Occupational Health Clinics
for Ontario Workers Inc.

Doing Something about Heat Stress

information session

John Oudyk MSc CIH ROH
Occupational Hygienist
October 30, 2014

introductions

who you are?

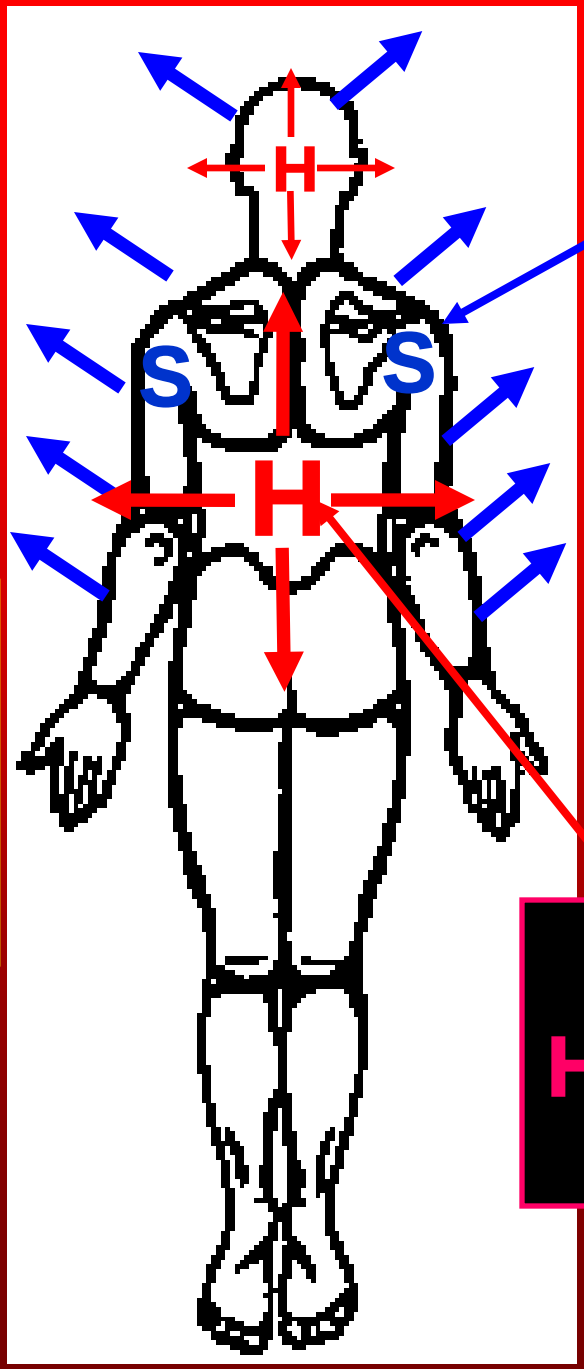
where you're from?

any specific question(s)?

Heat Balance

H

External Heat sources
hot weather
radiant heat sources



Cooling
evaporation of sweat

Internal Heat sources
muscle activity

What's the Law?

General Duty Clause:

- 25(2)(h) "... an employer shall, ... take every precaution reasonable in the circumstances for the protection of a worker;" taken from: OH&S Act

MOL Heath and Safety Guidelines: Heat Stress:

- "The MOL uses the TLVs® for Heat Stress published by the ACGIH".
  taken from: http://www.labour.gov.on.ca/english/hs/pdf/gl_heat.pdf

NO

1. **clothing** OK/adjustment?

YES

2/3a. WBGT screening/ detailed **action limit**

below

keep monitoring

above

2/3b. WBGT screening/ detailed **TLV®**

below

general controls

above or no data

4. heat strain evaluation
   - heart rate
   - core temperature

OK

excessive

5. **job-specific controls**

ACGIH Heat Stress / Strain TLV®

clothing adjustment changes

clothing	adjustment
work clothes	0.0
cloth coveralls (with only underwear)	0.0
double layer cloth	+3.0
SMS coveralls	+0.5
polyolefin coveralls	+1.0
limited-use vapour barrier coveralls	+11.0

What is a WBGT?

1. normal thermometer (dry-bulb)
2. wet-bulb thermometer
   - humidity
3. globe temperature
   - radiant heat

Wet **B**ulb **G**lobe **T**emp.

WBGT Formulas:

For indoor or shaded environments:

$$WBGT = 70\% \, T_{nwb} + 30\% \, T_g$$

T_{nwb} = natural wet-bulb temperature (70%)

T_g = globe temperature (30%)

For direct sunlight exposure:

$$WBGT = 70\% \, T_{nwb} + 20\% \, T_g + 10\% \, T_{db}$$

T_{db} = dry-bulb temperature

Screening WBGT (in °C):

work demands:	light	moderate	heavy	very heavy
100 % work; (breaks incl.)	28.0 31.0	25.0 28.0	not allowed	not allowed
75 % work; 25 % rest	28.5 31.0	26.0 29.0	24.0 27.5	not allowed
50 % work; 50 % rest	29.5 32.0	27.0 30.0	25.5 29.0	24.5 28.0
25 % work; 75 % rest	29.0 32.5	29.0 31.0	28.0 30.5	27.0 30.0

Action Level
TLV®

When are you acclimatized?

- acclimatization requires up to 3 weeks to be fully established and is noticeably decreased after 4 days:
- the 2009 TLV® suggests as a criteria: **exposed for 5 of last 7 days or 10 of the last 14 days**
- "**Hot spells in Ontario seldom last long enough to allow acclimatization**."
  (taken from Ontario Ministry of Labour Heat Stress Guideline: http://www.labour.gov.on.ca/english/hs/pdf/gl_heat.pdf)

Workload Descriptions (TLV Table 3):

Light: Sitting with light manual work with hands or hands and arms, and driving. Standing with some light arm work and occasional walking.

Moderate: Sustained moderate hand and arm work, moderate arm and leg work, moderate arm and trunk work, or light pushing and pulling. Normal walking.

Heavy: Intense arm and trunk work, carrying, shoveling, manual sawing; pushing and pulling heavy loads; and walking at a fast pace.

Very Heavy: Very intense activity at fast to maximum pace.

Adjusting for Weight:

Sample calculation:

standing = 42 watts*(55 min/60min)	= 38.5 watts
walking = 174 watts*(5 min/60min)	= 14.5 watts
light work, two arms	= 105 watts
basal metabolism	= 70 watts
total metabolic rate = **228 watts**	(light)

... but this applies to a 154 lb person,
for an 200 lbs person we need a correction factor:
228 watts * (200/154)= **296 watts** (moderate)

... for an 245 lb person we need a correction factor:
228 watts * (245/154)= **362 watts** (heavy)

... and, what if the worker is female, or dehydrated, or etc.? ...

