NACOSH Working Group on Heat
For Discussion April 27, 2023
Draft Report for NACOSH

The NACOSH Heat Injury and Illness Prevention Work Group, under Task #2, was charged with developing key recommendations on potential elements of heat injury and illness prevention rulemaking that OSHA should consider.

The work group compiled information, shared best practices, identified examples relevant across and within industries, and other sources. Sources of information include: existing standards, laws, programs and other frameworks; proposed standards and legislation; peer reviewed research, organizational and industry programs, consensus standards, and stakeholder comments and evidence in the rulemaking record, particularly a summary of the Advanced Notice of Proposed Rulemaking (ANPRM) comments. This work product of this working group is not meant to be a comprehensive list of elements for a potential standard, but core elements that provide consensus from the deep bench of expertise in this group.

The work group held public meetings on the following dates to report progress and hold discussion:
February 25, 2022
June 30, 2022
September 12, 2022
December 13, 2022
April 27, 2023

Members of the Work Group
Rebecca Reindel, AFL-CIO, Co-Chair
Kathleen Dobson, Alberici Constructors, Inc., Co-Chair
Cynthia Lewis, University of Arkansas for Medical Sciences, NACOSH Representative
Dominique Damian, Washington Farm Bureau
Enjoli DeGrasse, International Brotherhood of Teamsters
LTC David DeGroot, United States Army
Mirella Deniz-Zaragoza, Warehouse Workers Resource Center
Nicole Hernandez-Hammer, Service Employees International Union
Christopher Long, National Association of Manufacturers
Robert Matuga, Job-Site Safety Institute (JSI)
Kirk Sander, National Waste and Recycling Association
June Spector, University of Washington
Gavin West, The Center for Construction Research and Training (CPWR)
Jay Withrow, Virginia Department of Labor and Industry
Nezahualcoyotl Xiuhtecutli. Farmworker Association of Florida

Work Group Product 1 of 2:

Potential elements of heat injury and illness prevention rulemaking that OSHA should consider. Includes considerations, best practices, and additional resources.

Written Exposure Control Plan/ Heat Illness Prevention Plan

Applies to: all employers covered in the standard

Objectives: Process, documentation and feedback that informs revisions to heat controls.

- Provide framework for employers to walk through risk/hazard assessment
- Identifies triggers and what will take place
- Employers and employees know information about hazards and what to expect and who is in charge

1. Identify and describe work tasks and scenarios associated with heat hazards, including but not limited to: Environmental conditions (temperature, humidity, dry heat), heat sources (e.g., radiant heat), PPE, workload, work intensity, other risk factors
2. Identify and describe control measures for each of those tasks described above
3. The plan must describe separate procedures for high heat vs extreme heat conditions
4. The plan must include emergency preparedness and response procedures in the case of a heat-related adverse event
5. The plan must identify a responsible/competent person for being in charge of the plan
6. The plan must be regularly re-evaluated: updated at least annually, and after adverse events/sentinel events. A sentinel event could be that workers lose one or more days of work resulting from heat stress.
    a. Look at how other OSHA standards handle re-evaluation of the plan. One suggestion was LOTO
    b. Re-evaluation should take into account events, performance of the plan and outcomes over the past 6 mos/year/etc
7. Participation in development of each step of the plan by employees and their representatives
8. The plan must be accessible onsite by OSHA, and employees and their representatives (some providers also make these plans available to employees electronically)
9. Includes identification of supplies needed for controlling heat hazards, including supplies needed for emergency response
10. For emergency response purposes, identification of specific location of where workers will be performing work tasks. Some industries already have morning meetings everyday where location is reviewed before going out into the field or on a large site.
11. Adjusting of the plan as emergency events occur, to prevent them from occurring again
12. Include post-emergency and incident response: how to process and manage the work after an event.
13. The plan must include planning for foreseeable events growing in frequency and other emergencies. One example is wildfire smoke, which may require more worker reliance on PPE and double layer/non-breathable clothing that increase heat-related hazards.

How will controls be modified/changed, etc.? Can OSHA provide guidance or requirements on this either through the standard or an appendix?

