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Safety Fest of the Great NW – CWI Micron Campus
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Heat Illness and Prevention

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Agenda

- Case Examples
- Define Heat Stress
- Physiology of Heat
- Acclimatization
- Types of Heat Disorders
  - Effect on Safety
- How to Measure
- Exposure Limits
- Controls
- Heat Illness Prevention Program
- Sources of Help and Information

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Common Jobs

Outdoors

- Construction, especially roofing and road
- Maintenance
- Landscaping
- Delivery
- Security

Indoors

- Bakeries and kitchens
- Laundries
- Utilities, especially boilers
- Warehousing
- Manufacturing with heat sources

Local and National

CASE STUDIES

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42 Year-Old Roofing Worker

Scenario:

- Plenty of water, Gatorade, ice
- 3rd day on the job, slightly warmer
  - 86°F, 57% RH = **90°F Heat Index**
  - WBGT 82°F nearby (scattered clouds)
- Afternoon feeling ill. Rested alone in sun. Workers found minutes later w/ heat stroke and died at the hospital

Lessons:

- Protect new workers
- Never leave alone, seconds matter
- Take to cool location
- Temps don't have to be extreme

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Delivery Worker

Scenario:

- 6 years at company
- Driving and walking in neighborhoods
- Late May suddenly hotter
- 2nd day of heat developed cramps and heat exhaustion
- Hospitalized two days w kidney failure from dehydration

Lessons:

- Even experienced workers vulnerable when conditions warm
- All workers need time to adapt including local weather changes
- Make sure drinking enough fluids

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35 Year-Old Foundry Worker

Scenario:

- 6-year employee
- High heat from ovens and molten metal
- Normally worked in a cooler area
- New to a job in hotter environment near an oven
- Wore heavy protective clothing to prevent burns
- After several hours collapsed and died of heat stroke

Lessons:

- Can occur indoors
- Clothing can prevent release of heat from the body. Not accounted for by environmental monitoring
- Risk when assigned new tasks
- Can happen to healthy younger workers

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Central Idaho

- 18 year-old. First day working
- Sudden increase in weather temps
- Water gone before noon
- Other workers described signs of heat illness

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Logging Safety

Lessons:

- Heat can increase fatigue and affect clear thinking
- Ensure sufficient breaks and slow pace of work

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Commonalities and Culture of Workplace Tragedies

- Males (93%*)
- Emphasis on getting the job done
- Little or no planning before hand
  - No hazard assessments
- Seldom the first time
- None of them believed it would happen
- Preventable
- Lives and communities changed forever

*Source: Death on the Job: The Toll of Neglect. AFL-CIO. April 2019

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Physiology and Acclimatization

WHAT IS HEAT STRESS?

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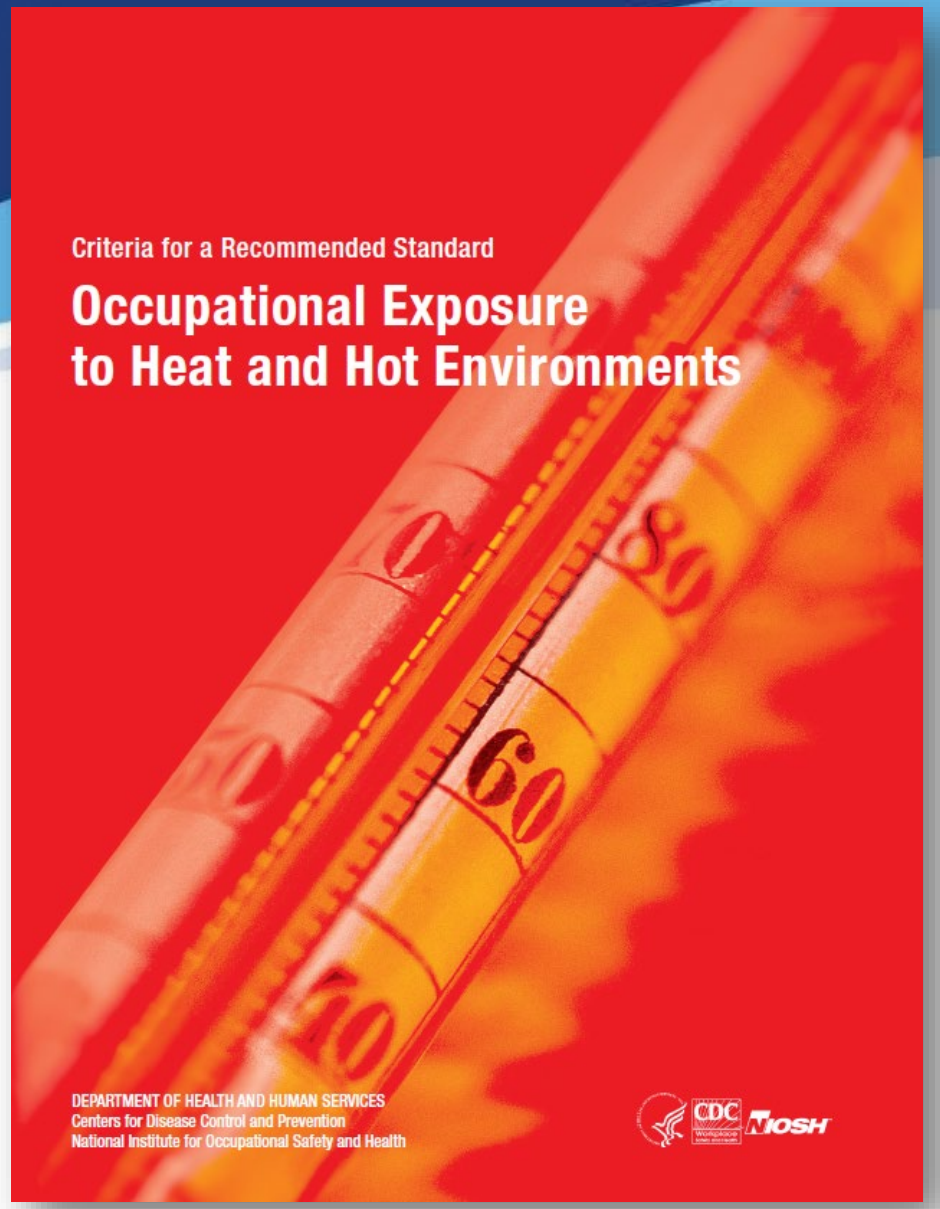
NIOSH Criteria Document

NIOSH, as part of OSH Act of 1970, to recommend safety and health standards

- **Goal:** ***Limit the exposures at which no worker will suffer diminished health, functional capacity, or life expectancy because of his or her work experience***



www.cdc.gov/niosh/topics/heatstress/

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Defining Heat Stress

Normal body functioning when core temperature maintained close to 37°C (98.6°F)

- **Illness and injuries occur when:**

Total heat load > Body's ability to dissipate heat

(environmental and metabolic > exchange from blood flow to skin / sweating)

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Heat Exchange Factors

- Air Temperature and Humidity
- Skin Temperature
- Air Velocity
- Evaporation of Sweat
  - Respiratory (generally minor,
- Radiant Temperatures
- Clothing

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Heat Equation

Change in Body Heat = (M – W) ± C ± R ± K - E

- (M – W) = Metabolic heat: Total metabolism minus external work performed
- C = Convective heat exchange (between air and skin)
- R = Radiative heat exchange (between solid objects and skin)
- K = Conductive heat exchange (direct contact between skin and surrounding surfaces …minor)
- E = Evaporative heat loss
  - Clothing factor

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Convection a function of:

- Ambient air temperature,
- Skin temperature, and
- Rate of air movement

- When temp >35°C (95°F), gain in body heat from air
- When temp ,35°C (95°F) heat will be lost to air

