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Emergency Responder Health and Safety Manual

Chapter 7

Physical Stress Management Program

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U.S. Environmental Protection Agency

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LIST OF ACRONYMS

ACGIH	American Conference of Governmental Industrial Hygienists
°C	Degrees Celsius
CFR	Code of Federal Regulations
CMAT	Consequence Management Advisory Team (formerly called National Decon Team (NDT))
dBA	Decibels measured on the A scale
dBC	Decibels measured on the C scale
ECT	Equivalent chill temperature
EMT	Emergency medical technician
EPA	U.S. Environmental Protection Agency
ERT	Environmental Response Team
°F	Degrees Fahrenheit
HASPs	Health and safety plans
HAZWOPER	OSHA's Hazardous Waste Operations and Emergency Response standard
HQ	Headquarters
MHR	Maximum heart rate
NFPA	National Fire Protection Association
NIOSH	National Institute for Occupational Safety and Health
NOAA	National Oceanic and Atmospheric Administration
NRR	Noise reduction rating
NWS	National Weather Service
OLEM	Office of Land and Emergency Management (formerly called Office of Solid Waste and Emergency Response (OSWER))
OSC	On-Scene Coordinator
OSHA	Occupational Safety and Health Administration (U.S. Department of Labor)
PEL	OSHA's permissible exposure limit
PPE	Personal protective equipment
SHEMP	Safety, Health, and Environmental Management Program
SSD	Safety and Sustainability Division (formerly called Safety, Health and Environmental Management Division (SHEMD))
STS	Standard threshold shift
TLV	ACGIH's threshold limit value
TWA	Time-weighted average
WBGT	Wet bulb globe temperature

1.0 INTRODUCTION

1.1 Background Information and Regulatory Basis

EPA emergency responders respond to sudden releases of oil or hazardous substances, and in some cases, must work under difficult physical conditions while wearing protective clothing and equipment. For example, responders might be required to work in environments that pose altitude, heat, cold, noise, or vibrational stress. Also, given the nature of field work, emergency responders may overexert themselves or experience fatigue. Text Box 1 lists the physical stressors addressed in this chapter.

Text Box 1
Physical Stressors Addressed in This Chapter

- Fatigue
- Heat stress
- Cold stress
- Noise stress
- Vibration
- Overexertion (due to heavy manual labor)
- Altitude

The following Occupational Safety and Health Administration (OSHA) regulations and EPA guidelines were used to develop this chapter:

- Safety Health and Environmental Management (SHEM) Guideline No. 33 (Heat Stress and Cold Stress, December 2004).
- SHEM Guideline No. 37 (Occupational Noise and Hearing Conservation, October 2004).
- 29 CFR 1910.95 (OSHA Occupational Noise Exposure standard).

In addition, documents by the American Conference of Governmental Industrial Hygienists (ACGIH), the National Fire Protection Association (NFPA), and others contributed to the content of this chapter.

This chapter provides specific requirements that all EPA organizations must meet to implement a physical stress management program for emergency responders. These minimum requirements have been established to ensure that:

- Emergency responders receive training on the hazards associated with physical stressors, the symptoms associated with them, procedures to prevent adverse effects from occurring, and procedures for addressing adverse health effects (Section 3);
- Appropriate medical surveillance is conducted (before entering and while in the field) to monitor employee health status (Section 4);
- Nationally consistent procedures are in place for implementing engineering/administrative controls that reduce the risks posed by physical stressors (Sections 5 through 11);
- Nationally consistent recordkeeping practices are implemented (Section 12); and
- Evaluations are performed to assess the effectiveness of EPA's physical stress management program and to foster continual improvement (Section 13).

The procedures presented in this chapter represent the minimum requirements that EPA organizations must meet to avoid exposure to (and potentially experiencing adverse effects from) physical stressors.

1.2 Instructions for Users

In accordance with OSWER Directive 9285.3-12, this chapter must be implemented across all EPA regions, the Environmental Response Team (ERT), the Consequence Management Advisory Team (CMAT), and Headquarters (HQ). This means each EPA organization must adopt the minimum Agency requirements and management practices listed in the chapter and produce a customized version of the chapter which is reviewed/updated on an annual basis.

To customize the chapter, users must (1) complete Appendix A and (2) insert organization-specific information into the blank spaces (highlighted in yellow) that appear throughout the chapter. If organizations advocate additional policies and procedures exceeding the minimum Agency requirements, they must document them in Appendix B. Tools have been developed to support this chapter, including a glossary (Appendix C). Appendix D provides instructions for incorporating physical stress information in site-specific health and safety plans (HASPs).

See the Introduction to this manual for details on customizing and posting an organization's physical stress management program to EPA's Web site (http://www.epaosc.net/_HealthSafetyManual).

2.0 ROLES AND RESPONSIBILITIES

Health and Safety Program Contacts (HSPCs), Removal Managers, Safety, Health, and Environmental Management Program (SHEMP) Managers, and individual emergency responders have roles and responsibilities in implementing the Agency's physical stress management program. Appendix A details the tasks that these key personnel must perform. If an organization wishes to delegate a task to someone other than the default assignment in the appendix, users can do so when they customize Appendix A and when they fill information into the yellow-highlighted areas that appear throughout the chapter's text.

3.0 PHYSICAL STRESS TRAINING

Emergency responders and their supervisors must have a thorough understanding of the hazards and symptoms associated with exposure to physical stressors, measures that can be taken to prevent adverse health effects, and procedures (including first aid) to follow if adverse effects occur. All On-Scene Coordinators (OSCs) and emergency responders must receive physical stress management training appropriate to the physical hazards they are exposed to during the completion of their job duties.

The training program consists of up to seven modules. Table 1 summarizes the content covered in each module and the minimum frequency of delivery. The required modules can be covered during annual health and safety refresher training (as required by 29 CFR 1910.120). Decisions related to training delivery are left to the discretion of the SHEMP Manager (or another designated person), who is responsible for ensuring that training occurs and is tracked and documented (Section 12.1). The Removal Manager must be informed of employees who have/have not completed their training requirements. The HSPC (or another designated person) may assist with these tasks. The Removal Manager (or another designated person) must (1) provide the resources (including time and monetary support) needed to complete the training modules, (2) prevent employees who have NOT completed their training requirements from working in the field, and (3) attend training sessions to demonstrate management's support of the physical stress management program.

Table 1
Components of EPA's Physical Stress Training Program

Training Module	Frequency of Delivery	Training Program Content
Fatigue	Initial training upon assignment to field duties and as needed thereafter	• How fatigue impairs judgment and performance. • The relationship between fatigue and accidents. • Rules of thumb regarding work/rest schedules.
Heat Stress[a]	SHEM Guideline 33 requires initial training upon assignment to duties and retraining if changes in the workplace or personal protective equipment (PPE) render previous training obsolete, and/or it is apparent that an employee has not retained the information presented during the initial training course.	• Hazards and potential health effects associated with heat stress. • Predisposing factors and symptoms of heat-related disorders. • First aid and emergency medical procedures to follow in the event of heat stress. • Work practices, precautions, and procedures to take in areas that pose heat stress hazards. • Reporting procedures for employees that experience signs of heat stress. • Eating and drinking habits. • The purpose, advantages, and descriptions of environmental and medical surveillance programs. • Proper use of protective clothing and equipment.
Cold Stress[a]		• Recognition of symptoms of hypothermia, frostbite, or excessive cooling of the body (even when shivering does not occur). • First aid and emergency medical procedures, including rewarming procedures. • Safety work practices and personal protective clothing. • Eating and drinking habits. • The purpose, advantages, and descriptions of environmental and medical surveillance programs.
Hearing Conservation Awareness	Initial training upon assignment to duties	• The effect noise has on hearing. • The purpose, advantages, disadvantages, and attenuation of hearing protectors. • Instructions in selecting, fitting, using, and caring for hearing protectors.
Occupational Noise Exposure	Initial training upon enrollment in the Hearing Conservation Program and annually thereafter (as mandated in OSHA 29 CFR 1910.95).	• The effect noise has on hearing. • The purpose, advantages, disadvantages, and attenuation of hearing protectors. • Instructions in selecting, fitting, using, and caring for hearing protectors. • The purpose and procedures associated with audiometric testing. *Note: Attendees must receive the following handouts: (1) a copy of OSHA 29 CFR 1910.95, (2) additional materials that OSHA has given EPA on hearing protection, and (3) other educational materials that EPA has prepared about noise stress and hearing conservation programs.*
Vibration Stress	Initial training upon assignment to duties and as needed thereafter	• Injuries caused by vibration stress. • Signs and symptoms of injury. • Engineering and work practice controls. • Sources/recognition of vibration hazards in the field.
Overexertion Injuries/Heavy Manual Labor	Initial training upon assignment to duties and as needed thereafter	• How overexertion injuries occur. • Symptoms and consequences of overexertion injuries. • Job tasks which cause injuries. • Methods to minimize injury. • Reporting injuries.
Altitude	Initial training upon assignment to duties and as needed thereafter	• Hazards and potential health effects associated with work at altitude. • Predisposing factors and symptoms of altitude illnesses. • Emergency procedures to follow in the event of altitude illness. • Work practices, precautions, and procedures for work at altitude. • Eating and drinking habits and the impact on altitude tolerance.

[a] Training requirements listed in SHEM Guideline No. 33.
[b] Training requirements listed in OSHA 29 CFR 1910.95(k) and SHEM Guideline No. 37.

4.0 MEDICAL SURVEILLANCE

The purpose of medical surveillance is to identify employees who are at risk of experiencing adverse health effects associated with physical stressors. Critical information is obtained about the health status of employees before they go into the field (annual physical exams) and while they are actually working in the field (onsite medical monitoring).

4.1 Before Going Into the Field—Obtaining an Annual Medical Examination

Emergency responders must obtain a medical examination each year (see the Medical Surveillance Program chapter of the Emergency Responder Health and Safety Manual). These examinations will determine if employees are capable of performing their duties while wearing PPE under stressful conditions (e.g., temperature extremes). Physicians look for medical conditions (such as heart disease, diabetes, atherosclerotic vascular disease, and central nervous system disease) that might increase an individual's risk for heat stroke or intolerance for cold stress. Employees who have such conditions must be aware of the symptoms of stress when working in the field. In some cases, a physician might determine that an individual is not medically cleared to perform his/her duties and will recommend restrictions on the employee's activities.

4.2 In the Field—Conducting Onsite Medical Monitoring

Monitoring vital signs in the field helps identify those employees who are overly stressed and at risk of developing adverse health effects (Appendix D and Appendix E).

4.2.1 Determining When Onsite Medical Monitoring Is Necessary

The Onsite Safety Officer is responsible for determining whether onsite medical monitoring (e.g., blood pressure and heart rate measurements) is required. The SHEMP Manager (or other designated person) or the HSPC (or other designated person) will assist with this determination (if necessary). Onsite medical monitoring must be performed whenever high air temperatures, high humidity, PPE, strenuous physical activities, or a combination of these factors increase the potential for a heat-related injury. (Section 6.1 provides additional details about determining whether heat stress concerns are warranted.) In addition, regardless of what environmental conditions exist, onsite medical monitoring must always be performed whenever employees are required to don Level A PPE (i.e., blood pressure and heart rate monitoring must be conducted prior to donning and after doffing Level A PPE) (See Text Box 2).

Text Box 2
Demand of Wearing PPE

Wearing PPE is physically demanding, exacerbates other physical stressors present at a site, suppresses the body's ability to dissipate heat, and makes it difficult for coworkers to observe the symptoms of heat stress.

4.2.2 Procedures for Onsite Medical Monitoring

If onsite medical monitoring is necessary, the Onsite Safety Officer is responsible for ensuring that a Medical Monitor is present to track employee vital signs. The Medical Monitor must be someone who knows how to measure and interpret vital signs, recognize the symptoms of physical stress-related disorders, and monitor work/rest cycles. The Onsite Safety Officer may obtain support from a health professional to serve as the Medical Monitor, such as a local emergency medical technician (EMT) (or an EMT crew if necessary), a nurse, or a nurse assistant.

When onsite medical monitoring is necessary, the Onsite Safety Officer must establish medical or vital signs checkpoints for employees to go through before entering the work (hot) zone, after leaving the

decontamination (decon) line, and before leaving the work site at the end of the work shift. The Medical Monitor must take vital signs as employees pass through the checkpoints and monitor work/rest cycles. Appendix E provides tools to assist the Medical Monitor. Appendix E-1 lists the vital signs (e.g., heart rate, blood pressure, oral temperature, etc.) that must be monitored, thresholds that raise concern, and corrective actions to protect employees. Appendix E-2 provides a form to assist tracking an employee's vital signs. If the Medical Monitor believes an employee is stressed, this information must be communicated to the employee and the Onsite Safety Officer, or to the employee's direct supervisor, with recommended corrective action.

5.0 FATIGUE

Fatigue is often accompanied by feelings of weariness, sleepiness, or irritability, and leads to inefficiency and a reduced capacity for work. Fatigue presents a risk as it can impair judgment, affect vision, and slow down reflexes. Fatigue also increases the likelihood of automobile accidents and is the number one cause of workplace fatalities. Emergency responders and their supervisors must understand the danger of fatigue and implement administrative and work practice controls to minimize fatigue.

5.1 Establishing Reasonable Work/Rest Schedules

Individuals must receive adequate time to rest and recover after long or physically demanding work shifts. The following guidelines must be followed to establish reasonable work/rest schedules, prevent low morale and employees from becoming overly fatigued:

- **A 16-hour shift must be the MAXIMUM that individuals are allowed to work**. The 2:1 work/rest ratio is a rule of thumb that supervisors must follow when establishing work/rest schedules. This means that individuals who have worked for 16 hours continuously (including transportation time to and from a site) must be provided an 8-hour rest period. On rare occasions it may be necessary for emergency responders to exceed the 16-hour limit due to the nature and extent of the response. If this occurs, the 2:1 work ratio must be restored as quickly as possible and efforts must be made to establish more workable shifts.
- **Shorter work shifts must be established (8 to 12 hours or less) during long-term or high altitude response activities**. Shortening shifts helps employees maintain a high level of alertness and performance and prevents adverse psychological, physiological, and musculoskeletal consequences.
- **Seven-day work weeks should be avoided.** Seven-day work-week schedules should be avoided if at all possible because they hasten fatigue and contribute to low morale.
- **Limits must be placed on the amount of time employees are allowed to drive.** EPA recognizes one provision of the Department of Transportation's Federal Motor Carrier Safety Administration (FMCSA) Hours-of-Service Regulations for driving time (49 CFR Part 395). Individuals may drive up to 11 hours (includes time taken for rest, meal, and fuel stops) during a 14-hour work shift. Exceedances will only be allowed in cases where an employee is driving with a partner and upon approval of the local SHEMP Manager (or another designated person). If another eligible driver is present, that individual may take over for the driver and operate the vehicle until he/she has reached the 14-hour work shift limit. Allowable driving time is shorter if an employee has already been working in the field. For example, an employee who has worked onsite for 8 hours can only drive for 6 hours.
- **Rest periods must really be rest periods**. When emergency responders work long or physically demanding shifts, Lead OSCs/Onsite Safety Officers, Removal Managers, and SHEMP Managers must reduce nonessential tasks. For example, transportation back to lodging or administrative support for routine paperwork and expense reports may be provided so that the rest period is not an extension

of the work period. Additionally, providing an environment with adequate heat, ventilation, air conditioning, and light reduces the effects of fatigue.

The Onsite Safety Officer and supervisors directly in charge of emergency responders must inform employees of EPA's work/rest guidelines and ensure that they do not assign work schedules that exceed these guidelines under most circumstances. To meet these guidelines, it may be necessary to mobilize additional personnel to relieve those already working. If additional resources are necessary, the Onsite Safety Officer must notify the Removal Manager, who will ensure that the appropriate numbers of emergency responders are provided for the response activity.

