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15 October 2021

Jay Withrow
Director, Division of Legal Support, ORA, OPPPI, and OWP
Virginia Department of Labor and Industry
600 E. Main Street, Suite 207
Richmond, VA 23219

Via email: jay.withrow@doli.virginia.gov and princy.doss@doli.virginia.gov

RE: Comments Regarding the Proposed Heat Illness Prevention Standard

Dear Mr. Withrow:

First, I would like to thank you for the opportunity to serve the Commonwealth of Virginia as a member of Regulatory Advisory Panel Member for heat stress prevention standard. The background you provided and the interactions with other panel members provided me with fresh insights to managing heat stress through a regulation. This letter and the attached comments are for the record. The foundation is my 40 years of research and practice in industrial hygiene with a strong interest in heat stress as well as the experience working with the panel of stakeholders. While I am an employee of the University of South Florida and involved with funded programs, professional organizations, and general practice, the opinions expressed here are my own and should not be interpreted as those with whom I am associated.

Heat stress is a serious workplace hazard and its effects are seen in heat-related illness, acute injury and accidents, and lost productivity. The probability of heat stress impacting the health and well-being of workers increases with the level of heat stress and raised with recent previous exposures (i.e., a carryover effect from at least the previous day and likely the previous few days).

Following a public health model, heat stress thresholds that have been described by Federal and state governments and professional organizations (e.g., NIOSH, ACGIH, ISO) are designed to protect most healthy, hydrated workers in a way that the heat stress exposure can be safely sustained for hours. This criterion carries the implicit understanding that many workers can safely work above the threshold; and it is this fact that may cause problems with fully understanding the risks involved. We cannot know who the less heat tolerant healthy person is. It is also important to understand that there are employees who have a lower heat tolerance than the limits would prescribe. These employees carry personal risk factors that may be inherent such as genetic and capacity factors as well as chronic or acute disease with the associated treatments.

To protect those whose heat stress tolerance is less than the heat stress criteria, the General Controls described in the attached comments become a floor in the prevention of heat-related illness. This floor centers around appreciating that heat stress can be a hazard for at least some workers and being prepared to deal with heat-related disorders, especially heat stroke, as they might occur. As a foundation, a written program of heat stress

management that includes policy statements, training, heat stress hygiene practices, and an emergency response plan becomes essential.

Once again, thank you for the opportunity to participate and to submit my written comments. I remain available to you if I can provide any assistance in preparing any of the technical aspects of the regulation.

Sincerely,

Thomas E. Bernard
Professor

Attachment: Bernard Comments on Core HSMP VOSH 20211015

Comments for the Record: Core Elements of Heat Stress Management

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Introduction

Individuals exhibit a broad range of ability to tolerate heat stress. There is no reliable way of knowing how personal factors like aerobic capacity and obesity as well as chronic and acute disease affect the degree of heat tolerance. Assessment schemes have a threshold exposure with a goal of protecting most healthy, hydrated workers. The implication of protecting most healthy, hydrated workers with a prescribed limit is that most workers can safely work above those limits. The problem is knowing who those workers are and how much above the limit they can safely work. The other implication is that those with less heat tolerance may have a greater probability of over-exposure.

Heat stress assessment often includes environmental conditions, work demands and clothing requirements. In general, the environmental threshold is adjusted inversely to the metabolic rate and then further adjusted by the degree to which clothing affects heat exchange. Prescribed exposure limits also adjust for acclimatization state.

The following is a framework for a heat stress management program (HSMP) to consider in the VOSH regulation.

Trigger Point

A trigger point is a working condition at which the regulation would apply. The practical importance is informing employers who never have operations above the trigger point that heat stress is not a likely hazard. For those employers who can anticipate regular occurrences, the trigger point establishes the recognition threshold that heat stress may be a hazard and that the employer health and safety program should address heat stress. Consequently, the trigger point should not be viewed as a condition that should be evaluated on an hourly or daily basis.