Radiation (R) a function of:

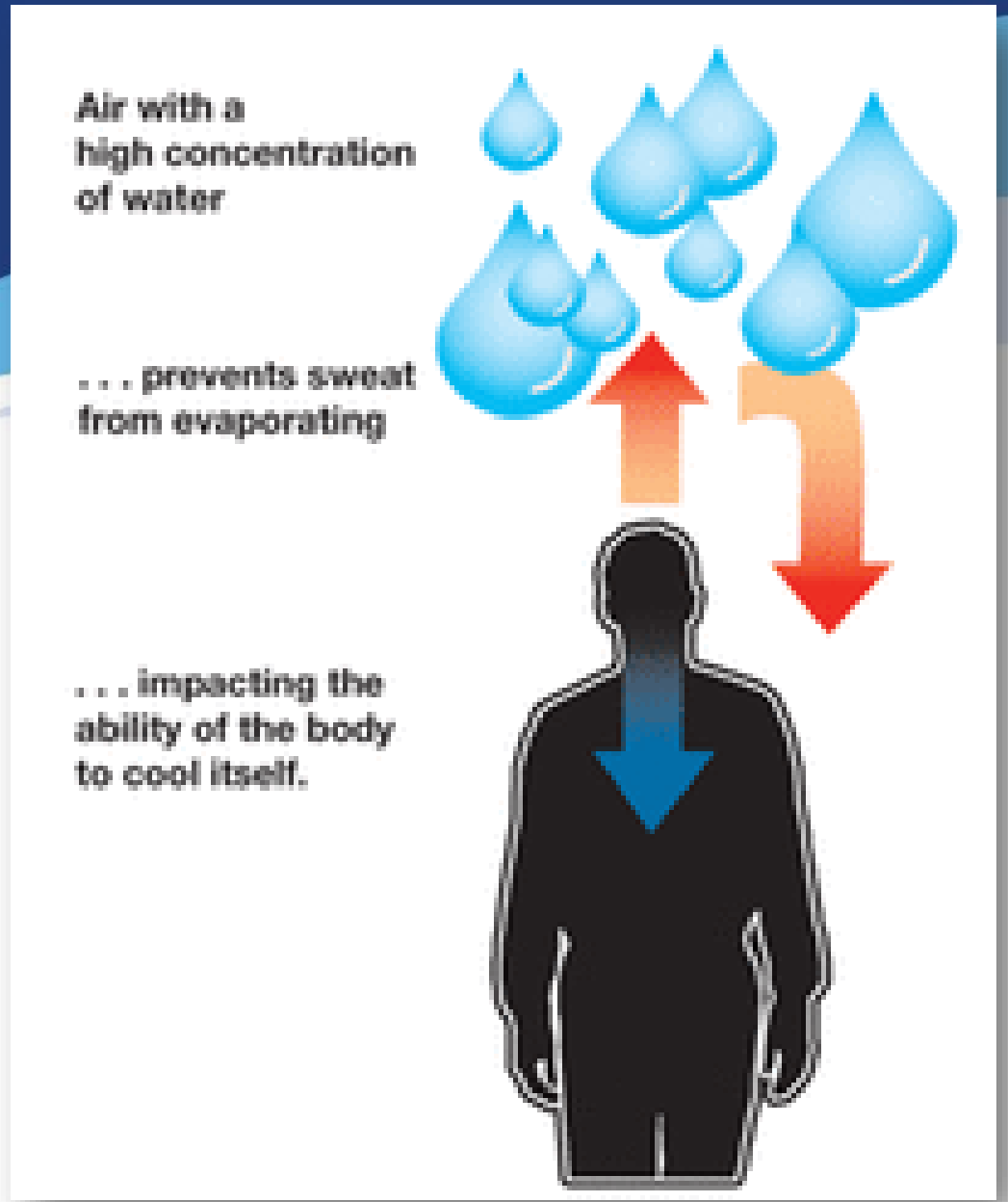
- Temp of solid surroundings, and
- Skin temperature

- Affected by barriers, including clothing

Evaporation (R) a function of:

- Air movement
- Vapor pressure difference between
  - Ambient air (humidity)
  - and wetted skin (assumed 95°F)

➢ Affected by clothing



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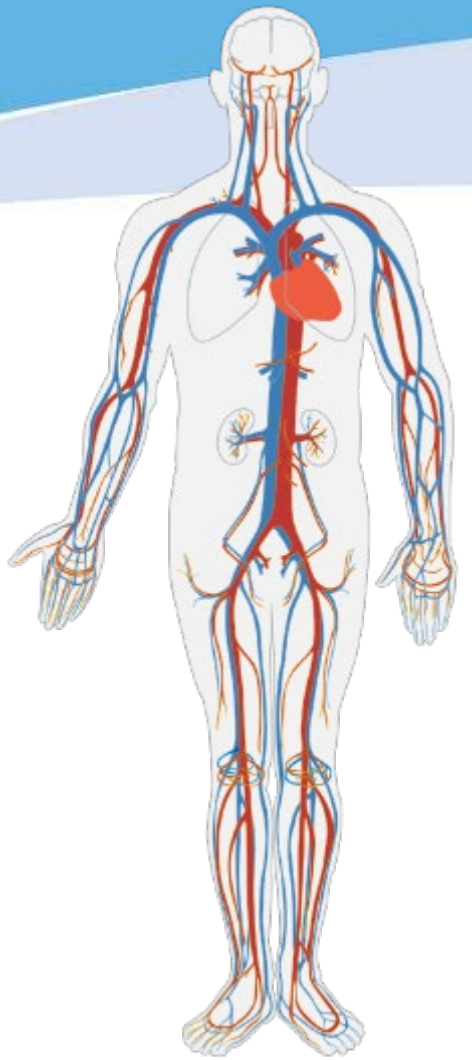
Clothing

Alters the rate of heat exchange by

- Convection
- Conduction
- Radiation and
- Sweat evaporation

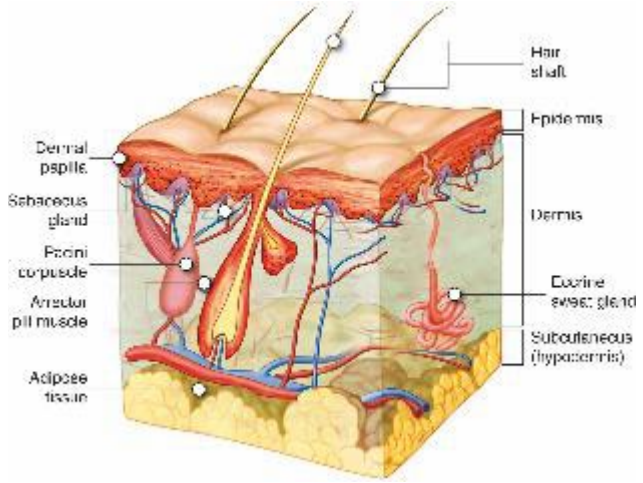
Thicker and more impermeable, interferes with heat exchange

Body's Response to Heat



- Central Nervous System
- Circulatory System
- Sweating

  And more



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Work and Heat

- Body naturally makes heat – thermogenesis
- As work 
  - Cardiac output – heart rate and volume 
  - Muscle temps 
  - Oxygen may be insufficient = anerobic 
  - Initial vasoconstriction to other parts of body 

Competition for blood between muscles, skin, other organs

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Recovery

- Dissipate lactic acid build-up
- Dissipate heat load
- Replenish water loss
- Restore oxygen balance
- ATP recovery in muscle
  - and more