5.2 Other Practices Designed to Address Fatigue

In addition to establishing work/rest schedules, the following practices help address fatigue:

- **Promote good nutrition and exercise**. Proper nutrition and exercise are key components for successfully conducting operations with long or physically demanding shifts. Employees should avoid consuming large amounts of caffeine, alcohol, and sugary foods and get regular exercise.
- **Encourage self-awareness**. Employees must be encouraged to alert their supervisors if they feel fatigued or burdened by their physical duties.
- **Encourage use of the buddy system**. Emergency responders must be encouraged to look out for each other. Whenever possible, emergency responders must work in pairs or teams.

6.0 HEAT STRESS

Emergency responders must perform strenuous physical activities in environments with high air temperatures or high humidity, often while wearing PPE. PPE reduces the body's ability to dissipate heat and can cause heat stress. Heat stress is the heat load imposed on a worker from metabolic heat (due to physical activity), environmental factors (air movement, air temperature, radiant heat, and humidity), and clothing. Heat stress can lead to heat strain (the body's physiological response to heat stress) and a variety of heat-related disorders including heat stroke (the most serious heat illness and a medical emergency that can cause brain damage or death). Other heat-related disorders by increasing order of severity include heat rash, heat syncope, heat cramps, and heat exhaustion.

It is very difficult to predict who will experience a heat-related disorder in a specific setting because individual responses to heat stress vary greatly from one individual to another in the same environment, and for the same individual in different settings and from time to time. The effects of heat stress are progressive and dangerous if left ignored. Excessive heat strain can be avoided by recognizing and understanding personal characteristics that predispose its development, watching for the symptoms of excessive heat strain, and addressing them as soon as they appear. Appendix F provides information on the symptoms and first aid/corrective actions for heat-related disorders. EPA's approach for managing heat stress follows.

6.1 Assessing the Potential for Heat-Related Hazards

When working in the field, the Onsite Safety Officer must assess conditions to determine whether administrative/engineering controls must be implemented to reduce the physiological strain caused by heat stress and/or whether onsite medical monitoring is required. When making assessments, the Onsite Safety Officer must consider the following:

- **Environmental factors**. Air temperature, humidity, and sources of radiant heat (such as the sun or hot machinery) may contribute to heat stress. The greater the magnitude of these factors the greater the heat burden to the employee. Air movement (e.g., from a breeze or a fan) enhances cooling through evaporation of perspiration. Employees will not benefit from a breeze, however, if working in an enclosed area.
- **Clothing and work demand levels**. Wearing heavy or reduced-permeability clothing (e.g., water-vapor-impermeable, air-impermeable, and thermally insulating clothing, as well as encapsulating suits (Level A) and multiple layers of clothing) and high physical exertion increases the chance of adverse health effects from the heat. As noted by ACGIH, "[w]ith heat removal hampered by clothing, metabolic heat may produce excessive heat strain even when ambient conditions are considered cool." Workers wearing chemical protective clothing may start to exhibit signs of heat strain when performing heavy exercise in temperate conditions (69.8°F or 21°C).[1]
- **Personal factors**. Some people are more susceptible to heat-related disorders. Under the same environmental and work conditions, employees who are acclimatized (i.e., accustomed to working in the prevailing environmental conditions), in good health, and well hydrated are less likely to experience heat-related health effects than employees who are not. Other factors that affect individual heat sensitivity include age; weight; state of physical fitness; metabolism; use of alcohol, drugs, and prescription and over-the-counter medications; and a variety of medical conditions (e.g., hypertension).

ACGIH's Threshold Limit Values (TLVs) provide a tool to assess potential heat stress situations and make decisions about appropriate work-rest regimes. Appendix G provides detailed information about the TLV approach. Each organization's HSPC (or other designated person) must maintain the most recent edition of the ACGIH TLV booklet[2] and ensure that the information is made available to the Onsite Safety Officer. The TLV approach involves the following steps:

- **Performing environmental monitoring to determine the wet bulb globe temperature (WBGT).** The WBGT is obtained from a direct-reading instrument[3] that takes air temperature, humidity, radiant heat sources, and air movement into consideration. *(Note: Although WBGT readings are reported in degrees, the measurement incorporates information about more than just air temperature. As a result, standard air temperature readings cannot be substituted for WBGT measurements.)*
- **Comparing WBGT measurements to ACGIH's TLVs**. Appendix G presents ACGIH's screening criteria for heat stress exposure under different work-rest regimes and levels of physical activity for both acclimatized and un-acclimatized employees. The screening criteria include adjustments for the impact that different ensembles of clothing (with reported clothing adjustment factors) have on an employee's tolerance for heat. **ACGIHs TLV screening values must not be used to make decisions**

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[1] Bélard, J.L., Stonevich, R.L. Overview of Heat Stress among Waste Abatement Workers. Appl. Occup. Environ. Hyg. 10 (11): 903-907 (1995).

[2] *TLVs 7 and BEIs 7 Based on the Documentation of the Threshold Limit Values for Chemical Substances and Physical Agents & Biological Exposure Indices*. The ACGIH TLV booklet is published on an annual basis and may be obtained from the American Conference of Governmental Industrial Hygienists, 1330 Kemper Meadow Drive, Cincinnati, Ohio 45240-4148. Telephone: 513-742-2020; Web site: http://www.acgih.org.

[3] Examples of portable heat stress monitors include the QUESTEMP° Series (32/34/36) of portable heat stress monitor kits (Quest Technologies, Inc., Oconomowoc, WI); the RSS-214 WIBGET heat stress monitor (AIM, Centennial, CO), and the Metrosonics hs-32 general purpose area heat stress monitor (Quest Technologies, Inc., Oconomowoc, WI).

about safe conditions for employees wearing completely encapsulating suits (Level A), or multiple layers of clothing or other clothing types where no data are available for clothing adjustments. For these kinds of ensembles, the ACGIH TLVs are not a useful screening method to determine a threshold for heat stress management. The Onsite Safety Officer must assume that individuals wearing these ensembles risk heat-related disorders even in mild temperature conditions. Onsite medical monitoring must be required for employees wearing Level A PPE or clothing types/ensembles that lack clothing adjustment factors.

6.2 Managing the Risks Associated with Heat Stress

6.2.1 Increasing Preparedness and Raising Awareness

The best defense against heat stress is to acclimatize employees before they go into the field. Increase employees' heat tolerance by implementing a heat acclimatization program and by improving general physical fitness. Acclimatization is a gradual process that requires physical activity under heat stress conditions similar to those anticipated for the work (i.e., acclimatization to one heat stress level does not provide full acclimatization to a higher level of heat stress). Substantial acclimatization requires 1 to 2 hours of continuous heat stress exposure per day for at least 5 days and, for practical purposes, is complete in 10 to 14 days. Acclimatization is lost quickly if heat stress exposure stops. Two days without exposure is made up the first day back at work. However, a week or two without exposure requires 4 to 7 days for re-acclimatization to occur.

Before working in a hot environment, employees must understand the hazards associated with heat stress, including the symptoms of heat-related disorders, preventative measures, and first aid procedures. These topics must be covered in the training program discussed in Section 3. Supervisors must ensure that employees review the key points about heat stress in the Quick Reference Guide whenever they work at a site where heat stress is a concern.

6.2.2 Engineering/Administrative Controls and PPE to Mitigate Heat Stress

The Onsite Safety Officer is responsible for determining which heat stress controls must be used, incorporating information about these controls into site-specific HASPs, and ensuring that the controls are implemented. Engineering and administrative controls must be used before PPE. Local organizations (e.g., fire departments, police departments, construction firms, etc.) may also be consulted for the precautions they take to minimize heat stress.

Examples of engineering/administrative controls include:

- Scheduling "hot jobs" for the cooler part of the day or for the cooler part of the year if the task does not have to be performed immediately.
- Positioning large pedestal fans for localized, spot cooling (provided they do not interfere with other workplace controls or affect exposure to chemical agents).
- Placing shields or barriers around equipment that produces radiant heat.
- Providing a cool, shaded, or air-conditioned rest area for employees with ample hydration supplies.
- Limiting the amount of time employees spend in hot environments by decreasing their work time in the hot environment and/or increasing their recovery time spent in cooler environments. Work-to-rest ratios are best determined by onsite medical monitoring (Section 4.2).

- Reducing the metabolic demands of a job through mechanization, special tools, or by increasing the number of employees per task.
- Providing adequate amounts of cool potable water near work areas (including onsite medical monitoring exit checkpoints) and encouraging all employees to drink a cup of water every 15 to 20 minutes (at least 1 quart per person, per hour) to maintain fluid replacement. Thirst sensation should not be relied upon as the sole guide for water intake and proper hydration.
- Supplementing fluid replacement (hydration) with commercial electrolyte replacement drinks (sports drinks) to help retain fluids and maintain electrolyte levels. Electrolyte replacement drinks are appropriate during the first 5 to 10 days of activity in heat (when un-acclimatized workers lose more salt in sweat), under conditions of profuse sweating, and for first aid. (See Text Box 3 for proper heat stress hydration.)
- Identifying and medically monitoring employees with high risk factors (e.g., hypertension, prescription or non-prescription medication that reduces heat tolerance, etc.).

Text Box 3
Hydration for Heat Stress

Before Work: Drink extra fluids (1 to 2 cups of water, juice, or a sports drink) to prepare for the heat.

During Work: Take several fluid breaks every hour, drinking at least 1 quart of fluid (primarily water). Supplement fluid replacement with a sports drink to maintain electrolyte levels.

After Work: Continue drinking (beyond thirst) to replace fluid losses and ensure rehydration.

Enhance rehydration by adding extra salt to meals; eating bananas and citrus fruits; drinking lemonade, orange juice, or tomato juice; and avoiding excess caffeine (coffee and colas) and alcohol.

Specialized PPE must be considered an option when engineering/administrative controls do not protect employees from heat stress hazards. Examples include ice- or cold-pack vests, inline vortex units that cool the air provided to suits and respirators, and water-cooled suits that circulate fluid to absorb excess heat. Additional information on protective equipment for managing heat stress is available in the OSHA Technical Manual, Section III, Chapter IV. PPE cooling systems: (1) must not be used in lieu of administrative and work practice controls; (2) may be quite heavy and limit mobility; (3) may mask heat stress symptoms and delay proper hydration (e.g., ice-pack vests); (4) provide cooling for a limited period of time; and (5) may require extra resources not present at every site (e.g., air compressors and refrigeration/freezer capacity) to store equipment.

6.2.3 Symptoms of and Responding to Heat Stress

The Onsite Safety Officer must implement a buddy system in which employees are responsible for observing fellow workers for symptoms of heat stress. Common early symptoms include headache, muscle cramps, and unusual fatigue. Treatment for early symptoms of heat stress includes resting in a cool place and drinking plenty of fluids (water and an electrolyte replacement drink).

If left untreated, mild cases of heat illness can progress to more serious conditions characterized by:

- Confusion or irritability;
- Nausea/vomiting;

Text Box 4
Emergency First Aid for Heat Stress

- Lay employee down in a shady, cool area;
- Elevate the feet;
- Remove all outer clothing;
- Pour cool water on employee and vigorously fan to cool; and
- Get employee to a hospital as quickly as possible.

- Weakness;
- Rapid pulse;
- Excessive sweating or hot dry skin;
- Seizures; and
- Fainting or loss of consciousness.

If any of these symptoms are observed, immediately call for medical assistance and administer emergency first aid (Text Box 4).

The Onsite Safety Officer must ensure that employees have access to emergency medical services (in a reasonable time frame) including the provision of first aid treatment.[4] If timely access is an issue or the risk of heat stress is significant, emergency medical services (EMTs and an ambulance) must be available at the site. All employees and supervisors must receive information on first aid procedures during physical stress management training (Section 3). These procedures are listed in Appendix F.

7.0 COLD STRESS

Cold stress is the physiological response resulting from the body's or a portion of the body's (such as the hands, feet, head, or limbs) net heat loss and can lead to various injuries or health effects. In cold environments, body energy is used to maintain the internal core (rectal) temperature (99.6°F / 37.6°C). If the core temperature falls due to cold exposure, the body shifts blood circulation from the extremities (hands, feet, arms, and legs) to the core (chest and abdomen) causing exposed extremities to cool rapidly. This increases the risk of developing frostbite and hypothermia, the former of which causes tissue damage (possibly leading to amputation) and the latter of which can be deadly. Where cold water is present, trench foot is another condition that may arise. The symptoms, adverse effects, and first aid procedures associated with trench foot, frostbite, and hypothermia are in Appendix H and Section 7.2. Other hazards associated with cold weather are noted in Text Box 5.

Text Box 5
Other Hazards Associated with Cold Weather

Eye effects. Employees working in a snow- and/or ice-covered terrain may experience adverse eye effects from ultraviolet light and glare (temporary loss of vision and/or conjunctivitis) and blowing ice crystals. This problem can be avoided by providing employees with glacier glasses or snow goggles.

Increased exposure to volatile organic compounds. Cold air is denser than warm air and can cause a modest increase in volatile contaminant concentrations due to evaporation (mass/volume). Working at high altitudes may lead to an increase in respiration rates (due to reduced oxygen levels or increased activity) and cause employees to inhale larger volumes of air and potentially more air contaminants. This issue might affect respiratory protection requirements.

[4] Consult the local emergency medical service provider to determine the typical response time as well as the emergency response equipment available. OSHA states that acceptable response time for administering emergency medical care is based on the severity of potential accidents. For example, a 3- to 4-minute response time (from time of injury to time of administering first aid) is required if possible accidents could result in severe bleeding, suffocation, or other life threatening or permanently disabling injury or illness. A longer response time, such as 15 minutes, is acceptable if a life-threatening or permanently disabling injury is an unlikely outcome of an accident.

7.1 Assessing the Potential for Cold-Related Hazards

There is little risk of cold stress when air temperatures are equal to or greater than 61°F (16°C).[5] When temperatures are below 61°F (16°C), local weather conditions must be monitored to determine the potential for cold-related hazards (Text Box 6). When determining if cold weather poses a hazard consider: (1) air temperature (dry bulb temperature); (2) air velocity; (3) relative humidity; (4) contact with cold water or surfaces; (5) potential for clothes to become wet (rain or snow melt, or from perspiration); and (6) personal factors (e.g., allergies, cardiovascular disease, diabetes, use of drugs that impair thermoregulatory response, and smoking or drinking).

Two tools to aid in protecting employees are:

- **The National Weather Service (NWS)** provides a color-coded windchill chart that shows how rapidly frostbite can occur at different temperatures and wind speeds (see Appendix I).
- **ACGIH** publishes detailed guidelines (reported as TLVs) for protecting workers from cold. The TLVs, based on dry bulb temperatures or the wind chill index (equivalent chill temperatures), help employers recognize and mitigate cold stress. The HSPC (or other designated person) must ensure that cold stress information is available to EPA employees. The ACGIH TLV booklet lists actions to be taken when air and wind chill temperatures fall to specific levels (Appendix I).

Text Box 6
Obtaining Local Weather Information

Local news and the Internet are good sources of weather information for a specific work location. Information on current conditions and short- and long-term forecasts is also available through the National Oceanic and Atmospheric Administration (see http://iwin.nws.noaa.gov/iwin/iwdspg1.html.) In addition, site conditions are usually monitored with a portable weather (meteorological) station. Weather parameters monitored include wind speed, wind direction, atmospheric pressure, air temperature, relative humidity, and others.

7.2 Managing the Risks Associated with Cold Stress

7.2.1 Increasing Preparedness and Raising Awareness

Employees must understand the hazards associated with cold stress before working in a cold environment. These include the symptoms, preventative measures, and first aid procedures for cold-related stress/injury. These topics must be covered in the training program discussed in Section 3. Supervisors must ensure that employees review the key points about cold stress in the Quick Reference Guide whenever they work at a site where cold stress is a concern.

