Occupational Exposure to Heat and Hot Environments

Model Policy

Developed for the First Responder Center for Excellence
By the Center for Fire, Rescue & EMS Health Research, NDRI-USA, Inc.
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1 Introduction

The National Institute for Occupational Safety and Health (NIOSH) recommends compliance with standards in order to minimize worker exposure to extreme heat in the workplace. Compliance with recommended standards should prevent or greatly reduce the risk of adverse health effects of exposed workers. Heat-related occupational illnesses, injuries, and reduced productivity can occur when total heat load (environmental and internal/metabolic) exceeds the capacity of the body to maintain normal functions. The reduction of adverse health effects can be accomplished by the proper application of engineering and work practice controls, worker training and acclimatization, measurements and assessment of heat stress, medical monitoring, and proper use of heat-protective clothing and personal protective equipment (PPE).

2 Recommendations for an Occupational Standard for Workers Exposed to Heat and Hot Environments

The occurrence of heat-related illnesses among a group of workers in a hot environment, or the recurrence of such illnesses in individual workers, represents “sentinel health events”, which indicate that heat control measures, medical screening, or environmental monitoring measures may not be adequate [Rutstein et al. 1983]. One occurrence of heat-related illness in a particular worker indicates the need for medical inquiry about appropriate workplace protections. The recommendations in this document are intended to provide limits of heat stress so that workers’ risks of incurring heat-related illnesses and disorders are reduced.

Almost all healthy workers who are not acclimatized to working in hot environments and who are exposed to combinations of environmental and metabolic heat less than the applicable NIOSH Recommended Alert Limits (RALs) should be able to tolerate the heat stress (i.e., the sum of metabolic heat plus environmental heat, minus the heat lost from the body to the environment) without a substantial increase in their risk of incurring acute adverse health effects. Almost all healthy workers who are heat-acclimatized to working in hot environments and who are exposed to combinations of environmental and metabolic heat less than the applicable NIOSH Recommended Exposure Limits (RELs) should be able to tolerate the heat stress without incurring adverse effects. In this criteria document, when not otherwise qualified, the term “healthy workers” refers to those who are physically and medically fit and do not require additional protection, modifications in acclimatization procedures, or additional physiological monitoring beyond the normal recommendations for the amount of heat exposure.

1.1 Workplace Limits and Surveillance

1.1.1 Recommended Limits

Unacclimated workers

Total heat exposure to workers should be controlled so that unprotected (i.e., those not wearing PPE that would provide protection against heat) healthy workers who are not acclimatized to working in hot environments are not exposed to combinations of metabolic and environmental heat greater than the applicable RALs.

Acclimatized workers

Total heat exposure to workers should be controlled so that unprotected healthy workers who are acclimatized to working in hot environments are not exposed to combinations of metabolic and environmental heat greater than the applicable RELs.

Effect of Clothing

1.1.2 Determination of Environmental Heat

Heart rate, core body temperature, and body water loss can be assessed as measures of physiologic response to heat.

1.2 Medical Monitoring

1.2.1 General

(1) The employer should institute a medical monitoring program for all workers who are or may be exposed to heat stress above the RAL, whether they are acclimatized or not. A medical monitoring program is essential to assess and monitor workers' health and physical well-being both prior to and while working in hot environments; to provide emergency medical care or other treatment as needed and gather medical information (e.g., identify changes in health status, identify training needs for prevention efforts).

(2) The employer should ensure that all medical evaluations and procedures are performed by or under the direction of the responsible healthcare provider (e.g., licensed physician or other licensed and/or credentialed healthcare professional).

(3) The employer should provide the required medical monitoring without cost to the workers, without loss of pay, and at a reasonable time and place.

1.2.2 Preplacement Medical Evaluations

For the purposes of the preplacement medical evaluation, all workers should be considered to be unacclimated to hot environments. At a minimum, the preplacement medical evaluation of each prospective worker for a hot job should include the following elements:

(1) A comprehensive work and medical history. The medical history should include a comprehensive review of all body systems as would be standard for a preplacement physical examination, along with specific questions regarding previous episodes of diagnosed heat-related illness, rhabdomyolysis, and questions aimed at determining acclimatization to the new employment environment.

(2) A comprehensive physical examination should be conducted. At the discretion of the responsible healthcare provider, candidates who anticipate increased stress of physical activity of the job in a hot environment, those over 50 years of age or those younger than 50 years of age with underlying cardiac risk factors may need to have additional testing (e.g., electrocardiogram (ECG) with interpretation by a cardiologist).

(3) An assessment of the use of therapeutic drugs, over-the-counter medications, supplements, alcohol, or caffeine that may increase the risk of heat injury or illness.

(4) An assessment of obesity, defined as a body mass index (BMI) ≥ 30. Measure height and weight to calculate body mass index according to the following formula:

$$BMI = \text{weight (in pounds)} \times 703 / [\text{height (in inches)}]^2$$

(5) An assessment of the worker's ability to wear and use any protective clothing and equipment, especially respirators, that is or may be required to be worn or used.

1.2.3 Periodic Medical Evaluations

Periodic medical evaluations should be made available at least annually to all workers who may be exposed at the worksite to heat stress exceeding the RAL. At minimum, the employer should provide the evaluations specified above. If circumstances warrant (e.g., an increase in job-related heat stress or changes in health status), the medical evaluation should be offered at more frequent intervals at the discretion of the responsible healthcare provider.

