



# Safety and Health

for Field Operations



**Safety and Health for Field Operations  
Handbook 445-3-H**

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# Introduction

This Survey Manual Handbook was developed to complement Survey Manual Handbook SM 445-2-H. This Handbook lays the groundwork for incorporating occupational safety and health into the planning of all field projects and tasks. This Handbook will assist supervisors in providing a safe and healthful workplace for Bureau employees and volunteers. In addition, it provides employees with information on safe work practices, identification of hazards, and reporting of unsafe working conditions.

This Handbook is a tool that supports management's responsibility to promote positive safety and health attitudes among employees and to integrate safe procedures into all Bureau activities. Supervisors are responsible for recognizing and rewarding employees for outstanding performance in the area of occupational safety and health.

Every Bureau supervisor, employee, and volunteer is responsible for following safe work practices and procedures, and for identifying and reporting unsafe conditions. The purpose of this Handbook is to provide assistance in carrying out those responsibilities.

All Bureau employees and volunteers are responsible for familiarizing themselves with this Handbook and for utilizing safe work practices and procedures during performance of duties. For the purposes of this Handbook, Bureau volunteers are considered to be employees.

Any use of trade, product, or firm names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

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## Topic 1. Job Hazard Analysis

A job hazard analysis is a technique that focuses on job tasks as a way to identify hazards before they occur. It focuses on the relationship between the employee, the task, the tools, and the work environment. Ideally, after you identify uncontrolled hazards, you will take steps to eliminate or reduce them to an acceptable risk level.

You can help prevent workplace injuries and illnesses by looking at your workplace operations, establishing proper job procedures, and ensuring that all employees are trained properly.

One of the best ways to determine and establish proper work procedures is to conduct a job hazard analysis. A job hazard analysis is one component of the larger commitment of a safety and health management system.

Supervisors can use the findings of a job hazard analysis to eliminate and prevent hazards in their workplaces. This is likely to result in fewer worker injuries and illnesses; safer, more effective work methods; reduced workers' compensation costs; and increased employee productivity. The analysis also can be a valuable tool for training new employees in the steps required to perform their jobs safely.

For a job hazard analysis to be effective, management must demonstrate its commitment to safety and health and follow through to correct any uncontrolled hazards identified. Otherwise, management will lose credibility and employees may hesitate to go to management when dangerous conditions threaten them.

### What jobs are appropriate for a job hazard analysis?

A job hazard analysis can be conducted on many jobs. Priority should go to the following types of jobs:

- Jobs with the highest injury or illness rates.
- Jobs with the potential to cause severe or disabling injuries or illness, even if there is no history of previous accidents.
- Jobs in which one simple human error could lead to a severe accident or injury.
- Jobs that are new to your operation or have undergone changes in processes and procedures.
- Jobs complex enough to require written instructions.

## Conducting a Job Hazard Analysis

*Involve employees.*—It is very important to involve your employees in the hazard analysis process. They have a unique understanding of the job, and this knowledge is invaluable for finding hazards. Involving employees will help minimize oversights, ensure a quality analysis, and get workers to “buy in” to the solutions because they will share ownership in their safety and health program.

*Review accident history.*—Review with your employees your work-site’s history of accidents and occupational illnesses that needed treatment, losses that required repair or replacement, and any “near misses”—events in which an accident or loss did not occur, but could have. These events are indicators that the existing hazard controls (if any) may not be adequate and deserve more scrutiny.

*Conduct a preliminary job review.*—Discuss the hazards employees know exist in their current work and surroundings. Brainstorm with them for ideas to eliminate or control those hazards. **If any hazards exist that pose an immediate danger to an employee’s life or health, take immediate action to protect the worker.** Any problems that can be corrected easily should be corrected as soon as possible. Do not wait to complete your job hazard analysis.

This will demonstrate your commitment to safety and health and enable you to focus on the hazards and jobs that need more study because of their complexity. For those hazards determined to present unacceptable risks, evaluate types of hazard controls.

*List, rank, and set priorities for hazardous jobs.*—List jobs with hazards that present unacceptable risks, based on those most likely to occur and with the most severe consequences. These jobs should be your first priority for analysis.

*Outline the steps or tasks.*—Nearly every job can be broken down into job tasks or steps. When beginning a job hazard analysis, watch the employee perform the job and list each step as the employee takes it. Be sure to record enough information to describe each job action without getting overly detailed. Avoid making the breakdown of steps so detailed that it becomes unnecessarily long or so broad that it does not include basic steps. You may find it valuable to get input from other employees who have performed the same job. Later, review the job steps with the employee to make sure you have not omitted something. Point out that you are evaluating the job itself, not the employee’s job performance. Include the employee in all phases of the analysis—from reviewing the job steps and procedures

to discussing uncontrolled hazards and recommended solutions. See example Job Hazard Analysis.

Sometimes, in conducting a job hazard analysis, it may be helpful to photograph or videotape the employee performing the job. These visual records can be handy references when doing a more detailed analysis of the work.

## Identifying Hazards

A job hazard analysis is an exercise in detective work. Your goal is to discover the following:

- What can go wrong?
- What are the consequences?
- How could it arise?
- What are other contributing factors?
- How likely is it that the hazard will occur?

To make your job hazard analysis useful, document the answers to these questions in a consistent manner. Describing a hazard in this way helps to ensure that your efforts to eliminate the hazard and implement hazard controls help target the most important contributors to the hazard. Good hazard scenarios describe:

- Where is it happening (environment)?
- Who or what is it happening to (exposure)?
- What precipitates the hazard (trigger)?
- What outcome would occur should it happen (consequence)?
- Are there other contributing factors?

Rarely is a hazard a simple case of one singular cause resulting in one singular effect. More frequently, many contributing factors tend to line up in a certain way to create the hazard.

## Consider

At a minimum, you must consider the following hazard categories in your analysis. (There may be others.)

- Impact.
- Penetration, such as from knives, needles, broken glass.
- Compression such as rollover.
- Chemical.

- Temperature extremes such as heat or cold.
- Harmful dust.
- Radiation, ionizing and nonionizing from sources such as uranium dust, lasers, ultraviolet light.
- Ergonomics.
- Electricity.

At a minimum, you must consider the hazard's potential effect on:

- Feet.
- Head.
- Eyes and face.
- Hands.
- Whole body.
- Respiratory system.

## **Correcting and Preventing Hazards**

After reviewing your list of hazards with the employees, consider what control methods will eliminate or reduce them. The most effective controls are engineering controls that physically change a machine or work environment to prevent employee exposure to the hazard. The more reliable or less likely a hazard control can be circumvented, the better. If this is not feasible, administrative controls may be appropriate. This may involve changing how employees do their jobs. Discuss your recommendations with all employees who perform the job and consider their responses carefully. If you plan to introduce new or modified job procedures, be sure they understand what they are required to do and the reasons for the changes.

## **Periodic Review**

Annually reviewing your job hazard analysis ensures that it remains current and continues to help reduce workplace accidents and injuries. Even if the job has not changed, it is possible that during the review process you will identify hazards that were not identified in the initial analysis.

It is particularly important to review your job hazard analysis if an illness or injury occurs on a specific job. Based on the circumstances, you may determine that you need to change the job procedure to prevent similar incidents in the future. If an employee's failure to follow proper job procedures results in a "close call," discuss the

situation with all employees who perform the job and remind them of proper procedures. Any time you revise a job hazard analysis, it is important to train all employees affected by the changes in the new job methods, procedures, or protective measures adopted.

For more details, see

- SM 445-2-H Chapter 15—Job Hazard Analyses.
- 29 CFR 1910.132, General requirements (Personal Protective Equipment).
- 29 CFR 1910 Subpart I Appendix B, Non-mandatory Compliance Guidelines for Hazard Assessment and Personal Protective Equipment Selection.

## Example Job Hazard Analysis

### JOB HAZARD ANALYSIS

<b>Job: Grinding Wheel Castings</b>		
Job Location: Cascades Field Station, WA	Analyst: John Powell	Date: September 30, 2013
Task Description	Hazard Description	Hazard Controls
Employee reaches into metal box to the right of the machine, grasps a 15-pound casting and carries it to grinding wheel. Employee grinds 20 to 30 castings per hour.	Employee could drop casting onto his foot. The casting's weight and height could seriously injure the worker's foot or toes.	<ol style="list-style-type: none"> <li>1. Remove castings from the box and place them on a table next to the grinder.</li> <li>2. Wear steel-toe shoes with arch protection.</li> <li>3. Use protective gloves that allow a better grip.</li> <li>4. Use a device to pick up castings.</li> </ol>
Same as above.	Castings have sharp burrs and edges that can cause severe lacerations.	<ol style="list-style-type: none"> <li>1. Use a device such as a clamp to pick up castings.</li> <li>2. Wear cut-resistant gloves that allow a good grip and fit tightly to minimize the chance that they will get caught in the grinding wheel.</li> </ol>
Same as above.	Reaching, twisting, and lifting 15-pound castings from the floor could result in a muscle strain to the lower back.	<ol style="list-style-type: none"> <li>1. Move castings from the ground and place them closer to the work zone to minimize lifting. Ideally, place them at waist height or on an adjustable platform or pallet.</li> <li>2. Train workers not to twist while lifting, and reconfigure work stations to minimize twisting during lifts.</li> </ol>

## Topic 2. Personal Protective Equipment

The purpose of personal protective equipment is to reduce employee exposure to hazards when engineering and administrative controls are not feasible or effective to reduce these risks to acceptable levels. Personal protective equipment has the serious limitation that it does not eliminate the hazard at the source and may result in employees being exposed to the hazard if the equipment fails.



**Protective gloves.**

Personal protective equipment, or PPE, is designed to protect employees from serious workplace injuries or illnesses resulting from contact with chemical, radiological, physical, electrical, mechanical, or other workplace hazards. Besides face shields, safety glasses, hard hats, and safety shoes, protective equipment includes a variety of devices and garments such as goggles, coveralls, gloves, vests, earplugs, and respirators.

### Job Hazard Analysis

If employees are assigned personal protective equipment to use, the selection of it must be made using a job hazard analysis (JHA) to determine the hazards that are present or may be present during certain conditions and the protective controls that are to be used. Personal protective equipment is considered the last line of defense. Engineering controls and/or administrative controls should be used to reduce risks to employees before personal protective equipment is considered. However, employees working in the field often encounter hazards that cannot be fully eliminated with engineering or administrative controls due to the remote location and/or the unusual work environment.

The job hazard analysis must specify:

- What personal protective equipment is required to be worn.
- The type and material of personal protective equipment that must be worn.
- Under what conditions the personal protective equipment is required to be worn.

## Training

Employees who are required to wear personal protective equipment must be trained on the following:

- How to use protective equipment properly.
- How to determine when personal protective equipment is necessary.
- Knowing what kind of protective equipment is necessary.
- Understanding the limitations of the personal protective equipment.
- How to put on, adjust, wear, and take off personal protective equipment.
- How to maintain protective equipment properly.

## Head Protection

Hard hats can protect employees from head impact, penetration injuries, and electrical injuries such as those caused by falling or flying objects, fixed objects, or contact with electrical conductors. Employees must cover and protect long hair to prevent it from getting caught in machine parts such as belts and chains.

## Inspection and Care

- A daily inspection of the hard hat shell, suspension system, and other accessories for holes, cracks, tears, or other damage that might compromise the protective value of the hat is essential.
- Paints, paint thinners, and some cleaning agents can weaken the shells of hard hats and may eliminate electrical resistance. Consult the helmet manufacturer for information on the effects of paint and cleaning materials on their hard hats.
- Never drill holes, paint, or apply labels to protective headgear, as this may reduce the integrity of the protection. Do not store protective headgear in direct sunlight, such as on the rear window shelf of a car, since sunlight and extreme heat can damage them.
- Hard hats with any of the following defects should be removed from service and replaced:
  - Perforation, cracking, or deformity of the brim or shell;
  - Indication of exposure of the brim or shell to heat, chemicals, or ultraviolet light and other radiation, in addition

to a loss of surface gloss. Such signs include chalking or flaking.

- Always replace a hard hat if it sustains an impact, even if damage is not noticeable.

The Occupational Safety and Health Administration's regulation describes three classes of hard hats (A, B, and C). These are from an earlier American National Standards Institute (ANSI) standard. Most hard hats sold today are labeled using a more current standard.

- Hard hat impact types.
  - Type I hard hats are intended to reduce the force of impact resulting from a blow only to the top of the head.
  - Type II hard hats (bump caps) are intended to reduce the force of impact resulting from a blow that may be received off center or to the top of the head. A Type II hard hat typically is lined on the inside with thick, high-density foam.
- Electrical classes.
  - Class G (general) hard hats are intended to reduce the danger of contact exposure to low-voltage conductors. Test samples are proof tested at 2,200 volts (phase to ground). However, this voltage is not intended as an indication of the voltage at which the hard hat protects the wearer.
  - Class E (electrical) hard hats are intended to reduce the danger of exposure to high-voltage conductors. Test samples are proof-tested at 20,000 volts (phase to ground). However, this voltage is not intended as an indication of the voltage at which the helmet protects the wearer.
  - Class C (conductive) hard hats are not intended to provide protection against contact with electrical conductors.

## Foot and Leg Protection

In addition to foot guards and safety shoes, leggings (for example, leather, aluminized rayon, or other appropriate material) can help prevent injuries by protecting employees from hazards such as falling or rolling objects, sharp objects, wet and slippery surfaces, molten metals, hot surfaces, and electrical hazards.

Examples of situations in which an employee should wear foot and/or leg protection include:

- When heavy objects such as barrels or tools might roll onto or fall on the employee's feet.

- Working with sharp objects such as nails or spikes that could pierce the soles or uppers of ordinary shoes.
- Exposure to molten metal that might splash on feet or legs.
- Working on or around hot, wet, or slippery surfaces.
- Working when electrical hazards are present.

### Examples of Foot and Leg Protection

- **Leggings** protect the lower legs and feet from heat hazards such as molten metal or welding sparks or to protect legs from snake bites. Safety snaps allow leggings to be removed quickly.
- **Metatarsal guards** protect the instep area from impact and compression. Made of aluminum, steel, fiber or plastic, these guards may be strapped to the outside of shoes.
- **Toe guards** fit over the toes of regular shoes to protect the toes from impact and compression hazards. They may be made of steel, aluminum, or plastic.
- **Combination foot and shin guards** protect the lower legs and feet; they may be used in combination with toe guards when greater protection is needed.
- **Safety shoes** have impact-resistant toes and heat-resistant soles that protect the feet against hot work surfaces common in roofing, paving, and hot-metal industries. The metal insoles of some safety shoes protect against puncture wounds. Safety shoes may also be designed to be electrically conductive to prevent the buildup of static electricity in areas with the potential for explosive atmospheres or nonconductive to protect workers from workplace electrical hazards.

### Eye and Face Protection

It is important to choose the appropriate eye and face protection for the particular hazard. Besides spectacles and goggles, personal protective equipment such as special helmets or shields, spectacles with side shields, and face shields can protect employees from the hazards of flying fragments, large chips, hot sparks, optical radiation, splashes from molten metals, as well as objects, particles, sand, dirt, mists, dusts, and glare.

### Examples of Eye and Face Protection

- *Safety spectacles (glasses).*—These protective eyeglasses have safety frames constructed of metal or plastic and

impact-resistant lenses. Side shields are available on some models.

- *Goggles.*—These are tight-fitting eye protection that completely cover the eyes, eye sockets, and the facial area immediately surrounding the eyes and provide protection from impact, dust, and splashes. Some goggles will fit over corrective lenses.
- *Welding shields.*—Constructed of vulcanized fiber or fiberglass and fitted with a filtered lens, welding shields protect eyes from burns caused by infrared or intense radiant light; they also protect both the eyes and face from flying sparks, metal spatter, and slag chips produced during welding, brazing, soldering, and cutting operations. OSHA requires filter lenses to have a shade number appropriate to protect against the specific hazards of the work being performed in order to protect against harmful light radiation.
- *Laser safety goggles.*—These specialty goggles protect against intense concentrations of light produced by lasers. The type of laser safety goggles an employer chooses will depend upon the equipment and operating conditions in the workplace.
- *Face shields.*—These transparent sheets of plastic extend from the eyebrows to below the chin and across the entire width of the employee's head. Some are polarized for glare protection. Face shields protect against nuisance dusts and potential splashes or sprays of hazardous liquids but will not provide adequate protection against impact hazards. Face shields used in combination with goggles or safety spectacles will provide additional protection against impact hazards.

## Hearing Protection

Employees who are exposed to noise that is loud enough that they must shout to be heard at arm's length from another person must have a noise exposure assessment performed. The noise measurements will help select the appropriate level of hearing protection.

Wearing earplugs or earmuffs can help prevent damage to hearing. Exposure to high noise levels can cause irreversible hearing loss or impairment as well as physical and psychological stress.

## Examples of Hearing Protection

- **Single-use earplugs** may be made of foam or silicone rubber. They are self-forming and, when properly inserted, they work as well as most molded earplugs.
- **Pre-formed or molded earplugs** must be individually fitted by a professional and can be disposable or reusable. Reusable plugs should be cleaned after each use.
- **Earmuffs** require a perfect seal around the ear. Glasses, facial hair, long hair, or facial movements such as chewing may reduce the protective value of earmuffs.

The proper type of hearing protection must be selected based on the noise exposure. Your Safety Officer or Industrial Hygienist can assist in selecting the proper hearing protection. If employees are exposed to occupational noise at or above 85 decibels averaged over an 8-hour period, they must be included in a hearing conservation program. More information is in Topic 5-7. Noise.

## Hand Protection

Employees exposed to harmful substances through skin absorption, severe cuts or lacerations, severe abrasions, chemical burns, thermal burns, and harmful temperature extremes will benefit from hand protection. Assess the job for chemical and physical exposures. Base selection of gloves on the evaluation of performance characteristics relative to task(s) to be performed, conditions present, duration of use, hazards and potential hazards identified.

### *Care of gloves.*

- Protective gloves should be inspected before each use to ensure that they are not torn, punctured, or made ineffective in any way.
- A visual inspection will help detect cuts or tears, but a more thorough inspection by filling the gloves with water and tightly rolling the cuff towards the fingers will help reveal any pinhole leaks.
- Gloves that are discolored or stiff may also indicate deficiencies caused by excessive use or degradation from chemical exposure.
- Any gloves with impaired protective ability should be discarded and replaced.
- Reuse of chemical-resistant gloves should be evaluated carefully, taking into consideration the absorptive qualities

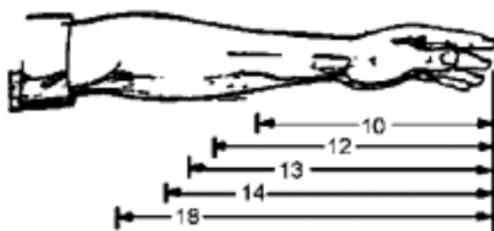
of the gloves. A decision to reuse chemically exposed gloves should take into consideration the toxicity of the chemicals involved and factors such as duration of exposure, storage, and temperature.

*Thickness.*—Determine the degree of dexterity required for tasks, and the cut and abrasion resistance needed.

- Thicker gloves are heavier and have better chemical resistance.
- Thinner, lighter gloves have better touch sensitivity and flexibility but less chemical resistance.
- Generally, doubling glove thickness will quadruple breakthrough time of a chemical.
- Glove thickness is in mils or gauge. (A 10-gauge glove equals 10 mils, or 0.010 inch.)

*Length.*—Determine the length needed.

- Extra splash or immersion protection is provided by gloves longer than 14 inches.
- For deep tank cleaning or glove box applications, gloves may be up to 31 inches.
- Generally, longer gloves are made with thicker materials.



**Gauntlet lengths.**

*Chemicals.*—If chemicals are used,

- Determine the chemicals' toxic properties:
  - Potential local skin effects.
  - Potential absorption through the skin.
  - Resultant systemic effects.
- Determine length of exposure:
  - Splash protection.
  - Intermittent contact.

- Complete immersion.
- Continual contact.
- Determine chemical concentration and temperature. The higher the concentration and temperature of a chemical, the shorter the breakthrough time.
- **No one glove is suited for all chemical exposures.**
- Base selection of glove material on the manufacturer's chemical resistance guide. Chemical compatibility can vary from manufacturer to manufacturer.

#### *Types of gloves.*

- **Disposable gloves.** Usually made of lightweight plastic, these gloves can help guard against mild irritants.
- **General purpose gloves.** Made of cotton or fabric blends and may be coated with nitrile, these gloves are generally used to improve grip when handling slippery objects. Also help insulate hands from mild heat or cold.
- **Leather gloves.** Used to guard against injuries from sparks or scraping against rough surfaces. Also used in combination with an insulated liner when working with electricity.
- **Metal mesh gloves.** Used to protect hands from accidental cuts and scratches. Most commonly used by employees working with cutting tools or other sharp instruments.
- **Aluminized gloves.** Made of aluminized fabric and designed to insulate hands from intense heat. Most commonly used by employees working with molten materials.
- **Chemical resistance gloves.** Protect hands from corrosives, oils, solvents, and other chemicals.
  - **Butyl** provides the highest permeation resistance to gas or water vapors; frequently used for ketones (for example, methyl ethyl ketone, acetone) and esters (for example, amyl acetate, ethyl acetate).
  - **Neoprene** is a synthetic rubber material that provides excellent tensile strength and heat resistance. Neoprene is compatible with some acids and caustics. It has moderate abrasion resistance.
  - **Nitrile** provides protection against a wide variety of solvents, harsh chemicals, fats, and petroleum products and also provides excellent resistance to cuts, snags, punctures, and abrasions.

- **Polyvinyl chloride (PVC)** provides protection against a wide variety of solvents, harsh chemicals, fats, and petroleum products and also provides excellent resistance to cuts, snags, punctures, and abrasions.
- **Polyvinyl alcohol (PVA™)** is a water-soluble synthetic material that is highly impermeable to gases. It has excellent chemical resistance to aromatic and chlorinated solvents. This glove cannot be used in water or water-based solutions.
- **Viton®** is a fluoroelastomer material that provides exceptional chemical resistance to chlorinated and aromatic solvents. Viton is very flexible, but it has minimal resistance to cuts and abrasions.
- **SilverShield®/4H** (made from Norfoil® material) is a lightweight, flexible laminated material that resists permeation from a wide range of toxic and hazardous chemicals. It offers the highest level of overall chemical resistance but has virtually no cut resistance.

## Body Protection

In some cases employees must shield most or all of their bodies against hazards in the workplace, such as exposure to heat and radiation as well as hot metals, scalding liquids, body fluids, hazardous materials or waste, and other hazards. In addition to fire-retardant wool and fire-retardant cotton, materials used in whole-body personal protective equipment include rubber, leather, synthetics, and plastic.

### *Examples of body protection.*

- Anti-exposure garments (for example, survival “dry” suit).
- Fire resistant clothing (for example, *Nomex®*, *Kevlar®*).
- Diving suit or wetsuit.
- Bunker gear for firefighting.
- Leather or *Kevlar®* chaps for chainsaw operations.
- Hazmat protective clothing, which is classified Level A, B, C, or D, is based upon the degree of protection.
- Paper-like disposable suits provide protection against dust and splashes.

## Respiratory Protection

When engineering controls are not feasible to control airborne exposures below applicable limits, employees must use appropriate respirators. Adverse health effects can be caused by breathing air contaminated with harmful dusts, fogs, fumes, mists, gases, smokes, sprays, or vapors. Respirators generally cover the nose and mouth or the entire face or head and help prevent illness and injury. A proper fit is essential for respirators to be effective. Required respirators must be approved by the National Institute for Occupational Safety and Health (NIOSH) and medical evaluation and training must be provided before use.



**Woodcut of Stenhouse's mask.**

### Selection of respirator.

In order for the correct respirator to be selected,

- The contaminant(s) must be identified.
- Concentration of the contaminant(s) must be known or calculated.
- Percent of oxygen must be known. When working in normal atmospheric conditions, assume 21 percent oxygen (no oxygen deficiency). Work above 14,000 feet is oxygen deficient.

For emergency situations, a self-contained breathing apparatus (SCBA), or a supplied air respirator with an auxiliary SCBA is required.

- The respirator must be operated in a pressure demand or other positive pressure mode.
- The respirator must be equipped with a full facepiece.

When one or more of the contaminants is covered by a substance-specific standard, respirator selection must comply with the applicable standard. These substance-specific contaminants are:

- Acrylonitrile.
- Arsenic (inorganic).
- Asbestos.
- Benzene.
- 1,3-Butadiene.

- Cadmium.
- Chromium(VI), hexavalent chromium.
- Coke oven emissions.
- Cotton dust.
- 1,2-Dibromo-3-chloropropane.
- Ethylene oxide.
- Formaldehyde.
- Lead.
- Methylene chloride.
- Methylenedianiline.
- Vinyl chloride.
- 13 Carcinogens.

*Respirator types.*

- **Single-strap dust masks** are not NIOSH-approved. They must not be used to protect from hazardous atmospheres. However, they may be useful in providing comfort from pollen or other allergens.
- **Approved filtering facepieces (dust masks)** can be used for dust, mists, welding fumes, and other contaminants. They do not provide protection from gases or vapors.
- **Half-face respirators** can be used for protection against most vapors, acid gases, dusts, or welding fumes. Cartridges/filters must match contaminant(s) and be changed periodically.
- **Full-face respirators** are more protective than half-face respirators. They can also be used for protection against most vapors, acid gases, dusts, or welding fumes. The face shield protects face and eyes from irritants and contaminants. Cartridges/filters must match contaminant(s) and be changed periodically.
- **Powered-air-purifying respirators (PAPR)** use battery-powered blowers to force air through a filter for the wearer to breathe. Approved PAPRs employ various types of elastomeric facepieces or helmet/hood-type head coverings. Cartridges/filters must match contaminant(s) and be changed periodically.
- **Loose-fitting powered-air-purifying respirators** offer breathing comfort from a battery-powered fan which pulls

air through filters and circulates air throughout helmet/hood. They can be worn by most employees who have beards.

- A **Self-Contained Breathing Apparatus (SCBA)** is used for entry and escape from atmospheres that are considered immediately dangerous to life and health (IDLH) or are oxygen deficient. Another type of atmosphere-supplying respirator is an airline respirator or supplied-air respirator. The air for these respirators must at least meet the requirements for Grade D breathing air. (It is recommended that employees ask to see the most recent air test certificate.)

*Respirator Requirements.*—With the exception of voluntary use of a dust mask for nuisance dust, the following requirements apply to employees who use respirators or have respirators available for emergencies. Employees must:

- Have a medical evaluation.
- Be fit tested annually with the same make, model, style, and size of respirator that will be used.
- Be trained annually.
- Not have facial hair that comes between the sealing surface of the facepiece and the face or that interferes with valve function; or have any other condition that interferes with the face-to-facepiece seal or valve function.
- Know when to change cartridges or respirators.
- Store respirators to protect them from damage, contamination, dust, sunlight, extreme temperatures, excessive moisture, and damaging chemicals, and they shall be packed or stored to prevent deformation of the facepiece and exhalation valve.

If voluntary respirator use is permissible, respirator users must read the information contained in Appendix D to 29 CFR 1910.134, Information for Employees Using Respirators When Not Required Under the Standard.

*High-Visibility Apparel.*—High-visibility apparel is to be worn by Bureau employees who work:

- On or near roadways—the apparel must meet the current American National Standards Institute (ANSI) 107 standard for Class 2 or Class 3 garments.

- On or near roadways at night or during times of low visibility (for example, rain, snow, fog)—the apparel must meet the ANSI 107 standard for Class 3 garments.
- On bridges—the apparel must meet the ANSI 107 standard for Class 3 garments. The employee must also wear a personal floatation device.
- Some States require Class 3 garments to be worn by employees working on or near roadways at any time, in any weather conditions.

*Classes.*—The class number is marked on the apparel label. However, Class E trousers, bib overalls, or shorts worn in combination with a Class 2 coat or vest becomes a Class 3 ensemble.

*Replace High-Visibility Apparel.*—The service life of apparel is affected by factors such as higher elevations, hot climates, UV exposure, type of work performed while wearing the apparel, and the length of exposure to the environment. Facial sweat and bug spray are also factors in the service life of apparel.

- When high-visibility apparel is faded, torn, dirty, worn, defaced, or not visible at 1,000 feet by day or night, it should be replaced.
- Depending on frequency of use and recommended care of individual products, the service life of most high-visibility apparel can be expected to be from 6 months to 3 years.

*Training.*—It is recommended that employees who work on or near roadways have training on selecting high-visibility safety apparel, including appropriate situations where each type of apparel is required or recommended. Suggested topics are:

- What are the three classes of apparel?
- What factors should be considered when selecting apparel?
- What factors affect the wear and tear on apparel?
- When should apparel be replaced?

**Personal Fall Arrest Systems** are addressed in the Fall Protection topic.

**Personal Floatation Devices** are addressed in the Near, On, In, or Over Water topic and in the Travel (Watercraft) topic.

For more details, see

- SM 445-2-H Chapter 17—Work Zone Safety.
- SM 445-2-H Chapter 18—Respiratory Protection Program.
- SM 445-2-H Chapter 19—Hearing Conservation Program.
- SM 445-2-H Chapter 26—Personal Protective Equipment.
- 29 CFR 1910 Subpart I, Personal Protective Equipment.
- 29 CFR 1926 Subpart E, Personal Protective and Life Saving Equipment
- NIOSH Recommendations for Chemical Protective Clothing database.

## Topic 3. Personal Safety

### Topic 3-1. Check-Out and Check-In System

#### Prepare

Bureau activities sometimes require employees to travel and work in remote and hazardous areas.

- Employees performing field activities must be provided with an orientation to the field hazards and how to protect themselves.
- Employees must have dependable and verified communications.
- An appropriate number of employees must be assigned to accomplish the mission or task. At least two employees are recommended when working in hazardous areas or conditions.
- Hazardous areas include, but are not limited to:
  - Surfaces of ice-covered rivers, lakes, and glaciers.
  - Rock slides.
  - Lava flows.
  - Restless volcanoes.
  - Hazardous waste cleanup sites (for example, Superfund sites).
  - Prescribed burns.
  - Underwater diving.
  - High-altitude work (above 8,000 feet).
  - Temperature extremes (above 110 or below minus 20 degrees Fahrenheit).
  - Climbing ladders more than 50 feet in length.
  - Flood measurements during major storms (for example, hurricanes).
  - Work in an area which requires supplied air respirators (for example, oxygen deficient or potentially oxygen deficient area).
  - Search and rescue operations.

## Assess

- Assessing field hazards is a continual process. The job hazard analysis (JHA) process assists both supervisors and employees in minimizing or eliminating those hazards.
- Employees should report near misses of any type to their supervisors. These reports help management reassess the risks and revise the job hazard analysis.
- Managers must allow the use of a “buddy system” in high-risk situations. Make sure employees know this option is available to them.

## Communications

All field locations must have established communications in order to request assistance. The communication system must be tested and verified that it works in the field location. The system used in the field must allow requests for:

- SOS (emergency).
- Help needed (assistance, not emergency).
- Check in (status okay).

## Check out

Managers must maintain a written or electronic record to account for employees in the field. The record must contain:

- Name of employee(s).
- Estimated time to leave for the field.
- Planned itinerary.
- Destination or work area.
- Estimated time of return from the field.
- Contact information (for example, cell phone number, radio frequency).
- Mode of travel (for example, truck, all-terrain vehicle (ATV), airplane, boat, horse, on foot).
- Alternate plans in the event of bad weather, heavy traffic, or other problems.
- Alternate contact information (for example, family member, friend).

## Check in

- Set a time each day when all employees or crews must check in.
- If employees are in the field more than 24 hours, a check-in verification must be made each day.
- A crew leader may check in the entire crew if the crew leader has verified the safety of each employee in the crew. Check in must be communicated to the project manager or higher level manager in the office. If the manager is not available, the duty must be transferred to a responsible person.

## Respond

Search and rescue procedures must be initiated:

- When a check-in from a field employee or crew at the designated time is missed.
- When a “Help” needed message is received.
- When a “SOS” emergency message is received.

## Topic 3-2. Search and Rescue

Bureau employees may provide emergency assistance to persons whose lives or safety are in danger on or adjacent to public lands. Such assistance must be fully coordinated with the local agencies that have the primary responsibility for emergency assistance.

Bureau personnel do not replace existing search and rescue organizations but may supplement those already in existence. Where search and rescue needs exist, managers may assist local authorities as deemed necessary.

Search and rescue procedures must be initiated:

- When a check-in from a field employee or crew at the designated time is missed.
- When a “Help” needed message is received.
- When a “SOS” emergency message is received.

## Authority

The primary responsibility for search and rescue resides with the law enforcement agency with jurisdiction. All search and rescue incidents are potentially law enforcement incidents and therefore require immediate law enforcement intervention.

There may be incidents where agencies and organizations outside of the jurisdiction have a responsibility to conduct search and rescue events that cross jurisdictional lines. Examples are:

- Military aircraft incidents.
- Missions for missing or overdue aircraft, or for an activated Emergency Locator Transmitter (ELT), or Emergency Position Indicating Radio Beacon (EPIRB).
- Emergency Medical Service (EMS) helicopter operations.
- Search incidents along borders of jurisdiction, including rivers.

## Organization

A predetermined management system, such as the Incident Command System, should be used on all search and rescue missions. In the very early stages some functions may be unnecessary and one or two people may carry out several, or even all of them. As the mission becomes more complex, the need to designate specific functions increases. The more complex the mission, the greater the need for individuals with specialized training to carry out each function.

A qualified person should be appointed to see to the needs of relatives or close friends on the scene and to keep them informed of the progress of the mission. A local chaplain or information officer might be a good choice.

## Search Procedures

### *First Notice.*

- Call local authorities and provide information about the last known location, expected activities, and route.
- Determine relative urgency of the incident and notify the following as deemed necessary:
  - Family of missing person(s).
  - Center Director.
  - Supporting full-time safety manager.
  - Regional or Associate Director.
  - Bureau Occupational Safety and Health Manager.
  - Director.
- Obtain current weather information, including ground winds, temperature, precipitation, and the forecast.

*Check the obvious.*—Check the easily forgotten obvious places such as restrooms, tents, vehicles, and intended destination.

*Relative urgency.*—The following guide will help determine the relative urgency of the situation. The lower the priority factor, the more urgent is the situation. If any single category is rated 1, the search would require an emergency response.

<b>Subject</b>	<b>Profile</b>	<b>Priority factor</b>
Number of subjects	One (alone)	1-2
	More than one (unless separation is suspected)	2-3
Age	Very young	1
	Very old	1
	Other	2-4
Time	Reliable, punctual (being late is out of character)	1
		2
	Usually reliable, on time	3
	Reliability, punctuality questionable	4
	Completely unreliable	
Circumstances	At risk for any reason	1
	Adequate information, low risk	2
	Questionable information	3
	High probability not in the area	4
Subject experience profile	Not experienced, does not know the area	1
	Not experienced, knows the area	2
	Experienced, does not know the area	3
	Experienced, knows the area	4
Medical condition	Known or suspected illness or injury	1
	Healthy	3
	Known fatality	4
Physical condition	Unfit	1
	Fit	2
	Very fit	3
Clothing	Inadequate	1
	Adequate	2
	Very good	3
Weather	Existing hazardous weather	1
	Predicted hazardous weather (< 8 hours)	1-2
	Predicted hazardous weather (> 8 hours)	2-3
	No hazardous weather predicted	3
Terrain and hazards	Known hazardous terrain or other hazards	1
	Few or no hazards	2-3
Equipment profile	Inadequate for the environment	1
	Questionable for the environment	1-2
	Adequate for the environment	3

NOTE: Elapsed time from when the subject was missing, along with the political sensitivity of the circumstances, will have the effect of increasing the relative urgency.

#### *Search by Bureau Employees.*

Although the law enforcement agency with jurisdiction is in charge, Bureau employees can assist in the initial search. Coordinate activities with the law enforcement agency. Report plans for searches and results at least daily.

Prepare Bureau field personnel for deployment. For example, call in field employees within a 100-mile radius to assist in the search.

#### *Establish probable boundaries for the search area.*

- Identify last known location.
- Identify areas that were visited within the last 12 hours.
- Identify areas that were scheduled to be visited.
- Identify cell phone usage.
- Consider terrain idiosyncrasies and natural barriers to travel.
- Consider natural routes of travel.
- Estimate time constraints and distance possibly traveled.

A minimum convex polygon can be calculated using those points. The minimum convex polygon is considered the core search area.

#### *Tactics.*

Initial actions should have three objectives:

- Confine the subject(s) travel, prevent enlargement of the search area.
- Effectively use the resources that are immediately available.
- Find the subject or any possible clues.

#### *Confinement and attraction methods.*

- Road or trail blocks.
- Camp-ins.
- Lookouts (survey searches).
- Track traps.
- Road or trail patrols (trail running).
- String lines.
- Noise.

- Smoke.
- Lights.

*Clue Finding.*—Although clues such as footprints, discarded items, or scent articles may not lead directly to the subject, their most profound effect can be to eliminate portions of the search area. Every person involved in the search, especially in the early phases, must be constantly reminded to be “clue conscious.”

### *Create and Implement Search Plans.*

Night search plan:

- Teams of two persons per vehicle (buddy system) and two vehicles (buddy system).
- Designate the communication person within each vehicle.
- Check in every 30 minutes (text) with partner vehicle.
- If a vehicle misses a check in by 30 minutes, notify Lead Scientist immediately.
- Check in every 2 hours and share progress with Lead Scientist (SPOT or text).
- If there is no text service, do not leave sight of the partner vehicle.
- NO FOOT SEARCHES and no searches on unimproved roads that require 4-wheel drive at night.

Search procedure:

- Conducted using spotlights and binoculars.
- Stop every 200 to 500 yards (600 to 1,500 feet). Use high elevation vantage points.
- Flag searched main roads periodically with red flags.

Early morning search plan:

- Contact local land managers (additional support), authorities, and Bureau management.
- Develop vehicle search plan.
  - Scanning—Use spotting scopes and binoculars from vantage points.
  - Drive all roads (two-track, unimproved, or improved) that have fresh tire tracks within the initial search area boundaries. Flag these searched roads with red flags.

- If a two-track and unimproved road has no fresh tracks during the search, flag with an orange flag at entrance.
- Leapfrog roads until all roads are accounted for within the core area.

Daytime search plan:

Develop a flight plan, 2 hours after sunrise, weather permitting.

- Use an Office of Aviation Services (OAS) carded pilot, carded aircraft, and an aviation-trained Bureau passenger.
- Begin search in the initial search area and then expand.
- Use as a spotter the person most familiar with the area.
- Use an additional spotter.
- Maintain communication between the pilot and the ground crew.
- Coordinate with other search and rescue operation(s) (for example, other flights).

## **Rescue and Evacuation**

A rescue and evacuation plan should be established once the subject has been located.

- Immediately after locating the subject(s), necessary emergency medical care must be provided and information necessary to plan the evacuation must be given to the Incident Commander.
- If the subject's location is not on a trail or other easily accessible area, the best route into the location should be marked with flagging tape. This will provide for a quicker response by medical teams and/or other personnel and will help to determine evacuation requirements.
- The rescue and evacuation will be carried out by the fastest, most effective method, but taking into consideration:
  - The condition of the subject.
  - Safety of the subject and rescuers.
  - Equipment and human resources available.
  - Terrain.
  - Weather.
  - Natural resource protection.
- The safety of all personnel is of paramount importance.

- If there is major or multi-system trauma involved, a helicopter evacuation to the nearest Level I Trauma Center should be considered.
- A contingency plan for ground evacuation must be prepared in case the helicopter evacuation cannot be completed due to mechanical problems, deteriorating weather, or other factors.
- For safety reasons, helicopter operations must be managed by experienced personnel using accepted techniques and proper equipment.
- Heliports will be prepared per local protocols.

## **Potential Hazards to Search and Rescue Employees**

Employees who take part in a search and rescue operation must take precautions to avoid becoming a victim. Searches may be conducted in unfamiliar areas and in adverse weather. The rescue may involve victim rescue or body recovery around piles of rubble and other debris, collapsed structures or near structural steel. Hazards may include:

- Exposure to blood or body fluids, or pathogens from sewer system breaks.
- Damaged utility services, including downed electrical cables, overhead power lines, broken gas lines, steam and water mains, or compressed gas cylinders.
- Construction and other types of debris, including overhanging debris.
- Airborne smoke and dust (for example, asbestos, crystalline silica) and possible eye and skin injuries from dust and flying debris.
- Confined spaces (limited openings from entry or exits), possible hazardous atmospheres, including possible flammable or toxic environments.
- Slips, trips, or fall hazards from holes, protruding rebar, etc.
- Dangers due to proximity to heavy machinery (for example, cranes, loaders, debris-hauling trucks).
- Handling a variety of sharp, jagged materials.
- Potential for secondary collapse of unstable structures.
- Excessive noise from rescue/ventilation or other heavy equipment, including generators.

### *Recommendations.*

- Monitor for signs of heat or cold stress, such as altered vital signs, confusion, excessive sweating, and fatigue. Adjust work schedules, rotate personnel, and add additional employees to work teams. Refrain from food and beverages in areas exposed to toxic materials.
- N-95 or greater respiratory protection is acceptable for most activities with dust exposure, including silica and cement dust. Use full face respirators with P-100 organic vapor/acid gas combination cartridges if airborne contaminants are causing eye irritation.
- Wear high-visibility and/or retroreflective garments or vests to assure that search and rescue employees are readily identifiable by other rescue and support agencies.
- Decontamination of employees and equipment may be needed before leaving the site. It is important to prevent adverse health effects by containing any hazards to the site; this will prevent secondary contamination of off-site facilities or additional equipment.

### *Critique.*

A critique of the incident should be held as soon as feasible after the incident. A detailed, honest review of the incident should include:

- How and why the incident occurred.
- How it could have been prevented.
- What was done.
- What worked well and what went wrong.
- Review/modification of the preplan.

Keep the emphasis on solving problems rather than finding fault.

## **Topic 3-3. First Aid**

First aid is emergency care provided for injury or sudden illness before emergency medical treatment is available. The first-aid provider in the workplace is someone who is trained in the delivery of initial medical emergency procedures, using a limited amount of equipment to perform a primary assessment and



**First aid kit.**

intervention while awaiting arrival of emergency medical service personnel.

## **Preplanning**

Preplanning includes determining response times. Consult with the local fire and rescue service or emergency medical professionals to obtain estimated response times for permanent and temporary locations and for all times of the day and night at which employees are present. Because it can be a workplace event, sudden cardiac arrest should be considered when planning the first-aid program.

## **First-Aid Kits**

First-aid kits must be available in two central areas such as the kitchen, shop area, recreation tent, or project leader's tent. Kits should be large enough to accommodate the number of people in the crew.

## **Automated External Defibrillators**

Automated external defibrillators (AEDs) provide the critical and necessary treatment for sudden cardiac arrest caused by ventricular fibrillation, the uncoordinated beating of the heart leading to collapse and death. Using AEDs as soon as possible after sudden cardiac arrest, within 3-4 minutes, can lead to a 60 percent survival rate. CPR is of value because it supports the circulation and ventilation of the victim until an electric shock delivered by an AED can restore the fibrillating heart to normal.

An AED program includes:

- Physician oversight.
- Compliance with local, State, and Federal regulations.
- Coordination with local emergency medical services.
- A quality assurance program.
- Periodic review.

## **Eyewashes and Showers**

Where employees use corrosive materials, an eyewash and shower must be readily available for quick drenching or flushing of the eyes and body. Eyewash equipment is not an acceptable substitute for protective eyewear.

## Preventive Inoculations

Preventive inoculations may be obtained at Bureau expense. Inoculations may be administered only if it can be clearly shown that conditions warrant preventive inoculations, that the inoculations are necessary to protect employee health, and that the official duties of the employees expose them to contact by poison or disease.

## Training

All Bureau employees whose work assignment in the field places them beyond reasonable accessibility to a medical facility in terms of time and distance (15 minutes and/or 10 miles) must be trained to render first aid or be accompanied by someone who has a valid certificate in first aid and cardiopulmonary resuscitation (CPR).

*Advanced or wilderness first aid.*—Where medical services are greater than 1 hour away, employees must have advanced first aid or wilderness first aid training. Where multiple employees are assigned to a specific field location, at least two must be certified in first aid and CPR.

*Refresher training.*—Employees must receive first aid refresher training every 3 years and CPR refresher training annually or as required by the organization administering the training and certification program (for example, American Red Cross).

*Bloodborne pathogens.*—If an employee is expected to render first aid as part of his or her job duties, the employee is covered by the requirements of the Occupational Exposure to Bloodborne Pathogens standard (29 CFR 1910.1030). This standard includes specific annual training requirements.

## Elements of a First Aid Training Program

There are a number of elements to include when planning a first aid training program. These recommendations are based on the best practices and evidence available at the time this guide was written.

*Teaching methods.*—Training programs should incorporate the following principles:

- Basing the curriculum on a consensus of scientific evidence where available.
- Having trainees develop “hands-on” skills through the use of mannequins and partner practice.
- Having appropriate first-aid supplies and equipment available.

- Exposing trainees to acute injury and illness settings as well as to the appropriate response through the use of visual aids.
- Including a course information resource for reference both during and after training.
- Allowing enough time for emphasis on commonly occurring situations.
- Emphasizing skills training and confidence-building over classroom lectures.
- Emphasizing quick response to first-aid situations.

The training program should include instruction or discussion on the following:

*Preparing to respond to a health emergency.*

- Prevention as a strategy in reducing fatalities, illnesses, and injuries.
- Interacting with the local EMS system.
- Maintaining a current list of emergency telephone numbers (police, fire, ambulance, poison control) accessible by all employees.
- Understanding the legal aspects of providing first-aid care, including Good Samaritan legislation, consent, abandonment, negligence, assault and battery, State laws and regulations.
- Understanding the effects of stress, fear of infection, panic; how they interfere with performance; and what to do to overcome these barriers to action.
- Learning the importance of universal precautions and body substance isolation to provide protection from blood-borne pathogens and other potentially infectious materials. Learning about personal protective equipment—gloves, eye protection, masks, and respiratory barrier devices. Appropriate management and disposal of blood-contaminated sharps and surfaces, and awareness of OSHA’s Blood-borne Pathogens standard.

*Assessing the scene and the victim(s).*—The training program should include instruction in the following:

- Assessing the scene for safety, number of injured, and nature of the event.
- Assessing the toxic potential of the environment and the need for respiratory protection.

- Establishing the presence of a confined space and the need for respiratory protection and specialized training to perform a rescue.
- Prioritizing care when there are several injured.
- Assessing each victim for responsiveness, airway patency (blockage), breathing, circulation, and medical alert tags.
- Taking a victim's history at the scene, including determining the mechanism of injury.
- Performing a logical head-to-toe check for injuries.
- Stressing the need to continuously monitor the victim.
- Emphasizing early activation of EMS.
- Indications for and methods of safely moving and rescuing victims.
- Repositioning ill/injured victims to prevent further injury.

*Responding to life-threatening emergencies.*—The training program should be designed or adapted for the specific worksite and may include first-aid instruction in the following:

- Establishing responsiveness.
- Establishing and maintaining an open and clear airway.
- Performing rescue breathing.
- Treating airway obstruction on a conscious victim.
- Performing CPR.
- Using an AED.
- Recognizing the signs and symptoms of shock and providing first aid for shock due to illness or injury.
- Assessing and treating a victim who has an unexplained change in level of consciousness or sudden illness.
- Controlling bleeding with direct pressure.
- Poisoning
  - Ingested poisons: alkali, acid, and systemic poisons. Role of the Poison Control Center (1-800-222-1222).
  - Inhaled poisons: carbon monoxide; hydrogen sulfide; smoke; and other chemical fumes, vapors, and gases. Assessing the toxic potential of the environment and the need for respirators.
  - Knowledge of the chemicals at the worksite and of first aid and treatment for inhalation or ingestion.

- Effects of alcohol and illicit drugs so that the first-aid provider can recognize the physiologic and behavioral effects of these substances.
- Recognizing asphyxiation and the danger of entering a confined space without appropriate respiratory protection. Additional training is required if first-aid personnel will assist in the rescue from the confined space.
- Responding to medical emergencies
  - Chest pain.
  - Stroke.
  - Breathing problems.
  - Anaphylactic reaction.
  - Hypoglycemia in diabetics taking insulin.
  - Seizures.
  - Pregnancy complications.
  - Abdominal injury.
  - Reduced level of consciousness.
  - Impaled object.

*Responding to non-life-threatening emergencies—*

- Wounds
  - Assessment and first aid for wounds including abrasions, cuts, lacerations, punctures, avulsions, amputations, and crush injuries;
  - Principles of wound care, including infection precautions;
  - Principles of body substance isolation, universal precautions, and use of personal protective equipment.
- Burns
  - Assessing the severity of a burn;
  - Recognizing whether a burn is thermal, electrical, or chemical and the appropriate first aid;
  - Reviewing corrosive chemicals at a specific worksite, along with appropriate first aid.
- Temperature extremes
  - Exposure to cold, including frostbite and hypothermia;
  - Exposure to heat, including heat cramps, heat exhaustion, and heat stroke.

- Musculoskeletal injuries
  - Fractures;
  - Sprains, strains, contusions, and cramps;
  - Head, neck, back, and spinal injuries;
  - Appropriate handling of amputated body parts.
- Eye injuries
  - First aid for eye injuries;
  - First aid for chemical burns.
- Mouth and teeth injuries
  - Oral injuries, lip and tongue injuries, broken and missing teeth;
  - The importance of preventing aspiration of blood and/or teeth.
- Bites and stings
  - Human and animal bites;
  - Bites and stings from insects; instruction in first-aid treatment of anaphylactic shock.

For more details, see 29 CFR 1910.151, Medical services and first aid.

## **Topic 3-4. Workplace Violence**

Workplace violence is violence or the threat of violence against employees. It can occur at or outside the workplace and can range from threats and verbal abuse to physical assaults and homicide, one of the leading causes of job-related deaths. However it manifests itself, workplace violence is a growing concern for employers and employees nationwide.

### **Who is Vulnerable?**

Workplace violence can strike anywhere, and no one is immune. However, some employees are at increased risk. Among them are employees who work alone or in small groups, during late night or early morning hours, in high-crime areas, or in community settings where they have extensive contact with the public.

### **Zero Tolerance for Workplace Violence**

The USGS has a zero tolerance policy toward workplace violence against or by its employees.

Employees must not enter any location where they feel unsafe. Ask for a “buddy” to accompany you in unsafe areas or request police assistance in potentially dangerous situations or at night.

## **How can employees protect themselves?**

Employees should:

- Learn how to recognize, avoid, or diffuse potentially violent situations by attending a personal safety training program. The Department of the Interior online course “Safety: Personal Safety Through Awareness” provides general guidance about how to identify and respond to unsafe situations you may encounter in the workplace, while on field assignments, and elsewhere.
- Alert supervisors to any concerns about safety or security and report all incidents immediately in writing.
- Avoid traveling alone into unfamiliar locations or situations whenever possible.
- Carry only minimal money and required identification into community settings.

## **What should managers do following an incident of workplace violence?**

- Encourage employees to report and log all incidents and threats of workplace violence.
- Provide prompt medical evaluation and treatment after the incident.
- Report violent incidents to the local police promptly.
- Inform victims of their legal right to prosecute perpetrators.
- Discuss the circumstances of the incident with staff members. Encourage employees to share information about ways to avoid similar situations in the future.
- Offer stress debriefing sessions and post-traumatic counseling services to help workers recover from a violent incident.
- Investigate all violent incidents and threats, monitor trends in violent incidents by type or circumstance, and institute corrective actions.
- Discuss changes in recommended procedures during regular employee meetings.



## Topic 4. Travel

### Topic 4-1. Walking

We need to **recognize** slip, trip, and fall hazards in the workplace, **evaluate** where those hazards exist, then **control** the hazards.



