Heat-Related Illness and Injury in Construction

National Work Zone Management Conference

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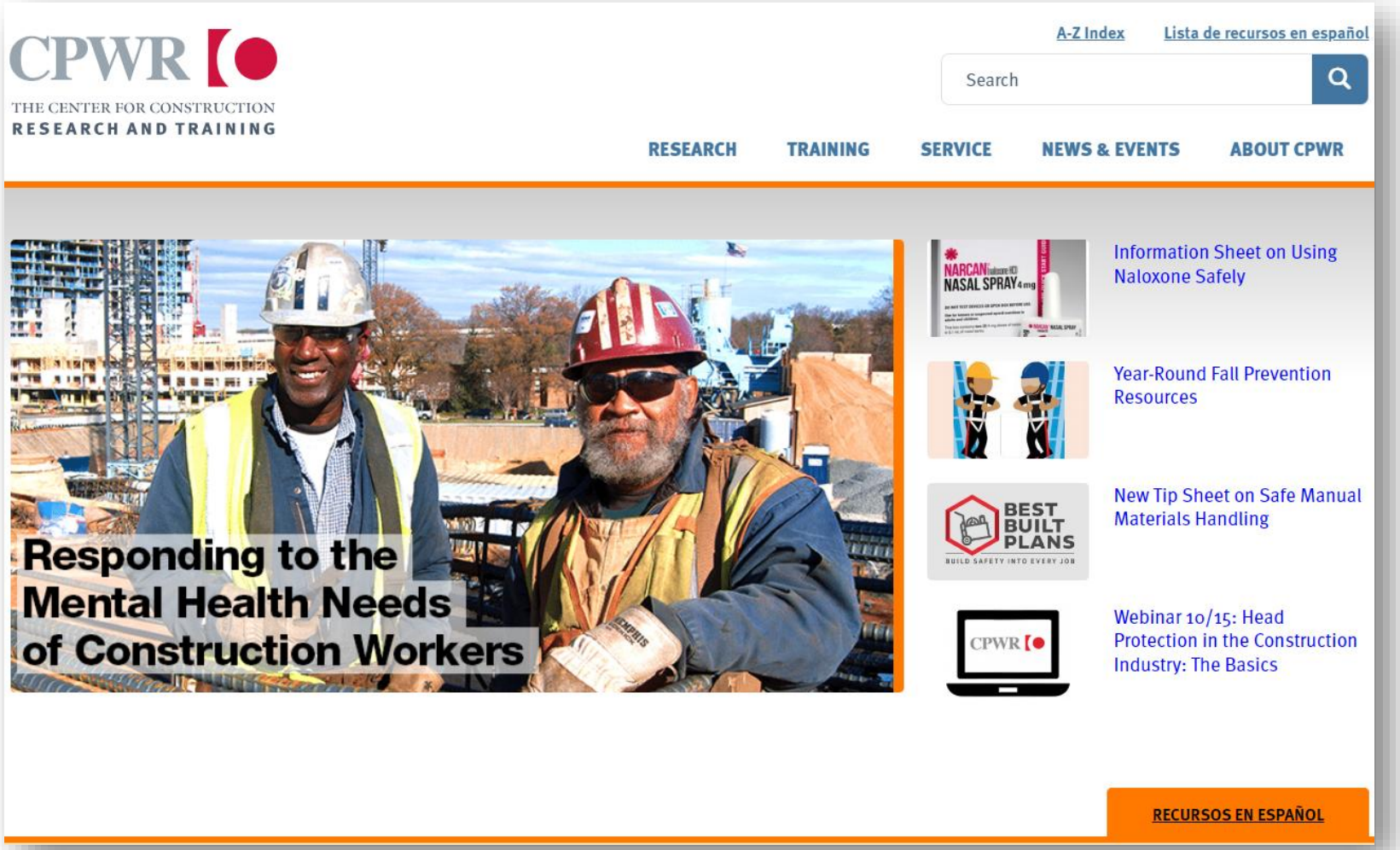
After today, you should be able to:

Explain why heat is an occupational hazard to be taken seriously

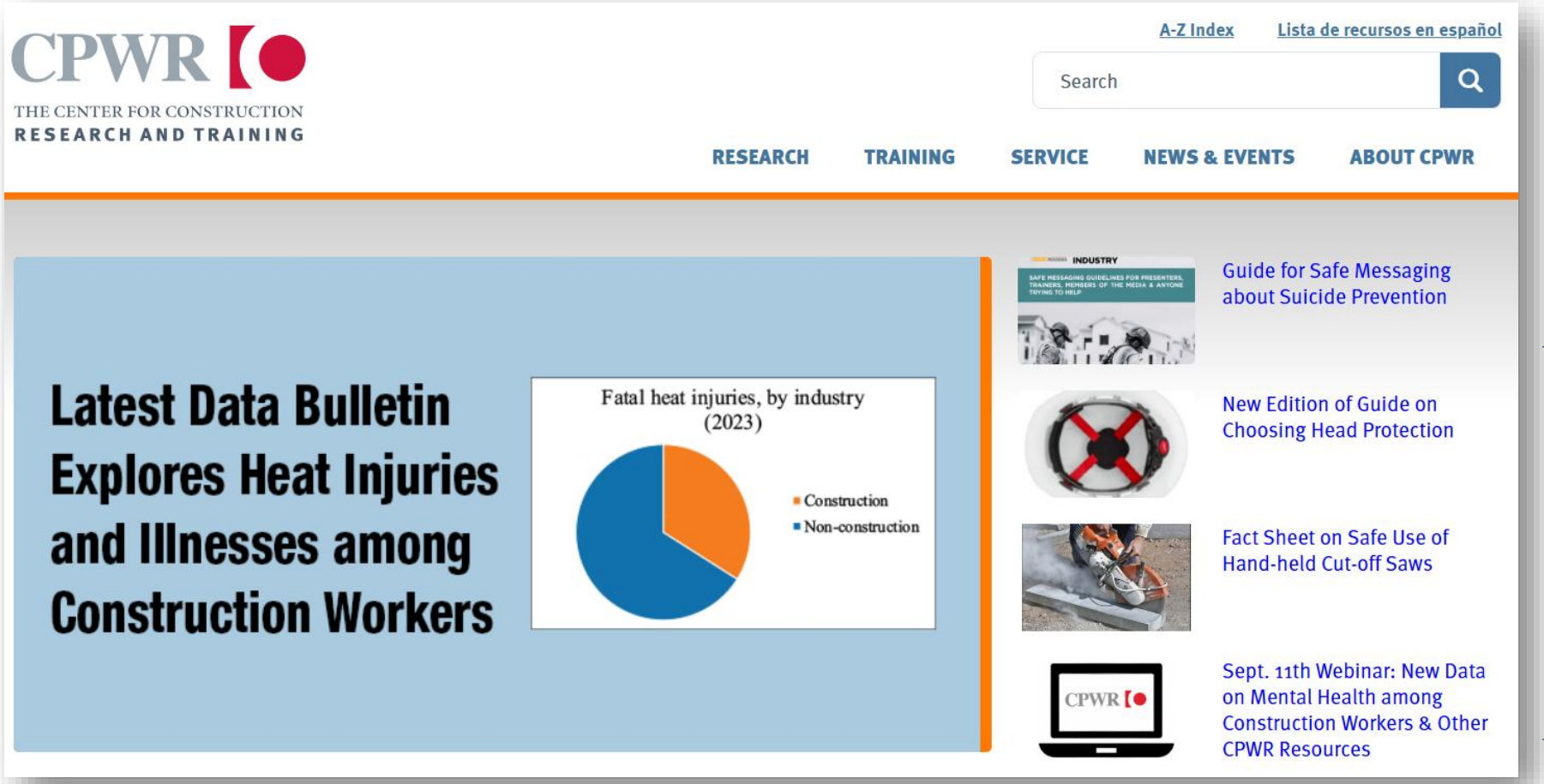
Describe protective measures to prevent heat-related illnesses and injuries

CPWR has served as the NIOSH National Construction Center since 1990

- Non-profit organization
- Created by **N**orth **A**merica's **B**uilding **T**rades **U**nions



Visit our website to access free resources and sign up for our mailing list to stay current on S&H news



https://www.cpwr.com/

https://www.cpwr.com/newsletter-sign-up/

Heat is the leading cause of weather-related deaths in the US

Photo by FEMA/Greg Henshall


Photo by Justin Hobson via Wikimedia Commons


U.S. Air Force photo by Edward Aspera Jr.