1.2.4 Emergency Medical Care

If the worker develops signs or symptoms of heat stroke or heat exhaustion, the employer should provide immediate emergency medical treatment (e.g., call 911 and cool down the worker). Other non-life-threatening heat-related illnesses may be treated with appropriate first aid procedures.

1.2.5 Information to Be Provided to the Responsible Healthcare Provider

The employer should provide the following information to the responsible healthcare provider performing or responsible for the medical monitoring program:

(1) A copy of this recommended standard.

(2) A description of the affected worker's duties and activities (e.g., shift schedules, work locations) as they relate to the worker's environmental and metabolic heat exposure.

(3) An estimate of the worker's potential exposure to workplace heat (both environmental and metabolic), including any available workplace measurements or estimates.

(4) A description of any protective equipment or clothing the worker uses or may be required to use.

(5) Relevant information from previous medical evaluations of the affected worker that is not readily available to the responsible healthcare provider.

1.2.6 Responsible Healthcare Provider's written Report of Medical Findings

The employer should obtain a written opinion from the responsible healthcare provider, which should include the following elements:

(1) Occupationally pertinent results of the medical evaluation.

(2) A medical opinion as to whether the worker has any medical conditions that would increase the health risk of exposure to heat in the work environment.

(3) An estimate of the individual's tolerance to withstand hot working conditions.

(4) An opinion as to whether the worker can perform the work required by the job (i.e., physical fitness for the job).

(5) Recommendations for reducing the worker's risk for heat-related illness, which may include use of cooling measures, accommodations or limitations related to work/rest schedules and/or workload, or reassignment to another job, as warranted.

(6) A statement that the worker has been informed by the responsible healthcare provider of the results of the medical evaluation and any medical conditions that require further explanation or treatment. The worker is cleared to work in the hot environment so long as no adverse health effects occur. Specific findings, test results, or diagnoses that have no bearing on the worker's ability to work in heat or a hot environment should not be included in the report to the employer. Safeguards to protect the confidentiality of the worker's medical records should be enforced in accordance with all applicable federal and state privacy regulations and guidelines.

1.3 Surveillance of Heat-related Sentinel Health Events

1.3.1 Definition

Surveillance of heat-related sentinel health events is defined as the systematic collection and analysis of data concerning the occurrence and distribution of adverse health effects in defined populations at risk for heat injury or illness.

1.3.2 Requirements

In order to evaluate and improve prevention and control measures for heat-related effects (including the need for exposure assessment), the following should be obtained and analyzed for each workplace: (a) workplace modifications, (b) identification of highly susceptible workers, (c) data on the occurrence or recurrence in the same worker, (d) distribution in time, place, and person of heat-related adverse effects, and (e) environmental or physiologic measurements related to heat.

1.4 Protective Clothing and Equipment

Engineering controls and safe work practices should be used to ensure that workers' exposure to heat stress is maintained at or below the applicable RAL or REL specified. In addition, protective clothing and equipment (e.g., water-cooled garments, air-cooled garments, ice-packet vests, wetted overgarments, and heat-reflective aprons or suits) should be provided by the employer to the workers when the total heat stress exceeds the RAL or REL (see 6.3 Personal Protective Clothing and Auxiliary Body Clothing).

1.5 Employee Information and Training

1.5.1 Information Requirements

All new and current workers who work in areas where there is reasonable likelihood of heat injury or illness, and their supervisors, should be kept informed, through continuing education programs, of the following:

(1) Heat stress hazards.

(2) Predisposing factors.

(3) Relevant signs and symptoms of heat injury and illness.

(4) Potential health effects of excessive heat stress.

(5) General first aid as well as worksite-specific first aid procedures.

(6) Proper precautions for work in heat stress areas.

(7) Workers' responsibilities for following proper work practices and control procedures to help protect the health and provide for the safety of themselves and their fellow workers, including instructions to immediately report to the supervisor the development of signs or symptoms of heat-related illnesses.

(8) The effects of therapeutic drugs, over-the-counter medications, alcohol, or caffeine that may increase the risk of heat injury or illness by reducing heat tolerance.

(9) The purposes for and descriptions of the environmental and medical monitoring programs and the advantages to the worker of participating in these surveillance programs.

(10) Proper use of protective clothing and equipment.

(11) Cultural attitude toward heat stress. A misperception may exist that someone can be "hardened" against the requirement for fluids when exposed to heat by deliberately becoming dehydrated before work on a regular basis. This misperception is dangerous and must be counteracted through educational efforts.

1.5.2 Training Programs

(1) The employer should institute a training program, conducted by persons qualified by experience or training in occupational safety and health, to ensure that all workers potentially exposed to heat stress and their supervisors have current knowledge of at least the information specified in this section. For each affected worker, the instructional program should include adequate verbal and/or written communication of the specified information. The employer should develop a written plan of the training program that includes a record of all instructional materials.

(2) The employer should inform all affected workers of the location of written training materials and should make these materials readily available, without cost to the affected workers.

1.5.3 Heat Stress Safety Data Sheet

(1) The information specified in this section should be recorded on a heat stress safety data sheet or on a form specified by the Occupational Safety and Health Administration (OSHA).

(2) In addition, the safety data sheet should contain:

(a) Emergency and first aid procedures, including site-specific contact information.