**An unexpected fall in the river.**

#### *General.*

- Recognize trip hazards and communicate them to others. (See something, say something.)
- Wear appropriate footwear for the weather and walking conditions.
- Watch out for and avoid slippery spots (water, ice, oil, etc.).
- Remove snow, ice, or leaves in walking areas used by many persons (for example, sidewalks, parking lots, entrances).
- Look for changes in surface elevation. It only takes a half inch change to create a tripping hazard.
- Slow down and take smaller steps when stepping to a different surface material. Any transition between surfaces is a potential tripping hazard because of differences in the coefficient of friction between materials.
- Put materials and equipment where they belong. The small amount of time it takes to put something away correctly can save countless hours of lost time, pain and suffering, and medical expenses.
- A hose, cord, or other loose objects on the floor can create a tripping hazard. If they are in use, try to anchor them to the floor with tape or cover with a mat or carpet to reduce the tripping hazard.
- Place guards over or around holes in floors. Even if you don't fall through, holes can cause serious injuries.
- Use the handrail when climbing up or down stairs or a ramp. Handrails don't do any good unless you use them.
- If you are carrying a load, turn 45 degrees or more to the side and side step down a staircase one step at a time. This will

give you better traction and footing on each tread. You can see where to place your feet if you are turned sideways.

- Make sure you have good lighting.
- If a floor or steps are routinely wet or slippery from rain, try to improve the drainage and/or add sturdy drainage rubber type mats.

Our work requires us to walk in all kinds of terrain and in some of the most challenging conditions. Techniques for handling difficult walking conditions come from experienced mountaineers, adventure travel experts, survival experts, and martial arts. Being prepared for the conditions in the field is critical.

### *Walking on snow or ice.*

- If you know you are going to be walking on snow and ice you can come prepared with good boots with Vibram® or equivalent soles.
- You might want crampons, an ice axe, and other ice gear.
- Snow can have pretty good traction, but sometimes it may be necessary to kick steps into the snow for better footing. On steep snow it may take several kicks to create a level platform big enough to make a good step.
- Going down you might have to side step or turn and face the hill and step backwards and go down the same way you went up.
- If you fall on steep snow make sure you know how to self-arrest. Short controlled slides can be an efficient way to descend a snow field. Uncontrolled slides can be fatal!
- If you have to wade through deep snow, consider using snowshoes or skis.
- If you can walk on top of the snow watch out for breakable crust that may or may not support your weight.
  - When this happens your leg will break through and you will drop unexpectedly. If you are not prepared you can pitch forward and twist your knee.
  - The rule in this case is “if it’s breakable crust you have to break it.” In other words, stomp each step so your foot goes through the crust.
  - You may have to walk through deep snow but you are less likely to hurt a knee.
  - Take turns breaking trail; let someone else take over when you get tired.

### *Walking on icy riverbanks.*

- Working near a riverbank in the winter requires special attention. Riverbanks are generally steep and may be covered with ice.
- Pick a route to the water's edge carefully.
- Side step using small steps and kick a platform with each step down to the water.
- Waders or hip boots may not have the best soles for walking through snow or ice, so use a traction aid like strap-on cleats.
- Go slowly and use a walking stick or hiking pole for additional balance and support.
- Don't forget to wear your personal floatation device.

### *Walking on mixed rock and ice.*

One of the most common situations we face is mixed conditions. One minute you are walking on dry solid rock or pavement and the next you are on sheer ice.

- What happens when you step onto sheer ice?
  - Your body instantly senses a complete lack of traction and starts to tense.
  - You instinctively take tiny steps.
  - You spread your stance and slow your movements. (Walk like a penguin.)
  - As long as you don't try to start or stop too fast it is possible to walk on ice.
- The key is to use your eyes and recognize what you are putting your foot on. This enables you to change your gait as conditions change.
- How do you recognize ice?
  - Look at the surface texture.
  - If it is smooth and reflects light, chances are that it is slippery.
  - If you see bumps or a gritty appearance it may still be slippery, but not as slippery as sheer ice.

### *Working on snow or ice.*

Not only do we have to walk on snow and ice, but we often have to work on it.

- Establish a solid footing before commencing your task.

- Take the time to dig out or stomp a level platform where you can comfortably stand.
- Think about how you can position yourself so you are not in the way or in between things that could move.
- Anticipate how things will shift or move as you work and be able to adjust your position as needed.

### *Walking on uneven or rough terrain.*

Sometimes our work takes us to the most inhospitable places where just walking is a challenge. Natural terrain can be extremely uneven with rocks, logs, and sticks to trip over. Each and every footstep can be a different angle and the surface may be loose or the rock we step on could move. (Even big rocks can move.)

- The key to navigating over rough terrain is to use your eyes.
- Don't place your feet anywhere where your eyes have not already scanned.
- Slow down! Being in a hurry and walking over rough terrain is like drinking and driving. Sooner or later you will crash.
- Carry loads in a balanced manner and not blocking your vision.
- Lift your feet a little higher than normal and adjust your gait so that each step lands in the best possible spot.

### *Walking on steep terrain.*

Steep terrain adds a real element of danger to our work.

- Depending on the nature of the work and the level of exposure to a fall hazard, you may need to employ fall protection.
- If you ever have questions about fall hazards at a site, contact your supporting Safety Manager for advice.
- For a situation where only easy scrambling is required, the key is to go slow and pick your route carefully.
- Don't go straight up or down. Walk in a zigzag pattern, and when needed, use your hands to negotiate short, steep sections.
- Check all hand holds and foot holds before putting your weight on them, and watch for loose rocks.
- Don't lean into the hill, as this reduces the surface area of your boot in contact with the rock.
- Be especially careful of loose rock that could fall and hit people below.

- Traverse slopes one at a time and do not position one person directly below another.
- If you knock a rock loose warn others below by yelling out “ROCK!”

### *Walking on slippery vegetation.*

Sometimes we have to thrash through thick vegetation without a trail. This can be tough going!

- Be careful what you’re putting your weight on.
- Downed limbs and deadfall can break when you step on them or your foot can slip. Wet deadfall can be as slippery as ice.
- Handholds can be equally tenuous. Vines that are handy to grab can snap or whole plants can pull out from the roots if you pull too hard.
- The trick to climbing through vegetation is to use all your limbs (hands and feet) and try to distribute your weight evenly.
- You may have to sit down and straddle a log in order to get across or over.
  - Never try to stand and walk the length of a log unless it is safe to do so.
  - Most logs are unsafe; they can be slippery or the bark can be rotten, and a fall from the standing position can be bad.
  - When in doubt sit down and scoot across.

### *Walking in slippery streambeds.*

We frequently walk up and down streambeds or wade across streams and rivers.

- Most streambed material is made up of rounded rocks or boulders that are commonly coated with slippery moss or algae. *Didymosphenia geminata*, commonly known as didymo or rock snot, is a species of diatom that blooms in freshwater rivers and streams with consistently cold water temperatures. It is as slippery as it sounds.
- When walking in streambeds not only do you have slippery footing, but the force of moving water wants to push your feet downstream.
  - This makes it very difficult to maintain balance without some sort of brace.

- The trick to crossing streams is to use a stick, wading rod, or paddle as an upstream brace. Place the brace upstream where you can really lean on it, then move one foot at a time sideways. This gives you support and stability while you hunt for footing.
- If you are wearing a backpack, undo the waist belt and sternum strap so the pack doesn't weigh you down if you fall in.
- Always look for the safest place to cross, such as a wide and shallow section. Be aware of deep holes and downstream hazards.
- Don't forget to wear your personal floatation device.

### *Carrying awkward loads.*

Consider all the types of terrain we've been talking about and now add an awkward, cumbersome piece of equipment that is also very fragile and expensive. This is where advance planning is important.

- Before you leave the office think about how you are going to transport your gear.
- You may need to fabricate a special pack frame. Don't try to carry too much.
- Plan on multiple trips to pack equipment in and out or ask your supervisor to send more employees into the field for the task.

### *Carrying heavy loads.*

- Heavy loads are best carried on your back.
- Don't overload yourself. Take time to plan, schedule, and organize your work in order to make it easier and safer.

### *Ashes to ashes, we all fall down.*

Despite our best efforts to avoid a fall, sooner or later, we are all going to take a tumble. Therefore, it's very important to know how to fall in a way that minimizes the forces on the body. Falls can happen for a wide variety of reasons. Usually it's because we were not paying attention to our footing and either our foot slips when we needed it to stay (SLIP) or our foot stops when we needed it to move (TRIP). This can happen quickly or slowly and can involve almost any body position.

- Almost all falls have one thing in common. Prior to a fall, everything is fine and we are not anticipating anything bad.

- Then, in an uncontrollable moment, your center of gravity shifts outside of your circle of stability. If you are unable to compensate by moving your hands or feet, you go DOWN!
- How you land determines the nature and severity of your injury.

### *How to fall.*

This is how to fall so you can minimize injury.

- Don't try to catch yourself. Go with the fall, but fall properly using the "break fall" technique (ukemi).
- Aim for a soft spot.
- Breathe out as much as possible.
- Tuck in your chin and keep your head up.
- Don't put your arm out to stop your fall but use your palms and forearms to slap the ground.
- Fold your body like an accordion or tuck your head and roll.
- If you hit hard, don't move immediately; sit up slowly, then get help to stand.
- For forward falls,
  - Place the tips of your thumbs and the tips of your index fingers together in front of your chest forming a triangle.
  - As you fall forward hit the ground with your palms, forearms, and elbows at the same time, while keeping your head up and turned slightly to the side.
- For backward falls,
  - Bend your knees, hold one arm out to the side at about 45 degrees and slap the ground with your palm and forearm as you hit on your buttock, side, and shoulder.
  - This will dissipate the energy over a wide area and lessen the force of the impact.
  - This takes practice, preferably on a mat.

### *What can YOU do to avoid going down?*

- Anticipate the terrain and conditions where you will be working and wear the appropriate footwear.
- Use your eyes; look at every spot where you plan to step.
- Test the coefficient of friction by trying to slide your foot.
- Kick steps into steep slopes to create your own stairs.

- Use walking aids like a walking stick, hiking poles, or a wading rod for stability and balance.
- Alter your gait for the conditions by taking smaller steps or using a wider stance.
- And if you do fall, use a fall breaking technique to lessen the impact.

## Topic 4-2. Vehicles

Traffic crashes are the leading cause of on-the-job fatalities in America. About half the Federal employees who die on the job lose their lives in transportation incidents. Thousands of Federal employees are injured in traffic accidents.



**Utility truck.**

### Seat Belts Save Lives

- Using seat belts cuts the risk of death by 45 percent for people riding in cars and by as much as 60 percent for those traveling in trucks or sport utility vehicles.
- Seat belts save 14,000 lives each year. Every State in the Nation has a law mandating seat belt use, but about 20 percent of Americans still fail to buckle up.
- Federal employees are required to wear seat belts every time they travel on public business as passengers or drivers by Executive Order 13043.

### Safe Driving Practices

You are the Bureau's most valuable asset. The way that you drive says everything about you and the Bureau. Make a positive statement by following these work-related safe driving practices.

#### *Stay Safe.*

- Bureau employees (drivers and passengers) must wear seat belts in government vehicles, rental cars, private cars, and taxis, whenever and wherever they go on public business.
- Be well-rested before driving.

- Avoid taking medications that make you drowsy.
- Set a realistic goal for the number of miles that you can drive safely each day.
- If you are impaired by alcohol or any drug, do not drive.

### *Stay Focused.*

- Driving requires your full attention. Avoid distractions, such as adjusting the radio or other controls, eating, or drinking.
- Continually search the roadway to be alert to situations requiring quick action.
- Stop about every 2 hours for a break. Get out of the vehicle to stretch, take a walk, and get refreshed.
- Employees and volunteers must not exceed 10 hours of driving time (behind the wheel) during a 16-hour duty period. This 10-hour period includes rest and meal breaks.

### *Aggressive Driving Prohibited.*

- Keep your cool in traffic!
- Be patient and courteous to other drivers.
- Do not take other drivers' actions personally.
- Reduce your stress by planning your route ahead of time (bring the maps and directions), allowing plenty of travel time, and avoiding crowded roadways and busy driving times.

## **Training**

Defensive training requirements are addressed in SM 445-2-H Chapter 16—Motor Vehicle Safety. In addition, employees must have hands-on coaching for vehicles that they are not used to driving, such as:

- Stick shift (standard).
- Large truck.
- Towing a trailer.
- Four-wheel drive.

Coaching may be provided by the supervisor or another experienced driver.

## **Disabled Vehicle**

In case of a disabled or stuck vehicle, remain with the vehicle. The vehicle can be more easily seen from the air than a person can alone,

and it also provides shelter from the sun or the cold. If lost and without radio contact, sweep the horizon during the daytime with the light beam of a signal mirror. This beam is visible over a great distance and might be seen by someone. Flash vehicle headlights (three rapid flashes) at night, especially if aircraft can be heard.

## Winter Travel

To minimize the hazards associated with winter driving, both the vehicle and the driver must be prepared in advance.

### *Vehicle preparations.*

- **Electrical system**
  - Battery—recharge or replace if the battery is weak. Also have the charging system checked.
  - Ignition—check for damaged ignition wires and cracks in the distributor cap.
  - Lights—check all lights (headlights, side lights, emergency flashers, directional lights, taillights, brake lights, and parking lights) for proper functioning.
- **Brakes.** Check brakes and adjust to ensure equal braking.
- **Tires.** The traction between tires and roadway determines how well a vehicle rides, turns, and stops. Traction is crucial for safe driving in winter. Proper tire selection is very important.
  - Use all-season radial tires only in areas that receive only light snowfall.
  - Use snow tires in areas that receive heavy snowfall.
  - Use chains on all four wheels when you expect severe snow and icy roads. Check with your local Department of Transportation office to see if the use of tire chains is legal in the region through which you are planning to drive.
  - Check tire pressure and if necessary restore it to levels recommended by the tire manufacturer. The pressure drops about 1 pound per square inch (psi) for every 9 degrees Fahrenheit drop in temperature.
  - Do not mix radial tires with other types.
  - Check tire balance and correct if necessary.
  - Check wheel alignment and correct if necessary.

- **Exhaust system**
  - Check the exhaust system for leaks. A properly sealed exhaust system reduces the risk of carbon monoxide poisoning.
  - Keep the window in your vehicle slightly open when you're stuck in snow, and run the engine and heater to keep warm.
  - Keep the exhaust pipe clear of snow. A blocked pipe can force carbon monoxide back into the car interior.
- **Heating/cooling system**
  - Check the radiator and hoses for leaks.
  - Ensure that your vehicle always has a sufficient amount of antifreeze rated for the coldest weather.
  - Check the defrosters (front and back) to make sure they are working efficiently.
- **Windshield wipers**
  - Ensure that windshield wipers function efficiently. Replace them if they are old or worn.
  - Fill the washer container with an antifreeze fluid and top it up frequently.
- **Fuel**
  - Fill up the fuel tank before you leave on your trip.
  - Do not let the fuel level get too low—the driving time to the next gas station may take much longer than you ever expected, and if you get stuck, the car engine will be your only source of heat.

*Winter driving kit.*

A well-stocked winter driving kit helps to handle any emergency. Consider including:

- Properly fitting tire chains.
- Bag of sand or salt (or kitty litter).
- Traction mats.
- Snow shovel.
- Snow brush.
- Ice scraper.
- Booster cables.
- Warning devices such as flares or emergency lights.

- Fuel line de-icer (methanol, also called methyl alcohol or methyl hydrate).
- Extra windshield wiper fluid appropriate for sub-freezing temperatures.
- Roll of paper towels.
- Flashlight and a portable flashing light (and extra batteries).
- Blanket.
- Extra clothing, including hat and wind-proof pants, and warm footwear.
- First aid kit.
- Snack bars or other “emergency” food and water.
- Matches and emergency candles (only use with a window opened to prevent build-up of carbon monoxide).
- Road maps.
- “Call Police” or other help signs or brightly colored banners.

*Preparing yourself.*

- Plan your driving in advance.
- Avoid driving when fatigued.
- Contact your State Department of Transportation for road conditions where you are traveling.
- Check weather conditions for your travel route (and time) before you begin driving.
- Plan your arrival time at a destination by taking into account any delays, including slower traffic, reduced visibility, road-blocks, abandoned automobiles, or collisions.
- Inform someone of your route and planned arrival time.
- Choose warm and comfortable clothing. If you need to remove outdoor clothing later while driving, STOP the vehicle in a safe spot.
- Warm up your vehicle BEFORE driving off. It reduces moisture condensing on the inside of the windows.
- NEVER warm up your vehicle in a closed garage.
- Remove snow and ice from your entire vehicle. It helps to see and, equally important, to be seen.
- Wear sunglasses on bright sunny days.
- Bring a cell phone if you have one but do not leave it in the car as the battery may freeze.

### *Driving in winter.*

- SLOW DOWN! Posted speed limits are for ideal travel conditions. Driving at reduced speeds is the best precautionary measure against any misfortune while driving on slippery roads. “Black ice” is invisible.
- Be alert. Black ice will make a road look like shiny new asphalt. Pavement should look gray-white in winter.
- Do not use cruise control. Winter driving requires you to be in full control at all times.
- Reduce your speed while approaching intersections covered with ice or snow.
- Allow for extra travelling time or even consider delaying a trip if the weather is inclement.
- Drive with low-beam headlights on. Not only are they brighter than daytime running lights but turning them on also activates the tail lights. This makes your vehicle more visible.
- Lengthen your following distance behind the vehicle ahead of you. Stopping distance on an icy road is double that of stopping on a dry one. For example, from around 140 feet at the speed of 35 miles per hour, to over 260 feet on an icy road surface.
- Stay in the right-hand lane except when passing and use turn signals when changing lanes.
- Steer with smooth and precise movements. Changing lanes too quickly and jerky steering while braking or accelerating can cause skidding.
- Be aware and slow down when you see a sign warning that you are approaching a bridge. Steel and concrete bridges are likely to be icy even when there is no ice on the asphalt surface. (Bridges over open air cool down faster than roads, which tend to be insulated somewhat by solid ground.)
- Consider getting off the road before getting stranded if the weather is worsening.
- Be patient and pass other cars only when it is safe to do so.

### *What to do in a skid.*

- Above all do not panic.
- Look where you want your vehicle to go and steer in this direction.

- DO NOT BRAKE!
- DO NOT ACCELERATE!
- Disconnect the driving force on the drive wheels by doing either of the following:
  - If you're using automatic transmission, shift to neutral. However, if you cannot do that immediately, do not touch the transmission gear.
  - If you're using manual transmission, declutch.

*How to brake on a slippery road.*—If the emergency does not require slamming the brakes as hard as possible, squeeze braking (also known as threshold braking) along with declutching (manual shift) or shifting to neutral (automatic transmission) will do the job most efficiently.

*Braking without antilock brakes.*

- Use the heel-and-toe method. Keep your heel on the floor and use your toes to press the brake pedal firmly just short of locking up the wheels.
- Release the pressure on the pedal, and press again in the same way.
- Repeat this until you come to a full stop.

*Braking with antilock brakes.*—Also use heel-and-toe method, but do not remove your foot from the brake pedal until the vehicle comes to a complete stop.

*Stuck or stranded in snow.*

- Don't panic!
- Avoid over-exertion and over-exposure to the cold. Cold weather can put extra stress on the heart and contribute to the hazards of over-exertion. Sweaty clothes next to the skin are not good insulators against the cold.
- Stay in the car if you cannot shovel your car out of the snow.
- Stay in the car in blizzard conditions. Do not leave the car for assistance unless help is visible within about 100 yards.
- Turn on flashing lights or set up flares. A brightly colored cloth on the radio antenna may make your vehicle more visible in daylight.
- Run the car engine occasionally (about 10 minutes every hour) to provide heat (and to conserve fuel). Ensure that the tail exhaust pipe is free of snow and keep the window opened

slightly (on the side shielded from the wind) to prevent the buildup of carbon monoxide when the engine is running.

- Bundle up in a blanket. If there is more than one person in the car, share—two people sharing blankets will be warmer than either person alone in a blanket.
- Wear a hat and scarf. The head and neck are major sources of heat loss from the body.
- Monitor for any signs of frostbite and hypothermia.
- Do not fall asleep. If there is more than one person in the car, take turns sleeping.
- Do not stay in one position too long. Do some exercises to help the circulation; for example, move arms and legs or clap your hands.
- Watch for traffic or rescuers.

## **Desert and Arid Areas**

- Carry at least 1 gallon of water per person per day of your trip. Plastic jugs are handy and portable. If you are going off the beaten track, plan on taking 2 days' water for each person.
- Be sure your vehicle is in good condition.
- Carry additional water for your vehicle's radiator.
- Try to have a vehicle with air conditioning. However, don't overwork your vehicle if it's small or under-powered by using the air conditioning all the time. Turn it off while going up steep or long hills, for example.
- When you're off the freeways and major highways, fill up with gas and water whenever you can.
- Keep an eye on the sky. Flash floods may occur any time you are downslope from "thunderheads," even though it may not rain where you are.
- In winter, temperatures can go well below freezing. Always carry enough clothing or blankets to keep warm in these conditions.
- Although nights can be very cold, necessitating proper attire, clothing for the desert should be lightweight, light colored, and cover the whole body. Have appropriate eyewear to protect eyes from sun glare.
- If your vehicle breaks down, stay near it. Your emergency supplies are with the vehicle.

- Don't wander off away from the car unless it's to get help from a clearly visible call box on the road you're on or an obviously inhabited building within a few minutes' walk.
- Any further than this and you have a good chance of never being seen alive again. If you have any doubts about how far away something is, don't leave your car.
- If water is limited, keep your mouth shut and breathe through your nose to reduce water loss and drying of mucous membranes.
- DO NOT talk, eat, smoke, drink alcohol, or take salt.
- DO NOT sit or lie directly on the ground. Ground temperature may vary by 30 degrees or more from air temperature.
- Know how to change the tires and wheels on your vehicle. Changing a wheel in the desert can be difficult if you're surrounded by sand or unstable ground. Bring strong, flat wooden boards to put under the jack so it doesn't sink into the sand.

For more details, see SM 445-2-H Chapter 16—Motor Vehicle Safety.

### **Topic 4-3. Watercraft**

Watercraft operators must be qualified to handle the size, type, and class of watercraft they are operating.

- Never attach an anchor to the stern of a watercraft. Exercise care in releasing and raising the anchor. Make sure the anchor line and the anchor type are adequate for the size of watercraft and for the type of bottom material present. Use extreme caution in tidal influenced areas.
- Watercraft should have a person assigned as the lookout at all times.
- While the watercraft is underway, personnel should keep movements to a minimum.
- Watercraft operations at night should be kept to a minimum and operate at slower speeds. Appropriate navigational lighting is mandatory for all craft during night operations. Use of other lighting at night should be kept to a minimum so as to protect night vision and avoid confusing operators of other vessels in the area.

- For rubberized boats or lifeboats, inspect all seams, surfaces, fabric condition, valves, and ability to hold air under operating pressure before each use.
- Metal and plastic craft should have skid-proof paint applied to the deck of the craft to avoid slipping.
- The outer surface of tubes on rubber, polyvinyl chloride (PVC), and chlorosulfonated polyethylene synthetic rubber such as Hypalon® rafts should be of a nonskid, slick-type coating.
- Keep oars and oarlocks in good condition. Spare oars, oarlocks, or paddles should be carried on long trips.
- Check with local residents when operating on unfamiliar rivers and lakes for conditions that may be unique to that area.
- Get reliable weather reports.
- Avoid traveling in high winds, in rough water, or if a storm threatens.
  - If caught in a storm, keep the bow to the sea or open water and reduce speed. If the bow is not kept pointed into the waves, then the waves will push the bow aside, turning the boat side-on to the waves. Once side-on to the waves, the waves will roll the boat side to side violently. The boat may broach and may even capsize.
  - If in a canoe, lower the center of gravity by kneeling on the bottom.
- Avoid operating during lightning storm activity.
  - Upon sighting an approaching storm, proceed to the closest shore and beach the craft, if possible.
  - Do not take refuge under a tree or tall object.
  - If unavoidably caught on open water during a lightning storm, watercraft constructed of metal offer the best grounding and will more readily distribute the energy of a lightning strike.
  - If you are in a metal craft insulate yourself from metal surfaces by sitting on nonconductive material.
  - Do not handle metal oars, tools, motors, or fishing equipment.
  - In lightning prone areas, nonmetal watercraft should be equipped with a lightning protection system consisting of

a conductor, extending to a height above all persons and equipment on board, connected directly to a ground plate mounted on the outside of the hull.

## Training

- *Motorboat operators.*—Only employees who have successfully passed the Department of the Interior (DOI) Motorboat Operator Certification Course (MOCC) are authorized to operate motorized watercraft.
  - *Exemption.*—Employees without MOCC certification may operate motorized watercraft to gain experience for certification purposes only under the direct supervision of a MOCC operator.
  - MOCC certification is valid for a period of 5 years. Prior to lapse in certification, operators must complete the appropriate recertification procedure described in SM 445-2-H Chapter 31.
  - Operators of specialized watercraft (for example, airboats, hovercraft, personal watercraft) must complete the DOI MOCC and complete an approved training program specific for these craft.
- *Additional training.*
  - All employees conducting watercraft operations must have current first aid and cardiopulmonary resuscitation (CPR) certifications.
  - Additionally, when operating more than 1 hour away from emergency medical response, advanced or wilderness first aid training is required.
  - Over-the-water training is also required for all employees working from watercraft.
- *Operators of nonmotorized craft.*—Operators of nonmotorized craft (for example, canoes, rafts, kayaks, rowboats) must be approved by their supervisor to use that watercraft for the specific work or task.
  - The supervisor is responsible for ensuring that the employee has the knowledge and skills to use the specific type of watercraft for the particular mission or task.
  - At a minimum, the employee must demonstrate to the satisfaction of the supervisor the hands-on practical skills appropriate to the task.

- Demonstrated practical skills should include at a minimum:
  - Familiarity with the type of watercraft being used (boat type, terminology, basic handling techniques).
  - Good boating techniques (basic paddle strokes, ability to maneuver).
  - Emergency procedures (self-rescue and assisted rescue, use of safety equipment).
  - Ability to perform the required task using the watercraft (for example, canoes, rafts, kayaks, rowboats) must be approved by their supervisor to use that watercraft for the specific work or task.
- The supervisor may use a self-certification letter documenting the employee's competence on the types of waters for the mission or have the employee complete a basic training course appropriate to the watercraft the employee will be operating and appropriate for the class of water on which the employee will be boating.

## **Identity Required**

- All USGS watercraft shall be marked with a USGS identifier.
- Identifiers may include the USGS logo, research vessel name, or other identifiers conspicuously displayed on the port and starboard sides at the highest level above the waterline.
- USGS airboats may display the identity on their rudders.

## **Solo Operations**

- Solo watercraft operations are prohibited unless a written job hazard analysis demonstrates that a solo operation provides the equivalent safety of a two-person team.
- The job hazard analysis must be signed by the supervisor and reviewed and renewed at least annually.

## **Float Plan**

- All watercraft missions will be properly documented with a float plan.

## **Personal Floatation Devices (PFDs)**

- Worn by all onboard occupants, when working over the water, and in close proximity to the water's edge.

- Must be properly fitted.
- Must be U.S. Coast Guard approved.
- Must be international orange or meet the ANSI 107 standard high-visibility yellow-green.
- Must be routinely inspected and maintained in good, serviceable condition.

## **Safety Briefing**

Prior to launching, the operator must conduct a safety briefing with all crew and passengers. Locations and use of all emergency equipment onboard must be discussed during this briefing.

## **Required Equipment**

In addition to basic safety devices required by Federal, State, or local regulations, motorized watercraft must be outfitted with the following:

- Kill switch and lanyard.
- Paddle.
- Bailing device or bilge pump.
- Rope throw bag.
- Type IV throwable device.
- First aid kit.
- U.S. Coast Guard (USCG) approved Type B-I or B-II fire extinguisher, mounted in a location accessible to the operator.
- Tool kit.
- Pyrotechnics, in serviceable condition.
- Anchor and adequate line for the area.
- Sound producing device.
- Dependable communications for the area of operation.
- Navigation lights (mounted or mountable).

## **Fuel**

- Spare fuel must be carried in a safety can that is *approved* by a nationally recognized testing laboratory or the Department of Transportation.
- During refueling, always shut off engine, close all spaces where vapors can accumulate, and move fuel cans to a dock or shore if possible.

- After refueling is completed, place full fuel cells on board, open all enclosed spaces, and ventilate for approximately 5 minutes prior to restarting the engine or reactivating electrical or electronic equipment. Do the “sniff test.”
- Properly secure all fuel containers.

## **Loading, Unloading, and Moving**

- Cargo plus personnel, fuel, water, and onboard equipment should not exceed the rated capacity of the watercraft.
  - Maintain a safe margin below the danger point of overloading. Consider weather and other adverse conditions that might be encountered.
  - Post the maximum safe load limit or refer to the U.S. Coast Guard capacity plate on each craft under 26 feet in length.
  - Load computations must take into consideration the actual weight of each person to be on board rather than the mean 150 pounds per person used by the USCG for determining the allowable number of persons on board.
- When transporting cargo, balance the load evenly between port and starboard sides. Secure cargo so that it will not shift when the craft is in motion. Where possible, load and unload from the side rather than over the bow or stern.
- Do not stack cargo above gunnels because it will raise the boat’s center of gravity and affect the watercraft’s stability.
- When possible, enter or leave the craft from the side rather than the bow or stern. Step into the center of the craft. Steady yourself while moving in a canoe or kayak by placing one hand on each gunnel.
- Do not stand up, change places, or make sudden moves in a watercraft. Go to shore if necessary to change places, repair a motor, or reposition cargo.

## **Personal Protection**

- Employees operating in cold water conditions must wear additional personal protective equipment appropriate to the job and conditions, such as wet suits, dry suits, USGC approved Type III or V anti-exposure coveralls or work suits.

## **Emergencies**

- Personnel assigned to watercraft must be trained in emergency procedures.
- Do not attempt to swim to shore from an overturned craft. Hang onto the craft until it drifts, can be paddled to shore, or until help arrives.
- First-aid kits in waterproof containers and survival gear appropriate for the environment must be carried on the watercraft.
- When involved in an overturned or sinking craft, surviving the incident often depends on what you carry on your person. Equip your PFD with personal survival items that you can use in emergencies (for example, strobe light, mirror, whistle, pencil flares, smoke flares, knife, small waterproof flashlight, sunscreen).
- Learn how to use personal clothing as a floatation device, should you find yourself in the water without a PFD. This procedure requires that you discard your heavy outer clothing and shoes.
- If you are in Arctic or sub-Arctic water, keep all outer clothing on your body. Hang onto the boat, oar, or anything that is floating nearby until help comes. Initiate “Help/Huddle” techniques to reduce loss of body heat.
- Plan your trip and file a float plan. Always close out your float plan with the responsible person assigned to initiate search and rescue operations in the event of an accident.

## **Boat and Trailer Inspections**

Annual inspections are mandatory for watercraft.

<b>Boat and trailer checklist</b>		
<b>Boat ID:</b> _____	<b>Insp. by:</b> _____	<b>Date:</b> _____
Storage Location: _____		
	Satisfactory (yes/no)	Required action
Personal floatation devices		
Lifebuoy, ring buoy, rope throw bag		
Fire extinguisher mounted		
Paddles, oars		
Anchor(s), lines		
Adequate fuel/spare fuel tanks		
Flame arrester		
Blower		
Battery condition		
Navigation lights		
Throttle, shift, steering controls		
Navigation lights, spare bulbs		
Searchlights		
Whistle/sound producing device		
Additional communication equipment		
Compass		
Bilge pump, hand pump, or bailing bucket		
Flares, warning lights, flags		
Spare propeller kit		
Emergency tools		
Topographic map or paper chart of mission area		
First aid kit in waterproof container		
Tagline flags, markers		
Trailer tires, wheels, spare bearings		
Trailer taillights, turn signals, brakes		
Trailer safety chains, boat tie-down straps		
Trailer winch, cable, line, or strap		
Trailer brakes (if equipped)		

For more details, see SM 445-2-H Chapter 31—Watercraft Safety.

## Topic 4-4. Aviation

### Training

- All employees who fly in an aircraft, except on an airliner or an Alaskan air taxi point-to-point seat fare, must complete DOI Basic Aviation Safety training.
- Supervisors of employees who fly must complete Aviation Safety Training for Managers training.

### Procurement

- All aircraft services must be procured through the DOI Office of Aviation Services.
- Exceptions include procurement of aircraft services outside the United States and U.S. territories.

### Pilot Qualifications

- Always check the Pilot's DOI Qualification Card before boarding aircraft to make sure he/she is qualified for aircraft type and mission.
- Never fly if the Pilot's Qualification Card is outdated or the card is not available.

### Flying Practices

- Always ensure that a formal flight following protocol is in place including someone who is responsible for monitoring the flight progress from start to finish.
- Adhere to Department of the Interior and Bureau policy regarding having a Project Aviation Safety Plan in place to include: flight following, mishap procedures, and risk assessment.
- Make sure the pilot is briefed on the mission objective and parameters of the flight.
- Always check the DOI Aircraft Data Card to make sure aircraft is approved for performing the mission.
- Make sure you have been briefed by the pilot on the following:
  - Approach and boarding.
  - Seat belt (use and adjustment).
  - Smoking rules.
  - Fire extinguisher (location and use).
  - Emergency exits (location and use).

- Survival equipment (location and use).
- Oxygen (if available).
- Emergency locator transmitter (location and use).
- Other emergency procedures.
- Deplaning and departing.

## Special-Use Flights

**Airplanes** involved in the following activities are considered to be special-use aircraft:

- Changes to the airplane that invalidate the airplane's standard airworthiness certificate (for example, door removal).
- Flight conducted below 500 feet above ground level.
- Float wheel or ski operations conducted on unprepared landing sites.
- Wheel operations on unprepared landing areas (airplane).

**Helicopters** involved in the following activities are considered to be special-use aircraft:

- Low-level flight (within 500 feet of the surface).
- Mountain flying (helicopter).
- Resource reconnaissance.
- Fire reconnaissance.
- Air tactical group supervision.
- Toe-in, single-skid, and step-out landing (helicopter).
- Cargo letdown.
- External load—short line < 50 feet (helicopter).
- External load—long line >50 feet (helicopter).
- Rappel.
- Short haul.
- Offshore platform landings (helicopter).
- Vessel landings.
- Water landings—floats or hull (helicopter).
- Animal darting, paintball.
- Animal eradication.
- Animal gathering and capture.
- Handheld net gun.

- Aerial ignition.
- Night vision goggles.
- Smoke jumping/para-cargo.
- Water/retardant application.

### **Personal Protective Equipment (PPE) Requirements for Special-Use Flights.**

- An aviator’s protective helmet (pilots and crew members must have communications, passengers may have helmets without communication).
- Fire-retardant clothing.
- All-leather boots which extend above the ankle.
- All-leather or leather and “Nomex” gloves.
- Federal Aviation Administration (FAA) approved personal floatation device (PFD) for overwater operations.
- Waivers for snow boots, waders, or other PPE must be signed by employees and supervisors.

*Waiver, dated May 6, 2006.*—A risk assessment indicated that fire-resistant clothing/gloves and all leather upper boots do not provide adequate protection from exposure, frostbite, and hypothermia in snow/cold/wet conditions. In addition, the use of fire resistant clothing in extreme heat conditions promotes the greater risk of heat exhaustion or hyperthermia.

The May 6, 2006, waiver applies to USGS employees, volunteers, persons supervised by USGS employees, and contractors when conducting special-use missions under *either of* the following conditions:

- In extreme weather or environmental conditions, the use of synthetic or synthetic natural fiber blends is authorized in lieu of fire-resistant clothing (inner and outerwear). Footwear made of rubber (hip waders) or rubber combined with cotton, canvas, or leather with felt liners (snow-pack or bunny boots) may be worn in lieu of leather boots, or
- The requirement for fire-resistant clothing (Nomex) and leather boots is waived for helicopter special-use operations conducted in aircraft using Jet A fuel.

In addition, for use of the PPE waiver, supervisors must verify that all persons involved in these aviation operations have been informed of the increased personal hazard associated with wearing other than fire-resistant clothing, gloves, and footwear in the event of a post-mishap fire.

## **Preflight Preparations**

- Provide the pilot with a precise weight of your cargo. Cargo that is questionable with regard to aircraft and passenger safety shall be cleared in advance of your flight. Extremely large items should be itemized separately to ensure that space will be available.
- When hazardous materials are part of the cargo, the passengers, crew, and pilot must complete hazardous materials training (A-110) and a copy of the DOI hazardous materials waiver must be carried onboard.
- Report the number of passengers to determine the gross weight of the aircraft.
- Always give the destination, latitude, longitude, and elevation (if possible) of your field camp and the airstrip, if you know the location. Prominent place names in the area are also helpful.
- Have a radio available in camp for monitoring of aircraft arrival, departure, and emergencies.

## **Passenger Procedures and Safety Precautions**

- Do not disembark from aircraft until pilot has given the okay. Make sure propellers or rotor stopped. Even with propellers stopped, use caution when walking near them; they're about head high and a serious head injury could occur. Normally, deplane from cargo door and proceed straight out from aircraft, not forward.
- When approaching an airplane, always approach the cargo door from the side or the rear of the aircraft.
- After unloading any aircraft, inspect the area around the aircraft for any loose materials that might be picked up by an air blast upon takeoff and cause damage to the aircraft or injury to personnel.
- Always observe the seat belt sign and make sure seat belts are fastened during takeoffs and landings and whenever the aircraft encounters turbulence.
- Always observe the "NO SMOKING" signs or the instructions by the pilot. Also, smoking is prohibited while refueling or on the ramp.

## Helicopters

### *Cargo Loading.*

- Consideration of center of gravity (CG) limitations is important in loading of all aircraft, but is particularly important and critical in helicopters. In a helicopter the load is carried under a single point like a pendulum; therefore, very little out-of-CG loading can greatly affect the controllability of the helicopter.
- It is important to properly secure all materials loaded on or in a helicopter.
- Do not overload the aircraft. Normally the pilot will stow equipment and distribute the weight. However, during the work day, you might be loading and unloading equipment as well as adding other materials. Therefore, it is your responsibility to ensure that gear is always stowed properly and that weight is properly distributed.
- Normally, loading and unloading equipment at camp is no problem because the engine is usually shut down, but if the engine is still running, the following precautions must be taken:
  - Make sure there are no loose or light materials that might be pulled into the main rotor blade or tail rotor.
  - If light materials are placed near the helicopter, make sure that heavier materials are placed over them.
  - Long items should always be carried horizontally while they are being loaded.

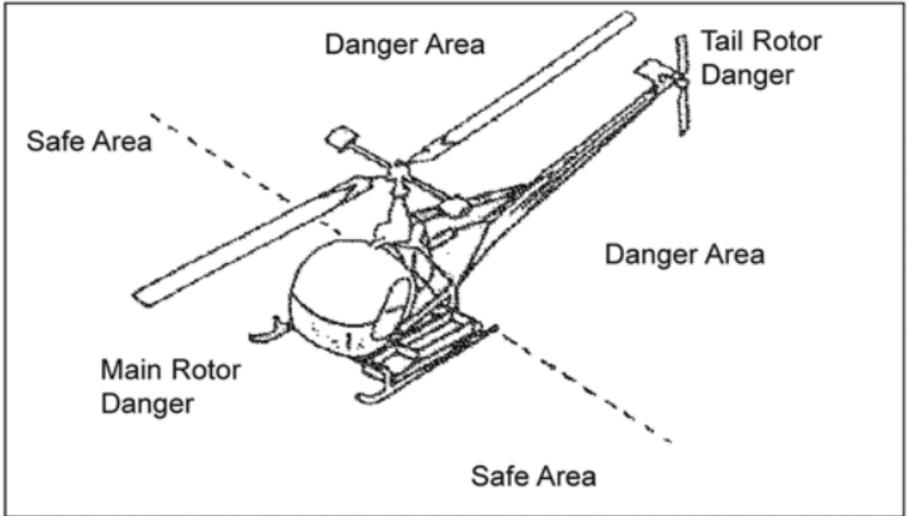
### *Tail Rotor.*

- The tail rotor constitutes the most serious hazard on a helicopter and is unprotected and nearly invisible when in motion.
- Never proceed rearward of the tail boom and the main cabin.
- Never duck under the tail boom.
- Never deplane to the rear. Walk straight out to the side or to the front in a low position and always stay in view of the pilot. (See figures 1 and 2.)

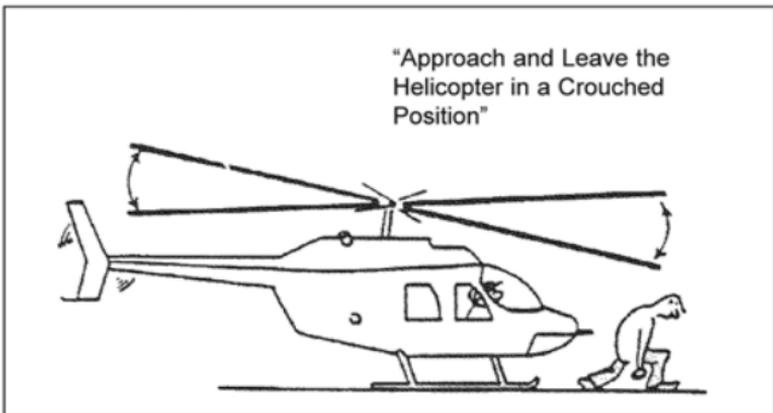
### *Main rotor.*

- When the helicopter is sitting on level ground, the main rotor is sufficiently above the ground not to be of danger, but still leave in a crouched position. (See figure 2.)

- While on uneven ground, the rotor presents a major hazard. Always approach or exit a helicopter on uneven ground on the downhill side. (See figure 3.)
- Always stay within the pilot's view.



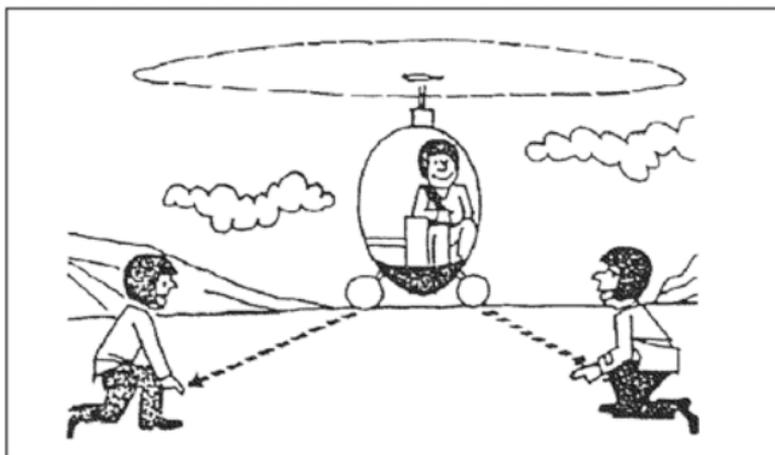
**Figure 1.** Helicopter safe and danger areas.



**Figure 2.** Main rotor.



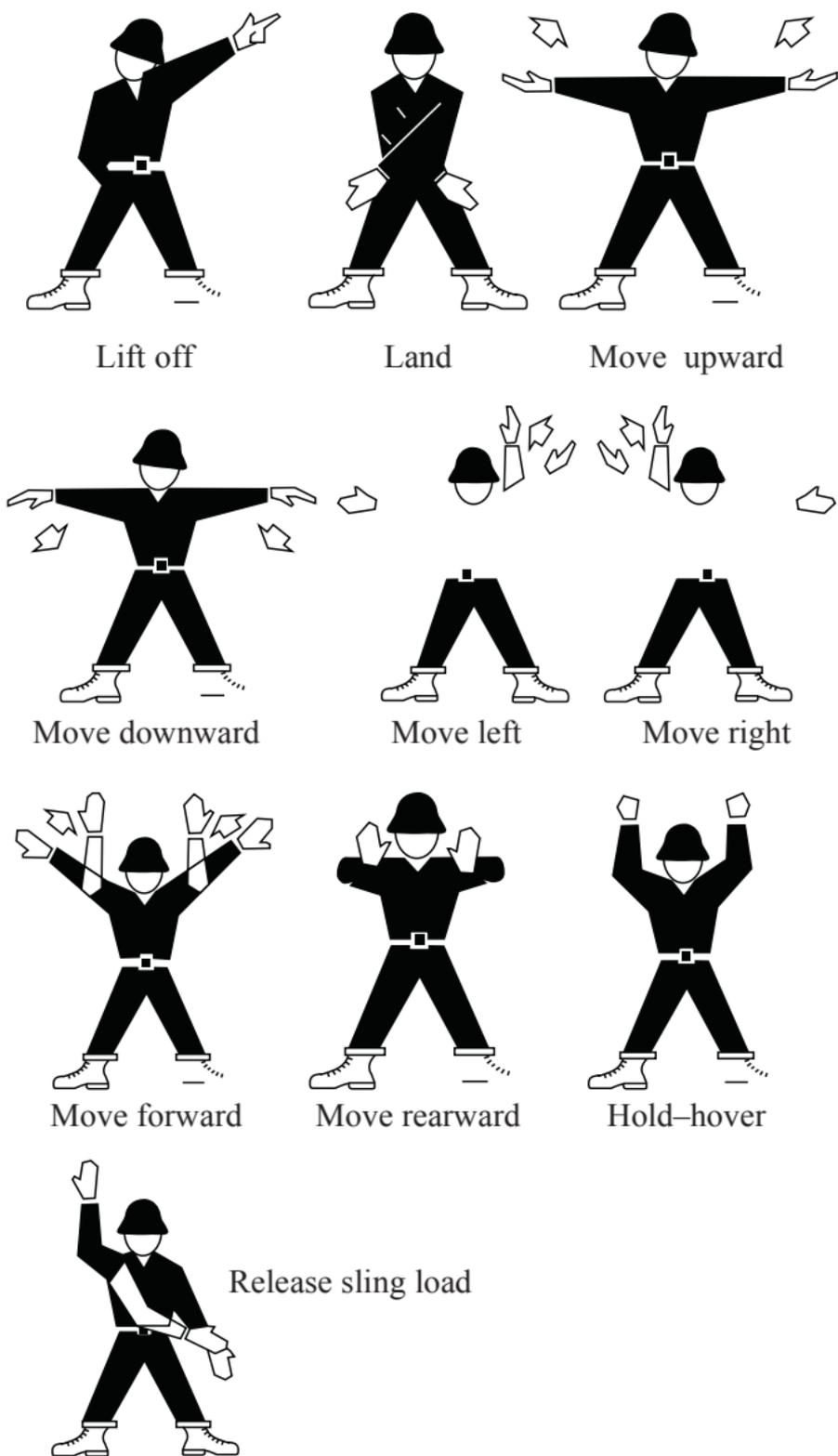
**Figure 3.** Downhill is safe. Carry tools horizontally below waist level (never upright or over shoulder).



**Figure 4.** Proper position for crew/passenger prior to boarding and after departing a helicopter and prior to and during helicopter departure.

*Adverse weather.*

- Avoid thunderstorms.
  - Remain at least 5 nautical miles from the edge of a thunder cell when operating in a low-level environment.
  - Develop contingency plans for severe weather that provide suitable alternatives for aircraft that need to be either diverted or relocated.
  - Monitor long-range weather activity and forecasts.
  - Delay aerial operations when strong storm cells are approaching.
  - Suspend operations if within 5 nautical miles of a thunderstorm.
- Avoid flying when conditions for visual flight rules are marginal, such as low clouds, haze, or fog.



**Figure 5.** Helicopter hand signals.

For more details, see SM 445-2-H Chapter 27—Aviation Safety.

## **Topic 4-5. Off-Highway Vehicles**

Off-highway vehicles (OHVs) are vehicles that are not designed to travel streets or highways, including all-terrain vehicles (ATVs), utility-terrain vehicles (UTVs), snowmobiles, and off-road motorcycles. In addition to following Bureau field work procedures, OHV use requires a formal risk assessment, training, and appropriate personal protective equipment. Documentation of training will be maintained at Bureau offices. Specific authorization for operation of OHVs is required. Where required by State law, operators must have a special State endorsement to operate off-highway vehicles.

### **Job Hazard Analysis**

Supervisors are responsible for ensuring that a formal risk assessment (job hazard analysis) has been prepared and approved for operation of an OHV. A field risk assessment must include the possibility of significant changes in weather, terrain, or circumstances.

### **Training**

Each OHV operator must complete an operator training course developed by a manufacturer or other appropriate source, and taught by an individual who has successfully completed an OHV instructor course in order to qualify for OHV authorization. Courses must be specific to each vehicle class, to include field instruction, and be documented. Refresher training, with a ride check, is required every 3 years, at a minimum.

### **Pre-Ride Inspection**

The operator should reference the vehicle owner's manual. Before every ride, a pre-ride inspection must be performed. Examples of items to be checked are:

- Tires and wheels.
- Controls and cables.
- Lights and electrical.
- Oil, fuel, fluids, air filter.
- Chassis, chain/driveshaft, suspension, external equipment.

### **Personal Protective Equipment**

OHV operators and passengers must wear the following personal protective equipment:

- A helmet approved by the Department of Transportation, Snell Memorial Foundation, or American National Standards Institute (ANSI). Helmets must be fastened.
- A face shield, impact-resistant goggles, or impact resistant glasses or sunglasses meeting the ANSI Z-87 standard.
- Full-fingered gloves.
- Long-sleeved shirt and long trousers.
- Over-the-ankle protective boots.
- Clothing prudent for the conditions and terrain. This may include additional gear depending on the weather conditions, hazards, and environmental issues.
- Additional personal protective equipment for off-road motorcycle operation includes: knee pads, shin pads, and elbow pads.
- Additional personal protective equipment for snowmobile operation includes: face mask, appropriate gloves, snowsuit, and snowmobile boots.

## Requirements

- When a rollover protective structure (ROPS) is available, it must be incorporated into the vehicle.
- When seat belts are available, all vehicle occupants must wear seat belts while the vehicle is in motion.
- Items carried on OHVs include scientific equipment, gear, spray tanks, and firearms; items must be attached or affixed to the OHV in a manner that precludes the items from becoming entangled during operation.
- All guns must be unloaded when transported on an OHV.
- If the OHV has a rollover protective structure, the attachment device must not compromise the structural integrity (for example, drilling into the rollover protective structure).
- The manufacturer's maximum weight rating for utility and cargo racks must not be exceeded.
- OHVs must be properly secured for transport using a minimum of two (2) tie-down straps with a working load limit of at least 50 percent of the weight of the OHV.
- Fire extinguishers and first aid kits must be readily available when using OHVs.
- Must be at least 18 years old to operate any motor vehicle for the USGS, including OHVs.

## Prohibition

- The use of three-wheeled ATVs by Bureau employees for Government business is prohibited.

For more details, see SM 445-2-H Chapter 16—Motor Vehicle Safety.

## Topic 4-6. Trailers

There's a lot more to towing a trailer than just hitching up and taking off down the road. This guidance is not a substitute for the technical information found in manufacturers' towing guides and vehicle owner's manuals. Its purpose is to give you some basic information about factors to consider and equipment you will need to ensure your safety and that of your passengers, as well as the safety of other people on the road, when you are towing a trailer.

### Tow Vehicle

The tow vehicle and the proper equipment to tow a trailer depend on the type of trailer, its size and weight, and the amount of weight being towed. The vehicle owner's manual contains these specifications. There are numerous types of trailers, but in general they fall into four categories: flatbed or open trailers, boat trailers, enclosed trailers, and recreational vehicle trailers (including travel trailers, fifth-wheel trailers, and folding camping trailers).

A towing package for a vehicle may include a heavy duty radiator, battery, flasher system, alternator, suspension, and brakes, as well as an engine-oil cooler, transmission-oil cooler, wiring harness, specific axle ratio, and special wheels and tires.

While the vehicle may have certain tow ratings, you must have a matching hitch system that can handle the same specifications. To ensure safety, you may have to install extra towing equipment.