NO

1. **clothing** OK/adjustment?

YES

2/3a. WBGT screening/ detailed **action limit**

below

keep monitoring

above

2/3b. WBGT screening/ detailed **TLV®**

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4. heat strain evaluation
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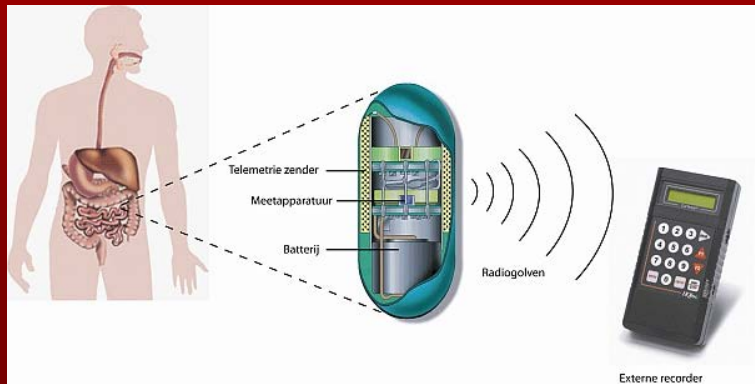
2009 ACGIH Heat Stress/ Strain TLV®

Physiological Monitoring?

- check heart rate, body temperature
- is this medical monitoring?
- should data collected be treated as medical information? (i.e. confidential)
- who is qualified to collect info, store it, interpret?
- what happens if exceed limits?
- personal vital signs monitoring equipment (e.g. swallow monitoring pill, ear temperature monitor, heart rate monitor) – who sets alarms on machines?



Heart rate app

https://itunes.apple.com/ca/app/instant-heart-rate-heart-rate/id409625068?mt=8

For persons with <u>normal</u> cardiac performance:

1. Measure heart rate 1 minute after peak work effort – should be less than 120 beats/minute

2. Sustained heart rate in excess of (180 – age) beats/minute

Heat stress death 1990 - Inquest Findings:

- Brian Freeman, arts student, on the second day on a summer job as a garbage collector experienced a heat stroke; died 17 days later
- No training to recognize symptoms
- WBGT too difficult to apply and doesn't take into account vulnerabilities
- Rather than relying on the TLV, train workers to enable them to self-regulate (recognize symptoms and know how to reduce heat stress with breaks and fluid intake)
- issues around malignant hyperthermia, a genetic condition (1 in 200) which makes people more susceptible to heat strain

Response to a Heat Stroke Death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NEWS »

World
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Health
Arts & Entertainment
Technology & Science
Money
Consumer Life
Sports
Diversions
Weather
Your Voice

Story Tools: E-MAIL | PRINT | Text Size: S M L XL | REPORT TYPO | SEND YOUR FEE

Barrie bakery reopens after heat stroke death

Last Updated: Tuesday, August 21, 2001 | 9:34 AM ET
CBC News

The Crissa Bakery in Barrie has reopened this week. It has been closed since bakery worker, 44-year-old Kim Warren, died of heat stroke, earlier this month. The temperature inside the bakery was more than 49 degrees when Warren died.

MORE HEA
Western
to promis
aid: repor
Vancouve

- the hazard of heat stress was tragically illustrated by a fatal incident in Barrie in 2001
- soon after the incident, the CAW approached OHCOW to find a simpler way of evaluating heat stress (e.g. Humidex), than the WBGT (wet bulb globe temperature)
- the Oshawa GM assembly plant was used for the pilot study & GM management had input into the development

WBGT-Humidex correlation

- a mid-sized manufacturing firm (350 workers) with some heated presses (400 °F)
- during summer of 2002 three students hired to take WBGT/Humidex measurements continuously on 3 shifts (>7000 measurements taken)
- based on 3773 measurements (all measurements above 22°C WBGT) resulting regression equation:

Humidex = 1.9392*WBGT - 11.338

WBGT (in °C):

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Action Level
TLV®

WBGT (in °C):

work demands:	light	moderate	heavy	very heavy
100 % work; (breaks incl.)	43 49	37 43	not allowed	not allowed
75 % work; 25 % rest	44 49	39 45	35 42	not allowed
50 % work; 50 % rest	46 51	41 47	38 45	36 43
25 % work; 75 % rest	47 52	45 50	43 48	41 47

Action Level
TLV®

WBGT (in °C):

work demands:	light	moderate	heavy	very heavy
100 % work; (breaks incl.)	43	37	not allowed	not allowed
75 % work; 25 % rest	44	39	35	not allowed
50 % work; 50 % rest	46	41	38	36
25 % work; 75 % rest	47	45	43	41

Action Level

2007 Humidex Response Plan:

Humidex	action
30-33	alert & information & water
34-37	warning, education & double water
38-39	restrict activity 25% & actively monitor for signs of heat strain
40-41	restrict activity 50% & actively monitor for signs of heat strain
42-44	restrict activity 75% & actively monitor for signs of heat strain
45+	stop work

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Action Level
TLV®

acclimatized version:

Humidex1	Response	Humidex2
25-29	supply water to workers on an “as needed” basis	32-35
30-33	post Heat Stress Alert notice; encourage workers to drink extra water; start recording hourly temperature and relative humidity	36-39
34-37	post Heat Stress Warning notice; notify workers that they need to drink extra water; ensure workers are trained to recognize symptoms	40-42
38-39	Work with 15 minutes relief per hour can continue; provide adequate cool (10-15°C) water; at least 1 cup (240 mL) of water every 20 minutes worker with symptoms should seek medical attention	43-44
40-41	Work with 30 minutes relief per hour can continute in addition to the provisions listed previously;	45-46*
42-44	if feasible, work with 45 minutes relief per hour can continuein addition to the provisions listed above.	47-49*
45 or over	only medically supervised work can continue *at Humidex exposures above 45, heat stress should be managed as per the ACGIH TLV®	50* or over

Humidex Based Heat Response Plan

1. Training – train everyone for signs & symptoms and what to do
2. Adjust for clothing – add 5° for overalls on top of clothes
3. Select a mmeasurement location – not in direct sunlight
4. Measure workplace Humidex – begin when ambient temperature is above 26°C and then be taken hourly
5. Adjust for radiant heat – add 2-3° to Humidex for full sun, pro-rate for other sources

Scenarios:

Radio says the temperature outside is **32°C** and the relative humidity is **40%**, what would the Humidex be:

1. if you were working outside in the sun?
2. if you had to wear leather protective apron (for welding sparks) plus PPE?
3. if you were working inside?

CAVEAT (warning)!