(b) Notes to the responsible healthcare provider regarding classification, medical aspects, and prevention of heat injury and illness. These notes should include information on the category and clinical features of each injury and illness, predisposing factors, underlying physiologic disturbance, treatment, and prevention procedures.

1.6 Control of Heat Stress

1.6.1 General Requirements

(1) The employer should establish and implement a written program to reduce exposures to or below the applicable RAL or REL by means of engineering and work practice controls.

(2) Where engineering and work practice controls are not sufficient to reduce exposures to or below the applicable RAL or REL, they should be used to reduce exposures to the lowest level achievable by these controls and should be supplemented by the use of heat-protective clothing or equipment. In addition, a heat alert program should be implemented as specified in this section.

1.6.2 Work and Hygienic Practices

(1) Work modifications and hygienic practices should be introduced to reduce both environmental and metabolic heat when engineering controls are not adequate or are not feasible. The most effective preventive work and hygienic practices for reducing heat stress include, but are not limited to the following:

(a) Limiting the time the worker spends each day in the hot environment by decreasing exposure time in the hot environment and/or increasing recovery time spent in a cool environment.

(b) Reducing the metabolic demands of the job by such procedures as mechanization, the use of special tools, or an increase in the number of workers per task.

(c) Increasing heat tolerance by instituting a heat acclimatization plan and by increasing physical fitness.

(d) Training supervisors and workers to recognize early signs and symptoms of heat illnesses and to administer relevant first aid procedures.

(e) Implementing a buddy system in which workers are responsible for observing fellow workers for early signs and symptoms of heat intolerance, such as weakness, unsteady gait, irritability, disorientation, changes in skin color, or general malaise.

(f) Some situations may require workers to conduct self-monitoring, and a workgroup (i.e., workers, responsible healthcare provider, and safety manager) should be developed to make decisions on self-monitoring options and standard operating procedures.

(g) **Hydration**. Providing adequate amounts of cool (i.e., less than 15°C [59°F]), potable water near the work area and encouraging all workers that have been in the heat for up to 2 hours and involved in moderate work activities to drink a cup of water (about 8 oz.) every 15 to 20 minutes. Individual, not communal, drinking cups should be provided. During prolonged sweating lasting more than 2 hours, workers should be provided with sports drinks that contain balanced electrolytes to replace those lost during sweating, as long as the concentration of electrolytes/carbohydrates does not exceed 8% by volume.

1.6.3 Heat Alert Program

A written Heat Alert Program should be developed and implemented whenever the National Weather Service or other competent weather service forecasts that a heat wave is likely to occur the following day or days. A heat wave is indicated when the daily maximum temperature exceeds 35°C (95°F) or when the daily maximum temperature exceeds 32°C (90°F) and is 5°C (9°F) or more above the maximum reached on the preceding days. Temperature and relative humidity are the measurements used for the calculated Heat Index and are available 24/7 from the National Weather Service. See Appendix B for more information.

1.7 Recordkeeping

1.7.1 Environmental and Metabolic Heat Surveillance

(1) The employer should establish and maintain an accurate record of all measurements made to determine environmental and metabolic heat exposures to workers, as required in this recommended standard.

(2) Where the employer has determined that no metabolic heat measurements are required as specified in this recommended standard, the employer should maintain a record of the screening estimates relied upon to reach the determination.

1.7.2 Medical Surveillance

The employer should establish and maintain an accurate record for each worker subject to medical monitoring, as specified in this recommended standard.

1.7.3 Surveillance of Heat-related Sentinel Health Events

The employer should establish and maintain an accurate record of the data and analyses specified in this recommended standard.

1.7.4 Heat-related Illness Surveillance

The employer should establish and maintain an accurate record of any heat illness or injury and the environmental and work conditions at the time of the illness or injury.

1.7.5 Heat Stress Tolerance Augmentation

The employer should establish and maintain an accurate record of all heat stress tolerance augmentation for workers by heat acclimatization procedures.

2 Control of Heat Stress

2.1 Administrative Controls

The job risk factors for occupational heat stress are thermal environment, work demands, and clothing requirements. These are reflected in occupational exposure limits (OELs) traditionally based on WBGT, such as NIOSH RELs and ACGIH TLVs®, and in ISO 7243. Many workers spend some part of their working day in a hot environment where the temperature is above the OELs. Strategies to reduce the effects of heat in the workplace include primarily eliminating the heat with engineering controls, although in some situations administrative controls and PPE will be necessary.

In some situations, it may be technologically impossible or impractical to completely control heat stress by the application of engineering controls; the level of environmental heat stress may be unpredictable and variable (as in seasonal heat waves), and exposure time may vary with the task and with unforeseen critical events. When applying engineering controls for heat stress is not practical or sufficient, other solutions must be sought to keep the worker's total heat stress level within limits that will not be associated with an increased risk of heat-related illnesses.

Administrative controls consist of mainly five strategies: (1) limiting or modifying the duration of exposure time; (2) reducing the metabolic component of the total heat load; (3) enhancing the heat tolerance of the workers by, for example, heat acclimatization and physical conditioning; (4) training the workers in safety and health procedures for work in hot environments; and (5) medical screening of workers to be aware of which individuals have low heat tolerance and/or low physical fitness.

2.1.1 Limiting Exposure Time and/or Temperature

There are several ways to control the daily length of time and temperature to which a worker is exposed in heat stress conditions [OSHA-NIOSH 2011].