7.2.2 Engineering/Administrative Controls and PPE to Mitigate Cold Stress

The Onsite Safety Officer is responsible for determining which cold-related controls to employ. Examples of controls and other protective measures include:

[5] The ACGIH TLV Booklet recommends special provisions (e.g., warm air jets, radiant heaters, contact warm plates) for keeping a worker's hands warm if fine work is performed with bare hands for more than 10 to 20 minutes in an environment below 61°F (16°C). For sedentary work, gloves should be used if fine manual dexterity is not required.

- Instructing employees to wear appropriate protective clothing, such as a hat, insulated boots or footwear, and layers of clothing (Appendix J).
- Scheduling the coldest work for the warmest part of the day or for the warmest part of the year if the task does not have to be performed immediately.
- Arranging work to minimize sedentary positions (e.g., sitting and standing) for long periods.
- Keeping the appropriate work rate to preclude heavy perspiration so that clothing does not become wet.
- Providing a warm shelter (if possible) that employees can go to during rest periods.
- Providing warm, sweet (non-caffeinated/non-alcoholic) drinks and soups to maintain energy and fluid levels.
- Providing general or spot heating (such as warm air jets, radiant heaters, or contact warm plates) to increase the temperature at the workplace, especially if employees are required to perform fine work with their hands. If fine work is required for more than 10 to 20 minutes at a time, ACGIH recommends periodic hand warming whenever air temperatures drop below 61°F (16°C).
- Using insulated material on equipment handles (especially metal handles) when temperatures drop below 30°F (-1°C).
- Avoiding the use of unprotected metal chair seats.
- Shielding work areas from windy conditions.
- Implementing a work-rest schedule that reduces the exposure time in the cold environment and/or increases the recovery time spent in warm environments. *(Note: It is important to avoid fatigue since energy is needed to keep the body's muscles warm.)*
- Identifying and medically monitoring employees with high risk factors (e.g., diseases of the nervous system, vascular disease, cold intolerance, or use of drugs that impair thermoregulation).

7.2.3 Symptoms of and Responding to Cold Stress

The Onsite Safety Officer must implement a buddy system in which employees are responsible for observing fellow workers for symptoms of cold stress, especially when the wind chill is 10.4°F (-12°C) or lower. Early symptoms of cold stress include cold hands and other extremities, shivering, and reduced manual dexterity. Treatment for early symptoms of cold stress includes rewarming in a heated shelter or rest area, consuming warm, sweet drinks and soup for fluid replacement and energy, and putting on extra insulating clothing (if inadequate).

If left untreated, early symptoms of cold stress can progress to more serious conditions characterized by:

- Pain in the extremities;
- Severe shivering;
- Fatigue;
- Drowsiness;
- Loss of coordination;
- Slurred speech;

- Unusual behavior (confusion, disorientation, irritability, euphoria, other); and
- Numbness, tingling, stinging, itching, burning, or aching of the hands, feet or other extremities.

If any of these symptoms are observed, immediately call for medical assistance and administer emergency first aid (Text Box 7).

Text Box 7
Emergency First Aid for Cold Stress

- Move employee to a warm area and prevent further cold exposure;
- Handle minimally and gently;
- Remove wet clothes and replace with warm, dry, loose clothing;
- Place copious amounts of insulation (blankets, towels, newspapers, etc.) around the employee to prevent heat loss; and
- Get to a hospital as quickly as possible.

The Onsite Safety Officer must ensure that employees have access to emergency medical services (in a reasonable time frame) including the provision of first aid treatment (see footnote 4, Section 6). If timely access is an issue or the risk of cold stress is significant, emergency medical services (EMTs and an ambulance) must be available at the site. All employees and supervisors must receive information on first aid procedures during physical stress management training (Section 3). Appendix H lists actions that must be taken for trench foot, frostbite, and hypothermia.

8.0 NOISE AND HEARING CONSERVATION

As discussed in Text Box 8, occupational noise exposure can lead to adverse effects including permanent hearing loss. The extent of damage depends primarily on the intensity and the duration of the noise exposure. OSHA's permissible exposure limit (PEL) for occupational noise exposure is an 8-hour time-weighted average (TWA) sound pressure level of 90 decibels measured on the A scale (dBA) (slow response) of a standard sound level meter. (See Appendix C, the Glossary, for a discussion of the frequency weighting network used to measure noise with a sound level meter.) Exposures at and above this level are considered potentially hazardous and an 8-hour TWA of 85 dBA (or, equivalently, a dose of 50 percent) requires participation in a hearing conservation program.

Text Box 8
Adverse Effects Associated with Noise Exposure

Tinnitus is a condition characterized by permanent ringing in the ears.

Temporary hearing loss can result from short-term exposures to noise, but normal hearing returns after a period of rest.

Permanent hearing loss can occur from prolonged exposure to high noise levels.

Noise can create **communication interference**, which makes it difficult for workers to hear verbal communication, alarms, or warning sounds.

Physiological stress reactions, such as a rise in blood pressure, an increase in sweating, and a faster heart rate, can result from exposures to occupational noise.

Hearing threshold shifts might initially be temporary, but may become permanent with prolonged exposures.

The OSHA Noise Exposure standard (29 CFR 1910.95) and SHEM Guideline No. 37 provide information about procedures that must be taken to protect employees from excessive exposure to occupational noise. Whenever employee noise exposures equal or exceed an 8-hour TWA of 85 dBA, the following hearing conservation program elements are required:

- Training (noise hazards, hearing protection, audiometric testing);
- Audiometric testing; and
- Provision for and use of hearing protection.

Because emergency responders might respond to sites where the noise levels exceed 85 dBA, these employees must receive

training, audiometric testing, and hearing protectors as required by the OSHA standard and SHEM guidelines. In the field, EPA must monitor noise exposure, implement engineering and administrative controls to reduce noise exposure if necessary, and promote the use of hearing protection if it is infeasible to reduce exposures to acceptable levels.

8.1 Training

Emergency responders must receive annual occupational noise and hearing conversation training. Section 3 of this chapter (which addresses training) presents information about the topics that must be covered.

8.2 Audiometric Testing

As noted in the manual's Medical Surveillance Program chapter, all emergency responders must receive a medical examination each year, including audiometric testing. The SHEMP Manager must ensure that the audiometric tests are performed by a licensed or certified audiologist, otolaryngologist, or other physician, or by a properly trained and certified technician. Requirements that must be met when performing and interpreting audiograms are outlined in Section 1910.95(g) and Appendices C through F of 29 CFR 1910.95. If the examiner determines that an employee has experienced a standard threshold shift (STS), the employee must be notified of this fact in writing within 21 days of the determination and the SHEMP Manager (or other designated person) must perform the follow-up activities listed in Text Box 9.

Text Box 9
Follow-up Procedures if an Employee Experiences a Work-Related Standard Threshold Shift
(from Section 1910.95[g][8] of OSHA's Noise Exposure standard 29 CFR 1910.95)

Unless a physician determines that the STS is not work related or aggravated by occupational noise exposure, the employer must ensure that the following steps are taken when an STS occurs:

- Employees not using hearing protection must be fitted with hearing protection, trained in its use and care, and required to use hearing protection.
- Employees already using hearing protection must be refitted and retrained in its use and provided with hearing protection offering greater attenuation if necessary.
- The employee must be referred for a clinical audiological evaluation or an otological examination, as appropriate, if additional testing is necessary or if the employer suspects that a medical pathology of the ear is caused or aggravated by wearing hearing protection.
- The employee must be informed of the need for an otological examination if a medical pathology of the ear that is unrelated to the use of hearing protection is suspected.

8.3 Hearing Protection

EPA must provide hearing protection (e.g., ear plugs and ear muffs) to emergency responders. A variety of suitable hearing protection must be made available from which employees can select. The SHEMP Manager (or other designated person) must ensure that employees receive a proper initial fitting, as well as training on how to use and care for their hearing protection. In the field, the Onsite Safety Officer is responsible for ensuring that hearing protection is available on site and that it is worn by:

- Any employee who is subjected to noise exceeding the sound pressure levels listed in Table 2 (see below); or
- Any employee who is exposed to an 8-hour TWA of 85 dBA (or greater) and either (1) has not yet received a baseline audiogram or (2) has already experienced an STS.

To be conservative, until noise monitoring can be performed at a site, assume that hearing protection is required if employees need to raise their voices to be heard, since this could be an indicator that sound pressure levels exceed 85 dBA.

Different hearing protection has different noise reduction ratings (NRRs). The NRR is often printed on the hearing protection package or the manufacturer's Web site. Higher NRRs generally suggest more effective hearing protection than lower NRRs. However, laboratory-obtained real ear attenuation for hearing protection can seldom be achieved in the workplace. To estimate the adequacy of hearing protection attenuation in the work environment, use a noise dosimeter or sound level meter set to the A-weighting network and:

1. Obtain the employee's A-weighted TWA.
2. Subtract 7 decibels from the NRR and then subtract the remainder from the A-weighted TWA to obtain the estimated A-weighted TWA under the hearing protection.

If the noise dosimeter does not display the employee's A-weighted TWA, convert the A-weighted dose to a TWA by consulting SHEM Guideline 37, Appendix A or the OSHA Noise Exposure Standard, Appendix A. Other methods for estimating the adequacy of hearing protection attention are listed in SHEM Guideline 37, Appendix B.

When deciding which type of protection is adequate, supervisors must remember that the goal is to reduce exposure to an 8-hour TWA of 90 dBA or less. In the special case of an employee who has experienced hearing loss (recorded as an STS), the goal is to reduce exposure to 85 dBA or less as an 8-hour TWA. Ear plugs or ear muffs are typically adequate for most noise exposure situations encountered by EPA employees. However, some very noisy environments (e.g., an airport flight line) require extra noise attenuation, such as ear plugs plus ear muffs worn simultaneously as "double hearing protection."

8.4 Measuring Noise Exposure Levels

Employees developing a HASP must obtain information in advance about the noise levels and types of equipment at a site, as well as whether emergency responders will be working near noise sources. In the absence of site-specific information, employees making decisions about the need for hearing protection may rely on historic noise exposure information and experiences with similar equipment and working conditions. Once in the field, noise monitoring must be conducted if the Onsite Safety Officer suspects that exposures might be at or above 85 dBA, the level at which two people standing a few feet apart can talk in normal tones. Factors which suggest that noise exposures might be approaching this level include employee complaints about the loudness of noise or noisy conditions which make normal conversation difficult.

There are two basic types of instruments that are commonly used to measure noise exposure: (1) the sound level meter, and (2) the noise dosimeter (see the Glossary, Appendix C, for details). Regardless of which method is used, the Onsite Safety Officer must ensure that all noise measurements are recorded and must use these measurements to determine whether it is necessary to take action to protect employees from potentially damaging noise levels.

8.5 Exposure Limits That Trigger the Need for Protective Measures

OSHA has established guidelines to help determine which noise exposures are permissible and which present a hazard. OSHA's permissible noise exposures (Table 2) indicate how long it is acceptable to be exposed to different sound pressure levels. As noted in Section 1910.95(b)(1) of OSHA's Occupational Noise Exposure standard, when employees are subjected to noise exceeding the sound pressure levels

listed in Table 2, employers are required to take action to protect employees, which they can do by implementing administrative/engineering controls or, if such measures are not effective, by instructing employees to wear hearing protection. As a general rule, for every 5 decibel increase in sound level, the allowable amount of time the unprotected employee can spend in that environment is cut in half. The footnote for Table 2 specifies the technique that employers can use to determine whether permissible levels have been exceeded in instances where the daily noise exposure is composed of two or more periods of exposure at different levels.

Table 2
OSHA Sound Pressure Levels and Durations of Work That Must Not Be Exceeded

Sound Pressure Level (decibels on the A-weighted scale)	Duration	Sound Pressure Level (decibels on the A-weighted scale)	Duration
80	32 hours	99	2 hours, 18 minutes
81	28 hours	100	2 hours
82	24 hours	101	1 hour, 42 minutes
83	21 hours	102	1 hour, 30 minutes
84	18 hours	103	1 hour, 18 minutes
85	16 hours	104	1 hour, 6 minutes
86	14 hours	105	1 hour
87	12 hours	106	52 minutes
88	10.5 hours	107	46 minutes
89	9 hours	108	40 minutes
90	8 hours	109	34 minutes
91	7 hours	110	30 minutes
92	6 hours	111	27 minutes
93	5 hours	112	23 minutes
94	4.5 hours	113	20 minutes
95	4 hours	114	18 minutes
96	3.5 hours	115	15 minutes
97	3 hours	118	10 minutes
98	2.5 hours	122	5 minutes

Source: Adapted from Appendix A of OSHA's Occupational Noise Exposure standard.
Note: When the daily noise exposure is composed of two or more periods of noise exposure of different levels, their combined effect should be considered, rather than the individual effect of each. If the sum of the following fractions: $C_1/T_1 + C_2/T_2 + \ldots + C_n/T_n$ *exceeds unity, then, the mixed exposure should be considered to exceed the limit value.* C_n *indicates the total time of exposure at a specified noise level, and* T_n *indicates the total time of exposure permitted at that level. Exposure to impulsive or impact noise should not exceed 140 decibels peak sound pressure level.*

For example, if an employee has a daily noise exposure composed of four periods of noise exposure as follows:

Noise Period	Noise Level	Total Duration of Exposure at the Noise Level (C_n)	Total Duration of Exposure Permitted at the Noise Level (T_n) (from OSHA Table G-16A)
1	80 dBA	1 hour	32 hours
2	90 dBA	5 hours	8 hours
3	95 dBA	1 hour	4 hours
4	100 dBA	1 hour	2 hours

Then $C_1/T_1 + C_2/T_2 + C_3/T_3 + C_4/T_4 = 1/32 + 5/8 + 1/4 + 1/2 = 0.031 + 0.625 + 0.25 + 0.5 = 1.41$
Thus, the combined effect is greater than unity (1) and exceeds the OSHA PEL for a mixed exposure.

8.6 Engineering and Administrative Controls

If noise levels exceed OSHA's permissible levels (Table 2), administrative and/or engineering controls must be implemented to reduce the noise to levels that fall below the ranges listed in Table 2. The Onsite Safety Officer is responsible for determining the engineering and administrative controls that must be employed, incorporating information about these controls into the site-specific HASP, ensuring that the controls are implemented, and performing follow-up monitoring to determine whether the controls have succeeded in reducing noise exposures to permissible levels. If engineering/administrative controls alone do not effectively reduce noise levels, then the Onsite Safety Officer must ensure that emergency responders are using appropriate PPE (i.e., hearing protection) while performing onsite activities. Engineering and administrative controls that reduce noise exposure include:

- Installing sound-dampening materials;
- Installing a muffler;
- Erecting acoustical enclosures and barriers;
- Increasing the distance between employees and noise sources (e.g., placing electric power generators or compressors at a distance from work areas);
- Selecting less noisy equipment when a choice is available;
- Rotating employees who are operating noisy machines;
- Shifting an employee to a less noisy job once daily maximum noise doses have been approached;
- Temporarily powering-down noisy equipment when employees must be in an area;
- Keeping windows and doors closed when noisy outdoor equipment is nearby; and
- Moving unnecessary workers out of areas with high noise operations (e.g., when pressure relief valves are bled).

9.0 VIBRATION

Emergency responders have the potential to suffer adverse effects when operating machinery on the job. EPA's strategy for protecting emergency responders from the adverse effects of vibration includes:

- **Identifying potential vibration hazards.** The SHEMP Manager (or another designated person) must arrange task-specific evaluations of vibration hazards and implement follow-up procedures if necessary. Emergency responders must help identify potential hazards and bring them to management's attention. Additionally, the Removal Manager, SHEMP Manager, and HSPC must review potential sources of vibration as part of the annual program evaluation (Section 13).
- **Minimizing the effects of vibration through the use of engineering and work practice controls, protective equipment, and proper equipment maintenance**. The best engineering control is to isolate the individual from the source of vibration if possible. Purchasing equipment with vibration controls built into the design is an effective solution. Positioning is also important; efforts must be made to eliminate awkward, asymmetric postures when working with tools, sitting, or standing. Adequate lumbar support, adjustable seat pans, back and arm rests, and other ergonomic modifications also provide better support and reduce vibration. The Onsite Safety Officer must determine which controls need to be applied at a particular site and seek advice from the Removal Manager, SHEMP Manager, or HSPC if assistance is needed in implementing these controls.