Additional Resources to Consider:

- McCarthy R. (2019). Outcomes of a Heat Stress Awareness Program on Heat-Related Illness in Municipal Outdoor Workers. J Occ Env Med. 61(9):724-728
- WA outdoor heat CBA draft 2133 PCBA (wa.gov)
- Standardized Regulatory Impact Assessment (SRIA) of the Proposed California Regulation for Heat Illness Prevention in Indoor Places of Employment (cal-osha.com)
- Sahu, S, M Sett, and T. Kjellstrom. Heat Exposure, Cardiovascular Stress and Work Productivity in Rice Harvesters in India: Implications for a Climate Change Future. Industrial Health 2013, 51, 424–431.
- J. Foster, J.W. Smallcombe, S. Hodder, O. Jay and A.D. Flouris, and L. Nybo, and G.Havenith. An advanced empirical model for quantifying the impact of heat and climate change on human physical work capacity. International Journal of Biometeorology. https://doi.org/10.1007/s00484-021-02105-0

Training

Objective: Everyone needs to know how to implement the plan
Both workers and supervisors must be trained.

The group developed a framework/categories for training (should include but not be limited to):

1) Identification of hazards – including:
    a) Examining the working environment.
    b) Worker training on the employer methods used to assess conditions.
    c) Risk factors that may make people more susceptible: medical, certain uses of PPE (should be specific and have access to alternatives not to discourage use of safety equipment), etc.
    d) Incorporation of the use of the NIOSH Heat Index app
2) Mitigation of hazards through prevention
    a) Control measures
    b) Acclimatization policy and procedures for that worksite (trainings to be explicit about differences in work/rest schedules for unacclimatized vs acclimatized workers)
    c) Hydration and rest break needs, allowances, and procedures
    d) For taking breaks, need to know where water is
    e) Monitoring
    f) Importance of coming forward without retaliation
3) Reporting (how to report adverse heat-related events)
4) Emergency response (preparation for and active response) –
    a) Recognition of signs/ symptoms
    b) Monitoring

c) First aid/medical attention – person responsible for and procedures for performing first aid in the field
d) Coordination
e) Communication
f) Pinpointing location (not always on GPS). This can change daily so frequency of coordinating this information daily and as work environments change is crucial.
g) Identifying minimum training requirements for performing first aid.
    i) One suggestion was looking at the appendix in the logging standard.
h) Procedures for emergency occurrences to feed back into the plan (tracking, trends) to avoid repeat situations and prevent signs/symptoms from occurring
i) Practice response. Some industries already use “man down drills”
j) Addressing “hero syndrome”

Notes on learning methods and teaching aides:
*Use of graphical representation – some examples others have used have graphics and animation without sound so they are more accessible to everyone
*Adult learning methods
*Use culturally appropriate references, not just language translation. Some examples others have used relate to cars and sports.

In an appendix, could OSHA provide a recommended training guide in several formats to accommodate various workplace settings:
1) For use in the classroom
2) Toolbox talk / Tailgate trainings
*These examples should be tailored separately for workers and for supervisors.

Some best practices on frequency of trainings:
Annually (in spring: Feb - May), entry and re-entry.
Smaller refresher trainings at least once every several months.

Additional Resources to Consider Include:

- Clear Communication Index User Guide | The CDC Clear Communication Index | Centers for Disease Control and Prevention
- CDC Clear Communication Index Score Sheet
- Federal plain language guidelines
- Toolkit for Making Written Material Clear and Effective (cms.gov)
- Grzywacz JG, Gonzales-Backen M, Liebman A, Marín AJ, Trejo M, Gudino CO, Economos J, Tovar-Aguilar JA. Attending to Pesticide Exposure and Heat Illness Among Farmworkers: Results From an Attention Placebo-Controlled Evaluation Design. J Occup Environ Med. 2019 Sep;61(9):735-742.
- Marquez D, Krenz JE, Chavez Santos É, Torres E, Palmández P, Sampson PD, Blancas M, Carmona J, Spector JT. The Effect of Participatory Heat Education on Agricultural Worker Knowledge. J Agromedicine. 2023 Apr;28(2):187-198.