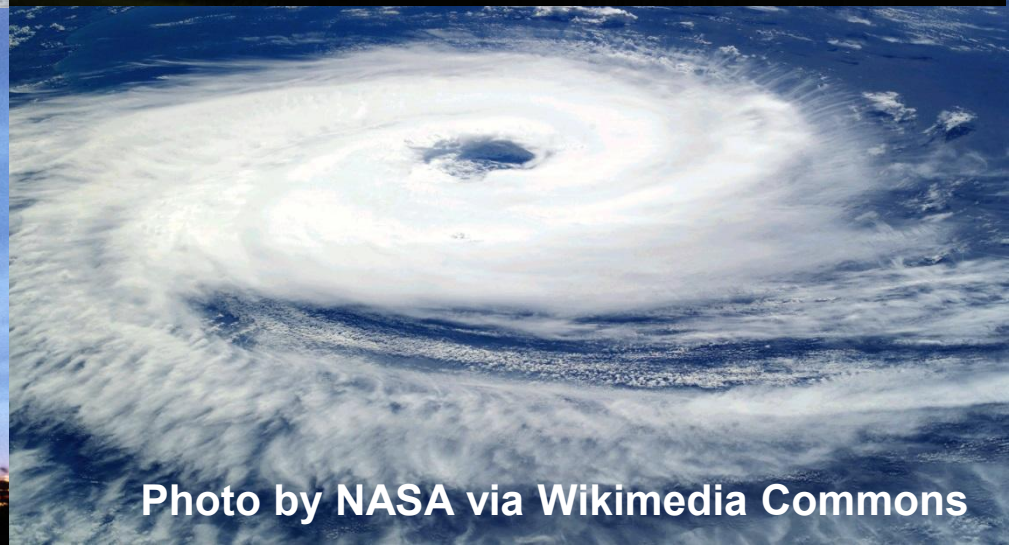
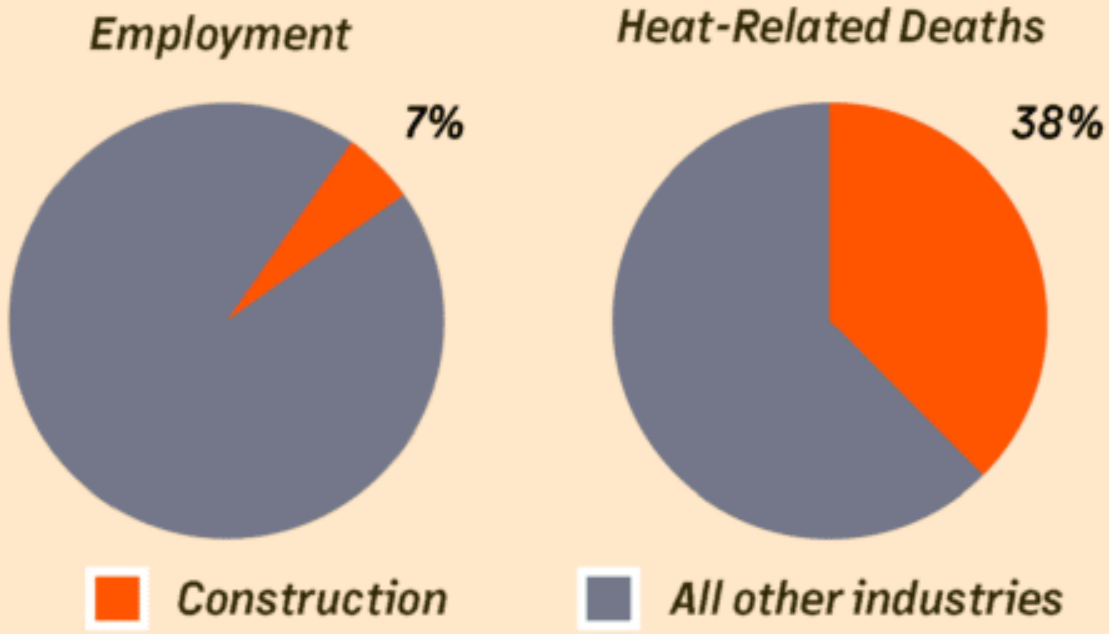


Photo by NASA via Wikimedia Commons

HEAT-RELATED DEATHS IN CONSTRUCTION

Construction workers accounted for **only 7%** of the U.S. workforce, but experienced **38% of all heat- related deaths at work in 2020.**[1,2,3]

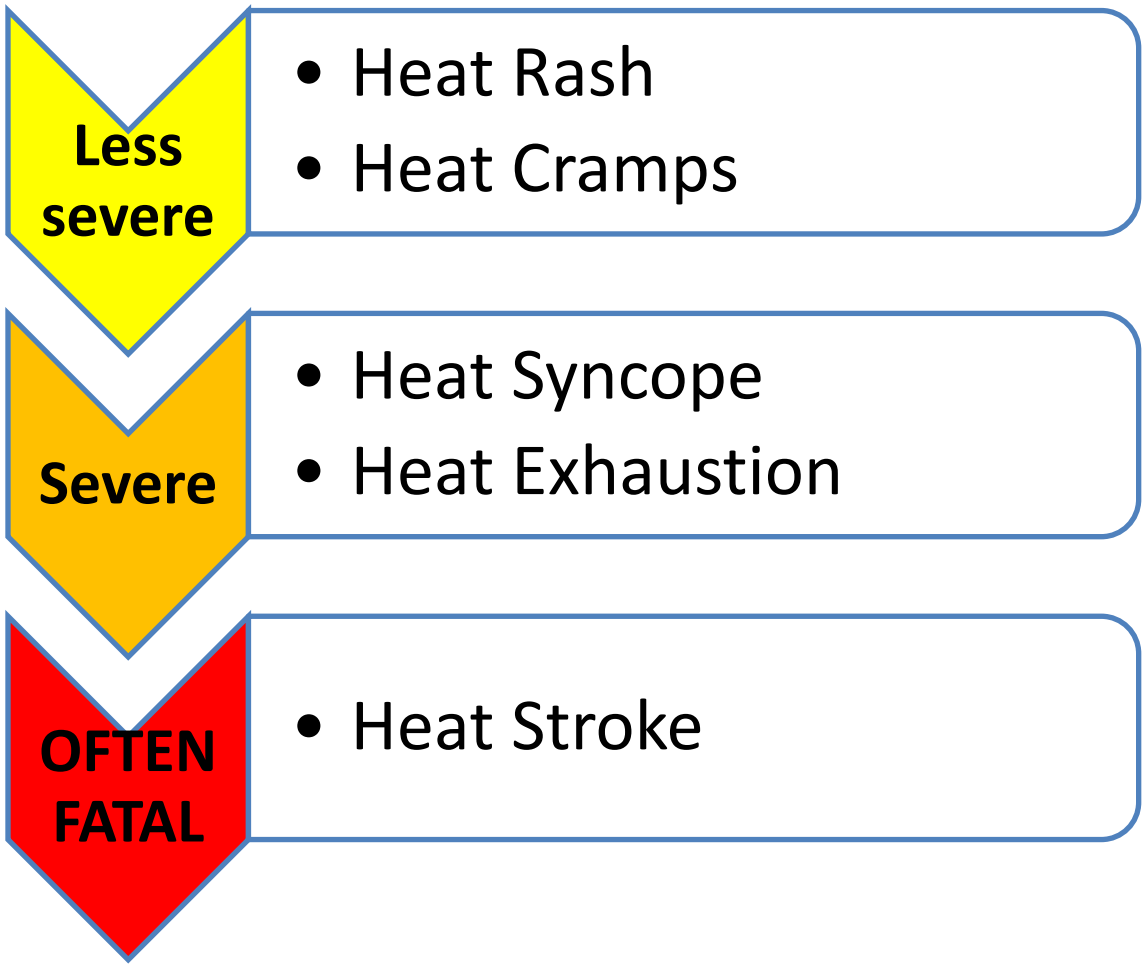


[1] CPWR- The Center for Construction Research and Training. [2022]. Fatal and Nonfatal Injuries in the Construction Industry. https://www.cpwr.com/wp-content/uploads/DataBulletin-May2022.pdf
[2] U.S. Bureau of Labor Statistics. [2022]. Census of Fatal Occupational Injuries (2011 forward) One Screen Tool. https://www.bls.gov/iif/data.htm
[3] U.S. Bureau of Labor Statistics. [2022]. Household Data Annual Averages 18b. Employed persons by detailed industry and age. https://www.bls.gov/cps/cpsaat18b.htm

Heat-related deaths are difficult to track

Published Dec. 14, 2024 | Updated Jan. 21, 2025:
https://www.tampabay.com/investigations/2024/12/14/florida-workers-died-heat-their-deaths-were-kept-authorities/

Heat illnesses range from less severe to fatal, but symptoms don't always occur in a particular order



Workers with heat illness should:

- Stop working
- Cool down
- Drink fluids

Heat stroke is a medical emergency

1. Results in **death or disability** without rapid recognition and treatment
2. **Sweating differs** for classic vs. exertional heat stroke
3. **Change in mental status** (e.g., confusion, delirium) is an important indicator

Exertional heat stroke is more common in workplace settings

Table 1. Epidemiologic and Clinical Features of Classic and Exertional Heatstroke.

Feature*	Classic Heatstroke	Exertional Heatstroke
Age group	Prepubertal, elderly	Postpubertal and active
Occurrence	Epidemic (heat waves)	Sporadic (any time of year)
Concurrent activity	Sedentary	Strenuous
Health status	Chronically ill	Generally healthy
Medications	Often being used (prescribed medications)	Usually none being used (sometimes ergogenic aids, illicit drugs)
Mechanism	Absorption of environmental heat and poor heat dissipation	Excessive heat production, which overwhelms heat-loss mechanisms
Sweating	May be absent (dry skin)	Usually present (wet skin)
CNS dysfunction	Common	Common
Acid–base disturbance	Respiratory alkalosis	Metabolic acidosis
Rhabdomyolysis	Unusual	Frequent
Liver dysfunction	Mild	Marked to severe
Renal failure	Uncommon (<5%)	Common (25–30%)
DIC	Mild	Marked to severe
ARDS	Common	Common
Creatine kinase	Mildly elevated	Markedly elevated
Calcium	Normal	Low (hypocalcemia)
Potassium	Normal	Usually high (hyperkalemia)

* ARDS denotes acute respiratory distress syndrome, CNS central nervous system, and DIC disseminated intravascular coagulation.

