fans are placed strategically throughout the plant when things get really hot.

The ACGIH TLV for heat stress and strain is the "gold standard" for the evaluation and assessment of heat stress. If the simpler Humidex-based heat response plan does not allow for proper measurement of heat stress risk, the ACGIH TLV should be used.

The ACGIH TLV has 4 methods of heat stress assessment. Method 1 is the most commonly used and least complicated method. It consists of a table of TLV and Action Limit (AL) screening criteria based on the effective WBGT (WBGT_{eff}). The screening criteria for heat stress exposure considers:

- the contributions of environment (WBGT),
- metabolic work demands adjusted for weight as light, moderate, heavy, or very heavy, (follow table 1 of the ACGIH TLV)
- work-rest pattern, (follow table 2 of the ACGIH TLV)
- clothing; (Appendix 3 SOP)
- level of acclimatization.

Screening TLV / Detailed TLV (ACGIH)

Using the "official" screening WBGT measurements and appropriate application of work-rest regimens to prevent heat stress. For complex and unusual exposures there is also the option to follow the technically challenging "TLV Analysis" method outlined in the ACGIH TLV documentation. **A WBGT meter is needed for these methods.**

Detailed WBGT

Workplace are not implementing the TLV properly, so the **online calculator will walk them through the TLV steps**

- training
- metabolic correction for weight
- outdoor sun/indoor
- clothing adjustment factors
- acclimatization
- noting the difference in thermal regulation for those biologically female at birth



ACGIH TLV (WBGT)

Recommended if:

- You think you are acclimatized
- Working with process heat
- Heavy or very heavy work load

Detailed WBGT

Most workplace are not implementing the TLV properly, Our new online calculator will walk them through the steps:

- training
- metabolic correction for weight
- outdoor sun/indoor
- clothing adjustment factors
- acclimatization



ACGIH Method 1: Screening Criteria Based on $WBGT_{eff}$

supported
self-management

Humidex/WBGT Estimate-based
heat response plan

screening TLV (ACGIH)
/detailed TLV

TLV physiological
monitoring

- requires:
 - measurement of WBGT
 - clothing adjustment cor or $WBGT_{eff}$)
 - assign metabolic work c
 - determine acclimatizati
 - determine unadjusted v
- use criteria in **Table 3** to c
- based on **1 hour** time-we
- Assumes 8 hour days and

Table 3. Screening Criteria using $WBGT_{eff}$ (°C) for Acclimatized and Unacclimatized Workers

Allocation of Work in a Cycle of Work and Recovery	Metabolic Rate for Acclimatized Workers				Metabolic Rate for Unacclimatized Workers			
	Light	Moderate	Heavy	Very Heavy	Light	Moderate	Heavy	Very Heavy
75 to 100%	31.0	28.0	–	–	28.0	25.0	–	–
50 to 75%	31.0	29.0	27.5	–	28.5	26.0	24.0	–
25 to 50%	32.0	30.0	29.0	28.0	29.5	27.0	25.5	24.5
0 to 25%	32.5	31.5	30.5	30.0	30.0	29.0	28.0	27.0

Notes:

- See Table 1 for metabolic work demand categories.
- The thresholds are computed as a TWA Metabolic Rate where the metabolic rate for rest is taken as 115 W and work is the representative (midrange) value of Table 1. The time base is taken as the proportion of work at the upper limit of the percent work range (e.g., 50% for the range of 25% to 50%).
- $WBGT$ values are expressed to the nearest 0.5 °C.
- If work and rest environments are different or work and rest are distributed over more than 1 location, hourly time-weighted averages (TWA) $WBGT$ should be calculated and used. TWAs for work rates should also be used when the work demands vary within the hour. Note that the metabolic rate for rest is already factored into the screening limit.
- Values in the table assume 8-hour workdays in a 5-day workweek with conventional breaks.
- Because the physiological strain associated with Heavy and Very Heavy work among less fit workers regardless of $WBGT$ may be unsustainable, screening criteria values are not provided for near continuous work and for up to 25% rest in an hour for Very Heavy. The screening criteria are not recommended, and, instead, a TWA analysis and/or physiological monitoring should be used.
- Table 3 is intended as an initial screening tool to evaluate whether a heat stress situation may exist and thus the table is more protective than the TLV or AL. Because the values are more protective, they are not intended to prescribe work and recovery periods.