*Manufacturers' tow vehicle ratings.*—Manufacturers' tow vehicle ratings address tongue weight as well as the individual, combined, and fully loaded weights at which a tow vehicle can safely tow a trailer. They also can be used to guide the selection of brake and hitching systems as well as tow vehicle tires. Together with the hitch system specifications, these weight considerations will help you select a safe tow vehicle. In general, manufacturers provide tow ratings for the maximum:

- Amount the tow vehicle may weigh when fully loaded, or gross vehicle weight rating (GVWR).

- Weight a vehicle can tow. This figure may vary depending on the vehicle's equipment, such as a manual or automatic transmission and whether it is equipped with four-wheel drive.
- Permissible combined weight of the tow vehicle, trailer, passengers, equipment, fuel, etc., that the vehicle can handle, or gross combination weight rating (GCWR).
- Weight a single axle can carry, or gross axle weight rating (GAWR).

*Weight of a trailer.*—You must know how much your trailer weighs fully loaded. For example, if you are towing an open trailer that carries a boat or motorcycle, the fully loaded weight includes the weight of the trailer with the boat or motorcycle and any additional items being towed, such as fuel tanks, motors, and safety equipment. The best way to know the actual weight of your loaded trailer is to weigh it at a public scale.

Manufacturers consider the loaded weight of a trailer when specifying tongue weight—the amount of the trailer's weight that presses down on the trailer hitch. Too little tongue weight can cause the trailer to sway. Too much tongue weight can cause many problems, including not enough weight on the front wheels of the tow vehicle. When this occurs, the tow vehicle will be less responsive to steering. A weight-distributing hitch can remedy this problem by transferring weight to the front axle of the tow vehicle.

Manufacturers also establish the gross axle weight and provide a rating that denotes the maximum weight a single axle can carry. The gross axle weight rating listed on the tow vehicle's certification label must not be exceeded.

## **Connecting the Trailer**

*Hitching systems.*—The trailer towing industry has developed a classification system that differentiates hitches according to the amount of weight they can tow. This system addresses tongue weight and total weight.

The three most common types of hitches are the weight-carrying hitch, the weight-distributing (or load equalizer) hitch, and the fifth-wheel hitch, or gooseneck. Weight-carrying hitches are designed to carry all of the trailer's tongue weight. Weight distributing hitches are used with a receiver hitch and special parts that distribute the tongue weight among all tow vehicle and trailer axles. Fifth-wheel hitches

are designed to mount the trailer connection in the middle of the truck bed.

Make sure the hitch has provisions for the connection of safety chains, which are required by most States. When connected, safety chains should have some slack to permit sharp turns but should not drag on the road. In addition, they should cross under the trailer tongue to help prevent the tongue from dropping to the road in the event the trailer separates from the tow vehicle.



**Safety chain.**

*Braking systems.*—The brake system will depend on your tow vehicle and the type and fully loaded weight of your trailer. For a trailer with a loaded weight of more than 1,500 pounds, many States require a separate braking system and a breakaway switch, located on the tongue of the trailer, to activate the trailer brakes in the event the trailer separates from the tow vehicle. There are two basic types of brake systems designed to activate the brakes on a trailer:

- Electronically controlled brakes usually provide automatic and manual control for trailer brakes. They require that the tow vehicle be equipped with a controlling device and additional wiring for electrical power. These brakes typically have a control box installed within reach of the driver and can be manually or automatically applied. The control box may require adjustment or “tuning in” for variations in trailer load.
- Surge brakes are independent hydraulic brakes activated by a master cylinder at the junction of the hitch and trailer tongue. These brakes are not controlled by the hydraulic fluid in the brake system of the tow vehicle. Note: The hydraulic system of the tow vehicle should never be directly connected to the hydraulic system of the trailer. These systems are self-compensating and do not require adjustment for variation in trailer load.

Some States require braking systems on all axles of the trailer. Check your State’s requirements by contacting the motor vehicle administration.

*Wiring systems.*—Federal law requires trailers to have taillights, brake lights, side marker lights, turn signals, and side and rear reflectors. Some trailers also have backup lights. To provide power to these lights, a four-way (or more) connector is hooked into the tow

vehicle's electrical system. Many tow vehicle manufacturers offer a 7-way connector that may include an electric brake signal, power supply, and backup lights, in addition to the typical four functions. Note: You must ensure that the signals on the electrical connector of the tow vehicle match the electrical connector of the trailer.

Because the wiring systems of many tow vehicles use separate wires for turn signals and stop lights, you may need a taillight converter. This converter will combine these wires so that they can be connected to the trailer lighting system. Most factory-installed towing packages include a trailer wire harness that will perform this function if required. If you tow more than one type of trailer, you also may need an adapter to accommodate differences in the wiring systems.

## **Tires**

All of the trailer tires should be the same type, size, and construction. Do not mix bias-belted and radial tires. In selecting tires for the trailer, buy the size, type, and load range found on the trailer's certification label or in the owner's manual. Keep in mind that tires have a load rating that indicates the amount of weight they can carry safely. As with your tow vehicle, always maintain proper tire pressure and replace worn tires. Remember, your tow vehicle tires may require a higher tire pressure for towing, especially heavy loads.

## **Loading and Weight Distribution**

Your ability to handle and control your tow vehicle and trailer is greatly improved when the cargo is properly loaded and distributed.

Refer to your tow vehicle and trailer owner's manuals to find out how to:

- Balance weight from side to side.
- Distribute cargo weight evenly along the length of the trailer.
- Secure and brace all items to prevent them from moving during travel.
- Adjust the height of the tow vehicle/trailer interface.
- Apply load leveling (weight distributing) hitch bars.

Most trailers and tow vehicles should be level (parallel to the ground) during travel. Check the instructions from your trailer manufacturer to make sure this is correct for your combination of vehicles.

## State and Local Requirements

States and municipalities may require special permits and licenses based on the size and weight of your trailer, especially if it is over 8 feet wide. Some States require additional equipment for the tow vehicle, such as side- and rear-view mirrors. Surge brakes may not be legal in some jurisdictions.

In addition to licenses and permits, there may be weight, height, and width limits for using certain roads, bridges, and tunnels. Also, be aware of restrictions regarding the transport in tunnels of propane gas and other volatile gases or fuels.

Inquire at the local motor vehicle administration to find out what requirements affect you.

## Driving with a Trailer

Take time to practice before driving on main roads. Never allow anyone to ride in or on the trailer. Before you leave, check routes and restrictions on bridges and tunnels. Consider the following safety tips each time you drive with a trailer.

### *General handling.*

- Use the driving gear that the manufacturer recommends for towing.
- Drive at moderate speeds. This will place less strain on your tow vehicle and trailer. Trailer instability (sway) is more likely to occur as speed increases.
- Avoid sudden stops and starts that can cause skidding, sliding, or jackknifing.
- Avoid sudden steering maneuvers that might create sway or undue side force on the trailer.
- Slow down when traveling over bumpy roads, railroad crossings, and ditches.
- Make wider turns at curves and corners.
- Because your trailer's wheels are closer to the inside of a turn than the wheels of your tow vehicle, they are more likely to hit or ride up over curbs.
- To control swaying caused by air pressure changes and wind buffeting when larger vehicles pass from either direction, release the accelerator pedal to slow down and keep a firm grip on the steering wheel.

### *Braking.*

- Allow considerably more distance for stopping.
- If you have an electric trailer brake controller and excessive sway occurs, activate the trailer brake controller by hand. Do not attempt to control trailer sway by applying the tow vehicle brakes; this will generally make the sway worse.
- Always anticipate the need to slow down.
- To reduce speed, shift to a lower gear and press the brakes lightly.

### *Acceleration and passing.*

- When passing a slower vehicle or changing lanes, signal well in advance and make sure you allow extra distance to clear the vehicle before you pull back into the lane.
- Pass on level terrain with plenty of clearance. Avoid passing on steep upgrades or downgrades.
- If necessary, downshift for improved acceleration or speed maintenance.
- When passing on narrow roads, be careful not to go onto a soft shoulder. This could cause your trailer to jackknife or go out of control.

### *Downgrades and upgrades.*

- Downshift to assist with braking on downgrades and to add power for climbing hills.
- On long downgrades, apply brakes at intervals to keep speed in check. Never leave brakes on for extended periods of time or they may overheat.
- Some tow vehicles have specifically calibrated transmission tow-modes. Be sure to use the tow-mode recommended by the manufacturer.

### *Backing up.*

- Put your hand at the bottom of the steering wheel. To turn left, move your hand left. To turn right, move your hand right. Back up slowly. Because mirrors cannot provide all of the visibility you may need when backing up, have someone outside at the rear of the trailer to guide you whenever possible.
- Use slight movements of the steering wheel to adjust direction. Exaggerated movements will cause greater movement

of the trailer. If you have difficulty, pull forward and realign the tow vehicle and trailer and start again.

### *Parking.*

- Try to avoid parking on grades. If possible, have someone outside to guide you as you park. Once stopped, but before shifting into Park, have someone place blocks on the downhill side of the trailer wheels. Apply the parking brake, shift into Park, and then remove your foot from the brake pedal. Following this parking sequence is important to make sure your vehicle does not become locked in Park because of extra load on the transmission. For manual transmissions, apply the parking brake and then turn the vehicle off in either first or reverse gear.
- When uncoupling a trailer, place blocks at the front and rear of the trailer tires to ensure that the trailer does not roll away when the coupling is released.
- An unbalanced load may cause the tongue to suddenly rotate upward; therefore, before uncoupling, place jack stands under the rear of the trailer to prevent injury.

## **Maintenance**

Tow vehicles often have more frequent maintenance requirements, including changes of engine and transmission oils and filters, lubrication of components, and cooling system checks. Check your owner's manual for information on scheduled maintenance of your tow vehicle and trailer. Here are some additional maintenance suggestions.

*Tires.*—Periodic inspection and maintenance of tow vehicle and trailer tires and wheels are essential to towing safety, including spare tires. Proper tire pressure affects vehicle handling and the safety of your tires. You can find the correct tire pressure for your tow vehicle in the owner's manual or on the tire information placard.

- Under inflation reduces the load-carrying capacity of your tow vehicle or trailer, may cause sway and control problems, and may result in overheating, causing blowouts or other tire failure.
- Over inflation causes premature tire wear and affects the handling characteristics of the tow vehicle or trailer.

*Brakes.*—On a regular basis, have the brakes on both vehicles inspected. Be sure that necessary adjustments are made and any damaged or worn parts are replaced.

*Hitch.*—Check the nuts, bolts, and other fasteners to ensure that the hitch remains secured to the tow vehicle and the coupler remains secured to the trailer. The connection point may require periodic lubrication to permit free movement of the coupler to the hitch ball.

*Wiring.*

- Make sure connector-plug prongs and receptacles, light bulb sockets, wire splices, and ground connections are clean and shielded from moisture. Lightly coat all electrical terminal connections with nonconducting (dielectric), light waterproof grease.
- Clean the prongs with very fine sandpaper, being careful not to damage the contact area.
- Clean the surface deposits in the connector holes. (Make sure the lights are off to prevent blowing a fuse.) Try to clean off only the deposits and lubricate lightly with dielectric, light waterproof grease.



## Topic 5. Industrial Hygiene

### Topic 5-1. Health Hazards

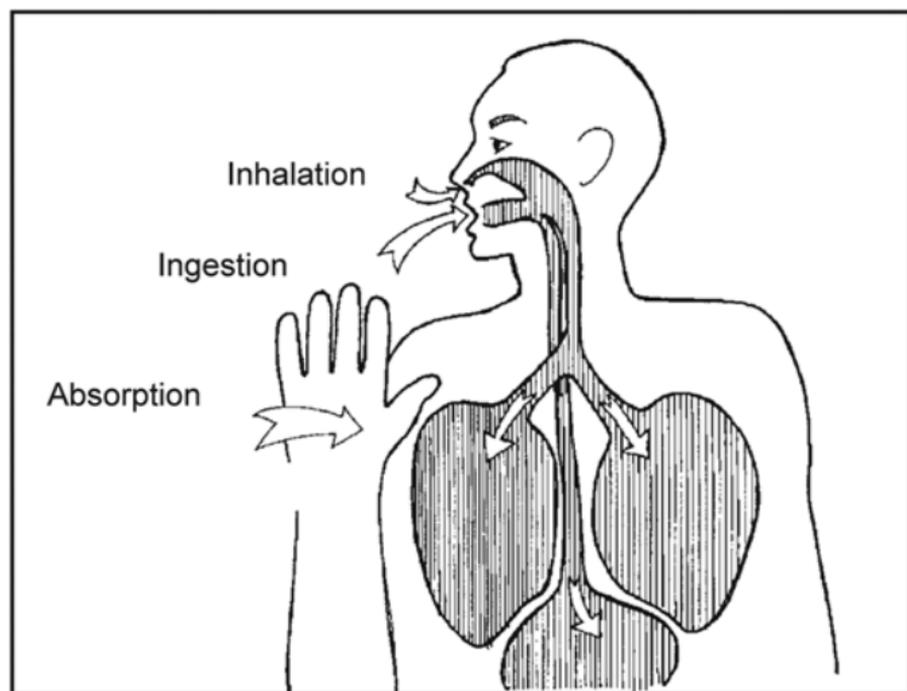
Because of the potential for exposing employees and volunteers to unhealthful, noisy, and ergonomically incorrect work environments, it is imperative that safety managers assist in designing and evaluating workplace settings and to reduce the risk of such conditions. It is also important that designs and conditions are planned and prepared in a manner that ensures the safety and health of cooperators and the visiting public.

#### Health Hazards

Health hazards may exist in a wide spectrum of chemical forms, including: mist, liquid, vapor, gas, dust, and fumes.

#### Routes of Entry

Employees may be exposed to health hazards in the following ways: skin absorption, inhalation (air contaminants), injection, and ingestion through poor hygiene practices.



**Routes of entry.**

## Standards of Exposure

To safeguard employees against health hazards, there are specific standards and limits for each type of exposure. The limits sometimes have very strict boundaries between what is safe and unsafe. The safety manager or industrial hygienist should be consulted concerning standards of exposure.

## Required Exposure Assessments

Although many health hazards can be estimated as unlikely, possible, or probable overexposures, some health hazard exposure assessments are required by a specific regulation. Usually the assessment is performed by representative personal monitoring. However, mathematical models or monitoring results from similar operations may be used.

If you use or are exposed to any of the health hazards listed here, ask to see the exposure assessment or, if there is no assessment, ask your safety manager or industrial hygienist to have the required assessment performed.

- Acrylonitrile
- Arsenic (inorganic)
- Asbestos
- Benzene
- 1,3-Butadiene
- Cadmium
- Chromium(VI), hexavalent chromium
- Coke oven emissions
- Cotton dust
- 1,2-Dibromo-3-chloropropane
- Ethylene oxide
- Formaldehyde
- Hazardous waste site cleanup operations
- Lead
- Methylene chloride
- Methylenedianiline
- Noise (need to shout to be understood at arm length away)
- Vinyl chloride
- 13 Carcinogens

- 4-Nitrobiphenyl, Chemical Abstracts Service Register Number (CAS No.) 92933;
- alpha-Naphthylamine, CAS No. 134327;
- Methyl chloromethyl ether, CAS No. 107302;
- 3,3'-Dichlorobenzidine (and its salts) CAS No. 91941;
- bis-Chloromethyl ether, CAS No. 542881;
- beta-Naphthylamine, CAS No. 91598;
- Benzidine, CAS No. 92875;
- 4-Aminodiphenyl, CAS No. 92671;
- Ethyleneimine, CAS No. 151564;
- beta-Propiolactone, CAS No. 57578;
- 2-Acetylaminofluorene, CAS No. 53963;
- 4-Dimethylaminoazo-benzene, CAS No. 60117; and
- N-Nitrosodimethylamine, CAS No. 62759.

## **Reducing or Eliminating Employee Exposure**

After an industrial hygiene evaluation has been conducted, if a hazardous exposure has been identified, immediate action must be taken to reduce the exposure as outlined below.

*Engineering Controls.*—The most effective and inexpensive engineering controls are designed into the facility or process before construction. For existing construction, personal protective equipment (PPE) may be required as an interim measure until engineering controls are implemented.

*Ventilation Controls.*

- Local exhaust ventilation installed in an enclosure, or as close as possible to the point of contaminant generation, is much more effective and provides better protection than general or building ventilation.
- Ventilation systems frequently are ineffective if adequate make-up air is not provided. Temper (heat) make-up air before it is introduced into the workplace in winter.
- For information regarding lab safety, refer to 29 CFR 1910.1450, Occupational exposure to hazardous chemicals in laboratories, or consult the safety manager.
- Many well-designed systems fail to protect employees because maintenance is minimal or nonexistent after installation. Regularly scheduled maintenance of environmental

control systems must be provided to ensure continued employee health protection.

*Substitution/isolation.*

- Eliminate or minimize, to the extent possible, hazardous materials, equipment, or processes by replacing all or part of the hazardous elements.
- Carefully investigate all substitutions to ensure that new hazards are not introduced.
- Hazardous processes may be isolated or enclosed to eliminate employee contact.

*Work methods as controls.*—Safe work practices, proper equipment, and good housekeeping will minimize unnecessary exposure to spilled substances. A housekeeping program must be established at each facility to clean up any spills of nontoxic substances promptly, and for regular cleanup and maintenance.

- *Vacuum cleaning.*—Vacuum cleaning is the most efficient method of collecting settled dust particles without causing appreciable re-entry into the workplace air. Blowing the settled dust particles with an air hose should never be done.
- *Wet methods.*—When vacuum cleaning equipment is not available, wet methods, such as using water and/or other wetting agents to remove dust particles on floors, may be done to minimize airborne dust caused by sweeping.

*Administrative controls.*—Administrative controls assist in reducing employee exposure. Time exposure limitation is achieved by rotating jobs or by reducing work periods. At best, administrative controls should only be used for brief periods until engineering corrections can be implemented.

*Personal protective equipment.*—Some operations are not amenable to engineering controls, so personal protective equipment may be the only practical way to limit employee exposure. Personal protective equipment may also be used for brief periods during repair of engineering controls and/or to ensure greater personal protection. It is essential that personal protective equipment be fitted to the individual employee and that the employee be carefully trained in the use and limitations of the equipment.

## Records

Employee exposure and medical records must be maintained in accordance with 29 CFR 1910.1020.

Employee exposure records must be maintained for at least 30 years. These records include:

- Environmental (workplace) monitoring or measuring of a toxic substance or harmful physical agent, including personal, area, grab, wipe, or other form of sampling, as well as related collection and analytical methodologies, calculations, and other background data relevant to interpretation of the results obtained.
- Biological monitoring results that directly assess the absorption of a toxic substance or harmful physical agent by body systems (such as the level of a chemical in the blood, urine, breath, hair, fingernails) but not including results that assess the biological effect of a substance or agent or that assess an employee's use of alcohol or drugs.
- Safety data sheets indicating that the material may pose a hazard to human health.
- In the absence of the above, a chemical inventory or any other record that reveals where and when used and the identity (for example, chemical, common, or trade name) of a toxic substance or harmful physical agent.

Employee medical records must be maintained for at least the duration of employment plus 30 years. These are records concerning the health status of an employee that are made or maintained by a physician, nurse, or other health care personnel, or technician, including:

- Medical and employment questionnaires or histories (including job description and occupational exposures).
- The results of medical examinations (pre-employment, pre-assignment, periodic, or episodic) and laboratory tests (including chest and other X-ray examinations taken for the purpose of establishing a baseline or detecting occupational illnesses and all biological monitoring not defined as an "employee exposure record").
- Medical opinions, diagnoses, progress notes, and recommendations.
- First aid records.
- Descriptions of treatments and prescriptions.

- Employee medical complaints.

For more details, see

- SM 445-2-H Chapter 51—Industrial Hygiene Program.
- 29 CFR 1910 Subpart Z, Toxic and Hazardous Substances.

## **Topic 5-2. Hazard Communication**

Information about the identities and hazards of chemicals must be available and understandable to employees. Chemical manufacturers and importers are required to evaluate the hazards of the chemicals they produce or import, and they must prepare labels and safety data sheets to convey the hazard information to their downstream customers. Employers with hazardous chemicals in their workplaces (including laboratories) must have labels and safety data sheets for their exposed employees and train them to handle the chemicals appropriately.

### **Hazard Classification**

Hazard classification provides specific criteria for classification of health and physical hazards, as well as classification of mixtures.

- For each chemical, the chemical manufacturer or importer must determine the hazard classes, and, where appropriate, the category of each class that apply to the chemical being classified.
- Laboratories that ship hazardous chemicals are considered to be either a chemical manufacturer or a distributor and must ensure that any containers of hazardous chemicals leaving the laboratory are labeled and that a safety data sheet is provided.

### **Hazard Communication Program**

The Hazard Communication Program is required to have:

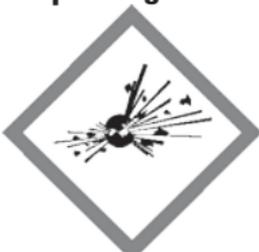
- Written Hazard Communication Program.
- List of hazardous chemicals known to be present using a product identifier from the safety data sheet.
- Labels and other forms of warning.
- Safety data sheets.
- Employee information and training.

## Labels

Chemical manufacturers and importers are required to provide a label that includes:

- **Product identifier**, which can be the chemical name, code number, or batch number or another identifier that matches the product identifier on the Safety Data Sheet.
- **Signal word**, either “Danger” or “Warning.”
- **Pictogram**. (See figures below.)
- **Hazard statement** for each hazard class and category describes the nature of the hazard(s) of a chemical, including, where appropriate, the degree of hazard. For example: “Causes damage to kidneys through prolonged or repeated exposure when absorbed through the skin.”
- **Precautionary statements** describe recommended measures that should be taken to minimize or prevent adverse effects resulting from exposure to the hazardous chemical or improper storage or handling.
  - There are four types of precautionary statements: (1) prevention (to minimize exposure); (2) response (in case of accidental spillage or exposure and the need for emergency response or first aid); (3) storage; and (4) disposal.
  - For example, “Do not breathe vapors or spray. Get medical attention if you feel unwell. Dispose of contents in accordance with local/regional/national/ international regulations.”
- **Name, address, and telephone number** of the chemical manufacturer, importer, or other responsible party.

## Pictograms

<p><b>Health hazard</b></p>  <p>Carcinogen                      Mutagenicity                      Reproductive toxicity                      Respiratory sensitizer                      Target organ toxicity                      Aspiration toxicity</p>	<p><b>Flame</b></p>  <p>Flammables                      Pyrophorics                      Self-heating                      Emits flammable gas                      Self-reactives                      Organic peroxides</p>	<p><b>Exclamation mark</b></p>  <p>Irritant (skin and eye)                      Skin sensitizer                      Acute toxicity                      Narcotic effects                      Respiratory tract irritant                      Hazardous to ozone layer (non-mandatory)</p>
<p><b>Gas cylinder</b></p>  <p>Gases under pressure</p>	<p><b>Corrosion</b></p>  <p>Skin corrosion/burns                      Eye damage                      Corrosive to metals</p>	<p><b>Exploding bomb</b></p>  <p>Explosives                      Self-reactives                      Organic peroxide</p>
<p><b>Flame over circle</b></p>  <p>Oxidizers</p>	<p><b>Environment (non-mandatory)</b></p>  <p>Aquatic toxicity</p>	<p><b>Skull and crossbones</b></p>  <p>Acute toxicity (fatal or toxic)</p>

## Example Label

HS85

Batch number: 85L6543



**Warning**

Harmful if swallowed

Wash hands and face thoroughly after handling. Do not eat, drink or smoke when using this product. Dispose of contents/container in accordance with local, state and federal regulations.

**First aid:** If swallowed: Call a doctor if you feel unwell. Rinse mouth.

GHS Example Company  
123 Global Circle, Anyville, NY 130XX  
Telephone (888) 888-8888

## Safety Data Sheets

Safety Data Sheets have a 16-section format. By June 1, 2015, the new safety data sheets must have the following sections in a uniform format.

- Section 1, Identification.
- Section 2, Hazard(s).
- Section 3, Composition/information on ingredients.
- Section 4, First aid.
- Section 5, Fire-fighting measures.
- Section 6, Accidental release measures.
- Section 7, Handling and storage.
- Section 8, Exposure controls/personal protection.
- Section 9, Physical and chemical properties.
- Section 10, Stability and reactivity.
- Section 11, Toxicological information.
- Section 12, Ecological information.
- Section 13, Disposal considerations.
- Section 14, Transport information.
- Section 15, Regulatory information.
- Section 16, Other information.

Where employees must travel and work at more than one geographic location, the safety data sheets may be kept at the primary facility. However, there must be a method for employees to immediately obtain the required information in an emergency. It is recommended that employees who work in the field routinely carry hard copies in a binder or electronic copies of the safety data sheets.

## **Information and Training**

Employees must be given information and training on hazardous chemicals in their work area at the time of their initial assignment, and whenever a new chemical hazard the employees have not previously been trained about is introduced into their work area.

For more details, see

- SM 445-2-H Chapter 20—Hazard Communication Program.
- 29 CFR 1910.1200, Hazard communication.

## **Topic 5-3. Chemicals of Special Concern**

Bureau employees working in the field have exposures to many chemicals, but some of these chemicals are of special concern. These chemicals may:

- Be brought to the field as part of the work,
- Be products of a process, or
- Occur naturally.

The following chemicals are of concern because they may be life threatening and/or have poor warning properties.

### **Arsenic**

Arsenic combines with other elements such as oxygen, chlorine, and sulfur to form inorganic arsenic compounds.

Exposure to higher-than-average levels of arsenic occurs mainly in workplaces, near or in hazardous waste sites, and areas with high levels naturally occurring in soil, rocks, and water. Exposure to high levels of arsenic can cause death. Exposure to arsenic at low levels for extended periods of time can cause a discoloration of the skin and the appearance of small corns or warts.

The health hazard of inorganic arsenic is high. Exposure to airborne concentrations of inorganic arsenic may cause lung cancer and can be a skin irritant. Inorganic arsenic may also affect your body if swallowed. One compound in particular, arsenic trichloride, is especially

dangerous because it can be absorbed readily through the skin. Because inorganic arsenic is a poison, you should wash your hands thoroughly prior to eating or smoking.

## **Asbestos**

Asbestos is the name given to a group of naturally occurring asbestiform minerals used in certain products to resist heat and corrosion. Asbestos includes chrysotile, amosite, crocidolite, tremolite asbestos, anthophyllite asbestos, actinolite asbestos, and any of these materials that have been chemically treated and/or altered.

Asbestiform minerals occur naturally in rock and soil as the result of natural geologic processes. They are often found in veins near earthquake faults. Naturally occurring asbestos can take the form of long, thin, separable fibers. Natural weathering or human disturbance can break naturally occurring asbestos down to microscopic fibers that are easily suspended in air.

There is no health threat if asbestos fibers in soil remain undisturbed and do not become airborne. However, inhalation of asbestos fibers can cause serious diseases of the lungs and other organs that may not appear until years after the exposure has occurred. For instance, asbestosis can cause a buildup of scar-like tissue in the lungs and result in loss of lung function that often progresses to disability and death. Asbestos fibers associated with these health risks are too small to be seen with the naked eye. Smokers are at higher risk of developing some asbestos-related diseases.

## **Benzene**

Benzene is a clear, colorless and highly flammable liquid with a pleasant, sweet odor. The odor of benzene does not provide adequate warning of its hazard.

Benzene is used mainly as a solvent and as a starting material in making other chemicals. Benzene is a natural constituent of crude oil and is one of the most elementary petrochemicals. The highest exposures have typically been in the workplace, although these have decreased greatly over the last several decades due to Federal regulations. Most nonindustrial applications have been limited by benzene's carcinogenicity.

In the United States, concern over its negative health effects and the possibility of benzene's entering the groundwater have led to stringent regulation of gasoline's benzene content, with limits typically around 1 percent.

All ignition sources must be controlled when benzene is used, handled, or stored. Where liquid or vapor may be released, such areas shall be considered as hazardous locations. Benzene vapors are heavier than air; thus the vapors may travel along the ground and be ignited by open flames or sparks at locations remote from the site at which benzene is handled.

Benzene increases the risk of cancer and other illnesses. It is a well-known cause of bone marrow failure. Substantial quantities of epidemiologic, clinical, and laboratory data link benzene to aplastic anemia, acute leukemia, and bone marrow abnormalities. The specific hematologic malignancies that benzene is associated with include: acute myeloid leukemia, aplastic anemia, myelodysplastic syndrome, acute lymphoblastic leukemia, and chronic myeloid leukemia. The American Petroleum Institute stated in 1948 that “it is generally considered that the only absolutely safe concentration for benzene is zero.

## **Cadmium**

Cadmium is a common impurity in zinc ores. Coal can contain significant amounts of cadmium. It has excellent corrosion resistance even at relatively low thickness and in salt atmospheres. Employees who cut, grind, or weld on aircraft or in a marine environment should assume that those metals could contain cadmium. Even a very small percentage of cadmium in the metal alloy can cause overexposures.

The primary and most serious adverse health effects of long-term exposure to cadmium include kidney dysfunction, lung cancer, and prostate cancer. Cadmium may cause local skin or eye irritation and can affect long-term health if inhaled or ingested. Employees face a greater danger of cadmium exposure from inhalation than from ingestion. Exposure to cadmium that may be dangerous to life or health may occur where employees are exposed to cadmium dust or fumes, where compounds or surfaces that contain cadmium are heated, or where employees weld or cut with materials or solders that contain cadmium.

## **Carbon Dioxide**

Carbon dioxide is a colorless, odorless gas and should be treated as a material with poor warning properties. It is denser than air and high concentrations can persist in open pits and other areas below grade.

High concentrations of carbon dioxide may be present:

- In outgassing volcanic systems. (Carbon dioxide trapped in depressions can be lethal.)

- Areas containing critical equipment that require carbon dioxide extinguishing systems.
- Confined or enclosed areas containing dry ice.
- Poorly ventilated welding areas.

Gaseous carbon dioxide is an asphyxiant. Concentrations of 10 percent (100,000 part per million) or more can produce unconsciousness or death. Lower concentrations may cause headache, sweating, rapid breathing, increased heartbeat, shortness of breath, dizziness, mental depression, visual disturbances, or shaking.

## **Carbon Monoxide**

Carbon monoxide is a colorless, odorless, toxic gas which interferes with the oxygen-carrying capacity of blood. Carbon monoxide is non-irritating and can overcome persons without warning. Carbon monoxide is a common industrial hazard resulting from the incomplete burning of natural gas and any other material containing carbon such as gasoline, kerosene, oil, propane, coal, or wood. Many people die from carbon monoxide poisoning, usually while using gasoline-powered tools and generators in buildings or semi-enclosed spaces without adequate ventilation.

Employees may be exposed to high levels of carbon monoxide while:

- Performing prescribed burns.
- Working in a gasoline-powered boat at idle or slow speeds.
- Entering a well, pit, or excavation while using a gasoline-powered pump to pump out water.
- Working or sleeping in an area with a portable generator or portable combustion-type heater in or near the area.

Carbon monoxide is harmful when breathed because it displaces oxygen in the blood and deprives the heart, brain, and other vital organs of oxygen. Large amounts of carbon monoxide can overcome you in minutes without warning, causing you to lose consciousness and suffocate.

Besides tightness across the chest, initial symptoms of carbon monoxide poisoning may include headache, fatigue, dizziness, drowsiness, or nausea. Sudden chest pain may occur in people with angina. During prolonged or high exposures, symptoms may worsen and include vomiting, confusion, and collapse in addition to loss of consciousness and muscle weakness.

Symptoms vary widely from person to person. Carbon monoxide poisoning may occur sooner in those most susceptible: young children, elderly people, people with lung or heart disease, people at high altitudes, or those who already have elevated carbon monoxide blood levels, such as smokers. Carbon monoxide poisoning poses a special risk to fetuses.

## **Formaldehyde**

Formaldehyde is a colorless, strong-smelling gas often found in aqueous (water-based) solutions. Commonly used as a preservative in laboratories and in the field, formaldehyde is also found in many products such as chemicals, particle board, household products, glues, permanent-press fabrics, paper-product coatings, fiberboard, and plywood. It is also widely used as an industrial fungicide, germicide, and disinfectant.

Although the term formaldehyde describes various mixtures of formaldehyde, water, and alcohol, the term “formalin” is used to describe a saturated solution of formaldehyde dissolved in water, typically with another agent (most commonly methanol) added to stabilize the solution.

Employees can inhale formaldehyde as a gas or vapor or absorb it through the skin as a liquid.

Formaldehyde is a sensitizing agent that can cause an immune system response upon initial exposure. It is also a cancer hazard. Acute exposure is highly irritating to the eyes, nose, and throat and can make anyone exposed cough and wheeze. Subsequent exposure may cause severe allergic reactions of the skin, eyes, and respiratory tract. Ingestion of formaldehyde can be fatal, and long-term exposure to low levels in the air or on the skin can cause asthma-like respiratory problems and skin irritation such as dermatitis and itching.

## **Hexavalent Chromium**

Hexavalent chromium or Cr(VI) is rarely found in nature and is generally manmade. It is widely used in pigments, metal finishing (electroplating), wood preservatives and fungicides, and in chemical synthesis as an ingredient and catalyst.

Hexavalent chromium may also be present in fumes generated during the production or welding of chrome alloys. Chromium metal is often alloyed with other metals or plated on metal and plastic substrates to improve corrosion resistance and provide protective coatings.

Workplace exposure to hexavalent chromium may cause the following health effects:

- Lung cancer in workers who breathe airborne hexavalent chromium.
- Irritation or damage to the nose, throat, and lungs (respiratory tract) if hexavalent chromium is inhaled.
- Irritation or damage to the eyes and skin if hexavalent chromium contacts these organs.

## Hydrogen Sulfide

Hydrogen sulfide is a colorless, flammable, extremely hazardous gas with a “rotten egg” smell. Some common names for the gas include sewer gas, stink damp, swamp gas, and manure gas. It occurs naturally in crude petroleum, natural gas, and hot springs. In addition, hydrogen sulfide is produced by bacterial breakdown of organic materials and human and animal wastes (for example, sewage). Industrial activities that can produce the gas include petroleum and natural gas drilling and refining, wastewater treatment, coke ovens, tanneries, and kraft paper mills. Hydrogen sulfide can also exist as a liquid compressed gas.

Hydrogen sulfide is heavier than air and may travel along the ground. It collects in low-lying and enclosed, poorly ventilated areas such as basements, manholes, sewer lines, underground telephone vaults, and manure pits.

People can smell the “rotten egg” odor of hydrogen sulfide at low concentrations in air. However, with continuous low-level exposure, or at high concentrations, a person loses his/her ability to smell the gas even though it is still present (olfactory fatigue). This can happen very rapidly and at high concentrations; the ability to smell the gas can be lost instantaneously. Therefore, **DO NOT** rely on your sense of smell to indicate the continuing presence of hydrogen sulfide or to warn of hazardous concentrations.

For work within confined spaces, monitor for hydrogen sulfide before entering confined spaces and during entry if hydrogen sulfide may accumulate during the operation. For example, hydrogen sulfide may be released in a stilling well if submerged organic material is stirred up from the bottom of the well.

Hydrogen sulfide is both an irritant and a chemical asphyxiant with effects on both oxygen utilization and the central nervous system. Its health effects can vary depending on the level and duration of

exposure. Repeated exposure can result in health effects occurring at levels that were previously tolerated without any effect.

Low concentrations irritate the eyes, nose, throat and respiratory system (for example, burning/tearing of eyes, cough, shortness of breath). Asthmatics may experience breathing difficulties. The effects can be delayed for several hours, or sometimes several days, when working in low-level concentrations. Repeated or prolonged exposures may cause eye inflammation, headache, fatigue, irritability, insomnia, digestive disturbances, and weight loss.

Moderate concentrations can cause more severe eye and respiratory irritation (including coughing, difficulty breathing, accumulation of fluid in the lungs), headache, dizziness, nausea, vomiting, staggering, and excitability.

High concentrations can cause shock, convulsions, inability to breathe, extremely rapid unconsciousness, coma, and death. Effects can occur within a few breaths, and possibly a single breath.

In addition, hydrogen sulfide is a highly flammable gas and gas/air mixtures can be explosive. It may travel to sources of ignition and flash back. If ignited, the gas burns to produce toxic vapors and gases, such as sulfur dioxide.

Contact with liquid hydrogen sulfide causes frostbite. If clothing becomes wet with the liquid, avoid ignition sources, remove the clothing and isolate it in a safe area to allow the liquid to evaporate.

## **Isocyanates**

Isocyanates are compounds containing the isocyanate group (-NCO). They react with compounds containing alcohol (hydroxyl) groups to produce polyurethane polymers, which are components of polyurethane foams, thermoplastic elastomers, and polyurethane paints. Isocyanates are the raw materials that make up all polyurethane products.

Jobs that may involve exposure to isocyanates include painting, foam-blowing, and the production of many polyurethane products, such as polyurethane foam, insulation materials, surface coatings, packaging materials, adhesives, roofing, and during the thermal degradation of polyurethane products. Check the ingredients of any two-part product that must be combined before it is used, because one of the parts is likely to have an ingredient that ends with “isocyanate” (for example, hexamethylene diisocyanate, isophorone diisocyanate, methyl isocyanate, methylene bis (4-cyclohexylisocyanate),

methylene bisphenyl isocyanate, naphthalene diisocyanate, toluene-2,4-diisocyanate).

Health effects of isocyanate exposure include irritation of skin and mucous membranes, chest tightness, and difficulty breathing. Isocyanates include compounds classified as potential human carcinogens and known to cause cancer in animals. The main effects of hazardous exposures are occupational asthma and other lung problems, as well as irritation of the eyes, nose, throat, and skin.

## **Lead**

Lead is an ingredient in thousands of products widely used throughout industry, including lead-based paints, lead solder, electrical fittings and conduits, tank linings, plumbing fixtures, and many metal alloys.

Operations that can generate lead dust and fumes include:

- Demolition of structures.
- Flame-torch cutting.
- Welding.
- Use of heat guns, sanders, scrapers, or grinders to remove lead paint.
- Abrasive blasting of steel structures.

Lead exposure comes from inhaling fumes and dust, and lead can be ingested when hands are contaminated by lead dust. Removable lead on surfaces, such as lead weight, can be ingested and/or carried home on clothes, hair, and skin.

To reduce exposure to lead:

- Wear gloves when handling uncoated lead weights.
- Wear disposable clothing and approved respirators when exposed to airborne lead dust.
- Wash hands and face after work and before eating.
- Never enter eating areas wearing protective equipment.
- Do not wear clothes and shoes that were worn during lead exposure away from work.

Lead adversely affects numerous body systems and causes forms of health impairment and disease that arise after periods of exposure as short as days (acute exposure) or as long as several years (chronic exposure). The frequency and severity of medical symptoms increases with the concentration of lead in the blood. Common

symptoms of acute lead poisoning are loss of appetite, nausea, vomiting, stomach cramps, constipation, difficulty in sleeping, fatigue, moodiness, headache, joint or muscle aches, anemia, and decreased sexual drive. Acute health poisoning from uncontrolled occupational exposures has resulted in fatalities. Long-term (chronic) overexposure to lead may result in severe damage to the blood-forming, nervous, urinary, and reproductive systems.

## **Methylene Chloride**

Methylene chloride, also called dichloromethane, is a volatile, colorless liquid with a chloroform-like odor. It is a solvent that is often used by laboratories for extractions. It is commonly used as a paint, varnish, or graffiti stripper and in many other products such as adhesive remover, weld cleaner, anti-seize solvent, brake cleaner, and in some pesticides.

The predominant means of exposure to methylene chloride is inhalation and skin exposure. The Occupational Safety and Health Administration considers methylene chloride to be a potential occupational carcinogen. Short-term exposures to high concentrations may cause mental confusion, lightheadedness, nausea, vomiting, and headache. Continued exposure may also cause eye and respiratory tract irritation. Exposure to methylene chloride may make symptoms of angina more severe. Skin exposure to liquid methylene chloride may cause irritation or chemical burns.

## **Silica**

Quartz is the most common form of crystalline silica. Quartz is present in many materials in the construction industry, such as brick and mortar, concrete, slate, dimensional stone (granite, sandstone), stone aggregate, tile, and sand used for blasting. Other construction materials that contain crystalline silica are asphalt filler, roofing granules, plastic composites, soils, and to a lesser extent, some wallboard joint compounds, paint, plaster, caulking, and putty. Cristobalite, a less common form of crystalline silica, is formed at high temperatures (greater than 1,470 degrees Centigrade) in nature and by industrial processes. The ceramic and brick lining of boilers and vessels, some ceramic tiles, and volcanic ash contain cristobalite.

Respirable dust containing crystalline silica is known to cause silicosis, a serious and sometimes fatal lung disease, as well as increases the risk of lung cancer and other systemic diseases. Employees who inhale fine particles of silica may be at risk of developing silicosis. Dusts containing silica are produced when materials such as concrete,

masonry, tile and rock are cut, ground, crushed, or drilled. The small particles easily become suspended in the air and, when inhaled, penetrate deep into employees' lungs.

## **Uranium**

Uranium is an element found everywhere on Earth, but mainly in trace quantities. Natural uranium consists primarily of the uranium isotope uranium-238. Uranium-238 emits alpha particles that are less penetrating than other forms of radiation, and weak gamma rays. As long as it remains outside the body, uranium poses little health hazard.

However, uranium is a weak chemical poison that can seriously damage the kidneys at high blood concentrations. Virtually all of the observed or expected effects are from nephrotoxicity associated with deposition in the kidney tubules and glomeruli damage at high blood concentrations of uranium. The ionizing radiation doses from natural uranium are very small compared to the potential toxic effects from uranium ions in the body (primarily damage to kidney tubules). The closest analogy of uranium's "heavy metal" toxicity is lead. However, metallic lead has considerably higher toxicity than metallic uranium.

The most serious health hazard associated with uranium mining is lung cancer due to inhaling uranium decay products. Uranium mill tailings contain radioactive materials, notably radium-226 and heavy metals such as manganese and molybdenum, which can leach into groundwater.

## **Topic 5-4. Ergonomics**

Ergonomics is the study of the relationship between the worker and the work environment. It recognizes that work methods, equipment, facilities, and tool design all influence the worker's fatigue, motivation, productivity, and the likelihood of sustaining an occupational injury or illness.

Selecting the proper tool for the job and fitting it to the individual has become very important for productivity and employee health. The ergonomic evaluation of work and tools has helped people to understand that the layout of the work area, the variety and scheduling of tasks, and the way tools are used are all factors as important as tool design itself.

## Principles of Ergonomics

The objective of ergonomics is to adapt the job and workplace to the worker by designing tasks, work areas, controls, displays, safety devices, tools, lighting, and equipment to fit the worker. Some jobs expose workers to excessive vibration and noise, eye strain, heavy lifting, and repetitive motion. Also, temperature extremes may aggravate or increase ergonomic stress.

### Hazards

Pulled or strained muscles, ligaments, tendons, fractured (broken) or herniated (bulging) discs are common back problems. The majority of workplace back disorders result from chronic or long-term injury to the back rather than from one specific incident. Back disorders are frequently caused by excessive or repetitive twisting, bending, and reaching; carrying, moving, or lifting loads that are too heavy or bulky; staying in one position for too long; poor physical condition; and poor posture.

Frequent and prolonged use of tools can cause soreness, aches, pains, and fatigue, which, when ignored, can lead to chronic musculoskeletal injuries of various kinds. The most common examples of these work-related musculoskeletal disorders are tendonitis, tenosynovitis, bursitis, epicondylitis (tennis elbow), carpal tunnel syndrome and de Quervain's syndrome.

### Risk Factors

Cumulative trauma disorders are disorders of the musculoskeletal and nervous systems that are caused or made worse by repetitive motions or prolonged activities. Other risk factors for cumulative trauma and back disorders include:

- Forceful exertions, usually with the hands.
- Pinch grips.
- Prolonged static postures, either sitting or standing.
- Awkward postures of the upper body, including reaching above the shoulders or behind the back.
- Excessive bending or twisting of the wrist.
- Continued elevation of the elbow.
- Inappropriate or inadequate hand tools.
- Restrictive workstations and inadequate clearances.
- Vibration from power tools.
- Improper seating or support.

- Poor body mechanics.
- Lifting heavy objects or objects of abnormal sizes.

The combined effect of several risk factors often results in the onset of cumulative trauma disorders.

*Static load.*—Static load or effort occurs when muscles are kept tense and motionless. Examples of static effort include holding the arms elevated, or extended forwards or sideways. (Try holding your arm straight out in front of you for a few minutes. Put any object in your outstretched hand and its weight will add to the static effort.) Bending and twisting the neck or the whole torso can also increase static load considerably. Add the exertion of force required to use a tool and the static load can increase still further.

Static effort, that is holding any strained position for a period of time, is a particularly undesirable component in any work situation. Static effort increases the pressure on both the muscles, as well as on tissues, tendons, and ligaments. It also reduces blood flow, which causes a localized fatigue more quickly than would be expected by performing dynamic work (involving movement). Statically loaded muscles are much more vulnerable to fatigue and subsequent injury than muscles which are performing dynamic work. Furthermore, muscles which are tired by static work take more than 10 times longer to recover from fatigue.

*Awkward working positions and body postures.*—Hand tools are often used where the space is limited and access is difficult. When the hand holds and uses a tool in an awkward position it has less strength and is consequently more susceptible to soreness and eventual injury. If the arm is uncomfortable, the rest of the body is likely to be so as well, because it is natural to compensate for discomfort by trying to re-align the body by bending the back, rounding the shoulders, tilting the neck, and so on.

Awkward positions of the upper body considerably increase the effort needed to complete the task. The resulting fatigue, discomfort, and pain add further to the risk for developing injury.

*Tissue compression from forceful grips.*—As a rule, using a hand tool requires a firm grip. The resulting compression of soft tissue in the palm and fingers may obstruct blood circulation, resulting in numbness and tingling. Blisters are also common due to friction between the palm of the hand and the handle of the tool.

*Vibration.*—Certain heavy tools such as a chipping hammer can produce significant vibration which is responsible for hand-arm vibration syndrome, more commonly known as white finger or Raynaud’s syndrome.

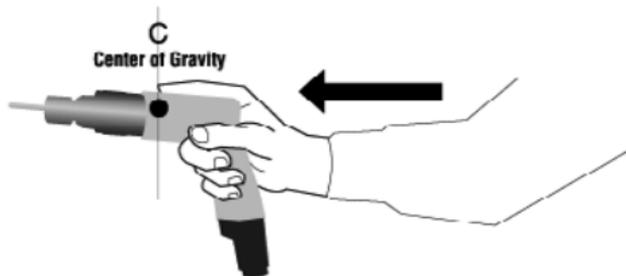
## Prevention and Controls

Ergonomic hazards are prevented primarily by the effective design of a job or job site and the tools or equipment used in that job. Based on information obtained in an analysis of the worksite, procedures can be established to correct or control ergonomic hazards using engineering and work practice controls.

*Design of tools.*—To be an effective “ergonomic” tool, it must decrease the physical demands placed on the persons using the tool.

*Weight of the tool.*

- Ideally, an employee should be able to operate a tool with one hand. Therefore the weight of the tool, especially for repetitive use, should not exceed 2 pounds. It is also important that the center of gravity be aligned with the center of the gripping hand.



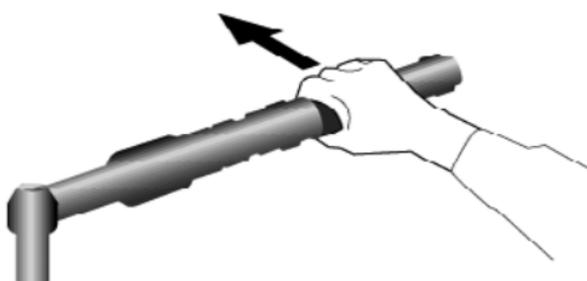
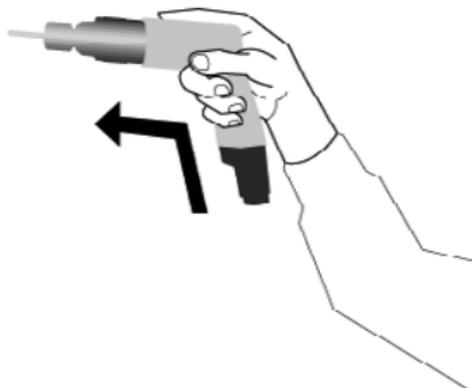
- In other words, tools should feel “easy” to hold, either in an upright position or in the position it will be used (for example, pointing down).
- For example, drills that are “front-heavy” will require effort (especially in the wrist and forearm) to hold in a usable position and should be avoided.
- The exception to this principle is a power hand tool, such as a grinder, that has to be heavy in order to reduce the force that the employee has to exert while using it.
- Tools heavier than 2 pounds or poorly balanced tools should be supported by counter-balancers.

### *Handles.*

- With the exception of tools for precision work (watchmaking, microsurgery, carving), the handles and grips of hand tools should be designed for a power grip.
- The belief that smaller tools should have smaller handles while larger tools have larger ones is debatable.

### *Handle shape.*

- Tools with “bent” or angled handles or tools with pistol-grips are beneficial where the force is exerted in a straight line in the same direction as the straightened forearm and wrist, especially when the force must be applied horizontally, as shown in the illustrations below.



- Tools with straight handles are for tasks where the force is exerted perpendicular to the straightened forearm and wrist; for instance, when the force must be applied vertically.
- Shaped tools such as bent-handle tools are effective where most of the tasks are done in the same plane and height as the arm and hand, and when only one or two other tools are used.
- Knowing the tasks and the layout of the workplace where they will be used is vital for selecting the right tools for any

given job. Select tools that do NOT require wrist flexion, extension, or deviation. In other words, select tools that allow you to keep the wrist straight or in a neutral position.

- The crucial ergonomic principle in tool use and design—bend the tool, not the wrists—however correct and valuable does not always prevent discomfort and injuries when bent-handle tools are used indiscriminately, regardless of the layout of the work situation.

#### *Diameter.*

- Handles should be cylindrical or oval in cross section, with a diameter of between 1 1/4 inch and 1 3/4 inch.
- For precision work the recommended diameter for handles is between 3/16 and 15/32 inch.
- For a greater torque, large screwdrivers should have a handle diameter up to 2 to 2 1/2 inches.

#### *Length.*

- A handle that is too short can cause unnecessary compression in the middle of the palm.
- It should extend across the entire breadth of the palm.
- Tool handles longer than 4 inches (preferably longer) will reduce the negative effects of any compression exerted.
- Rounded handles will minimize palm compression on the palm still further.
- Keep in mind that the use of gloves requires longer tool handles.

#### *Separation between handles.*

- Crushing, gripping, or cutting tools such as pliers or tongs are equipped with two handles.
- The recommended distance separating the handles is between 2 to 2 1/2 inches. Such a range will fit both male and female users. Tools with larger or smaller spans will reduce one's maximum grip strength and may contribute to the onset of carpal tunnel syndrome.

#### *Materials and texture of handles.*

- To ensure a good grip on a handle, sufficient friction must exist between the hand and the handle.
- This is particularly important where a considerable force must be applied with a sweaty hand.

- Hand tools should be made of non-slip, nonconductive and compressible materials. For example, textured rubber handles provide a good grip, reduce the effort needed to use the tool effectively, and prevent the tool from slipping out of the hand.
- Glossy coatings and highly polished handles should be avoided.
- The electrical and heat insulation properties of the handles are important for power hand tools. Handles made of plastics or compound rubber are recommended.
- Sharp edges and contours can be covered with cushioned tape to minimize lacerations.

### *Power tool triggers*

- Frequent movements of the index finger while operating the trigger of power tools (such as a power drill) poses a considerable risk for both “trigger finger” and “trigger thumb” (tendonitis in the index finger and/or thumb).
- A longer trigger that allows the use of two or three fingers to activate them reduces discomfort and minimizes the risk for injury.
- The recommended minimum length of the trigger is 2 inches.

### *Vibration*

- The only effective way to reduce vibration in power tools is at the design stage. This fact makes tool selection most critical.
- The common practices of covering handles of vibrating tools with a layer of viscoelastic material or of using anti-vibration gloves made of similar material are of dubious value. These “anti-vibration” materials will dampen vibration above certain frequencies that are characteristic for the kind of material, but most of the vibration energy in a handle of a power tool is below those frequencies.