Epstein Y, Yanovich R. Heatstroke. N Engl J Med. 2019 Jun 20;380(25):2449-2459. https://doi.org/10.1056/nejmra1810762

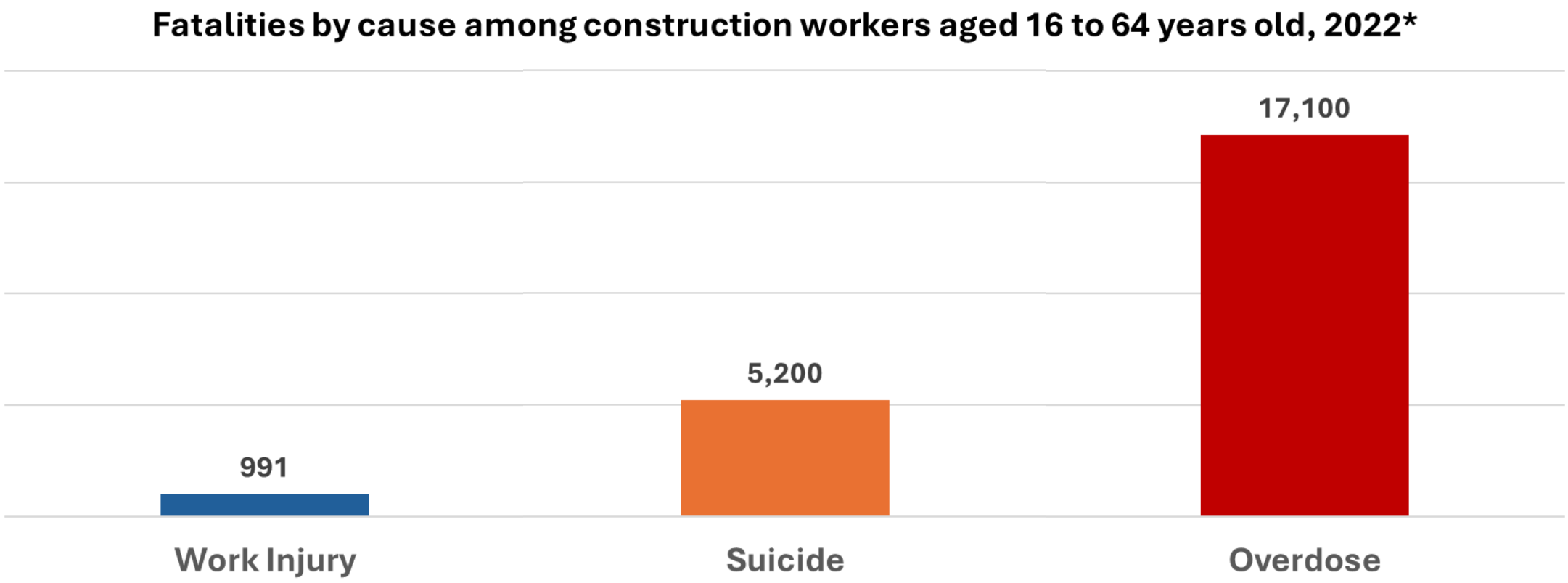
Research shows that heat exposure can exacerbate or trigger a wide range of health conditions:

- ischemic heart disease
- cardiac dysrhythmias
- ischemic stroke
- asthma
- chronic obstructive pulmonary disease
- respiratory tract infections
- hyperglycemia
- kidney failure
- neuropsychiatric disorders (e.g., psychosis, suicides, homicides, anxiety, and depression),
- adverse birth outcomes




Sorensen C, Hess J. Treatment and Prevention of Heat-Related Illness. N Engl J Med. 2022 Oct 13;387(15):1404-1413.

How many construction workers died from workplace injuries in 2022 versus suicide or overdose?



Source: National Center for Health Statistics, 2022 Mortality Multiple Cause-of-Death and U.S. Bureau of Labor Statistics, 2022 Census of Fatal Occupational Injuries.

* Work injury data population does not align 1:1 with mortality data. Interpret with caution. ^ Suicides include overdoses due to overlapping definitions

https://www.cpwr.com/wp-content/uploads/DataBulletin-September2024.pdf

Research shows that hotter temperatures are associated with increased risk of:

1. **Suicide**
2. **Hospital admissions for mental illness**
3. **Violent crime**

Thompson et al (2018); Yoo et al (2021); Stevens et al (2024); Simister & Cooper (2004); Heo et al (2024)

Researchers are also studying heat exposure as a cause of acute kidney injury and chronic kidney disease

Gibb K, Beckman S, Vergara XP, Heinzerling A, Harrison R. Extreme Heat and Occupational Health Risks. Annu Rev Public Health. 2024 May;45(1):315-335.

Studies published within the last 2 years show that heat stress and dehydration are associated with an increased risk of new-onset chronic diseases, accelerated aging, and premature mortality

Changes in DNA markers tied to ageing have also been linked to chronic heat exposure.

HUMAN BODY'S AGEING 'CLOCK' TICKS FASTER AFTER HEAT STRESS

Preliminary study suggests link between long-term heat exposure and molecular markers of ageing.

By Heidi Ledford

Exposure to extreme heat events is linked to molecular changes that could reflect accelerated ageing, according to a preliminary analysis of DNA markers in more than 3,000 people.

The US-based work, presented at the Gerontological Society of America's Annual Scientific Meeting in Seattle, Washington, in November, joins a host of efforts to understand the effects of rising temperatures on human health, as heatwaves strike around the world with increasing frequency.

Heat is known to strain the heart and kidneys and to slow cognition. But extreme heat could also have effects that are invisible – at first. "The physical toll might not immediately manifest as an observable health outcome, but rather could affect our body at the cellular and molecular

SCIENCE ADVANCES | RESEARCH ARTICLE

PUBLIC HEALTH

Ambient outdoor heat and accelerated epigenetic aging among older adults in the US

Eun Young Choi*, Jennifer A. Ailshire

nature reviews nephrology

Review article

https://doi.org/10.1038/s4

Long-term health outcomes associated with hydration status

Natalia I. Dmitrieva [1], Manfred Boehm[1], Paul H. Yancey [2] & Sofia Enhörning [3,4]

nature climate change

Article

Long-term impacts of heatwaves on accelerated ageing

Received: 14 January 2025

Accepted: 23 July 2025

Published online: 25 August 2025

Siyi Chen[1], Yufei Liu[1], Yuanyuan Yi[1], Yiling Zheng[1], Jun Yang [2], Tiantian Li [3], Ta-Chien Chan[4], Rui Duan[5], Shenjing He[1,6] & Cui Guo [1,6]

What might happen if you experienced these heat illness symptoms while working at height or operating machinery?