it”

Is



Metabolic category issue:

Note:

the 2022 TLV also specifies adjusting the metabolic rate for body weight

ACGIH® © 2022		Stress and Strain TLV – page 3
Moderate 235 to 360 W		and arm work, moderate ate arm and truck work, or Normal walking.
Heavy 360 to 470 W		rk, carrying, shoveling, and pulling heavy loads; e.
Very heavy > 470 W		st to maximum pace.

Note: The effect of body weight on the estimated metabolic rate can be accounted for by multiplying the estimated rate by the ratio of actual body weight divided by 70 kg (154 lb).

Source: (International Organization for Standardization (ISO) 2017).



Official ACGIH Clothing Adjustment Values:

ACGIH clothing adjustment values	°C WBGT	Humidex
Short Sleeves and Pants of Woven Material	-1.0	-2
Work Clothes (Long Sleeve Shirt and Pants)	0.0	0
Cloth (woven material) Coveralls over underwear	0.0	0
thin disposable SMS Polypropylene Coveralls over underwear	+0.5	+1
disposable polyolefin (Tyvek) coveralls over underwear	+1.0	+2
Adding a Hood (Full Head and Neck Covering; not Face)	+1.0	+2
Double Layer Woven Clothing (e.g., coveralls over work clothes)	+3.0	+6
Limited-Use Vapor-Barrier Coveralls with Hood	+11.0	+22

... but what if you're required to wear leather gloves, a hard hat, an N95 for the silica dust, earmuffs, etc., in addition to your overalls?



Clothing Adjustment Values (CAV)

Used values in Table 2. of the TLV

- We get frequent enquiries about clothing adjustment factors for clothing items and PPE that aren't on the list
- Searched the literature for articles which compared the cooling rates of the different parts of the body

found this paper: [Taylor, N. A., & Machado-Moreira, C. A. \(2013\).](#)

[“Regional variations in transepidermal water loss, eccrine sweat gland density, sweat secretion rates and electrolyte composition in resting and exercising humans”, Extreme physiology & medicine, 2, 1-30.](#)



Article comparing the cooling rates of the different parts of the body

Taylor and Machado-Moreira *Extreme Physiology & Medicine* 2013, 2:4
<http://www.extremephysiolmed.com/content/2/1/4>

REVIEW

Regional variations in transepidermal water loss, sweat gland density and electrolyte composition in exercising humans

Nigel AS Taylor* and Christiano A Machado-Moreira



Extreme Physiology & Medicine

Open Access

water loss,
excretion rates
and



Taylor & Machado-Moreira (2013)

Table 3 Regional contributions to evaporative heat loss (assuming 100% evaporation) from 14 body regions during thermal loading

Site	Rest heat loss (W)	Relative contribution (%)	Exercise heat loss (W)	Relative contribution (%)
Head (face)	27.81	10.2	91.30	13.8
Hand (palm)	4.33	1.6	12.88	1.9
Hand (dorsal)	9.63	23.5	27.36	4.1
Forearm	10.97	4.0	40.58	6.1
Upper arm	15.87	5.8	36.44	5.5
Axilla	2.48	0.9	6.75	1.0
Chest	22.00	8.1	50.60	7.7
Abdomen	21.71	8.0	45.68	6.9
Back	49.88	18.3	113.12	17.1
Buttocks	14.90	5.5	20.59	3.1
Thigh	42.06	15.4	102.59	15.5
Leg	37.89	13.9	88.56	13.4
Foot (sole)	3.75	1.4	6.83	1.0
Foot (dorsal)	9.75	3.6	17.43	2.6

The mean, whole-body sweat rates under these conditions would approximate $0.4 \text{ L}\cdot\text{h}^{-1}$ (rest) and $1.0 \text{ L}\cdot\text{h}^{-1}$ (light-moderate intensity exercise). Calculations were performed using the regional sweat rates from Figures 4 (resting states) and 5 (exercising states), an assumed heat loss of $2.43 \text{ kJ}\cdot\text{mL}^{-1}$ and the surface area of each region (Table 1) based upon the morphological reference adult [116].