- Sinyai C, Barlet G. Designing Occupational Safety and Health Training Materials for Clear Communication. J Occup Environ Med. 2020 Jun;62(6):431-438.

Environmental Monitoring

Objective: Monitoring the site of work to accurately assess conditions, and apply controls based on conditions.

- Onsite temp monitoring systems are used and helpful in a variety of work settings
    - For instance in back cab areas of trucks (delivery drivers), inside trailers, etc.
    - Cell phones can be a distraction at work, depending, especially when operating equipment
    - Importance of monitoring both temperatures and heat index, not one or the other
- What gets triggered when a threshold is reached during monitoring and when work is untenable (stop work authority)
    - Ties back to the exposure control plan
- Workers participate in monitoring – know the measurement approaches being used in their workplaces, can self-monitor, know what to do when a threshold is reached, how can it trigger a check-in on individuals
    - Ties back to training and anti-retaliation measures to ensure monitoring is performed and reported
    - Part of this monitoring assessment is properly/accurately assessing and characterizing the workload (light - medium - heavy, etc.)
    - Triggering rest breaks
- Communication needs: tracking to facilitate monitoring and check-ins, report mechanisms back to employer
- Heat waves are different than just planning for “high vs. extreme” heat
    - The need to examine relative change (i.e., sudden increase) from prior days. Human physiological response is not just based on absolute temp/condition.
- Need to be additional requirements for work scenarios with lone and remote workers: they don’t have buddy systems, communication and system for regular check-ins are key, and how (Radio? etc), need assessment before dispatched and as day progresses, what to do in case of emergency
    - Example: Oil and gas workers have routine check-ins with supervisors
    - Example: Deliver drivers also have check-ins with supervisors when self-monitoring triggers
- Heightened monitoring needed during acclimatization period
- Monitoring not considered in a vacuum. Needs to take into account acclimatization, workload and other factors.
- Monitoring must be specific to the working environment. For instance:
    - different types of pavement can dramatically change conditions
    - working inside containers outside (i.e., on a tarmac, in logistics industry) can be like an oven, or can be cooler -- need to monitor the conditions to know

- Who is in charge of making decisions regarding control measures at different triggers based on monitoring, including stop work authority
- Real-time monitoring not to take away from prevention/planning

Additional Resources to Consider:

- Bernard TE, Iheanacho I. Heat index and adjusted temperature as surrogates for wet bulb globe temperature to screen for occupational heat stress. Journal of Occupational and Environmental Hygiene. 2015 [accessed 2021 Dec 26];12(5):323–333.
- Dillane D, Balanay JAG. Comparison between OSHA-NIOSH Heat Safety Tool app and WBGT monitor to assess heat stress risk in agriculture. Journal of occupational and environmental hygiene. 2020 [accessed 2021 Dec 26];17(4):181–192.
- Flunker JC, Zuidema C, Jung J, Kasner E, Cohen M, Seto E, Austin E, Spector JT. Potential Impacts of Different Occupational Outdoor Heat Exposure Thresholds among Washington State Crop and Construction Workers and Implications for Other Jurisdictions. Int J Environ Res Public Health. 2022 Sep 14;19(18):11583.
- Maung, Z., & Tustin, A. W. (2020). The Heat Death Line: Proposed Heat Index Alert Threshold for Preventing Heat-Related Fatalities in the Civilian Workforce. New Solutions, 30(2), 138–145.
- Morris, C. E., Gonzales, R. G., Hodgson, M. J., & Tustin, A. W. (2019). Actual and simulated weather data to evaluate wet bulb globe temperature and heat index as alerts for occupational heat-related illness. Journal of occupational and environmental hygiene, 16(1), 54–65.
- Tustin, A. W., Lamson, G. E., Jacklitsch, B. L., Thomas, R. J., Arbury, S. B., Cannon, D. L., Gonzales, R. G., & Hodgson, M. J. (2018). Evaluation of Occupational Exposure Limits for Heat Stress in Outdoor Workers — United States, 2011–2016. MMWR. Morbidity and Mortality Weekly Report, 67(26), 733–737.