10.0 OVEREXERTION INJURIES FROM HEAVY MANUAL LABOR

Heavy manual labor can cause overexertion and the potential for injury. The SHEMP Manager (or another designated person) must ensure that tasks involving heavy manual labor are managed to minimize the opportunity for overexertion. The following procedures will help reduce the risk of injury:

- **Evaluate jobs, processes, and operations for injury potential**. When doing so, assess the three categories of risk factors (Text Box 10) that impact the likelihood of developing injuries.
- **Consider engineering/administrative controls if a job process or operation has the potential to cause overexertion**. Options that could be explored include the use of ergonomically designed tools or administrative controls such as job rotation, work pacing, or additional work breaks. The Onsite Safety Officer must determine which controls are appropriate and seek advice from the Removal Manager, SHEMP Manager, or HSPC if assistance is needed in implementing these controls.

Text Box 10
Risk Factors That Lead to Overexertion Injuries

Personal risk factors are conditions or characteristics of the employee that affect the probability that an overexertion injury may occur. Personal risk factors include age, level of physical conditioning, strength, and medical history.

Environmental risk factors are conditions or characteristics of the external surroundings that affect the probability that an overexertion injury may occur. Environmental risk factors include temperature, lighting, noise, and vibration.

Job-related risk factors are conditions or characteristics of the manual labor that affect the probability that an overexertion injury may occur. Job-related risk factors include weight of the load being moved, location of the load relative to the worker, size and shape of the object moved, and frequency of handling.

11.0 ALTITUDE

Emergency responders may be required to work at high altitudes. Altitude is defined on the following scale of feet above sea level: (1) High (8,000-12,000 feet); (2) Very High (12,000-18,000 feet); and (3) Extreme (18,000+ feet). As altitude increases, atmospheric (barometric) pressure decreases, the partial pressure of oxygen decreases, ultraviolet radiation increases, and the air gets drier and colder (Section 7). As the partial pressure of oxygen decreases there is less oxygen available for the body to use (hypoxia) and a series of physiological effects occur (see Table 3). Normal responses to working at altitude include increased rate and depth of breathing, increased heart rate, shortness of breath on exertion, sleep disturbances with frequent arousals and periodic breathing, and increased urination.

Several altitude-related illnesses can occur when ascending to high altitudes (above 8,000 feet) that range from uncomfortable symptoms to life-threatening conditions and death. The occurrence of these illnesses varies with the rate of ascent, elevation gained, and individual susceptibility. Text Box 11 lists the symptoms of altitude illnesses. If any of these symptoms are observed, immediately call for medical assistance. Emergency medical treatment and decent from altitude may be necessary.

Table 3
Barometric Pressure, Oxygen Partial Pressure, and Equivalent Percent Oxygen Concentration Variation with Altitude and Physiological Effects[a]

Altitude (feet)	Barometric Pressure (Torr or mm Hg)	Partial Pressure of Oxygen (pO_2) (Torr or mm Hg)	Equivalent Oxygen Concentration (%)	Physiological Effects of pO_2 Levels[b]
0	760	159	20.9	None in healthy adults
1,000	731	153	20.1	
2,000	704	147	19.3	
3,000	677	142	18.7	
4,000	652	137	18	
5,000	627	131	17.2	
6,000	603	126	16.6	Loss of night vision may occur at elevations above 5,000 feet.
7,000	580	121	16	Increased pulmonary ventilation and cardiac output, loss of coordination, and impaired attention and thinking may occur.
8,000	559	117	15.4	Rapid exposure to altitudes over 8,000 feet may cause high altitude sickness (respiratory alkalosis, headache, nausea and vomiting) in un-acclimatized individuals. Rapid ascent increases the risk of high altitude pulmonary edema and cerebral edema.
9,000	537	112	14.7	
10,000	517	108	14.2	
11,000	498	104	13.7	Abnormal fatigue on exertion, faulty coordination, impaired judgment, and emotional upset.
12,000	479	100	13.2	
13,000	461	98	12.8	
14,000	443	93	12.2	Impaired respiration, very poor judgment and coordination, and tunnel vision.

[a] The information in Table 3 was adapted from Table F-1 (Barometric Pressure, Oxygen Partial Pressure, and Percent Oxygen Concentration Variation with Altitude and Physiological Effect) in the 2007 ACGIH TLV Booklet.
[b] The approximate physiological effect in healthy adults is influenced by duration of the oxygen deficiency, work rate, breathing rate, temperature, health status, age, and pulmonary acclimatization.

To minimize the effects of working at higher altitudes, emergency responders must allow adequate time for their bodies to adjust or acclimatize to the decreased levels of oxygen. Acclimatization starts at low altitudes and continues to about 18,000 feet, but the process varies widely from one individual to another, both in time and degree. The average time for acclimatization is 3 to 5 days. Previous tolerance to altitude is a good indication of future tolerance; however, some individuals may not be able to acclimatize to altitude at all (e.g., due to preexisting conditions such as asthma, or other lung or heart disease).

To facilitate the adjustment of working at altitudes, the following guidelines are suggested:

Text Box 11
Symptoms of Altitude Illness

- Headache (moderate to severe)
- Loss of coordination
- Confusion
- Weakness/fatigue
- Lack of appetite
- Nausea/vomiting
- Cough (dry or productive)
- Shortness of breath at rest
- Bluish skin color
- Chest tightness or congestion
- Lightheadedness/dizziness

- Ascend gradually (e.g., spend several days at 5,000 feet before ascending to 10,000 feet).[6] If gradual ascent is not possible, rest for 2 days after arrival at altitude (light exercise/no heavy exertion).
- Sleep at a lower altitude than the workplace, if possible.
- Hydrate before, during, and after work — drink at least 4 to 5 quarts of water a day. Note that heat stress conditions may increase hydration needs (Section 6.2.2).
- Use work/rest cycles with reduced work rates and increased rest periods.
- Avoid salty foods, caffeine, alcohol, tobacco, and depressant drugs (e.g., sleeping pills, narcotics).
- Eat low fat, high carbohydrate meals.

The Onsite Safety Officer and supervisors directly in charge of emergency responders must ensure that employees adhere to the above guidelines when working at high altitudes.

The Onsite Safety Officer must implement a buddy system where employees are responsible for observing fellow workers for symptoms of altitude illness. The Onsite Safety Officer must also ensure that employees have access to emergency medical services in a reasonable time frame (see footnote 4, Section 6). If timely access is an issue or the risk of altitude illness is significant, emergency medical services (EMTs and an ambulance) must be available at the site.

Before working in a high altitude environment, all employees and supervisors must understand the hazards associated with altitude, including the symptoms of altitude illnesses, preventative measures, and emergency medical procedures. These topics must be covered in the training program discussed in Section 3.

Supervisors must ensure that employees review the key points about altitude in the Quick Reference Guide whenever they work at high altitudes.

12.0 RECORDKEEPING

EPA's recordkeeping goal is to ensure that nationally consistent, readily accessible records are maintained at each EPA organization. Table 4 and Sections 12.1 through 12.5 provide details about the specific recordkeeping procedures that must be followed, who is expected to complete specific forms, and who must retain copies of the records.

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[6] Gradual exposure to altitude will allow time for altitude tolerance to develop and reduce the risk of illness. Other guidelines for gradual ascent include: (1) No faster than 1,000 feet per day at altitudes over 9,000 feet with a rest every 2 to 3 days; or (2) a rest day at 8,000 feet, then a rest day for every 2,000 feet of further ascent. [Source: Burr, R.E. Environmental Medicine: Heat, Cold, and Altitude. In Military Preventive Medicine: Mobilization and Deployment, Volume 1 (Section 2, Chapter 19). Borden Institute, Office of The Surgeon General, U.S. Army Medical Department Center & School, U.S. Army, 2003. Page 399.]

Table 4
Recordkeeping Requirements Associated with the Physical Stress Management Program

Required Record	Details/Specified Forms	Completed/Compiled By[a]	Retained By[a]
Training records	Training rosters (see the "Forms" section of the manual's website)	Course Instructor	SHEMP Manager
	Training certification letters (see the "Forms" section of the manual's website)	SHEMP Manager	• SHEMP Manager • Employee
Documentation of onsite monitoring	• Noise exposure records • Environmental measurement records (e.g., WBGT readings)	Onsite employees	• OSC • SHEMP Manager
Documentation of onsite medical monitoring	Responder Field Medical Status Form (see Part II of Appendix E)	Medical Monitor (e.g., an EMT, nurse, or a nurse assistant)	SHEMP Manager
Audiometric test results	Audiometric test records	Examiners	SHEMP Manager
OSHA Log	*OSHA 300 Log of Work-Related Injuries and Illnesses*	SHEMP Manager	SHEMP Manager
Injury, Illness, and Near Miss Reporting	*OSHA & EPA 301 Injury, Illness and Near Miss Report*	Supervisors	SHEMP Manager
Physical Stress Management Program Evaluation Form	Checklist (see the "Forms" section of the manual's website)	SHEMP Manager (plus other relevant stakeholders)	SHEMP Manager

[a] The assignment of recordkeeping responsibilities has been made with regional audiences in mind, and as a result, the positions listed might not be applicable for ERT, CMAT, and HQ. Users can adjust the assignments when they go through the process of customizing Appendix A and filling information into the yellow-highlighted spaces that appear throughout Sections 12.1 through 12.5 of this chapter.

12.1 Training Records

Training records must be maintained to document the successful completion of employee training requirements. EPA accepts variation in training record documentation across EPA organizations. An acceptable format is to issue a training certification letter (see the "Forms" section of the manual's website for a template). If this approach is used, the SHEMP Manager (or another designated person) is responsible for issuing such letters and retaining copies. Emergency responders must also retain copies and ensure that they are available upon request. As an alternative, training rosters (see the "Forms" section of the manual's website for a template) can be used to document who was in attendance for a particular training course. The roster must be signed by the instructor and retained by the SHEMP Manager (or another designated person). All completed training must be documented in the FRM (see Section 5.3 of the manual's Introduction).

12.2 Documenting Environmental Conditions and Noise Exposure Measurements

A variety of field measurements might be taken to determine whether physical stress conditions (e.g., temperature, wind speed, etc.) pose a concern. The Onsite Safety Officer is responsible for ensuring that this monitoring occurs, retaining the monitoring records, and forwarding copies of the records to the SHEMP Manager (or another designated person). SHEM Guideline 37 (Occupational Noise and Hearing Conservation) requires the SHEMP Manager (or another designated person) to maintain records of all employee noise exposure measurements for at least 2 years.

12.3 Documentation of Onsite Medical Monitoring

The Medical Monitor (e.g., an EMT obtained to perform onsite monitoring) must use a form (see Appendix E-2 for a sample) to track employee vital signs in the field when required. Forms must be forwarded to the Onsite Safety Officer, who in turn must submit them to the SHEMP Manager (or another designated person), who will retain copies.

12.4 OSHA Recordkeeping and Reporting

If altitude illness, heat stroke, heat exhaustion, hypothermia, frostbite, or any other injuries, health effects, or near misses associated with physical stresses occur during site work, the employee's immediate supervisor (or another designated person) must complete an *OSHA & EPA 301-Injury, Illness & Near Miss Report* with the employee and forward this information to the SHEMP Manager. The SHEMP Manager is responsible for determining if the injuries or health effects are recordable under the OSHA recordkeeping requirements, and logging recordable cases under section M-6 ("All Other Illnesses") on the *OSHA 300 Log of Work-Related Injuries and Illnesses*. In addition, the SHEMP Manager (or another designated person) is required to record all work-related STS on the OSHA 300 Log. Page 21 of SHEM Guideline 37 (Occupational Noise and Hearing Conservation) summarizes the requirements for reporting STS on the OSHA 300 Log.

12.5 Evaluation Form

As described in Section 13, the SHEMP Manager (or another designated person) must complete the *Physical Stress Management Program Evaluation Form* (see the "Forms" section of the manual's website) annually and retain copies of the completed forms.

13.0 PROGRAM EVALUATIONS

An evaluation of each organization's program must be performed to ensure that EPA's physical stress management program is being implemented properly and performing satisfactorily across the Agency.

13.1 Internal Evaluations

As noted in Section 5.4.1 of the manual's Introduction, EPA's organizations must assess their health and safety programs at least annually. The purpose of the internal evaluation is to ensure that the organization's program is (1) being implemented in accordance with the minimum requirements identified in this chapter, and (2) meeting its ultimate objective to minimize the risk of injuries that result from physical stressors. The "Forms" section of the manual's website provides a checklist that can be used to assist in evaluating the physical stress management program.

13.2 External Evaluations

Once a year, representatives from the Core ER Audit Team evaluate each EPA organization to examine the elements of the organization's emergency response program, including health and safety and the physical stress management program, to ensure that the program is being implemented in a consistent fashion across the Agency. EPA organizations must provide the Core ER Audit Team members with the information they need to complete their evaluation.

13.3 Field Audits

Field audits must be performed to ensure that the protective measures required in the Agency's health and safety programs are being implemented in the field, including physical stress management. Care must be taken during these audits to ensure that issues related to physical stressors are addressed if such issues are relevant for a particular response action. Section 5.4.2 of the manual's Introduction provides additional information on the intent of the field audits, including the individuals who will be responsible for performing them and the number that must be completed each year.

APPENDIX A

Physical Stress Management Program: Designation of Roles and Responsibilities

Instructions for Users

Appendix A provides a place for users to insert organization-specific information into the Physical Stress Management Program chapter. This appendix presents a list of tasks that must be performed to ensure the smooth operation of a physical stress management program. The tasks are listed in rows. EPA position titles (e.g., the Removal Manager or the Health and Safety Program Contact) are listed in columns. Each task has been assigned to a default position. For some of the tasks, check marks have been placed in two or more columns to indicate that more than one person assumes responsibility for that task. **Please note that users can re-delegate tasks.**

Users must take the following steps to customize Appendix A:

- Fill in the background information requested at the top of page A-3. For example, indicate when the table is being updated and who is doing the updating.
- Fill in actual names under the position titles.
- Add columns to include additional key players (if necessary).
- Add rows to the table (if necessary) to provide information about activities that exceed the minimum requirements already included in Appendix A. (See Appendix B for a list of your organization's additional policies and procedures related to physical stress management.)
- Determine whether any of the recommended task assignments must be delegated to another person. (If so, move the check marks to re-assign the task.)
- Ensure that each task has been assigned to a specific person.

ATTENTION ERT, CMAT, and HQ Users: The tasks and position titles that appear in Appendix A have been written with regional audiences in mind. ERT, CMAT, and HQ users should modify the language that appears in the rows and column headers to reflect the needs of their organization.

APPENDIX A
Task Chart for Implementing the Physical Stress Management Program Chapter

This table has been customized for: Region 4.
Last Updated on: March 3, 2017.
Updated by Kevin Eichinger.