Derived Clothing Adjustment Values

- Take the relative contribution of the body part being covered to the evaporative cooling and apply this to the ACGIH table
- For example:
 - **hands (palm and dorsal)** contribute a combined value of **6.1%** to the total body heat loss due to sweat evaporation
 - **forearms, upper arms, arm pits, chest abdomen, back, buttocks, thighs and legs** contribute a combined value of **76.2%** to the total body heat loss due to sweat evaporation
- So, if the gloves covering the **hands (palm and dorsal)** have the same resistance to evaporation as **overalls** covering **forearms, upper arms, arm pits, chest abdomen, back, buttocks, thighs and legs** which has a CAV of 3.0°C WBGT then the gloves (e.g. leather gloves) would have a derived CAV of $6.1\%/76.2\% * 3.0\text{ °C WBGT} = \underline{0.24\text{ °C WBGT}}$; or rounded off to a **CAV of 0.2°C WBGT**





Derived CAV's

derived clothing adjustment values	°C WBGT	Humidex
impervious gloves	+0.2	+0.4
impervious apron	+0.3	+0.6
additional protective sleeves	+0.2	+0.4
leather welding jacket	+1.5	+3.0
medical mask	+0.05	+0.1
N95 disposable respirator	+0.1	+0.2
half face piece elastomeric demand respirator	+0.2	+0.4
ear muffs	+0.1	+0.2
toque	+0.6	+1.2
hard hat	+0.2	+0.4
goggles	+0.1	+0.2
face shield	+0.1	+0.2
woven fabric hospital gown	+1.5	+3.0



Physiological Monitoring



- Can be a useful tool when working on hot environments with high physical activity
- Concerns about collection and confidentiality of medical information
- Self-monitoring can lead to Self-calibration (evolves into supported self-management)
- Reliability and validity of self-monitoring technology (these tools are relatively new and should be tested)
- See monitoring guide for more information



**OHCOW**Occupational Health Clinics
for Ontario Workers Inc.OCCUPATIONAL
ILLNESSINJURY
PREVENTIONWORKPLACE
MENTAL HEALTHWORKER
PERSPECTIVE

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APPS, TOOLS AND CALCULATORS

VIEW ALL RESOURCES

Calculator

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First things first:

*What type of data have you collected?*

- Temperature and relative humidity
- Detailed WBGT Method

WBGT – Wetbulb Globe Temperature

NEXT >



Weakness



Fatigue



Dizziness

Learn more about the symptoms of heat stress with our [Heat Stress Symptoms](#) infographic.

UPDATED 2024

OR and RESPONSE PLAN

New [Heat Stress Toolkit](#)can be hazardous to your health.
are no exception.

Heat stress include:

The Calculator

This calculator provides three methods of calculation based on the information you have access to:

[Humidex-based Method](#) • [WBGT Estimate Method](#) • [Detailed WBGT Method*](#)

New Heat Stress Calculator – Prior to providing the calculated result:








Check status of 6 assumptions


1. adequate training
2. specify clothing in context
3. confirm absence of *detailed WBGT*)
4. specify indoor/outdoor
5. accept moderate/upper
6. confirm measurement

Only after responding to
temperature and relative
Bernard's *WBGT Estimation*

SUMMARY

This is a summary of the information you have provided:

METHOD OF CALCULATION: Humidex 
TEMPERATURE and RELATIVE HUMIDITY: 32°C | 22% 
TRAINING / KNOWLEDGE: Yes 
INDOORS / OUTDOORS: Outdoors in shade 
CLOTHING: Typical clothing | No PPE 
RADIANT HEAT: No radiant heat / moisture 
PHYSICAL DEMANDS: Unacclimatized | Moderate 

Use the edit icon  if you need to make any required changes.

The next step is to calculate the heat stress factor for this work scenario.
Press CALCULATE to continue:

CALCULATE!