- When possible, schedule hot jobs for the cooler part of the day (early morning, late afternoon, or night shift) and/or schedule hot jobs on alternate rather than successive days.
- Schedule routine maintenance and repair work in hot areas for the cooler seasons of the year.
- Alter the work/rest schedule to permit more rest time.
- Provide cool areas (e.g., air-conditioned or shaded) for rest and recovery.
- Add extra personnel to reduce exposure time for each member of the crew.
- Permit work interruption when a worker feels heat discomfort.
- Increase workers' water intake on the job.
- Adjust schedule, when possible, so that hot operations are not performed at the same time and place as other operations that require the presence of workers, such as maintenance and cleanup while tapping a furnace.

2.1.2 Reducing Metabolic Heat Load

In most work situations, metabolic heat is not the major part of the total heat load. However, because it represents an extra load on the circulatory system, it can be a critical component in high heat exposures. Heavy and very heavy metabolic rates require substantial rest periods.

2.1.3 Enhancing Tolerance to Heat

Stimulating the human heat-adaptive mechanisms can significantly increase the capacity to tolerate work in heat. However, the ability of people to adapt to heat varies widely, which must be kept in mind when considering any group of workers.

A properly designed and applied heat-acclimatization program will increase the ability of workers to work at a hot job and will decrease the risk for heat-related illnesses and unsafe acts. Heat acclimatization can usually be induced in 7 to 14 days of exposure at the hot job [DOD 2003; Navy Environmental Health Center 2007; ACGIH 2014]. For workers who have had previous experience with the job, the acclimatization regimen should be no more than 50% of the usual duration of work in the hot environment on day 1, 60% on day 2, 80% on day 3, and 100% on day 4. For new workers, the schedule should be no more than 20% of the usual duration of work in the hot environment on day 1, increasing by no more than 20% each day.

Being physically fit for the job will not replace heat acclimatization but can enhance heat tolerance for both heat-acclimatized and nonacclimatized workers [Pandolf et al. 1977; DOD 2003; Yeargin et al. 2006; Navy Environmental Health Center 2007]. The time required for non–physically fit individuals to develop acclimatization is about 50% greater than for the physically fit.

To ensure that water lost in the sweat and urine is replaced (at least hourly) during the work day, an adequate water supply and intake are essential for heat tolerance and prevention of heat-related illnesses.

Electrolyte balance in the body fluids must be maintained to help prevent heat-related illnesses. For unacclimatized workers who may be on a salt-restricted diet, additional salting of the food, with the concurrence of the responsible healthcare provider, during the first two days of heat exposure, may be needed to replace the salt lost in the sweat [Lind 1976; DOD 2003]. The heat-acclimatized worker loses relatively little salt in sweat and therefore usually does not need salt supplementation.

2.1.4 Health and Safety Training

A heat stress training program should be in place for all who work in hot environments and their supervisors. Workers and supervisors should be trained about the prevention and first aid of heat-related illness before they begin work in a hot environment and before heat index levels go up. Heat prevention training should be reinforced on hot days. Prevention of heat-related illnesses depends on early recognition of the signs and symptoms of impending heat-related illness and initiation of first aid and corrective procedures at the earliest possible moment. Employers should provide a heat stress training program that effectively trains all workers and supervisors about the following:

(1) Recognition of the signs and symptoms of the various types of heat-related illnesses—such as heat cramps, heat exhaustion, heat rash, and heat stroke—and in administration of first aid.

(2) The causes of heat-related illnesses and the personal care procedures that will minimize the risk of their occurrence, such as drinking enough water and monitoring the color and amount of urine output (see Appendix A).

(3) The proper care and use of heat-protective clothing and equipment and the added heat load caused by exertion, clothing, and personal protective equipment.

(4) The effects of nonoccupational factors (drugs, alcohol, obesity, etc.) on tolerance to occupational heat stress.

(5) The importance of acclimatization.

(6) The importance of immediately reporting to the supervisor any symptoms or signs of heat-related illness in themselves or in their coworkers.

(7) The employer's procedures for responding to symptoms of possible heat-related illness and for contacting emergency medical services if needed.

In addition to being trained about each of those topics, supervisors should be trained on the following:

(1) How to implement appropriate acclimatization.

(2) What procedures to follow when a worker has symptoms consistent with heat-related illness, including emergency response procedures.

(3) How to monitor weather reports.

(4) How to respond to hot weather advisories.

(5) How to monitor and encourage adequate fluid intake and rest breaks.

A buddy system should be initiated, in which workers on hot jobs are taught to recognize the early signs and symptoms of heat-related illness. Each worker and supervisor who has received the instructions is assigned the responsibility for observing, at periodic intervals, one or more fellow workers to determine whether they have any early symptoms of a heat-related illness. Any worker who exhibits signs and symptoms of an impending heat-related illness should be sent to the first-aid station for more complete evaluation and possible initiation of first-aid treatment. Workers on hot jobs where the heat stress exceeds the RAL or REL (for unacclimatized and acclimatized workers, respectively) should be observed by a fellow worker or supervisor.