TASKS ▼ / ROLES ►	Who is Responsible for Each Task or Action?							
	Removal Manager	SHEMP Manager	Health and Safety Program Contact	Lead OSCs/ Onsite Safety Officers	Emergency Responders*	Supervisors	Medical Monitors	Others
Name of person in role ►	See Appendix A-2 in the Introduction chapter for the names of personnel that fill these roles.							
General Tasks								
1. Ensure that procedures outlined in the Physical Stress Management Program chapter are followed by all responsible parties. Support initiatives that the SHEMP Manager establishes and authorize the use of funds and human resources to support the organization's physical stress management program.	✓							
2. Serve as the organization's technical expert (or assign another person) on physical stressors.		✓						
3. Serve as the organization's contact on physical stress-related issues for EPA's emergency responders. (Facilitate and coordinate communication between managers who administer the organization's physical stress management program and emergency responders who are subject to the program.)			✓					
4. Implement the Physical Stress Management Program chapter by: (1) customizing the chapter with organization-specific information, (2) reviewing/updating the customized version annually, and (3) adopting the requirements and practices in the chapter. Post the customized chapter to the manual's Web site and inform stakeholders of its availability.	✓	✓	✓	✓	✓	✓		
Tasks Associated with Physical Stress Management Training (Section 3)								
5. Attend and complete the training modules in EPA's physical stress management program (Table 1).				✓	✓	✓		
6. Prevent employees from working in the field if they have not completed the physical stress management training requirements. Provide the resources (including time and monetary support) needed to ensure successful completion of training courses. If possible, attend the training to demonstrate management's support.	✓							
7. Develop training materials that cover the components listed in Table 1 of this chapter and ensure that training is delivered to emergency responders.		✓	✓					
8. Ensure that training requirements are tracked (Section 5.3 of the manual's Introduction for procedures), and that the Removal Manager is aware of which employees have/have not completed their training requirements.		✓	✓					

TASKS ▼ / ROLES ►	Who is Responsible for Each Task or Action?							
	Removal Manager	SHEMP Manager	Health and Safety Program Contact	Lead OSCs/ Onsite Safety Officers	Emergency Responders*	Supervisors	Medical Monitors	Others
Name of person in role ►	See Appendix A-2 in the Introduction chapter for the names of personnel that fill these roles.							
Tasks Associated with Medical Surveillance (see Section 4)								
9. Obtain a medical examination and audiometric test.				✓	✓			
10. Ensure that emergency responders receive medical examinations.	✓	✓	✓					
11. Determine whether onsite medical monitoring is necessary (Section 4.2.1). If monitoring is necessary, arrange for a trained Medical Monitor (e.g., an EMT or other trained health care professional) to take vital signs on site.		✓	✓	✓				
12. If onsite medical monitoring is necessary, establish a checkpoint for employees when entering/exiting the work zone and leaving the work site. Take vital signs. Alert employees, their immediate supervisors, and the Onsite Safety Officer if monitoring results suggest an employee is overly taxed (Section 4.2.2).				✓			✓	
13. Ensure that Appendix E-2 of the Physical Stress Management Program chapter is given to the Medical Monitor.				✓				
Tasks Associated with Onsite Safety Controls—Addressing Fatigue (Section 5), Heat Stress (Section 6), Cold Stress (Section 7), Noise Stress (Section 8), Vibration (Section 9), Overexertion Due to Heavy Manual Labor (Section 10), and Altitude (Section 11)								
14. Establish reasonable work/rest schedules. (Section 5.1 recommends the 2:1 work/rest ratio, shorter work shifts for long-term or high altitude response activities, and limits on the amount of time employees are allowed to drive.)				✓		✓		
15. Alert the Removal Manager if additional employees are needed to relieve those working on site in order to establish a more reasonable work/rest schedule.				✓				
16. To avoid excessively long shifts, ensure that the appropriate number of employees are provided for response activities.	✓							
17. Determine whether heat stress or cold stress is a concern. Perform environmental monitoring, assess weather conditions, and account for the level of PPE to be worn. Determine administrative controls and work practices to be employed (Section 6.2.2 and Section 7.2.2), incorporate information on these controls into the site-specific HASP, and ensure that the controls are implemented in the field.				✓				
18. Ensure that emergency responders receive initial fitting for their hearing protectors and training on how to use and care for their protectors.		✓						
19. Ensure that hearing protectors are available and being worn if necessary. (See Section 8.3 for additional guidance.)				✓		✓		

TASKS ▼ / ROLES ►	Who is Responsible for Each Task or Action?							
	Removal Manager	SHEMP Manager	Health and Safety Program Contact	Lead OSCs/ Onsite Safety Officers	Emergency Responders*	Supervisors	Medical Monitors	Others
Name of person in role ►	See Appendix A-2 in the Introduction chapter for the names of personnel that fill these roles.							
20. Ensure that noise monitoring is performed if exposures might be at or above 85 decibels, and use noise measurements to determine whether it is necessary to take action to protect employees from potentially damaging noise levels (Table 2). If a hazard exists, determine the administrative controls and work practices that must be used (Section 8.6), incorporate information on these controls into the site-specific HASP, and ensure that the controls are implemented in the field. If the controls fail to reduce sound levels to "permissible noise exposure" levels, ensure that employees are using hearing protectors that will reduce noise exposure to acceptable levels.				✓				
21. Identify possible vibration hazards in the field and request task-specific evaluations.					✓			
22. Determine the administrative/engineering controls that must be taken to reduce vibrational stress (Section 9) or the risk of an overexertion injury (Section 10). Incorporate information on these controls into the site-specific HASP and ensure that the controls are implemented in the field.				✓				
23. Determine whether high altitude is a concern and the administrative controls and work practices to be employed (Section 11). Incorporate information on these controls into the site-specific HASP and ensure that the controls are implemented in the field.				✓				
24. Upon request, assist the Onsite Safety Officer in determining/implementing work practice, engineering, or administrative controls.		✓	✓					
25. Upon request, perform task-specific evaluations to assess the physical hazards.		✓						
26. Instruct emergency responders to review the Quick Reference Guide.		✓		✓		✓		
27. Ensure that employees have access to emergency medical services in a reasonable time frame.				✓				
28. If signs of physical stress are apparent, take corrective actions and/or provide first aid treatment until the employee can be provided with professional medical care.				✓	✓	✓	✓	
29. Provide technical support to emergency responders to ensure that the HASP addresses physical stress management issues.	✓	✓	✓					
30. Ensure that all physical stress-related components of the HASP are implemented in the field.	✓	✓	✓	✓				
Tasks Associated with Recordkeeping Activities (Section 12)								
31. Use employee training certificates or other forms (e.g., signed training logs) to document training.		✓	✓					
32. Retain training certification letters or other documentation to prove completion of a training requirement.		✓	✓		✓			
33. Ensure that the following records are submitted to the SHEMP Manager (or another designated person): (1) environmental records that document weather conditions, (2) noise exposure records, and (3) onsite medical monitoring records (must be retained in a confidential manner).				✓				

TASKS ▼ / ROLES ►	Who is Responsible for Each Task or Action?							
	Removal Manager	SHEMP Manager	Health and Safety Program Contact	Lead OSCs/ Onsite Safety Officers	Emergency Responders*	Supervisors	Medical Monitors	Others
Name of person in role ►	See Appendix A-2 in the Introduction chapter for the names of personnel that fill these roles.							
34. Retain copies of environmental monitoring, noise exposure records, and onsite medical monitoring records (must be retained in a confidential manner). Ensure that noise exposure measurement records are retained for at least 2 years.		✓	✓					
35. Record work-related altitude illness, noise injuries, heat stroke, heat exhaustion, hypothermia, frostbite, or other health effects associated with physical stresses on an *OSHA & EPA 301-Injury, Illness & Near Miss Report.*					✓	✓		
36. Forward completed *OSHA & EPA 301-Injury, Illness & Near Miss Reports* to the SHEMP Manager.						✓		
37. Determine if health effects on *OSHA & EPA 301-Injury, Illness & Near Miss Reports* are recordable under OSHA recordkeeping requirements and log recordable cases on the *OSHA 300 Log of Work-Related Injuries and Illnesses*.		✓						
38. Retain completed *Physical Stress Management Program Evaluation Forms*.		✓						
Tasks Associated with Program Evaluations and Field Audits (Section 13)								
39. Perform physical stress internal program evaluations on an annual basis. Complete the *Physical Stress Management Program Evaluation Form* (see the "Forms" section of the manual's website).	✓	✓	✓					
40. Correct deficiencies identified during internal evaluations. If necessary, request senior management assistance.	✓	✓	✓					
41. Upon request, provide physical stress management program information to Core ER Audit Team representatives for annual health and safety evaluations.	✓	✓	✓	✓				
42. Ensure that physical stress issues are addressed during field audits if relevant.		✓	✓					
Additional Tasks That Reflect Organization-Specific Practices (Appendix B)								
Attention users: Add rows if necessary.								

*Note: A list of the organization's emergency responders is provided in Appendix A-2 of the Introduction chapter.

APPENDIX B

Physical Stress Management Program: Documentation of Additional Policies and Procedures

The procedures and tasks outlined in the Physical Stress Management Program chapter represent the **minimum requirements** that each EPA organization must meet to minimize the hazards associated with physical stressors. If users advocate the use of additional policies and procedures, they must also:

- Add information about additional tasks in the rows that appear at the end of Appendix A and ensure that each task is assigned to a specific individual; and
- Ensure that the additional procedures are mentioned in the main text of the Physical Stress Management Program chapter. This can be accomplished by either (1) inserting the additional policies and procedures directly into the relevant portions of the main body of the chapter or (2) adding a sentence within the main text that directs readers to Appendix B for more information.

Topic	**Please document the additional elected policies and procedures required for Region 4 here.**
Section 3 Training	See R4 ERRB Standard Operating Guidelines at https://response.epa.gov/hsmanualregion4 1. SOG T103: Heat Stress Management and Rehabilitation Plan 2. SOG T105: Cold Stress Management and Rehabilitation Plan
Section 4 Medical Surveillance	
Section 5 Fatigue	
Section 6 Heat Stress	
Section 7 Cold Stress	
Section 8 Noise and Hearing Conservation	
Section 9 Vibration	
Section 10 Overexertion Injuries from Heavy Manual Labor	
Section 11 Altitude	
Section 12 Recordkeeping	
Section 13 Program Evaluations	
Other topics _____ _____ ____	

APPENDIX C

Glossary

GLOSSARY

Acclimatization
The physiological adaptations the body undergoes in response to new climatic or other environmental conditions such as altitude, temperature, and humidity.

Audiogram
A chart, graph, or table resulting from an audiometric test showing an individual's hearing threshold levels as a function of frequency.

Audiometer
The instrument used for measuring pure tone, air conduction hearing thresholds.

Audiometric tests
Tests conducted with audiometers that usually consist of air conduction, pure tone, and hearing threshold measurements at 500, 1000, 2000, 3000, 4000, and 6000 hertz (Hz). Right and left ears are individually tested.

Decibel (dB)
A convenient means for describing the logarithmic level of sound intensity, sound power, or sound pressure above arbitrarily chosen reference values. A decibel is the logarithm of a ratio (where the ratio of concern is the measured quantity over a reference quantity) and is defined as: dB = 10 log (A/B).

dBA
Sound pressure level in decibels measured with the A-weighting network on a sound level meter. The A-scale or frequency weighting discriminates (attenuates) against very low frequencies (as does the human ear) and is best for measuring general sound levels.

dBC
Sound pressure level in decibels measured with the C-weighting network on a sound level meter. The C-scale discriminates (attenuates) very little against low frequencies.

Dry bulb temperature
The temperature of air as registered by a thermal sensor (such as an ordinary mercury-in-glass thermometer) shielded from direct radiant energy sources.

Electrolytes and electrolyte balance
Electrolytes are chemicals (salts and minerals) in the blood that regulate bodily functions such as muscle contraction, nerve impulse conduction, acid-base balance of the blood, blood clotting, and normal heart rhythm. The body's major electrolytes are sodium, potassium, calcium, magnesium, chloride, bicarbonate, phosphate, and sulfate. Electrolyte balance refers to the equilibrium between the concentrations (normal range) of electrolytes that is necessary for normal health and functioning of the body. Electrolyte imbalance refers to electrolyte concentrations higher or lower than the normal ranges and is commonly caused by loss of body fluids through prolonged vomiting, diarrhea, sweating, or high fever.

Equivalent chill temperature or ECT (also called the windchill index)
To judge the cold hazard of an environment, the combined effect of both low air temperature and wind speed must be taken into consideration because the human body senses cold as a result of both air temperature and wind velocity. The ECT or the wind chill factor is the cooling effect of any combination of temperature and wind velocity or air movement on exposed human skin. This value can be obtained by

consulting an ECT chart (also called the wind chill index) relating the actual dry-bulb air temperature and the wind speed.

Frequency weighting networks (or scales)
Sound level meters (SLM) are normally equipped with three frequency weighting networks or scales, referred to as A, B, and C, because the human ear is not equally responsive to all sound frequencies. The responses of a SLM are modified with the frequency-weighting networks to respond to sound in a manner similar to the human ear response. The human ear is most sensitive in the range 2000 to 5000 Hertz and least sensitive at extremely high and low frequencies. This phenomenon is more pronounced at low sound pressure levels than at high sound pressure levels. The three weighting networks are electronic filters that attenuate sound level as a function of frequency and are the means by which the SLM responds more to some frequencies than to others. The very low frequencies are attenuated or filtered out severely by the A network, moderately by the B network, and minimally by the C network. The A-weighting approximates the ear's response for low-level sound (below 55 dB), is commonly used to measure noise to evaluate its effect on humans, and has been incorporated into many occupational noise standards. The B-weighting is intended to approximate the ear's response for sound pressure levels between 55 and 85 dB, and the C-weighting corresponds to the ear's response level above 85 dB.

Frostbite
Frostbite occurs when there is freezing of the fluids around the cells of body tissues. It usually occurs when temperatures are 28ºF or lower, but wind chill factors can allow frostbite to occur in above freezing temperatures. The most vulnerable parts of the body are the nose, cheeks, ears, fingers, and toes. Damage from frostbite can affect either the outer layers of skin only, or it can include tissue beneath these outer layers. Damage from frostbite can be serious; scarring, tissue death, and amputation are all possibilities, as is permanent loss of movement in the affected parts.

Hand-arm vibration
Hand-arm vibration occurs when segmental vibration is applied locally to the hands and arms from hand-held vibratory tools such as pneumatic impact and rotary tools, gasoline-powered chainsaws, and electronic tools such as grinders. It can affect one or both arms. The predominant health effect is known as hand-arm vibration syndrome—a condition that causes circulatory, sensory, motor, and musculoskeletal disturbances.

Heat strain
The overall physiological response from heat stress which dissipates excess heat from the body and includes an increase in body temperature, heart rate, and sweating. Heat strain is associated with a continuum of heat illness that includes mild illness (heat rash, heat cramps, and heat syncope), heat exhaustion, and heat stroke, the most severe heat disorder that is life-threatening. Heat strain and heat illness will worsen if not recognized and managed early (i.e., mild illness will progress to more serious heat-related disorders).

- ***Heat cramps:*** A mild form of heat injury that occurs after prolonged exposure to heat with profuse perspiration (e.g., due to strenuous activity) and inadequate electrolyte replacement (primarily sodium). The symptoms of heat cramps include spasm and pain in the muscles of the abdomen, arms, legs, hands, and feet.
- ***Heat syncope (fainting):*** Collapse and/or loss of consciousness without an increase in body temperature or cessation of sweating. It occurs during prolonged standing in a hot environment and results from blood pooling in dilated blood vessels in the skin and in the lower part of the body (i.e., inadequate venous blood return to the heart and brain). Heat syncope is treated by having the worker

lie or sit down and is prevented through acclimatization and intermittent activity (moving around) so blood flow to the brain is maintained.

- ***Heat exhaustion:*** A heat-related illness characterized by muscular weakness, distress, nausea, vomiting, dizziness, pale clammy skin, and fainting. It is usually associated with an inadequate water intake, lack of heat acclimatization and physical fitness, and compromised health status (e.g., predisposing medical conditions such as peripheral nerve injuries and chronic illnesses that weaken cardiac output or reduce circulating blood volume).
- ***Heat stroke:*** An acute medical emergency arising from exposure to heat, an excessive rise in body temperature, and failure of the temperature regulating mechanism. Body temperature may rise to 106ºF or higher within 10 to 15 minutes. Heat stroke can cause death or permanent disability if timely emergency treatment is not provided. The symptoms of heat stroke vary but may include an extremely high body temperature (above 103ºF); red, hot, and dry skin (no sweating); rapid, strong pulse; throbbing headache; dizziness; nausea; confusion; and unconsciousness.