Heat Stress Prevention & Control Program

VERSION 1.0
05/28/2024

Sample 10-page SOP

VERSION HISTORY				
VERSION	APPROVED BY	REVISION DATE	DESCRIPTION OF CHANGE	AUTHOR
1.0				

PREPARED BY	OHCOW	TITLE	Occupational Hygienists	DATE	May 28, 2024
APPROVED BY		TITLE		DATE	

... for a Word version of this SOP please send a request to:

joudyk@ohcow.on.ca
agauvin@ohcow.on.ca

1. NAME OF PROCEDURE

Heat Stress Prevention & Control Program

2. PURPOSE

The goal of this document is to outline the responsibilities and procedures to protect workers from heat stress and prevent heat-related illnesses.

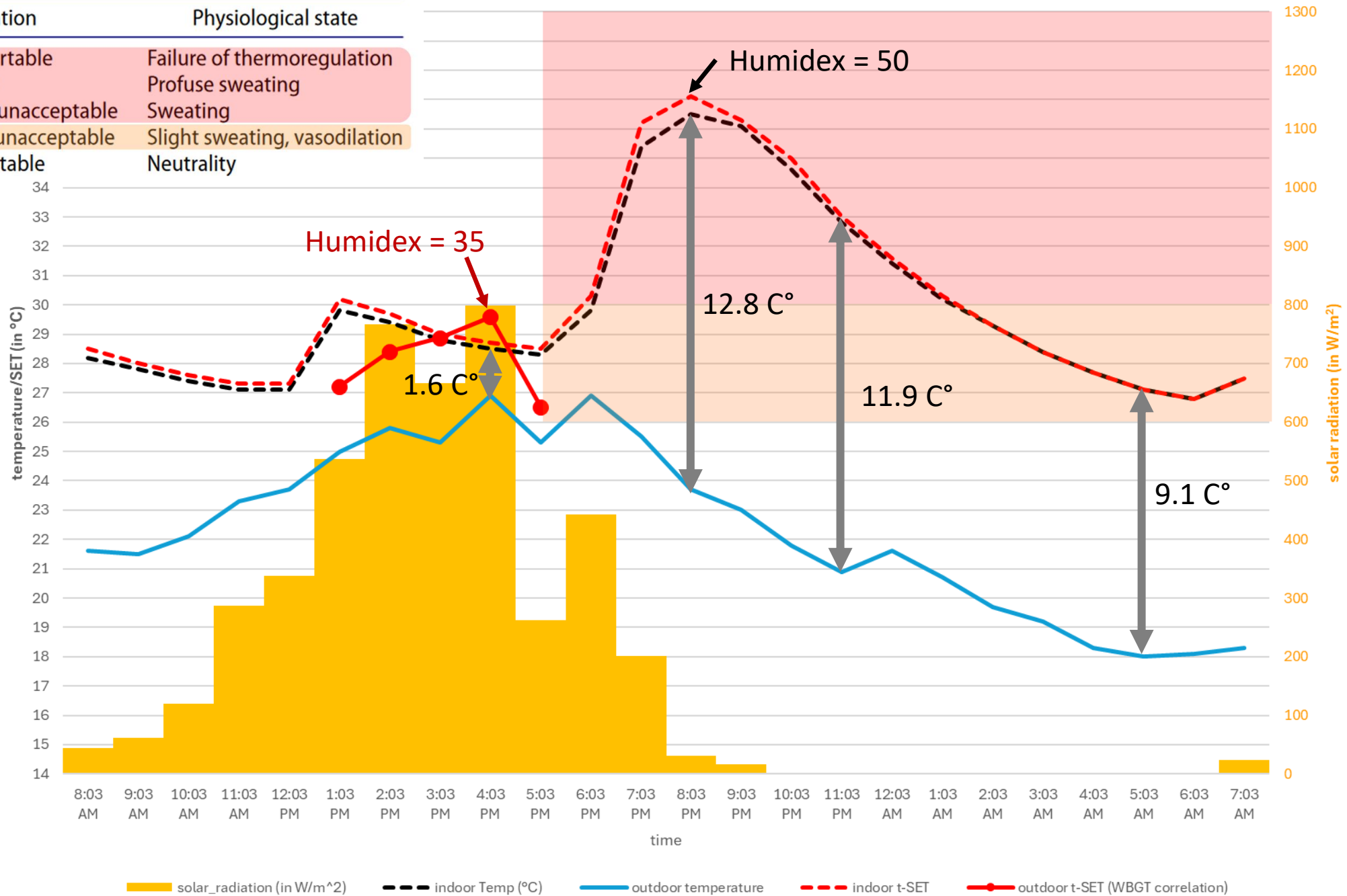


Table 2. Thermal sensation scale of SET (Parsons 2003).