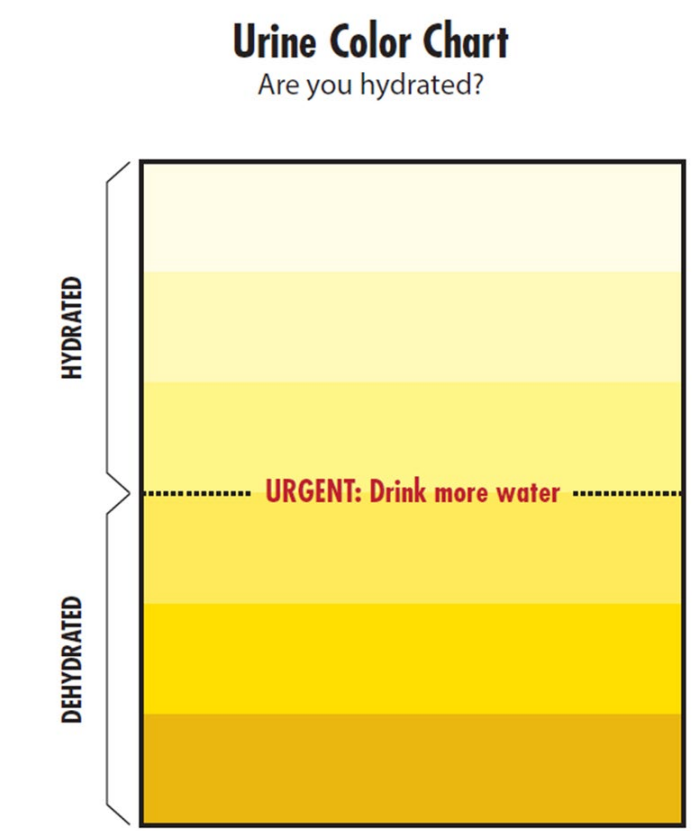
Hydration

- Evaporative cooling from sweat
  - Once sweat is dripping it is wasting more than evaporated
- Up to 1 liter/hour or more
- Thirst is insufficient to replenish
- Prolonged sweating (approx. > 2 hours) diminishes electrolytes

Hydration

- As the body dehydrates, less sweat is produced
  - Can dramatically and rapidly increase body temp
- Difficult to fully rehydrate during work

Important: Alcohol consumption after work can prolong rehydration



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Brain and Heat

- Affected by:
  - Diminished oxygen
  - Reduced blood volume
    - dehydration
    - demand of muscles and skin
  - Electrolyte imbalance
  - Heat

- Can impair cognitive function including
  - Psychomotor functioning
  - Vigilance

Acclimatization

50% to 70% of outdoor fatalities occurred withing the first few days of working in warm or hot environments

Physiological Adaptations

- Increased sweating efficiency
  - Greater production and reduced electrolyte loss
- Stabilization of circulation
- Ability to perform work at lower core temp and heart rate
- Increased skin blood flow at a given core temperature

Acclimatization Schedule

New workers:

20% exposure on day 1

Add no more than 20% each day

Previous experience

No more than 50% on day 1

60% day 2,

80% day 3,

100% day 4

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Maintaining Acclimatization

- Most workers can maintain if away from job (heat) few days

  i.e. weekend

- If absent (away from heat) a week or more
  - Gradually reacclimate over 2 to 3 days

Risk Factors

- **Individual Variability**

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Illness and Injuries

TYPES OF HEAT DISORDERS

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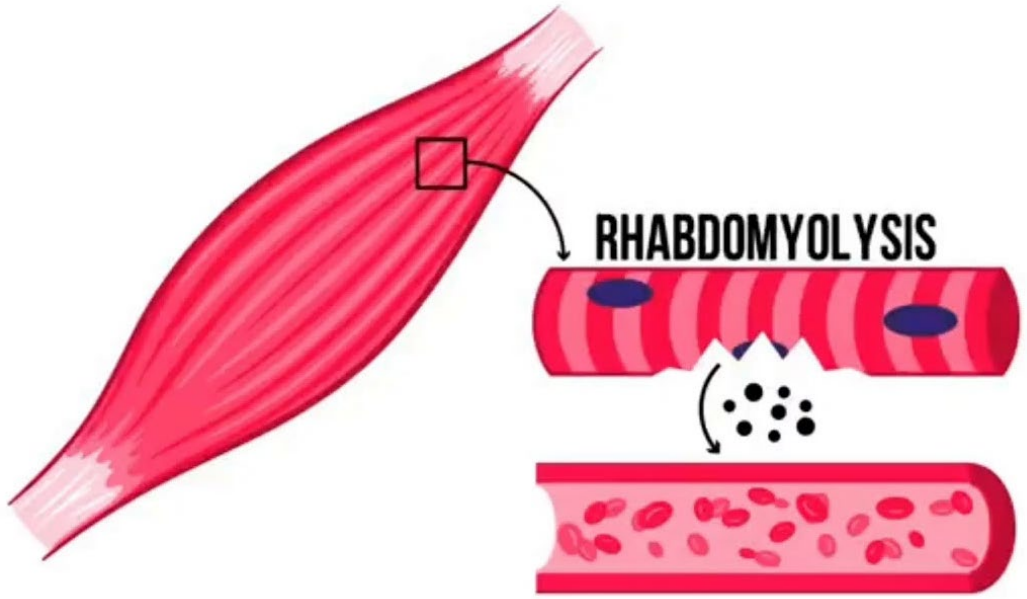
Rhabdomylosis

Breaking down of muscle, releasing into blood stream

- Muscle pain
- Dark urine “Coca Cola” or reduced urine from kidney damage
- Weakness



Heat Rash
aka “prickly heat” or sweat rash

- Excessive sweating
- Blocked sweat glands (days later)
- Clusters or red bumps on skin
  - Neck, upper chest and skin folds common

Other Heat Illnesses

Heat Syncope

- Dizziness
- Fainting
- From low blood pressure / flow to the brain

Heat Cramps

- Muscle spasms or pain
- Arms, legs or trunk common
- From fluid and electrolyte loss

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Heat Exhaustion

- Fatigue
- Irritability
- Headache
- Thirst
- Nausea or vomiting

- Dizziness or lightheadedness
- Heavy sweating
- Elevated body temperature or fast heart rate
- Decreased urine output

Heat Stroke

IMMINENT DANGER!!!

- Confusion
- Slurred speech
- Unconsciousness
- Seizures
- Heavy sweating or hot, dry skin
- Very high body temperature
- Rapid heart rate

Call 9-1-1
Take immediate action

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Environmental and Metabolic

MEASURING HEAT AND EXPOSURE LIMITS

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Standards

- OSHA General Duty Clause
- NIOSH Recommended
- ACGIH
- State Specific
  - California, Washington, Minnesota
- PPE, Sanitation (cool potable water), Medical Services/First Aid

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Environmental

WBGT – Most common

- **Dry bulb** – measures temp without other factors
- **Wet bulb** – measures sweat effectiveness
  - Factors wind speed and humidity in the air
- **Black globe** – hollow copper sphere painted flat black to measure radiant energy

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WBGT Equations

- **Outdoors**

$$WBGT_{out} = 0.7T_{nwb} + 0.2T_g + 0.1T_{db}$$

- **Indoors**

$$WBGT_{in} = 0.7T_{nwb} + 0.3T_g$$

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Environmental

Weather Data – Using downloadable calculator in the OSHA Technical Manual

- Air Temperature
- Solar Irradiance
- Wind Speed
- Relative Humidity %
- Date and time
- Barometric Pressure
- Longitude and latitude

National Climatic Data Center provides certified weather data.