Two case series reports by OSHA investigators of OSHA citations provides insight to when a heat-related illness may occur. The investigators have suggested a value for Heat Index or air temperature below which heat illnesses did not result in a citation. An important feature of this lower point is that includes workers with low heat tolerance including comorbidities. The recommended trigger point for outdoor work is an air temperature or Heat Index of 80 °F.

Indoor heat stress conditions may use the simple consideration of air temperature. Heat Index requires the measurement of humidity in the workplace that is not difficult. In most cases the outside triggers can be used.

As a note, a Heat Index of 82 °F in the sun is approximately the limit for unacclimatized workers working at a moderate metabolic rate using the wet bulb globe temperature (WBGT) schemes of NIOSH, ACGIH and ISO.

Written Heat Stress Program

When the trigger conditions are reasonably expected, the employer should have a written heat stress program that establishes the policies and actions described below.

- Assignment of responsibilities. The person responsible for developing and managing the heat stress program is identified. This person is responsible for knowing the heat stress hazards, developing the program to comply with the regulation, and advising others on the program implementation.
- Include policy statements
    - Self-determination
    - Acclimatization
- Include General Controls
- Consider Job Specific Controls as needed

General Controls
General Controls are those actions that should be taken once heat stress is identified as a workplace hazard. General Controls include

- ***Heat Stress Training.*** Pre-placement and periodic training with re-enforcement.
    - Causes of heat stress
    - Heat-related disorders including causes, recognition and first aid
    - Heat stress hygiene practices
    - Local risk mitigation strategies including a heat-related disorder response plan
- ***Heat Stress Hygiene Practices.*** Heat-stress hygiene practices are the actions taken by an individual to reduce the risks of a heat disorder. The individual is responsible for practicing good heat stress hygiene but management needs to support and minimize barriers.
    - *Self-determination*. The individual should seek relief from a heat stress exposure once extreme discomfort or the initial symptoms of a heat-related disorder are sensed. Often an employee can have significant physiological strain before they report that they are very uncomfortable or have the symptoms of heat exhaustion or stroke. Thus, the early recognition is important. Recovery should be long enough that the employee reports being recovered. (Note: Self-directed recovery may leave residual heat strain.)
    - *Fluid replacement*. Because thermal regulation depends on sweating and the necessary loss of water, the water must be replaced at frequent intervals to maintain acceptable hydration.
    - *Lifestyle and diet*. Practicing a generally accepted healthy lifestyle (getting adequate sleep, limiting non-work exposures to heat stress, exercising, not abusing alcohol or drugs, and eating a well-balanced diet) reduces the risk of heat-related disorders.
    - *Health status*. Those with any chronic disease should inform their provider of occupational exposures to heat stress and follow the recommendations. Those with an acute illness should report the condition to a supervisor, and the heat stress exposures should be restricted or reduced.
    - *Acclimatization*. Because acclimatization requires at least 4 days, allowances must be made for those workers who are not acclimatized to the heat, and performance expectations should therefore be reduced. (Note: Some professionals and literature would include acclimatization under administrative controls rather than a hygiene practice.)

There are several acclimatization schedules that circulate in the literature. As a general principle full acclimatization takes 7 to 14 days, but NIOSH and ACGIH propose a schedule of 4 days to reach a practical improvement. Some employers use a work practice of increasing the job demands by starting with tasks that have low demands and move employees up to tasks with higher demands.

The following is a scheme that effectively says that unacclimatized employees can be ramped up by considering the improvement in heat tolerance over 4 days. The value is a plus-up on Heat Index to show the effective level of heat stress. For an unacclimatized employee working at Heat Index of 90 °F is effectively exposed to a Heat Index of 100 °F.