Additional training and educational materials are available from:

- NIOSH at http://www.cdc.gov/niosh/topics/heatstress/
- OSHA at https://www.osha.gov/SLTC/heatstress/prevention.html#training
- Cal/OSHA at http://www.dir.ca.gov/DOSH/HeatIllnessInfo.html

2.1.5 Screening for Heat Intolerance

The ability to tolerate heat stress varies widely, even between healthy individuals with similar heat exposure experiences [Shvartz and Benor 1972; Wyndham 1974; Strydom 1975; Khogali 1997; Moran et al. 2007]. Heat intolerance factors in young, active persons may be congenital (e.g., ectodermal dysplasia or chronic idiopathic anhidrosis), functional (e.g., low physical fitness, lack of acclimatization, low work efficiency, or reduced skin area to body mass ratio), or acquired (e.g., sweat gland dysfunction, dehydration, infectious disease, x-ray irradiation, previous heat stroke, large scarred burns, or drugs) [Epstein et al. 1997; Moran et al. 2007]. One way to reduce the risk of heat-related illnesses and disorders within a heat-exposed workforce is to reduce or eliminate the exposure of heat-intolerant individuals to heat stress. The ability to identify heat-intolerant individuals, without resorting to strenuous, time-consuming heat-tolerance tests, is basic to any such screening process.

Data from laboratory and field studies indicate that individuals with low physical work capacity are more likely to develop higher body temperatures than are individuals with high physical work capacity when exposed to equally hard work in high temperatures. In these studies, none of the individuals with a maximum work capacity (VO2 max) of at least 2.5 liters of oxygen per minute (L·min-1) were heat intolerant, but 63% of those with VO2 max below 2.5 L·min-1 were. It has also been shown that heat-acclimatized individuals with a VO2 max less than 2.5 L·min-1 had a 5% risk of reaching heat stroke levels of body temperature (40°C, or 104°F), whereas those with a VO2 max above 2.5 L·min-1 had only a 0.05% risk [Wyndham 1974a; Strydom 1975].

Medical screening for heat intolerance in otherwise healthy individuals should include obtaining a history of any previous incidents of heat-related illness. Workers who have experienced a heat-related illness may be less heat-tolerant [Leithead and Lind 1964; Armstrong et al. 1990].

2.1.6 Heat Alert Program

When heat-related illnesses and disorders occur mainly during heat waves in the summer, a Heat Alert Program (HAP) should be established for preventive purposes. Although such programs differ in detail from one worksite to another, they all use the weather forecast of the National Weather Service. If a heat wave is predicted for the next day or days, a state of Heat Alert is declared to make sure that measures to prevent heat casualties will be strictly observed. Although this sounds quite simple and straightforward, in practical application, it requires the cooperation of the administrative staff, the maintenance and operative workforce, and the medical, industrial hygiene, and/or safety departments. An effective HAP is described below [Dukes-Dobos 1981]. Although this HAP is designed for indoor work settings, many aspects can also be used or modified for outdoor work settings such as in construction or agriculture. of a responsible healthcare provider, industrial hygienist or qualified safety and health professional, safety engineer, operation engineer, and manager. Once established, this committee takes care of the following tasks:

(a) Arrange a training course for all involved in the HAP that provides procedures to follow in the event a Heat Alert is declared; emphasize the prevention and

early recognition of heat-related illnesses and first aid procedures when a heat-related illness occurs.

(b) By memorandum, instruct the supervisors to perform these tasks:

(i) Reverse winterization of the site, that is, open windows, doors, skylights, and vents according to instructions and if appropriate (e.g., outside temperatures are cooler) for greatest ventilating efficiency at places where high air movement is needed.

(ii) Check drinking fountains, fans, and air conditioners to make sure that they are functional, that the necessary maintenance and repairs are performed, that they are regularly rechecked, and that workers know how to use them.

(c) Ascertain that, in the medical department, as well as at the job sites, all facilities required to give first aid in cases of heat-related illness are in a state of readiness.

(d) Establish criteria for the declaration of a Heat Alert. For instance, a Heat Alert would be declared if the area weather forecast for the next day predicts a maximum air temperature of at least 35°C (95°F) or if a maximum temperature of 32°C (90°F) is predicted and is 5°C (9°F).

(1) Each year, early in the spring, establish a Heat Alert Committee, which may consist higher than the temperature reached on any of the preceding three days.

(2) Procedures to be followed during the state of Heat Alert are as follows:

(a) Postpone tasks that are not urgent (e.g., preventive maintenance involving high activity or heat exposure) until the heat wave is over.

(b) Increase the number of workers on each team in order to reduce each worker’s heat exposure. Introduce new workers gradually to allow acclimatization (follow heat-acclimatization procedure).

(c) Increase rest allowances. Let workers recover in air-conditioned rest places.

(d) Turn off heat sources that are not absolutely necessary.

(e) Remind workers to drink water in small amounts frequently to prevent excessive dehydration, to weigh themselves before and after the shift, and to be sure to drink enough water to maintain body weight.

(f) Monitor the environmental heat at the job sites and resting places.

(g) Check workers' core temperature during their most severe heat-exposure period.

(h) Exercise additional caution on the first day of a shift change to make sure that workers are not overexposed to heat, because they may have lost some of their acclimatization over the weekend and during days off.

(i) Send workers who show signs of a heat disorder, even a minor one, for medical evaluation. Permission of the responsible healthcare provider to return to work must be given in writing.

(j) Restrict overtime work.