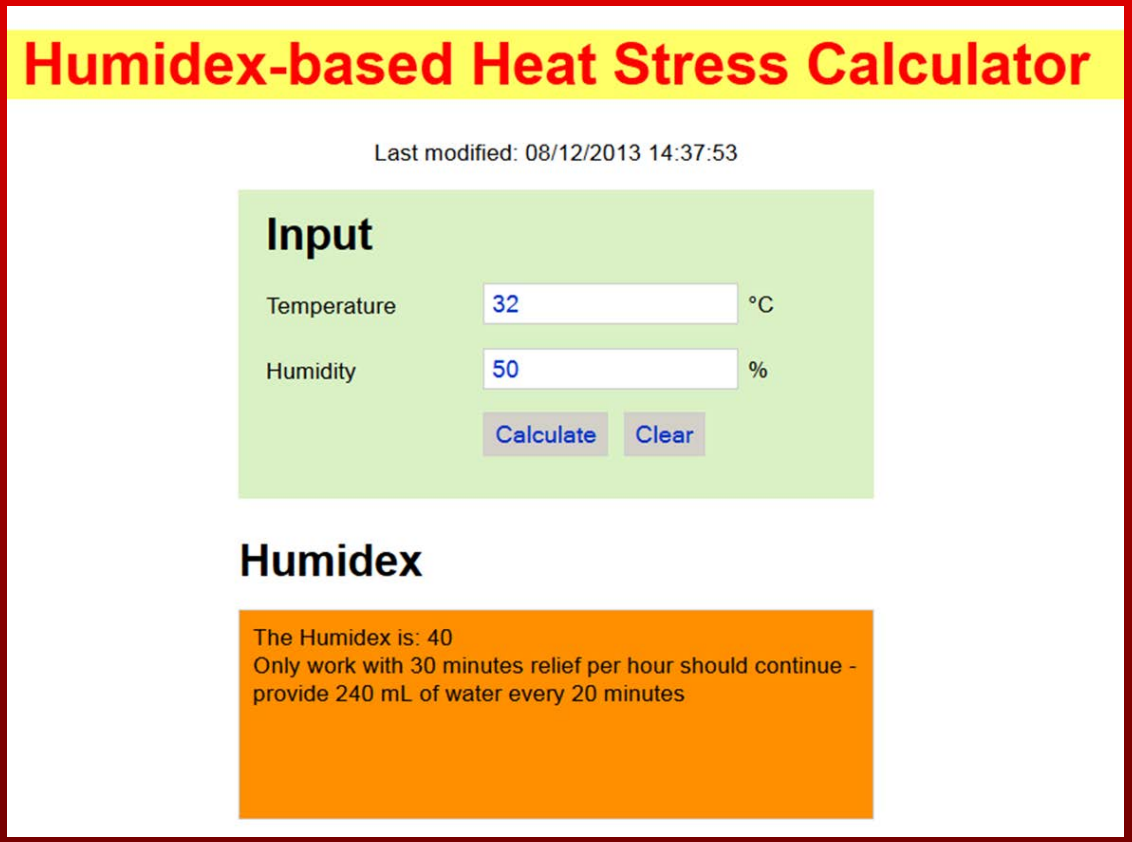
never ignore symptoms

even if
measurements meet
standards!

Calculator:

- Humidex calculator

http://www.ohcow.on.ca/uploads/heat-stress-calculator.html



So, … if it’s too hot, what do we do about it?

General Controls (1) Humidex 1

- Provide accurate verbal and written instructions, frequent training programs, and other information about heat stress and strain
- Encourage drinking small volumes (approximately 1 cup) of cool, palatable water (or other acceptable fluid replacement drink) about every 20 minutes
- Permit self-limitation of exposures and encourage co-worker observation to detect signs and symptoms of heat strain in others
- Adjust expectations of those returning to work after absence from hot exposure situations
- Monitor heat stress conditions and reports of heat-related disorders

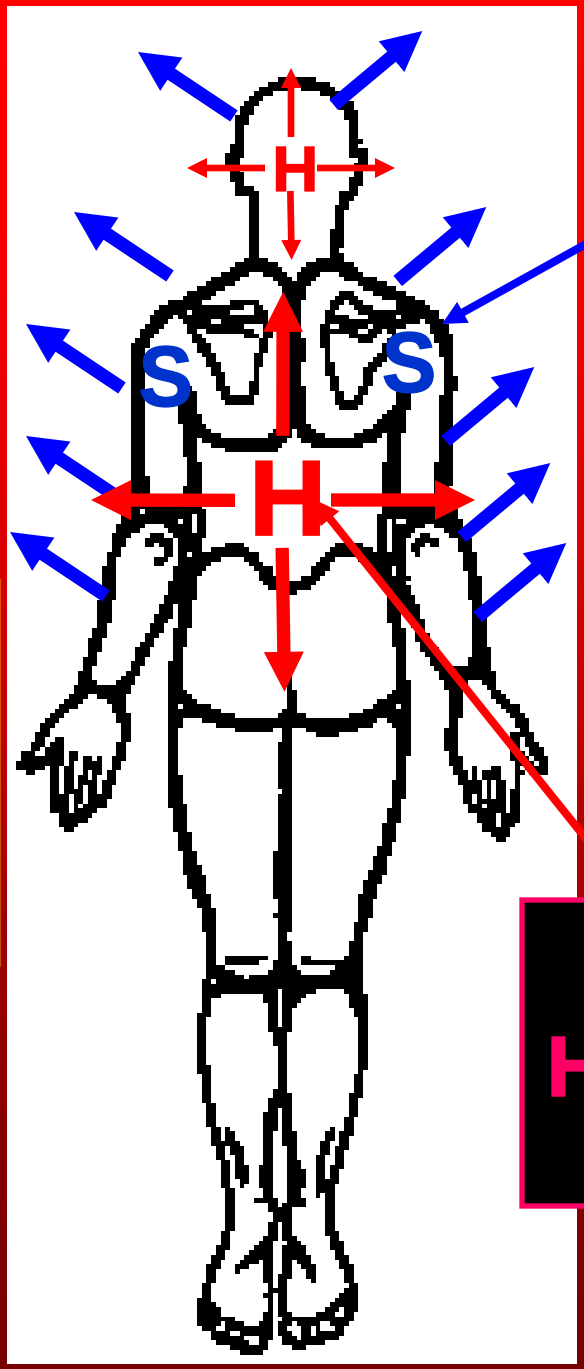
General Controls (2) Humidex 1

- Counsel and monitor those who take medications that may compromise normal cardiovascular, blood pressure, body temperature regulation, renal, or sweat gland functions; and those who abuse or are recovering from the abuse of alcohol or other intoxicants
- Encourage consumption of salty foods (with approval of physician if on a salt-restricted diet)
- Consider pre-placement medical screening to identify those susceptible to systemic heat injury