*Workplace.*—Tool selection is of critical importance for user safety, comfort, and health. However, even the best tool on the market will not transform a poorly designed work area into a safe and comfortable one for the operator.

Many work space components such as work surfaces, seats, flooring, tools, equipment, and environmental conditions determine whether or not the job is safe and healthy. If the workplace design does not meet

your physical needs, it can create risk factors for discomfort, aches and pains, fatigue, and eventually, work-related musculoskeletal disorders. On the other hand, in a well-designed workplace, where you have the opportunity to choose from a variety of well-balanced working positions and to change between them frequently, work can be carried out safely and injury-free.

*Body posture.*

- Avoid bending over your work; instead keep your back straight and, if possible, elevate the work area or task to a comfortable level.
- Keep your elbows close to your body, and reduce the need to stretch your arms overhead or out in front of you.
- Tool extensions can help where it is difficult to reach the object of work.
- Using a stepladder or step stool can improve the working body position where the task requires elevating your arms above the shoulder.
- At the same time, frequent stretching breaks will relieve any built-up muscle tension.
- If standing, distribute your weight evenly between the feet. Even better, use a foot stool or rail to rest your legs, and shift from one to the other periodically.

*Task variety.*—Jobs that involve using only one kind of tool for one or a few tasks that do not vary in the movements and muscles used can cause an overload of those muscles, ligaments, tendons, or tissues. The resulting overload on the same part of the body can cause pain and injury. A greater variety of tasks allows for changing body position to distribute the workload over different parts of the body, and to give overtaxed muscles some relief and recovery time.

- Rotate tasks among employees. Have employees move from one task to another according to a schedule. Ensure tasks are different in the type of movement and body parts used.
- Add more tasks to the job.
- Assign a larger part of work to a team. Each member of the team can share several different tasks.

*Work pace.*—A fast pace of work is a strong risk factor for work-related musculoskeletal disorders. If the pace is too fast, the muscles involved do not have enough time to recover from the effort and to restore sufficient energy to continue the work.

- If the pace of work is imposed externally (for example, on an assembly line), adjust the speed to that which is acceptable for the slowest employee.
- Incentive systems that reward for the quality of work naturally determine the “right” pace of work.
- Incentive systems that reward for the amount or quantity of work increase the risk for work-related musculoskeletal disorders and, in the long run, will compromise quality as well.

*Work breaks.*—The work break is a time period between tasks. Even short periods of time, literally seconds, that allow one to relax muscles are important in preventing injuries.

*Rest breaks.*—The rest break is the period after work stops. Besides allowing for refreshment, rest breaks can be used to stretch and relax.

*Adjustment period.*—An adjustment or acclimatization period is the time needed to get “in shape” when returning to work after a long absence, or when starting a new job. It should allow one to refresh old work habits or get used to a new routine. An adjustment period is a very important element of injury prevention. Inexperienced and “new” employees, as well as “old timers” returning to work after a period of recovery and rehabilitation, are more prone than most employees to both injury and re-injury, so adjustment periods are a vitally important way to reintegrate them into the workflow.

## **Training**

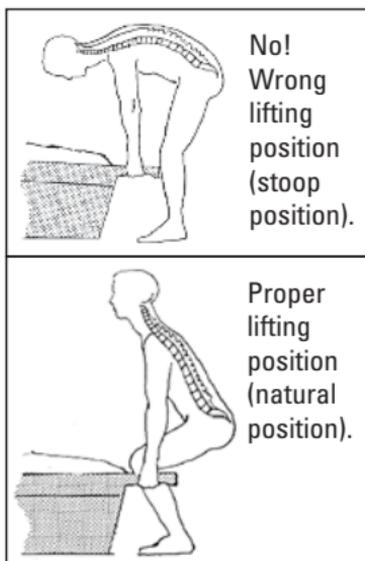
Training employees on the safe use of tools, and on the hazards involved in working with them, has always been extremely important. Today, more than ever, when new materials, new technologies, and new equipment are replacing older ones faster than ever before, the importance of such training is magnified. The introduction of a new tool or equipment, as well as any change in the way the job has been done previously should be preceded by refresher training that includes new information relevant to the changes being introduced. Even the best-designed tool, or the most ergonomically correct workstation, or the most up-to-date organization will fail to prevent injuries if the employee is not properly trained.

## **Lifting**

When lifting heavy materials, use a lift assist such as a hand cart, pallet jack, forklift, hoist, or other device if possible.

### *Manual lifting.*

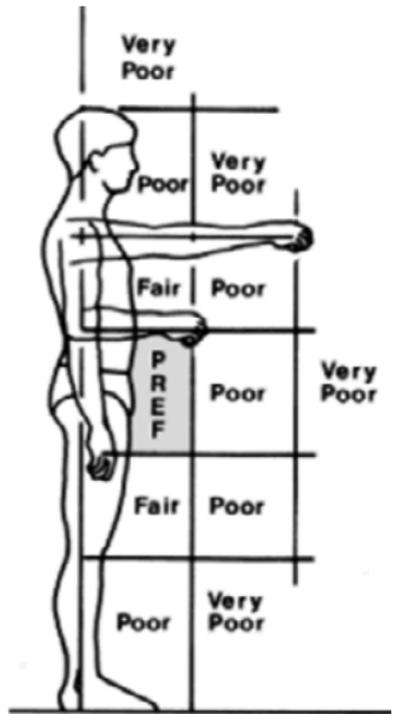
- For manual lifting, lift with your legs, not with your back.
- Materials that must be manually lifted should be placed at “power zone” height, about mid-thigh to mid-chest. Special care should be taken to ensure proper lifting principles are used.
- Maintain neutral and straight spine alignment whenever possible. Usually, bending at the knees, not the waist, helps maintain proper spine alignment.
- Order supplies in smaller quantities and break down loads off-site. When possible, request that vendors and suppliers break down loads prior to delivery. If you have to lift more than 50 pounds, ask for help.



### *When is a load too heavy to lift manually?*

- The National Institute for Occupational Safety and Health (NIOSH) developed a tool to help answer this question. The NIOSH lifting equation is used to assess a lifting task and given the conditions, determine a recommended weight limit for the task.
- The recommended weight limit is calculated using an equation that starts with a maximum lifting constant of 51 pounds. Each characteristic of the load and the lifting conditions either reduces the recommended weight limit or keeps it the same. These include:
  - Horizontal and vertical location of load.
  - Distance the load will be moved.
  - Asymmetry.
  - Frequency of the lift.
  - Hand coupling for the load.
  - Length of time during which the lifting will take place.

- The recommended weight that should not be exceeded assuming **ideal** lifting conditions and techniques is **51 pounds**.
- Ideal conditions are not realistic when calculating a recommended weight limit for most tasks. Thus, the 51 pounds will invariably be reduced to a lower weight.



*NIOSH lifting equation:*

$$RWL = LC \times HM \times VM \times DM \times AM \times FM \times CM$$

where

RWL	=	Recommended Weight Limit
LC Load Constant	=	51 pounds
HM Horizontal Multiplier	=	10 / H inch
VM Vertical Multiplier	=	1-0.003 /  V-30 inch
DM Distance Multiplier	=	0.82 + 1.8 / D inch
AM Asymmetric Multiplier	=	1-0.0032A degrees
FM Frequency Multiplier	=	from the table
CM Coupling Multiplier	=	from the table

The term “multiplier” refers to the reduction coefficient(s) that serve to decrease the load constant.

where

- H is distance of the hands from the midpoint between the ankles.
- V is distance of the hands above the floor at the origin or the destination of the lift.
- D is the absolute value of the difference in the vertical heights at the origin and the destination of the lift.

- A is the angular measure of how far the object is displaced from in front of the body at the beginning or the end of the lift.
- F is the average number of lifts per minute over a 15 minute period.
- Lifting Duration is a classification of work time and recovery time. Duration is short (1 hour), moderate (1–2 hours), or long (2–8 hours).
- Coupling is a classification of the quality of the hand-to-object coupling (for example, handle, cut-out, or grip). Coupling is good, fair, or poor.

Although the lifting equation does not apply to some of the conditions that USGS employees work in, it can be used as a guide.

*NIOSH Lifting Equation does not apply to lifting or lowering:*

- With one hand.
- For over 8 hours.
- While seated or kneeling.
- In a restricted work space.
- Unstable objects.
- While carrying, pushing, or pulling for more than one or two steps.
- With high-speed motion (faster than about 30 inches per second, a lift from floor to table height in less than 1 second).
- Unreasonable foot to floor interface (less than or equal to 0.4 coefficient of friction between the sole and the floor).
- With low coefficient of friction between hand and object.
- In an unfavorable environment such as temperature outside the 66–79 degrees Fahrenheit range or relative humidity outside 35–50 percent range.

### Coupling Multiplier (CM) Table

Coupling type	Coupling multiplier	
	V < 30 inches	V ≥ 30 inches
Good	1.00	1.00
Fair	0.95	1.00
Poor	0.90	0.90

## Frequency Multiplier (FM) Table

Frequency lifts/min (F):	Work Duration					
	≤ 1 hour		>1 but ≤ 2 hours		>2 but ≤ 8 hours	
	V < 30	V ≥ 30	V < 30	V ≥ 30	V < 30	V ≥ 30
≤0.2	1.00	1.00	00.95	0.95	0.85	0.85
0.5	0.97	0.97	0.92	0.92	0.81	0.81
1	0.94	0.94	0.88	0.88	0.75	0.75
2	0.91	0.91	0.84	0.84	0.65	0.65
3	0.88	0.88	0.79	0.79	0.55	0.55
4	0.84	0.84	0.72	0.72	0.45	0.45
5	0.80	0.80	0.60	0.60	0.35	0.35
6	0.75	0.75	0.50	0.50	0.27	0.27
7	0.70	0.70	0.42	0.42	0.22	0.22
8	0.60	0.60	0.35	0.35	0.18	0.18
9	0.52	0.52	0.30	0.30	0.00	0.15
10	0.45	0.45	0.26	0.26	0.00	0.13
11	0.41	0.41	0.00	0.23	0.00	0.00
12	0.37	0.37	0.00	0.21	0.00	0.00
13	0.00	0.34	0.00	0.00	0.00	0.00
14	0.00	0.31	0.00	0.00	0.00	0.00
15	0.00	0.28	0.00	0.00	0.00	0.00
>15	0.00	0.00	0.00	0.00	0.00	0.00

## Topic 5-5. Heat Illness Prevention

Every year, thousands of workers become sick from exposure to heat, and some even die. **These illnesses and deaths are preventable.**

- When heat stroke doesn't kill immediately, it can shut down major body organs causing acute heart, liver, kidney, and muscle damage, nervous system problems, and blood disorders.
- Workers suffering from heat exhaustion are at greater risk for accidents since they are less alert and can be confused.
- Any employee exposed to hot and humid conditions is at risk of heat illness, especially those doing heavy work tasks or using bulky protective clothing and equipment.
- Some employees might be at greater risk than others if they have not built up a tolerance to hot conditions.

## What is Heat Illness?

The body normally cools itself by sweating. During hot weather, especially with high humidity, sweating isn't enough. Body temperature can rise to dangerous levels if precautions are not taken. Heat illnesses range from heat rash and heat cramps to heat exhaustion and heat stroke. Heat stroke requires **immediate medical attention** and can result in **death**.

## Preventing Heat Exhaustion

*Water, Rest, Shade.*—Taking these precautions can mean the difference between life and death.

- Drink water every 15 minutes, even if you're not thirsty.
- Rest in the shade to cool down.
- Wear a hat and light-colored clothing.
- Learn the signs of heat illness and what to do in an emergency.
- Keep an eye on fellow employees.

*Additional good practices.*

- Gradually increase workloads and allow more frequent breaks for new workers or workers who have been away for a week or more to build a tolerance for working in the heat (acclimatization).
- It's better to drink small amounts frequently, as opposed to larger amounts less often.
- Avoid drinks like sodas or coffee that have caffeine, or alcoholic drinks—these drinks dehydrate you and can make it more dangerous to work in the heat. Also avoid sports drinks, as these contain too much sugar.
- People worry that if they drink a lot of water, they'll have to go to the bathroom more often. In fact, you'll mostly sweat it off.
- When you're not at work, continue to drink plenty of water to help your body recover from the workday.
- During a heat wave, you should take more frequent breaks.
- Pair off and watch your co-worker for signs of heat exhaustion. Remind your buddy to drink water or take a break. Talk to your buddy to make sure everything is okay. Sometimes people with heat exhaustion get disoriented and think they are okay. If you suspect a problem, keep checking on your co-worker or tell a supervisor.

- Sometimes people say they are more protected by dark-colored, heavier clothing. This will only make you hotter. Wear light-colored, lightweight cotton clothing.

*Heat index.*—The “heat index” is a single value that takes both temperature and humidity into account. The higher the heat index, the hotter the weather feels, since sweat does not readily evaporate and cool the skin.

*Project plans.*—Consider adding one or more of the following to a project plan or work schedule when the heat index is in the orange (103 to 115 degrees Fahrenheit) or red range (above 115 degrees Fahrenheit). Check those that apply to your plan.

- Schedule the more strenuous tasks during cooler times of the day.
- Start work earlier and end earlier.
- Add more scheduled breaks.
- Other.

## **Health Effects of Heat**

Employees must be educated about the symptoms of heat-related illnesses and their prevention.

Heat exhaustion can often affect you before you even realize it, so it’s important to be very aware of the signs. Just like you shouldn’t let a car engine overheat or it shuts down, you don’t want your body to get too hot.

*Where does the heat come from that causes our bodies to overheat?*

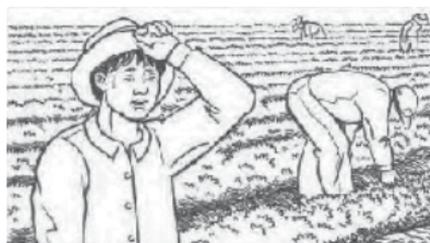
- Hot weather.
- Humid weather.
- Sun—you absorb more heat if you are in the sun.
- Heat our bodies generate when we are physically active and doing hard work.

*What are some signs that your body is getting too hot?*

- Headache, dizziness, or fainting.
- Weakness and wet skin.
- Irritability or confusion.
- Thirst, nausea, or vomiting.

These are the early signs that you need to cool off, rest, and drink water to let your body recover. If you don't, you could develop some of the more serious effects of heat. People react differently, so you may have just a few of these symptoms, or most of them.

Working outdoors is hard work and you will feel sweaty and tired. You need to drink water, take shade breaks, and rest to prevent heat problems. Then, if you feel better, you can go back to work, but you should still drink water frequently and take another break when you need to. If you don't feel better, talk to your supervisor right away.



Weakness, headache, and wet skin



Prevention: shade, water, and rest



Back to work

## Medical Emergency

- If you start to feel confused, or if you vomit or become faint, you may be having a more serious response.
- Employees may also develop what is called heat stroke.
- At this point, you may be confused, unable to think clearly, pass out, collapse, or have seizures (fits).
- You may stop sweating. Sweating is the main way our bodies cool off. Not sweating is a very serious emergency.

There have been cases where workers have seemed fine at lunch and a couple of hours later were found having seizures or unconscious. It can happen quickly. The best way to prevent heat exhaustion is by drinking plenty of water, taking breaks, and resting to cool off.

*You may be at greater risk if you*

- Aren't used to working in heat or doing heavy work.
- Are new to working outdoors.
- Are not physically fit or are overweight.
- Drink alcohol or take drugs (illegal drugs or prescription medicine).
- Wear heavy, dark, or tight clothing, or use personal protective equipment.
- Had some early heat-related symptoms the day before.

Most employees who died from heat stroke in the past few years were in their first few days on the job or were working during a heat wave. If you haven't worked in hot weather for a week or more, your body needs time to adjust. You need to take more breaks and not do too much strenuous work during your first weeks on the job.

Some health conditions can put you at greater risk of heat illness. These include diabetes, kidney and heart problems, pregnancy, and being overweight. If you have these, you should talk to your doctor about the work you do and ask whether there are any special precautions you need to take.

## **How to Respond to Symptoms**

If a coworker has signs of heat exhaustion—very sweaty, weak, and has a headache—what should you do?

- Notify the supervisor that the worker needs medical help.
- Move the person to a cooler place to rest in the shade. Don't leave him or her alone.
- Little by little, give him water.
- Loosen his clothing.
- Help cool the person. Fan him, put ice packs on his groin and underarms, or soak his clothing with cool water.

Be alert to unusual behavior. If a co-worker seems confused, is sitting by himself, or walking around aimlessly, ask him if he's okay. If he seems to be acting strangely, he may be suffering from heat stroke.



May have headache, dizziness, or fainting, weakness and wet skin, irritability or confusion, thirst, nausea, or vomiting.



May be confused, unable to think clearly, pass out, collapse, have seizures (fits), or may stop sweating.

**NEED MEDICAL HELP**

For more details, see SM 445-2-H Chapter 45—The Management of Occupational Heat Stress.

## Topic 5-6. Cold Illness Prevention

When the body is unable to warm itself, serious cold-related illnesses and injuries may occur, and permanent tissue damage and death may result. Cold-related illnesses can slowly overcome a person who has been chilled by low temperatures, brisk winds, or wet clothing.

Frostbite and hypothermia are the two most common types of cold injuries.

### Frostbite

*What happens to the body with frostbite?*

- Freezing in deep layers of skin and tissue.
- Pale, waxy-white skin color.
- Skin becomes hard and numb.
- Usually affects:
  - Fingers
  - Hands
  - Toes
  - Feet
  - Ears
  - Nose

### *First Aid for Frostbite on Land.*

- Move the person to a warm, dry area. Don't leave the person alone.
- Remove any wet or tight clothing that may cut off blood flow to the affected area.
- **DO NOT** rub the affected area; rubbing causes damage to the skin and tissue.
- **Gently** place the affected area in a warm (105 degrees Fahrenheit) water bath and monitor the water temperature to **slowly** warm the tissue.
- Don't pour warm water directly on the affected area because it will warm the tissue too fast, causing tissue damage. Warming takes about 25 to 40 minutes.
- After the affected area has been warmed, it may become puffy and blister.
- The affected area may have a burning feeling or numbness. When normal feeling, movement, and skin color have returned, the affected area should be dried and wrapped to keep it warm.
- **NOTE:** If there is a chance the affected area may get cold again, do not warm the skin. If the skin is warmed and then becomes cold again, it will cause severe tissue damage.
- Seek medical attention as soon as possible.

## **Hypothermia**

Hypothermia can occur when land temperatures are **above** freezing or water temperatures are below 98.6 degrees Fahrenheit.

### *What happens to the body with hypothermia?*

- Normal body temperature (98.6 degrees Fahrenheit) drops to or below 95 degrees Fahrenheit.
- Fatigue or drowsiness.
- Uncontrolled shivering.
- Cool bluish skin.
- Slurred speech.
- Clumsy movements.
- Irritable, irrational, or confused behavior.

*First Aid for Hypothermia on Land.*

- Call for emergency help (such as an ambulance or 911).
- Move the person to a warm, dry area. Don't leave the person alone.
- Remove any wet clothing and replace with warm, dry clothing or wrap the person in blankets.
- Have the person drink warm, sweet drinks (sugar water or sports-type drinks) if they are alert.
- **Avoid drinks with caffeine** (coffee, tea, or hot chocolate) or alcohol.
- Have the person slowly move arms and legs to create muscle heat.
- If individuals are unable to do this, place warm bottles or hot packs in the arm pits, groin, neck, and head areas.
- **DO NOT** rub the person's body or place them in warm water bath. This may stop the heart.

*First Aid for Hypothermia in Water.*

- Call for emergency help (such as an ambulance or 911). Body heat is lost up to 25 times faster in water.
- **DO NOT** remove any clothing. Button, buckle, zip, and tighten any collars, cuffs, shoes, and hoods because the layer of trapped water closest to the body provides a layer of insulation that slows the loss of heat.
- Keep the head out of the water and put on a hat or hood.
- Get out of the water as quickly as possible or climb on anything floating.
- **DO NOT** attempt to swim unless a floating object or another person can be reached; swimming or other physical activity uses the body's heat and reduces survival time by about 50 percent.
- If getting out of the water is not possible, wait quietly and conserve body heat by folding arms across the chest, keeping thighs together, bending knees, and crossing ankles.
- If another person is in the water, huddle together with chests close together.

## **Preventing Cold Illnesses**

Employees who are at risk must be trained to recognize the environmental and workplace conditions that lead to potential cold-induced

illnesses and injuries. They must learn the signs and symptoms of cold-induced illnesses and injuries and how to help a co-worker.

*Wear the right clothing.*

- Select proper clothing for cold, wet, and windy conditions.
- Layer clothing to adjust to changing environmental temperatures.
- Wear a hat and gloves, in addition to underwear that will keep water away from the skin (polypropylene).

*Reduce time in the cold environment.*

- Take frequent short breaks in warm, dry shelters to allow the body to warm up.
- Perform work during the warmest part of the day.

*Maintain energy. Work in pairs.*

- Avoid exhaustion or fatigue because energy is needed to keep muscles warm.
- Use the buddy system.
- Drink warm, sweet beverages (sugar water, sports-type drinks).
- Avoid drinks with caffeine (coffee, tea, or hot chocolate) or alcohol.
- Eat warm, high-calorie foods like hot pasta dishes.

*You may be at greater risk if you*

- Have predisposing health conditions such as cardiovascular disease, diabetes, or hypertension.
- Take certain medication. (Check with your doctor, nurse, or pharmacy and ask if any medicines you are taking affect you while working in cold environments.)
- Are in poor physical condition, have a poor diet, or are older.

For more details, see SM 445-2-H Chapter 48—Prevention of Cold Stress Injuries.

## **Topic 5-7. Noise**

When sound waves enter the outer ear, the vibrations impact the ear drum and are transmitted to the middle and inner ear. In the middle ear three small bones called the malleus (or hammer), the incus (or anvil), and the stapes (or stirrup) amplify and transmit the vibrations

generated by the sound to the inner ear. The inner ear contains a snail-like structure called the cochlea which is filled with fluid and lined with cells with very fine hairs. These microscopic hairs move with the vibrations and convert the sound waves into nerve impulses—the result is the sound we hear. Exposure to loud noise can destroy these hair cells and cause hearing loss.

## Hazards

- Exposure to high levels of noise can cause permanent hearing loss. Neither surgery nor a hearing aid can help correct this type of hearing loss.
- Short-term exposure to loud noise can also cause a temporary change in hearing (your ears may feel stuffed up) or a ringing in your ears (tinnitus). These short-term problems may go away within a few minutes or hours after leaving the noisy area. However, repeated exposures to loud noise can lead to permanent tinnitus and/or hearing loss.
- Loud noise can also create physical and psychological stress, reduce productivity, interfere with communication and concentration, and contribute to workplace accidents and injuries by making it difficult to hear warning signals.
- Noise-induced hearing loss limits your ability to hear high-frequency sounds, understand speech, and seriously impairs your ability to communicate.
- Hearing loss can interfere with your ability to enjoy socializing with friends, playing with your children or grandchildren, or participating in other social activities you enjoy, and can lead to psychological and social isolation.

## Warning Signs

Noise may be a problem if:

- You hear ringing or humming in your ears when you leave work.
- You have to shout to be heard by a co-worker an arm's length away.
- You experience temporary hearing loss when leaving work.

If you experience any of these warning signs, contact your safety manager or industrial hygienist and request a noise exposure evaluation.

## Exposure Monitoring

- When information indicates that any employee's exposure may equal or exceed an 8-hour time-weighted average of 80 decibels, A-weighted, representative personal exposure monitoring must be conducted.
- Employees must be notified of the results of exposure monitoring.

## Controls

Use controls to reduce noise exposures. Reducing noise by even a few decibels will reduce the hazard of hearing loss, improve communication, and reduce noise-related annoyance. There are several ways to control and reduce noise in a workplace.

**Engineering controls** that reduce sound exposure levels are available and technologically feasible for most noise sources. Engineering controls involve modifying or replacing equipment, or making related physical changes at the noise source or along the transmission path to reduce the noise level at the worker's ear. In some instances the application of a relatively simple engineering noise-control solution reduces the noise hazard to the extent that further requirements of OSHA's noise standard (audiometric testing, hearing conservation program, hearing protectors, training) are not necessary. Examples of inexpensive, effective engineering controls include:

- Choose low-noise tools and machinery.
- Maintain and lubricate machinery and equipment (for example, oil bearings).
- Place a barrier between the noise source and employee (for example, sound walls or curtains).
- Enclose or isolate the noise source.

**Administrative controls** are changes in the workplace that reduce or eliminate the worker exposure to noise. Examples include:

- Reduce the number of employees near the noise source if not required for the specific operation.
- Increase the employee's distance from the noise source.
- Limiting the amount of time a person spends at a noise source.
- Providing quiet areas where workers can gain relief from noise (for example, soundproof room or break area).

Controlling noise exposure through distance is an effective, yet simple and inexpensive administrative control. This control may be applicable when workers are present but are not actually working with a noise source or equipment. Increasing the distance between the noise source and workers reduces their exposure. In an open space, for every doubling of the distance between the source of noise and the worker, the noise is decreased by 6 decibels.

**Hearing protection devices** such as earmuffs and plugs are considered an acceptable but a less desirable option to control exposures to noise.

If you know your noise exposure, then use the following guide to select the appropriate level of hearing protection.

- Look for the Noise Reduction Rating (NRR) shown on the hearing protector package.
- Subtract 7 from the NRR.
- Subtract the remainder from the A-weighted 8-hour time-weighted average (TWA) to obtain the estimated noise under the ear protector.
- Estimated noise under the ear protector must be 85 decibels or less.

Example calculation:

$NRR = 29$

8-hour TWA exposure = 98 decibels A-weighted

$29 - 7 = 22$

$98 - 22 = 76$  decibels

(This is less than 85 decibels, so the hearing protection is acceptable.)

## Hearing Conservation Program

Employees whose 8-hour time weighted average noise exposure exceeds 85 decibels weighted on an “A” scale (dBA) or impact noise exceeds 140 dBA must be included in a Hearing Conservation Program including the following:

### *Engineering controls.*

- Feasible administrative or engineering controls must be used where employee exposures exceed 90 decibels as an 8-hour TWA or where impact noise levels exceed 140 decibels.

### *Audiograms.*

- Employees must have audiometric tests annually.

- Audiogram results will be provided to tested employees.
- Audiometric test results must be maintained in the employee's medical folder.

#### *Training.*

- Employees must attend annual training including the selection, use, and maintenance of hearing protectors and shall be responsible for using them in designated high-noise areas.

#### *Hearing protectors.*

- Employees must be provided with, and required to use, hearing protectors when the noise level is 85 decibels or higher.
- Workplaces where exposure to noise equals or exceeds an 8-hour time-weighted average of 85 decibels must be identified.
- Warning signs indicating high noise levels and the requirement that hearing protectors must be worn must be posted in work areas or on equipment where the noise level is 85 decibels or higher.
- Supervisors must provide and replace as necessary a variety of hearing protection for employees in high noise areas.
- Each employee will use and maintain the hearing protection as originally intended. Reusable insert-type hearing protection must be cleaned after each use and stored in a sanitary location (or disposed of).
- Supervisors must evaluate the suitability of hearing protection for the environment in which it is used.

### **Examples of Noise Exposures and Times**

<b>Measured sound level</b>	<b>Exposure time</b>	<b>8-hour time-weighted average</b>
85 dBA	8 hour	85 dBA
90 dBA	4 hour	85 dBA
95 dBA	2 hour	85 dBA
100 dBA	1 hour	85 dBA
105 dBA	30 minutes	85 dBA
110 dBA	15 minutes	85 dBA

For more details, see

- SM 445-2-H Chapter 19—Hearing Conservation Program.
- 29 CFR 1910.95, Occupational noise exposure.

## Topic 5-8. Camp Safety and Sanitation

All sites used for camps must be adequately drained. They must not be subject to periodic flooding, nor located within 200 feet of swamps, pools, sinkholes, or other surface collections of water, unless mosquitoes can be controlled on such still-water surfaces.



**Early USGS camp in Sonora, California.**

The camp must be located so the drainage from and through the camp will not endanger any domestic or public water supply. All sites must be graded, ditched, and rendered free from depressions in which water may become a nuisance.

All sites must be adequate in size to prevent overcrowding of necessary structures. The principal camp area where food is prepared and served and where sleeping quarters are located must be at least 500 feet from any area in which livestock are kept.

The grounds and open areas surrounding the shelters must be maintained in a clean and sanitary condition free from rubbish, debris, wastepaper, garbage, or other refuse.

### Shelters

- Every shelter in the camp must be constructed in a manner that will provide protection against the elements.
  - Each room used for sleeping purposes must contain at least 50 square feet of floor space for each occupant.
  - The ceiling must be at least 7 feet high.
- Beds, cots, or bunks, and suitable storage facilities such as wall lockers for clothing and personal articles must be provided in every room used for sleeping purposes.
  - Beds or similar facilities must be spaced not closer than 36 inches both laterally and end to end, and must be elevated at least 12 inches from the floor.
  - If double-deck bunks are used, they must be spaced not less than 48 inches both laterally and end to end.
  - The minimum clear space between the lower and upper bunk must be at least 27 inches.
  - Triple-deck bunks are prohibited.

- The floors of each shelter must be constructed of wood, asphalt, or concrete.
  - Wooden floors must be of smooth and tight construction.
  - The floors must be kept in good repair.
  - All wooden floors must be elevated not less than 1 foot above the ground level at all points to prevent dampness and to permit free circulation of air beneath.
  - Nothing in this section must be construed to prohibit “banking” with earth or other suitable material around the outside walls in areas subject to extreme low temperatures.
- All living quarters must be provided with windows that are at least as large as one-tenth of the floor area. At least one-half of each window must be constructed so it can be opened for ventilation.
- All exterior openings shall be effectively screened with 16-mesh material (16 x 16 mesh count). All screen doors shall be equipped with self-closing devices.
- In a room where workers cook, live, and sleep, a minimum of 100 square feet per person must be provided. Sanitary facilities must be provided for storing and preparing food.
- In camps where cooking facilities are used in common, stoves (in ratio of one stove to 10 persons or one stove to two families) must be provided in an enclosed and screened shelter. Sanitary facilities must be provided for storing and preparing food.
- All heating, cooking, and water heating equipment must be installed in accordance with State and local ordinances, codes, and regulations governing such installations. If a camp is used during cold weather, adequate heating equipment must be provided.

## **Potable Water**

- An adequate and convenient water supply, approved by the appropriate health authority, must be provided in each camp for drinking, cooking, bathing, and laundry purposes.
- A water supply is considered adequate if it is capable of delivering 35 gallons per person per day to the campsite at a peak rate of 2 1/2 times the average hourly demand.
- The distribution lines must be capable of supplying water at normal operating pressures to all fixtures for simultaneous

operation. Water outlets shall be distributed throughout the camp in such a manner that no shelter is more than 100 feet from a yard hydrant if water is not piped to the shelters.

- Where water under pressure is available, one or more drinking fountains shall be provided for each 100 occupants or fraction thereof. Common drinking cups are prohibited.

## **Prohibitions**

- Open containers such as barrels, pails, or tanks for drinking water from which the water must be dipped or poured, whether or not they are fitted with a cover, are prohibited.
- A common drinking cup and other common utensils are prohibited.

## **Nonpotable Water**

Nonpotable water must be posted or otherwise marked in a manner that will indicate clearly that the water is unsafe and is not to be used for drinking,

## **Toilet Facilities**

- Toilet facilities adequate for the capacity of the camp must be provided.
- Each toilet room must be located so as to be accessible without any individual passing through any sleeping room.
- Toilet rooms must have a window not less than 6 square feet in area opening directly to the outside area or otherwise be satisfactorily ventilated.
- All outside openings must be screened with 16-mesh material.
- No fixture, water closet, chemical toilet, or urinal may be located in a room used for other than toilet purposes.
- A toilet room must be located within 200 feet of the door of each sleeping room.
- A privy must not be closer than 100 feet to any sleeping room, dining room, lunch area, or kitchen.
- Where the toilet rooms are shared, such as in multifamily shelters and in barracks type facilities, separate toilet rooms must be provided for each sex.
  - These rooms must be distinctly marked “for men” and “for women” by signs printed in English and in the native language of the persons occupying the camp, or marked with easily understood pictures or symbols.

- If the facilities for each sex are in the same building, they must be separated by solid walls or partitions extending from the floor to the roof or ceiling.
- Where toilet facilities are shared, the number of water closets or privy seats provided for each sex must be based on the maximum number of persons of that sex which the camp is designed to house at any one time, in the ratio of one such unit to each 15 persons, with a minimum of two units for any shared facility.
- Urinals shall be provided on the basis of one unit or 2 linear feet of urinal trough for each 25 men.
  - The floor from the wall and for a distance not less than 15 inches measured from the outward edge of the urinals must be constructed of materials impervious to moisture.
  - Where water under pressure is available, urinals must be provided with an adequate water flush.
  - Urinal troughs in privies must drain freely into the pit or vault and the construction of this drain must be such as to exclude flies and rodents from the pit.
- Each toilet room must be lighted naturally or artificially by a safe type of lighting at all hours of the day and night.
- An adequate supply of toilet paper must be provided in each privy, water closet, or chemical toilet compartment.
- Privies and toilet rooms must be kept in a sanitary condition. They must be cleaned at least daily.

## **Sewage Disposal Facilities**

In camps where public sewers are available, all sewer lines and floor drains from buildings must be connected thereto.

## **Laundry, Hand Washing, and Bathing Facilities**

- Laundry, hand washing, and bathing facilities must be provided in the following ratio:
  - Hand wash basin per family shelter or per six persons in shared facilities.
  - Shower head for every 10 persons.
  - Laundry tray or tub for every 30 persons.
  - Slop sink in each building used for laundry, hand washing, and bathing.

- Floors must be of smooth finish but not slippery materials; they shall be impervious to moisture.
  - Floor drains must be provided in all shower baths, shower rooms, or laundry rooms to remove waste water and facilitate cleaning.
  - All junctions of the curbing and the floor must be covered.
  - The walls and partitions of shower rooms must be smooth and impervious to the height of splash.
- An adequate supply of hot and cold running water must be provided for bathing and laundry purposes. Facilities for heating water must be provided.
- Every service building must be provided with equipment capable of maintaining a temperature of at least 70 degrees Fahrenheit during cold weather.
- Facilities for drying clothes must be provided.
- All service buildings must be kept clean.

## Lighting

- Where electric service is available, each habitable room in a camp must be provided with at least one ceiling-type light fixture and at least one separate floor- or wall-type convenience outlet.
- Laundry and toilet rooms and rooms where people congregate must contain at least one ceiling- or wall-type fixture.
- Light levels in toilet and storage rooms must be at least 20 foot-candles at 30 inches from the floor. Other rooms, including kitchens and living quarters, must be at least 30 foot-candles at 30 inches from the floor.

## Refuse Disposal

- Fly-tight, rodent-tight, impervious, cleanable or single service containers approved by the appropriate health authority must be provided for the storage of garbage. At least one such container must be provided for each family shelter and must be located within 100 feet of each shelter on a wooden, metal, or concrete stand.
- Garbage containers must be kept clean.
- Garbage containers must be emptied when full, but not less than twice a week.

## **Construction and Operation of Kitchens, Dining Hall, and Feeding Facilities**

- In all camps where central dining or multiple family feeding operations are permitted or provided, the food handling facilities must comply with the requirements of the “Food Service Sanitation Ordinance and Code,” Part V of the “Food Service Sanitation Manual,” U.S. Public Health Service Publication 934 (1965).
- A properly constructed kitchen and dining hall adequate in size, separate from the sleeping quarters of any of the employees or their families, must be provided in connection with all food handling facilities.
- There may be no direct opening from living or sleeping quarters into a kitchen or dining hall.
- No person with any communicable disease may be employed or permitted to work in the preparation, cooking, serving, or other handling of food, foodstuffs, or materials used, in any kitchen or dining room operated in connection with a camp or regularly used by persons living in a camp.
- Freezer temperature should be set at zero or below; refrigerators should be set at 45 degrees Fahrenheit.

## **Insect and Rodent Control**

Effective measures must be taken to prevent infestation by and harborage of animal or insect vectors or pests.

## **Reporting Communicable Disease**

The camp manager must report immediately to the local health officer the name and address of any individual in the camp known to have or suspected of having a communicable disease.

If a case of suspected food poisoning or an unusual prevalence of any illness in which fever, diarrhea, sore throat, vomiting, or jaundice is a prominent symptom, the camp manager must report immediately the existence of the outbreak to the health authority by telephone, electronic mail, or any method that is equally fast.

For more details, see

- 29 CFR 1910.141, Sanitation.
- 29 CFR 1910.142, Temporary labor camps.

## Topic 5-9. Bloodborne Pathogens

Bloodborne pathogens are infectious microorganisms present in blood that can cause disease in humans. These pathogens include, but are not limited to, hepatitis B virus (HBV), hepatitis C virus (HCV), and human immunodeficiency virus (HIV), the virus that causes AIDS. Employees exposed to bloodborne pathogens are at risk for serious or life-threatening illnesses.



**Universal precautions during a bat necropsy.**

The Occupational Safety and Health Administration's Bloodborne Pathogen standard states what employers must do to protect employees who are occupationally exposed to blood or other potentially infectious materials, generally from human blood. However, many of the controls required by the standard can be applied to prevent bloodborne pathogen exposures from animal blood, saliva, or other fluids.

The standard requires the following:

- A written exposure control plan.
- Update the plan annually.
- Implement the use of universal precautions.
- Identify and use engineering controls.
- Identify and ensure the use of work practice controls.
- Provide personal protective equipment, such as gloves, gowns, eye protection, and masks.
- Make available hepatitis B vaccinations to all workers with occupational exposure.
- Make available post-exposure evaluation and follow-up to any occupationally exposed worker who experiences an exposure incident.
- Use labels and signs to communicate hazards.
- Provide information and training to workers at least annually.
- Maintain worker medical and training records.

Most Bureau employees who are included in an Exposure Control Plan (Bloodborne Pathogens) are members of an *automated external defibrillator* (AED) team.

For more details, see

- SM 445-2-H Chapter 25—Human Bloodborne Pathogens Protection Program.
- 29 CFR 1910.1030, Bloodborne pathogens.

## **Topic 5-10. Hantavirus**

Infection with hantavirus can progress to Hantavirus Pulmonary Syndrome (HPS), which can be fatal. People become infected through contact with hantavirus-infected rodents or their urine and droppings.

### **Symptoms**

On the basis of limited information, the Centers for Disease Control and Prevention (CDC) says it appears that symptoms may develop between 1 and 5 weeks after exposure to fresh urine, droppings, or saliva of infected rodents.

#### *Early symptoms.*

- Fatigue, fever, and muscle aches, especially in the large muscle groups—thighs, hips, back, and sometimes shoulders. These symptoms are universal.
- There may also be headaches, dizziness, chills, and abdominal problems, such as nausea, vomiting, diarrhea, and abdominal pain. About half of all HPS patients experience these symptoms.

#### *Late symptoms.*

- Four to 10 days after the initial phase of illness, the late symptoms of Hantavirus Pulmonary Syndrome appear. These include coughing and shortness of breath, with the sensation of, as one survivor put it, a “...tight band around my chest and a pillow over my face” as the lungs fill with fluid.
- Hantavirus Pulmonary Syndrome has a mortality rate of 38 percent.

### **Prevention**

Rodent control is the primary strategy for preventing hantavirus infection.

Eliminate or minimize contact with rodents in the workplace or campsite. Seal up holes and gaps in buildings. Place traps in and around your buildings and camps to decrease rodent infestation. Clean up easy-to-get food.

## Seal Up

Seal up holes inside and outside to prevent entry by rodents.

*Seal holes on the exterior.* Mice can squeeze through a hole the size of a nickel, and rats can squeeze through a hole the size of a half dollar! Prevent rodents from entering the home by checking inside and outside the house for gaps or holes.

*Look for gaps inside buildings.*

- Inside, under, and behind kitchen cabinets, refrigerators, and stoves.
- Inside closets near the floor corners.
- Around the fireplace.
- Around doors.
- Around the pipes under sinks and washing machines.
- Around the pipes going to hot water heaters and furnaces.
- Around floor vents and dryer vents.
- Inside the attic.
- In the basement or crawl space.
- In the basement and laundry room floor drains.
- Between the floor and wall juncture.

*Look for gaps outside buildings:*

- In the roof among the rafters, gables, and eaves.
- Around windows.
- Around doors.
- Around the foundation.
- Attic vents and crawl space vents.
- Under doors.
- Around holes for electrical, plumbing, cable, and gas lines.

Fill small holes with steel wool. Put caulk around the steel wool to keep it in place. Use lath screen or lath metal, cement, hardware cloth, or metal sheeting to fix large holes. These materials can be found at your local hardware store. Fix gaps in trailer skirtings and use flashing around the base of the building. If you do not seal up entry holes, rodents will continue to get inside. Outbuildings and garages should also be sealed to prevent the entrance of rodents.

## Trap Up

Trap rodents to help reduce the rodent population. Choose an appropriate snap trap. Traps for catching mice are different from those for catching rats. Carefully read the instructions before setting the trap.

When setting the trap, place a small amount of peanut butter (approximately the size of a pea) on the bait pan of the snap trap. Position the bait end of the trap next to the wall so it forms a “T” with the wall. Rodents prefer to run next to walls or other objects for safety and do not like being out in the open.

In attics, basements, and crawl spaces and other areas that do not have regular human traffic, set traps in any area where there is evidence of frequent rodent activity. Some rodents, particularly rats, are very cautious and several days may pass before they approach the traps. Other rodents, such as house mice and deer mice, are less cautious and may be trapped more quickly.

We do not recommend using glue traps or live traps. These traps can scare mice that are caught live and cause them to urinate. Since their urine may contain germs, this may increase your risk of being exposed to diseases.

Also place traps in outbuildings and in areas that might likely serve as rodent shelters. Natural rodent predators, such as nonpoisonous snakes, owls, and hawks, may also help control and reduce the number of rodents outside the home.

If you trap inside buildings, but do not seal up rodent entry holes, new rodents will enter the dwelling.

## Clean Up

Prevent contact with rodents by cleaning up your workplace or campsite.

*Eliminate possible rodent food sources.*

- Keep food in thick plastic or metal containers with tight lids.
- Clean up spilled food right away and wash dishes and cooking utensils soon after use.
- Keep outside cooking areas and grills clean.
- Always put pet food away after use and do not leave pet-food or water bowls out overnight.

- Keep bird feeders away from the house and utilize squirrel guards to limit access to the feeder by squirrels and other rodents.
- Use a thick plastic or metal garbage can with a tight lid.
- Keep compost bins as far away from the house as possible (100 feet or more is best).
- Keep grains and animal feed in thick plastic or metal containers with tight lids. In the evening, uneaten animal feed should be returned to containers with lids.

If storing trash and food waste inside, do so in rodent-proof containers, and frequently clean the containers with soap and water. Dispose of trash and garbage on a frequent and regular basis, and pick up or eliminate clutter.

Eliminate possible nesting sites outside. Elevate hay, woodpiles, and garbage cans at least 1 foot off the ground. Move woodpiles far away from the house (100 feet or more is best). Get rid of old trucks, cars, and old tires that mice and rats could use as homes. Keep grass cut short and shrubbery within 100 feet of buildings well-trimmed.

## **Cleaning Up**

When you begin cleaning, it is important that you **do not** stir up dust by sweeping or vacuuming up droppings, urine, or nesting materials.

*How to clean up mouse and rat urine and droppings.*

- Wear rubber or vinyl gloves.
- Spray urine and droppings with a disinfectant or a mixture of bleach and water. Make sure you get the urine and droppings very wet. Let it soak for 5 minutes.
- Use a paper towel to wipe up the urine or droppings.
- Throw the paper towel in the garbage.
- Mop or sponge the area with a disinfectant or bleach solution.
- Steam clean or shampoo upholstered furniture and carpets with evidence of rodent exposure.
- Wash any bedding and clothing with laundry detergent in hot water if exposed to rodent urine or droppings.
- Wash gloved hands with soap and water or spray a disinfectant or bleach solution on gloves before taking them off.
- Wash hands with soap and warm water after taking off your gloves.

- DO NOT sweep or vacuum up mouse or rat urine, droppings, or nests. This will cause virus particles to go into the air, where they can be breathed in.

*Use either of these when cleaning up after mice and rats.*

- General-purpose household disinfectant. Make sure the word “disinfectant” is written on the label, or
- Bleach and water solution. Mix 1 1/2 cups of household bleach with 1 gallon of water. Smaller amounts can be made with 1 part bleach and 9 parts water.

*How to clean up a dead mouse or rat in a snap trap and how to clean up a rodent nest.*

- Wear rubber or vinyl gloves.
- Spray the dead mouse, rat, or nest, as well as the surrounding area, with a disinfectant or a mixture of bleach and water. Let it soak.
- Place nesting materials or trap with the dead rodent in a plastic bag. If you plan to reuse the trap, get the mouse or rat out of the trap by holding it over the bag and lifting the metal bar. Let the mouse or rat drop in the bag. Disinfect the trap.
- Seal the bag. Place the full bag in a second plastic bag. Seal that bag.
- Throw the bag into a covered trash can that is regularly emptied or contact your State health department for information on other ways to throw away dead mice and rats.
- Wash gloved hands with soap and water or spray a disinfectant or bleach solution on gloves before taking them off.
- Wash hands with soap and warm water after removing your gloves.

*Important.*

- If you live in the western United States, you may be at risk for plague carried by fleas from rodents.
- Use insect repellent containing N,N-Diethyl-meta-toluamide (DEET) on clothing, shoes, and hands to reduce the risk of flea bites while picking up dead rodents.
- Contact your local or State health department to find out if plague is a danger in your area and for more information on other flea-control methods.

*How to clean out cabins, sheds, barns, or other outbuildings.*

- Open all doors and windows. Leave them open for 30 minutes before cleaning.
- Wear rubber or vinyl gloves.
- Clean up all rodent urine, droppings, nests, or dead mice or rats by using a disinfectant or a mixture of bleach and water.
- Mop floors or spray dirt floors with a disinfectant or mixture of bleach and water.
- Clean countertops, cabinets, and drawers with a disinfectant or a mixture of bleach and water.
- Steam clean, shampoo, or spray upholstered furniture with a detergent, disinfectant, or a mixture of bleach and water.
- Wash any bedding and clothing with laundry detergent in hot water if you see any mouse or rat urine or droppings on them.

*How to clean attics, basements, crawl spaces, and other storage areas.*

Before cleaning attics, basements, crawl spaces, and other storage areas, it is necessary to completely remove the existing rodent infestation by trapping. When there is no evidence of infestation, wait about 5 days before beginning to clean these areas. Before cleaning the space, ventilate the area by opening the doors and windows for at least 30 minutes to allow fresh air to enter the area and to remove potentially contaminated air from the area. Use cross-ventilation and leave the area during the airing-out period.

*When cleaning attics, basements, crawl spaces, and other storage areas:*

- Wear rubber or vinyl gloves when cleaning up urine, droppings, or nesting materials. Note that a dust mask may provide some protection against dust, molds, and insulation fibers, but does not protect against viruses.
- Spray any urine, droppings, and nesting materials with either a bleach and water solution (1 part bleach to 9 parts water) or a household disinfectant prepared according to the label instructions for dilution and disinfection time. Soak well. This will inactivate any virus. Use a paper towel or rag to pick up the materials and dispose of them.
- Mop floors after spraying them using a bleach/water solution or a disinfectant. Dirt floors can be sprayed with either a bleach and water solution or a disinfectant.

- If exposed insulation has become contaminated with urine and droppings, it should be placed into plastic bags for removal.
- To remove any potentially contaminated materials from storage vessels/boxes:
  - First, move the storage vessels/boxes outside and place them in an area that is well ventilated and exposed to direct sunlight. The outside of the storage vessels/boxes can be disinfected using a bleach and water solution or disinfectant solution.
  - Next, remove the potentially contaminated materials while in the sunlit, ventilated area. Remain upwind so that any dust or debris is not blown toward your face. Some contaminated stored materials, such as clothing or books, can be decontaminated by following the recommended methods of disinfection provided by the Centers for Disease Control and Prevention (CDC). Items that are no longer needed can be discarded.
- Dispose of any cardboard boxes contaminated with urine or droppings. Plastic, glass, or metal containers can be disinfected by spraying with the bleach and water solution or disinfectant. Then, using a rag or paper towel, wipe up the urine or droppings and dispose of the waste.
- Decontaminate gloves with disinfectant or bleach and water solution. Wash hands well with soap and warm water.

### *Heavy rodent infestation.*

Special precautions should be used for cleaning homes or buildings with heavy rodent infestation. The special precautions may also apply to vacant dwellings that have attracted large numbers of rodents and to dwellings and other structures where hantavirus has been confirmed in the rodent population.

Persons involved in the cleanup of heavy rodent infestations should wear the protective equipment listed here:

- Coveralls (disposable, if possible).
- Rubber boots or disposable shoe covers.
- Rubber or vinyl gloves.
- Protective goggles.

- Use appropriate respiratory protection device, such as a half-mask air-purifying (or negative-pressure) respirator with a high-efficiency particulate air (HEPA) filter or a powered air-purifying respirator (PAPR) with HEPA filters. Employees using elastomeric respirators must be included in a Respiratory Protection Program.
- Personal protective gear must be decontaminated upon removal at the end of the day. All potentially infective waste material (including respirator filters) from clean-up operations that cannot be burned or deep-buried onsite must be double-bagged in appropriate plastic bags. The bagged material must be labeled as infectious (if it is to be transported) and disposed of in accordance with local requirements for infectious waste.

## Topic 5-11. *Pfiesteria*

*Pfiesteria* are microscopic marine dinoflagellates which produce toxins that have caused fish kills and lesions on fish in coastal waters along the eastern United States. The occurrence of *Pfiesteria* has been attributed to nutrient enrichment, warm water temperatures, moderate to high salinity, and fish excretions.

While *Pfiesteria* has been identified as a potential cause of fish kills in the Chesapeake Bay and other estuaries, there is growing evidence that other pathogens also cause lesions in Chesapeake Bay fish.



**Fish.**

### Health Effects

Human health effects from exposure to *Pfiesteria* toxins include flu-like symptoms, skin disorders, respiratory infections, and memory loss. Human health effects result from two primary pathways—inhaling chemical toxins produced by certain life stages of the organism, and direct contact with water, bottom sediments, or fish affected by *Pfiesteria*. The effects on humans can be treated medically. If you have been exposed to *Pfiesteria* toxins and begin to show any of the symptoms listed above, promptly consult a physician.

## Sample Collection Procedures

Personnel will consult with the State or local department of health or other agencies with *Pfiesteria* expertise before working in or around waters where *Pfiesteria* are suspected.

- **Under no conditions will safety procedures be less stringent than protocols determined by local agencies.**
- The following guidelines adapted from the State of Maryland, Department of Health and Mental Hygiene, will be followed, as a minimum, when collecting samples in an area where exposure to toxins is likely to occur:
  - A job hazard analysis will be developed specifically for the work to be performed.
  - Wear heavy waterproof gloves and protective clothing, and eye and face protection.
  - If personal contact with *Pfiesteria*-contaminated water should occur, immediately wash affected area with soap and water. Wash hands and any exposed areas thoroughly with soap and water after sampling. After returning home, a full shower is recommended.
  - Avoid contamination of shipping coolers. If contamination of coolers should occur, immediately wash the coolers with soap and water.
  - Respirators with HEPA (**P100**) and organic vapor filters must be available for use. The need to wear a respirator will be determined by project personnel and supervisors, in conjunction with guidance from the State and local health department and your safety manager.
  - Contaminated protective clothing and equipment should be placed in a plastic bag and sealed until they can be washed with soap and water.

## Sample Shipment Procedures

Prior to shipping samples to any USGS or non-USGS laboratory, field personnel must contact the laboratory and determine if they are prepared to handle potentially contaminated samples.