Workplace control measures

Use of a control measure cannot prevent the intended purpose of the control. Make sure intention meets the need. Some examples include:

1) Water – make sure it is palatable/potable or no one will be able to drink it
2) Water breaks – make sure they are scheduled and without retaliation or they won't be taken
3) Shade – cannot be taken in a warm vehicle, etc. or defeats the purpose

Control measures, such as dehumidifiers, fans, etc. should loop back to monitoring. Monitoring conditions accurately will contribute to knowing which controls are needed and how they should be adjusted.

Engineering controls

Consider approaches across industries and industry-specific
Ventilation, especially in indoor work places, ensure specifications and maintenance to industry standards for proper function
Scheduled, mandatory rest breaks – takes into account human variability (in cooler environments)
Exhaust fans (LEV)
Portable engineering control: portable fans, tents, shielding/insulation, proactive misting
*Note: Above certain temperatures, fans have the opposite effect because they blow hot air on people and make environmental conditions warmer
The group is unsure if dehumidifiers improve or make worse.
Devices that move air can be used in more targeted ways (towards, away from worker)

Some industry-specific examples (that are or could be adapted to other industries) include:

- Isolating steam leaks from workers
- Indoor: Focus on building engineering, keeping buildings cooler when workers are there. Example: Janitorial work (e.g., buildings, planes): the HVAC is often turned off before/during workers' shifts

Workplace practice controls
Some examples include:

- Coolers with ice available to workers going out to field (note: coolers must be sanitized)
- Chasing the sun – plan work according to sun direction at different times of the day (especially outdoor work, but indoor work can apply depending on setting)
- Addressing local ordinances that don't let work to start in certain areas until a certain time in the morning, when it's already warming
- Scheduled, mandatory rest breaks – takes into account human variability (in warmer environments)
- Cooling cabs/vehicles

Some industry-specific examples (that are or could be adapted to other industries) include:

Administrative controls:
Rotating workers
Adjusting metabolic workload (using power tools, heavy labor, certain equipment can increase)
Communication and system for regular check-ins are key, and how (Radio? etc), need assessment before dispatched and as day progresses

Some industry-specific examples (that are or could be adapted to other industries) include:

- Innovation in waste and recycling industries, trying to make some measures more accessible: having corporate accounts with partner stores where workers can come in for water/electrolyte drinks
- Construction, other industries: Buddy system

Personal protective equipment:

Cooling vests and other gear
*Note: Be careful that PPE load can contribute to heat load, performed in conjunction with appropriate assessment and training
*Note: A lot of PPE options out there, but with mixed effectiveness

Some industry-specific examples (that are or could be adapted to other industries) include:

- Oil and Gas, while doing demolition and dust: clean suits with vortex for heat controls

Additional Resources to Consider:

- Zhao Y, Yi W, Chan APC, Wong DP. Impacts of cooling intervention on the heat strain attenuation of construction workers. Int J Biometeorol. 2018 Sep;62(9):1625-1634. doi: 10.1007/s00484-018-1562-y. Epub 2018 May 25. PMID: 29802501.
- Moyce S, Armitage T, Mitchell D, et al. Acute kidney injury and workload in a sample of California agricultural workers. American Journal of Industrial Medicine 2020;63:258–68.
- Pan, Q., Sumner, D. A., Mitchell, D. C., &; Schenker, M. (2021). Compensation incentives and heat exposure affect farm worker effort. PloS One, 16(11).
- Smallcombe J, Foster J, Hodder S, Jay O, Flouris A, Havenith G. (2022). Quantifying the impact of heat on human physical work capacity; part IV: interactions between work duration and heat stress severity. International Journal of Biometeorology. 66(12).
- Spector JT, Krenz J, Blank KN. Risk Factors for Heat-Related Illness in Washington Crop Workers. Journal of Agromedicine. 2015;20(3).
- Carballo-Leyenda B, Villa J, López-Satué J, Collado P, Rodríguez-Marroyo J. (2018). Fractional contribution of wildland firefighters' personal protective equipment on physiological strain. Frontiers in Physiology. 9:1139.
- Fletcher OM, Guerrina R, Ashley CD, Bernard TE. Heat stress evaluation of two-layer chemical demilitarization ensembles with a full face negative pressure respirator. Ind Health. 2014;52(4):304-12. doi: 10.2486/indhealth.2012-0197. Epub 2014 Apr 5. PMID: 24705801; PMCID: PMC4243016.
- Cheuvront S, & Kenefick R. (2021). Personalized fluid and fuel intake for performance optimization in the heat. Journal of Science and Medicine in Sport. 24(8): 735–738.
- Chicas R, Xiuhtecutli N, Dickman NE, et al. Cooling intervention studies among outdoor occupational groups: a review of the literature. Am J Ind Med. 2020;63:988-1007.
- Chicas R, Xiuhtecutli N, Elon L, Scammell MK, Steenland K, Hertzberg V, McCauley L. Cooling Interventions Among Agricultural Workers: A Pilot Study. Workplace Health Saf. 2021 Jul;69(7):315-322.
- Hosseinlou A, Khamnei S, Zamanlu M. The effect of water temperature and voluntary drinking on the post rehydration sweating. Int J Clin Exp Med. 2013 Sep 1;6(8):683-7. PMID: 24040477; PMCID: PMC3762624.