Heat stress
The net heat load to which a worker may be exposed, based on a combination of factors including work load, environmental factors (e.g., air temperature and movement, humidity, radiant heat exchange), and clothing.

Hypothermia
A lowering of the core body temperature to 95ºF or below. Hypothermia occurs when body heat is lost faster than it can be replaced. It is most likely to occur at very cold temperatures; but can occur above 40ºF if a person becomes chilled from rain, high wind, perspiration, or submersion in cold water. The warning signs in adults include impaired coordination, cold and pale skin, shivering, exhaustion, confusion, fumbling hands, memory loss, slurred speech, and drowsiness. Below about 86ºF, most victims are unconscious. At 68 to 77ºF, death can result due to heart failure.

Noise dose
The amount of actual exposure relative to the amount of allowable exposure, and for which 100% and above represents exposures that are hazardous. The noise dose is calculated according to the following formulas:

- When the sound level, L, is constant over the entire work shift, the noise dose, D, in percent, is given by: $D = 100\ C/T$ where C is the total length of the work day, in hours, and T is the reference duration corresponding to the measured sound level, L, as given by Table G-16a in 29 CFR 1910.95, Appendix A.
- When the workshift noise exposure is composed of two or more periods of noise at different levels, the total noise dose over the work day is given by:

  $D = [C_1/T_1 + C_2/T_2 + ... + C_n/T_n] \times 100$, where C_n indicates the total time of exposure at a specific noise level, and T_n indicates the reference duration for that level as given by Table G-16a in 29 CFR 1910.95, Appendix A.

Noise dosimeter
An instrument (which functions as a "data-logger") that stores sound level measurements and integrates these measurements over time to provide an average noise exposure reading for a given period of time (e.g., an 8-hour workday). The results are presented as a noise dose and/or time-weighted average. A microphone is attached to a worker's clothing and the exposure measurements are read at the end of the

desired time period. Since the dosimeter is worn by a worker, it measures noise levels in all the locations where that specific worker spent time during the period monitored.

Noise reduction rating (NRR)
The noise reduction rating is a single-number attenuation index that represents the overall average noise reduction, in decibels, that a hearing protection device will provide in an environment with a known C-weighted sound level. It is pre-calculated by manufacturers and required by law to be shown on the label of each hearing protector sold in the United States.

Orthostatic vital signs
Orthostatic (tilt or postural) vital signs are serial measurements of blood pressure and pulse that are taken with the patient in the supine, sitting, and standing positions. The results are used to assess possible blood volume depletion and the need for fluid replacement, more extensive testing, or treatment. A sustained drop of 20 mm Hg in systolic blood pressure or a sustained rise of 20 beats per minute in pulse with sitting or standing is a positive test for orthostasis and indicates dehydration or mild shock.

Permissible exposure limit
Permissible exposure limits or PELs are occupational exposure limits for chemical and physical agents established by the Occupational Safety and Health Administration (OSHA). OSHA PELs have the force of law.

Recommended exposure limit
Recommended exposure limits or RELs are occupational exposure limits for chemical and physical agents established by the National Institute for Occupational Safety and Health (NIOSH). RELs are recommended exposure limits and do not have the force of law (unless enacted into law by OSHA or a state with an OSHA-approved job safety and health program).

Sound level meter
A direct-reading electronic instrument that measures sound pressure level. Sound level meters can typically measure overall sound levels (weighted or flat), sound levels in discreet frequency bands, and maximum, minimum, peak, equivalent, and instantaneous sound levels for specific periods of time. These measurements can be used to screen various noise sources to determine which make the most significant contribution to worker exposure. This method is most accurate when the noise levels are relatively constant and workers stay at a constant distance from the noise source.

Standard threshold shift
A change in hearing threshold relative to the baseline audiogram of an average of 10 dB or more at 2000, 3000, and 4000 Hertz (Hz) in either ear.

Threshold limit value
Threshold limit values or TLVs are occupational exposure limits for chemical substances and physical agents established by the American Conference of Governmental Industrial Hygienists (ACGIH). TLVs are guidelines to be used by professionals trained in the practice of industrial hygiene and do not have the force of law (unless enacted into law by OSHA or a state with an OSHA-approved and monitored job safety and health program).

Time-weighted average (TWA)
TWA refers to an exposure which has been weighted for a certain time duration. An 8-hour TWA represents the average exposure measured over an 8-hour workday.

Tinnitus
A condition characterized by a sensation of ringing, buzzing, roaring, or other sound in the ears. Tinnitus often occurs in conjunction with hearing loss.

Trench foot
Trench foot or immersion foot is caused by long, continuous exposure to cold without freezing, combined with persistent dampness or actual immersion in water. Symptoms consist of swelling, tingling, itching, burning, and pain. Blistering and ulceration may also occur.

Wet bulb, globe temperature (WBGT)
A composite temperature used to estimate the effect of heat stress. It is influenced by air temperature, humidity, air movement, and radiant heat. WBGT values are calculated using one of the following equations:

With direct exposure to sunlight: $WBGT_{out} = 0.7T_{nwb} + 0.2T_g + 0.1T_{db}$

Without direct exposure to the sun: $WBGT_{in} = 0.7T_{nwb} + 0.3T_g$
where:

T_{nwb} = natural wet bulb temperature (humidity indicator)
The natural wet-bulb temperature is determined with a wet-bulb thermometer (a mercury-in-glass thermometer with the bulb covered with a cloth saturated with water that is exposed to natural air movement and unshielded from radiation) or a standard sling psychrometer or its equivalent. This temperature is influenced by the evaporation rate of water and depends on the amount of water vapor in the air (humidity).

T_g = globe temperature (radiant heat indicator)
The globe temperature is determined with a globe thermometer (a thin-wall, blackened copper sphere with a temperature-sensing device at its center) and is a measure of radiant heat.

T_{db} = dry bulb temperature (normal air temperature)
Dry bulb temperature is temperature determined with an ordinary mercury-in-glass thermometer shielded from direct radiant energy sources.

The WBGT is an index of the environmental contribution to heat stress and is adjusted for the contributions of work demands (light, moderate, heavy, and very heavy work rates) and clothing. The higher the WBGT value the lower the allocation of work (percent work) in the work/rest regimen.

Whole-body vibration
Vibration transmitted to the entire human body through some supporting structure such as a vehicle seat, platform, or building floor. Whole-body vibration can create lower back pain.

Wind chill
See equivalent chill temperature.

APPENDIX D

Instructions for Site-Specific HASP Development: Physical Stress Management

Emergency responders can use information from the customized version of their Physical Stress Management Program chapter to develop site-specific health and safety plans (HASPs). For example, emergency responders can do the following when developing their HASP:

- **Insert customized versions of the following sections (depending on which physical stressors are a concern at a particular site) into the HASP:**

Appendix A	Physical Stress Management Program: Designation of Roles and Responsibilities
Appendix B	Physical Stress Management Program: Documentation of Additional Policies and Procedures
Section 3	Physical Stress Training
Section 4	Medical Surveillance
Appendix E	Tools for the Onsite Medical Monitor
Section 5	Fatigue
Section 6	Heat Stress
Section 7	Cold Stress
Appendix F	Heat Illnesses—Potential Outcomes, Symptoms, and First Aid/Corrective Actions
Appendix G	ACGIH's Heat Stress TLVs
Section 8	Noise and Hearing Conservation
Appendix H	Cold Injury and Illness—Potential Outcomes, Symptoms, and First Aid/Corrective Actions
Appendix I	Recognizing and Mitigating Cold Stress/Cold Hazards
Appendix J	Protective Clothing for Cold Environments
Section 9	Vibration
Section 10	Overexertion Injuries from Heavy Manual Labor
Section 11	Altitude
Section 12	Recordkeeping

Note: These sections might contain more background information than is necessary for a HASP. Thus, emergency responders are encouraged to streamline and edit these sections to meet their needs.

- **Insert additional site-specific information into the HASP**. For example, if emergency responders develop their own program-implementation forms as opposed to using the sample forms included in this chapter, these documents will need to be incorporated into the HASP. Additionally, the HASP needs to include any site-specific procedures that are required to comply with state or local regulations.

APPENDIX E

Tools for the Onsite Medical Monitor

E-1 **Monitoring Vital Signs or Conditions and Identifying When Corrective Action Is Needed**
E-2 **Onsite Medical Monitoring Tracking Form (Sample)**

APPENDIX E-1

Monitoring Vital Signs or Conditions and Identifying When Corrective Action is Needed[a]

Vital Sign or Condition	Scenarios Where Monitoring Is Warranted	Evaluation Procedures	Decision Criteria/Course of Action
Heart rate (pulse)	Conditions for potential heat stress (regardless of what type of PPE is worn)	*Entry heart rate:* Measure the entry heart rate (radial pulse) before donning PPE. Calculate the worker's maximum heart rate (MHR), where **MHR = 220 - Age**. Then calculate 70% of the MHR. Example: 70% MHR for a 35 year old would be = (220-35) x 0.70 = 130 *(Note: For convenience, the Medical Monitoring Tracking Form (see Part II of Appendix E) lists the average 70% MHR for several age ranges.)*	*Entry heart rate:* If entry heart rate exceeds 70% MHR, the worker must not be allowed to conduct on-scene activities that contribute to physical stress. Or, if the entry heart rate exceeds 110 beats per minute (bpm), shorten the next work period by one third and maintain the same rest period. Adjust work/rest cycles as needed to achieve appropriate vital signs.
		Exit heart rate: Determine the exit heart rate (and measure other vital signs) at the beginning of each rest period and then every 5 or 10 minutes until the heart rate returns to within 10% of entry level.	*Exit heart rate:* If an exit heart rate does not return to within 10 % of the pre-entry level within 10 minutes of stopping activities (and removing PPE), then the worker must receive additional medical evaluation (e.g., orthostatic vital signs). Contact the medical advisor for further guidance. Notify the Onsite Safety Officer of status.
Oral temperature	Conditions for potential heat stress (regardless of what type of PPE is worn)	*Entry temperature:* Measure oral temperature with a clinical thermometer at the beginning and the end of the work. Be aware of the thermometer response time and encourage the worker to avoid talking or opening his or her mouth during the test period. Avoid taking the reading shortly after the worker has consumed fluids. *(Note that recent fluid intake can cause false readings.)*	*Entry temperature:* If the entry oral temperature exceeds 99.5 °F, the worker must not be allowed to conduct on-scene activities that contribute to physical stress.
		Exit temperature: Determine the exit temperature (and measure other vital signs) at the beginning of each rest period.	*Exit temperature:* If exit oral temperature exceeds 99.7°F, shorten the next work cycle by one third and monitor carefully. If the exit oral temperature exceeds 101°F, the worker must receive additional medical evaluation. Contact the medical advisor for further guidance. Notify the Onsite Safety Officer of status.

Vital Sign or Condition	Scenarios Where Monitoring Is Warranted	Evaluation Procedures	Decision Criteria/Course of Action
Respiration rate (breaths/minute)	Level A entry (before and after donning PPE) or other conditions for potential heat stress (regardless of what type of PPE is worn)	*Entry respirations:* Measure the entry respirations before donning PPE. Count breaths for one minute.	*Entry respirations:* If respirations exceed 24 breaths per minute, exclude worker from entry and check other vital signs (heart rate, blood pressure, temperature).
		Exit respirations: Determine the exit respirations at the beginning of each rest period and then every 5 or 10 minutes until the entry rate is re-established.	*Exit respirations:* If an exit respiration rate does not return to within 10% of the pre-entry level within 10 minutes of stopping activities (and removing PPE), the worker must receive more medical evaluation (e.g., orthostatic vital signs). Contact the medical advisor for further guidance. Notify the Onsite Safety Officer of status.
Estimation of fluid loss (weight)	Level A or B entry or other conditions raise concern about the workers' ability to drink adequate hydrating fluids	Weigh the worker at the beginning and end of each work day and before and after each Level A or B entry. To the extent possible, ensure that conditions are similar during the entry and exit measurements.	Weight loss should not exceed 1.5% of total body weight in a work day. If weight loss exceeds this amount, fluid intake should increase (1 cup every 20 minutes). *Immediate steps:* If loss of 3% or less occurs, drink fluid to replenish/maintain hydration. Adjust standard work/rest guidelines, if necessary. If loss is greater than 3%, contact the medical advisor for further guidance. Notify the Onsite Safety Officer of status.
Blood pressure	Level A entry (before and after donning PPE) or other conditions raise concern about the workers' ability to drink adequate hydrating fluids	*Entry blood pressure:* Blood pressure must be taken prior to entry. Record readings in units of millimeters of mercury (mm Hg), with the higher systolic value over the lower diastolic value (e.g., 120/80 mm Hg).	*Entry blood pressure:* If entry diastolic blood pressure (lower number) is above 105 mm-Hg, he or she must be prohibited from donning Level A or B PPE, informed that they are at increased risk of complications associated with hypertension (i.e., heart attack or stroke), and encouraged to seek follow-up consultation with a doctor.
		Exit blood pressure: Determine the exit blood pressure at the beginning of each rest period and then every 5 or 10 minutes until 10% of the entry rate is re-established.	*Exit blood pressure:* If exit diastolic pressure (lower number) is not within 10 percent of the entry level within 10 minutes, continue taking vital signs every 5 to 10 minutes and consider obtaining orthostatic vital signs. Contact the medical advisor for further guidance. Notify the Onsite Safety Officer of status.

Vital Sign or Condition	Scenarios Where Monitoring Is Warranted	Evaluation Procedures	Decision Criteria/Course of Action
General health (history)	Conditions for heat stress (regardless of what type of PPE is worn)	Talk to the responder and pay attention to both the worker's responses and physical appearance. Ask "How do you feel?" prior to entry; also ask whether the worker has experienced a condition that could affect heat tolerance. Examples of such conditions include: *In past 2 weeks:* a change in prescription medications; *In past 72 hours:* illness (nausea, vomiting, diarrhea, fever, respiratory infection, use of over-the-counter medications (e.g., cold or allergy medications), or heavy alcohol consumption (all of which can cause dehydration); *or* pregnancy; *or* any alcohol consumption within the past 6 hours. For level A or B entry (or other conditions that raise concern about the worker's ability to drink adequate fluids), maintain visual contact with the responder or use the buddy system, particularly in situations where it is difficult to communicate (e.g., when using full-facepiece respirators).	*General health upon entry:* Workers must be excluded from entry if their responses indicate current dizziness, headache, chest pains, poor health, large open sores, or that the person has experienced a condition that could affect heat tolerance (the specific condition need not be indicated). Further medical examination is appropriate. *General health during level A or B entry:* A worker who complains of dizziness, headache, chest pains, nausea, weakness, or shortness of breath, or shows changes in speech or behavior, must immediately have their PPE removed, be decontaminated (if necessary), and be evaluated. *General health upon exit:* Contact the medical advisor if the individual is not alert and oriented, is dizzy, shows signs of slurred speech or weakness, or is not feeling well. The medical advisor will determine the appropriate treatment or action. The Onsite Safety Officer must be notified of the worker's condition.
Recently experienced heat illness	Conditions for heat stress (regardless of what type of PPE is worn)	Determine whether the responder has experienced heat illness in the past 72 hours.	An individual who has experienced heat illness in the past 72 hours must be excluded from additional conditions of heat stress.
Orthostatic (postural) vital signs	This specialty test is performed when exit heart rate and/or blood pressure do not return to within 10% of entry levels within 10 minutes or if fluid loss is greater than 3%	Contact the medical advisor for further guidance when these conditions occur. Orthostatic testing (postural vital signs) can help medical personnel differentiate between certain causes of elevated heart rate and blood pressure. Specifically, a dehydrated person may not have adequate blood volume in the circulatory system to maintain a steady blood pressure with changes in position (supine, sitting, and standing). Obtain orthostatic vital signs by first having the individual lie down for several minutes. Then test the person's heart rate and blood pressure while he or she is lying down and again within 2 minutes of sitting or standing up. Provide support and encourage the person to lie down again if he or she becomes dizzy during the test.	Follow-up medical attention should be considered (1) if the blood pressure remains elevated or (2) if the following occurs 2 minutes after the person sits or stands up: • the pulse increases 20 beats/minute or more, or • systolic pressure (upper number) decreases by 20 mmHg (compare to the systolic pressure lying down). Increased heart rate and/or decreased systolic blood pressure suggest circulatory fluid levels are not adequate to maintain blood pressure in the standing position (due to the effect of gravity) and the heart may beat faster to compensate. The medical advisor will determine the appropriate treatment or action. The Onsite Safety Officer must be notified of the worker's condition.