- Under no circumstances will water from potentially contaminated locations be sent to any laboratory without prior notification.

- It is the responsibility of those shipping samples to ensure that all sample labels, laboratory request forms, and shipping logs clearly state that “*Pfiesteria* toxins may be present.”

## Sample Analysis Procedures

Processing water samples that potentially contain *Pfiesteria* for chemical analysis can be safely done only with special precautions in the laboratory. Each laboratory has the responsibility to ensure that safety measures are in place before they accept potentially contaminated samples for processing.

- USGS laboratories will ensure that engineering controls are in place and personal protective equipment is available prior to analysis of samples collected in areas where *Pfiesteria* toxins are suspected.
- The following guidelines must be followed:
  - A job hazard analysis will be developed specifically for the work to be performed.
  - Personal protective equipment (waterproof gloves, protective clothing, and eye and face protection) will be worn by all laboratory personnel at risk of coming in direct contact with the samples. In the event direct contact with the sample should occur, immediately wash affected area with soap and water.
  - The samples will be analyzed under a fume hood, if possible. If analytical procedures require oven drying, the laboratory ovens used must be vented to the outside.
  - For processes that cannot be performed under a fume hood, all laboratory personnel at risk of breathing the chemical toxins must wear a respirator with a HEPA (P100) and organic vapor filter, in addition to wearing the personal protective equipment listed in **Sample Collection Procedures** above, until the stage of analysis when samples are dry. Employees who wear respirators must be included in a Respiratory Protection Program.
  - Contaminated protective clothing and equipment must be placed in a plastic bag and sealed until they can be washed with soap and water.

## Topic 6. Radiation

### Topic 6-1. Ionizing Radiation

Bureau employees may be exposed to ionizing radiation while performing field work. These exposures fall into three general categories: X-ray producing machines, naturally occurring radioactive materials, and licensed radioactive materials.



**Radiation symbol.**

#### Training

Employees who are potentially exposed to ionizing radiation as part of their work duties must complete a basic course in ionizing radiation including:

- Fundamentals of ionizing radiation (for example, units, types of radiation, routes of exposure).
- Biological effects of ionizing radiation (dose/effect).
- Basic radiation protection procedures (time, distance, shielding).
- As Low As Reasonably Achievable (ALARA).
- Overview of the Bureau Ionizing Radiation Program.

The Department of the Interior course in DOI Learn, Safety: Ionizing Radiation, or an equivalent course will meet this requirement.

#### X-ray Producing Machines

In addition to the basic course, employees who work with X-ray producing machines must complete additional training related to the Occupational Safety and Health Administration (OSHA) requirements. These employees must have hands-on instruction on the operation of the machine(s) they will be expected to operate. Additional topics must include:

- How X-rays are produced.
- Types of machines.
- Monitoring.
- Engineering and administrative controls.
- Personal protective equipment.
- Authorized operators.
- Surveys.

## **Naturally Occurring Radioactive Materials (NORM)**

In addition to the basic course, employees who are, or may be, exposed to naturally occurring radioactive materials must complete additional training related to the OSHA requirements. Additional topics must include:

- Naturally occurring radioactive materials that employees may be exposed to in their work.
- Internal versus external exposures.
- Protective equipment.
- Monitoring.
- Decontamination.
- Good hygiene practices.

## **Licensed Radioactive Materials**

Employees who work with licensed radioactive materials must be trained on the specific requirements of the license and their responsibilities.

### **Monitoring**

Due to the potential for contamination of work areas during use of radioactive materials, it is necessary to monitor the operations as often as possible.

- Work areas should be checked before use to determine the background radiation level or prior contamination.
- The survey instrument should be turned on and placed proximal to the work area in order to check radiation levels and to warn the worker if radiation levels rise significantly.
- Hands should be checked frequently for the presence of contamination due to splashing or aerosols.
- At the end of the use of the work area, or each day, monitor work areas to determine the presence of contamination.
- Clothing and shoes should also be monitored.
- If contamination is found, the area or equipment must be decontaminated.

### **Protective Equipment**

In order to prevent contamination of skin, eyes, or personal apparel, protective equipment should be utilized during use of radioactive material. The specific types of protective equipment needed are

dictated by the nuclide, level of activity, chemical form, and procedures. Two main categories of protective equipment are personal protective equipment and engineering controls. Personal protective equipment is protective equipment worn by the employee. Examples are gloves, laboratory coats, and safety glasses. Engineering controls are external equipment designed to protect the employee, or are a part of the design of the work area. Examples are fume hoods, biological safety cabinets, building ventilation systems, and shields.

At a minimum, employees working with radioactive materials must wear laboratory coats, gloves, and eye protection. Additional protective equipment may be necessary or prudent. Contact a health physicist if you have questions about protective equipment.

### **General Rules for Radiation Safety**

- Do not eat, drink, or smoke in areas designated for radioactive materials use, storage, or disposal. “Eating” includes gum, candy, beverages, and chewing tobacco. Do not apply cosmetics in the laboratory. Do not consume medication in radioisotope laboratories. Do not dispose of food or empty food wrappers or containers anywhere in the laboratories.
- Laboratories must not be used for food storage, particularly refrigerators.
- Gloves must be worn during any and all operations in which contamination of the hands is possible.
- Never pipette radioactive liquids by mouth.
- Store and transport radioactive materials in containers that will prevent breakage and spillage. Secondary containment is important when transporting radioactive materials. Use trays and carts.
- Use ventilation hoods or glove boxes if the radioactive material may become airborne and for high-activity uses, such as stock solutions.
- The individual(s) responsible for any contamination will be required to decontaminate the area of concern.
- Regularly check your hands, clothing, and shoes for contamination and again prior to leaving the work area after working with radioactive material.
- Always dispose of radioactive waste in a radioactive waste container.
- Always wear your assigned radiation detection badge(s) when working with radioactive materials.

- Wear laboratory coats when working with radioactive materials. Laboratory coats must be buttoned up, not worn open.
- Users of high-energy beta or gamma nuclides must wear eye protection, such as safety glasses or eye glasses.

### **Decontaminating Naturally Occurring Radioactive Materials**

- Handling equipment or tools with removable contamination from naturally occurring radioactive materials (NORM) requires implementation of universal precautions (gloves, protective clothing) and decontamination of items (shoes, personal protective equipment) with water or another rinse.
- Contact the Radiation Safety Officer in the event of possible internal contamination from NORM either through the presence of cuts and abrasions, inhalation, or ingestion.
- Equipment used to collect samples from the environment should be field decontaminated prior to returning from the field site. Nonporous sampling equipment can be decontaminated using one or more of the methods below:
  - Use a wet wipe to clean the equipment.
  - Rinse the equipment with water.
  - Wash the equipment in detergent and water followed by a water rinse.
  - For grossly contaminated equipment, contact the Radiation Safety Officer.
- After decontamination, equipment should be handled only when wearing clean gloves in order to prevent recontamination. Also, clean equipment should be moved upwind from the decontamination area to prevent recontamination.
- If the equipment is not to be immediately used it should be dried, covered with plastic sheeting, or wrapped in aluminum foil to prevent recontamination. The area where the equipment is kept prior to use must be free of contaminants.
- Porous materials or single-use personal protective equipment must be labeled and securely bagged prior to returning from the field site.
- NORM contaminated waste must be properly disposed. Contact the Radiation Safety Officer if you have any questions concerning disposal.

## Portable X-ray Producing Machines

- When using a portable X-ray producing machine, a logbook should be used to record each operation.
- If possible when transporting the machine, remove and store the battery in a transport case or remove keys from interlock.
- The operator may require a briefing or more training prior to going to the field if he or she is not familiar with the specific machine.
- Open beam instruments require additional precautions to protect the public. Establish:
  - Hazard warnings
  - Restricted area
- Portable cabinet systems may need:
  - Hazard warnings
  - Restricted area
- Personal monitoring is recommended until representative data demonstrates the exposures are less than 10 percent of the exposure limit.

## Visiting Non-USGS Sites

When visiting locations that are not under the control of the USGS, employees must comply with the Bureau ionizing radiation policies. If you are not able to confirm through monitoring data or surveys that anticipated exposures will be within OSHA and USGS exposure limits, do not enter the area.

For more details, see

- SM 445-2-H Chapter 50—Ionizing Radiation.
- 29 CFR 1910.1096, Ionizing radiation.

## Topic 6-2. Nonionizing Radiation

Nonionizing radiation is electromagnetic radiation having enough energy to excite atoms (make them move more rapidly) but not enough to ionize them (alter them physically). Nonionizing radiation includes sub-radiofrequency, radiofrequency, and microwave radiation; infrared, ultraviolet, and high-intensity visible light; and laser radiation.

## Exposure Limits

Employee exposures to nonionizing radiation must be maintained as low as practicable, but at no time exceeding the ACGIH Threshold Limit Values (TLVs). In addition, exposures to the public from Bureau-owned or operated sources must be maintained as low as practicable.

## Inspect and/or Survey

Nonionizing sources must be inspected at least annually and surveyed if modifications were made.

## Radiofrequency (RF) and Microwave

Radiofrequencies are in the region between 30 kilohertz (kHz) and 300 gigahertz (GHz) with wavelengths between 100 kilometer (km) and 1 millimeter (mm). Microwave radiation is a subset of RF.

### *Examples of sources.*

- Radio and television broadcast stations.
- Portable radio systems (base-station transmitters, vehicle-mounted transmitters, and handheld transmitters).
- Microwave antennas (point-to-point).
- Satellite systems (ground-based antennas used for satellite-earth communications).
- Radar systems.
- Unintentional radiators, leakage fields (for example, microwave ovens, dielectric heaters, medical diathermy, induction heaters).

*Biological effects.*—Biological effects that result from heating of tissue by RF energy are often referred to as “thermal” effects. RF radiation can be harmful due to the ability of RF energy to rapidly heat biological tissue. Two areas of the body, the eyes and the testes, are particularly vulnerable to RF heating because of the relative lack of available blood flow to dissipate the excessive heat load.

An RF field can produce alternating electric potentials on ungrounded conducting objects. A person touching such an object will be subjected to an RF current flowing to the ground. This is called contact current. The body can also be that (conducting) object in which a current is induced by the field. This is known as an induced body current. These effects are seen at low RF frequencies.

*Other hazards.*—RF radiation may:

- Affect medical electronic devices.
- Activate explosive devices or create hazards from ignition of flammable materials.
- Produce X-ray radiation with high-voltage equipment.

*Exposure assessments.*—Direct-beam hazard distances must be calculated or measured for radiofrequency sources.

*Controls.*

- Controls must be implemented to prevent overexposures (for example, interlocks, antenna stops, training, procedures).
- At a minimum, the hazard distance must be communicated to the affected employees. Standard signage with the hazard information is an acceptable form of communication.
- Standard signage with the hazard information must be posted.

*Training.*—Employees who operate or work near RF transmitters must have education and training commensurate with the level of the potential hazard. They must be made aware of the hazards and the available controls to reduce their exposure.

## **Ultraviolet Light**

Ultraviolet (UV) light is a type of optical radiation, which means its physical behavior is similar to that of visible light. The UV spectrum is divided into three main wavelength bands: UV-A or “blacklight” (315–400 nanometers); UV-B or “erythema” (280–315 nanometers); and UV-C or “germicidal” (100–280 nanometers). Wavelengths shorter than about 190 nanometers are strongly absorbed by air. UV light is not visible to the human eye, but many broadband UV sources also emit visible light.

*Examples of sources.*—Sunlight, welding and plasma arcs, xenon lights, mercury vapor lights, germicidal lamps, curing lamps, sun-lamps, tanning lamps, ultraviolet light-emitting diodes (ULEDs), and UV photolithography.

*Biological effects.*

- UV radiation is strongly absorbed by proteins and deoxyribonucleic acid (DNA). Because UV radiation does not penetrate deeply into tissue, the target organs are the skin and eye. Acute overexposure may cause erythema (redness or

- burning) of the skin and photo keratitis (inflammation of the cornea), also called “snow blindness” or “welder’s flash.”
- Chronic overexposure can cause cataracts, skin aging, and immunosuppression.
  - The International Agency for Research on Cancer (IARC) has classified UV, including the UV-A, UV-B, and UV-C bands, as a Group 1 human carcinogen. Specifically, UV exposure can cause malignant melanoma, non-melanoma skin cancers, and possibly eye cancer.
  - Although dark pigmentation can reduce the risks of UV exposure, all skin types are at risk.
  - UV can also interact with a number of naturally occurring and synthetic photosensitizers, including some drugs, to increase the potency of UV radiation in causing skin burns or cancer.

#### *Other Hazards.*

- UV-C radiation at wavelengths less than 242 nm reacts with oxygen to form ozone, which in some cases could reach lethal concentrations if not removed by local exhaust ventilation.
- Sources of ozone-generating UV-C include gas-shielded arc welding, xenon lamps, mercury lamps, and germicidal lamps.
- Short-arc UV lamps contain gas under elevated pressure, posing a potential explosion hazard even when cold.

#### *Exposure assessments.*

- Field measurement of UV radiation should be performed with broadband detectors that have a spectral response that is well matched to the relevant effectiveness function over the entire spectral range of the UV source. Integrating meters can be used to obtain measurements of cumulative UV dose in Joules per square centimeter.
- For solar UV exposure, the Global Solar UV Index, which is widely available as part of local weather forecasts, is a good awareness tool for assessing the risk of outdoor work or recreational activities.

#### *Controls.*

- Enclose or orient UV sources so that direct or reflected radiation does not fall on skin or eyes.

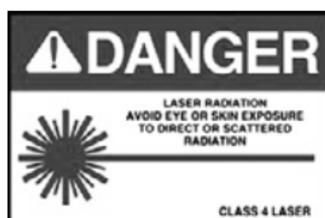
- Limit duration of exposure so that effective UV dose does not exceed 3 millijoules per square centimeter in a day.
- Cover skin with tightly woven fabrics or leather; nitrile or latex gloves are recommended if a barrier to fluids is also needed.
- Choose eyewear that is specifically rated for UV absorption. It should be noted that many transparent materials such as glass and polycarbonate absorb UV-B and UV-C but transmit significant fractions of UV-A.
- Sunscreens of sun protection factor (SPF) 15 or higher should be used on skin that cannot be covered by clothing, and as a backup for protective clothing.

### *Training.*

Employees who work with UV light must have education and training commensurate with the level of potential hazard. They must be made aware of the hazards and the available controls to reduce their exposure.

## **Lasers**

A laser is a device that emits light (electromagnetic radiation) through a process of optical amplification based on the stimulated emission of photons. The term “laser” originated as an acronym for Light Amplification by Stimulated Emission of Radiation.



**Laser sign.**

Lasers can be found in virtually all work environments. Lasers are classified according to their hazard potential. Class 1 and 2 lasers require no specific controls for their intended use. Class 3a and 3R lasers are similarly relatively low risk and only pose a hazard when the beam is intentionally viewed and the eyes natural aversion response is over-ridden. Class 3b lasers pose an eye hazard from direct ocular exposure to the beam. Class 4 lasers pose not only a hazard from direct exposure to the beam but can also pose a hazard from diffusely scattered light. They can also pose a risk of injury to the skin and ignite combustible materials.

*Biological effects.*—The wavelength determines where the beam will present the greatest hazard.

- For wavelengths between 1,400 nanometers and 10 millimeters (mid-infrared and far-infrared) the beam will interact

with the surface of the exposed tissue with the damage being thermal in nature.

- For UV-B and UV-C, the beam will interact with the cornea.
- UV-A will interact with the lens in a photochemical manner and can cause cataracts with even very short duration exposures.
- Visible (400–700 nanometers) and near infrared (700–1,400 nanometers) wavelengths will interact with the retina. Retinal injuries may be thermal in nature for continuous wave and long pulse lasers or photo acoustic (ablation with no thermal effect) for short pulse lasers. Retinal injuries are generally permanent and their severity is dependent upon their size and location on the retina.

*Other hazards.*—Lasers may have numerous ancillary hazards associated with them that may actually present a more severe hazard than the laser light itself.

- High-voltage sources are generally present and with lasers usually located on metal optical tables; grounding is an important issue.
- Gas lasers may have pressure or toxic gas hazards present.
- If dye lasers are being used it is important to understand the toxicity of the dyes being used as well as the solvents and determine if there are any synergistic effects when they are combined.
- Lasers used for material processing or medical procedures may present respiratory hazards from laser-generated airborne contaminants.

*Exposure limits.*—The Maximum Permissible Exposure (MPE) limits are based upon a combination of the wavelength and exposure duration. Calculating the MPE can be difficult and in the case of repetitively pulsed lasers must be determined three different ways and the most restrictive limit used. Determining the MPE should be done following the processes in ANSI Z136.1. There are software tools available. Most laser eyewear vendors will calculate it for you to aid in selecting eyewear.

*Controls.*

- Use isolation and controlled access to Class 3b and 4 lasers. Rooms with permanently installed open beam Class 4 lasers should have door interlocks capable of disabling the laser. Beams should be confined to the table, and steps should

be taken to minimize stray reflections. Beams should be enclosed whenever possible.

- If lasers are to be used outdoors, additional consideration should be given for the potential to interfere with aviation. Guidelines for the use of lasers outdoors can be found in ANSI Z136.1 and FAA Advisory Circular 70-1.
- Laser users should ALWAYS wear properly rated laser eyewear when hazardous open beams are present.
- Laser protective eyewear is rated using Optical Density (OD), a logarithmic scale of the amount of attenuation the filter provides for a specific wavelength or wavelength range.
- It is important to remember that all modes of operation and possible wavelengths should be considered when choosing the eyewear.
- Another factor to take into account is the visible light transmission of the eyewear; in other words, will the eyewear interfere with the tasks or the need to view the beam?
- Additional assistance in selection of eyewear can be obtained from the laser manufacturer and/or the laser eyewear manufacturer.

*Training.*—Employees who use Class 3b or Class 4 lasers must have education and training commensurate with the level of potential hazard. They must be made aware of the hazards and the available controls to reduce their exposure.

For more details, see SM 445-2-H Chapter 50—Non-ionizing Radiation.



## Topic 7. Portable Tools

### Topic 7-1. Hand Tools

Hand tools are tools that are powered manually. Hand tools include anything from axes to wrenches. The greatest hazards posed by hand tools result from misuse and improper maintenance.

Hand (manual) tools do not use external power for operation and are used for various manual jobs. They are mainly used in small-scale projects and for finishing work.



**Hammer with cracked handle.**

*Commonly used hand tools include the following:*

- Hammers
- Screw drivers
- Spades
- Wrenches
- Saws
- Chisels
- Riveters
- Axes
- Bullfloats

These hand tools can be of various types and configurations, depending on the manufacturer and type of usage. Hand tools require less training than power tools. However, if misused, they can cause serious injuries to employees and bystanders.

### **Hazards**

*Examples of hazards include the following:*

- If a chisel is used as a screwdriver, the tip of the chisel may break and fly off, hitting the user or other employees.
- If a wooden handle on a tool, such as a hammer or an ax, is loose, splintered, or cracked, the head of the tool may fly off and strike the user or other employees.
- If the jaws of a wrench are sprung, the wrench might slip.
- If impact tools such as chisels, wedges, or drift pins have mushroomed heads, the heads might shatter on impact,

sending sharp fragments flying toward the user or other employees.

- Poor housekeeping, not properly storing, and/or unattended hand tools can create tripping and slipping hazards to employees.
- Employees who use hand tools are sometimes exposed to the hazards of falling, flying, abrasive, and splashing objects, or to harmful dusts, fumes, mists, vapors, or gases.
- A foreign body in the eye is a common injury due to lack of eye protection while operating or sharpening a tool.
- A serious injury can be caused by accidentally hitting or dropping a heavy tool, such as an ax, on a foot.

## General Rules

- Select the proper tool for the particular operation.
- Appropriate personal protective equipment (PPE) must be provided and worn.
- Do not wear bulky gloves to operate hand tools.
- Inspect hand tools to determine if they are in safe condition before use. Tools with defects that will compromise the safety of employees must be removed from service. If there is a manufacturer's instruction manual, it should be maintained with the tools.
- Keep tools in safe working condition, stored properly in suitable containers, and protected against corrosion.
- Carry tools in a sturdy tool box to and from the worksite.
- Do not throw tools. Hand them, handle first, directly to other employees.
- Do not carry tools in a way that interferes with using both hands on a ladder, while climbing on a structure, or when doing any hazardous work. If working on a ladder or scaffold, tools should be raised and lowered using a bucket and hand line.
- Do not carry a sharp tool in your pocket.
- Employees should be trained in the proper use and handling of tools and equipment that they will be expected to use. They should be able to recognize the hazards associated with the different types of tools and the associated safety precautions.

- When employees use saw blades, knives, or other tools, they should direct the tools away from aisle areas and away from other employees working in close proximity.
- Knives and scissors must be sharp. Dull tools can cause more hazards than sharp ones.
- Cracked saw blades must be removed from service.
- When using equipment with long handles, keep it clear from the path of traffic or moving equipment.
- Do not use wrenches when jaws are sprung to the point that slippage occurs.
- Do not hold the stock in the palm of your hand when using a cutting tool or a screwdriver.
- Impact tools such as drift pins, wedges, and chisels must be kept free of mushroomed heads.
- The wooden handles of tools must not be splintered.
- Iron or steel hand tools may produce sparks that can be an ignition source around flammable substances. Where this hazard exists, spark-resistant tools made of nonferrous materials should be used where flammable gases, highly volatile liquids, and other explosive substances are stored or used.

## **Chisels**

- Wear safety glasses or goggles to protect eyes from flying particles.
- Use screens to protect other persons from flying chips.
- Check stock thoroughly for knots, staples, nails, screws, or other foreign objects before chiseling.
- Clamp stock so it cannot move.
- Adjust your stance so that you do not lose your balance if the tool slips.
- Chip or cut away from yourself.
- Keep your hands and body behind the cutting edge.
- Use a wooden or plastic mallet with a large striking face on all chisels. Only heavy-duty or framing chisels are made of a solid or molded handle that can be struck with a steel hammer.
- Make finishing or paring cuts with hand pressure alone.
- Place chisels safely within the plastic protective caps to cover cutting edges when not in use.

- Do not use a wood chisel as a pry or a wedge.
- Do not use a wood chisel on metal.
- Do not use an all-steel chisel with a mushroomed face or a chipped edge. Redress with a file or whetstone.
- Do not use a grinder to redress heat-treated tools. Use a whetstone.
- Do not use a dull chisel.

### **Chopping Tools (Ax, Pulaski Axe, Hoedad, and so forth)**

- Wear stout leather boots and safety glasses or goggles for eye protection. Hard hats are needed when there is any chance of being struck by something overhead. Hard hats are a must for tree-felling operations.
- Use the right tool for the job. Keep your tool sharp with a splinter-free handle and a tight head. A dull edge will glance off of a surface more easily than a sharp edge.
- Treat the ends of ax handles and other swinging tools to prevent slippage. Inspect wedges for tightness.
- When swinging an ax or similar tool, place your feet firmly and shoulder-width apart. Grip the handle near the end. Make sure there is ample clearance from objects and persons near the swing arc. Always chop away from feet, legs, and body. Guard against loss of grip or control of tool if a glancing blow is struck against the target object.
- Sheathe all chopping tools when not in use.
- Never leave an ax or similar tool in normal path of movement or sticking in a tree or stump.
- Observe safe spacing between crew members carrying sharp or pointed tools. Travel on foot in single file.
- Sheathe tools and hand-carry on the downhill side. Never carry the tool on your shoulder. Keep the other hand free. If you trip, slip, or fall, throw the tool to the downhill side. Use both of your hands to regain your balance or break your fall.
- Be watchful of the force released by cutting a sapling that is being held in a bowed position by adjacent trees or brush.
- Maintain 15-foot intervals between workers using tools.
- Allow overhead clearance when using a brush-cutting tool. Use the proper handhold. Keep body well braced and balanced. Make each stroke productive.

- Do not chop directly through a knot if you can chop around it or chop the knot out. Knots often are very hard and can chip your ax or adze.
- Never strike the ground with your ax. If you need to cut roots, use a grubbing tool like a Pulaski or grub hoe. If you have to use an ax, use a “grubbing” ax that you don’t care about abusing.
- Never try to drive a stake or wedge with the flat side of your double-bit ax. It is almost sure to crack the eye.
- Never use the poll of a single-bit ax for pounding steel wedges. The poll is there for counter balance to the bit. It is not there for pounding. The poll is not tempered properly to pound and will become deformed or chips of steel may fly off. A single-bit ax can be safely used to pound wooden or plastic wedges but not for harder materials.
- The ax head is brittle at extremely cold temperatures. It is likely to chip unless it is warmed before using. One way to warm up your ax is to place it (sheathed, of course) under your armpit for a few minutes. Or warm it between your hands. If you don’t want to share some of your body heat with your ax (which by now should be considered a family member), chop very slowly for at least 2 minutes in order to warm the ax up in the wood.

## Files

- Protect hands with leather gloves that fit correctly when filing sharp objects.
- Fit files with substantial handles and guards.
- Never use a file as a pry.
- Keep files clean to reduce slipping.

## Hammers

- Wear safety glasses or goggles.
- Select hammers with secure heads that are of suitable type and weight, and have a proper handle length for the job to be done.
- Choose a hammer with a striking face diameter approximately 1/2 inch larger than the face of the tool being struck.
- Ensure that the head of the hammer is firmly attached to the handle.
- Replace loose, cracked, or splintered handles.

- Discard any hammer with a mushroomed or chipped face or with cracks in the claw or eye sections.
- Strike a hammer blow squarely with the striking face parallel to the surface being struck. Always avoid glancing blows and over and under strikes. (Hammers with bevelled faces are less likely to chip or spall.)
- Allow sufficient working space. Look behind and above you before swinging the hammer.
- Watch the object you are hitting.
- Hold the hammer with your wrist straight and your hand firmly wrapped around the handle.
- Do not use one hammer to strike another hammer, other hard metal objects, stones, or concrete.
- Do not redress, grind, weld, or reheat-treat a hammer head.
- Do not strike with the side or cheek of the hammer.

## Handsaws

- Wear safety glasses or goggles.
- Select a saw of proper shape and size for the stock being used.
- Select a saw with the number of teeth per inch for the desired finish. For example: a coarse tooth blade (2 or 3 teeth per inch) should be used for thicker stock. Eighteen to 32 teeth per inch should be used on thinner metals or plastic (1/4 inch).
- Choose a saw handle that keeps the wrist in a natural position in the horizontal plane.
- Choose a saw with a handle opening of at least 5 inches long and 2.5 inches wide and slanted at a 15 degree angle.
- Check the stock being cut for nails, knots, and other objects that may damage or buckle the saw.
- Start the cut by placing your hand beside the cut mark with your thumb upright and pressing against the blade. Start the cut carefully and slowly to prevent the blade from jumping. Pull upward until the blade bites. Start with a partial cut. Then set the saw at the proper angle. Apply pressure on the down stroke only.
- Hold stock being cut firmly in place.
- Use a helper, a supporting bench, or vise to support long stock if required.

- Keep teeth and blades properly set.
- Protect teeth of saw when not in use.
- Keep saw blades clean.
- When using a hacksaw,
  - Select the correct blade for material being cut.
  - Secure the blade with the teeth pointing forward. Tighten the nut until the blade is under tension.
  - Keep the blade rigid and the frame properly aligned.
  - Cut using steady strokes, directed away from you.
  - Use the entire length of blade in each cutting stroke.
  - Use light machine oil on the blade to keep it from overheating and breaking.
  - Cut harder materials more slowly than soft materials.
  - Clamp thin, flat pieces requiring edge cutting.
  - Keep the saw blade clean and lightly oiled.
  - Do not apply too much pressure on the blade, as the blade may break.
  - Do not twist when applying pressure.
  - Do not use when the blade becomes loose in the frame.

## **Machetes**

- Wear stout leather boots, safety glasses or goggles for eye protection, cut-resistant gloves, and long pants.
- When carrying a machete, tuck the blade between your upper arm and chest with the handle projecting out the front so if you slip you aren't going to seriously harm yourself.
- Use a sheath when not in use.
- Check to make sure the area within range of your swing is clear and that nobody, or nothing, is standing behind you. Injuries often happen when the swing is interrupted by an unseen object or when the blade is deflected off the object.
- Swing the machete away from yourself and others. Be especially careful of your legs and feet while cutting brush in front of you.
- Establish and maintain a solid stance with good footing before striking with the machete. Be prepared for over-swing if the material cuts more easily than expected.

- Do not hack perpendicularly into the object you are chopping. Hack at a 45 degree angle, alternating between chopping in opposite directions to remove slices of material, opening a gap. This prevents the machete from becoming imbedded and stuck in thick, woody vegetation.
- Check the machete's sharpness before starting out and when resting. Clean and sharpen the machete when finished so it is ready for the next use.

## Pickaxes

- Wear stout leather boots and safety glasses or goggles for eye protection.
- Use pickaxes with handles that are free from splinters and securely fastened to the head.
- Grip the handle tightly so the pickaxe will not slip out of your hand when it strikes.
- When swinging a pickaxe, make sure that you have overhead and side clearance.
- Make sure the object is in front of you so that you are not trying to hit something that is close to your feet; this will minimize the chance of driving the pickaxe through your own foot or leg.
- Before you do any work with a pickaxe, pick it up and give it a few practice swings. Feel its weight and make sure you feel comfortable swinging it over and over again. Do this slowly, practicing the basic pickaxe swinging technique.
- Let the weight of the pickaxe do the work. When you feel comfortable hitting objects with the pickaxe, begin pulling it directly over your head before swinging it. This gives you more power and improves your aim. Only do this after you have practiced a few days.

## Screwdrivers

- Depending on the work, you may need to wear safety glasses or goggles.
- Always match the screwdriver to the screw head, both in terms of size and type.
- Choose contoured handles that fit the shank tightly, with a flange to keep the hand from slipping off the tool.
- Use a slot screwdriver with a blade tip width that is the same as the width of the slotted screw head.

- For cross head screws, use the correct size and type of screwdriver. A Phillips screwdriver may slip out of a screw head designed for use with the slightly flatter-tipped Pozidriv screwdriver. (The *Pozidriv screwdriver* and screws are distinguishable from Phillips by the second set of radial indentations set 45 degrees from the cross recess.)
- Use a vise or clamp to hold the stock if the piece is small or if it moves easily.
- Keep the screwdriver handle clean. A greasy handle could cause an injury or damage from unexpected slippage.
- Shut off electricity before beginning work on electrical equipment (lock out, de-energize, and tag out).
- Do not use a screwdriver with a plastic handle for work on live electrical equipment. Only qualified electricians may work on live electrical equipment and only when it is not feasible to de-energize and lock out. Live electrical work requires use of tools that have insulated handles designed for electrical work and a nonconducting shaft.
- Use nonmagnetic tools when working near strong magnets (for example, in some laboratories).
- Use a screw-holding screwdriver (with screw-holding clips or magnetic blades) to get screws started in awkward, hard-to-reach areas.
- Use an offset screwdriver in close quarters where a conventional screwdriver cannot be used.
- Use a screwdriver that incorporates the following features when continuous work is needed:
  - a pistol grip to provide for a straighter wrist and better leverage,
  - a “Yankee drill” mechanism (spiral ratchet screwdriver or push screwdriver) that rotates the blade when the tool is pushed forward,
  - a ratchet device to drive hard-to-move screws efficiently, or
  - use a powered screwdriver.
- If the tip of the screwdriver becomes rounded, file it square and make sure



**Offset screwdriver.**



**Yankee drill mechanism with a pistol grip.**

the edges are straight. A dull or rounded tip can slip out of the slot and cause hand injury or damage to materials.

- Store screwdrivers in a rack or partitioned pouch so that the proper screwdriver can be selected quickly.
- Never use a screwdriver as a chisel.
- Don't carry a screwdriver loose in pockets.

## Snips

Snips are made in various shapes and sizes for various tasks. The handle can be like those on scissors with finger and thumb holes or like plier handles. Models are available for cutting in straight lines, in curves to the left, or curves to the right. Universal snips can cut in both straight and wide curves. Left cut snips are for making cuts to the left and straight cuts. Right cut snips are for making straight cuts and cuts to the right. Straight cut snips are for making straight cuts and shallow cuts to the right or left. Offset snips permit you to keep your hands safely above the cut while cutting directly through the center of a large sheet.

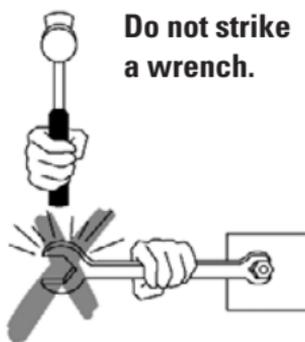
- Use snips for cutting soft metal only. Hard or hardened metal should be cut with cutting tools designed for that purpose.
- Use ordinary hand pressure for cutting. If extra force is needed, use a larger tool.
- Cut so that the waste is on the right if you are right-handed or on the left if you are left-handed.
- Avoid springing the blades. This results from trying to cut metal that is too thick or heavy for the snips you are using.
- Keep the nut and the pivot bolt properly adjusted at all times.
- Oil the pivot bolt on the snips occasionally.
- Use the locking clip (if available) to keep the snips closed when not in use.
- Do not try to cut sharp curves with straight cut snips.
- Do not cut sheet metal thicker than the manufacturer's recommended upper limit.
- Do not extend the length of handles to gain greater leverage.
- Do not hammer or use your foot to exert extra pressure on the cutting edges.
- Do not attempt to resharpen snips in a sharpening device designed for scissors, garden tools, or cutlery.

## Wrenches

Wrenches are made in various shapes and sizes and are used for gripping, fastening, turning, tightening, and loosening things like pipes, pipe fittings, nuts, and bolts. There are two major kinds of wrenches: pipe wrenches used in plumbing for gripping round (cylindrical) things and general use wrenches used on nuts and bolts that have flat, parallel surfaces, such as square or hexagonal (hex).

- Use the correct wrench for the job. Use pipe wrenches for plumbing fittings. Use general use wrenches for nuts and bolts. Do not use pipe wrenches on nuts or bolts. Do not use pipe wrenches for lifting or bending pipes.
- Never use pliers instead of a wrench or a wrench as a hammer.
- Do not use a makeshift wrench.
- Discard any damaged wrenches (for example, open-ended wrenches with spread jaws or box wrenches with broken or damaged points). Do not use a wrench that has a bent handle or is damaged.
- Select the wrench with the correct jaw size to avoid slippage.
- Do not use a wrench on moving machinery.
- Do not insert a shim in a wrench for better fit.
- Do not strike a wrench (except a “strike face” wrench) with a hammer, or similar object, to gain more force.
- Do not increase the leverage by adding sleeved additions (such as a pipe) to increase tool handle length.
- Do not expose a wrench to excessive heat (like from a blow torch) that could affect the temper of the metal and ruin the tool.
- Wear safety glasses or goggles where there is a likely hazard of flying particles or falling debris.
- Position your body in a way that will prevent you from losing balance and hurting yourself if the wrench slips or something (for example, a bolt) suddenly breaks.
- Use a box or socket wrench with a straight handle, rather than an offset handle, when possible.
- Ensure that the jaw of an open-ended wrench is in full contact (fully seated, “flat,” not tilted) with the nut or bolt before applying pressure.

- When turning with an adjustable wrench, the direction of the turn should be against (towards) the permanent jaw.
- Do not pull on an adjustable wrench that is loosely adjusted. Make sure it does not “slide” open during use.
- Ensure that the teeth of a pipe wrench are sharp and free of oil and debris and that the pipe or fitting is clean to prevent unexpected slippage and possible injuries.
- Apply a small amount of pressure to a ratchet wrench initially to ensure that the ratchet wheel (or gear) is engaged with the pawl (a catch fitting in the gear) for the direction you are applying pressure.
- Support the head of the ratchet wrench when socket extensions are used.
- Pull on a wrench using a slow, steady pull. Do not use fast, jerky movements. Don't push.
- Stand aside when work is done with wrenches overhead.
- Keep tools well maintained (cleaned and oiled).
- Clean and place tools and wrenches in a tool box, rack, or tool belt after use.



## Topic 7-2. Portable Power Tools

The types of power tools are determined by their power source: electric, pneumatic, liquid fuel, hydraulic, and powder-actuated.

While power tools are extremely helpful, they also produce large amounts of noise and vibrations. Using power tools without hearing protection over a long period of time can put a person at risk for hearing loss. Most power tools, including drills, circular saws, belt sanders, and chainsaws operate at sound levels above the 85 decibels and some operate at levels above 100 decibels.

### General

- Ensure that you have been trained to use the tool safely. Read the operator's manual before using the tool and operate the tool according to the manufacturer's instructions. Use only tested and approved tools.

- Review the manufacturer’s instructions before using a tool.
- Inspect tools for any damage prior to each use.
- Check the handle and body casing of the tool for cracks or other damage.
- Ensure that the power tool has the correct guard, shield, or other attachment that the manufacturer recommends.
- Use only the attachments that the manufacturer recommends for the tools you are using.
- Wear safety glasses or goggles. Add a face shield when full face protection is needed. Where necessary, wear safety shoes or boots and hearing protection.
- Do not wear loose clothing, ties, or jewelry that can become caught in moving parts.
- Keep tools clean and lubricated, and maintain them according to the manufacturers’ instructions.
- Be careful to prevent hands, feet, or body from injury in case the machine slips or the tool breaks.
- Reduce physical fatigue by supporting heavy tools with a counter-balance wherever possible.
- Never carry a tool by the cord or hose.
- Keep cords and hoses away from heat, oil, and sharp edges.
- Never yank a cord or hose to disconnect it from the receptacle.

*If a tool is defective,*

- Remove it from service and tag it clearly “Out of service for repair.”
- Replace damaged equipment immediately—do not use defective tools “temporarily.”
- Have tools repaired by a qualified person—do not attempt field repairs.

## **Pneumatic Tools**

Pneumatic tools are powered by compressed air. Common types of air-powered hand tools include buffers, nailing and stapling guns, grinders, drills, jack hammers, chipping hammers, riveting guns, sanders, and wrenches. There are several dangers associated with the use of pneumatic tools. First and foremost is the danger of getting

hit by one of the tool's attachments or by some kind of fastener the employee is using with the tool.

- Post warning signs where pneumatic tools are used. Set up screens or shields in areas where nearby persons may be exposed to flying fragments, chips, dust, and excessive noise.
- Ensure that the compressed air supplied to the tool is clean and dry. Dust, moisture, and corrosive fumes can damage a tool. An in-line regulator filter and lubricator increases tool life.
- Use the proper hose and fittings of the correct diameter.
- Use hoses specifically designed to resist abrasion, cutting, crushing, and failure from continuous flexing.
- Choose air-supply hoses that have a minimum working pressure rating of 150 pounds per square inch gage (psig) or 150 percent of the maximum pressure produced in the system, whichever is higher.
- Check hoses regularly for cuts, bulges, and abrasions. Tag and replace, if defective.
- Blow out the air line before connecting a tool. Hold hose firmly and blow away from yourself and others. Never aim an air hose at anyone.
- Make sure that hose connections fit properly and are equipped with a mechanical means of securing the connection, such as a chain, wire, or positive locking device.
- Install quick disconnects of a pressure-release type rather than a disengagement type. Attach the male end of the connector to the tool, not the hose.
- Pneumatic tools that shoot nails, rivets, staples, or similar fasteners and operate at pressures more than 100 pounds per square inch (psi) must be equipped with a special device to keep fasteners from being ejected, unless the muzzle is pressed against the work surface.
- Do not operate the tool at a pressure above the manufacturer's rating.
- Turn off air pressure to the hose when not in use or when changing power tools.
- Do not carry a pneumatic tool by its hose.
- Avoid creating trip hazards caused by hoses laid across walkways or curled underfoot.
- Do not use compressed air to blow debris or to clean dirt from clothes.

- **Cleaning with compressed air is dangerous.**
- Do not use compressed air for cleaning unless no alternate method of cleaning is available. The nozzle pressure **MUST** remain below 30 pounds per square inch (psi). Personal protective equipment and effective chip guarding techniques must be used.
- Use of heavy jackhammers can cause fatigue and strains. Heavy rubber grips reduce these effects by providing a secure handhold. Employees operating a jackhammer must wear safety glasses and safety shoes that protect them against injury if the jackhammer slips or falls. A face shield also should be used.

## Compressors

All air receivers must be in compliance with the American Society of Mechanical Engineers (ASME) standard.

- Inspect each month for leaks and signs of corrosion on surfaces.
- Replace worn parts and remove corrosion.
- Make sure that the receiver is equipped with a readily visible pressure gage with one or more spring-loaded safety valves. The total relieving capacity of the safety valves must prevent pressure in the receiver from exceeding the maximum allowable working pressure of the receiver by more than 10 percent.
- Test safety valves frequently and at regular intervals.
- Do not place a valve of any type between the air receiver and its safety valve or valves.
- A drain pipe and valve must be installed at the lowest point on the tank. The drain valve on the air receiver must be opened and the receiver completely drained frequently (at least monthly) to prevent the accumulation of excessive amounts of liquid in the receiver.
- Fusible plugs are sometimes fitted to the receivers of air compressors as a precaution against the ignition of any lubricating oil vapor that might be present. Should the action of the compressor heat the air above a safe temperature, the core will melt and release the pressure. Do not replace the fusible plug with an ordinary pipe plug.
- Clean or replace air filters as needed to extend the life of the air compressor and reduce energy costs.

## Electric Tools

Portable electric tools may be either corded or battery powered. Electrical shocks, which can lead to injuries such as heart failure and burns, are among the major hazards associated with electric-powered tools. Under certain conditions, even a small amount of electric current can result in fibrillation of the heart and death. An electric shock also can cause the user to fall off a ladder or other elevated work surface and be injured due to the fall. To protect the user from shock and burns, electric tools must have a three-wire cord with a ground and be plugged into a grounded receptacle, be double insulated, or be powered by a low-voltage isolation transformer.

### Inspect

- If the tool has auxiliary or double handles, check to see that they are installed securely.
- Inspect cords for defects: check the power cord for cracking, fraying, and other signs of wear or faults in the cord insulation.
- Check for damaged switches and ones with faulty trigger locks.
- Inspect the plug for cracks and for missing, loose, or faulty prongs.
- Use only the kind of battery that the tool manufacturer specifies for the battery-powered tool that you are using.
- Recharge a battery-powered tool only with a charger that is specifically intended for the battery in that tool.
- Before changing accessories, making adjustments, or storing the tool, unplug the cord or, if battery powered, remove the battery from the tool or ensure that the tool is switched off or locked off. A tool that accidentally starts while changing a bit or other accessory could remove your finger.
- Store a battery pack safely so that no metal parts, nails, screws, wrenches, and so on can come in contact with the battery terminals; this could result in shorting the battery and possibly cause sparks, fires, or burns.

## Liquid Fuel Tools

Fuel-powered tools are usually operated with gasoline. The most serious hazard associated with the use of fuel-powered tools comes from fuel vapors that can burn or explode and also give off dangerous exhaust fumes.

- Handle, transport, and store gas or fuel only in approved flammable liquid containers and according to proper procedures for flammable liquids.
- Before refilling a fuel-powered tool tank, the user must shut down the engine and allow it to cool to prevent accidental ignition of hazardous vapors.
- When a fuel-powered tool is used inside a closed area, effective ventilation and/or proper respirators such as atmosphere-supplying respirators must be used to prevent breathing carbon monoxide.
- Fire extinguishers must be available in the area.

## **Powder-Actuated Tools**

Powder-actuated tools operate like a loaded gun and must be treated with extreme caution. They must be operated only by specially trained employees.

- Wear suitable ear, eye, and face protection.
- Select a powder level—high or low velocity—that is appropriate for the powder-actuated tool and necessary to do the work without excessive force.
- The muzzle end of the tool must have a protective shield or guard centered perpendicular to and concentric with the barrel to confine any fragments or particles that are projected when the tool is fired. A tool containing a high-velocity load must be designed not to fire unless it has this kind of safety device.
- To prevent the tool from firing accidentally, two separate motions are required for firing.
  - The first motion is to bring the tool into the firing position, and the second motion is to pull the trigger.
  - The tool must not be able to operate until it is pressed against the work surface with a force of at least 5 pounds greater than the total weight of the tool.

*If a powder-actuated tool misfires,*

- Hold the tool in the operating position for at least 30 seconds before trying to fire it again.
- If it still will not fire, the user must hold the tool in the operating position for another 30 seconds and then carefully remove the load in accordance with the manufacturer's instructions.

- This procedure will make the faulty cartridge less likely to explode.
- The bad cartridge should then be put in water immediately after removal.
- If the tool develops a defect during use, it should be *tagged* and must be *taken out of service immediately* until it is properly repaired.

*Safety precautions that must be followed when using powder-actuated tools include the following:*

- Do not use a tool in an explosive or flammable atmosphere.
- Inspect the tool before using it to determine that it is clean, that all moving parts operate freely, and that the barrel is free from obstructions and has the proper shield, guard, and attachments recommended by the manufacturer.
- Do not load the tool unless it is to be used immediately.
- Do not leave a loaded tool unattended, especially where it would be available to unauthorized persons.
- Keep hands clear of the barrel end.
- Never point the tool at anyone.

*When using powder-actuated tools to apply fasteners, several additional procedures must be followed:*

- Do not fire fasteners into material that would allow the fasteners to pass through to the other side.
- Do not drive fasteners into very hard or brittle material that might chip or splatter or make the fasteners ricochet.
- Always use an alignment guide when shooting fasteners into existing holes.
- When using a high-velocity tool, do not drive fasteners more than 3 inches from an unsupported edge or corner of material such as brick or concrete.
- When using a high-velocity tool, do not place fasteners in steel any closer than 1/2 inch from an unsupported corner edge unless a special guard, fixture, or jig is used.

## **Hydraulic Power Tools**

- The fluid used in hydraulic power tools must be an approved fire-resistant fluid and must retain its operating characteristics at the most extreme temperatures to which it will be exposed. The exception to fire-resistant fluid involves all hydraulic

fluids used for the insulated sections of derrick trucks, aerial lifts, and hydraulic tools that are used on or around energized lines. This hydraulic fluid must be of the insulating type.

- The manufacturer's recommended safe operating pressure for hoses, valves, pipes, filters, and other fittings must not be exceeded.

## **Jacks**

- All jacks, including lever and ratchet jacks, screw jacks, and hydraulic jacks must have a stop indicator, and the stop limit must not be exceeded.
- The manufacturer's load limit must be permanently marked in a prominent place on the jack, and the load limit must not be exceeded.
- A jack should never be used to support a lifted load. Once the load has been lifted, it must immediately be blocked up. Put a block under the base of the jack when the foundation is not firm, and place a block between the jack cap and the load if the cap might slip.
- To set up a jack, make certain of the following:
  - The base of the jack rests on a firm, level surface;
  - The jack is correctly centered;
  - The jack head bears against a level surface; and
  - The lift force is applied evenly.
- Proper maintenance of jacks is essential for safety.
- All jacks must be lubricated regularly.
- In addition, each jack must be inspected according to the following schedule:
  - For jacks used continuously or intermittently at one site, inspect at least once every 6 months.
  - For jacks sent out of the shop for special work, inspect when sent out and inspect when returned.
  - For jacks subjected to abnormal loads or shock, inspect before use and immediately thereafter.

For more details, see

- 29 CFR 1910.169, Air receivers.
- 29 CFR 1910 Subpart P, Hand and portable powered tools and other hand-held equipment.

## Topic 7-3. Chainsaws

Get acquainted with your saw so you have a good idea how it works and know the most important parts, especially parts related to safety.

### Chainsaw Parts

- **Chain catcher** is on the bottom of the saw and catches the chain if it breaks or derails.
- **Throttle lock** is on the inside of the rear handle. To prevent accidental throttle advance, when you squeeze the throttle control you must also depress the throttle lock on the top of the handle. Gasoline-powered chainsaws must be equipped with a continuous pressure throttle control system that will stop the chain when pressure on the throttle is released.
- **Stop control** can stop the engine quickly.
- **Right-hand guard** protects your right hand if the chain were to break or derail.
- **Kickback protection.** The saw has a chain brake to stop the chain in the event of a kickback. Chainsaws must be equipped with a chain brake. The chain brake can be triggered by:
  - The user's hand pushing the kickback protection forward.
  - The inertial forces that arise during a kickback.

Kickback can occur during most types of operations due to lack of care, and is caused by the saw contacting something with the upper part of the bar nose (the kickback zone). In a kickback situation, the saw is thrown as a result of the force of the rotating chain. Usually the saw is thrown upward and backward. The chainsaw kickback device must not be removed or otherwise disabled.

### Training

Employees that use chainsaws for their work must be trained when:

- Initially assigned the work.
- Assigned new work tasks, tools, equipment, machines, or vehicles.
- He or she demonstrates unsafe job performance.

*Training must include all of the following:*

- Safe performance of assigned work tasks.
- Safe use, operation, and maintenance of tools, machines, and vehicles that will be used or operated, including emphasis on

understanding and following the manufacturer's operating and maintenance instructions, warnings, and precautions.

- Recognition of safety and health hazards associated with the specific work tasks, including the use of measures and work practices to prevent or control those hazards.
- Recognition, prevention, and control of other safety and health hazards in the logging industry.
- USGS procedures, practices, and requirements for field work.
- The requirements of 29 CFR 1910.266.

A written certification record of the training must contain the name of the employee trained, the date(s) of the training, and the signature of the person who conducted the training or the signature of the employer.

In addition, employees that use chainsaws for their work must complete first-aid and cardiopulmonary resuscitation (CPR) training. The training and certificate must remain current.

## **Personal Protective Equipment**

Personal protective equipment (PPE) cannot prevent an accident from happening, but it can help to reduce the level of injury if one does occur. The minimum PPE required for chainsaw operations is listed below.

- Helmet with a full coverage visor and hearing protection.
- Heavy duty gloves.
- Boots with protective toecap, saw protection, and a heavy tread.
- Trousers or chaps constructed with cut-resistant material and a highly visible jacket or vest.

Do not wear loose-fitting clothing.

## **Medical**

First-aid kits are required at each worksite where trees are being cut (felling, buckling, limbing), at each active landing, and on each employee transport vehicle.

## Operation

*Check the chain to make sure it is sharp and tensioned properly.*

- If it is not a new chain, it's a good idea to file (sharpen) it.
- Re-tension a new chain after operating for a short period.

*When fueling,*

- Place the saw on a stable surface at least 10 feet away from any sources of ignition.
- Overfill protection will help avoid unnecessary spillage.
- To avoid fire, move the saw away from the fueling area before starting it.

The buddy system is recommended, but stay at least 15 feet apart and further when felling trees.

*Starting the saw.*

- Place the saw flat on the ground and clear the area.
- Activate the chain brake by pushing the kickback protection forward; otherwise the chain will start to rotate when the saw starts.
- Depress SmartStart decompression control, if the saw has this feature.
- If the engine is cold, pull the choke out fully.
- Put your right foot partway through rear handle. Hold the front handle firmly with your left hand.
- Pull the starter handle with your right hand until the engine starts.
- Push the choke in again, with the throttle on half way.
- Continue to pull the starter handle until the saw starts.
- Hit the throttle once so the engine speed drops to idle.
- If the engine is already warm, don't use the choke, but the other steps are the same.
- Check that the chain brake works.
- Place the saw on a stable surface and squeeze the throttle.
- Activate the chain brake by pushing your left wrist against the kickback protection, without releasing the handle.
- The chain should stop immediately.

- Check the chain lubrication by holding the saw above a light surface, such as a stump, and hit the throttle. A line of oil should be visible on the surface.

#### *Good practices.*

- Hold the saw firmly by both handles and hold your thumbs and fingers around the handles.
  - Make sure you hold your left thumb under the front handle, to reduce the force of a possible kickback.
- Have respect for the saw, but don't be afraid of it.
  - If you hold it close to your body it won't feel as heavy, and you'll be more balanced and in better control of the saw.
  - For the best balance, stand with your feet apart.
- If you aren't used to using a chainsaw, get acquainted by practicing on a log.