- Sawka M, Burke L, Eichner E, Maughan R, Montain S, Stachenfeld N. (2007). American College of Sports Medicine position stand. Exercise and fluid replacement. Medicine and Science in Sports and Exercise, 39(2), 377–390.

Acclimatization

Important issue that can't be glossed over
Many employers already doing this
There are existing examples of "work hardening programs" (increased intensity over period of 7-10 days) that can be leaned into
Consideration of return to work procedures, not just new employees
Monitoring and observations need to feed back into acclimatization plan
Physiologically, humans cannot build tolerance while in a sudden heat wave

Additional Resources to Consider:

- NIOSH criteria document
- Heat Stress Acclimatization | NIOSH | CDC
- Daanen HAM, Racinais S, Périard JD. Heat Acclimation Decay and Re-Induction: A Systematic Review and Meta-Analysis. Sports Med. 2018 Feb;48(2):409-430. doi: 10.1007/s40279-017-0808-x. PMID: 29129022; PMCID: PMC5775394.
- Périard, J. D., Racinais, S., & Sawka, M. N. (2015). Adaptations and mechanisms of human heat acclimation: Applications for competitive athletes and sports. Scandinavian Journal of Medicine and Science in Sports, 25(S1), 20–38. https://doi.org/10.1111/sms.1240
- Shvartz E, Saar E, Meyerstein N, Benor D. A comparison of three methods of acclimatization to dry heat. J Appl Physiol. 1973 Feb;34(2):214-9. doi: 10.1152/jappl.1973.34.2.214. PMID: 4686355.
- SHARP Stats: Heat-Related Illness in New Workers (wa.gov)

Additional notes on Worker participation

Workers a critical part of the development and evaluation process of the written control plan.
On emergency response, need feedback from workers and supervisors on knowing the location of workers on worksites and how they will help locate workers.

Additional Resources to Consider:

- OSHA's Recommended Practices for Safety and Health Programs (developed from previous NACOSH work): https://www.osha.gov/safety-management/step-by-step-guide
- Also, potentially ANSI Z10, ISO 1800
- ILO: https://www.ilo.org/global/topics/safety-and-health-at-work/normative-instruments/WCMS_107727/lang--en/index.htm
- Burgess-Limerick R. Participatory ergonomics: Evidence and implementation lessons. Appl Ergon. 2018 Apr;68:289-293.

Additional notes on Emergency response:
Should address immediate first aid performed in the field/onsite.
Initiating cooling needs to happen promptly.

Additional Resources to Consider Include:

- Also see Emergency Access plans in UCT Korey Stringer Institute citation below.
- Filep E, Murata Y, Endres B, Kim G, Stearns R, Casa D. (2020). Exertional Heat Stroke, Modality Cooling Rate, and Survival Outcomes: A Systematic Review. Medicina (Kaunas, Lithuania). 56(11): 1–24.
- Casa DJ, McDermott BP, Lee EC, Yeargin SW, Armstrong LE, Maresh CM. Cold water immersion: the gold standard for exertional heatstroke treatment. Exerc Sport Sci Rev. 2007 Jul;35(3):141-9.