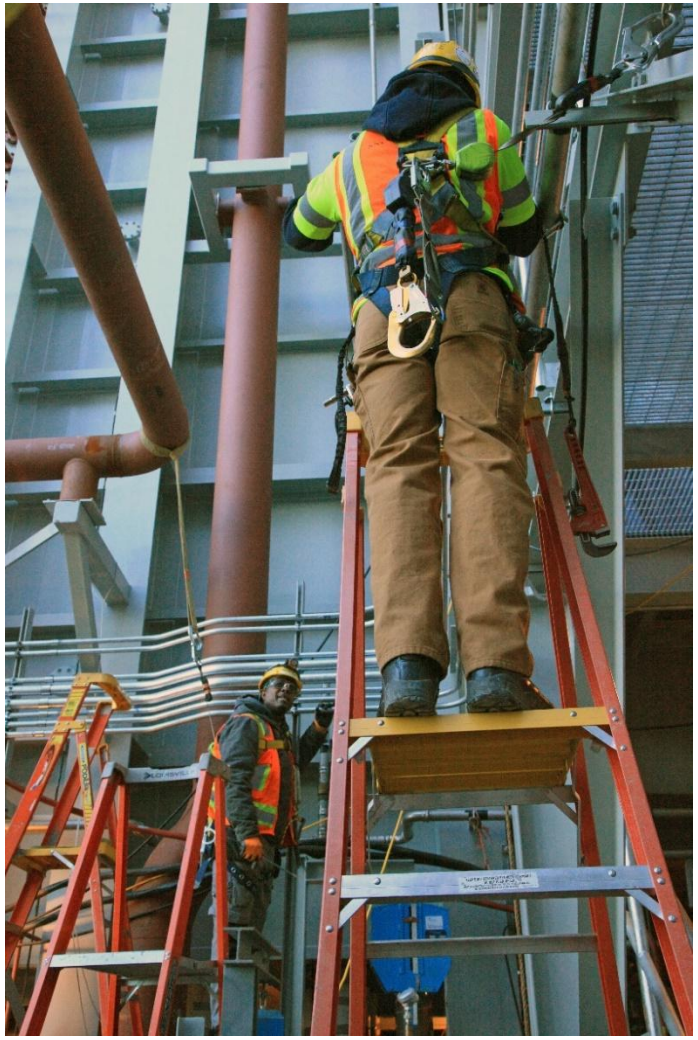
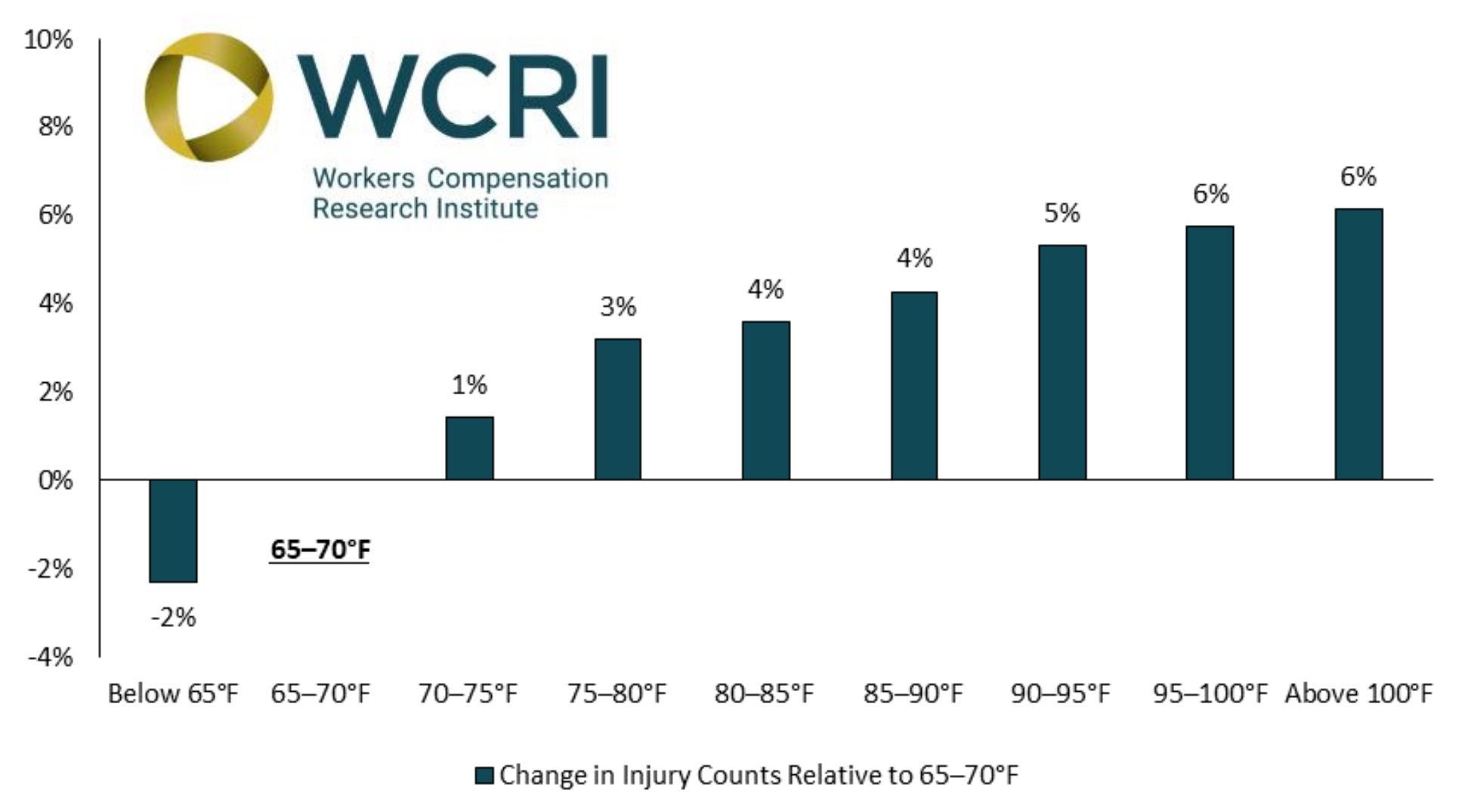


Image courtesy: Earl Dotter/SNC-Lavalin

- Dizziness
- Light-headedness
- Fainting
- Altered mental state
- Confusion
- Muscle cramps
- Seizures

Workers' comp data from 24 states show increasing injuries at higher temps



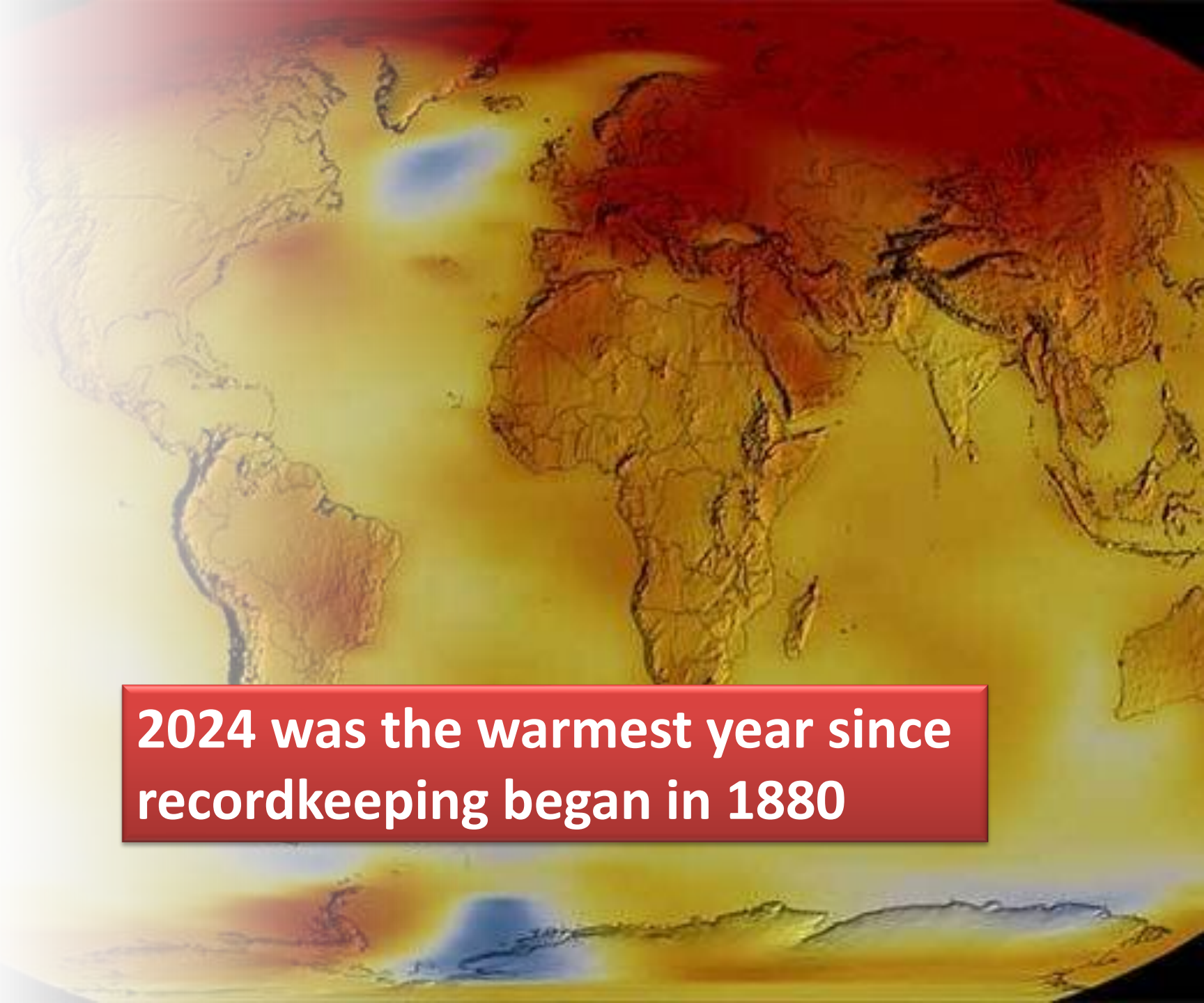
This effect was even stronger in construction!

https://www.wcrinet.org/news/news_info/wcri-study-explores-excessive-heats-influence-on-workplace-injuries

Productivity losses due to heat stress cost the US economy an estimated $98 billion annually

Luke A Parsons *et al* 2022 *Environ. Res. Lett.* 17 014050 DOI 10.1088/1748-9326/ac3dae

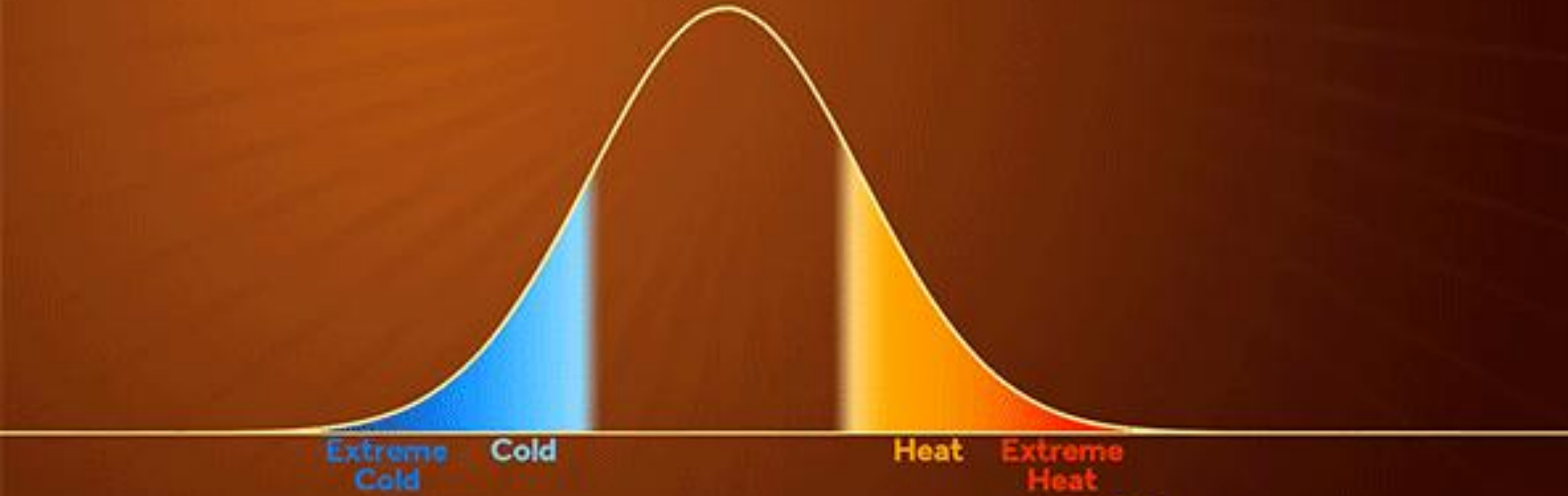
The past 10 years were the warmest on record