2.2 Personal Protective Clothing and Auxiliary Body Cooling

Personal protective clothing and equipment (PPE) can protect the worker from radiant heat. However, PPE does not allow air exchange through the garment and may impede evaporative cooling. PPE should be worn loosely and workers are encouraged to take breaks when possible to avoid becoming overheated. When unacceptable levels of heat stress occur, there are generally only four approaches to a solution: (1) modify the work; (2) modify the environment; (3) modify the worker by heat acclimatization; or (4) modify the clothing or equipment. Improving human tolerance requires that the individuals be fully heat acclimated to the level of heat, be trained in the use of and practice in wearing protective clothing, be in good physical condition, and be encouraged to drink as much water as necessary (e.g., 1 cup [8 oz.] of water or other fluids every 15–20 minutes) to compensate for sweat water loss.

3 Medical Monitoring

Employers should establish a medical monitoring program for workers with occupational exposure to hot environments. The medical monitoring program should include elements of medical screening (secondary prevention) and surveillance (primary prevention) with the goal of early identification of signs or symptoms that may be related to heat-related illness and prevention of adverse outcomes. Early detection of symptoms using medical screening, subsequent treatment, and workplace interventions are intended to minimize the adverse health effects of exposure to hot environments. Medical screening data may also be used for the purposes of medical surveillance to identify work areas, tasks, and processes that require additional prevention efforts.

3.1 Program Oversight

The employer should assign responsibility for the medical monitoring program to a responsible healthcare provider. The responsible healthcare provider should be a qualified physician or other qualified health care professional (as determined by appropriate federal and state laws and regulations) who is informed and knowledgeable about the following:

- Potential workplace exposures to heat and hot environments.
- Administration and management of a medical monitoring program for occupational hazards.
- Identification and management of heat-related illnesses.
- Where respiratory protection is being used, establishment of a respiratory protection program based on an understanding of the requirements of the OSHA respiratory protection standard and types of respiratory protection devices available at the workplace.

3.2 Medical Monitoring Program Elements

Recommended elements of a medical monitoring program for workers at risk for heat-related illnesses and injuries should include worker education, a preplacement medical evaluation, regularly scheduled or periodic follow-up medical evaluations, and reports of incidents of heat-related illnesses and injuries. The purpose of preplacement and periodic medical evaluations of persons working at a particular hot job is (1) to determine if the persons can meet the demands and stresses of the hot job, with reasonable assurance that the safety and health of the individuals and/or fellow workers will not be placed at risk; (2) to inquire whether persons have already suffered from an adverse health effect from heat stress exposure; and (3) to work with management to modify the job as necessary. Based on the findings from these evaluations, more frequent and detailed medical evaluation may be necessary.

3.3 Medical Surveillance – Periodic Evaluation of Data

To ensure that control practices provide adequate protection to workers in hot areas, data from the medical monitoring program should be evaluated periodically in a systematic manner. Such evaluations may detect repeated incidents on the job, episodes of heat-related disorders, or frequent absences that could be related to heat and could be used as the basis for appropriate worksite interventions. Job-specific clustering of heat-related illnesses or injuries should be followed up by the responsible healthcare provider in collaboration with others responsible for occupational safety and health at the worksite (e.g., industrial hygienists).

3.4 Employer Actions

The employer should ensure that the responsible healthcare provider's recommended restriction of a worker's exposure to heat or a hot environment or other workplace hazards is followed and that the RAL is not exceeded without taking additional protective measures. Efforts to encourage worker participation in the medical monitoring program and to promptly report any symptoms to the responsible healthcare provider are important to the program's success. Medical evaluations performed as part of the medical monitoring program should be provided by the employer at no cost to the participating workers. Where medical removal or job reassignment is indicated, the affected worker should not suffer loss of wages, benefits, or seniority.

3.5 Considerations Regarding Reproduction

3.5.1 Pregnancy

The medical literature provides limited data on potential risks for pregnant women and fertile women with heavy work and/or added heat stress within the permissible limits (e.g., where t_{re} does not exceed 38°C or 100.4°F; see Chapter 5). However, because the human data are limited and because research data from animal experimentation indicate the possibility of heat-related infertility and teratogenicity, a woman who is pregnant or who may potentially become pregnant should be informed by the responsible healthcare provider that absolute assurances of safety during the entire period of pregnancy cannot be provided. The worker should be advised to discuss this matter with her own healthcare provider and discuss necessary accommodations with her supervisor if recommended.

3.5.2 Fertility

Heat exposure has been associated with temporary infertility in both females and males, with the effects being more pronounced in males [Rachootin and Olsen 1983; Levine 1984]. In a study examining the time to pregnancy associated with heat exposure, the time was significantly prolonged in a subgroup of male welders and bakers [Thonneau et al. 1997]. Sperm density, motility, and the percentage of normally shaped sperm can decrease significantly when the temperature of the groin is increased above a normal temperature [Procope 1965; Henderson et al. 1986; Mieusset et al. 1987; Jung and Schuppe 2007]. Available data are insufficient to ensure that the REL protects against such effects. Thus, the responsible healthcare provider should question workers exposed to high heat loads about their reproductive histories.

3.5.3 Teratogenicity

The consequences of hyperthermia during pregnancy depend on the temperature elevation, the duration, and the stage of fetal development at the occurrence [Edwards 2006]. The body of experimental evidence reviewed by Lary [1984] indicates that, in the nine species of warm-blooded animals studied, prenatal exposure of the pregnant females to hyperthermia may result in a high incidence of embryo deaths and in gross structural defects, especially of the head and central nervous system (CNS). An elevation of the body temperature of the pregnant female to 39.5°C to 43°C (103.1°F–109.4°F) during the first week or

two of gestation (depending on the animal species) resulted in structural and functional maturation defects, especially of the CNS, although other embryonic developmental defects were also found. It appears that some basic developmental processes may be involved, but selective cell death and inhibition of mitosis at critical developmental periods may be primary factors. Hyperthermia in these experimental studies did not adversely affect the pregnant females, but did adversely affect developing embryos. The length of hyperthermia in the studies varied from 10 minutes a day over a 2- to 3-week period to 24 hours a day for 1 or 2 days.