Heat Balance

H

External Heat sources
hot weather
radiant heat sources

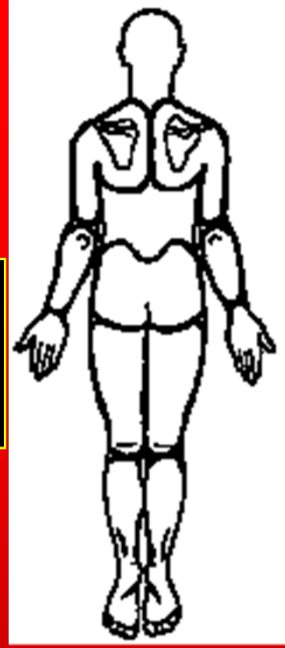


Cooling
evaporation of sweat

Internal Heat sources
muscle activity

External heat source controls

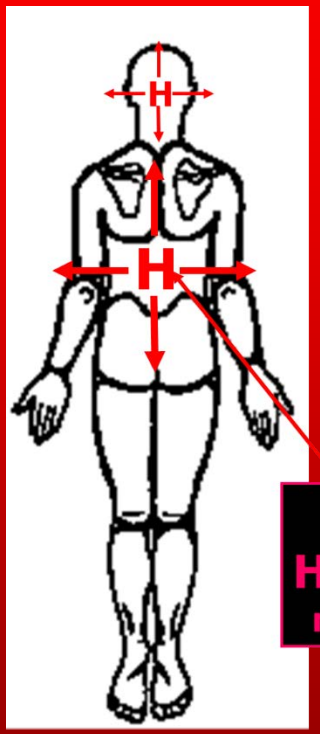
External Heat sources
hot weather
radiant heat sources

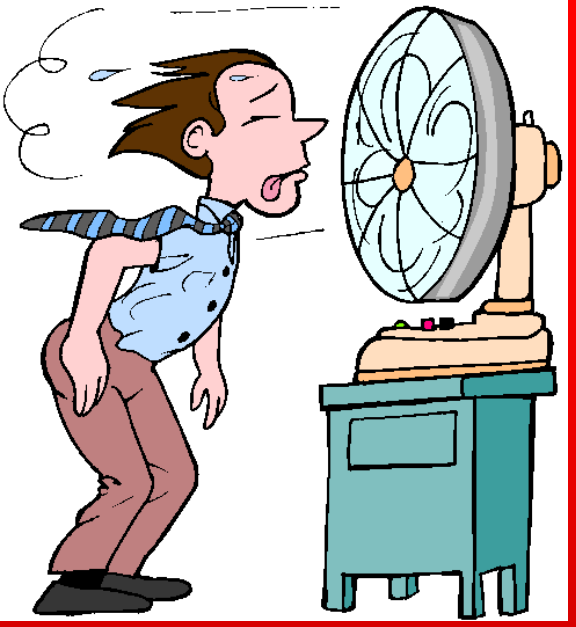


- **At the source**
  - Replace/isolate heat producing processes
  - Block radiant heat with barriers (shade)
- **Along the path**
  - Isolate worker from heat
  - Air condition workplace (booth)
  - Capture hot air with exhaust ventilation

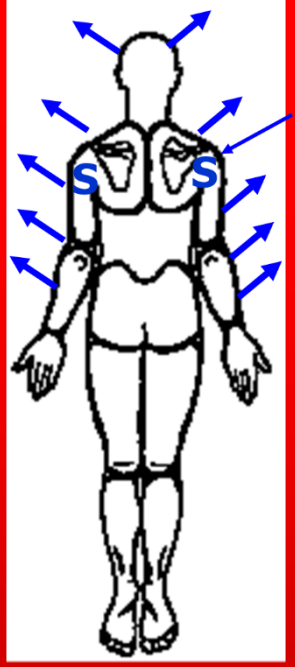
Internal source controls:

- **At the <u>other</u> source**
  - Reduce workload
    - improve ergonomics,
    - provide assistance,
    - increase relief time
    - slow down
  - Provide adequate water
  - Actively cool body
  - Gradually acclimatize
  - Ensure good nutrition and rest





Cooler Fans



- Purpose of a cooling fan is primarily to increase the rate of sweat **evaporation** but it also cools by **convection** if the air is cooler than the skin
- Fan coolers may **interfere with local exhaust** ventilation for contaminant control, therefore be careful in where they are placed and how they are pointed

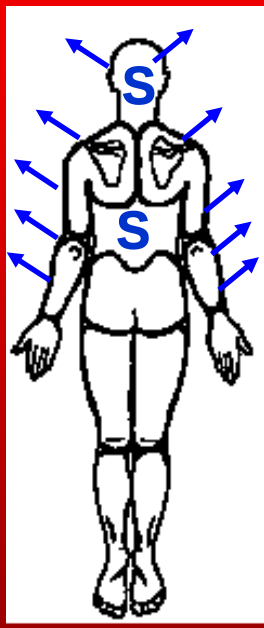
Cooler Fans (limitations)

- If the **relative humidity** is over **75-80%** the fan will no longer increase evaporation of sweat
- The closer the air temperature is to **skin temperature** (35-36°C) the less effective the cooling
  - if the air temperature exceeds skin temperature then the fan **may even heat up the body** (like a convection oven)!

Promoting Cooling

- Wear loose clothes that allow sweat to evaporate easily (cotton)
- Take internal heat sources into account when using any personal protective clothing that prevents sweat from evaporating
- Wash clothes regularly and maintain good personal hygiene

Cooling
evaporation of sweat



Drink Water

Acclimatization does not decrease your body's need for water.

Drink plenty of water!

Dehydration

fluid loss	time*	effect & symptoms (* timing may vary based on intensity of work and heat/humidity)
0.75 L	1 hr	unnoticed (at 1.5% weight loss you are considered dehydrated)
1.5 L	2-3 hrs	loss of endurance, start to feel thirsty, feel hot, uncomfortable
2.25 L	3-4 hrs	loss of strength, loss of energy, moderate discomfort
3 L	4-5 hrs	cramps, headaches, extreme discomfort
3.5-4 L	5-6 hrs	heat exhaustion, nausea, faint
5+ L	7+ hrs	heat stroke, collapse, unconsciousness

taken from: OH&S Canada Volume 69, Number 5, page 52, May 2000

How Much Water is Enough?

- More than you want just to satisfy your thirst
- Sources of water are:
  1. Fluids - 1 cup or 8 oz = 240 mL every 20 min
  2. Foods - fruit & veggies are 90% water
- Why 10-15°C? ... to maximize the amount you drink (not too cold, not luke warm)
- Does it need to be delivered to the work station? ... depends on workplace logistics ...