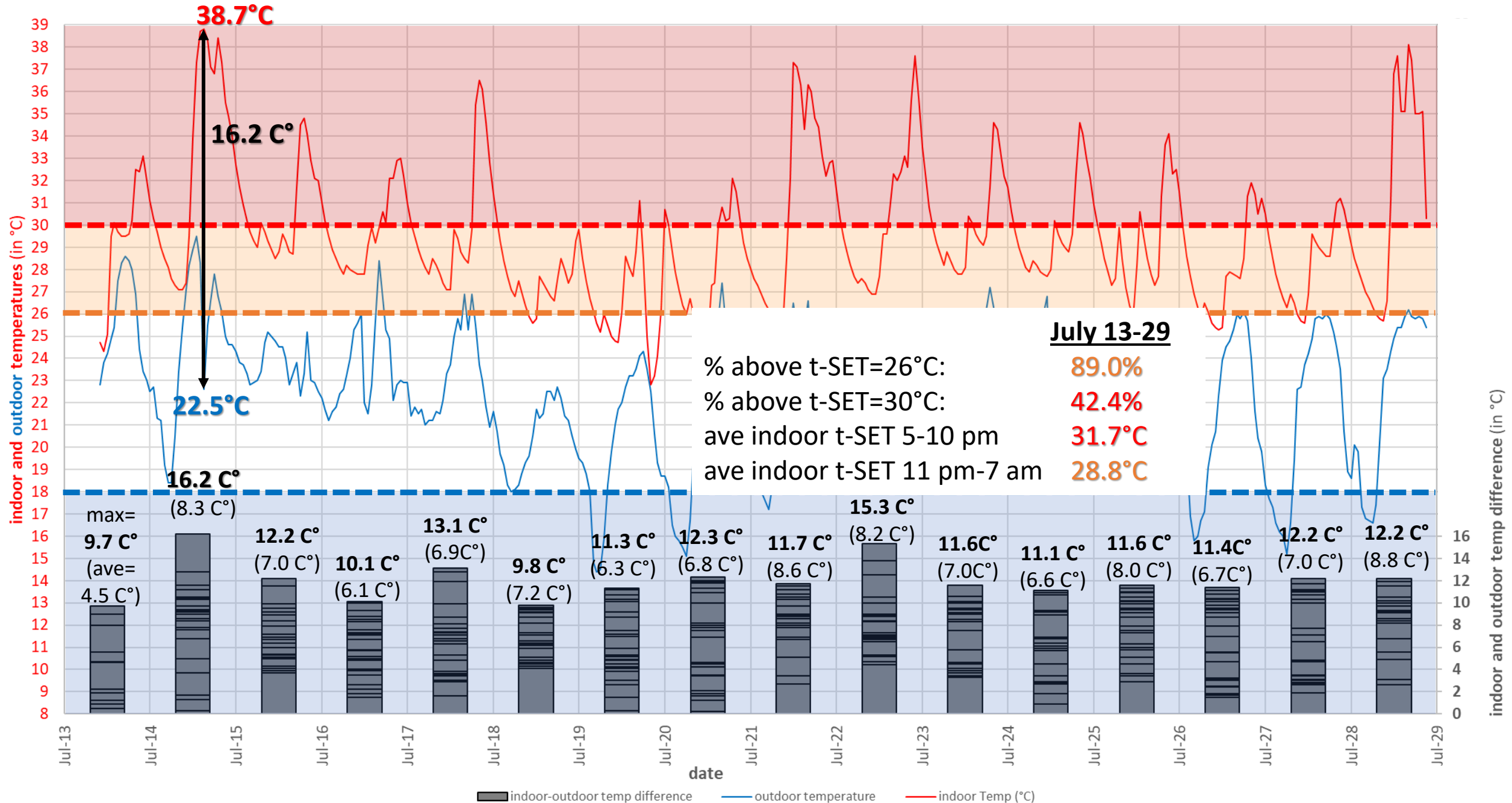
SET (°C)	Thermal sensation	Physiological state
> 37.5	Very hot, very uncomfortable	Failure of thermoregulation
34.5 - 37.5	Hot, very unacceptable	Profuse sweating
30.0 - 34.5	Warm, uncomfortable, unacceptable	Sweating
25.6 - 30.0	Slightly warm, slightly unacceptable	Slight sweating, vasodilation
22.2 - 25.6	Comfortable and acceptable	Neutrality