Add Clothing Adjustment Factor

Clothing Worn	CAF
Work clothes (long sleeves and pants). Ex: Standard cotton shirt/pants.	0
Coveralls (w/only underwear underneath). Ex: Cotton or light polyester material.	0
Double-layer woven clothing.	3°C (5.4°F)
SMS Polypropylene Coveralls	0.5°C (0.9°F)
Polyolefin coveralls. Ex: Micro-porous fabric (e.g., Tyvek™).	1°C (1.8°F)
Limited-use vapor-barrier coveralls. Ex: Encapsulating suits, whole-body chemical protective suites, firefighter turn-out gear.	11°C (19.8°F)

From ACGIH 2017 TLVs and BEIs Table 1

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Determine Metabolic Work Rate

Work Category	Metabolic Rate (Watts)	Examples
Rest	115	Sitting
Light	180	Sitting, standing, light arm/hand work and occasional walking
Moderate	300	Normal walking, moderate lifting
Heavy	415	Heavy material handling, walking at a fast pace
Very Heavy	520	Pick and shovel work

From ACGIH 2017 TLVs and BEIs Table 1

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Factor the Worker's Body Weight

- Compared to 70 kg (154 lbs worker)

$$\frac{\text{Work Watts from Table} \times \text{Body Weight}}{\text{70 kg (or 154 lbs)}}$$

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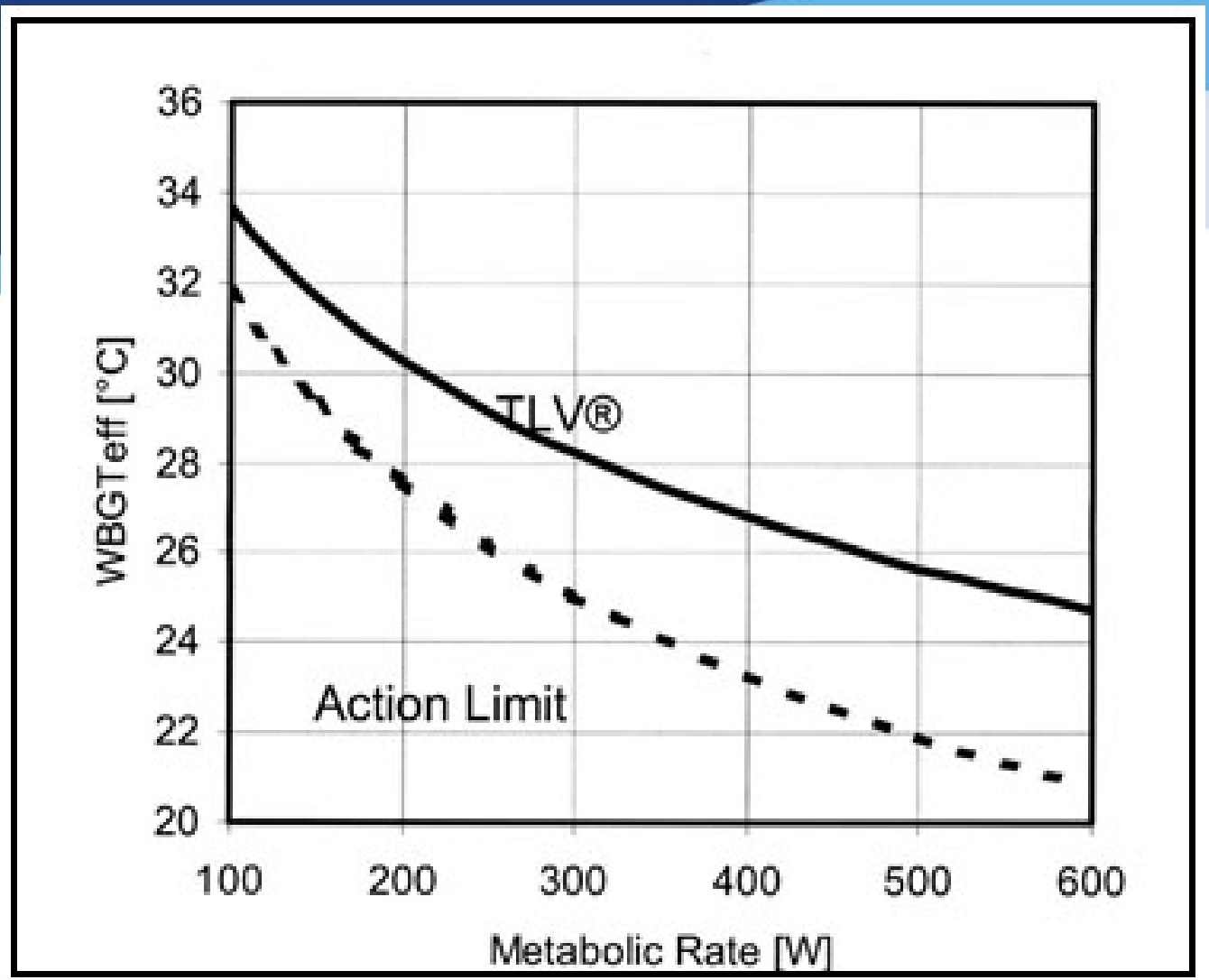
Determine TLV and Action Level

TLV, REL, OEP, PEL = Not to Exceed

Action Limit, AL, RAL = Point at which actions to be taken



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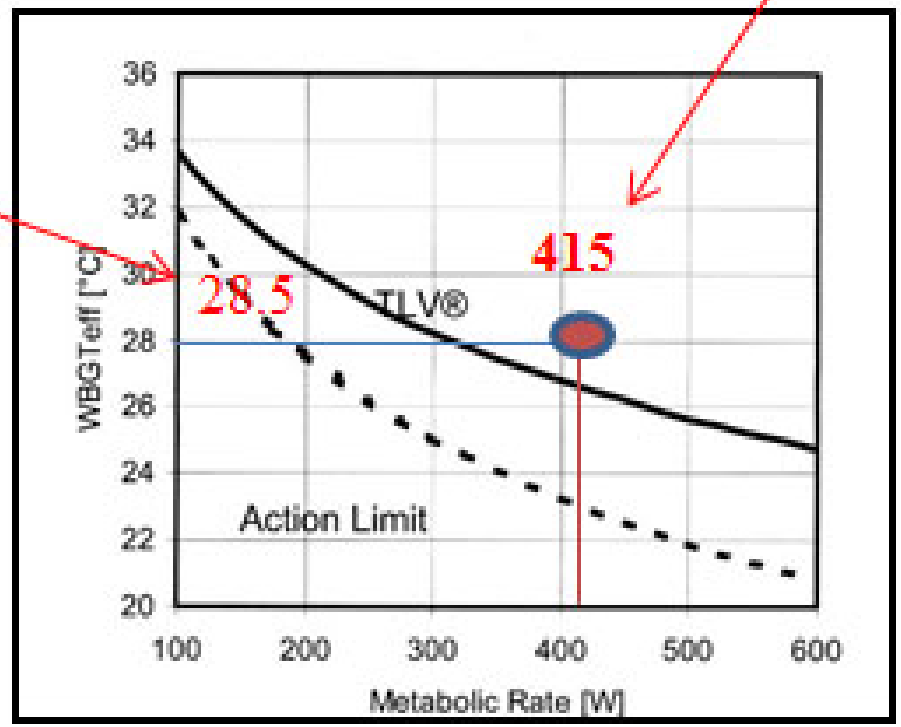
Example

- WBGT = 25.5°C (77.9°F)
- Double layered woven clothing, add 3°C = 28.5°C (83.3°F)
- Heavy work = 415 watts*

*Did not account for different body weight

Metabolic work rate from Table 3

$WBGT_{eff}$ from Step 2



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Physiologic Monitoring

- **More accurate assessment of heat tolerance**
- **Individualized measurement of response**
- **Impermeable clothing may contribute and is not measured with environmental monitoring**

Examples:

- Heart rate
- Body temperatures
- Weight changes during a work shift (sweating)

Caution! WBGT is NOT effective when wearing impermeable clothing!