2024 was the warmest year since recordkeeping began in 1880

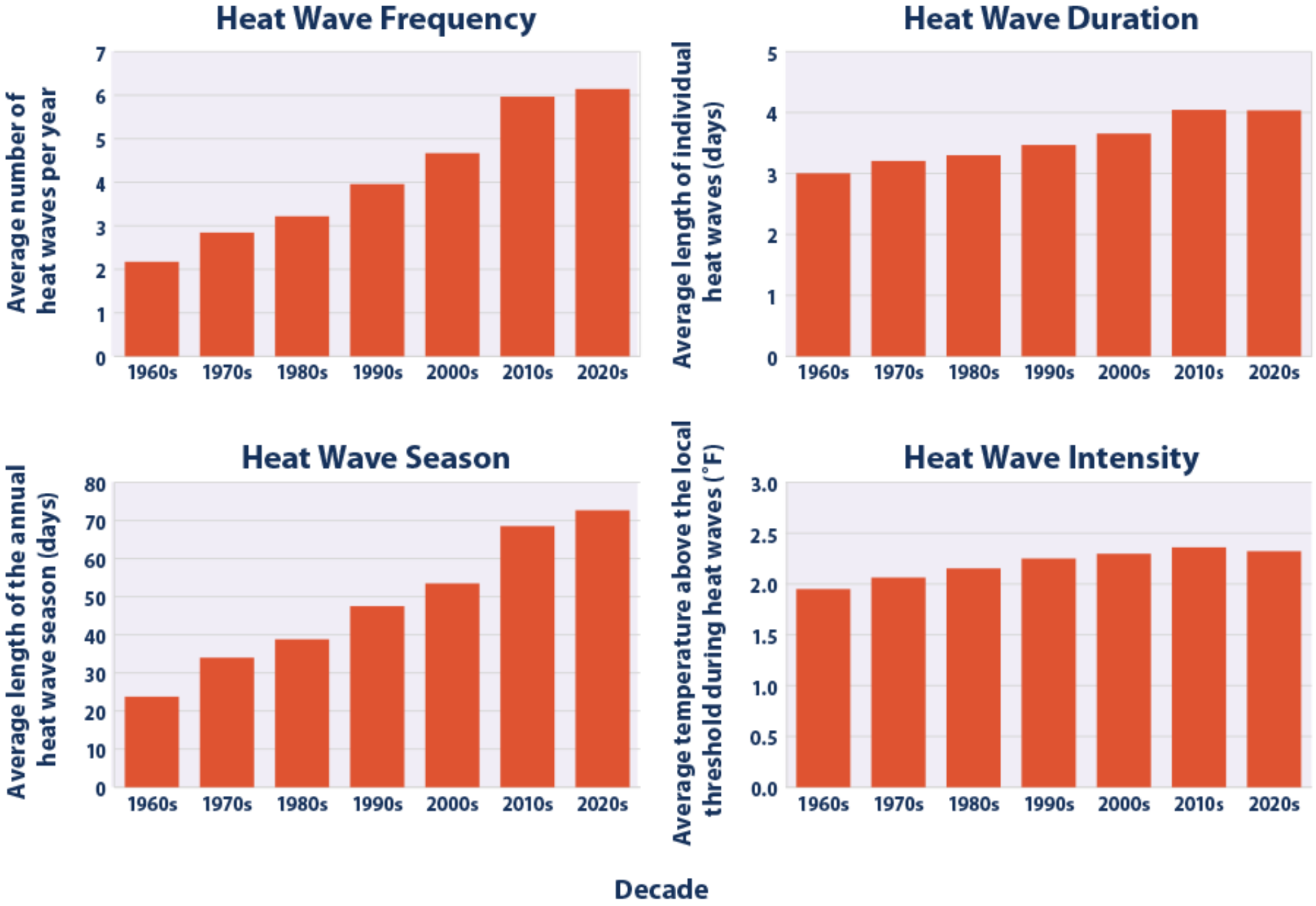
Source: NASA/GISS
https://climate.nasa.gov/vital-signs/global-temperature/

SMALL CHANGE IN AVERAGE
BIG CHANGE IN EXTREMES



CLIMATE CENTRAL

Heat waves in the US are getting worse



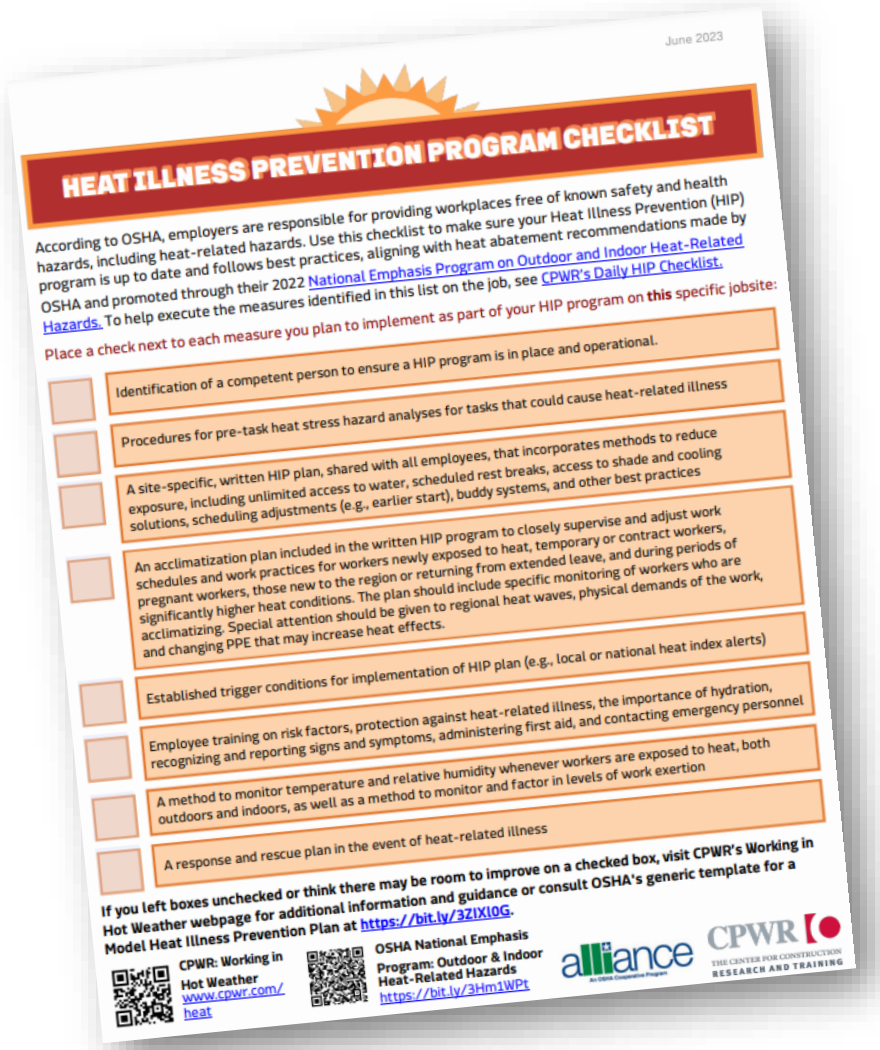
Data Source: NOAA 2021.

For more info: https://www.epa.gov/climate-indicators/climate-change-indicators-heat-waves

So, what can we do to work safely in the heat?

The NIOSH criteria document and ANSI/ASSP standard offer comprehensive guidance

CPWR's collection of free resources includes programmatic and daily checklists to develop and implement effective plans



June 2023

HEAT ILLNESS PREVENTION PROGRAM CHECKLIST

According to OSHA, employers are responsible for providing workplaces free of known safety and health hazards, including heat-related hazards. Use this checklist to make sure your Heat Illness Prevention (HIP) program is up to date and follows best practices, aligning with heat abatement recommendations made by OSHA and promoted through their 2022 National Emphasis Program on Outdoor and Indoor Heat-Related Hazards. To help execute the measures identified in this list on the job, see CPWR's Daily HIP Checklist.