State		Day 1	Day 2	Day3	Day 4
Unacclimatized	New employee; Away for a week or more due to illness; Absent for 3 weeks	+10 °F	+8 °F	+4 °F	Practically Acclimatized
Mostly Unacclimatized	Away for less than a week due to illness; Absent for 2 weeks	+8 °F	+4 °F	Acclimatized	Acclimatized
Somewhat Unacclimatized	Absent for 1 week	+4 °F	Acclimatized	Acclimatized	Acclimatized

Some Caution	Absent less than 1 week	Reduce Expectations	Acclimatized	Acclimatized	Acclimatized

- Surveillance
  - Environmental. If the written plan calls for specific actions at different heat stress levels (see below), supervisors need a means to assess the environment.
  - Medical. Beyond recommendations to employees with chronic disease to seek counseling from their healthcare provider, monitoring of sentinel health events is recommended. These sentinel events are heat-related disorders, patterns of accidents, absenteeism, and chronic fatigue.
    - If the employer finds that an employee has lower heat tolerance than others based on sentinel events or advice of a healthcare provider, then interventions can be designed for them (e.g., adjust work requirements during high levels of heat stress).
- ***First aid and emergency response plan.*** The plan should include the ability to recognize early symptoms of heat-related disorders by first line supervisors and workers. In the event of a suspected heat stroke, a method for immediate emergency cooling of the person (ice water immersion or other aggressive method) and arrangements for transport to the hospital are necessary. It is crucial to start cooling immediately and not to wait for an emergency service to arrive.
  - While the prevalence of heat stroke is very low, it is life threatening. The buddy system is important for the recognition of heat stroke, especially because the person may not have the cognitive function to understand the risk and to take any protective steps. In addition to recognizing the signs of heat stroke, the observing employee needs to take aggressive action to cool the person experiencing symptoms and execute the emergency response plan including calling 911. These steps also require training.
- ***Pre-Job Briefings.*** These should follow the usual practice but may include readiness for work. For heat stress, readiness for work would include questions about quality of sleep and appetite as well as symptoms of acute illness.

Heat Stress Limits for Job Specific Controls

First, it is worthwhile to discuss severity of a heat stress exposure in terms of outcomes. The following table suggests levels of severity for moderate work demands (300 W) in ordinary woven cloth work clothing outside in direct sun (lowers the threshold Heat Index by 6 °F).

Level	WBGT	Heat Index In Sun	Description
Acceptable	< 25 °C	< 82 °F	Low probability (< 1%) of unsustainable heat stress for anyone
Caution	25 – 28 °C	82 – 92 °F	Low probability (< 1%) of unsustainable heat stress for anyone who is acclimatized
Moderate	28 – 31 °C	92 – 106 °F	Low probability (< 1%) of rapid heat gain
High	31 – 34 °C	106 – 125 °F	Significant probability (up to10%) of rapid heat gain
Extremely High	> 34 °C	> 125 °F	Likelihood (> 10%) of rapid heat gain

Taking the Caution Level as the point to implement job specific controls, the following table illustrates how metabolic rate affects the threshold Heat Index for work in direct sun.

Work Demands	V Light	Light	Moderate
Heat Index In Sun and Steady Work	118	106	92

While not presented here, the effects of other clothing can be accounted for.

The recommended Severity level is Caution. Once this level is exceeded, Job Specific Controls are needed to bring the exposure within the limit.

Note: For those suggesting a 90 °F High Heat Stress level, the above table supports this decision for work in the sun or other radiant heat source.

Job Specific Controls
Job Specific Controls are those that apply to specific situations. While not all job specific controls apply to specific work places, they are provided here as an opportunity to think about possibilities. The job specific controls follow the traditional hierarchy of engineering controls followed by administrative controls, and then personal protection, usually in the form of personal cooling.

Specific Controls follow.