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More Simplified Guidance

Rules of Thumb, including:

- Heat Index
- ACGIH Work / Rest
- OSHA Heat Stress Calculator

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Table C-1. Heat index–associated protective measures for worksites

Heat index	Risk level	Protective measure
Less than 91°F (33°C)	Lower (caution)	Basic health and safety planning
91°F to 103°F (33°C to 39°C)	Moderate	Implement precautions and heighten awareness
103°F to 115°F (39°C to 46°C)	High	Additional precautions to protect workers
Greater than 115°F (46°C)	Very high to extreme	Even more aggressive protective measures

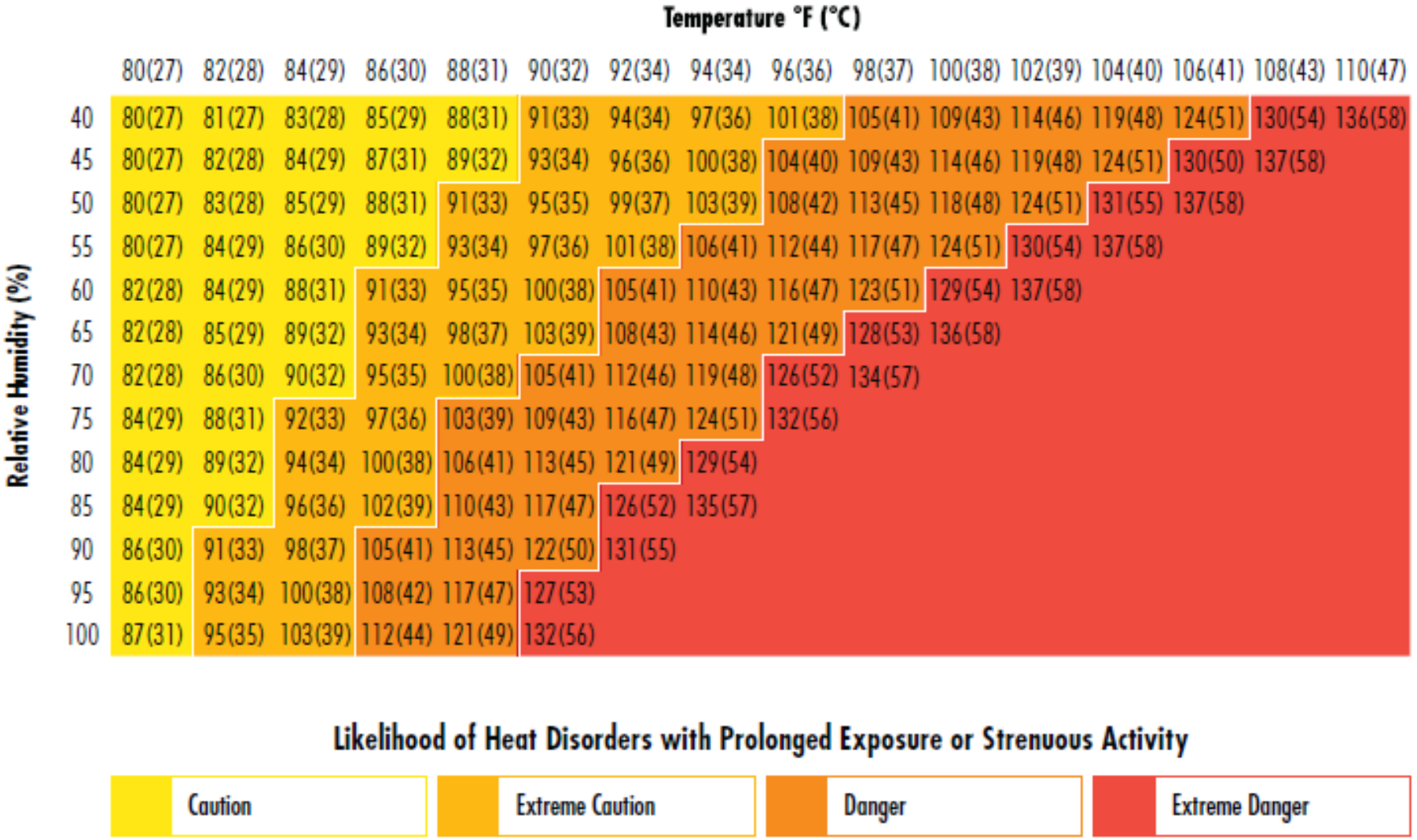
Adapted from OSHA [2012c].

Additional information about protective measures mentioned in the above table can be found on OSHA's website.

Note: The presence of a radiant heat source may decrease the accuracy and usefulness of the above heat index.

NOAA's National Weather Service

Heat Index



Likelihood of Heat Disorders with Prolonged Exposure or Strenuous Activity

Caution | Extreme Caution | Danger | Extreme Danger

Adapted from NOAA [2012].

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OSHA Heat Stress Calculator

Prevention » Heat Stress Calculator

Fill in the following form to determine whether a worker's heat stress is above recommended limits. Please read OSHA's Heat Hazard Recognition page for more information about WBGT, workload, acclimatization status, and clothing.

Wet bulb globe temperature (WBGT, degrees Fahrenheit):	82.5
Workload:	Heavy
Acclimatization status:	Acclimatized
Clothing:	Normal work clothing
Body weight:	Normal weight

Submit Reset

Result

Heat Stress is Above Limits

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ACGIH Threshold Limit Value

Hazardous for healthy acclimatized worker

% Work	Workload			
	Light	Moderate	Heavy*	Very Heavy*
75 to 100%	31.0°C **87.8°F**	28.0°C **82.4°F**	N/A	N/A
50 to 75%	31.0°C **87.8°F**	29.0°C **84.2°F**	27.5°C **81.5°F**	N/A
25 to 50%	32.0°C **89.6°F**	30.0°C **86.0°F**	29.0°C **84.2°F**	28.0°C **82.4°F**
0 to 25%	32.5°C **90.5°F**	31.5°C **88.7°F**	30.5°C **86.9°F**	30.0°C **86.0°F**

*Not provided for Heavy/Very Heavy work for continuous and 25% rest because of the extreme physical strain.
Detailed job hazard analyses and physiological monitoring should be used for these cases rather than these screening criteria.

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ACGIH Action Limits

Hazardous for healthy non-acclimatized worker

% Work	Workload			
	Light	Moderate	Heavy*	Very Heavy*
75 to 100%	28.0°C (82.4°F)	25.0°C (77°F)	N/A	N/A
50 to 75%	28.5°C (83.3°F)	26.0°C (78.8°F)	24.0°C (75.2°F)	N/A
25 to 50%	29.5°C (85.1°F)	27.0°C (80.6°F)	25.5°C (77.9°F)	24.5°C (76.1°F)
0 to 25%	30.0°C (86.0°F)	29.0°C (84.2°F)	28.0°C (82.4°F)	27.0°C (80.6°F)

*Not provided for Heavy/Very Heavy work for continuous and 25% rest because of the extreme physical strain.

Detailed job hazard analyses and physiological monitoring should be used for these cases rather than these screening criteria.