[a] When onsite medical monitoring is necessary, the Onsite Safety Officer must establish vital signs checkpoints for employees to pass through before entering the work (hot) zone, after leaving the decontamination (decon) line, and before leaving the work site at the end of the day. Exit checkpoints must be equipped with sufficient hydration supplies (water and sports drinks).

Sources: NFPA 471 (National Fire Protection Association, 2002, *Recommended Practice for Responding to Hazardous Materials Incidents)*, and OSHA TM (OSHA Technical Manual, Section III, Chapter 4.V.E. (TED 01-00-015).

APPENDIX E-2

Onsite Medical Monitoring Tracking Form (Sample)

RESPONDER FIELD MEDICAL STATUS			
Incident Location: **Date:** _____	**Hazard: CHEM, BIO, RAD**	**PPE Used:**	**Vital signs within 10% of entry level?**
RESPONDER NAME:		**Age:**	
Monitored Signs and Conditions:	**ENTRY** Perform tests within one hour before donning PPE; exclude individual from entry if indicated levels are exceeded.	**EXIT** After removing PPE; repeat tests every 5 to 10 minutes. Perform other tests or treatment if not within 10% of baseline (entry levels) after 10 minutes, or if criteria are exceeded.*	
Monitored By: (Initials)			✓
BLOOD PRESSURE (systolic/diastolic mm-Hg)	**BP =_____/_____** (Not to exceed 105 diastolic) **Time _____**	**BP =___/___ Time _____** **BP =___/____ Time _____**	
RESPIRATION RATE (breaths/minute)	**Respiration rate =_____** (Not to exceed 24/minute**)** **Time_____**	**Resp =_____Time_____** **Resp =_____Time_____**	
HEART RATE (beats/minute) Calculate 70% max =_____ (see next page) 70% maximum=(220-age) x 0.70	**HR =_____Time _____** (Not to exceed 70% of maximum heart rate. Additionally, if HR exceeds 110 beats/minute, shorten the work period.)	**HR = _____** **Time_____** **HR = _____** **Time_____**	
TEMPERATURE (□F, oral)	**Temp= _____ Time_____** 97.0□F minimum 99.5□F maximum at entry	**Temp=_____** **Time_____** **Temp=_____** **Time_____** If over 99.7□F, shorten next work cycle by one-third. If over 101□F, further medical evaluation is required.	
GENERAL HEALTH (history, "how do you feel?")			
WEIGHT (calculate fluid loss - see next page)	**Pounds = _____**	**Pounds = ____** >3% change?__ Loss of 3% or more requires further medical evaluation.	
***OTHER:_____** (orthostatic (postural) vital signs, etc.)	**Notes:**	**Notes:**	
SCBA USE	**On air time_____** **psi _____**	**Off air time_____** **psi_____**	

HEART RATE (beats/minute)

Quick Look-up		
Age	**70% MHR**	**85%**
20-25	140	170
25-30	136	165
30-35	132	160
35-40	128	155
40-45	125	152
45-50	122	148

Calculate Responder MHR

(220 - _____) x 0.70 = _____ beats/minute
[age]

ESTIMATE FLUID LOSS

Quick Look-up	
Worker weight	**Fluid loss 3%**
100 lb	3 lb
130 lb	4 lb
170 lb	5 lb
200 lb	6 lb
230 lb	7 lb
270 lb	8 lb

A. ***Calculate responder fluid loss:***

(entry weight) - (exit weight) = loss

_____ - _____ = _____ lbs
[entry weight] [exit weight] [fluid loss]

A

B. ***Calculate 3% of responder's weight:***

(weight) x (3/100) = 3% of total weight

_____ x 0.03 = _____ lbs
[entry weight] **B**

Is responder fluid loss (A) greater than calculated 3% of entry weight (B)?

ADDITIONAL NOTES AND RECORDS:

APPENDIX F

Heat Illnesses—Potential Outcomes, Symptoms, and First Aid/Corrective Actions

Information about Heat Illnesses[a]

Heat Illness	Symptoms	First Aid/Corrective Actions
HEAT FATIGUE is a feeling of weakness brought on by high outdoor temperature. A factor that predisposes an individual to heat fatigue is lack of acclimatization.	• Impaired performance of skilled sensorimotor, mental, or vigilance jobs. • Cool, moist skin. • Weakened pulse. • May feel faint.	Move to a cool area before a more serious heat-related condition develops. Acclimatization and training for work in hot environments is advisable.
HEAT RASHES are the most common problem in hot work environments and are regarded as the least serious of heat illnesses. Prickly heat is the most common form of heat rash. It manifests itself as red papules and appears in areas where the skin is persistently wetted by unevaporated sweat (and is often complicated by wearing PPE). The papules give rise to a prickling sensation as sweating increases. If left untreated, heat rash papules may become infected.	Rash/irritated skin.	Mild drying lotions are usually prescribed to treat heat rash. In addition, the skin must be kept clean in order to prevent infection. May require some time away from tasks requiring the use of PPE.
HEAT SYNCOPE (also known as heat collapse) is characterized by fainting while standing in the heat. The condition is similar to heat exhaustion, except that heat syncope does not affect the body's heat balance. Fainting occurs because blood pools in the extremities and prevents enough oxygen from reaching the brain. The onset of heat collapse is rapid and unpredictable. Preventative measures include acclimatizing workers to hot environments and avoiding static standing positions in the heat.	Fainting.	Treatment for heat syncope includes: • Moving the employee to a cooler area. • Allowing the employee to rest while lying down. • Having employees avoid tasks where they are immobile. Recovery is usually prompt and complete. Employees who experience heat syncope should be evaluated by an occupational medicine physician and be medically cleared before returning to work in an environment with potential heat stress conditions. Employees who are medically cleared to return to work should be acclimatized.

Heat Illness	Symptoms	First Aid/Corrective Actions
HEAT CRAMPS involve painful muscle spasms, typically in the abdomen, arms, or legs. Although less severe than heat stroke or heat exhaustion, heat cramps are often the first signal that a person is having trouble with the heat. The cramps are most often caused by an electrolyte imbalance that results from perspiration without adequate water and electrolyte replenishment.	Painful muscle spasms in the abdomen, arms, or legs.	Treatment includes replacing the loss of fluids and electrolytes from the body. • Give the employee an electrolyte replacement drink (sports drink). Call for immediate medical assistance. • Refusing water, vomiting, and changes in consciousness mean the victim's condition is getting worse. • If vomiting occurs, stop giving fluids and position the victim on his/her side. • Watch for breathing problems. • Keep the victim lying down and continue to cool the body. Place ice packs or cold packs (if available) on each of the victim's wrists and ankles, on the groin, under each armpit, and at the back of the neck. • DO NOT apply rubbing alcohol (isopropyl alcohol). • Exert firm pressure with hands on the cramped muscles or gently massage to help relieve pain.
HEAT EXHAUSTION occurs with excessive water and electrolyte loss, which happens when there is inadequate intake of water and electrolyte replacement to compensate for loss of fluid through perspiration. While this condition responds favorably to prompt treatment, it can progress to heat stroke if left untreated. Heat exhaustion can be accompanied by fainting, which can result in injury or pose a hazard if the victim is operating machinery or involved in an operation that should not be left unattended.	• Headache. • Nausea. • Dizziness, vertigo, and possible fainting. • Tiredness and weakness. • Thirst. • Giddiness. • Profuse perspiration. • Pale or flushed, cool, moist, clammy skin. *Note: Heat exhaustion is distinguished from heat stroke by the presence of normal mental status and by a lower body temperature (below 104°F [40°C].*	This condition requires medical attention. Rapid and preemptive response is necessary to effectively treat employees exhibiting symptoms of heat exhaustion and prevent progression to heat stroke. Immediate steps include: • Moving the employee to a cooler environment. • Laying the employee down and elevating the feet. • Giving the employee sips of water or an electrolyte replacement drink. • Allowing the employee to rest until urine volume/color indicates that the body's water balance has been restored.

Heat Illness	Symptoms	First Aid/Corrective Actions
HEAT STROKE is the most serious heat illness. It occurs when the body's temperature regulation system fails and internal temperature rises to critical levels. Heat stroke is a life-threatening situation that requires immediate emergency medical care and hospitalization. Heat stroke can lead to renal failure, brain damage, or death. The likelihood of heat stroke increases when air temperatures are higher than skin temperature, and when individuals are low on fluids, sleep deprived, un-acclimatized to the hot environment, or using certain medications, such as antihistamines, phenothiazine, and cyclic antidepressants. Other risk factors that can increase the likelihood of heat stroke include use of PPE, obesity, febrile illness, skin disorders that affect sweating, alcohol abuse, and a history of previous heat-related illness.	• Altered mental status (e.g., confusion, irritability, irrational behavior, loss of consciousness, or the inability to think coherently) *Note: Altered mental status (caused by heat injury to the brain) distinguishes heat stroke from all other forms of heat-related illness.* • Convulsions/seizures. • Dry, pale skin with no sweating (although sweating does not rule out heat stroke) or hot, red skin that appears sunburned. • Internal body temperatures equal to or exceeding 105.8°F (41°C). • Rapid, weak pulse. • Rapid, shallow breathing.	**CALL FOR AN AMBULANCE**. Heat stroke is a medical emergency that requires immediate emergency medical services. Immediate first aid measures may include: • Rapid cooling by immersion in chilled water with massage or wrapping in wet sheets and vigorous fanning with cool dry air. (Avoid overcooling.) • Treatment for shock if present. .

[a] Most of the information presented in this table was excerpted directly from SHEM Guideline 33 (December 2004).

APPENDIX G

ACGIH's Heat Stress TLVs

ACGIH's Heat Stress TLVs

Background

The heat stress Threshold Limit Values (TLVs) (Table G-1 below) were developed by the American Conference of Governmental Industrial Hygienists (ACGIH) and are expressed as wet bulb globe temperatures (WBGTs) in degrees Celsius (°C). The WBGT is a useful first-order index of the environmental contribution to heat stress and must be adjusted for the contributions of work demands and clothing. The TLVs represent workplace conditions under which it is believed that nearly all adequately hydrated, unmedicated, healthy workers (excluding those wearing clothing ensembles that limit heat loss) may be repeatedly exposed without developing adverse health effects or exceeding a core temperature of 100.4°F (38°C).

WBGT measurements collected in the field are compared to the WBGT screening values listed in Table G-1 to determine whether heat stress conditions pose concern at a particular site. The table accounts for varying levels of work demands (e.g., light to very heavy work, see Table G-2 for details) and heat stress levels considered safe for acclimatized workers (who are accustomed to working in heat) and un-acclimatized workers. Correction factors must be applied to the field WBGT measurement to account for different clothing ensembles (see Table G-3 for details). **However, the TLV screening criteria must never be used to guide decisions regarding whether conditions are safe for workers wearing (1) completely encapsulating suits (Level A PPE) or (2) multiple layers or other clothing types where no data are available for heat loss adjustments.** In these situations, assume that individuals wearing this type of clothing are at risk of developing heat-related illness (even when ambient conditions are considered cool) and implement onsite medical monitoring for these workers.

Using the TLV Screening Table (*Note: See page H-5 for an example*)

Step #1: Select the work-rate category from Table G-2.

Step #2: Determine the clothing adjustment factor for the clothing ensemble employees are wearing from Table G-3. (If no value is available in the table for the type of clothing, or encapsulating suits or multiple layers are worn, the TLV screening criteria cannot be used and onsite medical monitoring is required in conjunction with an effective heat stress management program.)

Step #3: Obtain a field WBGT measurement with a portable heat stress monitor (see footnote 3 in Section 6) and adjust the reading for the clothing employees are wearing by adding the clothing adjustment factor to the WBGT reading.

Step #4: Compare the clothing adjusted WBGT measurement to the WBGT value listed in Table G-1 for the work-rest regime that applies to the workers. If the measured WBGT adjusted for clothing is less than the Action Limit, there is little risk of excessive exposure to heat stress. If the value is above the Action Limit, but below the TLV, a heat stress management program must be in place (i.e., heat stress monitoring, appropriate work practices and hydration, medical surveillance, and training for workers and supervisors).

In contrast, if the adjusted field measurement is higher than the TLV in Table G-1, additional measures are required to ensure the safety of workers such as a more detailed analysis of the work task and exposure (consult the ACGIH Documentation of the Threshold Limit Values for Heat Stress and Strain), onsite medical monitoring to assess the degree of heat strain, and job-specific administrative/engineering controls.

Note: Table G-1 is a screening tool. As noted by the ACGIH, it is possible that a condition may be above the TLV or Action Limit criteria provided in Table G-1 and still not represent an exposure above the TLV or the Action Limit. To make this determination, a detailed analysis is required. Methods are fully described in ACGIH's Documentation of the TLV for Heat Stress and Strain, in industrial hygiene and safety books, and in other sources. Further, any time workers report symptoms of heat-related disorders such as fatigue, nausea, dizziness, and lightheadedness, a re-analysis of exposure conditions and controls should be conducted.

Table G-1
Screening Criteria for Heat Stress (WBGT Values in °C)

Work Allocation in an Hourly Cycle of Work and Recovery	TLVs for Acclimatized Workers				Action Limits for Un-acclimatized Workers			
	Light	Moderate	Heavy	Very Heavy	Light	Moderate	Heavy	Very Heavy
75% to 100%	31.0	28.0	--	--	28.0	25.0	--	--
50% to 75%	31.0	29.0	27.5	--	28.5	26.0	24.0	--
25% to 50%	32.0	30.0	29.0	28.0	29.5	27.0	25.5	24.5
0% to 25%	32.5	31.5	30.5	30.0	30.0	29.0	28.0	27.0

Notes to Table G-1:

- Adapted from the 2007 TLVs® and BEIs® Based on the Documentation of the Threshold Limit Values for Chemical Substances and Physical Agents & Biological Exposure Indices. American Conference of Governmental Industrial Hygienists, Cincinnati, OH.
- WBGT values are expressed to the nearest 0.5°C.
- If work and rest environments (locations) are different, hourly time-weighted average (TWA) WBGT values should be calculated and used.
- If work demands vary within the hour, hourly time-weighted averages (TWAs) for work rates (Table G-1) should be calculated and used. Note that the metabolic rate for rest is already factored into the screening limits.
- Screening values assume a work-rest regimen of a 5-day workweek and an 8-hour workday with short morning and afternoon breaks (approximately 15 minutes each) and a longer lunch break (30 to 60 minutes). When workdays are extended, consult the ACGIH Documentation of the Threshold Limit Values for Heat Stress and Strain.
- Because of the physiological strain associated with heavy and very heavy work among less fit workers, screening values are not provided for continuous (heavy and very heavy) work, and for up to 25% rest in an hour for very heavy work. As a result, this table must <u>not</u> be used as a screening guide for workers who perform heavy work for more than 45 minutes per hour or very heavy work for more than 30 minutes per hour. Onsite medical monitoring is a better option under such circumstances.