Place a check next to each measure you plan to implement as part of your HIP program on **this** specific jobsite:

- ☐ Identification of a competent person to ensure a HIP program is in place and operational.
- ☐ Procedures for pre-task heat stress hazard analyses for tasks that could cause heat-related illness
- ☐ A site-specific, written HIP plan, shared with all employees, that incorporates methods to reduce exposure, including unlimited access to water, scheduled rest breaks, access to shade and cooling solutions, scheduling adjustments (e.g., earlier start), buddy systems, and other best practices
- ☐ An acclimatization plan included in the written HIP program to closely supervise and adjust work schedules and work practices for workers newly exposed to heat, temporary or contract workers, pregnant workers, those new to the region or returning from extended leave, and during periods of significantly higher heat conditions. The plan should include specific monitoring of workers who are acclimatizing. Special attention should be given to regional heat waves, physical demands of the work, and changing PPE that may increase heat effects.
- ☐ Established trigger conditions for implementation of HIP plan (e.g., local or national heat index alerts)
- ☐ Employee training on risk factors, protection against heat-related illness, the importance of hydration, recognizing and reporting signs and symptoms, administering first aid, and contacting emergency personnel
- ☐ A method to monitor temperature and relative humidity whenever workers are exposed to heat, both outdoors and indoors, as well as a method to monitor and factor in levels of work exertion
- ☐ A response and rescue plan in the event of heat-related illness

If you left boxes unchecked or think there may be room to improve on a checked box, visit CPWR's Working in Hot Weather webpage for additional information and guidance or consult OSHA's generic template for a Model Heat Illness Prevention Plan at https://bit.ly/3ZIXI0G.

CPWR: Working in Hot Weather www.cpwr.com/heat

OSHA National Emphasis Program: Outdoor & Indoor Heat-Related Hazards https://bit.ly/3Hm1WPt

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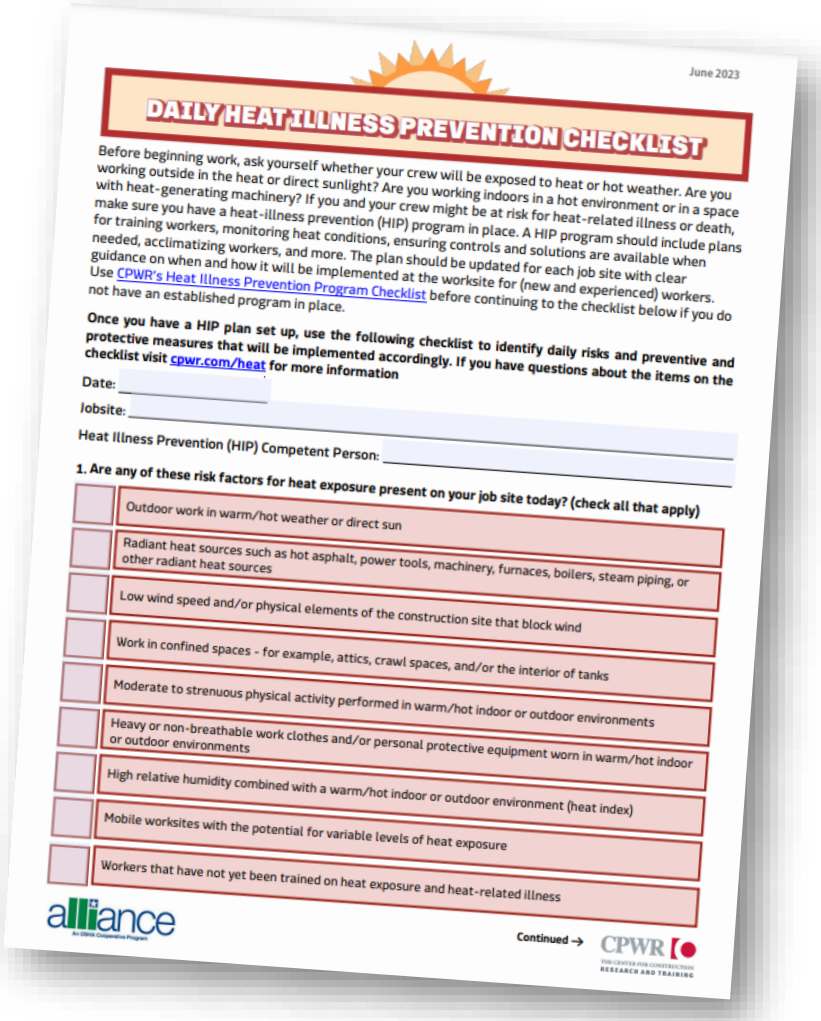

June 2023

DAILY HEAT ILLNESS PREVENTION CHECKLIST

Before beginning work, ask yourself whether your crew will be exposed to heat or hot weather. Are you working outside in the heat or direct sunlight? Are you working indoors in a hot environment or in a space with heat-generating machinery? If you and your crew might be at risk for heat-related illness or death, make sure you have a heat-illness prevention (HIP) program in place. A HIP program should include plans for training workers, monitoring heat conditions, ensuring controls and solutions are available when needed, acclimatizing workers, and more. The plan should be updated for each job site with clear guidance on when and how it will be implemented at the worksite for (new and experienced) workers. Use CPWR's Heat Illness Prevention Program Checklist before continuing to the checklist below if you do not have an established program in place.

Once you have a HIP plan set up, use the following checklist to identify daily risks and preventive and protective measures that will be implemented accordingly. If you have questions about the items on the checklist visit cpwr.com/heat for more information

Date: _____

Jobsite: _____

Heat Illness Prevention (HIP) Competent Person: _____

1. Are any of these risk factors for heat exposure present on your job site today? (check all that apply)

- ☐ Outdoor work in warm/hot weather or direct sun
- ☐ Radiant heat sources such as hot asphalt, power tools, machinery, furnaces, boilers, steam piping, or other radiant heat sources
- ☐ Low wind speed and/or physical elements of the construction site that block wind
- ☐ Work in confined spaces - for example, attics, crawl spaces, and/or the interior of tanks
- ☐ Moderate to strenuous physical activity performed in warm/hot indoor or outdoor environments
- ☐ Heavy or non-breathable work clothes and/or personal protective equipment worn in warm/hot indoor or outdoor environments
- ☐ High relative humidity combined with a warm/hot indoor or outdoor environment (heat index)
- ☐ Mobile worksites with the potential for variable levels of heat exposure
- ☐ Workers that have not yet been trained on heat exposure and heat-related illness

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Continued →

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www.cpwr.com/heat

Some solutions are common sense

Drinking an 8-ounce cup of water every 15 to 20 mins is recommended when working in hot conditions

Photo courtesy: Sunbelt Rentals

Sugar Farms in Nicaragua

Slide courtesy of Dr. Barrak Alahmad, Harvard University

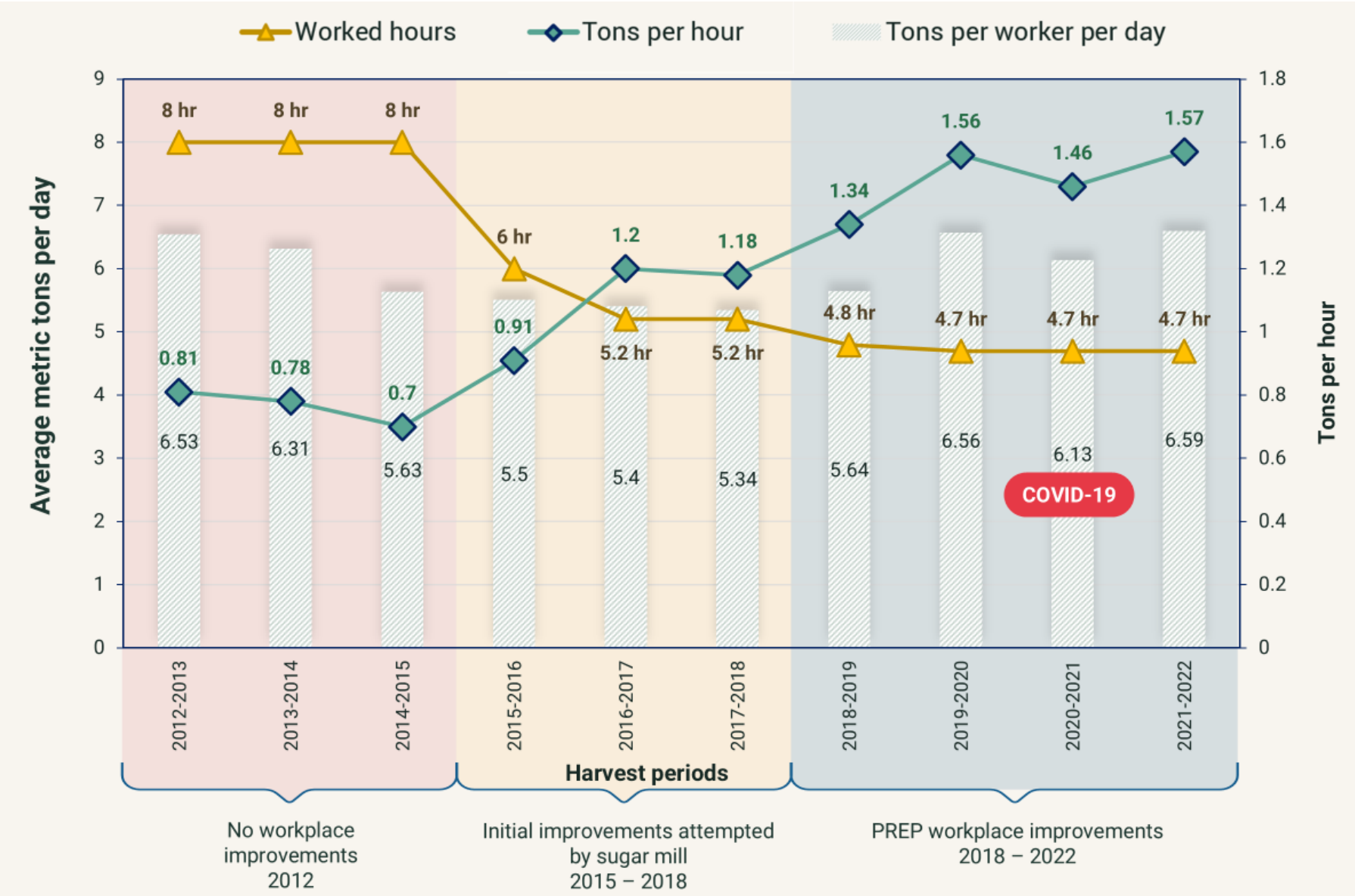
Adelante initiative

Data driven interventions:

1. **Rest (intervals throughout)**
2. **Shade**
3. **Water**
4. **Sanitation**

la isla network

https://www.laislanetwork.org/



CPWR has received questions about providing shade for mobile worksites or other unique environments

Portable shade structure with forklift slots for transport
www.jobsiteshade.com

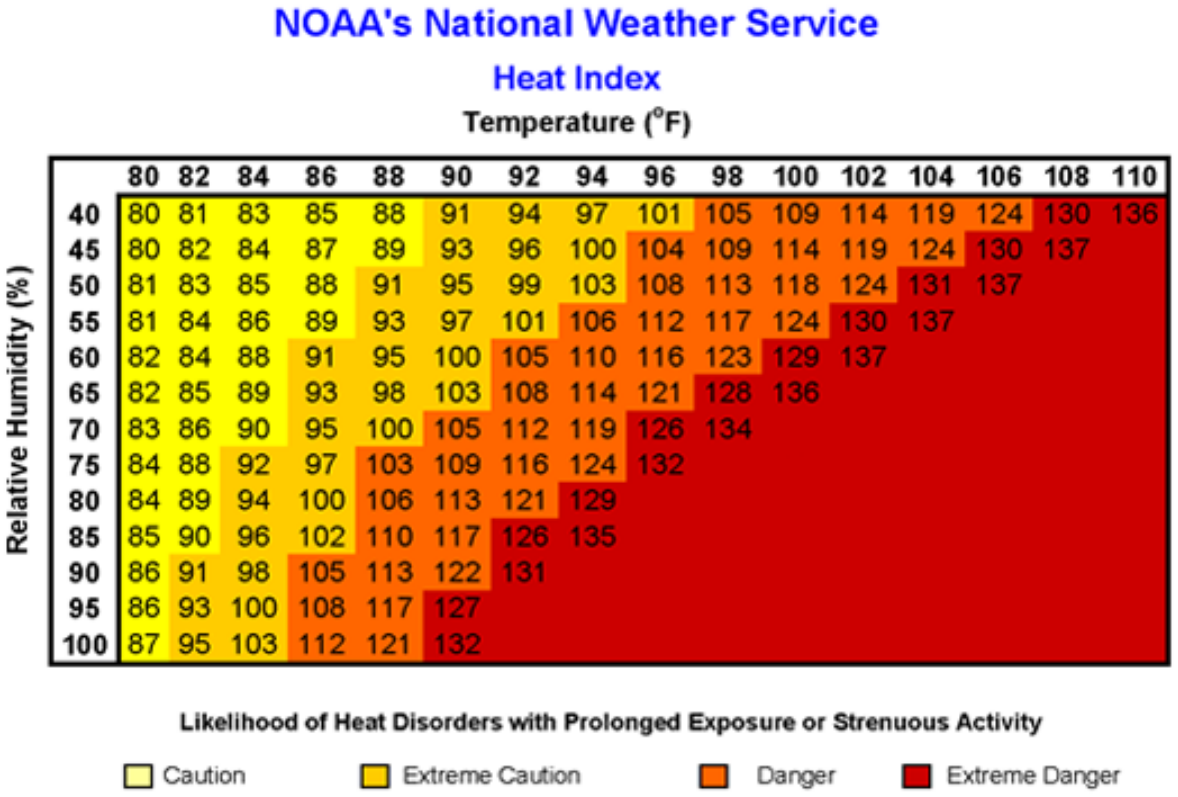
Companies are designing innovative solutions, and a workforce who builds things for a living can too!

Other important components of a heat safety plan include:

- Environmental monitoring
- Acclimatization
- Training
- Heat stress controls
- Emergency response

Environmental monitoring helps to implement appropriate control measures and evaluate their effectiveness

The NWS Heat Index combines air temperature and relative humidity into a single value that indicates how hot the weather will feel



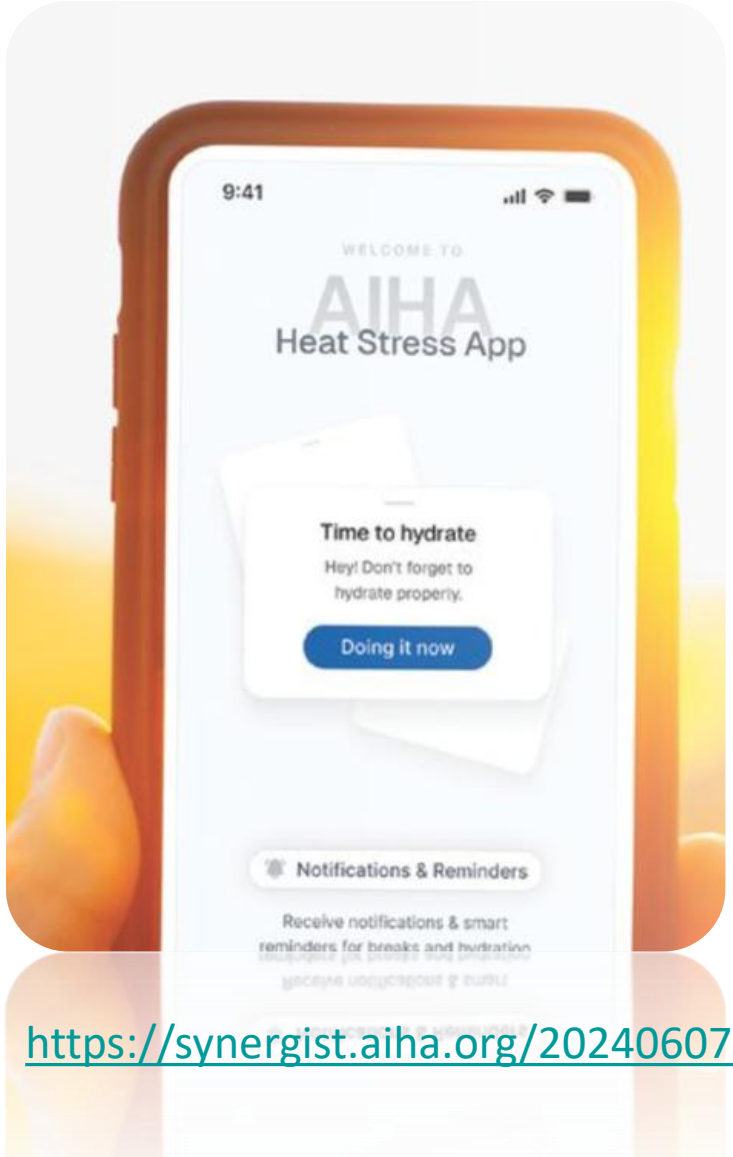
- Values were devised for shady, light wind conditions, so exposure to full sun can increase values up to 15˚
- They also do not account for the physical demands of the work nor clothing/PPE requirements

WBGT adjusts usual air temperature measurements by accounting for:

- humidity
- wind
- radiant heat (e.g., from sunlight or machinery)

Heat safety apps are available from OSHA-NIOSH and AIHA

https://www.cdc.gov/niosh/heat-stress/communication-resources/app.html



https://synergist.aiha.org/20240607-heat-stress-mobile-app

Why does acclimatization matter?

Over 70% of heat-related deaths occur during a worker's first week on the job!

https://www.osha.gov/heat-exposure/protecting-new-workers

“Acclimatization” means the body's temporary adaptation to work in heat that occurs as a person is exposed over time

Like dogs that shed fur when it’s hot, our bodies adapt to working in the heat!