What to drink:

- Electrolyte drinks (e.g. Gatorade) are usually not needed for typical North American diet (can be used for first aid for cramps).
- Stay away from caffeinated carbonated, diet drinks and alcohol as they take water out of your body.
- Water is the best; juices and/or noncaffeine sport drinks are also good (juices contain energy restoring glucose).

Eat Healthy

You can and should replace essential elements lost during sweating;

Eat a balanced diet rather than taking salt tablets or drinking expensive sports drinks.

Personal Protective Equipment

Special cooling vests or ice vests have been developed to wear under chemical–resistant suits

(use on a case by case basis – they may not work for everyone)

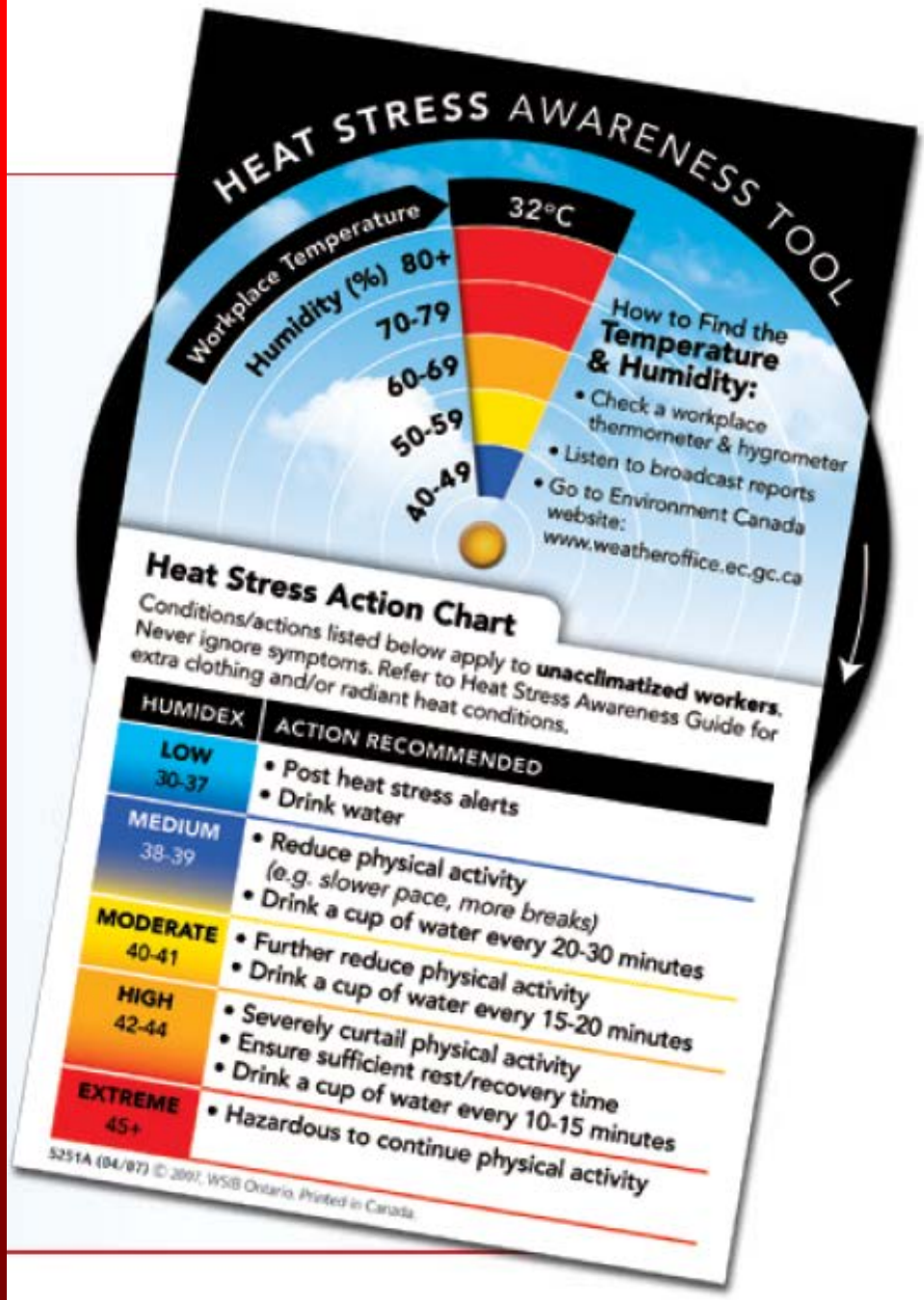
Job Specific Controls Humidex 2

- Consider engineering controls that reduce the metabolic rate, provide general air movement, reduce process heat and water-vapor release, and shield radiant heat sources, among others
- Consider administrative controls that set acceptable exposure times, allow sufficient recovery, and limit physiological strain
- Consider personal protection that is demonstrated effective for the specific work practices and conditions at the location
- In addition to general controls