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Engineering, Administrative, and PPE

CONTROLS

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Engineering Controls

Make cooler and reduce workload through mechanization

- Examples:
  - Air conditioning
  - Increased air movement
  - Misting fans
  - Local exhaust at high heat and moisture production
  - Eliminate steam leaks
  - Reflective shields
  - Insulation

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Work Practices / Administrative

- Modify schedules/activities for non-acclimatized
- Mandatory rest breaks – shade or cooler locations
- Schedule work at cooler times of day
- Rotate job functions
- Reduce physical demands through planning
- Ensure drinking water or electrolyte fluids
- Buddy system
- Physiological monitoring

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Personal Protective Equipment

- Insulated suits
- Reflective clothing
- Reflecting face shields
- Cooling neck wraps
- Cooling vests – ice packs, cool air

NOTE: Beware of the effects of other PPE, such as protective clothing and respirators/masks

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EFFECTIVE HEAT PROGRAM

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Heat Illness Plan

- Decide who will provide **daily oversight**
- How to protect unacclimatized workers
  - Consider temporary workers
  - Workers returning from extended time away from heat
- How to ensure first-aid and summon emergency medical help

Heat Illness Plan

- Decide what controls will be used: Engineering, Administrative, PPE
- Determine how will heat stress be measured
- How to follow heat advisories or heat warnings
- Determine when heat stress is hazardous
- Train supervisors and workers
- Ensure day-to-day supervision – by trained and equipped person throughout the day

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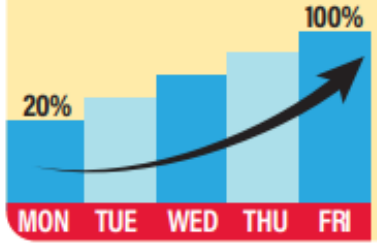
Prevent Heat Illness at Work

Outdoor and **indoor** heat exposure can be dangerous.

Ways to Protect Yourself and Others

Ease into Work. Nearly 3 out of 4 fatalities from heat illness happen during the first week of work.



- ✓ **New** and **returning** workers need to build tolerance to heat (acclimatize) and take frequent breaks.
- ✓ **Follow the 20% Rule**. On the first day, work no more than 20% of the shift's duration at full intensity in the heat. Increase the duration of time at full intensity by no more than 20% a day until workers are used to working in the heat.

Drink Cool Water

Drink cool water even if you are not thirsty — at least 1 cup every 20 minutes.

Take Rest Breaks

Take enough time to recover from heat given the temperature, humidity, and conditions.

Find Shade or a Cool Area

Take breaks in a designated shady or cool location.

Dress for the Heat

Wear a hat and light-colored, loose-fitting, and breathable clothing if possible.

Watch Out for Each Other

Monitor yourself and others for signs of heat illness.

If Wearing a Face Covering

Change your face covering if it gets wet or soiled. Verbally check on others frequently.

First Aid

Watch for any other signs of heat illness and act quickly. When in doubt, call 911.

If a worker experiences:

- Headache or nausea
- Weakness or dizziness
- Heavy sweating or hot, dry skin
- Elevated body temperature
- Thirst
- Decreased urine output

Take these actions:

- » Give water to drink
- » Remove unnecessary clothing
- » Move to a cooler area
- » Cool with water, ice, or a fan
- » Do not leave alone
- » Seek medical care if needed

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MEDICAL EMERGENCY

The following are signs of a medical emergency!

- Abnormal thinking or behavior
- Slurred speech
- Seizures
- Loss of consciousness

1. CALL 911 IMMEDIATELY
2. COOL THE WORKER RIGHT AWAY WITH WATER OR ICE
3. STAY WITH THE WORKER UNTIL HELP ARRIVES

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Culture of Workplace Safety and Health

- Culture is critical
- Supervisor sets the tone
- Worker involvement without fear of reprisal
- In hot conditions, skipping breaks is not safe!

SOURCES OF HELP

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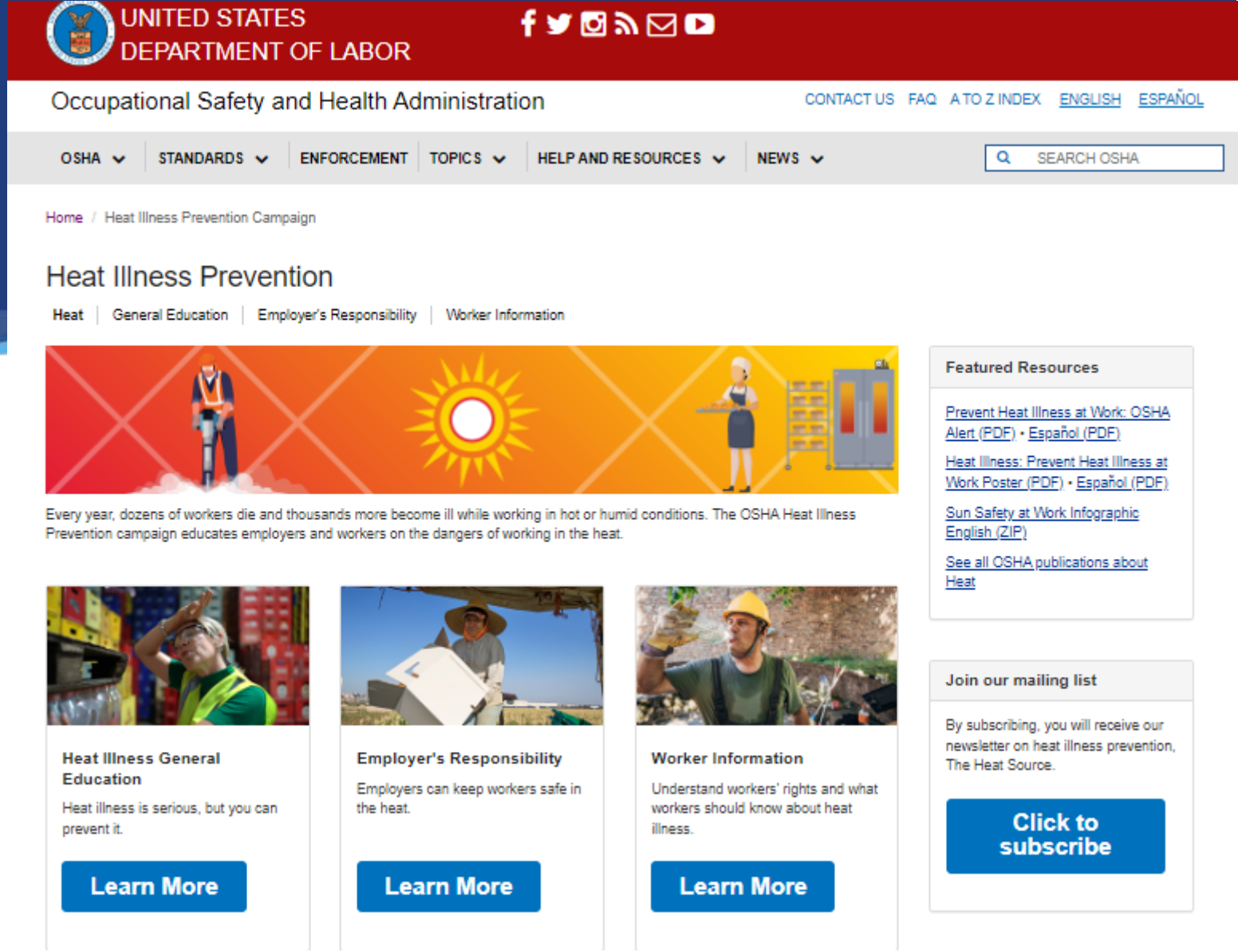
OSHA Webpage

- National Emphasis Program (NEP)
- Annual Heat Illness Campaign
- Spanish Language Resources
- Printable Materials



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Heat

Overview: Working in Outdoor and Indoor Heat Environments

Millions of U.S. workers are exposed to heat in their workplaces. Although illness from exposure to heat is preventable, every year, thousands become sick from occupational heat exposure, and some cases are fatal. **Most outdoor fatalities, 50% to 70%, occur in the first few days of working in warm or hot environments because the body needs to build a tolerance to the heat gradually over time. The process of building tolerance is called heat acclimatization. Lack of acclimatization represents a major risk factor for fatal outcomes.**

Occupational risk factors for heat illness include heavy physical activity, warm or hot environmental conditions, lack of acclimatization, and wearing clothing that holds in body heat. (See also, personal risk factors, below.)