daily
graph
example

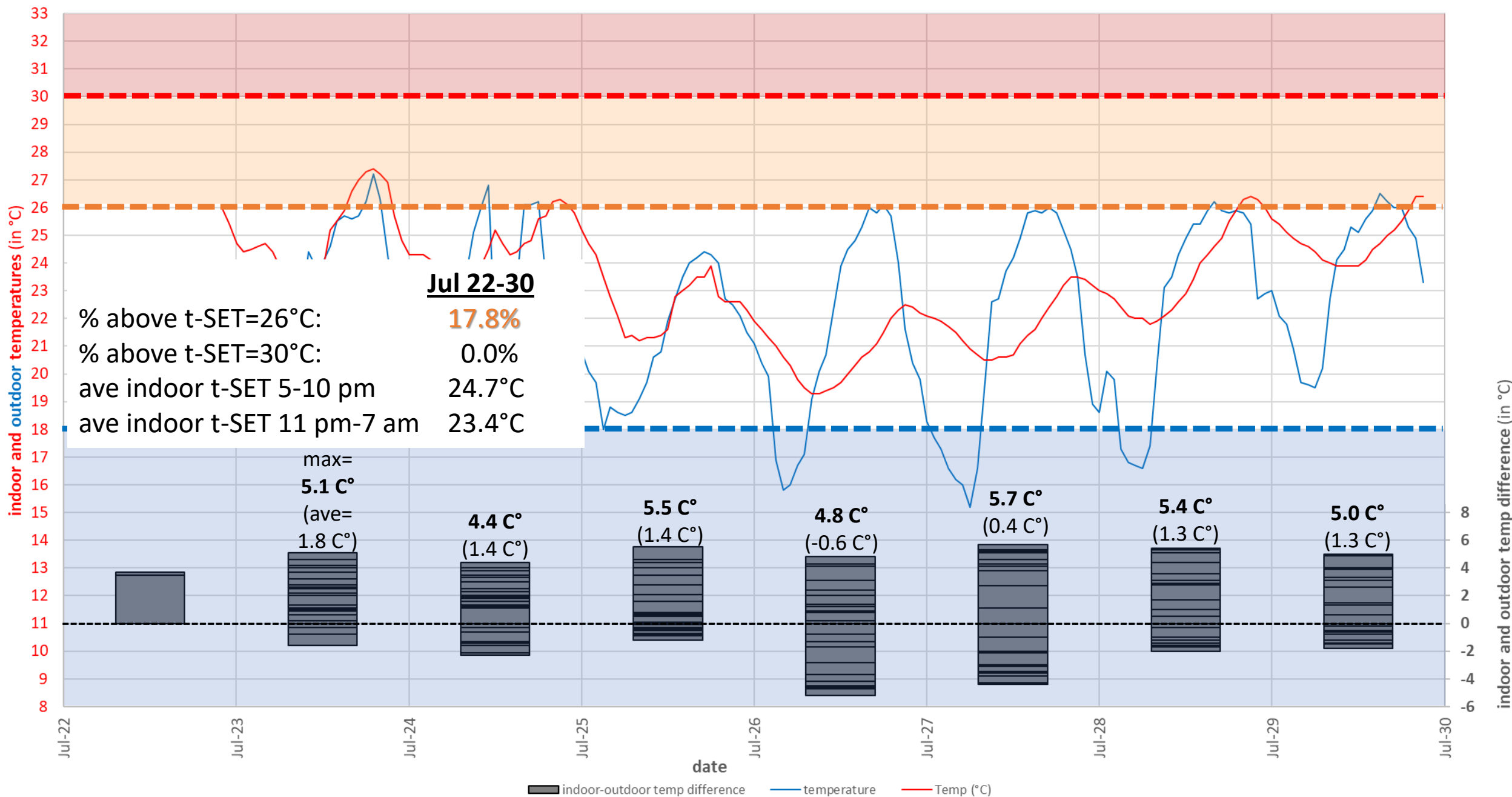
Aranet4 25EB0 (July 17-18, 2024)