Resources

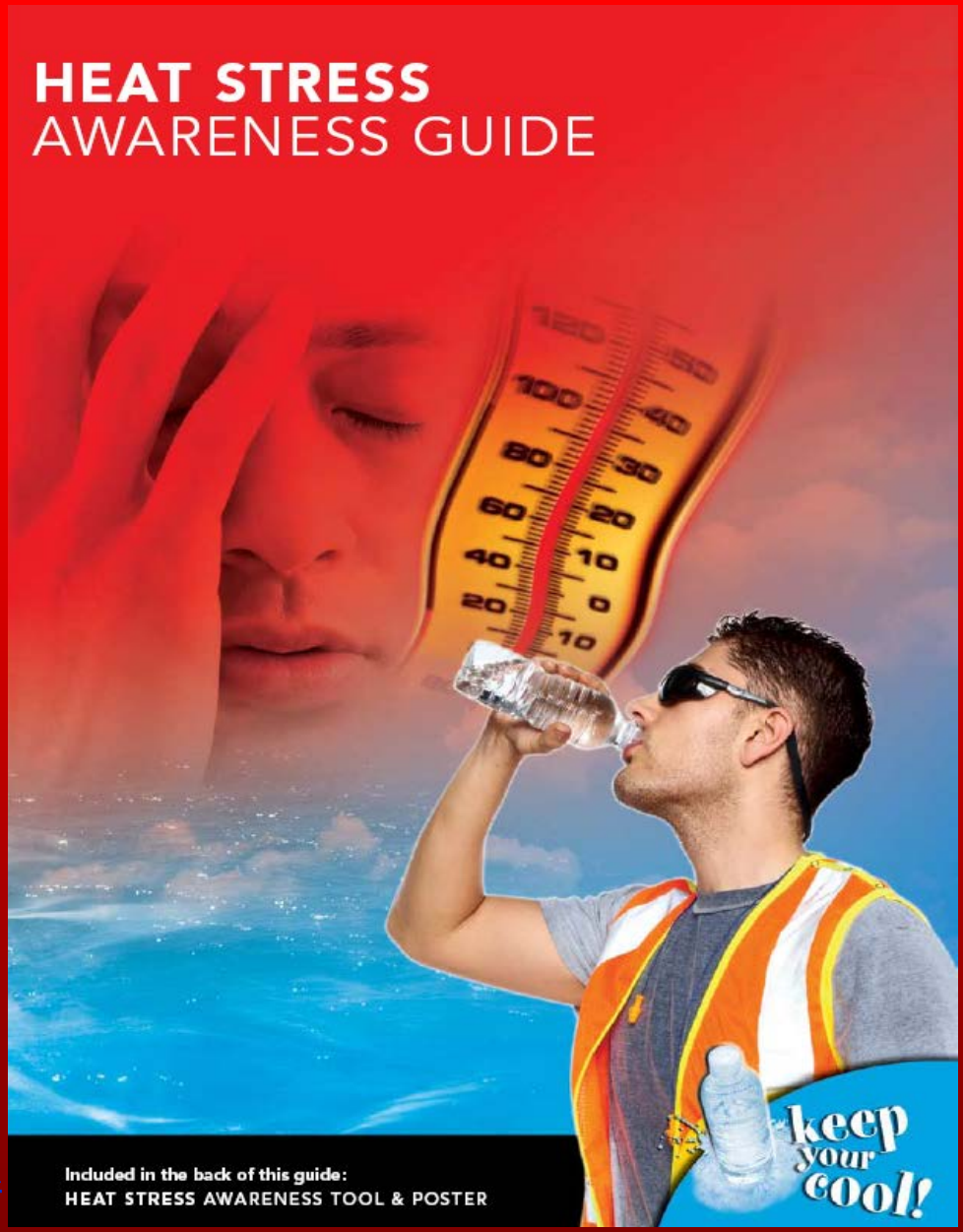
OHSCO Package: the poster

OHSCO Package: the heat stress awareness tool (wheel)



OHSCO Package: the Awareness Guide (online only)

http://www.ohcow.on.ca/uploads/Resource/OHSCOHeatStressAwarenessToolkit/Heat%20Stress%20Awareness%20Guide.pdf



Resources

Occupational Health Clinics for Ontario Workers

Centre de Santé des Travailleurs(ses) de l'Ontario

Toll Free: 1-877-817-0336

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RESOURCES

- GENERAL HANDOUTS
- TECHNICAL INFO SHEETS
- WORK BOOKS
- SOFTWARE PROGRAMS

Occupational Health and Safety Council of Ontario's (OHSCO) Heat Stress Awareness Toolkit

Heat Stress Awareness Poster
Heat Stress Awareness Tool
Heat Stress Awareness Guide

http://www.ohcow.on.ca/heatstressawarenesstoolkit

Humidex-based Heat Stress Calculator

Last modified: 08/12/2013 14:37:53

Input

Temperature 32 °C

Humidity 50 %

Calculate Clear

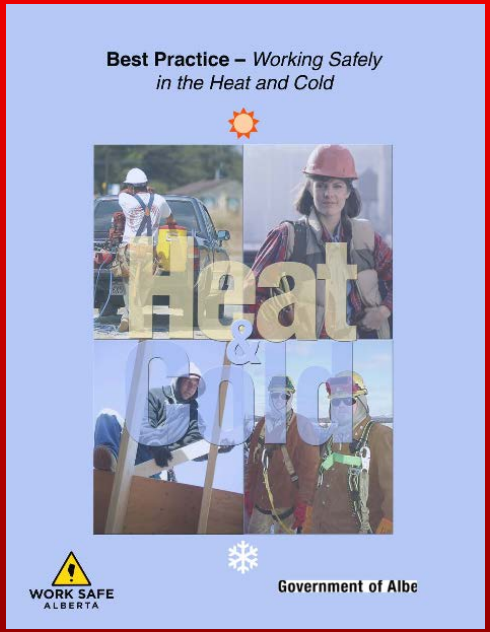
Humidex

The Humidex is: 40
Only work with 30 minutes relief per hour should continue - provide 240 mL of water every 20 minutes

http://www.ohcow.on.ca/uploads/heat-stress-calculator.html

other jurisdictions …

- BC H&S Guideline G7.29-4: Heat stress assessment using a **Humidex** index
  http://www2.worksafebc.com/publications/OHSRegulation/GuidelinePart7.asp#SectionNumber:G7.29-4
- Alberta has incorporated the Humidex plan in a 96 page bulletin for workplaces



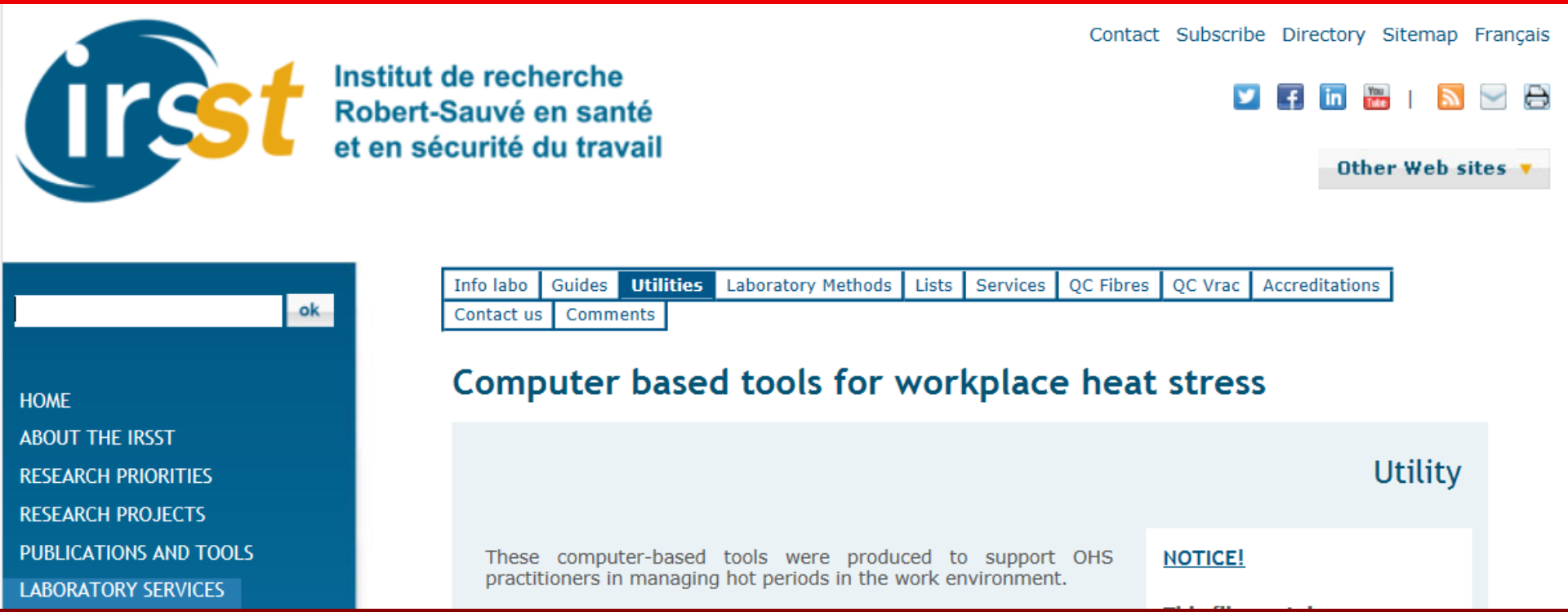
http://work.alberta.ca/documents/WHS-PUB_gs006.pdf