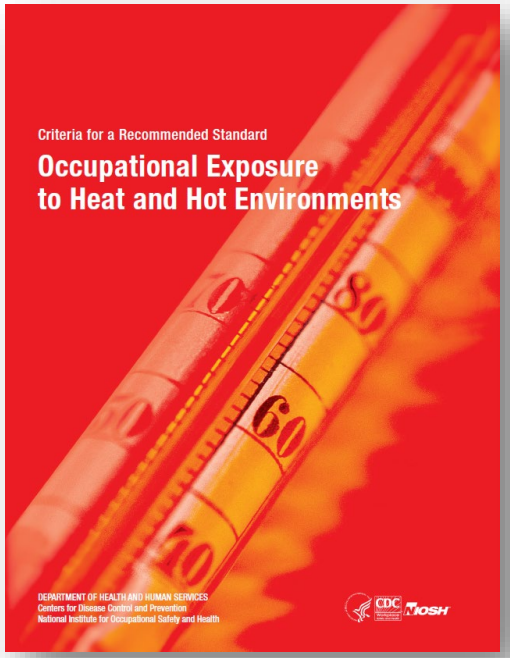
Hazardous heat exposure can occur indoors or outdoors, and can occur during any season if the conditions are right, not only during heat waves. The following is a list of some industries where workers have suffered heat-related illnesses.

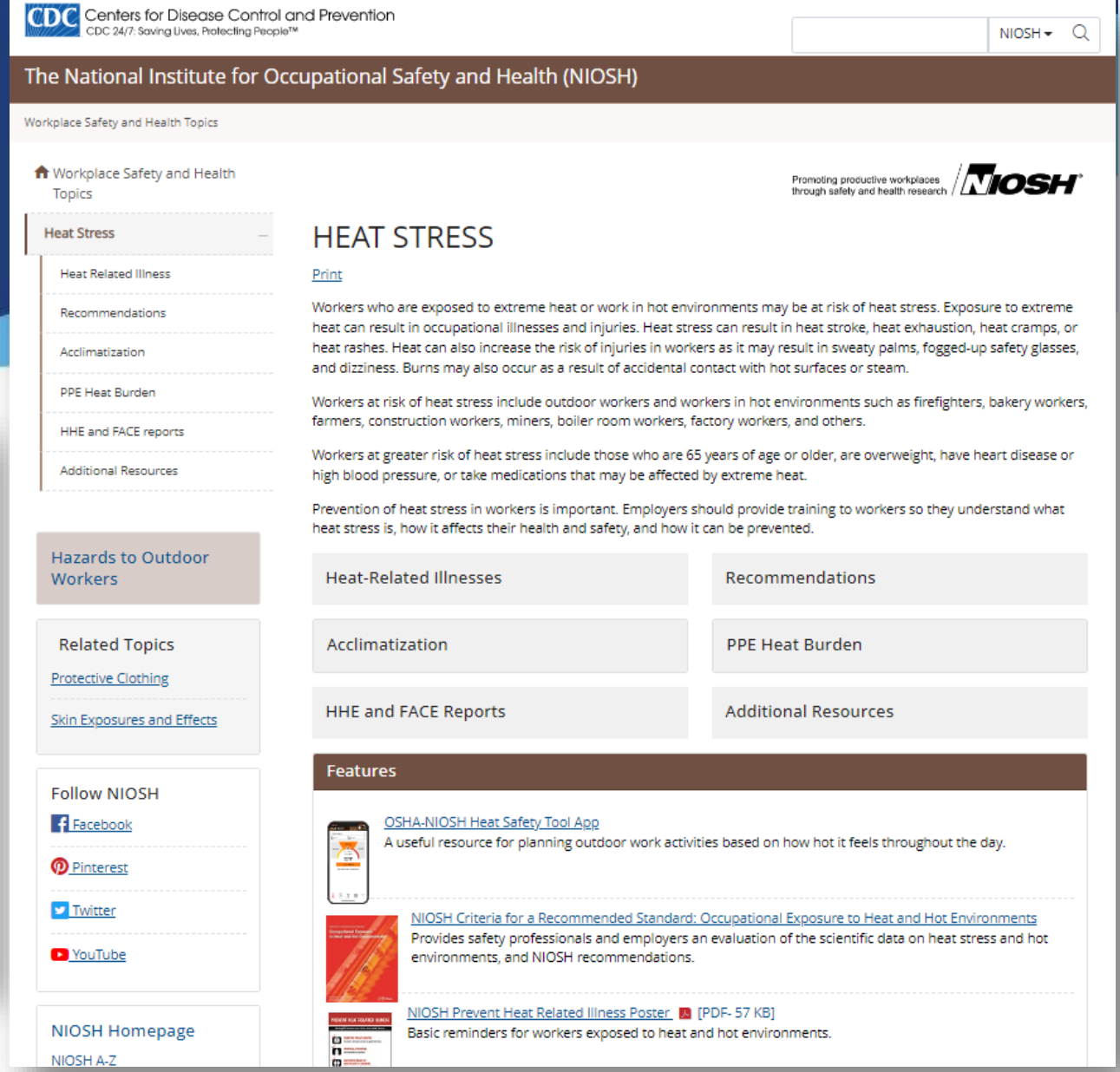
Outdoors	Indoors
Agriculture	Bakeries, kitchens, and laundries (sources with indoor heat-generating appliances)

Highlights

- National Emphasis Program – Outdoor and Indoor Heat-Related Hazards. OSHA Directive CPL 03-00-024, (April 8, 2022). NEW
- OSHA Publishes Advance Notice of Proposed Rulemaking for Heat Injury and Illness Prevention in Outdoor and Indoor Work Settings. OSHA, (October 27, 2021).
- COVID-19 Guidance on the Use of Cloth Face Coverings while Working Outdoors in Hot and Humid Conditions. OSHA, (September 2020).
- COVID-19 Guidance on the Use

National Institute for Occupational Health and Safety (NIOSH)





www.cdc.gov/niosh/topics/heatstress/

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OSHA NIOSH Heat App

- Visual indicator of current heat index and risk levels
- Precautionary recommendations
- Interactive hourly forecast
- Editable location, temp and humidity to calculate for different locations
- Signs and symptoms and first aid