### **Prohibitions**

- Drop starting a chainsaw is prohibited. You must start the chainsaw with the chain brake engaged.
- Never use a chainsaw to cut directly overhead.
- Never fuel a running or hot chainsaw.

### **Felling Trees**

#### *Prevent accidents.*

- Are there any roads, overhead lines, or buildings nearby?
- If so, and if you're a beginner, leave the job to someone with more experience.
- If you know that people often pass through the area, set up warning signs.

#### *Decide direction.*

- Is the tree leaning?
- Which way is the wind blowing?
- Considering the surroundings and ease of subsequent work, which direction should it be felled?

#### *Safe retreat.*

- Clear obstructive undergrowth from around the tree.
- Remove branches and other obstacles on the ground.

- On both sides of the tree, you should be able to walk unobstructed at an angle away from the falling tree and remain there at a safe distance.

*Limbing, buttress roots.*

- You might need to limb the lower part of the trunk.
- The safest way to do this is with a pulling chain, moving from above, downwards.
- Use the trunk as protection between you and the saw.
- **Never climb higher than shoulder height.**

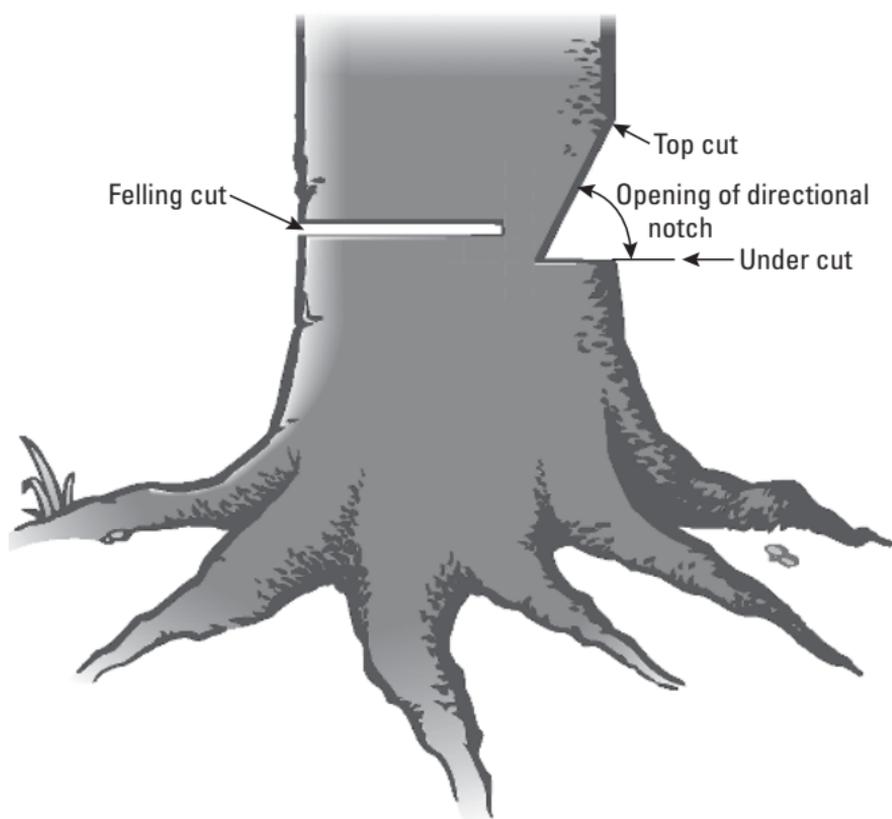
## **Directional Felling**

Sawing a directional notch determines which direction the tree will fall. The directional notch can be made in a variety of ways. The one shown here is the open directional notch.

Stand by the tree and decide exactly which direction you want to fell it. Choose some feature from the surroundings as a guide. If the tree has buttress roots, it's a good idea to remove them.

First, make a top cut into the stem, at an angle of about 60 degrees. Saw to a depth of about 20–25 percent of the tree's diameter. Then make a horizontal undercut that meets the top cut. Next saw a horizontal felling cut slightly above the level of the undercut. It's important that you stop sawing just before you reach the directional notch, leaving what is called a hinge. The hinge guides the tree as it falls. Its width should be 10 percent of the tree's diameter or at least 1 inch.

*Keep a safe distance.*—Make sure that no people are within the safety radius, **at least twice the length of the tree**, that you plan to fell.



## Topic 7-4. Portable Generators

Portable generators are internal combustion engines used to generate electricity and are commonly used at remote campsites and during disaster response. Portable generators can be dangerous if used incorrectly.

### Major Causes of Injuries and Fatalities

- Shocks and electrocution from improper use of power or accidentally energizing other electrical systems.
- Carbon monoxide from a generator's exhaust.
- Fires from improperly refueling the generator or inappropriately storing fuel.

## **Safe Work Practices**

- Inspect portable generators for damage or loose fuel lines that may have occurred during transportation and/or handling.
- Keep the generator dry.
- Maintain and operate portable generators in accordance with the manufacturer's use and safety instructions.
- Never attach a generator directly to the electrical system of a structure (home, office, or trailer) unless the generator has a properly installed transfer switch because this creates a risk of electrocution for utility workers.
- Always plug electrical appliances directly into the generator using the manufacturer's supplied cords. Use undamaged heavy-duty extension cords that are grounded (3-pronged).
- Use ground-fault circuit interrupters (GFCIs) as per the manufacturer's instructions.
- Before refueling, shut down the generator.
- DO NOT store fuel indoors.

## **Carbon Monoxide Poisoning**

Carbon monoxide is a colorless, odorless, toxic gas. Many people have died from carbon monoxide poisoning because their generator was not adequately ventilated.

- DO NOT use a generator indoors.
- DO NOT place a generator outdoors near doors, windows, or vents.
- Place generators downwind with a noise control barrier.
- If you or others show symptoms of carbon monoxide poisoning (dizziness, headaches, nausea, tiredness) get to fresh air immediately and seek medical attention.

## Topic 8. Wildlife Hazards

### Topic 8-1. Dangerous Animals

Employees that travel by foot and/or work in areas where dangerous animals are frequently present must be:

- Trained in methods to avoid an attack.
- Offered to be trained and equipped to carry bear spray. Bear spray will repel many kinds of aggressive animals (for example, wolves, coyotes, bears, moose, wild hogs, badgers, lynx, mountain lions) without killing or seriously injuring them.

In addition, managers may offer employees to be trained and equipped to carry firearms for defense against wild animals.



**Coyote.**

### Do Not Approach Wildlife!

If any wild animal changes its behavior due to your presence, you are too close. Do not approach wildlife, no matter how tame or calm they may appear to you. If you are in a national or State park, obey instructions from park staff on scene.

*You must stay at least:*

- 100 yards (300 feet) away from bears and wolves.
- 25 yards (75 feet) away from all other large animals (bison, elk, bighorn sheep, deer, moose, coyotes).

### Do Not Feed Wildlife

Wild animals that are feed by humans lose their fear of humans and can become aggressive. These animals are usually killed for public safety.

### Rabies

Rabies is present in wild mammals in some parts of the country. You may become infected with rabies if you are bitten or licked by

an infected animal, or if saliva or brain and nerve tissue comes into contact with your eyes, broken skin (cuts or scratches), or mucous membranes such as lips, mouth, or nasal passages. Rabies is almost always fatal in humans and animals, although symptoms may not show for several weeks.

Rabid animals may exhibit one or more of these symptoms:

- Loss of fear of humans.
- Glazed, poorly focused stare.
- Frequent shifting of aggressive behavior from one object to another.
- Stubborn, undeterred approach.
- Staggering walk of trot.
- Biting the ground or other inanimate objects such as sticks or rocks.
- Large number of porcupine quills in the mouth or neck.
- Lack of reflex response if struck by a thrown object.
- Excessive salivation.

If you suspect you have been exposed to an animal that may have rabies, inform your manager and seek medical care immediately.

- Kill the animal, if you are able to do so.
- Do not shoot it in the head or cut up the carcass. Diagnosis of rabies is accomplished by taking samples from the head.
- Place the animal in a strong, leak-proof bag. It can be frozen.
- Contact the local fish and wildlife office for directions about where to take the carcass.

## **Alligators**

Traumatic bites from alligators may cause amputations or even death. Injuries of alligator survivors range from minor lacerations and puncture wounds to major abdominal, chest, and limb trauma. External injuries may appear minor, but massive internal injuries may occur from direct heavy crushing injuries. If a person survives the traumatic injury, his or her wounds may be infected by various microbial organisms, especially gram-negative bacteria.

In areas where alligators are present or are frequently seen:

- Avoid approaching bodies of water that may be inhabited by alligators.
- Do not swim outside posted swimming areas.

- Do not swim at dawn, dusk, or nighttime when alligators most actively feed.
- Do not feed or entice alligators.
- Do not throw fish scraps into the water or leave them on shore.
- Do not allow pets to swim in waters unless they are known to be free of alligators.
- Do not remove alligators from their natural habitat or accept one as a pet.
- Call the local fish and wildlife office to report a nuisance alligator.

## **Bison**

Big as they are, bison can sprint three times faster than humans can run. They are unpredictable and dangerous. No data is worth personal injury. Every year visitors to parks are gored and some have been killed.

## **Bears**

In areas where bears are present or are frequently seen:

- Keep all food and garbage stored in a bear-proof manner.
- Be alert for tracks and other signs of bear activity.
- When possible, stay in groups of three or more people.
- The best way to avoid a bear is to take all necessary precautions to avoid surprise encounters.

*Bear attack.*—If precautionary measures fail and you are charged by a bear, you can still usually defuse the situation. Bear pepper spray is a good last line of defense and it is effective in more than 90 percent of the reported cases where it has been used.

- Become familiar with your pepper spray, read all instructions, and know its limitations.
- Bear pepper spray must be instantly available, not in your pack. However, remember that carrying pepper spray is not a substitute for vigilance and good safety precautions.
- If you have a surprise encounter with a bear, do not run. Slowly back away.
- If a bear charges, stand your ground and use your bear spray. It has been highly successful at stopping aggressive behavior in bears.

- If a bear charges and makes contact with you, fall to the ground onto your stomach and “play dead.”
- If you are injured by a bear (regardless of how minor), or if you observe a bear or signs of a bear, report it to a park ranger of the local fish and wildlife office as soon as possible. Someone’s safety may depend on it.

*Camping in bear country.*

- Never camp in an area that has obvious evidence of bear activity, such as digging, tracks, or scat.
- Odors attract bears, so avoid carrying or cooking odorous foods.
- Keep a clean camp.
- Do not cook or store food in your tent.
- All food, garbage, or other odorous items used for preparing or cooking food must be secured from bears.
- Food, cooking gear, and scented articles must be suspended when not being used.
- Treat all odorous products such as soap, deodorant, or other toiletries in the same manner as food.
- Do not leave packs containing food unattended, even for a few minutes.
  - Allowing a bear to obtain human food even once often results in the bear becoming aggressive about obtaining such food in the future.
  - Aggressive bears present a threat to human safety and eventually must be destroyed or removed from the park.
  - Do not allow bears or other wildlife to obtain human food.
- Sleep a minimum of 100 yards (91 meters) from where you hang, cook, and eat your food.
- Keep your sleeping gear clean and free of food odor.
- Do not sleep in the same clothes worn while cooking and eating.
- Hang clothing worn while cooking and eating in plastic bags.
- If a woman hikes or camps in bear country during menstruation, a basic precaution should be to wear internal tampons, not external pads. Used tampons should be double-bagged in a zip-lock type bag and stored the same as garbage.

## Cougars or Mountain Lions

The cougar is also commonly known as a mountain lion, puma, mountain cat, catamount, or panther. The sub population, Florida panther, is the only population east of the Mississippi River. Fatal cougar attacks are extremely rare and occur much less frequently than fatal dog attacks, fatal snake bites, fatal lightning strikes, or fatal bee stings. Approximately 20 people in North America were killed by cougars between 1890 and 2011.

As with many predators, a cougar may attack if cornered, if a fleeing human stimulates their instinct to chase, or if a person “plays dead.” Standing still however may cause the cougar to consider a person easy prey.

- Exaggerate the threat to the animal through intense eye contact, loud but calm shouting, and any other action to appear larger and more menacing, may make the animal retreat.
- Do not run. Try to back away from the cougar slowly. Sudden movement or flight may trigger an instinctive attack.
- Do not turn your back on the cougar. Face the cougar and remain upright.
- Do all you can to enlarge your image. Do not crouch down or try to hide. Pick up sticks or branches and wave them about.
- If a cougar attacks, fight back with sticks and rocks, or even your bare hands. Fighting back can be effective in persuading an attacking cougar to disengage.

## Coyotes

Coyotes quickly learn bad habits like roadside begging. This may lead to aggressive behavior toward humans. Never approach or feed a begging coyote.

## Moose

Moose attacks are more common than bear attacks and can be just as dangerous. A bull moose can weigh over 1,500 pounds.

Male moose are most aggressive when they go into their rut during the fall mating season. When it comes time to mate, male moose will stop eating for up to a month and their neck will swell in size. This is the time in which male moose exhibit dominant behavior and go into a frenzied rage. Winter is the second most common time for attacks.

From mid-May to June, female moose tend to be very aggressive. These are the months in which they will be defending their newborn calves from anything that may pose a threat.

If a moose feels threatened or agitated by a human, it may react in several ways. A moose will usually show signs that it is time to back off. You should back away if a moose is:

- Moving toward you.
- Laying back its ears.
- Making strange grunting noises.
- Stomping or clawing the ground.
- Swinging its head back and forth.

Depending on the situation you may need to seek cover behind a large tree or rock and keep moving around it to keep away. If you can safely do so, climb up a tall tree where the moose can't reach you. Then you can climb down after it leaves the area.

If you are knocked down, protect yourself as best you can by covering your head with your hands and arms and stay as still as possible. Trying to get up, hitting the moose, or grabbing the antlers will only further aggravate it.

## **Pigs or Hogs**

Wild pigs (feral hogs) have extremely strong jaws to crack open hard-shelled nuts such as hickory nuts and pecans. As they predate upon or scavenge animal carcasses, they can easily break bones and often consume the entire carcass, often leaving little if any sign behind.

The likelihood of a human being impacted by a hog/vehicle collision or contracting a disease from a wild pig is low. The risk of a physical attack by a wild pig is even lower. Where the rare wild pig attack occurs, it is usually during a hunting scenario where dogs are used to bay or corner a pig in a spot and the pig “runs through” the associated hunters standing nearby. Occasionally, humans inadvertently walk between a sow and her litter and the sow reacts to protect her young. Totally unprovoked attacks outside of these two scenarios are rare. Given a choice, wild pigs usually flee rather than fight.

## **Wolves**

Wolves rely on their speed and quickness to ensure their safety. Sometimes when people inadvertently stumble upon an occupied wolf den, the adult wolves will dash toward them, then veer off suddenly with sharp barks and snorts. Commonly the wolves then retreat and

howl repeatedly, but they may rush toward the intruder again. The vocalization behavior is very consistent when wolves are defending a den. If you are surrounded by wolves at close range that are howling or barking at your presence, you almost certainly are near a den or rendezvous site where young wolves are resting. One group of hikers were so taken by the loud barking and rushing behavior of a wolf pack that they climbed nearby trees until the wolves withdrew. An equally effective strategy is to retreat along the original route.

Typically, wolves do not aggressively defend kill sites to the point of attack, although they may growl or briefly run at a human intruder. Wolves commonly retreat into concealing cover and remain silent when they are flushed from a kill.

Generally, wolves only act with extreme aggression in self-defense when they are:

- Cornered by being caught in a trap.
- Pursued to the point of contact by a snowmobile, aircraft, or boat.
- Injured and feel they are unable to escape because of the injury.

For more details, see

- Topic 8-5 Bear Spray.
- SM 445-2-H Chapter 29—Firearms Safety Program.
- SM 445-2-H Chapter 46—Bear Spray Safety Program.

## Topic 8-2. Venomous Snakes

Venomous snakes found in the United States include rattlesnakes, copperheads, cottonmouths/water moccasins, and coral snakes. Although rare, some persons with a severe allergy to snake venom may be at risk of death if bitten. About 7,000 to 8,000 persons per year receive venomous bites in the United States. About 5 of those die. The number of deaths would be much higher if the victims did not seek medical care.

### Types of Venomous Snakes

*Rattlesnakes.*—There are many species of rattlesnakes in the United States. Rattlesnakes are the largest of the venomous snakes in the United States.



**Rattlesnake.**

They can accurately strike at up to one-third their body length. Rattlesnakes use their rattles or tails as a warning when they feel threatened. Rattlesnakes may be found sunning themselves near logs, boulders, or open areas. These snakes may be found in most work habitats including the mountains, prairies, deserts, and beaches. They are found across the United States.

*Copperheads.*—Copperheads vary in color from reddish to golden tan. The colored bands on their body are typically hourglass-shaped. Most adults are 18 to 36 inches long. They are not usually aggressive, but will often freeze when frightened. Persons are more likely to be bitten when they unknowingly step on or near a copperhead. Copperheads are often found in forests, rocky areas, swamps, or near sources of water like rivers. They are found in the Eastern States, extending as far west as Texas.



**Copperhead.**

*Cottonmouths or water moccasins.*—Cottonmouth snakes average 50–55 inches long. The adult snake's skin is dark tan, brown, or nearly black, with vague black or dark brown cross bands. Juveniles have a bold cross banded pattern of brown or orange with a yellow tail. Cottonmouths are frequently found in or around water. They do not scare easily and will defend themselves when threatened. They are found in wetland areas, rivers, and lakes in the southeastern States.



**Cottonmouth.**

*Coral snakes.*—These snakes are often confused with nonvenomous king snakes, which have similar colored bands although in a different arrangement. However, if the red bands are touching the yellow bands, then it is a venomous coral snake.

Coral snakes tend to hide in leaf piles or burrow into the ground. They are found in wooded, sandy, or marshy areas of the Southern United States.



**Coral snake.**

## Symptoms

Signs or symptoms associated with a snake bite may vary depending on the type of snake, but may include:

- A pair of puncture marks at the wound.
- Redness and swelling around the bite.
- Severe pain at the site of the bite.
- Nausea and vomiting.
- Labored breathing (in extreme cases, breathing may stop altogether).
- Disturbed vision.
- Increased salivation and sweating.
- Numbness or tingling around your face and/or limbs.

## Preventing Snake Bites

Employees should take the following steps to prevent a snake bite:

- Do not try to handle any snake.
- Stay away from tall grass and piles of leaves when possible.
- Avoid climbing on rocks or piles of wood where a snake may be hiding.
- Be aware that snakes tend to be active at night and in warm weather.
- Wear boots and long pants when working outdoors.
- Wear leather gloves when handling brush and debris.

## First Aid

Employees should take the following steps if they are bitten by a snake:

- Seek medical attention as soon as possible. (Dial 911 or call local Emergency Medical Services.)
- Try to remember the color and shape of the snake, which can help with treatment of the snake bite.
- Keep still and calm. This can slow down the spread of venom.
- Inform your supervisor.
- Apply first aid if you cannot get to the hospital right away.
- Lay or sit down with the bite below the level of the heart.
- Wash the bite with soap and water.

- Cover the bite with a clean, dry dressing.

**DO NOT do any of the following:**

- Do not pick up the snake or try to trap it.
- Do not wait for symptoms to appear if bitten; seek immediate medical attention.
- Do not apply a tourniquet.
- Do not slash the wound with a knife.
- Do not suck out the venom.
- Do not apply ice or immerse the wound in water.
- Do not drink alcohol as a painkiller.
- Do not drink caffeinated beverages.

## Topic 8-3. Arthropods

Stinging or biting insects, spiders, ticks, and other arthropods can be hazardous to outdoor employees. Health effects range from mild discomfort or pain to a lethal reaction for those employees allergic to the venom. Anaphylactic shock is the body's severe allergic reaction to a bite or sting and requires immediate emergency care. Thousands of people are stung by insects each year, and as many as 90 to 100 people in the United States die as a result of allergic reactions. This number may be underreported, as deaths may be mistakenly diagnosed as heart attacks or sunstrokes or may be attributed to other causes.

### Insects

**Bees, wasps, and hornets.**—Bees, wasps, and hornets are found throughout the United States and are most abundant in the warmer months. Nests and hives may be found in trees, under roof eaves, or on equipment such as ladders.

**Prevention.**—Take the following steps to prevent insect stings:

- Wear light-colored, smooth-finished clothing.
- Avoid perfumed soaps, shampoos, and deodorants.
  - Don't wear cologne or perfume.
  - Avoid bananas and banana-scented toiletries.



**Vespidae (wasps,  
yellow jackets,  
hornets).**

- Wear clean clothing and bathe daily. (Sweat may anger bees.)
- Wear clothing to cover as much of the body as possible.
- Avoid flowering plants when possible.
- Keep work areas clean. Social wasps thrive in places where humans discard food.
- Remain calm and still if a single stinging insect is flying around. (Swatting at an insect may cause it to sting.)
- If you are attacked by several stinging insects at once, run to get away from them. (Bees release a chemical when they sting, which may attract other bees.)
  - Go indoors.
  - A shaded area is better than an open area to get away from the insects.
  - If you are able to physically move out of the area, do not attempt to jump into water. Some insects (particularly Africanized honey bees) are known to hover above the water, continuing to sting once you surface for air.
- If a bee comes inside your vehicle, stop the car slowly and open all the windows.
- Employees with a history of severe allergic reactions to insect bites or stings should consider carrying an epinephrine auto injector (EpiPen) and should wear a medical identification bracelet or necklace stating their allergy.

*First aid.*—If an employee is stung by a bee, wasp, or hornet:

- Have someone stay with the employee to be sure that he or she does not have an allergic reaction.
- Wash the site with soap and water.
- Remove the stinger using gauze wiped over the area or by scraping a fingernail over the area.
  - Never squeeze the stinger or use tweezers.
- Apply ice to reduce swelling.
- Do not scratch the sting as this may increase swelling, itching, and risk of infection.

**Fire ants.**—Fire ants bite and sting. They are aggressive when stinging and inject venom, which causes a burning sensation. Red bumps form at the sting, and within a day or two they become white fluid-filled pustules.

*Prevention.*—Do not disturb or stand on or near ant mounds.

- Be careful when lifting items (including animal carcasses) off the ground, as they may be covered in ants.
- Fire ants may also be found on trees or in water, so always look over the area before starting to work.

*First aid.*—Employees with a history of severe allergic reactions to insect bites or stings should consider carrying an epinephrine auto injector (EpiPen) and should wear a medical identification bracelet or necklace stating their allergy.

Take the following steps if someone is stung or bitten by fire ants:

- Rub off ants briskly, as they will attach to the skin with their jaws.
- Antihistamines may help.
  - Follow directions on packaging.
  - Drowsiness may occur.
- Take the employee to an emergency medical facility immediately if a sting causes severe chest pain, nausea, severe sweating, loss of breath, serious swelling, or slurred speech.

**Scorpions.**—Scorpions usually hide during the day and are active at night. They may be hiding under rocks, wood, or anything else lying on the ground. Some species may also burrow into the ground. Most scorpions live in dry, desert areas. However, some species can be found in grasslands, forests, and inside caves.

*Symptoms.*—Symptoms of a scorpion sting may include:

- A stinging or burning sensation at the injection site (very little swelling or inflammation).
- Positive “tap test” (i.e., extreme pain when the sting site is tapped with a finger).
- Restlessness.
- Convulsions.
- Roving eyes.
- Staggering gait.
- Thick tongue sensation.
- Slurred speech.
- Drooling.
- Muscle twitches.
- Abdominal pain and cramps.
- Respiratory depression.

These symptoms usually subside within 48 hours, although stings from a bark scorpion can be life-threatening.

*Prevention.*

- Wear long sleeves and pants.
- Wear leather gloves.
- Shake out clothing or shoes before putting them on.
- Employees with a history of severe allergic reactions to insect bites or stings should consider carrying an epinephrine auto injector (EpiPen) and should wear a medical identification bracelet or necklace stating their allergy.

*First aid.*—Take the following steps if you are stung by a scorpion:

- Contact a qualified health care provider or poison control center for advice and medical instructions.
- Ice may be applied directly to the sting site (never submerge the affected limb in ice water).
- Remain relaxed and calm.
- Do not take any sedatives.
- Capture or take a picture of the scorpion for identification if it is possible to do so safely.

***Mosquitoes.***—Many diseases are carried by mosquitoes and transmitted to humans. Many thousands of people in the United States have been infected with West Nile virus (WNV). There are no medications to treat or vaccines to prevent WNV infection. Fortunately, most people infected with WNV will have no symptoms. About 1 in 5 people who are infected will develop a fever with other symptoms. Less than 1 percent of infected people develop a serious, sometimes fatal, neurologic illness.

Occasionally, an infected person will develop a more severe disease such as “West Nile encephalitis,” “West Nile meningitis,” or “West Nile meningoencephalitis.” Encephalitis refers to an inflammation of the brain, meningitis is an inflammation of the membrane around the brain and the spinal cord, and meningoencephalitis refers to inflammation of the brain and the membrane surrounding it. Almost 13,000 of the individuals who have been reported as having West Nile virus since 1999 have been seriously ill, and more than 1,200 have died.

Another mosquito-borne disease that can be found in some parts of the United States is dengue fever.

*Prevention.*—Use a repellent on exposed skin and clothes while outdoors. Repellents containing DEET, picaridin, IR3535, and some oil of lemon eucalyptus and para-menthane-diol products provide longer-lasting protection. To optimize safety and effectiveness, repellents should be used according to the label instructions.

- When weather permits, wear long sleeves, long pants, and socks when outdoors. Mosquitoes may bite through thin clothing, so spraying clothes with repellent containing permethrin or another EPA-registered repellent will give extra protection. Don't apply repellents containing permethrin directly to skin. Do not spray repellent on the skin under your clothing.
- Take extra care during peak mosquito biting hours. Take extra care to use repellent and protective clothing from dusk to dawn or consider avoiding outdoor activities during these times.
- Report dead birds to local authorities. Dead birds may be a sign that West Nile virus is circulating between birds and the mosquitoes in an area. By reporting dead birds to State and local health departments, you can play an important role in monitoring West Nile virus.

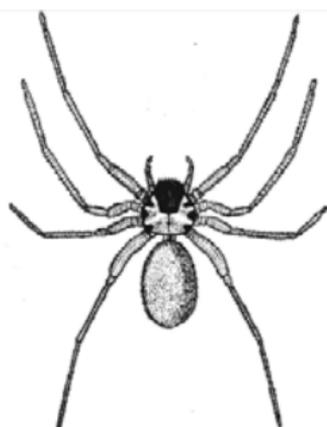
## **Venomous Spiders**

Venomous spiders found in the United States include the black widow, brown recluse, and hobo spiders. Spiders are usually not aggressive. Most bites occur because a spider is trapped or unintentionally contacted.

***Black widow spiders.***—Black widow spiders are found throughout North America, but are most common in the southern and western areas of the United States. They are identified by the pattern of red coloration on the underside of their abdomen. They are usually found in workplaces containing undisturbed areas such as woodpiles, under eaves, fences, and other areas where debris has accumulated. They may also be found living in outdoor toilets where flies are plentiful.

Black widow spiders build webs between objects, and bites usually occur when humans come into direct contact with these webs. A bite from a black widow can be distinguished from other insect bites by the two puncture marks it makes in the skin. The venom is a neurotoxin that produces pain at the bite area and then spreads to the chest, abdomen, or the entire body.

**Brown recluse spiders.**—The brown recluse spider, also known as the violin spider, is most commonly found in the Midwestern and Southern States of the United States. It is brown in color with a characteristic dark violin-shaped (or fiddle-shaped) marking on its head and has six equal-sized eyes (most spiders have eight eyes). Brown recluse spiders are usually found in workplaces with secluded, dry, sheltered areas such as underneath structures, logs, or in piles of rocks or leaves. If a brown recluse spider wanders indoors, it may be found in dark closets, shoes, or attics.



**Brown recluse spider.**

The brown recluse spider cannot bite humans without some form of counter pressure; for example, through unintentional contact that traps the spider against the skin. Bites may cause a stinging sensation with localized pain. A small white blister usually develops at the site of the bite. The venom of a brown recluse can cause a severe lesion by destroying skin tissue (skin necrosis). This skin lesion will require professional medical attention.

**Hobo spiders.**—The hobo spider is found throughout the Pacific Northwest. It is large and brown with a distinct pattern of yellow markings on its abdomen. Unlike many other similar looking spiders, hobo spiders do not have dark bands on their legs. To catch their prey, hobo spiders build funnel webs in holes, cracks, and recesses. They may be found in outdoor workplaces with retaining walls, and in foundations, window wells, and stacks of firewood and bricks. Indoors, they can nest between boxes or other storage items, on window sills, under baseboard heaters or radiators, behind furniture, and in closets. Hobo spiders do not climb like most spiders but are fast runners. These spiders are much more likely to attack if provoked or threatened. The bite of a hobo spider may go unnoticed; however a moderate to severe, slow-healing wound will develop.

**Symptoms.**—Symptoms associated with spider bites can vary from minor to severe. Although extremely rare, death can occur in the most severe cases. Possible symptoms resulting from a spider bite include the following:

- Itching or rash.
- Pain radiating from the site of the bite.

- Muscle pain or cramping.
- Reddish to purplish color or blister.
- Increased sweating.
- Difficulty breathing.
- Headache.
- Nausea and vomiting.
- Fever.
- Chills.
- Anxiety or restlessness.
- High blood pressure.

*Prevention.*

- Inspect or shake out any clothing, shoes, towels, or equipment before use.
- Wear protective clothing such as a long-sleeved shirt and long pants, hat, gloves, and boots when handling stacked or undisturbed piles of materials.
- Minimize the empty spaces between stacked materials.
- Remove and reduce debris and rubble from around the outdoor work areas.
- Trim or eliminate tall grasses from around outdoor work areas.
- Store apparel and outdoor equipment in tightly closed plastic bags.
- Keep your tetanus boosters up-to-date (every 10 years). Spider bites can become infected with tetanus spores.

*First aid.*—Take the following steps if you are bitten by a spider:

- Stay calm. Identify the type of spider if it is possible to do so safely. Identification will aid in medical treatment.
- Wash the bite area with soap and water.
- Apply a cloth dampened with cold water or filled with ice to the bite area to reduce swelling.
- Elevate bite area if possible.
- Do not attempt to remove venom.
- Notify your supervisor.
- Immediately seek professional medical attention.

## Ticks

Tick-borne pathogens can be passed to humans by the bite of infected ticks. Ticks can be infected with bacteria, viruses, or parasites. Some of the most common tick-borne diseases in the United States include: Lyme disease, babesiosis, ehrlichiosis, Rocky Mountain Spotted Fever, anaplasmosis, Southern Tick-Associated Rash Illness, Tick-Borne Relapsing Fever, and tularemia. Other tick-borne diseases in the United States include: Colorado tick fever, Powassan encephalitis, and Q fever. Lyme disease is the most commonly reported tick-borne disease in the United States.

Employees working outdoors are at risk of exposure to tick-borne diseases if they work at sites with ticks. Worksites with woods, bushes, high grass, or leaf litter are likely to have more ticks. Employees in most regions of the United States should be extra careful to protect themselves in the spring, summer, and fall when ticks are most active. Ticks may be active all year in some regions with warmer weather.

Ticks are usually more active in the months of April through October and peak in the summer months of June through August. The time of year when ticks are active may vary with the geographic region and climate. Be extra careful to protect yourself in the late spring and summer when immature ticks are most active.

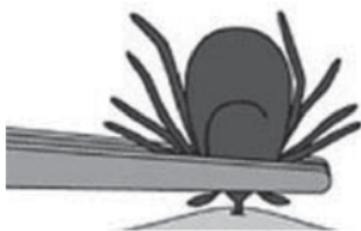
*Symptoms.*—There are many symptoms associated with tick-borne diseases. Infected employees may not have all of these symptoms and many of these symptoms can occur with other diseases as well. Some common symptoms of infection with tick-borne diseases include:

- Body/muscle aches
- Fever
- Headaches
- Fatigue
- Joint pain
- Rash
- Stiff neck
- Facial paralysis

*Prevention.*

- Wear a hat and light-colored clothing, including long-sleeved shirts and long pants tucked into boots or socks.

- Use insect repellents that provide protection for the amount of time you will be outdoors:
  - Follow repellent label directions for use.
  - Use repellents containing 20 to 30 percent DEET on your exposed skin and clothing to prevent tick bites.
  - Reapply repellents as needed.
- Use repellents such as permethrin for greater protection.
  - Permethrin kills ticks on contact.
  - Permethrin can be used on clothing but should not be used on skin.
  - One application of permethrin to pants, socks, and shoes typically stays effective through several washings.
  - Pre-treated clothing is available and remains protective for many (up to 70) washings.
- Check your skin and clothes for ticks every day. The immature forms of these ticks are very small and may be hard to see.
  - Shower or bathe as soon as possible after working outdoors to wash off and check for ticks.
  - Remember to check your hair, underarms, and groin for ticks.
  - Immediately remove ticks from your body using fine-tipped tweezers.
  - Grasp the tick firmly and as close to your skin as possible.
  - Pull the tick's body away from your skin with a steady motion.
  - Clean the area with soap and water.
  - Removing infected ticks within 24 hours reduces your risk of being infected with the Lyme disease bacterium.
- Wash and dry work clothes in a hot dryer to kill any ticks present.
- Learn the symptoms of tick-borne diseases.
- If you develop symptoms of a tick-borne disease seek medical attention promptly. Be sure to tell your health care provider that you work outdoors in an area where ticks may be present.



**Remove tick.**

*Diagnosis and Treatment.*—If you develop symptoms of a tick-borne disease, seek medical attention promptly. Be sure to tell your health care provider that you work outdoors in an area where ticks may be present.

Tick-borne diseases are diagnosed based on symptoms and the possibility that the employee has been exposed to infected ticks. Most cases can be successfully treated with specific types of antibiotics, especially if treatment is started early. However, some employees may have symptoms such as arthritis, muscle and joint pain, or fatigue for an extended period of time.

Also see SM 445-2-H Chapter 24—Prevention of Zoonotic and Vector-Borne Diseases in the Field.

## Topic 8-4. Poisonous Plants

Many native and exotic plants are poisonous to humans when ingested or if there is skin contact with plant chemicals. However, the most common problems with poisonous plants arise from contact with the sap oil of several ever-present native plants that cause an allergic skin reaction—poison ivy, poison oak, and poison sumac.

### Plant Identification

The old saying “*Leaves of three, let it be!*” is a helpful reminder for identifying poison ivy and oak, but not poison sumac, which usually has clusters of 7 to 13 leaves. Even poison ivy and poison oak may have more than three leaves and their form may vary greatly depending upon the exact species encountered, the local environment, and the season.

Being able to identify local varieties of these poisonous plants throughout the seasons and differentiating them from common non-poisonous look-a-likes are the major keys to avoiding exposure.

*Poison ivy.*—Range: Across the United States, except California, Alaska, and Hawaii.

- Eastern poison ivy is typically a hairy, ropelike vine with three shiny green (or red in the fall) leaves budding from one small stem.



**Poison ivy.**

- Western poison ivy is typically a low shrub with three leaves that does not form a climbing vine.
- May have yellow or green flowers and white to green-yellow or amber berries.

*Poison oak.*—Range: Primarily the Southeast and West Coast.

- Typically a shrub with leaves of three, similar to poison ivy.
- Pacific poison oak may be vine-like.
- May have yellow or green flowers and clusters of green-yellow or white berries.



**Poison oak.**

*Poison sumac.*—Range: Abundant along the Mississippi River and boggy areas of the Southeast.

- Woody shrub that has stems that contain 7 to 13 leaves arranged in pairs.
- May have glossy, pale yellow, or cream-colored berries.



**Poison sumac.**

## Symptoms

Poison ivy, poison oak, and poison sumac release an oil, urushiol, when the leaf or other plant parts are bruised, damaged, or burned. When the oil gets on the skin an allergic reaction, referred to as contact dermatitis, occurs in most exposed people as an itchy red rash with bumps or blisters. When exposed to 50 micrograms of urushiol, an amount that is less than one grain of table salt, 80 to 90 percent of adults will develop a rash. The rash, depending upon where it occurs and how broadly it is spread, may significantly impede or prevent a person from working.

Signs or symptoms associated with dermal contact with poisonous plants may include:

- Red rash within a few days of contact.
- Possible bumps, patches, streaking, or weeping blisters (blister fluids are not contagious).
- Swelling.
- Itching.

## Prevention

All employees who may be exposed to poison sumac, oak, and ivy must be instructed on how to identify them. Employees known to be highly sensitive to poison sumac, oak, and ivy should take extra precautions. If practical, do not assign allergic employees to work in areas where exposure could occur.

Employees can prevent contact with poisonous plants by taking these steps:

- Wear long sleeves, long pants, boots, and gloves. Wash exposed clothing separately in hot water with detergent.
- Barrier skin creams, such as a lotion containing bentoquatam, may offer some protection before contact. Barrier creams should be washed off and reapplied twice a day.
- After use, clean tools with rubbing alcohol (isopropanol or isopropyl alcohol) or soap and lots of water. Urushiol can remain active on the surface of objects for up to 5 years. Wear disposable gloves during this process.
- Wash hands before urinating. Be careful about wiping sweat from the face and around the eyes with your hands.
- DO NOT burn plants that may be poison ivy, poison oak, or poison sumac. Inhaling smoke from burning plants can cause severe allergic respiratory problems.
- DO NOT stand in the smoke of fires made of brush; it may contain unburned particles of poison oak.
- DO NOT use unidentified leaves as emergency toilet paper in the field.
- DO NOT attempt to desensitize yourself by eating the leaves. This can cause severe lesions in the mouth and around the rectum, and can cause kidney damage.
- DO NOT use a leaf mulcher in areas with poison oak unless your legs and arms are covered and you are wearing a face shield.

Employees should prevent being exposed to burning poisonous plants whenever possible. However, when exposure to burning poisonous plants is unavoidable, employees should be provided with:

- A NIOSH-certified half-face piece particulate respirator rated R-95, P-95, or better. This recommendation does NOT apply to wildland firefighters. Firefighters may require a higher

level of respiratory protection to protect against possible exposure to combustion products.

- These respirators should protect against exposure to burning poisonous plants, but will not protect against all possible combustion products in smoke, such as carbon monoxide.
- Respirators must be worn correctly and consistently throughout the time they are used.
- For respirators to be effective, there must be a tight seal between the user's face and the respirator.
- Respirators must be used in the context of a written comprehensive respiratory protection program as required by 29 CFR 1910.134.

## First Aid

Although over-the-counter topical medications may relieve symptoms for most people, immediate medical attention may be required for severe reactions, particularly when exposed to the smoke from burning these poisonous plants. Burning these poisonous plants can be very dangerous because the allergens can be inhaled, causing lung irritation.

Employees who come in contact with poisonous plants should:

- Immediately rinse skin with rubbing alcohol, specialized poison plant washes, degreasing soap (such as dishwashing soap) or detergent, and lots of water. Rinse frequently so that wash solutions do not dry on the skin and further spread the urushiol.
- Scrub under nails with a brush.
- Apply wet compresses, calamine lotion, or hydrocortisone cream to the skin to reduce itching and blistering. Follow the directions on any creams and lotions. Do not apply to broken skin, such as open blisters. Oatmeal baths may relieve itching.
- An antihistamine such as diphenhydramine (Benadryl) can be taken to help relieve itching. Follow directions on the package. Drowsiness may occur.
- In severe cases or if the rash is on the face or genitals, seek professional medical attention.
- Call 911 or go to a hospital emergency room if the employee is suffering a severe allergic reaction, such as swelling or difficulty breathing, or has had a severe reaction in the past.

## Topic 8-5. Bear Spray

Bear spray can repel many kinds of dangerous animals such as bears, bison, wolves, coyotes, moose, wild hogs, badgers, lynx, and mountain lions without killing or seriously injuring them.

Research indicates that persons who encounter grizzly bears and defend themselves with firearms suffer injury about 50 percent of the time. Persons defending themselves with bear spray escape injury most of the time, and those who are injured have attacks of shorter duration and sustain less severe injuries.

A firearm is a tool of last resort and is only to be used when other less-lethal deterrents, such as bear spray, are exhausted or become impractical. Bear spray is not a substitute for following proper dangerous animal avoidance techniques. Bear spray should be used as a deterrent only when facing an aggressive or attacking bear.



**Bear spray.**

### Authorization

With supervisory permission, any Bureau employee or volunteer can be authorized to carry bear spray while on official duty once they have completed the requirements in 445–2–H Chapter 46.

- Complete an appropriate Bear Spray Safety Training Course.
- Complete the Certificate of Need, including the supervisor's approval.

### Precautions

- Never intentionally approach a bear or any wild animal.
- Do not spray a passive bear to get it to leave the area.
- Bear spray is only meant to be used on charging or attacking bears.
- Learn and practice the use, storage, shipping, transport, and disposal of bear spray.

For more details, see SM 445-2-H Chapter 46—Bear Spray Safety Program.

## Topic 8-6. Firearms Safety

The Bureau provides appropriate firearms safety training for any employee or volunteer, or others who work under Bureau funding or direction and who use, handle, carry, or store a firearm as a part of his or her official duties.

### Firearms Use

Firearms are used by employees for defense against potentially dangerous wild animals and for specimen collecting for biological research. Firearms may also be used for signaling and survival in emergency situations.

Although firearms safety remains a constant emphasis and is a key element of any firearms safety training program, there are substantial differences in the two programs.

*Defense against wild animals.*—In the Defense Against Wild Animals training program, the firearms are restricted to those action and model types that can handle powerful, large-caliber cartridges. The firearm is a tool of last resort and is only used when other deterrents are exhausted or impractical.

*Specimen collection.*—The Specimen Collection training program deals with a broad range of firearm types, from rimfire to large-bore calibers and includes almost every type of firearm action, make, and model.

### Training

Both the Defense Against Wild Animals and the Specimen Collection firearms training programs change as new information from field experiences are incorporated into the curriculum and firearms training techniques from other professional training programs are reviewed and tested.

A number of more specialized curriculums are being developed to better satisfy the firearms training demands in the Bureau. Additional curriculums and courses are available or planned, including:

- Wild animal behavior (for example, bear, cougar).
- Bear pepper spray and other less-lethal deterrents for wild animals.
- Collection of waterfowl.
- Precision shooting.
- Small-caliber firearms for trapping.

Others courses will be added as needed. Specific instructor certifications are required to teach these courses.

## **Recertification**

- To recertify for defense purposes, an 8-hour approved Refresher Firearms Certification Course (RFCC) for Defense Against Wild Animals (Refresher Defense Course) must be attended annually in order to use government- or personally owned firearms. Recertification is valid for 12 months.
- To recertify for collection purposes, an approved Refresher Collection Course must be attended annually.
- Alternative firearms certification courses and training schedules may be substituted upon review and approval of the Bureau or regional Firearms Safety Committee.

*Instructors.*—Instructors must be able to independently and effectively teach the fundamentals of firearms safety and safe firearms handling. Detailed requirements for Firearms Instructors are specified in SM 445-2-H Chapter 29—Firearms Safety Program.

## **Obtaining Firearms Authorization**

With supervisory permission, any employee or volunteer can be authorized to carry a firearm while on official duty once they have completed the requirements as specified in SM 445-H Chapter 29—Firearms Safety Program. He or she must:

- Successfully complete the appropriate Basic or Refresher Firearms Safety Training Course.
- Complete a Certificate of Need. An approved study plan is required for issuance of a Certificate of Need for specimen collection.
- Complete a Qualification Inquiry.

## **Firearms and Ammunition Storage, Security, and Transport**

Any firearm (government- or personally owned) used by Bureau personnel must be under lock and key when not being used in the field, in transit, or when the firearm is not under the direct control of the cognizant person. The concept of “being locked” implies that the firearm is to be stored in a locked hard case or stored in a soft gun case and a trigger safety lock employed.

- Firearms and ammunition transported on commercial airlines must be declared and a Federal Aviation Administration tag must be signed stating that the firearm is unloaded. For field

- aircraft, the firearm must be declared to the pilot or authorized representative prior to boarding.
- Any personnel authorized to use a firearm must follow the State and municipal laws concerning the transportation and mode of carry of firearms in motor vehicles.
  - Any personnel authorized to use a firearm must follow the State and municipal laws concerning the personal carry of firearms. Only Bureau-authorized firearms may be carried.
  - State permits authorizing concealed carry are not recognized by the USGS.
  - Damaged or hand-loaded ammunition must not be used.
  - Damaged or faulty ammunition must be disposed of as recommended by the Regional Firearms Manager or local Firearms Safety Officer.
  - Small arms ammunition (for example, rifle, pistol, or shotgun cartridges) must be separated from materials classified by the U.S. Department of Transportation as flammable liquids, flammable solids, and oxidizing materials by a distance of 15 feet or by a fire partition having a fire resistance of at least 1 hour.
  - Small arms ammunition must not be stored together with Division 1.1, Division 1.2, or Division 1.3 explosives unless the storage facility is suitable for storage of explosive materials.

For more details, see SM 445-2-H Chapter 29—Firearms Safety Program.

## Topic 9. Altitude-Related Problems (above 8,000 feet)

Most effects of high altitude on humans are caused by exposure to low partial pressure of oxygen. The percentage saturation of hemoglobin with oxygen determines the content of oxygen in our blood. As we climb to around 7,000 feet above sea level, the saturation of oxyhemoglobin begins to plummet.

Short-term and long-term adaptations to altitude allow us to partially compensate for the lack of oxygen. However, there is a limit to the level of adaptation. Mountaineers refer to the altitudes above 26,000 feet as the “death zone,” where no human body can acclimatize.

Atmospheric pressure decreases exponentially with altitude, while the oxygen fraction remains constant to about 62 miles, so partial pressure of oxygen decreases exponentially with altitude as well.

### Symptoms

Altitude sickness commonly occurs above 8,000 feet. It presents as a collection of nonspecific symptoms, acquired at high altitude or in low air pressure, resembling a case of flu, carbon monoxide poisoning, or a hangover. Although susceptibility to altitude sickness varies, most people can ascend to 8,000 feet without difficulty. One or more of the following symptoms may indicate altitude sickness:

- Lack of appetite, nausea, or vomiting.
- Fatigue or weakness.
- Dizziness or lightheadedness.
- Insomnia.
- Pins and needles.
- Shortness of breath upon exertion.
- Nosebleed.
- Persistent rapid pulse.
- Drowsiness.
- Excessive flatulation.
- General malaise.
- Peripheral edema (swelling of hands, feet, and face).

Acute mountain sickness can progress to high-altitude pulmonary edema or high-altitude cerebral edema, which are potentially fatal. Symptoms that may indicate life-threatening altitude sickness include:

- Pulmonary edema (fluid in the lungs).
  - Symptoms similar to bronchitis.
  - Persistent dry cough.
  - Fever.
  - Shortness of breath even when resting.
- Cerebral edema (swelling of the brain).
  - Headache that does not respond to analgesics.
  - Unsteady gait.
  - Gradual loss of consciousness.
  - Increased nausea.
  - Retinal hemorrhage.

Chronic mountain sickness, also known as *Monge's disease*, is a different condition that only occurs after very prolonged exposure to high altitude.

## **Causes**

The rate of ascent, altitude attained, amount of physical activity at high altitude, as well as individual susceptibility are contributing factors to the onset and severity of high-altitude illness. Altitude sickness usually occurs following a rapid ascent and can usually be prevented by ascending slowly. In most of these cases, the symptoms are temporary and usually abate as altitude acclimatization occurs. However, in extreme cases, altitude sickness can be fatal.

Dehydration due to the higher rate of water vapor lost from the lungs at higher altitudes may contribute to the symptoms of altitude sickness.

## **Prevention**

Ascending slowly is the best way to avoid altitude sickness. Avoiding strenuous activity such as skiing or hiking in the first 24 hours at high altitude reduces the symptoms of altitude sickness. As alcohol tends to cause dehydration, which exacerbates altitude sickness, avoiding alcohol consumption in the first 24 hours at a higher altitude is optimal.

*Oxygen enrichment.*—Oxygen enrichment can counteract the hypoxia-related effects of altitude sickness. A small amount of supplemental oxygen reduces the equivalent altitude in climate-controlled rooms.

The Occupational Safety and Health Administration (OSHA) respiratory protection standard requires that employees be supplied with oxygen-enriched breathing air above 14,000 feet. OSHA allows acclimated workers to perform their work without oxygen-supplying respirators, at any altitude up to 14,000 feet, as long as the ambient oxygen content remains above 19.5 percent and the employee has no medical condition that would require the use of supplemental oxygen.

*Altitude acclimatization.*—Altitude acclimatization is the process of adjusting to decreasing oxygen levels at higher elevations. For high-altitude climbers, a typical acclimatization regimen is to stay a few days at a base camp, climb to a higher camp (slowly), and then return to base camp. A subsequent climb to the higher camp then includes an overnight stay. This process is then repeated a few times, each time extending the time spent at higher altitudes to let the body adjust to the oxygen level there.

*Climb high, sleep low.*—The general rule of thumb is to not ascend more than 1,000 feet per day to sleep. That is, one can climb from 10,000 feet to 15,000 feet in one day, but one should then descend back to 11,000 feet to sleep.

## **Treatment**

The only reliable treatment and, in many cases the only option available, is to descend. Attempts to treat or stabilize the patient in situ at altitude is dangerous unless highly controlled and with good medical facilities.



## Topic 10. Breakaway Sounding Reel Cable Installation

The breakaway sounding reel cable is a safety feature required on sounding reels. A breakaway kit can be installed to allow the cable to safely separate from the reel when the cable has completely paid out and an excessive overload is applied to the cable.

### Procedures

To help ensure the safety of employees, observers, and the public, breakaway sounding reel cable kits must be installed on all affected reels.

A-reels not equipped with a drag brake retrofit and A-pack reels are exempt from this requirement. The drag brake retrofit for the A-reel is available and may be ordered from the USGS Hydrologic Instrumentation Facility (HIF) warehouse. Use of this retrofit is highly recommended. Because not all A-reels will be equipped with the breakaway device, care should be taken in selecting the best reel for the task at hand. This issue relates to making discharge measurements during high flows.

During periods of high flow, debris in a stream could be caught by the equipment attached at the end of the sounding reel cable in the water. Even after complete payout of cable from the sounding reel, the debris caught on the end of the cable could pull the equipment and the streamgager into dangerous flood waters. Therefore, a modification to the cable was devised to provide a quick release, or breakaway, of the end of the cable from the sounding reel in the event that the cable payout from the reel reaches the end.

The breakaway cable design for sounding reels was developed for situations when debris could lodge on the sounding weight (or other equipment) in the water and subject the cable to an unmanageable force. Transfer of such a force to the reel structure can cause damage, loss of equipment, and danger to anyone in close proximity to the equipment.

### Parts Identification

The split-bolt connector located inside the sounding reel drum will be reused in the breakaway cable installation. The required parts listed below are available from the HIF.

- 2 Nicopress stop sleeves.
- 2 Nicopress tools.
- 1 ring—terminal.
- Heat-shrink protective tubing.

A pair of heavy-duty wire cutters is also required. To apply the heat-shrink tubing, a heat source, such as a soldering iron or cigarette lighter, can be used to shrink the tubing.

## Calculating Breakaway Strength

Before performing the installation, determine the desired breakaway strength.

- The 0.084-inch-diameter cable has eighteen 0.012-inch-diameter outer strands and eighteen 0.008-inch-diameter inner strands with a manufacturer rated strength of 500 pounds.
- The 0.100-inch-diameter cable has thirty 0.014-inch-diameter strands with a manufacturer rated strength of 1,000 pounds.
- The 0.125-inch-diameter cable has thirty 0.017-inch-diameter strands with a manufacturer rated strength of 1,500 pounds.

Break strength testing at the HIF produced average breaking strengths for three sizes of cable strands taken from three different size Ellsworth-type cables. The results are shown in the table below.

Ellsworth cable is a stainless steel reverse lay cable with an insulated center copper conductor. The cable allows suspension of the sounding weight and meter assembly and provides an electrical circuit between the meter and the headphone.