Retrospective epidemiologic studies have associated hyperthermia lasting from a day or less up to a week or more during the first trimester of pregnancy with birth defects, especially defects in CNS development (e.g., anencephaly) [Lary 1984]. In addition, a hyperthermic episode during pregnancy can result in embryonic death, spontaneous abortion, growth retardation, and other defects of development [Edwards 2006]. However, some of the information on hyperthermia's effects on a pregnancy stems from women with fevers, so it is difficult to determine whether defects are caused by metabolic changes in the mother due to the infection [Clarren et al. 1979; Pleet et al. 1981; Edwards 2006].

It is important to monitor every hour or so the body temperature of a pregnant worker exposed to total heat loads above the RAL/REL, to ensure that the core body temperature does not exceed 39°C to 39.5°C (102°F–103°F) during the first trimester of pregnancy. Regardless of sex, heat stress exposures with core body temperatures of 39°C (102°F) or greater should be avoided.

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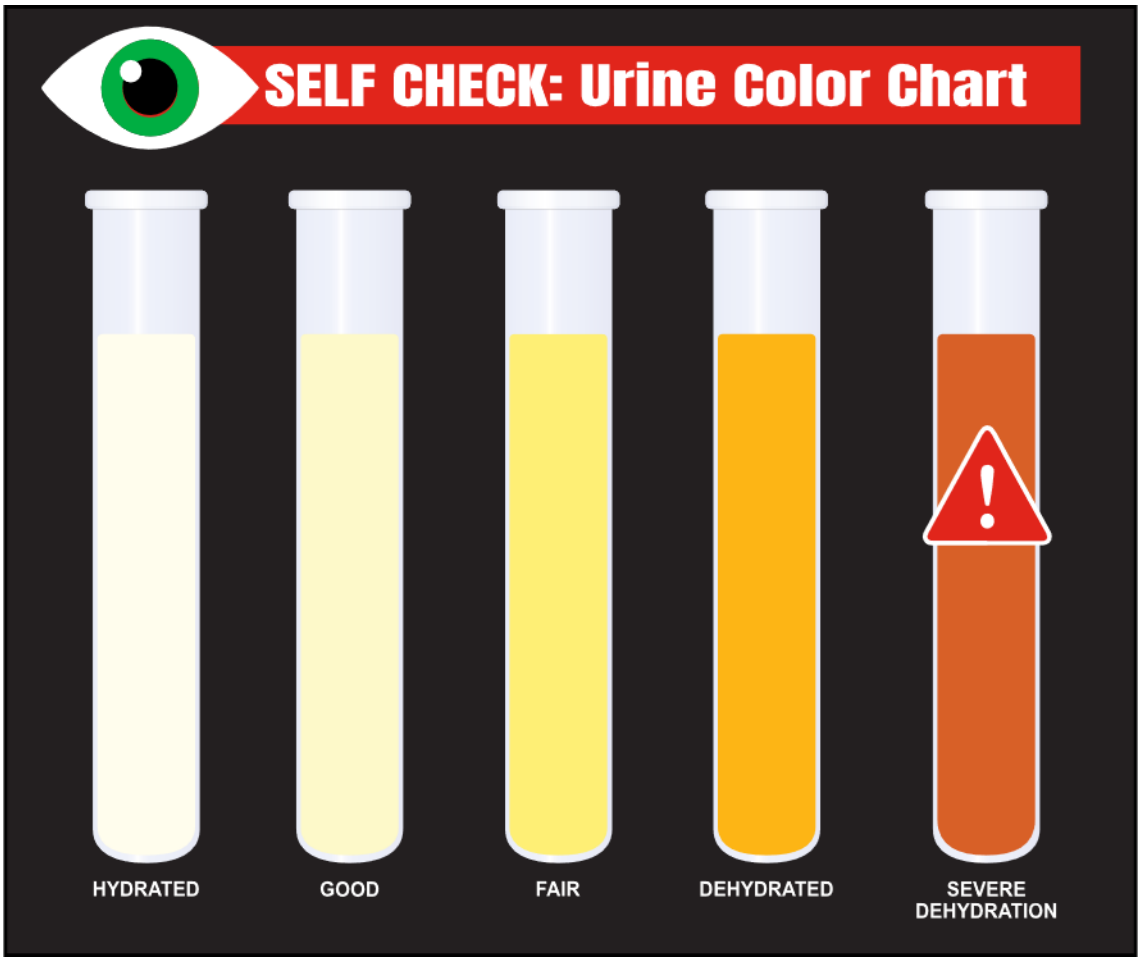
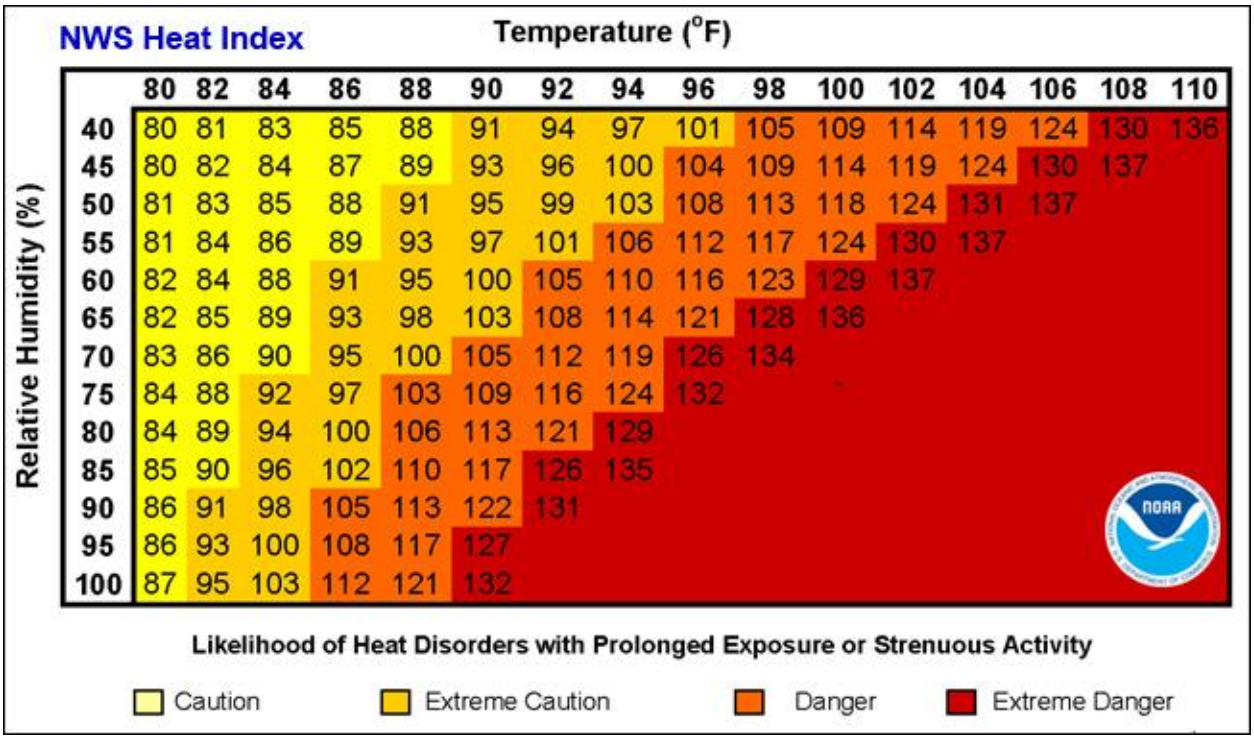
Appendix A. Urine Chart