Download on the App Store

GET IT ON Google Play

cdc.gov/niosh/topics/heatstress/heatapp.html

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NOAA

NATIONAL WEATHER SERVICE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

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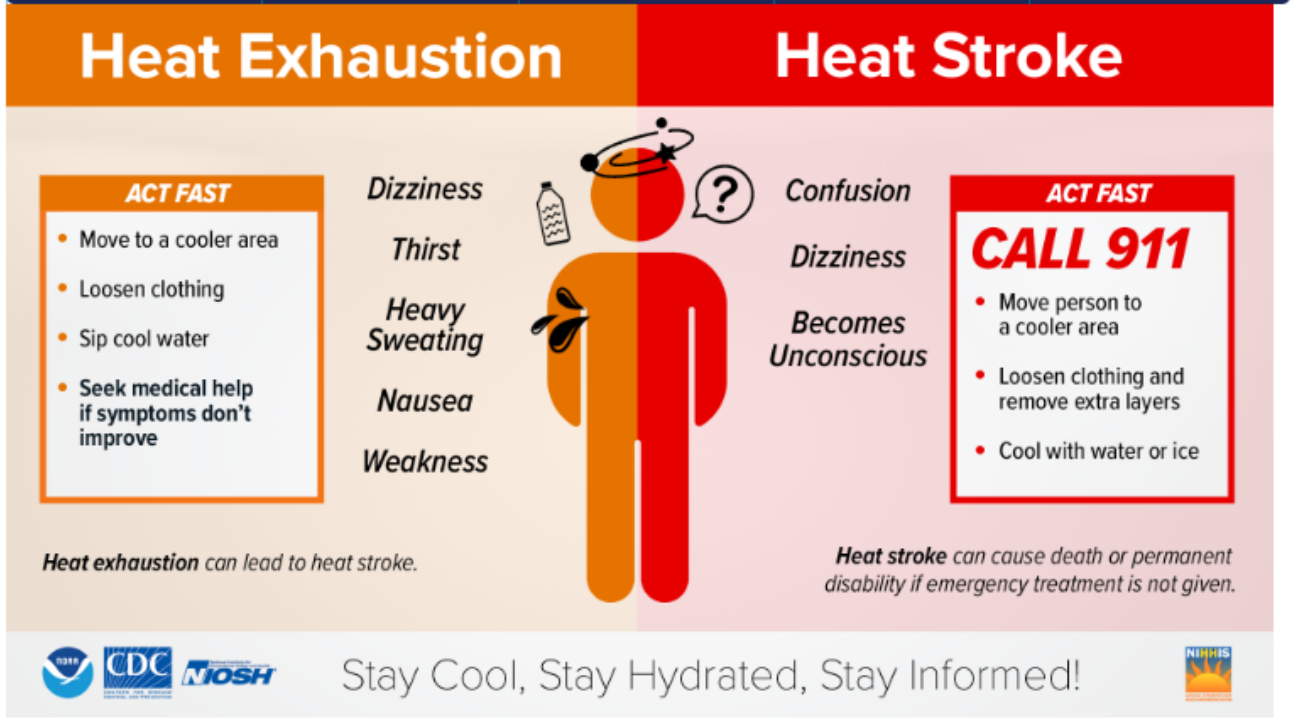
Heat Cramps, Exhaustion, Stroke

Weather.gov > Safety > Heat Cramps, Exhaustion, Stroke

Safety
National Program

Heat Safety | Heat Watch vs. Warning | Heat Forecast Tools | During a Heat Wave | Heat Related Illnesses



WRN

Heat Safety Resources

- Heat Safety
- Heat.gov
- Children, Pets and Vehicles
- Seasonal Safety Campaign
- Ultraviolet (UV) Safety
- Games and Activities for Kids
- Survivor Stories
- Education and Outreach
- Links and Partners

weather.gov/safety/heat-illness

OSHA® Occupational Safety and Health Administration

HEAT.gov

NIHHIS HEAT.gov
National Integrated Heat Health Information System

Home | News & Events | Learn | Urban Heat Islands | Tools & Information | At Risk Groups | Planning & Preparing | About

Welcome to HEAT.gov

Heat related illnesses and death are largely preventable with proper planning, education, and action. Heat.gov serves as the premier source of heat and health information for the nation to reduce the health, economic, and infrastructural impacts of extreme heat.

Heat.gov is the web portal for the National Integrated Heat Health Information System (NIHHIS)

News

The 2023 UHI Mapping Application is Now Open

Newly Published Guidebook on Urban Heat Resilience

Upcoming Webinar: An Introduction to the Plan Integration for Resilience Scorecard™ (PIRS™) for Heat

Tools & Information

Who is at Risk to Extreme Heat

Climate and Health Outlook

Current Conditions and Future Outlooks

Extreme Heat

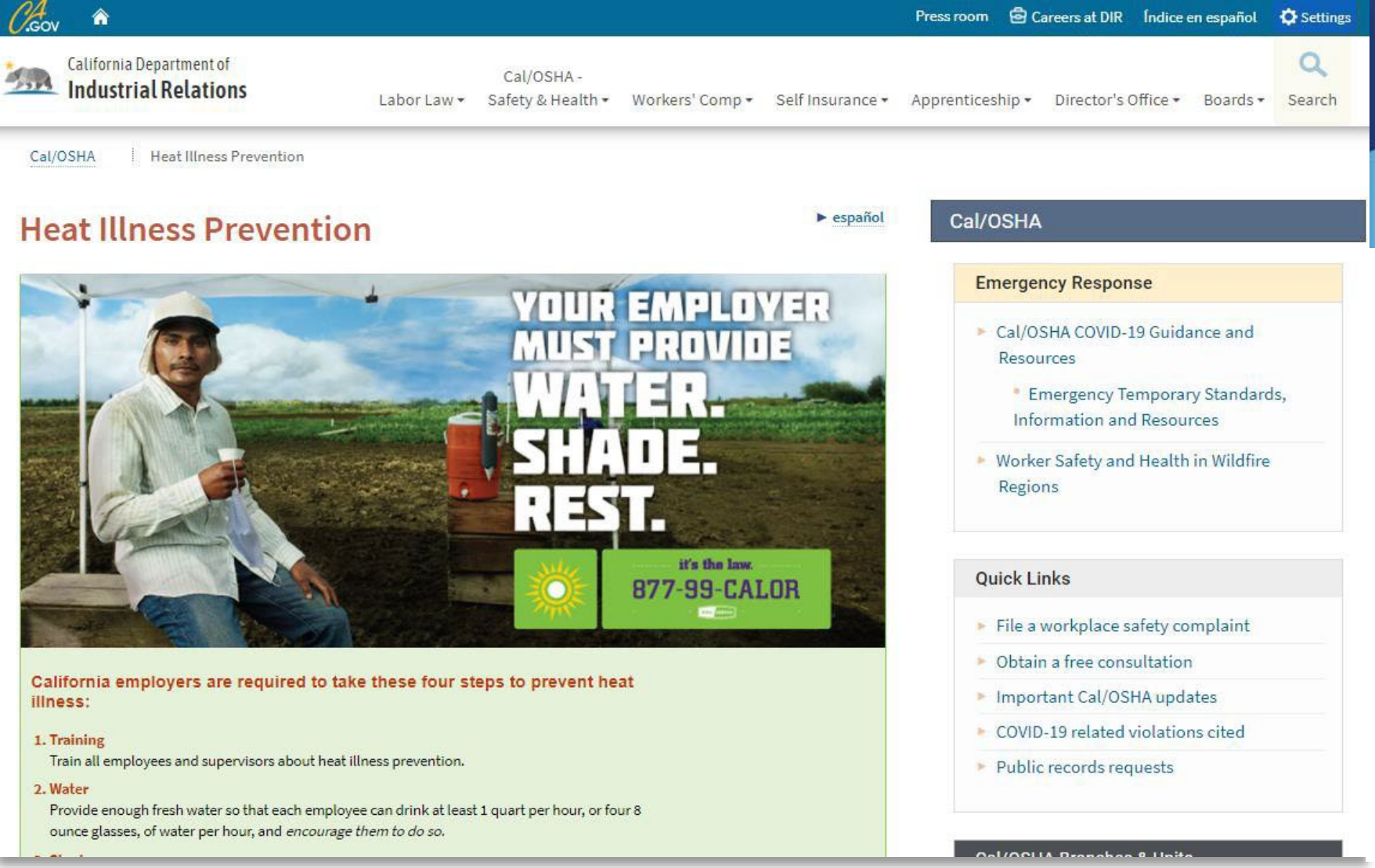
Last 30 days

0

People under heat alerts

At left, see the current number of people in the U.S. that are currently under active National Weather Service extreme heat advisories, watches, and warnings.

Below, interact with current and future heat tools to understand where dangerous heat conditions may exist in the future.



California Department of Industrial Relations

Dir.ca.gov/DOSH/HeatIllnessInfo.html

Contact by email:
heat@dir.ca.gov

www.osha.gov

800-321-OSHA (6742)