**Table 1.** Average breaking strength per strand for three size diameters.

Strand diameter (inches)	Cable diameter (inches)	Average breaking strength per strand (pounds)
0.012	0.084	9
0.014	0.100	16
0.017	0.125	39

**Table 2.** Breaking strength tests for multiple untwisted strands (diameter 0.014 inch) taken from a 0.100-inch-diameter Ellsworth-type cable.

<b>Number of strands</b>	<b>Average breaking strength (pounds)</b>
5	213
6	258
7	279
8	284
30	1,000

**Table 3.** Breaking strength tests for multiple untwisted strands (diameter 0.017 inches) taken from a 0.125-inch-diameter Ellsworth-type cable.

<b>Number of strands</b>	<b>Average breaking strength (pounds)</b>
7	383
8	473
9	499
30	1,500

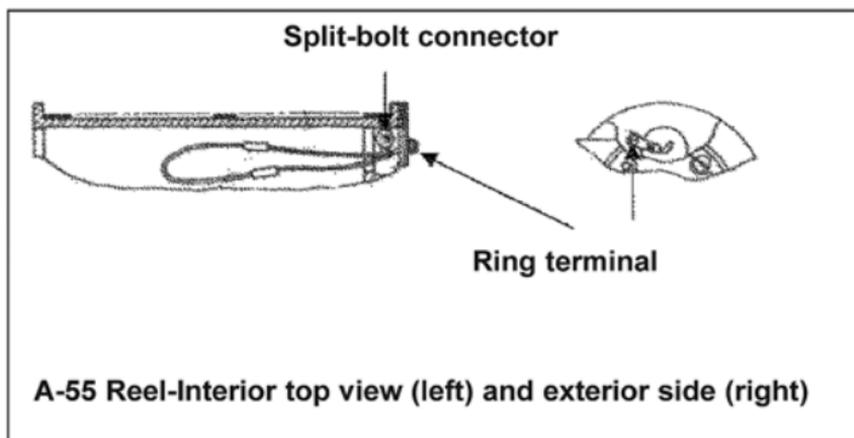
**Table 4.** Recommended number of twisted strands for the breakaway section to comply with the breakaway limit for each size of Ellsworth-type cable.

<b>Cable diameter (inches)</b>	<b>Breakaway limit (pounds)</b>	<b>Number of strands (remaining)</b>
0.084	250	21
0.100	500	15
0.125	500	10

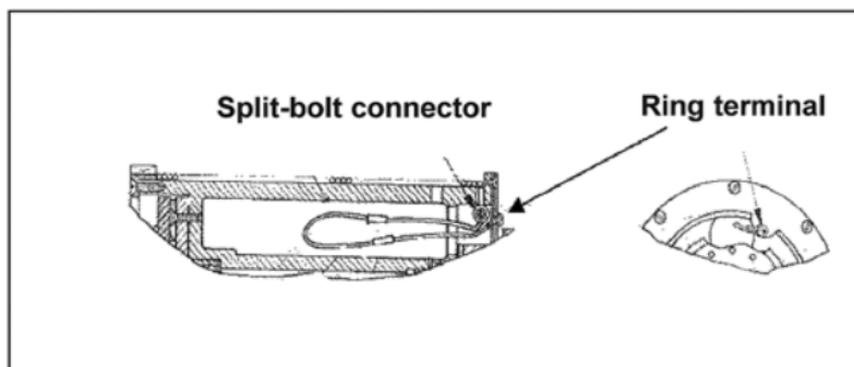
## Installation

Refer to Steps 1 through 10, as illustrated on the following pages.

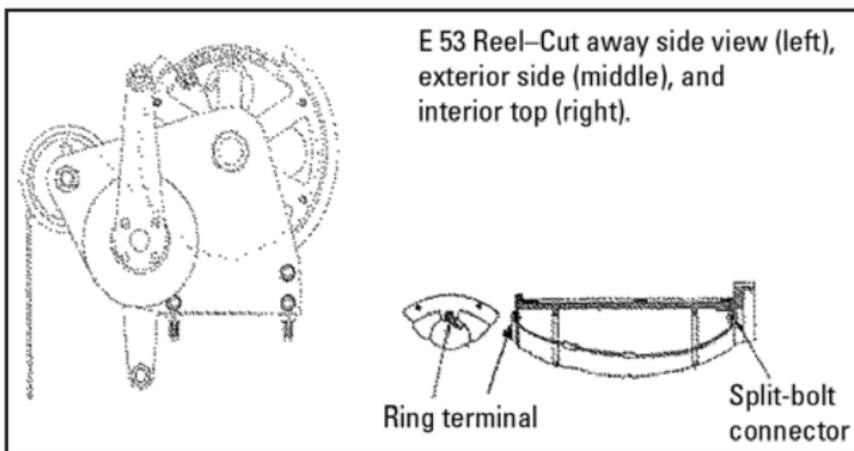
**Step 1.** Unspool all the existing cable from the sounding reel. Unscrew the termination connection (ring terminal) and remove the split-bolt connector inside the reel drum.



**Figure 1.**

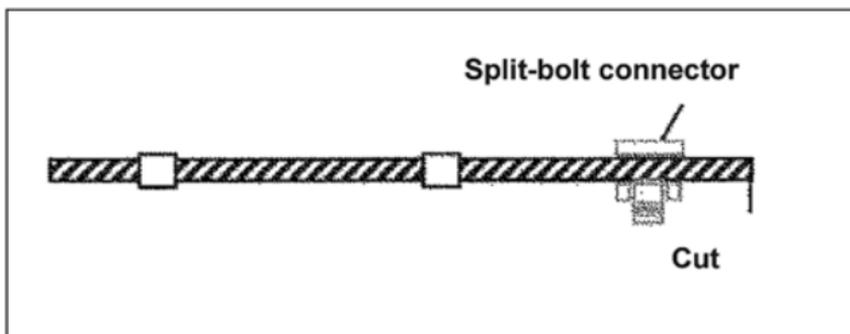


**Figure 2.**



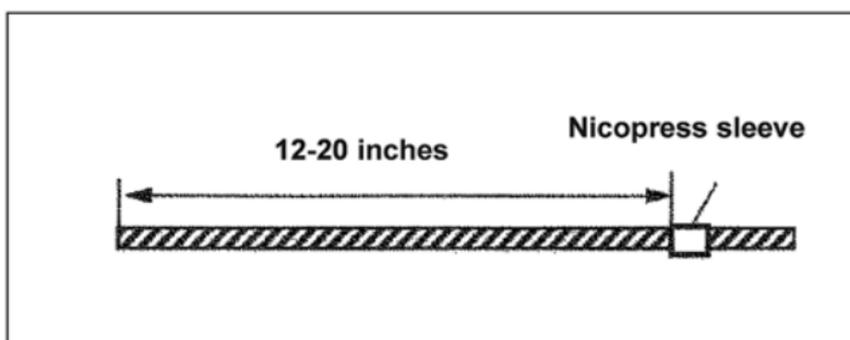
**Figure 3.**

**Step 2.** Cut cable above the existing crimp sleeve and split-bolt connector location. Pull the remaining cable from inside the drum, through the hole(s) in the reel drum, out of the drum.

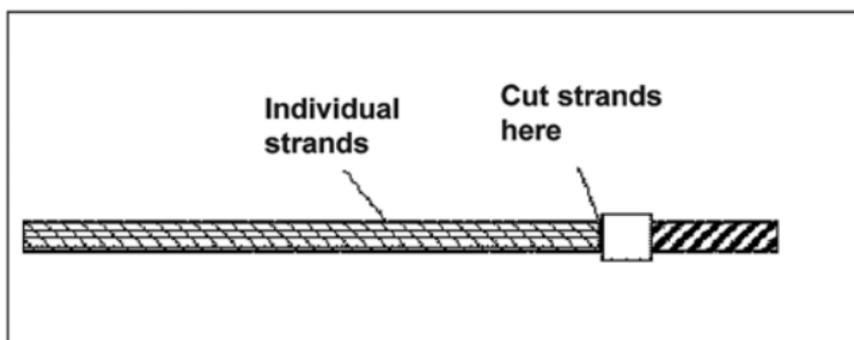


**Step 3.** For 0.084- and 0.100-inch-diameter cables, slide a Nicopress No. 872-17-J stop sleeve (“For 3/32-inch steel cable”) 12 inches from the cut end of the cable. (Note: For an E-53 reel, 20 inches from the cut end of the cable.) Using the “J” groove on a Nicopress tool, fully compress the sleeve on the cable.

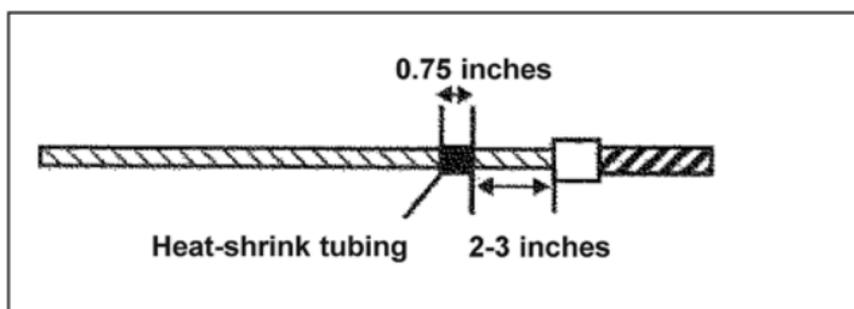
For a 0.125-inch-diameter cable, slide a Nicopress No. 872-18-J stop sleeve (“For 1/8-inch steel cable”) 12 inches from the cut end of the cable. (Note: For an E-53 reel, 20 inches from the cut end of the cable.) Using the “J” groove on a Nicopress tool, fully compress the sleeve on the cable.



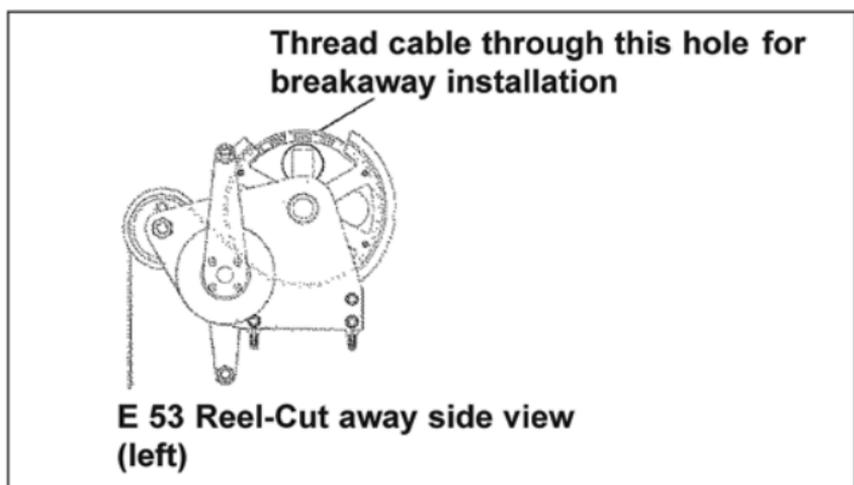
**Step 4.** Untwist and cut the number of strands from the cable to the end of the installed splice to achieve desired breakaway strength. Leave the remaining strands twisted as manufactured.



**Step 5.** Using a heat source, install a piece of heat-shrink protective tubing, approximately 3/4 inch in length, on the remaining twisted strands approximately 2 to 3 inches from the end of the first installed sleeve.



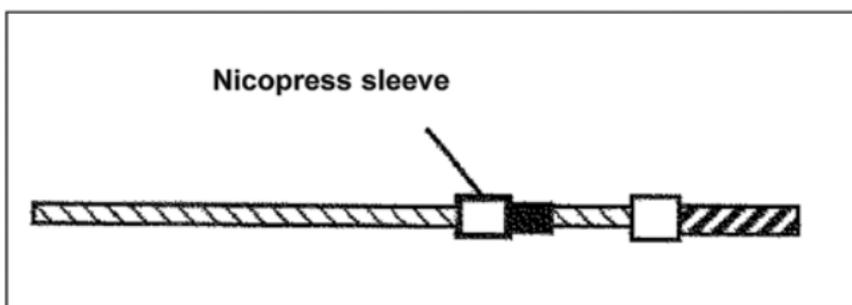
**Step 6.** Thread the end of the reduced section of cable through the hole in the reel drum to the inside of the drum. For the E-53 reel, thread the cable only through the hole as shown in the illustration below.



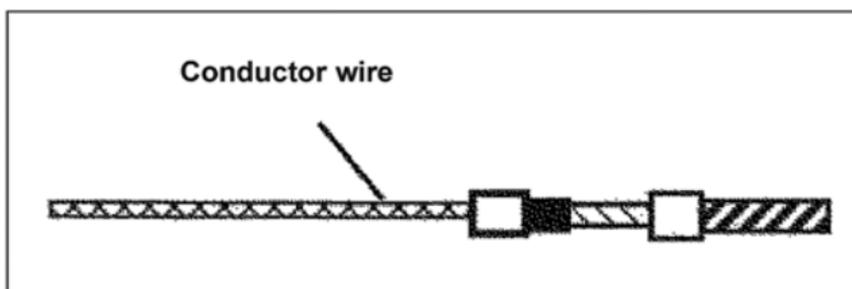
**Step 7.** For 0.084- and 0.100-inch-diameter cables, slide a Nicopress No. 872-1-C stop sleeve ("For 1/16- inch steel cable") onto the remaining twisted strands to the end of the heat-shrink tubing.

Note: Because of the tight fit of the stop sleeve on the 15-strand breakaway section of the 0.100-inch-diameter cable, it may be necessary to apply some lubricant to that reduced section of cable prior to sliding the stop sleeve onto it. In addition, it may be necessary to use pliers and twist the sleeve as you slide it on the reduced section of cable. Using the “C” groove on a Nicopress tool, fully compress the sleeve on the cable.

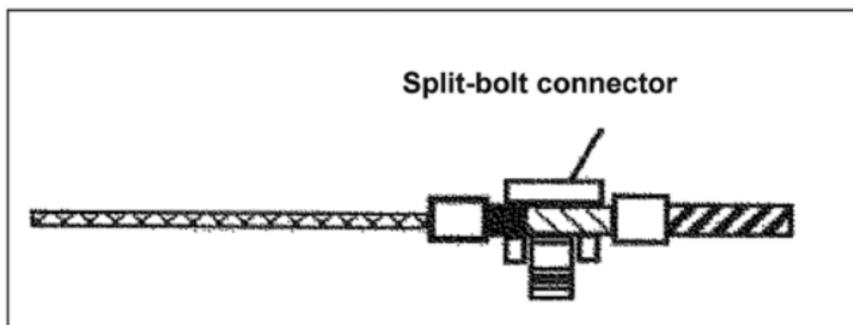
For 0.125-inch-diameter cable, slide a Nicopress No. 872-17-J stop sleeve (“For 3/32-inch steel cable”) onto the remaining twisted strands to the end of the heat-shrink tubing. Using the “J” groove on a Nicopress tool, fully compress the sleeve on the cable. In addition, using the “C” groove on a Nicopress tool (open the jaw of the tool fully), slightly overcompress the sleeve on the cable to assure a secure fit.



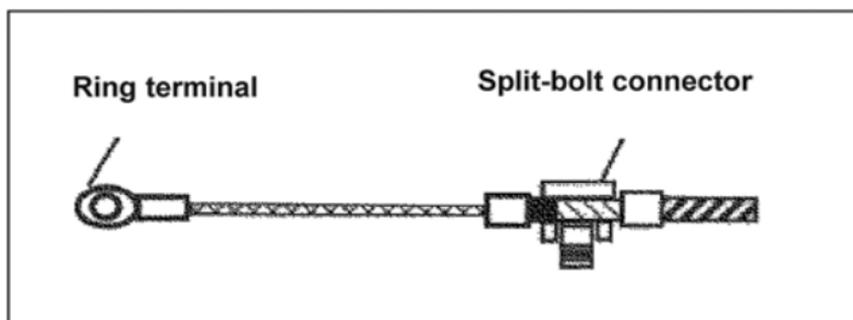
**Step 8.** Untwist and cut the strands remaining past the end of the second installed stop sleeve.



**Step 9.** Install the split-bolt connector on top of the heat-shrink tubing next to the second installed stop sleeve inside the drum. When fully tightened, the split-bolt connector may slide freely over the tubing.



**Step 10.** For the A-55 and B-56 reels, install the ring terminal on the end of the conductor wire and attach the terminal outside of the drum. For the E-53 reel, thread the conductor wire through the other two holes of the drum and into the drum. Install the ring terminal on the end of the conductor wire and attach the terminal outside of the drum. On all reels, make sure the split-bolt connector does not come in contact with the ring terminal mounting flange.



## Part Information and Procurement

The Breakaway Sounding Reel Cable Kit (stock number 2302075) and a technical information sheet are available from the HIF. With the technical information sheet and the kit, field personnel can modify the sounding reel cable so that the cable will break at the determined safe load.

## Topic 11. Caves

A cave is a large underground chamber, typically of natural origin, in a hillside or cliff. Caves are dangerous for the ill-prepared or uninformed. Most cave accidents are avoidable and result from a lack of knowledge of the cave being visited, poor pre-trip planning, inadequate equipment and knowledge of its use, or poor physical condition. All public information and education efforts that can reasonably be implemented, within the limits of funding and manpower, will be adopted to increase awareness of hazardous conditions. These guidelines do not cover abandoned mines.

Consideration should be given to the relative safety of the cave environment. Although most caves should not be considered hazardous, the environment does pose some risks, particularly to cave visitors who are not sufficiently skilled or careful. Cave managers should endeavor to inform cave visitors of the obstacles and potential dangers they may encounter, including:

- Complexity of passages.
- Tightness and extent of crawls.
- Presence and magnitude of vertical drops.
- Areas with loose rock.
- Existing pools and running water.
- Length and overall difficulty of the route.
- Flooding potential.

Caves may contain unusual hazards, such as airborne diseases, dangerous gases, and structural instability. Caves should be entered only by qualified cave visitors with special equipment, and only if the need for information is proportionate to the risk involved. Extra safety precautions should be taken, and special communications and rescue capabilities should be available.

In a few cases, a cave is extremely hazardous, even for the most skilled cave visitors. Cave managers should endeavor to close caves falling into this category to all use except the minimum required for administrative entry.

### Requirements

- Contact the local caving community National Speleological Society (NSS) affiliated grotto conservancy organization that manages a specific cave to request a cave hazard and

safety analysis. The NSS National Office may be reached by phone at (205) 852-1300 or via email at [nss@caves.org](mailto:nss@caves.org). The website address is <http://www.caves.org/>.

- The results of this hazard analysis should be included in a job hazard analysis to inform cave visitors prior to entry into the cave.
- Cave specialist employees must conduct underground work in groups of two or more, never alone.
- Snakes sometimes live in the entrance or twilight zone of caves. They can usually be avoided by using care in these areas. Caution must also be used when exiting the cave. (See instructions on animals, arthropods (for example, insects, ticks, spiders), and venomous snakes in this handbook.) The Bureau will provide nonprescription pharmaceutical products and devices to employees (for self-medication only) when requested and justified.
- Training should be provided in relevant winter, desert, or other local climatic survival techniques if applicable to the conditions.
- Basic survival equipment must be made available to cave specialists.
- Light sources should be helmet mounted in order to leave the hands free for negotiating the cave. It is recommended that the primary and first backup light source be helmet mounted. The third light source is usually a flashlight on a lanyard. The lanyard should go over the shoulder and under the arm rather than around the neck. This may prevent strangling in the event of a fall.
- Touching and/or in any other way disturbing animal droppings may lead to this material being inhaled or ingested by the cave visitors. The inhalation or ingestion of animal droppings is a health hazard. Avoid areas where bats, rodents, and other animal concentration areas unless required for the scientific work. Bat guano can be a source of exposure to histoplasmosis.
- When negotiating uneven or slippery cave passages, a belay may be useful. Training in the proper procedure for belaying should be practiced before the trip with the belay device that will be used on the trip.
- Carbon dioxide and methane can be common cave dangers. Air monitors must be carried in caves with these risks. A

butane lighter will burn poorly or go out with high carbon dioxide (low oxygen). Methane will generally cause the flames of carbide lamps and lighters to burn more brightly as the concentration increases. Methane is usually found in caves with decaying matter.

- Some caves contain radon gas hazards. Be aware that prolonged exposure to radon gas is a health hazard. If radon gas is a threat, radon exposure levels should be monitored to ensure that the maximum exposure limits of 100 picocuries per 40-hour work week are not exceeded.
- Obtain a cave map.
- Know the location of physical and legal access.
- Locate information on hazards.
- Inspect and test equipment before using. Be sure all equipment is adequate for the cave trip.
- Tell someone where you are going and when you should return. Utilize an appropriate check-out/check-in system. (See Topic 3-1 Check-Out/Check-In System.)

## **Recommended Caving Equipment**

### *Horizontal caves.*

- 1 helmet (labeled and approved by safety standards groups such as UIAA (International Union of Alpine Associates).
- 1 helmet-mounted light source.
- 2 spare light sources (one should be helmet mountable).
- Spare batteries for lights.
- 1 pair sturdy boots, with nonskid soles.
- Clothing suitable to the cave environment.
- 1 pair gloves.
- Kneepads and elbow pads, as needed.
- Water and food according to the trip's duration.
- Waste receptacles for transporting feces and urine out of the cave.
- First-aid kit, including hypothermia gear.

### *Vertical caves.*

- All horizontal gear.
- Personal climbing system.

- Ropes and webbing appropriate for the trip.
- Knowledge of proper use of equipment.
- Chest harness, as necessary.
- Seat harness.
- Descender.
- Ascenders (minimum of two points connecting seat harness to rope).
- Carabiners, webbing, and rope for attaching gear to harness.
- Rope (approximate lengths for cave; appropriate knowledge of use).

## Topic 12. Compressed Gas Cylinders

### Hazards

The mechanical failure of the cylinder, cylinder valve, or regulator can result in rapid diffusion of the pressurized contents into the atmosphere, leading to explosion, fire runaway reaction, or burst reaction vessels.

Unsecured cylinders can be knocked over very easily, causing serious injury and damage. Impact can shear the valve from an uncapped cylinder, especially if a regulator is attached.

- A full, standard-sized compressed gas cylinder at a pressure of about 200 atmospheres contains the kinetic energy equivalent to a small anti-tank weapon.
- Cylinders whose valves were accidentally broken off have been known to fly in excess of 1,500 feet and penetrate concrete walls.

Compressed gas cylinders are heavy. Injury to hands, feet, and backs can occur with improper methods of moving cylinders.

Gas cylinders may contain flammable, toxic, or corrosive gases; asphyxiates; or oxidizers.

### Labeling

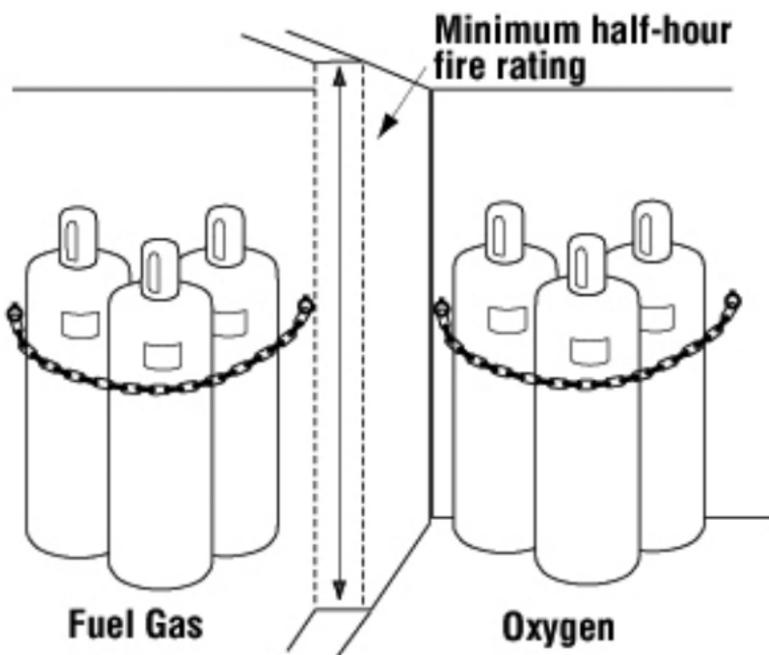
- Make sure contents of cylinders are identified with the chemical or the trade name of the gas.
- Don't accept unidentified cylinders.
- Don't rely on color codes. Read the label.
- Don't destroy or remove identification tags or labels.
- Whenever practical, the marking should be located on the shoulder of the cylinder.

### Transportation

Secure cylinders when transporting them, preferably in an upright position.

- Commercially available brackets, chains, or nylon straps may be used to secure the cylinders.
- Materials that stretch, such as bungee cords or rubber tie-downs, must not be used.
- Never move a cylinder while a regulator is attached.

- Cylinder valves must be closed before moving cylinders.
- If the cylinder is designed to accept a cap, make sure the protective cap covers the cylinder valve.
- Do not move cylinders by carrying, rolling, sliding, or dragging them across the floor.
- Do not let cylinders strike each other violently.
- To transport a cylinder, use a hand truck equipped with a chain or belt for securing the cylinder.
- When transporting cylinders with a crane or derrick, use a cradle, boat, or suitable platform. Do not use slings or electric magnets.
- Do not use valve-protection caps for lifting cylinders from one vertical position to another.
- Make sure portable compressed gas cylinders are constructed and maintained in accordance with the regulations of the U.S. Department of Transportation, 49 CFR Parts 171-179.



## Storage

- Leave caps on until the gas is about to be used.
- Secure gas cylinders to prevent them from falling over. Chains or a clamp-plus-strap assembly are the most common methods of keeping cylinders upright. Make sure the chain is high enough on the cylinder to keep it from tipping over. In areas with earthquakes, use at least two chains or straps.

- Small cylinders may be put on their side and blocked to prevent rolling. However, NEVER store acetylene on its side.
- Do not lay acetylene cylinders on their sides.
  - Because of acetylene's unstable nature, it must be stored under special conditions. This is accomplished by dissolving the acetylene in liquid acetone. The liquid acetone is then stored in the acetylene cylinder, which in turn, is filled with a porous (sponge-like) cementitious material.
  - If an acetylene tank has accidentally been left on its side, set it upright for at least 1 hour for each hour it has been on its side before it is used. If the time is unknown, set it upright for at least 8 hours before it is used.
- Store cylinders in a well-ventilated area away from all sources of heat or flames.
- Do not store flammable gases next to exits.
- Do not store incompatible gases together.
- When in storage, separate oxygen cylinders from fuel-gas cylinders; for example, acetylene, stabilized methylacetylene-propadiene (MAPP) gas, hydrogen; or combustible materials (especially oil or grease) by a minimum distance of 20 feet or by a noncombustible barrier at least 5 feet high with a fire-resistance rating of at least one-half hour.
- Store cylinders in assigned places away from elevators, stairs, or gangways.
- Store cylinders where they will not be knocked over or damaged by passing or falling objects, or be subject to tampering by unauthorized persons.
- Do not store cylinders in unventilated enclosures such as lockers and cupboards.
- If a cylinder is designed to accept a cap, keep caps in place and hand-tight except when cylinders are in use or connected for use.
- Use the smallest size cylinder that will do the job. Order corrosive and unstable gases in the minimum quantities. Corrosive gases, if stored for long periods, will corrode the valve internally and may be impossible to open or, if opened, may not close.
- Close the valve and replace the protective cap before returning the cylinder to storage.
- Separate empty and full cylinders during storage.

## Connections

- Do not use bars under valves or valve-protection caps to pry cylinders loose when frozen to the ground or otherwise fixed. Use warm (not boiling) water to thaw ice.
- Clear the cylinder valve of any dust or dirt before attaching the proper regulator. Before connecting the regulator to the cylinder valve, open the valve slightly and close immediately. When opening the valve, stand to one side of the outlet; never in front of it. Never crack a fuel-gas cylinder valve near welding work or near sparks, a flame, or other possible sources of ignition.
- Some regulators are only for specific gases; regulators should not be interchanged.
- Do not force connection fittings.
- Never tamper with safety devices in cylinder valves or regulators.
- Release adjusting screw on regulator before opening cylinder valve.
- Stand to the side of the regulator when opening cylinder valve.
- Open cylinder valve slowly.

## Use

- Review safety bulletins and safety data sheets, and read warning labels.
- The National Fire Protection Association (NFPA) specifies maximum quantities and sizes of hazardous gas cylinders stored and used in laboratory areas. (See NFPA 45.)
- A hammer or wrench must not be used to open cylinder valves. If valves cannot be opened by hand, the supplier must be notified.
- Use protective gloves and eye wear when handling cylinders containing cryogenic (super-cold) gases.
- Cylinders, cylinder valves, couplings, regulators, hose, and apparatus must be kept free from oily or greasy substances. Do not handle oxygen cylinders or apparatus with oily hands or gloves. A jet of oxygen must never be permitted to strike an oily surface, greasy clothes, or enter a fuel-oil or other storage tank.

- Cylinders are to be kept far enough away from welding or cutting operations so that sparks, hot slag, or flame will not reach them, or fire-resistant shields must be provided.
- Do not place cylinders where they might become part of an electric circuit.
- Close cylinder valves when work is finished.
- Before a regulator is removed from a cylinder valve, close the cylinder valve and release the gas from the regulator.
- If a cylinder is found to have a leaky valve or fitting, which cannot be stopped by closing the valve, take the cylinder outdoors away from sources of ignition and slowly empty it. Notify the supplier promptly.
- If a special wrench is required, leave it in position on the stem of the valve while the cylinder is in use so that the fuel-gas flow can be quickly turned off in case of emergency.
- Do not open an acetylene cylinder valve more than one and one-half (1 ½) turns of the spindle, and preferably no more than three-fourths (¾) of a turn.

## Empty Cylinders

- Never use cylinders as rollers or supports, whether full or empty.
- When a cylinder is empty, close the valve to prevent air and moisture from entering the tank. Remove the regulator. Replace the cylinder cap and label the tank “EMPTY” or “MT.”
- Handle and store empty cylinders the same as full cylinders.

## Common compressed gases.

Flammable	Hydrogen, acetylene, propane, methane, butane, ethane, ethylene, isobutane
Inert	Argon, helium, neon, nitrogen, carbon dioxide, air
Toxic	Carbon monoxide, phosgene, nitric oxide
Corrosive	Hydrogen chloride, ammonia, chlorine

For more details, see

- 29 CFR 1910.101, Compressed gases.
- 29 CFR 1010.253, Oxygen-fuel gas welding and cutting.
- NFPA 45, Standard on Fire Protection for Laboratories Using Chemicals.



## Topic 13. Confined Spaces

The Bureau has established procedures and policy for identifying permit-required confined spaces and associated hazards and for controlling such hazards to allow safe entry.

A confined space is one that is large enough to enter and perform assigned work in; it has limited or restricted ways to enter or exit the space; and it was not designed to be occupied continuously by a worker.



**Permit space–hopper.**

### Identification

A permit-required confined space (permit space) is a confined space that has one or more of the following features:

- It has or may contain a hazardous atmosphere. An example is a recently emptied fuel tank.
- It contains a material that can engulf a person who enters. An example is a stilling well that contains water.
- It has an inside design that could trap or asphyxiate a person who enters (inwardly converging walls, or a floor that slopes downward to a smaller section). An example is a hopper with converging sides.
- It has any other serious safety or health hazards. An example is an air handler with moving equipment. When the power to the equipment is disconnected and locked out, it is not a permit space.

A non-permit confined space may become a permit space when conditions change. For example, a crawl space under a building will become a permit space when welding is performed on pipes because:

- Oxygen level may be reduced.
- Carbon dioxide and carbon monoxide levels may increase.
- Gases may leak from welding equipment, creating a flammable atmosphere or displacing air.
- A fire may start, further reducing oxygen and increasing carbon dioxide and carbon monoxide.
- Fumes or gases from the welding process may exceed exposure limits.

Before entering any confined or enclosed space, employees should always consider the possibility that the space should be identified as a permit space. Also, consider the operation that will be performed and whether it could create a permit space.

Permit spaces that are owned or controlled by the USGS must be identified. Employees and contractors working in the area of these permit spaces must be informed of the location and hazards of the permit spaces. Each permit space must be posted with signs such as “DANGER PERMIT-REQUIRED CONFINED SPACE—AUTHORIZED ENTRANTS ONLY” or similar language. Manhole covers are not required to be posted because they are assumed to be permit spaces.

## Written Program

Employees who enter permit spaces must be covered by a written permit-required confined space program. The written program must include procedures to:

- Implement necessary measures to prevent unauthorized entry.
- Identify and evaluate permit space hazards before allowing employee entry.
- Test atmospheric conditions in the permit space before entry operations and monitor the space during entry.
- Perform appropriate testing for the following atmospheric hazards in this sequence: oxygen, combustible gases or vapors, and toxic gases or vapors.
- Establish and implement the means, procedures, and practices to eliminate or control hazards necessary for safe operations in permit spaces.
- Identify employee job duties.
- Provide and maintain, at no cost to the employee, personal protective equipment and any other equipment necessary for safe entry and working within permit spaces; employees are required to use the equipment.
- Ensure that at least one attendant is stationed outside the permit space for the duration of entry operations.
- Coordinate entry operations when employees of more than one employer are working in the permit space.
- Implement appropriate procedures for summoning rescue and emergency services and preventing unauthorized personnel from attempting rescue.

- Establish, in writing, and implement a system for the preparation, issue, use and cancellation of entry permits.
- Review established entry operations annually and revise the permit space entry program as necessary.
- Implement the procedures that any attendant who is required to monitor multiple spaces will follow during an emergency in one or more of those spaces.

## Entry Permit

A permit, signed by the entry supervisor, must be posted at all entrances or otherwise made available to entrants before they enter a permit space. The permit must verify that pre-entry preparations outlined in the standard have been completed. The duration of entry permits must not exceed the time required to complete an assignment.

Entry permits must include:

- Name of permit space to be entered, authorized entrant(s), eligible attendants, and individuals authorized to be entry supervisors.
- Test results.
- Tester's initials or signature.
- Name and signature of supervisor who authorizes entry.
- Purpose of entry and known space hazards.
- Measures to be taken to isolate permit spaces and to eliminate or control space hazards.
- Name and telephone numbers of rescue and emergency services and means to be used to contact them.
- Date and authorized duration of entry.
- Acceptable entry conditions.
- Communication procedures and equipment to maintain contact during entry.
- Additional permits, such as for hot work, that have been issued authorizing work in the permit space.
- Special equipment and procedures, including personal protective equipment and alarm systems.
- Any other information needed to ensure employee safety.

The entry supervisor must cancel the entry permit when an assignment is completed or when new conditions exist. New conditions must be noted on the canceled permit and used in revising the permit

space program. Canceled entry permits must be kept for at least 1 year.

## Training

Before the initial work assignment begins, employees who are required to work in permit spaces must be trained. Managers must ensure that the employees have acquired the understanding, knowledge, and skills necessary to safely perform their duties. This can be accomplished by a written or verbal test combined with the employee demonstrating the skills needed for the assigned duties. Additional training is required when:

- The job duties change.
- A change occurs in the permit space program or the permit space operation presents any new hazard.
- An employee's job performance shows deficiencies.

In addition to this training, rescue team members also require training in cardiopulmonary resuscitation (CPR) and first aid.

A certification of training is required and must be maintained. The certification must include:

- Employee's name.
- Printed names and signatures of the trainers.
- Dates of training.

## Assigned Duties

*Authorized entrants* are required to:

- Know space hazards, including information on the means of exposure such as inhalation or dermal absorption, signs of symptoms and consequences of the exposure.
- Use appropriate personal protective equipment properly.
- Maintain communication with attendants as necessary to enable them to monitor the entrant's status and alert the entrant to evacuate when necessary.
- Exit from the permit space as soon as possible when:
  - Ordered to do so by the authorized person;
  - He or she recognizes the warning signs or symptoms of exposure;
  - A prohibited condition exists; or
  - An automatic alarm is activated.

- Alert the attendant when a prohibited condition exists or when warning signs or symptoms of exposure exist.

*Attendants* are required to:

- Remain outside the permit space during entry operations unless relieved by another authorized attendant.
- Perform non-entry rescues when specified by the employer's rescue procedure.
- Know existing and potential hazards, including information on the mode of exposure, signs or symptoms, consequences, and physiological effects.
- Maintain communication with and keep an accurate account of those workers entering the permit space.
- Order an evacuation of the permit space when:
  - A prohibited condition exists;
  - A worker shows signs of physiological effects of hazard exposure;
  - An emergency outside the confined space exists; or
  - The attendant cannot effectively and safely perform required duties.
- Summon rescue and other services during an emergency.
- Ensure that unauthorized people stay away from permit spaces or exit immediately if they have entered the permit space.
- Inform authorized entrants and the entry supervisor if any unauthorized person enters the permit space.
- Perform no other duties that interfere with the attendant's primary duties.

*Entry supervisors* are required to:

- Know space hazards, including information on the mode of exposure, and signs or symptoms and consequences of exposure.
- Verify emergency plans and specified entry conditions related to permits, tests, procedures, and equipment before allowing entry.
- Terminate entry and cancel permits when entry operations are completed or if a new condition exists.
- Verify that rescue services are available and that the means for summoning them are operable.

- Take appropriate measures to remove unauthorized entrants.
- Ensure that entry operations remain consistent with the entry permit and that acceptable entry conditions are maintained.

*Rescue service personnel* must:

- Be capable of responding to an emergency in a timely manner.
- Be provided with personal protective and rescue equipment and training in how to use it.
- Receive the authorized entrants training and be trained to perform assigned rescue duties.
- Be trained in first aid and CPR.
- Practice rescue exercises yearly.
- Be provided access to permit spaces so they can practice rescue operations.
- Be informed of the hazards of the permit space.

### **Harnesses and retrieval lines**

- Authorized entrants who enter a permit space must wear a full body harness with a retrieval line attached to the center of their backs near shoulder level or above their heads.
- Wristlets may be used if it is demonstrated that the use of a full body harness is not feasible or creates a greater hazard.
- The retrieval line must be attached to a mechanical device or to a fixed point outside the permit space.
- A mechanical device must be available to retrieve someone from vertical-type permit spaces that are more than 5 feet deep.

### **Safety Data Sheet**

If an injured entrant is exposed to a substance for which a Safety Data Sheet or other similar written information is required to be kept at the worksite, it must be made available to the medical facility personnel treating the exposed entrant.

### **Reclassify a Permit Space**

A permit space, such as a stilling well or drinking water well, may be reclassified as a non-permit confined space under the following conditions:

- If the permit space poses no actual or potential atmospheric hazards (atmosphere tested and verified safe) and if all

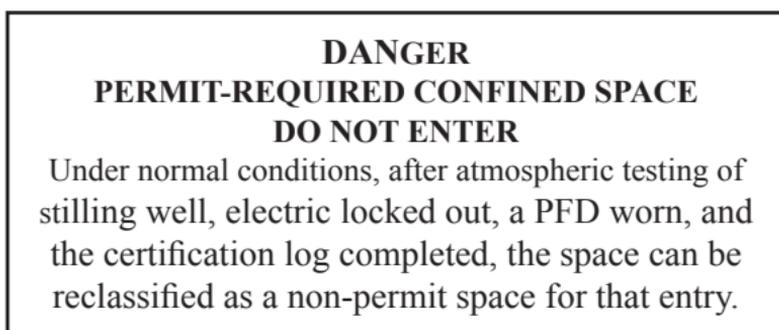
hazards within the space are eliminated without entry into the space (for example lockout for electrical hazards, wearing a PFD for water hazards, wearing fall protection for fall hazards), the permit space may be reclassified as a non-permit confined space for that entry, as long as the non-atmospheric hazards remain eliminated.

- Each time an entry is made to the permit space, the basis for determining that all hazards were eliminated must be documented with a **certification** that contains the date, the location of the space, and the signature of the person making the determination. A log containing this information may be used as the certification.

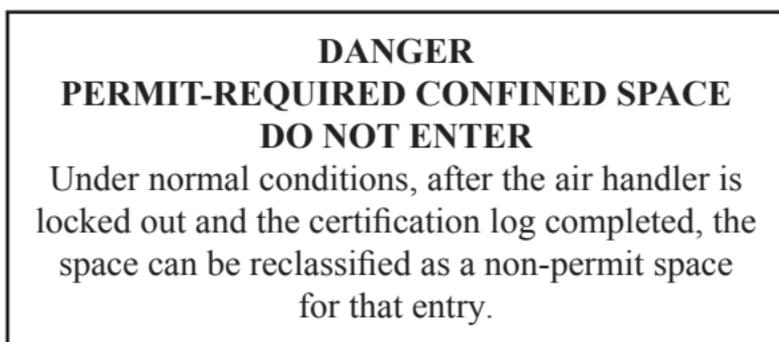
If it is necessary to enter the permit space to eliminate hazards, the entry must be made under a permit.

When there are changes in the use or configuration of a non-permit confined space that might increase the hazards to entrants, the space must be reevaluated and, if necessary, reclassified as a permit space.

For a permit space that is often reclassified as a non-permit space after eliminating a hazard, the posted sign could include the procedure for hazard elimination.



**Example sign for stilling well.**



**Example sign for air handler.**

For more details, see

- SM 445-2-H Chapter 40—Confined Spaces.
- 29 CFR 1910.146, Permit-required confined spaces.

## Topic 14. Electrical Safety

### Buildings

All electrical installations for Bureau owned, operated, or leased buildings including, but not limited to, gage stations, marina docks, cabins, and shelters must:

- Be installed, repaired, and/or maintained by a licensed electrician.
- Have a disconnect that will allow the electricity to be de-energized and that can be locked out.
- Be grounded or employees protected by ground-fault circuit interrupters (GFCIs). GFCIs will not protect equipment.
- If subjected to wet conditions, be protected from water; employees must be protected by ground-fault circuit interrupters.
- Have an arc flash hazard assessment and be labeled with the required precautions for live electrical work.

### Equipment

Normal use of electrical equipment causes wear and tear that results in insulation breaks, short circuits, and exposed wires. If there is no ground-fault protection, it can cause a ground fault that sends current through an employee's body.

- Use ground-fault circuit interrupters (GFCIs) on all 120-volt, single-phase, 15- and 20-ampere receptacles on all field equipment.
- Use double-insulated tools and equipment, distinctively marked.
- Visually inspect all electrical equipment before use. Remove from service any equipment with frayed cords, missing ground prongs, cracked tool casings, or other hazards.
- Use only equipment that is listed and labeled by a nationally recognized testing laboratory for the intended use.

### Extension Cords

Normal wear on cords can loosen or expose wires. Cords that are not 3-wire type, not designed for hard usage, or that have been modified increase your risk of contacting electrical current.

- Do not modify cords or use them incorrectly.

- Use factory-assembled cord sets and only extension cords that are 3-wire type.
- Use only cords, connection devices, and fittings that are equipped with strain relief.
- Remove cords from receptacles by pulling on the plugs, not the cords.
- Use of extension cords (flexible cords) for permanent installation of appliances and equipment is prohibited.
- Replace extension cords that are damaged so individual wires can be seen through the protective sheathing. Do not repair these.
- If an extension cord insulation is cut, it is better to cut the damaged section out and add a new plug than to try and repair the insulation.
- Never repair insulation using electrical tape, which does not have equivalent insulation and it is easily damaged.

## Power Lines

Overhead and buried power lines are especially hazardous because they carry extremely high voltage. Fatal electrocution is the main risk, but burns and falls are also hazards.

- Look for overhead power lines and buried power line indicators.
- Stay at least 10 feet away from overhead power lines and assume they are energized.
- Use nonconductive wood or fiberglass ladders when working near power lines.
- De-energize and ground lines when working near them. Call the electrical utility to do this.
- Call the electrical utility for work that it is responsible for, such as tree trimming.

For more information, see

- 29 CFR 1910 Subpart S, Electrical.
- National Fire Protection Association (NFPA) 70, National Electrical Code®.
- NFPA 70E, Standard for Electrical Safety in the Workplace®.

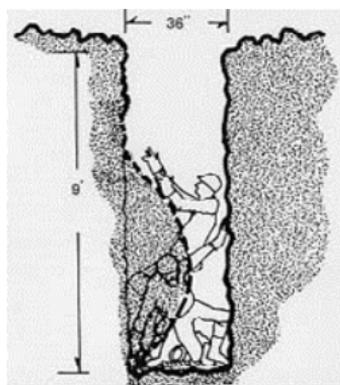
## Topic 15. Excavations

Cave-ins are the greatest risk at an excavation.

- Most accidents occur in trenches 5 to 15 feet deep.
- There is usually no warning before a cave-in.

Other hazards include:

- Asphyxiation due to lack of oxygen.
- Inhalation of toxic materials.
- Fire.
- Moving machinery near the edge of the excavation that can cause a collapse.
- Accidental severing of underground utility lines.



**Excavation cave-in.**

### Competent person

A competent person

- Is capable of identifying existing and predictable hazards in the surroundings, or working conditions that are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them.
- Must perform daily inspections.
- Classifies the soil unless Type C soil is assumed.

### Protective Systems

One of these three methods must be used to protect employees who enter excavations from cave-ins.

- **Sloping**—Slope or bench the sides of the excavation.
- **Shoring**—Support the sides of the excavation.
- **Shielding**—Place a shield between the side of the excavation and the work area.

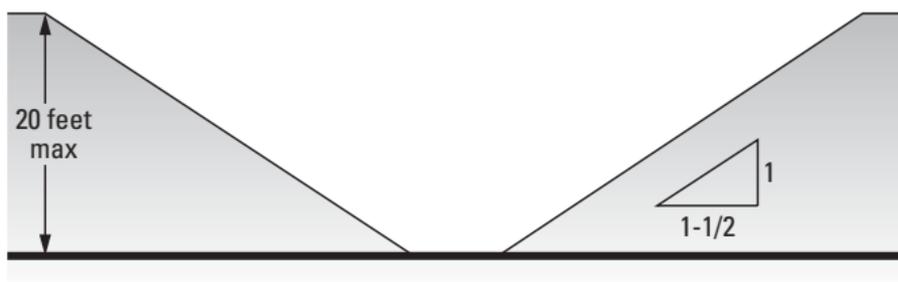
When designing a protective system, these factors must be considered.

- Soil classification.
- Depth of cut.

- Water content of soil.
- Changes due to weather and climate.
- Other operations in the vicinity.

*Sloping or benching.*

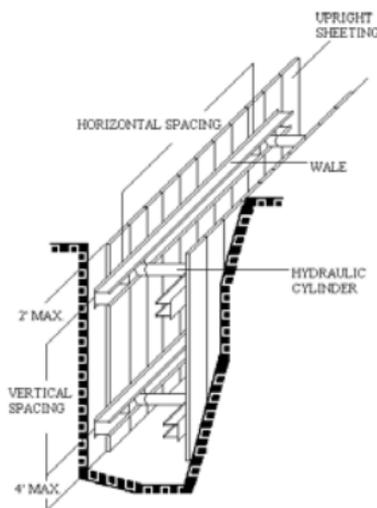
- You must know soil type or assume Type C soil.
- If you don't know soil type, slope 1 1/2 horizontal to 1 vertical (34 degrees from horizontal).
- May not exceed 20 feet in depth.



**Simple sloping in Type C.**

*Shoring.*

- Provides a framework to work in.
- Uses wales, cross braces, and uprights.
- Supports excavation walls.
- OSHA tables provide shoring data:
  - You must know soil type;
  - You must know depth and width of excavation; and
  - You must be familiar with the OSHA tables in 29 CFR 1926 Subpart P.

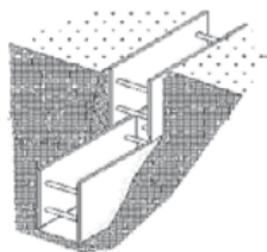


**Aluminum hydraulic shoring.**

*Shielding.*

- Provides a structure that is able to withstand the forces imposed on it by a cave-in.

- Can be permanent structures or can be designed to be portable and moved along as work progresses.
- An example is a trench box.



**Trench box.**

## **Mobile Equipment**

When mobile equipment is operated adjacent to an excavation, or when such equipment is required to approach the edge of an excavation, and the operator does not have a clear and direct view of the edge of the excavation, a warning system shall be utilized such as barricades, hand or mechanical signals, or stop logs. If possible, the grade should be away from the excavation.

## **Spoil (pile of excavated soil)**

- Don't place spoils within 2 feet from edge of excavation.
- Measure from nearest part of the spoil to the excavation edge.
- Place spoils so rainwater runs away from the excavation.
- Place spoil well away from the excavation.

## **Egress**

A stairway, ladder, or ramp must be present in excavations that are 4 or more feet deep, and must be within 25 feet of employees in an excavation.

## **Water**

Do not work in excavations in which there is accumulated water, or in excavations in which water is accumulating, unless precautions (such as a pump to remove water) have been taken to protect against the hazards posed by water accumulation.

## **Hazardous Atmosphere**

Where an oxygen deficiency or a hazardous atmosphere could reasonably be expected to exist, test the atmosphere before entering the excavation. If hazardous conditions exist, controls such as proper respiratory protection or ventilation must be provided. Controls used to reduce atmospheric contaminants to acceptable levels must be tested regularly. Where adverse atmospheric conditions may exist

or develop in an excavation, emergency rescue equipment such as breathing apparatus, a safety harness and line, and a basket stretcher must be readily available.

For more details, see 29 CFR 1926 Subpart P, Excavations.

## Topic 16. Gaging Stations

A gaging station is used by hydrologists to monitor and test terrestrial bodies of water. Gaging stations come in many forms and are located in diverse conditions.



**Gaging station by Susquehanna River at Harrisburg, Pennsylvania.**

### Hazard Analysis

In terms of gages, first ask: Does data need to be collected at the location?

Is the site dangerous? Is there another, safer location to collect the data from. How can we make it safer? What personal protective equipment might be needed? The job and site hazard analyses should evaluate ways to reduce the level of risk.

Other issues that should be considered in the hazard analysis and that are address within this handbook are:

- Confined space (for example, stilling well).
- Fall protection.
- Environmental hazards.
- Compressed gas cylinders.
- Gasoline.
- Measurements from a boat, by wading, during a flood, from a cableway.
- All-terrain vehicles, off-road vehicles. or snowmobile operations.
- Cableway.
- Working over or near the water.
- Working on ice-covered rivers.
- Working in hot or cold temperatures.
- Working on or near roadways.
- Use of power tools.
- Use of electrical heaters to avoid freezing.

The job hazard analysis (and the site hazard analysis, if separate) must be:

- Reviewed by the manager.
- Reviewed annually.
- Reviewed and updated whenever significant changes occur to the location or task.
- Discussed with affected employees, focusing on identified hazards and steps to be taken to reduce the risks.

### **Personal Floatation Device (PFD)**

- Your PFD must be worn any time you are working above, beside, or in any body of water.
- Always use a PFD that is in good condition.
- See the Personal Protective Equipment and the Near, On, In, or Over Water topics.

### **Preplanning**

Leave a trip plan with a designated person. This plan should include:

- A map with locations of places you will visit on your trip, such as:
  - Gaging stations.
  - Cableways.
  - Bridges.
  - Overnight stops.
- An itinerary of the stops you will make, along with estimated times you will be in these locations.
- An estimated time by which you will call the designated person.
  - If the designated person has not heard from you by the established time, that person should call the authorities and report the location you are believed to be at according to your itinerary.
  - See Check-Out and Check-In System and Search and Rescue topics (Topic 3, Personal Safety).

### **Equipment Check**

Inventory and inspect all specialized safety equipment you require for your trip. Some examples follow:

- Personal floatation device (PFD).
- Hard hat.

- High visibility clothing.
- Flares.
- Traffic cones.
- Flashing lights.
- Road signs.
- Flags.
- Wire cutters.
- Ladder.
- Fall protection equipment.

Replace all defective equipment before you leave for the field.