The US Army practices acclimatization and provides information on its benefits

Thermal Comfort	Exercise Performance
Core Temperature – Reduced Sweating Efficiency – Improved Earlier Onset Higher Rate Redistributed Sweat Output Skin Blood Flow – Improved Earlier Onset Higher Rate Metabolic Rate - Lowered	Cardiovascular Stability – Improved Heart Rate – Lowered Stroke Volume – Increased Blood Pressure – better Defended Myocardial Compliance – Improved Fluid Balance – Improved Thirst – Improved Electrolyte Loss – Reduced Total Body Water – Increased Plasma (Blood) Volume – Increased and Better Defended

Table 2.1 - Actions of heat acclimation from Army TB MED 507

NIOSH recommends increasing exposures gradually over a period of 7 to 14 days

Day Number	Experienced Heat Worker	New Worker
1	50%	20%
2	60%	40%
3	80%	60%
4	100%	80%
5	100%	100%

Acclimatization starts to be lost after about 1 week away from working in the heat

Training should inform workers about risk factors for HRI

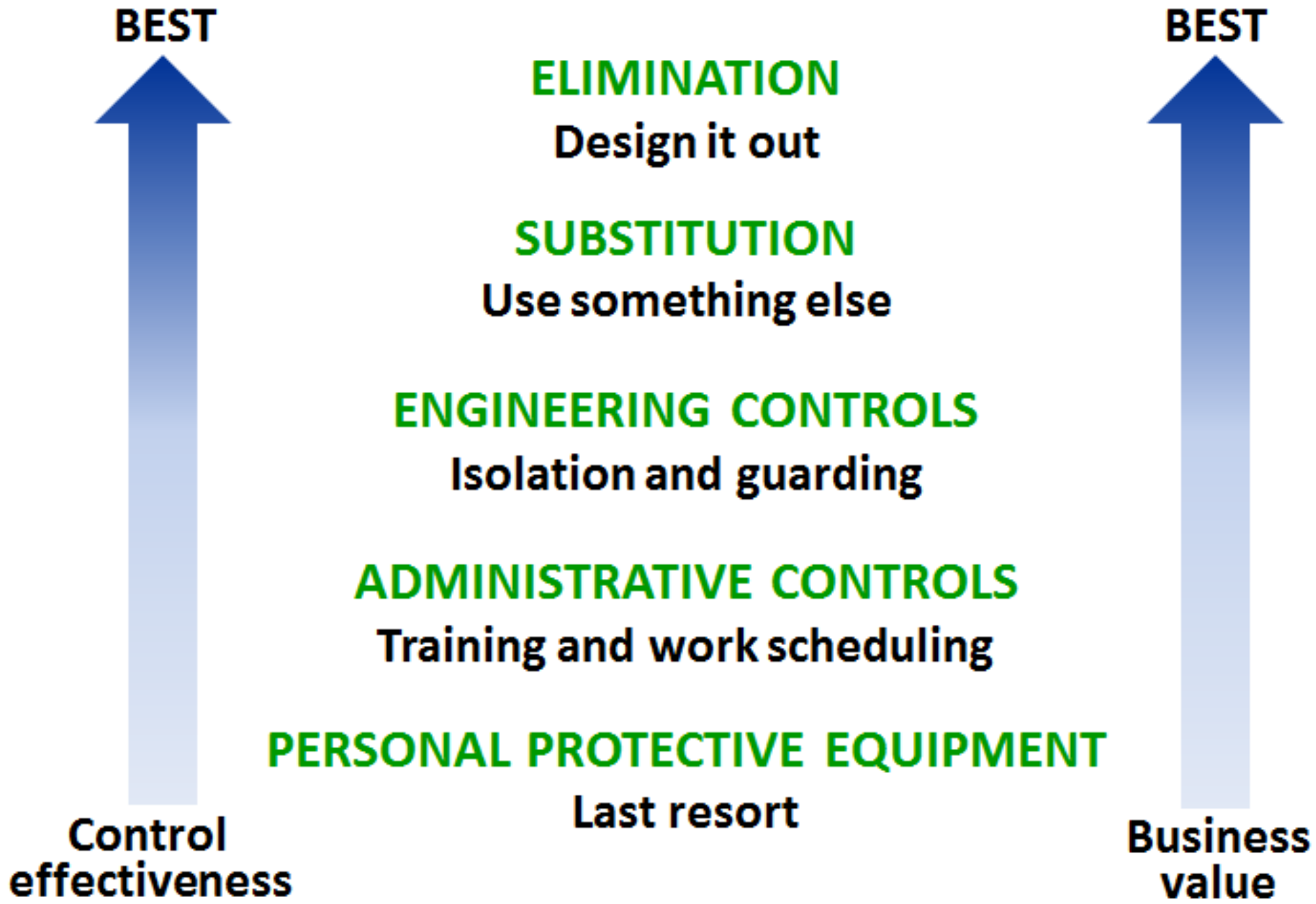
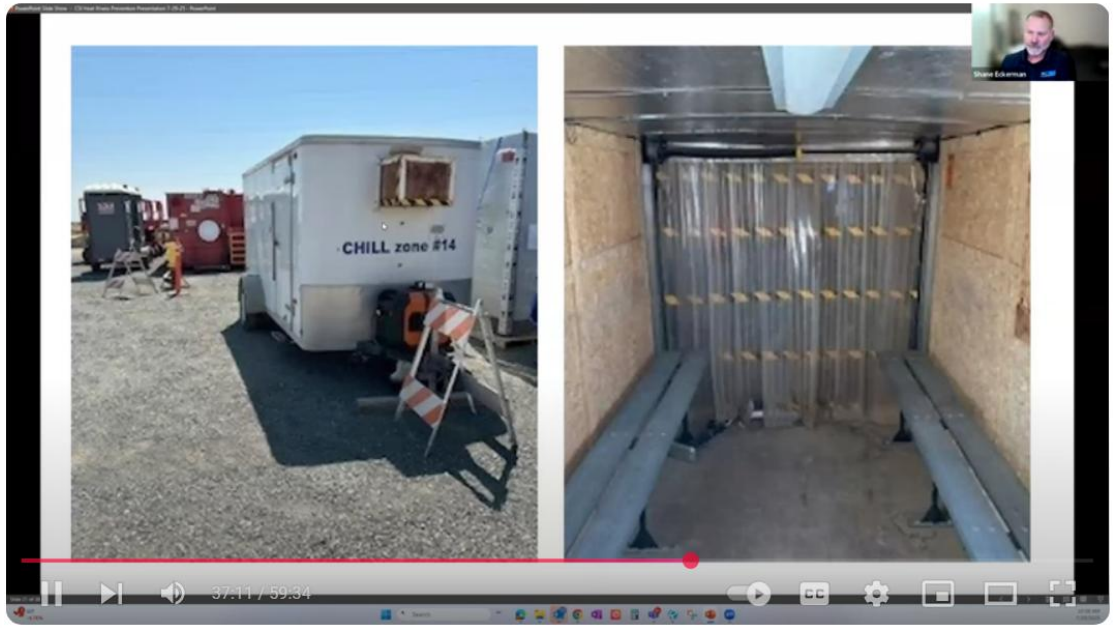


Image by NIOSH via Wikimedia Commons

Check out the NABTU-CPWR Summer Heat Webinar recording on YouTube to learn more about effective solutions being used in the field



https://www.youtube.com/watch?v=bSWnZJ7h_Lw

Emergency response plans should ensure that

- Medical services are available
- Workers know what to do when a co-worker suffers a heat illness
- First aid procedures are understood
- Clear directions to the worksite can be provided
- There is a plan to reschedule or stop work if conditions become too risky

CPWR is conducting research to advance heat safety in construction

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CURRENT RESEARCH

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Advancing Heat Safety in Construction

Gavin West
CPWR
Email: gwest@cpwr.com

Research Team
Rosa Greenberg, Cora Roelofs

Abstract:

This project will address heat-related health risks among construction workers, aiming to decrease heat stress incidence and reduce inequities in heat-related illness and injury risk. The first stage of this work will identify construction activities that pose a high risk of heat stress and collect context-rich information about the implementation of new and continuing heat stress solutions. Methods will include analyzing case narratives, conducting jobsite evaluations and interviews, administering surveys, and creating an advisory committee to help interpret results–all as part of creating intervention strategies. The second will develop targeted guidance, practical resources, and intervention strategies to prevent heat-related morbidity and mortality, such as creating planning tools and measuring their uptake and impact. The final aspect of this project will measure heat-related morbidity, mortality, and the adoption of heat safety solutions by analyzing national surveillance data, surveying a large representative panel of construction firms, and developing interactive data tools.

We are recruiting contractors to participate in our study

Contractors: Help Researchers Find Ways to Keep Your Workers Safe in Hot Weather

CPWR–The Center for Construction Research and Training is conducting a research study to understand and improve heat safety to better protect construction workers.

Project Goal: Develop and share strategies to prevent heat-related illnesses and save lives.

Research Questions

1. What are the impacts of extreme heat?
2. How is extreme heat managed at the job site?
3. What is working well to manage the effects of heat on workers and what areas remain challenging?
4. What are the opportunities for improvement?

Who Can Participate?

We are looking for construction firms, preferably with active worksites in Maryland or the Washington DC metro area, to participate in the study.

Study Process and Expectations[1]

Researchers will visit the site on two to three days during the summer of 2025 to collect information about the implementation and impact of heat illness prevention plans. This will include:

- A kickoff meeting to introduce the study and outline the process
- A walk-through of the site to observe heat illness prevention practices
- Management interviews to learn about supervisors' experiences, challenges, and needs with heat safety
- Brief worker surveys to gather their insights and experiences
- Wrap up meeting to report findings and answer questions

Ethical Considerations

Your company name will not be used without permission. Participation is voluntary and confidential. Participants may choose to withdraw from the study at any time.

[1]Details related to scheduling, walk-throughs, safety procedures, etc. will be discussed prior to enrollment.

To learn more, contact:
Project Director, Gavin West
gwest@cpwr.com
301-495-8522

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Helpful resources and guidance are available:

1. www.cpwr.com/heat
2. https://www.cpwrconstructionsolutions.org/
3. https://www.cdc.gov/niosh/heat-stress/about/index.html
4. https://www.osha.gov/heat-exposure
5. https://webstore.ansi.org/standards/asse/ansiasspa10502024
6. https://www.iso.org/standard/67188.html
7. https://www.aiha.org/get-involved/volunteer-groups/thermal-stress-working-group
8. https://www.acgih.org/science/tlv-bei-guidelines/

Thank you! Questions?

Gavin H. West, MPH

Director, Health Research

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