Other Resources for OSHA to Review:

https://www.ccohs.ca/oshanswers/phys_agents/heat/heat_control.html#section-1-hdr

Warrior Heat- and Exertion-Related Event Collaborative. Our website is https://us01.z.antigena.com/l/EUpDvSuml3MAIkifekr752Da3GL3sTcoVcQigpw5d2SxYgRJACL9AopBshWo8U6HeyBNGBMh8Tg0NaJlotMnTN2lT9NOOr0OHaZsw_5SYYhnvHSpE6PxfVi7qHdY94kBV8UBCm9vPF5d6aV3A0lw2up3GEwDHSJocUg2lxSHxtxsBMZ~LJ40Vj . This is more clinically-focused, so perhaps of lesser use to NACOSH and our WG.

The Defense Centers for Public Health - Aberdeen (formerly Army Public Health Center) has a heat illness prevention page with numerous resources. Here is the link to their page: https://phc.amedd.army.mil/topics/discond/hipss/Pages/default.aspx

The Korey Stringer at the University of Connecticut (https://heatsafetycoalition.com), Heat Safety Performance Coalition.

Morrissey MC, Casa DJ, Brewer GJ, Adams WM, Hosokawa Y, Benjamin CL, Grundstein AJ, Hostler D, McDermott BP, McQuerry ML, Stearns RL, Filep EM, DeGroot DW, Fulcher J, Flouris AD, Huggins RA, Jacklitsch BL, Jardine JF, Lopez RM, McCarthy RB, Pitisladis Y, Pryor RR, Schlader ZJ, Smith CJ, Smith DL, Spector JT, Vanos JK, Williams WJ, Vargas NT, Yeargin SW. Heat Safety in the Workplace: Modified Delphi Consensus to Establish Strategies and Resources to Protect the US Workers. Geohealth. 2021 Aug 1;5(8):e2021GH000443.
Consensus doc: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8388206/

ISO 7730 Moderate Thermal Environments - Determination of the PMV and PPD indices and specification of the conditions for thermal comfort (copyright)

ASHRAE Air Quality in Commercial Aircraft (copyright)

Morris NB, Jay O, Flouris AD, Casanueva A, Gao C, Foster J, Havenith G, Nybo L. Sustainable solutions to mitigate occupational heat strain - an umbrella review of physiological effects and global health perspectives. Environ Health. 2020 Sep 4;19(1):95. doi: 10.1186/s12940-020-00641-7. PMID: 32887627; PMCID: PMC7487490.

Austin E, Kasner E, Seto E, Spector J. Combined Burden of Heat and Particulate Matter Air Quality in WA Agriculture. J Agromedicine. 2021 Jan;26(1):18-27. doi: 10.1080/1059924X.2020.1795032. Epub 2020 Jul 30. PMID: 32730190; PMCID: PMC8171194.

Leon L. (2008). Thermoregulatory responses to environmental toxicants: the interaction of thermal stress and toxicant exposure. Toxicology and Applied Pharmacology. 233(1): 146–161.

Hesketh, M., Wuellner, S., Robinson, A., Adams, D., Smith, C., & Bonauto, D. (2020). Heat related illness among workers in Washington State: A descriptive study using workers' compensation claims, 2006-2017. American Journal of Industrial Medicine. 63(4): 300–311.

Park RJ, Pankratz N, Behrer AP. IZA DP No. 14560 Temperature, Workplace Safety and Labor Market Inequality. IZA Institute of Labor Economics. Bonn, Germany, 2021.

Jackson, LL and HR. Rosenberg. (2010) Preventing Heat-Related Illness Among Agricultural Workers, Journal of Agromedicine, 15:3, 200-215, DOI: 10.1080/1059924X.2010.487021

Wadsworth, G., Riden, H. E., & Pinkerton, K. E. (2022). Farmer perceptions of climate, adaptation, and management of farmworker risk in California. Journal of Agriculture, Food Systems, and Community Development, 11(2), 179–198. https://doi.org/10.5304/jafscd.2022.112.015