Videos

- The MOL has a 4 minute video summarizing heat stress hazards and how to respond to them

http://www.videodelivery.gov.on.ca/player/download.php?file=http://www.media.gov.on.ca/bfde244013aab14f/en/pages/text.html

IRSST



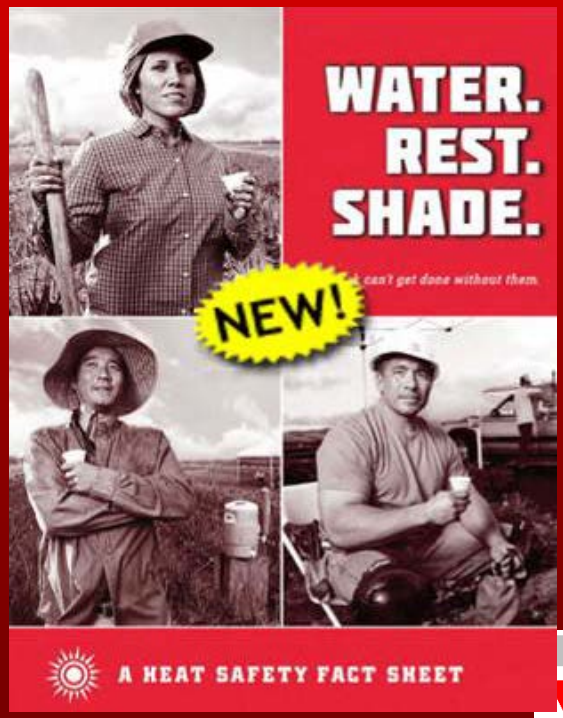
http://www.irsst.qc.ca/en/_outil_100042.html

WATER. REST. SHADE.

The work can't get done without them.

OSHA (US)

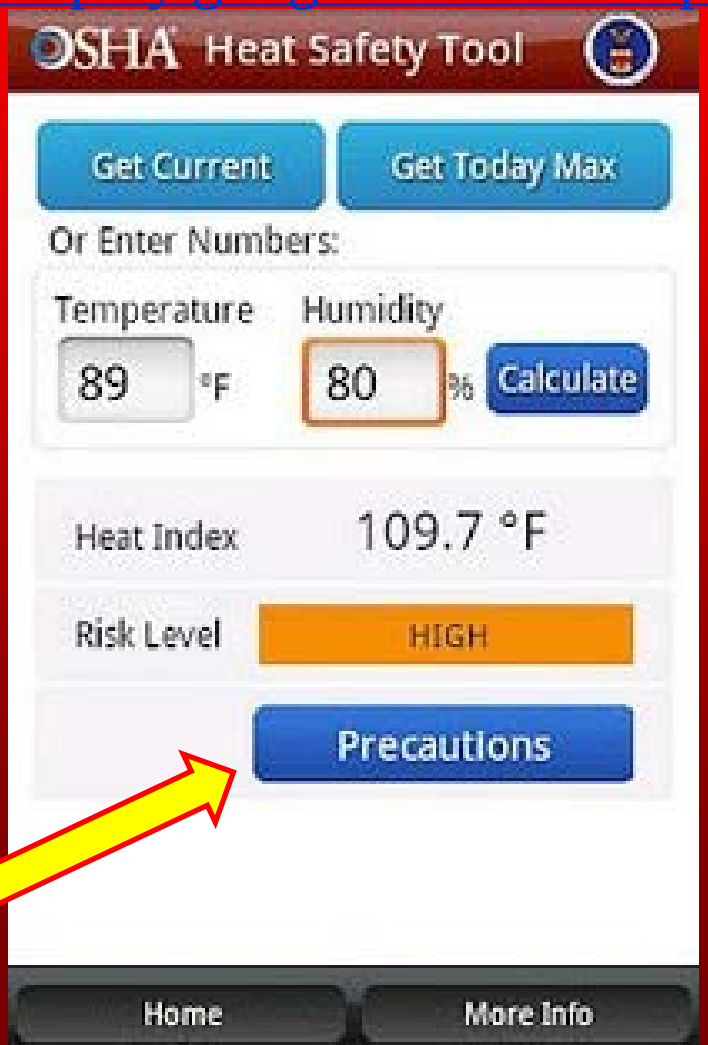
- New materials for 2011
- Poster and factsheets (also available in Spanish)
- Video for US employers