Table G-2
Work Rate Categories

Category	Representative Metabolic Work Rate (Watts)	Example Activities
Rest	115	Sitting.
Light	180	Sitting with light manual work with hands or hands and arms, and driving.
		Standing with some light arm work and occasional walking.
Moderate	300	Sustained moderate hand and arm work, arm and leg work, or arm and trunk work.
		Light pushing and pulling.
		Normal walking.
Heavy	415	Intense arm and trunk work, carrying, shoveling, manual sawing.
		Pushing and pulling heavy loads.
		Walking at a fast pace.
Very Heavy	520	Very intense activity at fast to maximum pace.

Notes to Table H-2:

- Adapted from the 2007 TLVs® and BEIs® Based on the Documentation of the Threshold Limit Values for Chemical Substances and Physical Agents & Biological Exposure Indices. American Conference of Governmental Industrial Hygienists, Cincinnati, Ohio.
- The effect of body weight on the estimated metabolic rate is determined by multiplying the estimated rate by the ratio of actual body weight divided by 154 lbs (70 kg).

Table G-3
Clothing Adjustment Factors for Some Clothing Ensembles

Clothing Type	Addition to WBGT (°C)
Work clothes (long sleeve shirt and pants)	0
Cloth coveralls (woven material)	0
Polyolefin coveralls	1
SMS (spun bonded-melt blown-spun bonded) polypropylene coveralls	1.5
Double-layer woven clothing	3
Limited-use vapor-barrier coveralls	11

Notes to Table H-3:

- Adapted from the 2007 TLVs® and BEIs® Based on the Documentation of the Threshold Limit Values for Chemical Substances and Physical Agents & Biological Exposure Indices. American Conference of Governmental Industrial Hygienists, Cincinnati, Ohio.
- The clothing adjustment factors must NOT be used for completely encapsulating suits (Level A PPE) and cannot be added for multiple layers. The use of coveralls assumes that only modesty clothing (underwear) is worn underneath, not a second layer of clothing.
- When clothing adjustment values are not available from Table G-1 or the published literature for the clothing ensemble workers are wearing, onsite medical monitoring is necessary.

EXAMPLE: Using the TLV Screening Table

The Onsite Safety Officer uses a direct reading WBGT meter and obtains a WBGT reading of 23°C. The work plan calls for a worker to perform moderately demanding physical work (walking about with light pushing or lifting) while wearing long-sleeve double layer (woven) coveralls. The worker arrives earlier in the week from a cooler climate, and is not acclimatized.

- Add 3.0 to the WBGT reading to adjust for the heavier clothing ensemble. The clothing adjusted WBGT reading is 23°C + 3.0°C = 26.0°C.
- Consult Table G-1 for un-acclimatized workers with a "moderate" work demand. The table includes a WBGT Action Limit of 26.0°C for a maximum work/rest regime of 75 percent work and 25 percent rest every hour (i.e., 45 minutes work and 15 minutes rest in a cool location). If the employee works no longer than 45 minutes of each hour and no harder than the "moderate" physical work load, adverse health effects due to heat stress are unlikely in a healthy hydrated worker. In this example, onsite medical monitoring is probably not necessary unless other factors, such as worker's health status, indicate otherwise.

Later in the day, the same employee switches to light work (standing, taking notes, with some walking about). The WBGT reading remains at 23°C.

- The adjusted WBGT reading is still 26.0°C because the employee's clothing ensemble has not changed.
- The WBGT Action Limits in Table G-1 for an un-acclimatized worker performing light work range from 28.0°C to 30.0°C.
- The measured WBGT reading adjusted for clothing is less than the Action Limits for light work. This finding suggests there is little risk of excessive exposure to heat stress.
- With the lighter physical exertion, the WBGT Action Limits indicate the employee can work for the full hour (and for several hours in a row) with no rest period (100 percent work), as long as the employee does not report heat-related symptoms and stays well hydrated.

APPENDIX H

Cold Injury and Illness—Potential Outcomes, Symptoms, and First Aid/Corrective Actions

Information about Cold Injury and Illness[a]

Cold Stress/Injury	Symptoms	First Aid/Corrective Action
TRENCH FOOT is a nonfreezing cold injury and is observed in people whose feet have been wet, but not freezing, for prolonged periods. It is usually associated with restricted circulation (constriction by shoes and clothing).	Symptoms include difficulty walking, numbness, swelling, itching, and tingling/burning pain. Skin color changes from red to pale and mottled, then gray to blue. Blistering, skin sores, and infection may occur.	• Prevent further exposure. • Remove wet, constrictive clothing. • Air-dry feet, no immersion in water. • Re-warm passively at room temperature. • No massaging or rubbing (may worsen the injury). • Elevate, wrap in dry, loose dressing. • Do not walk on injured feet. • Obtain medical evaluation and treatment.
FROSTBITE occurs when the skin freezes and loses water. Frostbite typically affects the extremities, particularly the feet, hands, nose, cheeks, and ears. Frostbite damage can result in scarring, tissue death, and loss of movement in the affected parts. In severe cases, amputation of the frostbitten area may be required. Frostbite usually occurs when temperatures are 28°F or lower, but wind chill factors can allow frostbite to occur in above freezing temperatures.	• The symptoms of frostbite include coldness, numbness, tingling, stinging, pain, blisters, and skin color changes to white or grayish-yellow, then to reddish-violet, and finally to black as the tissue dies. • When frostbite of the outer layer of skin occurs, the skin has a waxy or whitish look and is firm to the touch (the tissue underneath is still resilient). • In cases of deep frostbite, the tissues are cold, pale, and solid. Injury is severe.	Frostbite victims must receive medical attention as soon as possible. In the interim, victims must be brought into a warm area and given a warm non-alcoholic drink. Do NOT leave the victim alone. Do NOT rub the affected area in an effort to warm the frostbitten areas. As an alternative, wrap the area in a soft cloth. If help is delayed, rewarm the affected area by immersing it in warm (NOT hot) water that is slightly above body temperature (no hotter than 105°F [39°C]). Do NOT pour water on the affected part. Also, do not go through the process of rewarming an area if there is a possibility that it will get cold again. Warming and recooling will cause severe/permanent tissue damage.

Cold Stress/Injury	Symptoms	First Aid/Corrective Action
HYPOTHERMIA is a potentially life-threatening health condition that arises when body heat is lost faster than it can be replaced. Initial symptoms usually appear when the body temperature drops to around 95°F (36°C). Severe hypothermia develops when the body's temperature drops to around 82°F (28.0°C). Death is likely if the body's temperature drops below 78°F (25.5°C). The risk factors for hypothermia are: • Exhaustion; • Immobilization; • Injury or entrapment; • Use of alcohol or other substances that impair judgment; • Inadequate protective clothing; and • Drugs that impair thermoregulatory response.	• Symptoms include uncontrollable shivering (although the shivering response might be diminished in older adults), stomping of feet to generate heat, numbness, glassy stare, a puffy or swollen face, apathy, loss of coordination (e.g., fumbling items in one's hand), slurred speech, lethargy, confusion, a loss of logical thinking, and loss of consciousness. Also, the skin will likely be pale and cold and it might have large irregular blue or pink spots. • As body temperature falls, the above symptoms worsen and shivering may stop and workers may be unable to walk or stand. • If hypothermia progresses, significant drops in blood pressure, pulse rate, and respiration may result.	For **mild hypothermia** (core temperature 90°F - 95°F): • Move to a warm area and stay active. • Remove wet clothes; replace with dry clothes or blankets. • Cover the head. • Provide a warm (not hot) sugary drink to promote metabolism and assist in raising the internal core temperature. Avoid drinks with caffeine. For **moderate** (core temperature 82°F - 90°F) to **severe hypothermia** (core temperature below 82°F): • Immediate hospital treatment is required. Activate emergency medical services. • Handle the worker minimally and gently. • Move to a warm place and remove wet clothes. • Place copious amounts of insulation (blankets, towels, pillows, scarves, newspapers, etc.) around the worker to prevent heat loss. • Do not raise the feet. • Do not apply external heat to re-warm. If the worker is in the water and unable to exit, secure collars, belts, hoods, etc. in an attempt to maintain warmer water against the body. Move all extremities as close to the torso as possible to conserve body heat.

[a] Much of the information presented in this table was obtained from SHEM Guideline 33 (December 2004).

APPENDIX I

Recognizing and Mitigating Cold Stress/Cold Hazards

Recognizing and Mitigating Cold Stress/Cold Hazards

Introduction

Two tools that EPA managers can use to help assess cold weather conditions and make decisions about how to protect employees are available through:

- The National Oceanic and Atmospheric Administration's (NOAA's) National Weather Service (NWS), and
- The American Conference of Governmental Industrial Hygienists (ACGIH).

The NWS Windchill Chart

NOAA's most recent NWS Windchill Chart is presented below. It was created in 2001 and is considered more accurate than earlier windchill charts because it uses the human face as a model, is based on modern heat transfer theory (which describes the physics of heat loss from the body to its surroundings on cold and breezy days), and it uses wind speed calculated at the average height of the human face (5 feet) instead of at 33 feet (the standard anemometer height).The chart describes the relationship between air temperature, wind speed, and the combined effect these factors have on the human body. It indicates exposure times within which frostbite is likely to occur to exposed skin. The likelihood of frostbite increases as temperatures decrease and wind speeds increase. At higher wind speeds the air removes heat faster than a person's metabolism and circulatory system replace it, resulting in conditions that can cause or promote frostbite. More information about wind chill, including an online windchill calculator is available at http://www.nws.noaa.gov/om/cold/wind_chill.shtml.

NWS Windchill Chart

Wind (mph) \ Temperature (°F)	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45	26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Frostbite Times: 30 minutes, 10 minutes, 5 minutes

$$\text{Wind Chill (°F)} = 35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$$

Where, T= Air Temperature (°F) V= Wind Speed (mph)

Effective 11/01/01

ACGIH's TLVs for Cold Stress

ACGIH publishes detailed guidelines (reported as TLVs) to protect workers from adverse health effects due to cold. Some of the guidelines are based on dry bulb temperature and others are based on the wind chill index (equivalent chill temperatures or ECTs), which accounts for the combined effect of temperature and wind speed. The objective of the guidelines is the recognition of situations that could (1) reduce an employee's core temperature below 96.8°F or (2) allow tissue to freeze.

The guidelines are presented in ACGIH's TLV booklet,[7] which the Health and Safety Program Contact (or another designated person) should make available to EPA employees. The booklet presents:

- A chart that indicates how quickly frostbite sets in under different ECTs. Like the NWS Windchill Chart, the ACGIH ECT chart can be used to determine the level of danger associated with different combinations of air temperature and wind speed. It is important to note, however, that the NWS Windchill Chart may be a more accurate representation of the effective relationship between cold and wind on humans. Nevertheless, ACGIH's TLVs offer valuable advice for safety managers because (as described below) the booklet links specific mitigation actions to specific ECTs, a feature that can be particularly useful in providing insight into the actions that are required to protect workers under different scenarios.
- A table that identifies work/warm-up schedules for properly clothed workers for 4-hour periods of work at temperatures below freezing and provides insight on how long people can be exposed to varying levels of cold weather before they should be sent into a sheltered environment to warm up.
- A list of recommended actions to take when air temperatures or ECTs fall to certain levels (see below).

Examples of ACGIH Cold Stress Recommendations in the TLV Booklet[a]

TLV	Action[b]
Air temperature is less than 60.8°F (16°C)	• Measure air temperature regularly to ensure adequate information for decisionmakers. • Warm hands if "fine" work is required for more than 10 to 20 minutes at a time. Warm air jets, radiant heaters, or contact warm plates could be used. If fine manual dexterity is not required but the worker is sedentary, ensure that the worker is using gloves.
Air temperature is less than or equal to 39.2°F (4°C)	Workers must wear protective clothing appropriate for the temperature, wind, and level of physical activity (e.g., provide gloves for workers performing light work at 39.2°F). Provide auxiliary heat when exposed areas of the body cannot be protected from a sensation of excessive cold or frostbite.
Air temperature is less than or equal to 35.6°F (2°C)	Workers who become immersed in water or whose clothing becomes wet must immediately change clothing and potentially be treated for hypothermia.

[1] *TLVs 7 and BEIs 7 Based on the Documentation of the Threshold Limit Values for Chemical Substances and Physical Agents & Biological Exposure Indices*. The ACGIH TLV booklet is published on an annual basis and may be obtained from the American Conference of Governmental Industrial Hygienists, 1330 Kemper Meadow Drive, Cincinnati, Ohio 45240-4148. Telephone: 513-742-2020; Web site: http://www.acgih.org.

TLV	Action[b]
Air temperature is less than or equal to 30.2°F (-1°C)	• Measure and record both the dry bulb (air) temperature and the wind speed at least every 4 hours, and determine the ECT (windchill temperature) for each set of readings. • Ensure that metal tool handles and control bars are covered by insulating material. • Prevent workers affected by diseases or medications that interfere with normal body temperature regulation from working in the field.
Air temperature is less than or equal to 0°F (-17.5°C)	• Protect hands with mittens (rather than gloves). Machine controls and tools should be designed so that they can be operated without removing the mittens. • If wind speeds exceed 5 mph obtain a statement of medical qualification for any employee who routinely works under these conditions.
Air temperature is less than or equal to -11.2°F (-24°C) and wind speeds less than 5 mph	Obtain a statement of medical qualification for any employee who routinely works under these conditions.
ECT is less than or equal to 19.4°F (-7°C)	• The risk of injury from cold is moderate. • Record ECT (windchill temperature) along with the air temperature and wind speed. • If work is continuous, provide heated warming shelters (tents, cabins, restrooms) and ensure workers are well hydrated and nourished (avoiding diuretics such as coffee).
ECT is less than or equal to 10.4°F (-12°C)	• The risk of injury from cold is high. • Use the buddy system or visually supervise workers. • Manage work to avoid wet clothing (including wet clothing caused by heavy sweating), allow drying or changing frequently if clothes become wet. • Minimize sitting or standing still for long periods of time. • Avoid requiring newly arrived employees to work full time in the cold during their initial days onsite (e.g., alternate work and warming periods until employees are acclimated to working conditions). • Instruct employees in safety and health procedures for cold stress (e.g., at the safety meeting at the beginning of each work shift).
ECT is less than or equal to 25.6°F (-32°C)	Do not allow continuous exposure.

[a] Not a comprehensive list of ACGIH cold stress recommendations.

[b] Some of the language presented in this column has been streamlined from that which appears in ACGIH's TLV Booklet.

APPENDIX J

Protective Clothing for Cold Environments

Protective Clothing for Cold Environments

General Guidelines[8]

- Wear **layers** of clothing to insulate the body.
- Wear an **outer** layer to break the wind and allow some ventilation. The exterior shell layer should be windproof and preferably waterproof. Outer garments made of high-tech synthetic fabrics are windproof, moisture/water repellant or resistant, abrasion resistant, breathable, strong, soft, quick drying, and/or light-weight.
- Wear a **middle** layer of down or wool to absorb perspiration and provide insulation even when wet (such as wool sweaters, pants, or a down jacket). Avoid jeans and corduroys. Clothing made of synthetic materials is quick-drying, exceptionally warm (wet or dry), and/or warmer per pound than wool.
- Wear an **inner** layer of cotton or synthetic weave to allow ventilation. Undergarments should supply the worker with basic insulation and pull moisture away from the skin. Natural fibers, such as cotton, wool, or silk, can be quite warm and are sufficient for light activities. For heavier work activities, synthetic fabrics (e.g., polypropylene, treated polyester) absorb less moisture and carry water droplets away from the skin.
- Be aware that the type of fabric you choose for clothing is important. For example, cotton loses its insulation value when it becomes wet, but wool does not. Also be aware that the best combination of clothing to wear might differ depending on the specific cold stress situation.
- Wear a hat, insulated head covering under a hard hat, insulated hood, or headband for head protection and a neck gaiter or scarf to protect the neck.
- Wear insulated socks, boots, or other footwear.
- Keep a change of dry clothing available in case work clothes become wet.
- Do not wear tight clothing. Loose clothing allows better ventilation. Caution: loose clothing could get caught in tools or machinery.

[8] Source: SHEM Guideline 33 (December 2004).