Lincoln Weather Station hourly outdoor & BH-6 indoor temperatures (July 13-29, 2024)



Lincoln Weather Station hourly outdoor & BH-10 indoor temperatures (July 22-30, 2024)



Example of
bunkhouse
structure
from the
inside



SCHEDULE F HOUSING INSPECTION REPORT SEASONAL AGRICULTURAL WORKER PROGRAM AND AGRICULTURAL STREAM

Suggested addition:

HOUSING INTERIOR

3b. Is there a ventilation and/or cooling system that can maintain a temperature below 26 degrees Celsius (79 degrees Fahrenheit) in any living space within the housing?

Maintaining a room temperature no higher than 26 degrees Celsius (79 degrees Fahrenheit) as the maximum standard.

Yes No Could not be verified during this inspection due to: _____

<https://catalogue.servicecanada.gc.ca/content/EForms/en/Detail.html?Form=EMP5598>



... in either one of these sections?

<https://catalogue.servicecanada.gc.ca/content/EForms/en/CallForm.html?Lang=en&PDF=ESDC-EMP5598.pdf>

3. Is a permanent heating system that can maintain a temperature ranging between 20 to 23.5 degrees Celsius (68 to 75 degrees Fahrenheit) available within the housing?

A room temperature ranging between 20 to 23.5 degrees Celsius (68 to 75 degrees Fahrenheit) is the minimum standard. Portable space heaters cannot be used as the primary source of heating for any living space within the housing.

Yes No Could not be verified during this inspection due to:

5. Is there adequate ventilation by either natural or artificial means in the housing?

To prevent poor air quality, adequate ventilation by either natural means (e.g. windows) or artificial means (e.g. ceiling fans) is required.

Yes No Could not be verified during this inspection due to:

What's Next?

- Looking to collect data in different worksites and different industries to measure workplace heat stress conditions and record what actions were taken to prevent heat stress
- This information can be used as a measure to see if “employers are doing the right thing” according to OSHA - S. 25 (2)(h).
- This can also “add pressure” to the implementation of a heat stress regulation.





Thank you!



HEAT STRESS Toolkit

Humidex Based Heat Response Plan

What is it?

- > The Humidex 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. These WBGT's were translated into Humidex.
- > 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 translation 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 the Humidex plan is appropriate for your workplaces, if not, follow the ACGIH Heat Stress and Strain TLV[®]). This plan assumes moderate, unacclimatized work.

Adjusted* Humidex	Response	Effective** WBGT (°C)
25 – 29	supply water to workers on an "as needed" basis	≤ 23.0°C
30 – 33	post Heat Stress Alert notice; encourage workers to drink extra water; start recording hourly temperature and relative humidity	23.1 – 24.0°C
34 – 37	post Heat Stress Warning notice; notify workers that they need to drink extra water; ensure workers are trained to recognize symptoms	24.1 – 25.0°C
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	25.1 – 26.0°C
40 – 41	work with 30 minutes relief per hour can continue in addition to the provisions listed previously	26.1 – 27.0°C
42 – 44	if feasible, work with 45 minutes relief per hour can continue in addition to the provisions listed above	27.1 – 29.0°C
45*** or over	only medically supervised work can continue	29.1°C*** or over

* "adjusted" means adjusted for additional clothing and radiant heat (see steps #4 & #5)

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

***at Humidex above 45 (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.

April 2024



agauvin@ohcow.on.ca

joudyk@ohcow.on.ca

<https://www.ohcow.on.ca/heat-stress-toolkit/>