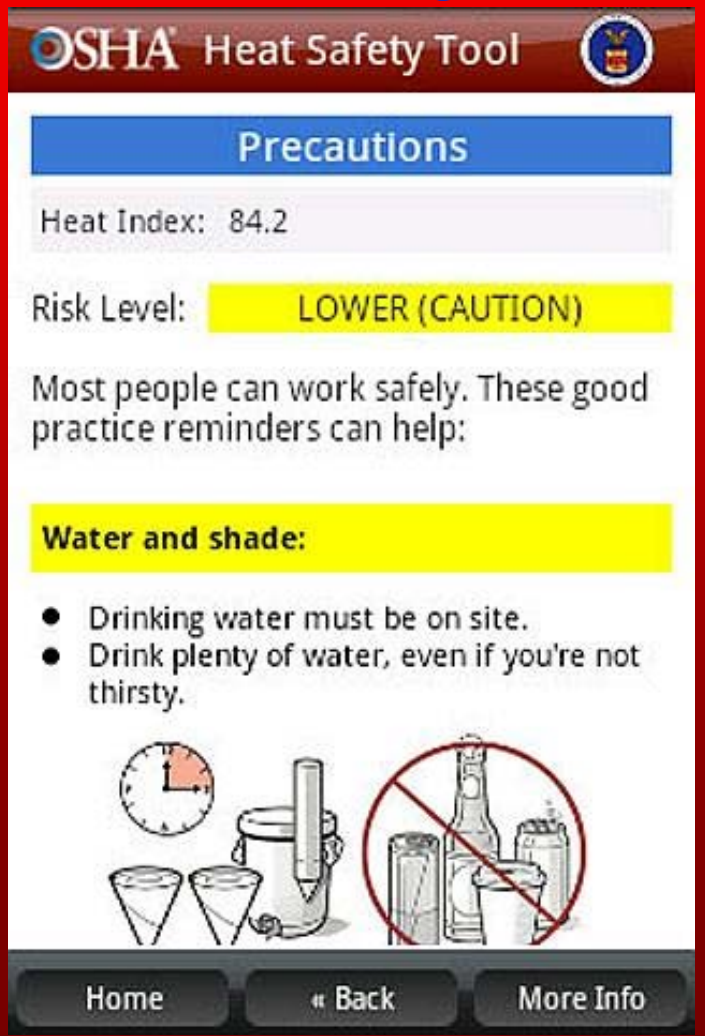


http://www.osha.gov/SLTC/heatillness/edresources.html

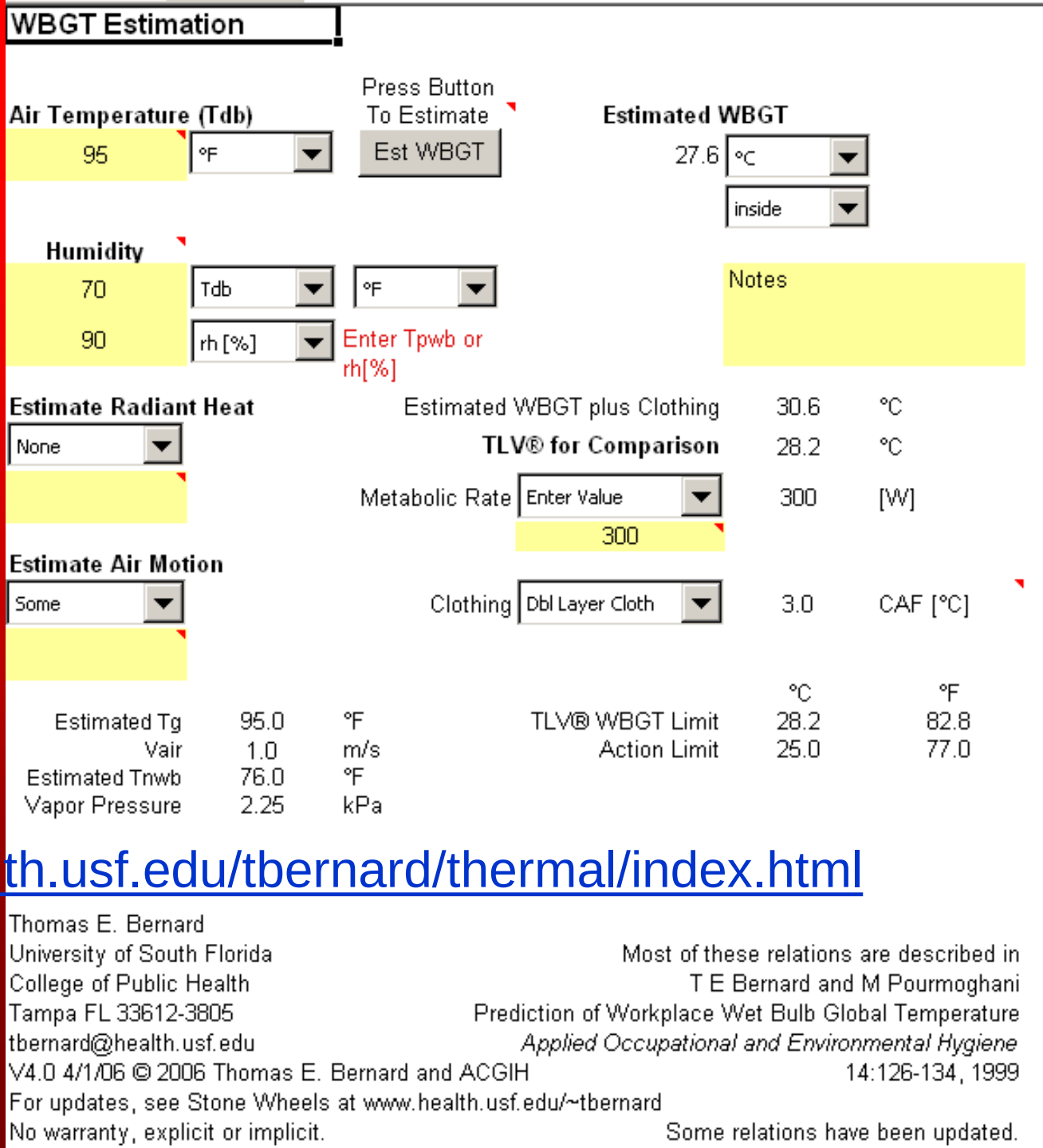
Heat stress app (US):

https://play.google.com/store/apps/details?id=com.erg.heatindex&hl=en





Thomas Bernard's calculators



WBGT Estimation

Air Temperature (Tdb): 95 °F

Press Button To Estimate: Est WBGT

Estimated WBGT: 27.6 °C

inside

Humidity: 70 Tdb °F

90 rh [%]

Enter Tpwb or rh[%]

Notes

Estimate Radiant Heat: None

Estimate Air Motion: Some

Estimated WBGT plus Clothing: 30.6 °C

TLV® for Comparison: 28.2 °C

Metabolic Rate: Enter Value 300 [W]

300

Clothing: Dbl Layer Cloth 3.0 CAF [°C]

				°C	°F
Estimated Tg	95.0	°F	TLV® WBGT Limit	28.2	82.8
Vair	1.0	m/s	Action Limit	25.0	77.0
Estimated Tnwb	76.0	°F			
Vapor Pressure	2.25	kPa			

http://personal.health.usf.edu/tbernard/thermal/index.html

Thomas E. Bernard
University of South Florida
College of Public Health
Tampa FL 33612-3805
tbernard@health.usf.edu

Most of these relations are described in
T E Bernard and M Pourmoghani
Prediction of Workplace Wet Bulb Global Temperature
Applied Occupational and Environmental Hygiene
14:126-134, 1999

Some relations have been updated.

Acknowledgements:

I'd like to acknowledge those who helped shape the ideas presented here:

George Botic
Dan Boone
Tom Harris
Paul Goggan
Paul Piels
Lejla Krdzalic

… any questions? …