Appendix B. Heat Index



Appendix C. Heat Related Illnesses

HEAT STROKE
Symptoms: Usually hot, dry skin; red, mottled or bluish. Sweating may still be present. Confusion, lose of consciousness, convulsions. Rapid pulse. Rectal temperature greater than 104ºF. When in doubt, treat as heat stroke. Can be fatal.
Treatment: **Medical emergency**. Call paramedics and start cooling the victim immediately. Remove the victim to a cool area. Soak clothing and skin with cool water and use a fan to create air movement. Shock may occur. Medical treatment is imperative.
Cause: Partial or complete failure of sweating mechanism. The body cannot get rid of excess heat

HEAT STROKE cont.
Prevention: Acclimatization, close monitoring for signs of heat illness, medical screening and drinking plenty of water.

HEAT EXHAUSTION
Symptoms: Fatigue, weakness, dizziness, faintness. Nausea, headache. Moist, clammy skin; pale or flushed. Rapid pulse. Normal or slightly elevated temperature.
Treatment: Have the victim rest in a cool area and drink fluids.
Cause: Dehydration causes blood volume to decrease.
Prevention: Acclimatization and drinking plenty of water.

HEAT SYNCOPE
Symptoms: Fainting while standing erect and immobile. A variant of heat exhaustion. Symptoms of heat exhaustion may precede fainting.
Treatment:
Move the victim to a cool area, have the victim rest and drink fluids.
Cause: Dehydration causes blood volume to decrease. Blood pools in dilated blood vessels of the skin and lower body, making less blood available to the brain.
Prevention: Acclimatization, drinking plenty of water, avoiding standing in one place and intermittent activity to avoid blood pooling.

HEAT CRAMPS
Symptoms: Painful muscle spasms in the arms, legs or abdomen during or after hard physical work.
Treatment: Resting, drinking water and eating more salty foods.
Cause: Not well understood. May be due to a loss of salt from sweating. Dehydration is a factor.
Prevention: Adequate water intake and adequate salt intake at meals; do not use salt tablets.

HEAT RASH
Symptoms: “Prickly heat”; tiny, raised, blister-like rash.
Treatment: Keeping skin clean and dry.
Cause: Skin is constantly wet from sweat. Sweat gland ducts become plugged, leading to inflammation.
Prevention: Showering after working in hot environment. Keeping skin dry.

TRANSIENT HEAT FATIGUE
Symptoms: Decline in performance, particularly in skilled physical work, mental tasks and those requiring concentration.
Treatment: No treatment necessary unless other signs of heat illness are present.
Cause: Discomfort. Stress from the heat less than what would result in other heat illnesses.
Prevention: Acclimatization and training.