- ***Engineering Controls.*** Engineering controls change the conditions so that the level of heat stress is reduced, ideally below the exposure thresholds.
    - *Reduce the metabolic rate.* A very effective means to reduce heat stress is to reduce the amount of internal heat generation.
    - *Change clothing requirements.* This generally applies to protective clothing so that the clothing provides adequate protection from the hazard but is not over-specified and thus add an unnecessary heat stress burden.
    - *Reduce temperature and humidity.* Reductions of air temperature and humidity are frequently achieved through spot or dilution ventilation. This is another method to significantly reduce the level of heat stress in the workplace. The ventilation systems can be temporary or permanent and may include mechanical cooling.
    - *Increase air motion.* Increasing air speed via fans is a time-honored method to enhance evaporative cooling, but it is of limited value once air speed exceeds 2 m/s. When air temperature is greater than 40 °C (104 °F), increasing air motion may actually increase heat stress.
    - *Control radiant heat.* When radiant heat is high, the effects can be reduced through combinations of insulating exterior surfaces and reducing surface emissivity. In addition, shields can be very effective.
- ***Administrative Controls.*** Administrative controls manage the risk through work practices. They are relatively easy to implement, although they may not be as cost-effective as other controls.
    - *Planned work time.* Limiting the heat stress exposure to a time period that would ensure that most workers are not overexposed is one way to limit the risk. The work time limit can be based on the WBGT or ISO methods of estimating safe exposure times.
    - *Self-determination.* Giving employees the opportunity to subjectively control the pace of work and the work time is frequently used as a means of controlling heat stress exposures. Self-pacing is a valuable means of reducing the physiological strain and improving efficiency. Subjective self-limitation, however, may not be reliable. Physiological monitoring to provide objective information on heart rate and body temperature will improve the reliability. The advantage of personal monitoring is that it allows the more heat-tolerant workers more exposure time. In this way, personal monitoring can improve productivity while controlling the risk of heat-related disorders.
    - *Recovery allowances.* It is important to provide adequate recovery from heat stress exposures. Including recovery times and locations in the analysis of overall evaluation of heat stress exposure provides insight as to whether or not the recovery allowance is adequate.

The following work and recovery table using Heat Index is an example of work outside in the sun with regular work clothing and rest occurs in a shaded area.

	Work Demands		
Work/Rest	V Light	Light	Moderate
60/0	118	106	92
45/15	119	107	97
30/30	120	113	104
15/45	122	119	113
No Work	125	125	125

    - *Scheduling work.* To the extent possible, scheduling work to times when the heat stress levels may be lower (e.g., night) is a useful way to control exposures.
- ***Personal Protection.*** Personal protection for heat stress exposures means providing a microenvironment around the worker that allows a greater loss of heat.
    - *Circulating air systems.* Venting air from supplied-air hoods or supplying breathing grade air directly under clothing enhances evaporative and convective cooling. Many times, the cooling is sufficient to virtually eliminate heat strain. The major disadvantage is that worker mobility is restricted with the airline.
    - *Liquid cooling systems.* This type of personal cooling is based on circulating cooling liquid (e.g., water) around some portion of the body within enclosed tubes or channels. The rate of cooling depends on the surface area of the body covered. The heat is taken up by a heat sink that is usually composed of ice but could theoretically be another material. The service time depends on the size of the heat sink or the ability to replenish the heat sink. The major disadvantage to these systems is the cost.
    - *Ice cooling (phase change) garments.* Ice cooling and phase change garments cool the body by direct transfer of heat from the body to the heat sink by conduction. These are sometimes referred to as passive systems because there is no mechanical movement of air or liquid.
    - *Forearm immersion in cold water*. By placing the forearms in a cold/ice water bath, the recovery from a heat stress exposure can be accelerated.

WBGT Alternative

Wet bulb globe temperature (WBGT) index is a widely recognized metric for environmental contributions to heat stress as recommended by NIOSH and ACGIH. The WBGT-based exposure assessment is more representative of how workers are affected by heat stress. The NIOSH RAL and ACGIH Action Limit can be substituted for the trigger limit and the NIOSH REL and ACGIH TLV can be used as the high heat stress limit.