## **Gaging Stations**

- If there is a dam or power plant upstream, check with the operator to ensure that there will not be a discharge while you are in the stream.
- Look for down power lines before entering the stream.
- Always wear your personal floatation device.
- While in the stream, watch upstream for debris and ice drifting towards you.
- Always use your wading rod and feel for drop-offs and holes.
- Never wade directly upstream. Always angle across the stream. If your feet become lodged and you fall backwards while facing upstream, you may not be able to get up due to the water pressure.
- In areas of warm water discharge, there will be heavy algae growing on the stream bottoms. Algae are especially slippery.
- See the Walking topic (Topic 4, Travel).

## **Cableways**

Before using a cableway:

- Inspect anchorages at both banks, when possible.
- Look for signs of excessive wear, vandalism, or accidental damage to:
  - Cable.
  - Backstays.
  - Anchors.
  - Cable car.

- Turnbuckles and all other associated hardware.
- Footings.
- A-frames and towers.
- Look for downed power wire in the stream or on the cable.
- Carry wire cutters of sufficient strength to cut the sounding line, should it become entangled.
  - If possible, reel off sounding line until slack before cutting wire.
  - Cut cable as close to reel as possible.
  - Hold onto cable car to steady yourself during rebound.

## Wire Rope

Below are some definitions to assist you with wire rope terminology.

- **Abrasion.** Surface wear on the wires of a wire rope.
- **Backstay.** Guy line used to support an A-frame or tower.
- **Breaking strength.** The measured load required to break wire rope in tension.
- **Cable.** A term applied to wire ropes, wire strands, and electrical conductors.
- **Cableway.** Aerial conveying system for transporting single loads along a suspended track.
- **Clip.** Fitting for clamping two parts of wire rope.
- **Construction.** Design of wire rope including number of strands, number of wires per strand, and arrangements of wires in each strand.
- **Core.** Member of a wire rope about which the strands are laid. It may be fiber, a wire strand, or an independent wire rope.
- **Corrosion.** Chemical decomposition of the wires of a rope by exposure to moisture, acids, alkalines, or other destructive agents.
- **Cover wires.** Outer layer of wires.
- **Diameter.** Distance measured across the center of a circle circumscribing the wires of a strand or the strands of a wire rope.
- **Eye or eye splice.** A loop with a thimble formed in the end of a wire rope.

- **Fatigue.** Term commonly applied to progressive fracture of wires of a rope.
- **Galvanize.** To coat with zinc to protect against corrosion.
- **Grades, wire rope.** Classification of strand by its breaking strength. In order of increasing breaking strengths they are Iron, Traction, Mild Plow Steel, Plow Steel, Improved Plow Steel, Extra Improved Plow Steel.
- **Guy line.** Strand or wire rope, usually galvanized, for holding a structure in position.
- **Regular lay rope.** Wire rope in which the wires in the strands and the strands in the rope are laid in opposite directions.
- **Shackle.** A “U” shaped fitting with pin.
- **Sheave.** A grooved pulley for use with wire rope.
- **Strand.** An arrangement of wires helically laid about an axis, or another wire of fiber center to produce a symmetrical section.
- **Thimble.** Grooved metal fitting to protect the eye of a wire rope.
- **Turnbuckle.** Device attached to wire rope for making limited adjustments in length. It consists of a barrel and right and left hand-threaded bolts.
- **Wire (round).** Single, continuous length of metal cold-drawn from a rod.
- **Wire rope.** A plurality of strands helically laid around an axis or a core.

*When working with wire rope:*

- Always wear gloves.
- Always wear safety glasses.
- Use the proper size wrench for tightening clips. Do not use pliers or vise grips.

For more details, see SM 445-2-H Chapter 41—Cableway Safety.

## Cableway Visual Inspection Checklist

(From SM 445-2-H Appendix 41-A)

Station Name/Number \_\_\_\_\_

Date of last cableway inspection \_\_\_\_\_ (Do not use the cableway if it has been more than 1 year since last inspection.)

Design unloaded sag for this cable is \_\_\_\_\_ feet.

Maximum stage for use of this cableway is \_\_\_\_\_ feet.

Before using the cableway at this station, please perform the following to the extent possible:

1. Visually check all support devices (the A-frames/towers, cables, cable car, and all connections) for any signs of tampering, vandalism, or deterioration.
2. Visually check the main cable and the cable clips (# of clips: \_\_\_) for proper installation, tightness, deterioration (rust, corrosion, etc.).
3. Visually check the backstay cables or guy lines which secure the A-frames/ towers in the upright position.

Make sure thimbles and the cable clips (# of clips: \_\_\_) are installed properly.

4. Visually check footings, anchors, and U-bar areas. Make sure all connections and fasteners are not buried, loose, bent, badly corroded, or showing signs of metal fatigue.

5. Visually check cable car for loose, badly corroded, bent or broken members. Verify that the car meets USGS standards (HIF cable cars with reinforcing members; or non-HIF cable cars tested for compliance). Make sure that puller, car braking system, sheaves, etc., are in proper working order.

**Caution:** Do not use the cableway if any deficiencies are found.

Note the deficiencies on an inspection checklist and submit the list to your supervisor for inclusion in the Site Information Management System—Cableway Management Interface.

Do not tighten the cable—reducing the sag—unless the sag diagram and a level are available, and an experienced person is involved. (Check 1–4 above for possible causes of excess sag before adjusting.)

Make sure every person in the cable car is wearing a personal floatation device. Never put your hands on the cable when the car is moving. Wear gloves. Always carry a wire-cutting tool when conducting streamflow or other hydrologic measurements.

## Topic 17. Fall Protection

Falls and falling objects can result from unstable working surfaces and misuse of fall protection. Employees are also subject to falls or to the dangers of falling objects if sides and edges, floor holes, and wall openings are not protected. Any time a Bureau employee is at a height of 4 feet or more, he or she must be protected.



**Standard railing.**

### Requirements

Fall protection must be provided for each employee on a walking/working surface with an unprotected side or edge 4 feet or more above a lower level.

Assess the workplace to determine if the walking/working surfaces on which employees are to work have the strength and structural integrity to safely support employees. Once employers have determined that the surface is safe for employees to work on, the employer must select one of the options listed for the work operation if a fall hazard is present.

- Where protection is required, select fall protection systems appropriate for given situations.
- Use proper construction and installation of safety systems.
- Supervise employees properly.
- Train employees in the proper selection, use, and maintenance of fall protection systems.

### Unprotected Sides, Wall Openings, and Floor Holes

Almost all sites have unprotected sides and edges, wall openings, or floor holes at some point during construction. If these sides and openings are not protected at your site, injuries from falls or falling objects may result, ranging from sprains and concussions to death. Use at least one of the following whenever employees are exposed to a fall of 4 feet or more above a lower level:

- Guardrail systems.
- Fall arrest systems.
- Cover or guard floor holes as soon as they are created.
- Guard or cover any openings or holes immediately.

- Construct all floor hole covers so they will effectively support two times the weight of employees, equipment, and materials that may be imposed on the cover at any one time.

## Standard Railings

Generally, the best choice for fall protection is a standard railing.

- A standard railing consists of a top rail, intermediate rail, and posts.
- Height of the top railing must be from 36 inches to 44 inches; 42 inches is preferred.
- The top rail must be smooth surfaced.
- The intermediate rail must be about halfway between the top rail and the floor, platform, runway, or ramp.
- The ends of the rails must not overhang the terminal posts except where the overhang does not make a projection hazard.
- The railing must be capable of withstanding a force of at least 200 pounds applied within 2 inches of the top edge, in any outward or downward direction, at any point along the top edge.
- If objects can fall on persons walking or working, either prevent entry to that area or provide toe boards or screens.

## Stairs

Every flight of stairs with four or more risers must have standard stair railings or standard handrails. Stair railings are similar to standard railings except the vertical height is 30 to 34 inches from the upper surface of the top rail to the surface of tread in line with the face of the riser at the forward edge of tread.

Stairs must be at least 22 inches wide and installed at an angle of 30 to 50 degrees from the horizontal. They must be designed and constructed with a safety factor of 5 and be strong enough to safely carry a moving concentrated load of at least 1,000 pounds.

Stair treads must be reasonably slip resistant, with nosings of a non-slip finish. Rise height and tread width must be uniform throughout the flight of stairs, including any foundation structure used as a tread. As little as 1/4 inch variation in rise or run of treads can cause a person to trip.

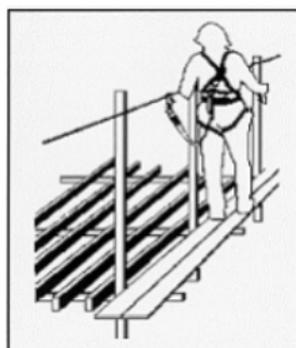
The handrail on winding stairs must be offset to prevent walking on portions of the treads that are less than 6 inches deep.

<b>Stairways</b>	<b>With</b>	<b>Must have</b>
Less than 44 inches wide	both sides enclosed	at least one handrail, preferably on the right side descending.
Less than 44 inches wide	one side open	at least one stair railing on open side.
Less than 44 inches wide	both sides open	one stair railing on each side.
44 to 88 inches wide		one handrail on each enclosed side and one stair railing on each open side.
88 or more inches wide		one handrail on each enclosed side, one stair railing on each open side, and one intermediate stair railing located approximately mid-way of the width.

## Personal Fall Arrest Systems

Employees who use personal fall arrest systems must have additional training by a competent person in the selection, use, and care of the personal fall-arrest systems.

When personal fall arrest systems are used, there must be a plan to assure that anyone who falls can be promptly rescued or can rescue one's self.



**Horizontal lifeline with shock-absorbing lanyard.**

## System Components

- *Anchorage* is the primary attachment for an employee's lifeline, lanyard, or deceleration device. The anchor must be able to hold a minimum load of 5,000 pounds. Or, it must be designed, installed, and used under the supervision of a qualified person, as part of a complete personal fall arrest system that maintains a safety factor of at least two, which means two times the impact of an employee free falling 6 feet.
- *Lanyard* is a flexible line of rope, wire rope, or strap that generally has a connector at each end for connecting the

- body belt or body harness to a deceleration device, lifeline, or anchor point.
- *Connectors* couple the components of a personal fall arrest system together. D-rings and snap hooks are the most common types of connectors.
  - *Full body harness* consists of webbing straps that are secured about an employee's body in a manner that will distribute the fall arrest forces over the thighs, pelvis, waist, chest, and shoulders.
  - *Lifeline* is a component consisting of a flexible line for connection to an anchor point at one end to hang vertically (vertical lifeline), or for connection to anchor points at both ends to stretch horizontally (horizontal lifeline), and which serves as a means for connecting other components of a personal fall arrest system to the anchor point.

## Swing Falls

Think about the potential for a swing fall when you connect a lifeline to a personal fall arrest system. You increase the risk of a swing fall by moving away from the anchorage point and increasing the lifeline length. You will swing back and forth under the anchorage during a fall. Remember this about swing falls:

- Fall distance can increase during a swing fall.
- The shock load for a swing fall can be the same as it would be for a vertical fall with the same change in elevation.
- During a swing fall you can strike an object at a lower level before the arrest system stops your fall.

## Fall Protection Plans

When standard railings and personal fall arrest systems are infeasible or create a greater hazard, a written fall protection plan must be prepared showing the method used to provide equivalent protection from falls.

For more details, see SM 445-2-H Chapter 44—Fall Protection.

## Topic 18. Fire Safety

It is the Bureau's policy to:

- Prevent or reduce the likelihood of a fire that may result in death, injury, or property damage.
- Alert those in a structure to the presence of an uncontrolled fire in the event one occurs.
- Better enable those threatened by a fire to survive in and evacuate from affected areas.
- Reduce the damage caused by a fire.



Fire extinguisher.

### Fire Prevention

When working in the field, it is even more important to prevent fires because response from the nearest fire department and emergency medical services may be delayed. Consequences of a fire in a remote location can be devastating to a large area and many people.

Identifying and separating the sources of fuel, oxidizers, and ignition are some key elements of fire prevention. It is equally important to develop procedures for handling and storing chemicals and materials that can cause or contribute to a fire.

*Identify fuel sources.*—Examples of fuel sources that may be present in the field are:

- Gasoline.
- Liquid propane gas.
- Acetylene.
- Explosives.
- Diesel.
- Pipes, drums, or tanks containing or that recently contained flammables or combustibles.
- Combustible dusts (for example, coal, wood, grain).
- Flammable chemical solvents, preservatives, and pesticides (for example, acetone, alcohols, benzene, ethers, formaldehyde, toluene, xylene).

*Identify sources of oxidizing agents.*—An oxidizing agent is an element or compound in an oxidation-reduction (redox) reaction that

accepts an electron from another species. The oxidizing agent is reduced, but the reactant (for example, fuel) is oxidized by having its electrons taken away by the oxidizing agent. Oxygen is the prime example among the varied types of oxidizing agents. An oxidizing agent is not necessarily combustible, but may cause or contribute to the combustion of other material.

Common oxidizing agents are:

- Oxygen.
- Ozone.
- Fluorine.
- Chlorine.
- Bromine.
- Iodine.
- Nitric acid.
- Sulfuric acid.
- Hydrogen peroxide and other peroxides.

Ignition sources include:

- Open flames.
- Matches (especially strike anywhere type).
- Smoking.
- Welding.
- Grinding.
- Power tools.
- Heaters.
- Cooking equipment (for example, stoves, hot plates, coffee pots, toasters).
- Hot surfaces (for example, boilers, furnaces, steam pipes, electric lamps, hot ducts and flues, electric coils, hot bearings).
- Electric wiring.
- Batteries.
- Sparks from grinding and crushing operations.
- Sparks caused by static electricity from rotating belts, mixing operations, or improper transfer of flammable or hot combustible liquids.
- Lightning.

## Handling and storage procedures

- Use the smallest amount of flammable liquid necessary in the work area.
- Store, handle, and use flammable and combustible liquids in well-ventilated areas.
- Keep storage areas cool and dry.
- Do not store propane, gasoline, and other highly flammable materials in enclosed areas where employees sleep.
- Keep flammables separated from oxidizing agents by at least 20 feet or separated by a fire wall.
- When using oxygen, keep all ignition sources far from the tank. Even a small static spark can cause oxygen-impregnated clothes to burn violently.
- Do not leave oily rags in the bottom of a pail. They could heat up enough to cause spontaneous combustion of the rags.
- Keep open flames and spark-producing equipment away from flammables.
- DO NOT smoke around flammables.
- Use approved explosion-proof equipment in flammable storage areas.
- Use approved portable safety cans for carrying, storing, and dispensing flammable and combustible liquids.
  - Approved safety cans are made from metal or very low-conductivity plastic.
  - Safety cans have spring-mounted spout caps.
  - The cap automatically opens when the vapor pressure builds up inside; this allows vapors to escape and prevents rupture (or explosion, in the event of fire).
  - The cap-operating mechanisms also cause the spout cap to close automatically when you finish filling or pouring from the safety can, or if the can is dropped.
- Never use plastic or glass containers for storing flammable liquids unless storage in metal containers would affect the required liquid purity or if the liquid would cause excessive corrosion of the metal container.
- **Keep containers closed when not in use.**
- Properly label all containers used for flammable and combustible liquids. This helps prevent accidentally mixing one

chemical with another and reduces the chances of mistaking one liquid for another.

- Never dispense flammable and combustible liquids near ignition sources.
- If a flammable liquid spills on clothes or other combustible materials, STOP the work, clean up the spill and, if on clothes, change. A small spill of gasoline from a portable power tool can easily be ignited from sparks.
- Always make sure that metal containers are bonded and grounded when dispensing.
- Practice good housekeeping and equipment maintenance. Keep area clear of burnable materials.

## Fire Warning and Extinguishing

Preparations to detect fires and extinguish fires in the early stages will reduce the negative consequences to employees, property, equipment, the public, and the environment.

*Fire warning.*—Most fire warning systems in the field are smoke detection alarms. These must be checked regularly to verify they are functioning. Batteries must be replaced on a routine schedule. DO NOT remove and leave a battery out of a smoke detector.

If a smoke detector must be replaced, check the label to determine if the detector contains Americium-241 and is covered by a Nuclear Regulatory Commission (NRC) general license for radioactive materials. If it is covered by a general license, the smoke detector must be returned to the manufacturer or transferred to a specific license.

*Fire extinguishing agents.*—Everyone in the field should have some type of fire extinguishing agent available. Some field personnel, such as a large vessel crew, may have carbon dioxide, halon, or foam suppression systems to protect critical elements.

- All extinguishing systems must be periodically serviced and tested.
- Signs must be posted for systems that use agents (for example, carbon dioxide, halon) that pose a serious health hazard.
- Employees required to perform a fire fighting operation as part of his or her duties must be trained.

*Portable fire extinguishers.*—The most common extinguishing agents used in the field are portable fire extinguishers. Portable fire extinguishers must be:

- Visually inspected monthly.
- Subjected to an annual maintenance check. Stored pressure extinguishers do not require an internal examination.
  - Since maintenance may involve disassembling the extinguisher, replacing parts, performing repairs or recharging, it should be performed by individuals that have been specifically trained and have the necessary equipment, manufacturer's servicing manuals, and recommended replacement parts.
- Have a written record of the annual maintenance date; retain this record for 1 year after the last entry or the life of the shell, whichever is less.
- Hydrostatically tested at the intervals listed in Table L-1 of 29 CFR 1910.157 or whenever they show new evidence of corrosion or mechanical injury.
- Disposed of when:
  - The unit has been repaired by soldering, welding, brazing, or use of patching compounds;
  - The cylinder or shell threads are damaged;
  - There is corrosion that has caused pitting, including corrosion under removable name plate assemblies;
  - The extinguisher has been burned in a fire; or
  - A calcium chloride extinguishing agent has been used in a stainless steel shell.

Employees expected to use portable fire extinguishers must be trained in their use when initially assigned and at least annually thereafter.

## **Emergency Exits**

Every workplace, including camps, trailers, and cabins, must have enough exits suitably located to enable everyone to get out of the facility quickly. Considerations include the type of structure, the number of persons exposed, the fire protection available, the type of industry involved, and the height and type of construction of the building or structure.

In addition, emergency exit doors must not be blocked or locked when employees are inside. Exit routes must be free of obstructions and marked with exit signs if the exit is not visible.

## Hotel and Motel Safety

The Hotel and Motel Fire Safety Act of 1990 (as amended) was enacted by Congress to save lives and protect property by promoting fire and life safety in hotels, motels, and other places of public accommodation. The law mandates that Federal employees on travel must stay in public accommodations that adhere to the life safety requirements in the legislation, those being:

- Hard-wired, single-station smoke alarms in each guest room in accordance with the National Fire Protection Association (NFPA) standard 72; and
- An automatic fire sprinkler system, with a sprinkler head in each guest room in compliance with NFPA standard 13 or 13R. Properties four stories or higher must have an automatic fire sprinkler system.

### Plan Ahead

- When making reservations, ask if the hotel or motel has smoke alarms and an automatic fire sprinkler system.
- When traveling, take a flashlight with you.
- Read the fire evacuation plan carefully. If one is not posted in your room, request one from the front desk.
- Locate the two exits nearest your room.
- Count the number of doors between your room and the exits. This will assist you in an emergency evacuation.
- Locate the fire alarms on your floor.

### Life Safety

- Never smoke in bed.
- Get in the habit of placing your room key and a flashlight where you can grab them on your way out of the room. Depending on the weather, you may want to leave shoes and a coat there too.
- If a fire is in your room, get out quickly. Close the door, sound the alarm, and notify the front desk.
- Always use a stairwell, never an elevator. The elevator could stop at the floor of the fire.
- If the fire is not in your room, leave if it is safe to do so. Be sure to take your room key with you in case fire blocks your escape and you need to re-enter your room.

- To check the hallway for fire, touch the door with the back of your hand to test the temperature. If the door is cool, get low to the floor, brace your shoulder against the door and open it slowly. Be ready to close it quickly if there are flames on the other side. Crawl low in the smoke to the nearest exit; the freshest air is near the floor.
- If your room door is hot, do not open it. Instead, seal the door with wet towels or sheets. Turn off the fan, heater, and air conditioner. Call the fire department to give your location. Signal from your window.
- DO NOT use elevators during fire emergencies.

## Vehicle Fires

A motor vehicle contains many types of flammable materials, including flammable liquids like gasoline and oil as well as solid combustibles such as hoses. Fuel leaks from ruptured fuel lines also can rapidly ignite. The recommended actions in case of a car fire are:

- If the vehicle is moving, politely signal and move to the side of the road.
- Shut off the engine.
- Get yourself and all other occupants out of the vehicle immediately.
- Get far away from the vehicle and stay away from it. Keep onlookers and others away.
- Warn oncoming traffic.
- Notify emergency services.
- Do not attempt to extinguish the fire yourself.

The last item is important due to the risk of explosion and the toxic fumes emanating from vehicle fires. Inhalation of toxic smoke and gases is the most common form of fire-related death.

Opening the hood of a car that may be on fire is especially dangerous, as it allows a rapid and significant surge of air into the engine compartment, which may cause a rapid increase in fire intensity.

Some countries require the carrying of a fire extinguisher. This should not be seen as overriding the advice above. It has been suggested that, when using a fire extinguisher on an engine fire, the extinguisher should be fully discharged through the gap created by simply releasing (but not lifting) the hood, and then the car should be left until the

fire department has said it is safe. As with all fires, the fire may flare up again when fresh oxygen is supplied.

For more details, see

- SM 445-2-H Chapter 36—Fire Safety.
- 29 CFR 1910 Subpart L, Fire Protection.

## Topic 19. Heavy Equipment

Heavy equipment can be classified into the following categories based on the type of operation:

- Excavating
- Lifting
- Loading and hauling
- Compaction
- Grading and finishing
- Paving and surface treatment
- Drilling



**Heavy equipment operation.**

Depending upon their versatility, the equipment may be used for multiple purposes. For example, backhoes are normally used for excavating but they can also load the excavated materials into trucks.

### General Heavy Equipment Operations

*Engineering controls and work practices.*

- All vehicles must have:
  - A service brake system, an emergency brake system, and a parking brake system.
  - Working headlights, tail lights, and brake lights.
  - An audible warning device (horn).
  - Intact windshield with working windshield wipers.
- Ensure that all operators have been trained on the equipment they will use.
- Check vehicles at the beginning of each shift to ensure that the parts, equipment, and accessories are in safe operating condition. Repair or replace any defective parts or equipment prior to use.
- Do not operate vehicle in reverse with an obstructed rear view unless it has a reverse signal alarm capable of being heard above ambient noise levels or a signal observer indicates that it is safe to move.
- Vehicles loaded from the top (for example, dump trucks) must have cab shields or canopies to protect the operator while loading.

- Ensure that vehicles used to transport workers have seats with operable seat belts, firmly secured and adequate for the number of workers to be carried.
- Equipment should have rollover protection and protection from falling debris hazards, as needed.
- Prior to permitting construction equipment or vehicles onto an access roadway or grade, verify that the roadway or grade is constructed and maintained to safely accommodate the equipment and vehicles involved.
- Do not modify the equipment's capacity or safety features without the manufacturer's written approval.
- Where possible, do not allow debris collection work or other operations involving heavy equipment under overhead lines.

### **Personal Protective Equipment**

- Hard hat for overhead impact or electrical hazards.
- Eye protection with side shields.
- Gloves chosen for job hazards expected such as heavy-duty leather work gloves for handling debris with sharp edges and/or chemical protective gloves appropriate for chemicals potentially contacted.
- ANSI-approved protective footwear.
- Respiratory protection as necessary—N, R, or P95; filtering face pieces may be used for nuisance dusts (for example, dried mud, dirt, and silt) and mold (except mold remediation). Filters with a charcoal layer may be used for odors.

### **Powered Industrial Trucks**

*Engineering controls and work practices.*

- Only handle loads within the rated capacity of the truck.
- Use rough-terrain trucks where conditions warrant their use.
- Carry loads low.
- When necessary, travel in reverse so the driver/operator has a clear view of the path of travel.
- Ascend or descend grades slowly; when ascending or descending grades in excess of 10 percent, loaded trucks should be driven with the load positioned upgrade.
- Ensure that forklifts/powering industrial trucks are not modified without the written approval of the manufacturer.

- When left unattended, ensure that the load-engaging means are fully lowered, controls are neutralized, power is shut off, and brakes are set.
- Maintain a safe distance from edges, including those of ramps and platforms.
- Ensure that dockboards or bridgeplates are capable of withstanding the load imposed and that they are properly secured before the vehicle is slowly and carefully driven over it.
- Only use safety platforms approved by the manufacturer when lifting personnel. Ensure that the lifting platform is firmly secured to the lifting carriage and/or forks before lifting personnel.
- Powered industrial truck operators must be trained and certified for the make and model of truck to be operated. Retraining and certification is required when operator behavior or work conditions indicate retraining is needed but no less than every 3 years.

## **Material Falling from Vehicles**

*Engineering controls and work practices.*

- Do not overload vehicles.
- Ensure that loads are balanced and are fully contained within the vehicle. Trim loads, where necessary, to ensure loads do not extend beyond the sides or top of the vehicle.
- Cover and secure loads before moving the vehicle.

## **Silica, Nuisance Dust, Dried Mud, or Silt**

*Engineering controls and work practices.*

- Stay upwind of or away from dust-generating activities, and in particular those involving crystalline silica-containing materials like concrete, brick, tile, drywall, mortar, sand, or stone. When inhaled, the fine crystalline silica particles contained in the dust can become lodged deep in the lung, which can lead to silicosis and other respiratory illnesses.
- Use water spray or mist to suppress dust generation, especially during operations that may create a lot of dust, such as cutting or sawing silica-containing materials, jack hammering, impact drilling, using heavy equipment, and demolishing structures.
- Avoid using compressed air to clean surfaces.

- Sample worker exposures to silica during dust-generating activities.

*Personal protective equipment.*

- At a minimum, use respirators with N, R, or P95 filters for work with crystalline silica-containing materials (for example, concrete, brick, tile, mortar). The use of N, R, or P100 filters may provide additional protection.
- Higher levels of respiratory protection may be needed for some operations, such as cutting concrete, sandblasting, and mixing concrete.
- N, R, or P95 respirators may be used for nuisance dusts (for example, dried mud, dirt, or silt) and mold (except mold remediation). Filters with a charcoal layer may be used for odors.

## **Noise**

*Engineering controls and work practices.*

- Use heavy equipment with enclosed, temperature-controlled cabs, when available.
- Place generators, compressors, and other noisy equipment at a distance or behind a barrier when possible.

*Personal protective equipment.*

- Hearing protection when working around potential noise sources and when noise levels exceed 90 decibels A-weighted. A useful “rule of thumb” is if you cannot hold a conversation in a normal speaking voice with a person who is standing at arm’s length (approximately 3 feet), the noise level may exceed 90 decibels.

## **Fueling**

*Engineering controls and work practices.*

- Ensure that ignition sources are at least 25 feet away from fueling areas.
- Prohibit smoking in fueling areas.
- Ensure that vehicles are attended while being fueled.

## Discovery of Unknown Chemicals

### *Engineering controls and work practices.*

- If hazardous chemical containers are found or leaking materials are detected:
  - Do not use spark-producing devices (for example, engines, tools, electronic and communications equipment) in the immediate area.
  - Take self-protective measures (move to a safe distance upwind) and contact hazardous material response personnel for evaluation/removal before continuing work in the area.

### *Personal protective equipment.*

- Evaluate the need to revise protective clothing, respirator, and glove selection.

## Other Potential Hazards

- Heat stress
- Cold stress
- Sunburn
- Poisonous plants
- Animal/insect bites
- Traffic control in work zones.

For additional information, see

- 29 CFR 1926 Subpart O, Motor Vehicles, Mechanized Equipment, and Marine Operations.
- 29 CFR 1926.251, Rigging equipment for material handling.
- 29 CFR 1910.178, Powered industrial trucks.



## Topic 20. Hot Work

Hot work is any work that involves burning, welding, using fire- or spark-producing tools, or that produces a source of ignition. It includes welding, cutting, burning, abrasive blasting, and other heat-producing operations.

Test for flammable gases in the work area before starting any hot work. Potentially hazardous areas include, but are not limited to, well heads, fuel tanks, mud tanks, tank batteries, gas separators, oil treaters, or confined spaces where gases can accumulate.

### Hazards

Employees performing hot work are exposed to the risk of fires or explosions due to flammable or combustible materials igniting and from flammable gas leaks from the hot work equipment. Fires are often the result of the “quick five minute” job in areas not intended for welding or cutting.

### Controls

Being issued a hot work permit before performing hot work is one of the steps involved in a hot work management program. Additional steps outlined below help to reduce the risk of starting a fire by welding or cutting in areas containing flammable or combustible materials.

In order to control or eliminate hot work hazards and their risks, policies, procedures, and the assignment of responsibilities should be identified, including:

#### *Policies.*

- Where and when hot work is allowed.
- Who authorizes hot work.

#### *Procedures.*

- What must be assessed before permitting/performing hot work in an area.
- What to do to prepare an area for hot work.
- What to do if hot work cannot be avoided in a hazardous area.
- What hot work tools and equipment are required.

- How to obtain a hot work permit, when they are required, and who can administer them.

#### *Training.*

- Employees, supervisors, maintenance individuals, fire wardens, trained fire watch individuals, and contractors all have different roles and must be trained accordingly.

#### *Communications.*

- Post hot work procedures.
- Post signs in areas that are prohibited from having hot work performed in them.

### **Inspect and Prepare for Hot Work**

- Inspect the work area thoroughly before starting. Look for combustible materials in structures (partitions, walls, ceilings).
- Sweep clean any combustible materials on floors around the work zone. Combustible floors must be kept wet with water or covered with fire-resistant blankets or damp sand.
- Use water ONLY if electrical circuits have been de-energized to prevent electrical shock.
- Remove any spilled grease, oil, or other combustible liquid.
- Move all flammable and combustible materials away from the work area.
- If combustibles cannot be moved, cover them with fire-resistant blankets or shields. Protect gas lines and equipment from falling sparks, hot materials, and objects.
- Use fire-resistant material to block off cracks between floorboards, along baseboards and walls, and under door openings. Close doors and windows.
- Cover wall or ceiling surfaces with a fire-resistant and heat-insulating material to prevent ignition and accumulation of heat.
- Vacuum up combustible debris from inside ventilation or other service duct openings to prevent ignition. Seal any cracks in ducts. Prevent sparks from entering into the duct work. Cover duct openings with a fire-resistant barrier and inspect the ducts after work has concluded.
- Secure, isolate, and vent pressurized vessels, piping, and equipment as needed before beginning hot work.

- Make sure that suitable fire-extinguishing equipment is immediately available. Such equipment may consist of pails of water, buckets of sand, a water hose, or portable extinguishers.

## Hot Work Permit

A hot work permit is only as good as the information included on it and the skills of the person issuing it.

- If the nature of the job changes, a new hot work permit should be issued.
- A permit must be issued before the hot work begins. The proper permit will record that safety requirements have been met.
- The person authorized to issue a permit should check the area of the hot work for:
  - Explosive atmospheres.
  - Nearby combustibles.
  - Fire protection equipment.
  - Safe condition of surrounding areas.
  - Notification of all persons involved.
  - Establishment of a fire watch.
- If flammable gases could be present, the hot work areas should always be monitored for those gases before hot work is performed. Results of the gas monitoring must be recorded on the permit. If flammable gases could accumulate during the work, continuous monitoring is required.

## Performing Hot Work

- Perform hot work in a safe location, or after fire hazards have been removed or covered. Use heat guards to confine the heat, sparks, and slag, and to protect the immovable fire hazards.
- Do not perform hot work where flammable vapors or combustible materials exist. Work and equipment should be relocated outside of the hazardous areas, when possible.
- Assign additional personnel (fire watch) to guard against fire while hot work is being performed.
- Fire watchers are required whenever welding or cutting is performed in locations where anything greater than a minor fire might develop.

- Fire watchers must be assigned during hot work when any of the following conditions are present:
  - Slag, weld splatter, or sparks might pass through an opening and cause a fire.
  - Fire resistant guards or curtains are not used to prevent ignition of combustible materials.
  - Combustible material closer than 35 feet to the hot work in either the horizontal or vertical direction cannot be removed, protected with flame-proof covers, or otherwise shielded with metal or fire-resistant guards or curtains.
  - The hot work is carried out on or near insulation, combustible coatings, or sandwich-type construction that cannot be shielded, cut back, or removed, or in a space within a sandwich-type construction that cannot be inserted.
  - Combustible materials may be ignited by conduction or radiation.

## **Fire Watch**

Fire watchers must:

- Have fire extinguishing equipment readily available and be trained in its use.
- Be familiar with facilities in order to activate the fire alarm system in the event of a fire.
- Watch for fires in all exposed areas. Extinguish them only when obviously within the capacity of the equipment available; otherwise, sound an alarm.
- Maintain the fire watch at least a half hour after completion of welding or cutting operations to detect and extinguish possible smoldering fires. Depending on the work done, the area may need to be monitored for longer (up to 3 hours) after the end of the hot work.

## **Inspect after Hot Work**

- Inspect the area following work to ensure that wall surfaces, studs, wires, or dirt have not heated up.

## Topic 21. Ice-Covered Rivers

### General Information

Working on ice-covered rivers can be very hazardous. If you break through the ice into several feet of flowing water, it will be very difficult for you to get out and very hazardous for a co-worker to try to rescue you. The risk involved with working on each ice-covered river should be weighed against the value of the data collected. Use extreme caution and good judgment to carefully evaluate site conditions including ice strength. Do not continue if the risk is too great.

**There is no substitute for experience.** Work with someone who has experience working on ice.

### Measurements through Ice

Do not attempt an ice measurement if there is any doubt that the ice will support the weight of the workers and equipment. Ice is a continually changing medium and therefore must be monitored and tested often.

Before going on the ice, review these safety concerns related to ice:

- The temperature has been or will be above freezing. Snow-melt increases the stage and the pressure on the ice sheet, which may cause it to break up rapidly (sometimes in a matter of minutes).
- The temperature has been cold enough for the ice sheet to form; however
  - Early-season ice may have spots of open water.
  - Thickness of ice may vary.
  - Ice sheet may not be frozen to either bank.
- The river stage is rising or falling. A dropping river stage may cause an ice bridge and may not support additional weight without the support of the water underneath.
- The ice is covered with snow.
  - Snow insulates the ice and slows development.
  - Blowing snow may blanket spots of open water.
  - Snow covers cracks and deformations.
- Ice at the bank may be thin and weak in areas. Also, it may be deformed and tilted, making traction difficult.
- Ice may feel “rubbery.” This means ice is flexing and is weak.

- Piers, rocks, and trees affect ice.
  - Ice may not build up around piers, rocks, and trees.
  - Open water may be around ice, rocks, and trees.
- Ice color.
  - Black or blue ice is usually strong.
  - White ice is weaker due to trapped air.

## Testing Ice

When crossing an ice-covered river, only one employee will walk on the ice to the location where the ice measurement is to be taken. The employee will test the ice continuously at each step using solid blows of a sharp ice chisel. The remaining employee(s) will stand in a location where they can toss a throw bag to the other employee in the event of an ice breakthrough. Once it is determined that the ice will support another employee, the second employee can go to the test site (if the measurement requires both employees).

- Test ice with a sharp blow from your ice chisel.
  - Hard ice will respond with a resounding ring.
  - Soft ice will respond with a dull thud. (Drill a test hole to determine if ice is safe to work on.)
  - Dangerous ice—If the chisel penetrates the ice, do not work on the ice.

## Drilling Holes

- Holes overflow or gush water—River stage has risen and is applying pressure to the ice and may cause it to break up rapidly.
- Power augers should have a deadman switch installed to stop the auger when the operator lets go.
- Keep auger blade covered when not in use. This helps keep blades sharp and helps prevent cuts.

## Personal Floatation Devices

Personal floatation devices (PFDs) are required and must be worn in all ice measurement operations, except in those cases where an approved site-specific Job Hazard Analysis defines the conditions for an exception and details “equivalent measures” taken to mitigate the hazard(s). Usually, exceptions are allowed only when wearing the PFD creates a greater hazard than not wearing the PFD.

- U.S. Coast Guard-approved Type III or Type V anti-exposure worksuit or thermal system float coat PFDs help protect against hypothermia.
- Suspender type self-inflating PFDs should not be worn for work in very cold conditions. In extremely cold temperatures the same amount of carbon dioxide gas will not expand to the same volume, reducing the PFD's buoyancy.

## **Rescue Equipment**

Each employee must carry a United States Coast Guard (USCG) approved throw bag. A throw bag is a nylon bag, a bit smaller than a 2-liter bottle, that contains a floating type rope which is attached to the bag on one end. The bag has a piece of foam inside so that it will float when thrown into water.

Two blankets should be available in the vehicle. These can be used to cover a person and provide extra warmth after rescue from an ice breakthrough.

Additional rescue equipment may be needed.

## **Cold Weather Clothing**

Appropriate clothing must be worn during cold weather as protection against hypothermia.

## **Equipment and Supplies**

Any or all of the following equipment and supplies may be needed.

- Ice chisel.
- Ice auger.
- Ice picks.
- Personal protective equipment.
- First aid kit.
- Survival gear.
- Food and water.
- Extra clothing.
- Non-slip boots or ice cleats.
- Extra vehicle keys.
- Chemical hand warmers.

Snowshoes can be used to travel across deep snow to the edge of a river. Snowshoes should be removed before walking on the ice.

Snowshoes can hinder rescue attempts if a person breaks through the ice. If you are depending on the snowshoes to prevent you from falling through the ice, then the ice is too thin to go on for the ice measurement!

Highway markers and orange cones can be used to warn motorists of parked vehicles and to the fact that workers may be nearby.

## **Job Hazard Analysis**

At least two workers must be present for work on ice-covered rivers except in those cases where an approved site-specific Job Hazard Analysis (JHA) defines the conditions for an exemption. One of the two employees present at an ice measurement must be experienced in working on ice-covered rivers. Under no conditions may an employee who is inexperienced in making ice measurements and/or who is unfamiliar with the measurement site attempt an ice measurement alone.

A site-specific JHA must be developed for each site where work on an ice-covered river is to be conducted. The JHA will identify, for each job step, the potential hazards and recommended procedures to be followed. The JHA must also contain:

- A section describing unsafe conditions under which no measurements or sampling operations will be attempted.
- The conditions, if any, for which the wearing of a PFD is not required.
- The conditions, if any, when only one employee may make measurements or collect samples.

## **Rescue Plan**

All team members must familiarize themselves with the telephone numbers and locations of the emergency medical and rescue facilities closest to the measurement site before going out on the ice-covered river to take a measurement.

If it is evident that a rescue would be dangerous or difficult to execute, the measurement or sampling must not be attempted. Before starting the measurement process, each employee must consider what would happen should he lose control and fall through the ice. Have a planned response for an emergency before going out on the ice. If an individual is confident that another employee is in position, has the needed equipment, and can attempt to make a rescue, the operation may proceed.

If acting as a rescuer, do not tie the rope from a throw bag to anything—either a swimmer, a rescuer; or anything on the bank. Moving water on a rescue rope can hold a swimmer under the water or pull the person on the bank into the water.

If it is possible for someone to break through the ice and drown, a rescue plan must be formulated and documented in the JHA before beginning work on an ice-covered river.

## **Communication**

A cell phone, satellite phone, two-way radio, or other reliable and verified communication is required for working at remote sites.

Also see Denner, J.C., Revised 1993, *A primer on clothing systems for cold-weather field work: U.S. Geological Survey Open-File Report 89-415, 16 p.*, <http://pubs.usgs.gov/of/1989/0415/report.pdf>.

## **Job Hazard Analysis for Working on Ice-Covered Rivers**

Below is a generic JHA. This document should be modified to represent the conditions found at each site. At least two workers should be present at each site, and one of the two must be experienced in working on ice-covered rivers. The experienced person must test the ice to ensure that it is safe to work on. Always allow enough time to complete your work safely.

Working on an ice-covered river with a high stream velocity and/or a water depth in excess of 3 feet can be very hazardous. A site-specific safety plan must be developed for each site where stream velocity is high or water depth exceeds 3 feet. The safety plan must include the rescue techniques that may be used if someone breaks through the ice.

Date: \_\_\_\_\_

Prepared by: \_\_\_\_\_

## Preparing for Field Work—Situations, Hazards, and Safe Practices

### Refueling equipment

Explosion, fire, hazardous vapors, splashing fuel in eyes, spills.	No smoking, refuel in well-ventilated area, keep fuel away from sparks or open flame, shut off equipment before refueling, keep fire extinguisher nearby, wear eye protection, have spill kit ready in case of fuel spill.
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### Loading and unloading equipment

Pinching fingers, crushing toes, back strain.	Wear gloves, use proper lifting techniques (lift with legs not back, get assistance as necessary).
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### Sharpening ice auger bits and ice chisels

Working with grinders, sharp edges.	Wear eye protection. Cover sharp edges with guards.
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### Transporting equipment to site

Unsecured equipment hitting vehicle occupants.	Secure equipment. Vehicle should have safety screen installed.
Fumes from gasoline-powered equipment and fuel containers.	Transport fuel in approved containers that are properly secured. Make certain vent caps are closed. Transport fuel outside vehicle when possible. Keep fire extinguisher in vehicle where it is easily retrieved for use.

### Working outdoors in the winter

Hypothermia – Wind chill – Wet clothing	Check the weather forecast before leaving. Dress appropriately. “A Primer on Clothing Systems for Cold-Weather Field Work,” U.S. Geological Survey Open-File Report 89-415, revised 1993, provides good information on cold weather clothing. Carry extra clothing. Know your limits. Don’t work in extremely cold weather or extremely cold wind chills. Regularly observe your co-worker in order to detect any signs of hypothermia. Avoid dehydration by drinking plenty of water. View hypothermia safety videos. Attend a wilderness/winter-survival first-aid training course.
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Eye or skin damage caused by ultraviolet rays.	Wear sunscreen and sunglasses to protect against ultraviolet rays.
Frostbite	Don't work in extremely cold weather or extremely cold wind chills. Regularly observe your co-worker in order to detect any signs of frostbite.
Contact with very cold metal surfaces can rapidly cause frostbite on exposed skin.	Wear gloves and other protective clothing.
Wet boots	Wear waterproof boots appropriate for cold weather.
Wet gloves	Wear waterproof boots appropriate for cold weather.
Remote sites—access to emergency help.	Bring a cell phone, satellite phone, or two-way radio and spare batteries. Keep a list of emergency phone numbers with the phone. Leave an itinerary in your office. If an overnight stay is expected, establish a call-in procedure.
Lost vehicle keys	Attach a spare set of vehicle keys to an easily accessible location on the vehicle.

### Traveling by snowmobile

Breaking through the ice.	When possible, don't travel on ice-covered rivers or lakes.
It is difficult to identify thin ice or avoid sudden hazards such as open water when using a snowmobile on ice-covered rivers.	Travel in a single file when using two or more snowmobiles. Stay about 50 feet apart while maintaining visual contact. The lead snowmobile operator should keep track of the trailing snowmobile. Travel on a proven, known trail if possible. Travel at reasonable speeds in order to be able to avoid hazards on the ice.
Injuries caused by being unfamiliar with safe snowmobile usage.	Review a job hazard analysis for operating snowmobiles. Attend snowmobile safety training.
Snowmobile breaks down	Carry snowshoes or skis, extra belt, spark plugs, gas, repair kit, and tools.

### Working on ice- and snow-covered rivers

Hidden hazards covered by ice and snow.	Scout the site prior to winter to find an appropriate winter measuring section.
Falling on the slippery surface.	Wear non-slip boots or ice cleats. Felt-soled waders are NOT recommended.

<p>Falling through the ice into the river, hypothermia, drowning. The danger of working on ice-covered streams should never be underestimated.</p> <ul style="list-style-type: none"><li>▪ Ice thickness may be irregular, especially late in the season when a thick snow cover may act as an insulator.</li><li>▪ Water just above freezing can slowly melt the underside of the ice, creating thin spots. Ice bridged above water may be weak, even though relatively thick.</li><li>▪ If temperatures have been or will be above freezing, snowmelt may increase the stage and this pressure on the ice sheet may cause the ice to break up rapidly (sometimes within a matter of minutes).</li><li>▪ Ice buildup in the river channel often constricts the flow causing faster, deeper water.</li><li>▪ Breaking through the ice into deep flowing water could easily sweep you downstream under the ice.</li></ul>	<p>Establish a rescue plan before you go onto the ice. Revise rescue plan to address current conditions. Wear clothing that will help protect you against hypothermia and provide flotation such as a float coat or anti-exposure worksuit. At least two workers should be present. One of the two must be experienced working on ice-covered rivers. Get additional information about the ice conditions from local officials or local residents (date of ice formation, open water, sources of warmer water, previous history). Check weather forecast for the scheduled work days.</p> <p>Visually estimate the condition of the ice if possible: Color- Blue ice is the strongest. Grey ice is generally poor. Snow cover- Snow insulates ice, which may prevent strong ice formation and bridge open water. Cracks- Intersecting cracks are the most dangerous.</p> <p>Ice buildup on the riverbanks could conceal thin ice that can be difficult to traverse. Ice near the riverbanks, piers, and rocks can be softer than the surrounding ice. Ice thickness is not the best measure of strength. Test the ice continually as you walk using solid blows of a sharp ice chisel. If after repeated blows the ice remains sound, proceed. If the ice chisel penetrates to the water, return to the riverbank immediately. When working on the ice, stay in close proximity to the area that has been tested.</p>
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<ul style="list-style-type: none"> <li>▪ Rescue attempts:</li> <li>▪ Rescue attempts on thin ice, snow bridges, or overflow can be very dangerous to the rescuer.</li> </ul>	<p>Always have a rescue plan formulated before beginning work on an ice-covered river. Have the proper rescue equipment on hand and use it according to your plan. Make sure you have emergency communication capability in case of an accident.</p> <p>Some possible rescue aids if someone breaks through the ice are below.</p> <p>(NOTE! Breaking through the ice on streams or rivers with high velocities or depths in excess of 3 feet is life threatening. The suggestions below are considered to be only marginally effective. No reliable method has been identified that will ensure a safe return if you fall through the ice. Therefore, considerable effort must be undertaken to establish the strength of the ice. When in doubt, discontinue the work.)</p> <ul style="list-style-type: none"> <li>▪ Wear a PFD, float coat, immersion suit, or inflatable suspenders to keep you afloat if you go in.</li> <li>▪ The lead person could be attached to a lightweight inflatable or pontoon boat to be used as support and floatation in case the ice breaks. A long rope could be dragged behind the boat in case a rescuer needs to pull the boat out of danger. The boat could also be used as a work platform.</li> <li>▪ The lead person can be attached to a float tube, large inner tube, or large styrofoam block using a harness and about 5 feet of rope. The lightweight floatation gear is dragged behind as one walks across the ice.</li> <li>▪ Carry a pair of ice picks (sharpened metal rods in wooden handles) to help grab the ice.</li> <li>▪ Use a rescue pole to help pull a victim out of the water. (A rescue pole is a sealed PVC pipe with rope running through the inside. Each end is capped and the caps are drilled to allow the rope to exit the pole.) The pole is used to extend a rescue rope to the victim.</li> <li>▪ Keep a throw bag easily accessible (a self-contained rescue rope in a bag).</li> </ul>
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<ul style="list-style-type: none"> <li>▪ Rescue attempts:</li> <li>▪ Rescue attempts on thin ice, snow bridges, or overflow can be very dangerous to the rescuer.— Continued</li> </ul>	<ul style="list-style-type: none"> <li>▪ Keep rescue equipment at sites that are difficult to transport to every trip. For example, an extension ladder can be used for many tasks, including rescue.</li> <li>▪ When at a cableway location, a safety rope can be used to secure an employee to the cableway or cablecar in case of ice failure.</li> <li>▪ If working under a bridge, a safety line could be attached to the bridge structure. Use the bridge-safety plan for your site if a co-worker will be working on the bridge deck with a safety line.</li> <li>▪ If a safety line is attached to the lead person, DO NOT attach the other end to someone else who may potentially be pulled in.</li> </ul>
<p>Open water away from riverbank is dangerous.</p>	<p>Use caution when approaching open water located away from the bank. The ice may thin near the open water.</p>
<p>Warm water inflow may reduce ice thickness in local areas.</p>	<p>Know your site. Ask about the ice conditions from local officials or local residents. Check weather forecasts for the area.</p>
<p>Water in an ice-covered river can overflow. Overflow is dangerous and can make visual references to ice stability impossible.</p>	<p>If you arrive at a site with significant overflow conditions, do not walk onto the ice. If you create significant overflow by augering holes in the ice, leave if conditions become unstable. Look for an alternative location.</p>
<p>Overflow may refreeze, causing one or more layers of ice with flowing water or slush between the layers.</p>	<p>If the overflow has refrozen causing layered ice conditions, carefully evaluate the ice thickness to ensure it will hold your weight. If there is any doubt, find another location or discontinue any work on the river until conditions have improved.</p>

### Making holes in the ice to measure flow or collect samples.

<p>Ice chisels—Using an ice chisel to chop holes in the ice can be very strenuous. Excessive sweating can cause wet clothes and hypothermia. The ice chisel may slip and injure you. Don't step into a hole you are chopping in the ice, the thinner ice may fail.</p>	<p>Ice chisels are not recommended in most situations. Use a gasoline powered ice auger with sharp bits. Carry extra sets of sharp bits.</p>
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<p>Chainsaws—Chainsaws can be difficult to handle in the cold and require protective clothing to prevent injury from the sharp chain. You will undoubtedly get wet, increasing the risk of hypothermia. Don't step into a hole you are cutting in the ice; the thinner ice may fail.</p>	<p>Chainsaws are not recommended. Use a gasoline-powered ice auger with sharp bits. Carry extra sets of sharp bits.</p>
<p>Hand ice augers—Overexertion, sweating.</p>	<p>Work at a reasonable pace. Alternate tasks frequently with co-worker.</p>
<p>Gasoline-powered ice auger— Hazards:</p> <ol style="list-style-type: none"> <li>(1) Entanglement with the turning auger blade.</li> <li>(2) The cutting head may skip around until the point secures the blade.</li> <li>(3) Leaning on the ice auger to force it to cut into the ice may entangle the user.</li> <li>(4) The auger blades may catch in the ice. This sudden torque may injure the user or rip the machine out of the user's hands.</li> <li>(5) Sustained high noise from ice auger.</li> <li>(6) Cuts from the ice auger bits.</li> <li>(7) The ice may cause pressurized flow, which can suddenly geyser out of a completed hole.</li> <li>(8) Boot stuck in auger hole concealed by slush or overflow.</li> </ol>	<ol style="list-style-type: none"> <li>(1) Ensure clothing such as scarves, mittens, parkas, and bootlaces are not in danger of tangling in the ice auger. Keep feet well away from the auger, especially when starting the hole.</li> <li>(2) Use an ice chisel to cut a shallow X in the ice to start the auger.</li> <li>(3) Use sharp bits. Carry extra sets of sharp bits. Utilize auger extensions for deeper holes. When using auger extensions, keep the powerhead at a workable level (not too high or too low).</li> <li>(4) Use only those augers with safety clutches or emergency shutoff devices that will stop the spinning auger if it catches. Use two people as necessary to handle the ice auger when drilling holes.</li> <li>(5) Use hearing protection.</li> <li>(6) Wear gloves. Use the protective cap usually provided with ice augers to protect the bits and the user. Carry a first aid kit.</li> <li>(7) Wear appropriate clothing. Evaluate the overflow and determine if it is safe to continue working on the ice if the overflow is major.</li> <li>(8) Use caution around worksite. Mark location of holes.</li> </ol>

### Working under bridges.

<p>Objects such as snow or ice may fall from the roadway.</p>	<p>Don't work directly under the edge of an overhead bridge if there is a danger from falling objects. Wear a hard hat if near overhead hazards.</p>
<p>Ice may be thin near piers.</p>	<p>Avoid working near bridge piers.</p>

### Measuring streamflow or collecting water samples.

Hypothermia due to inactivity following exertion.	Dress appropriately, carry extra clothing, avoid dehydration.
Handling cold, wet equipment. Frostbite.	Wear gloves and other protective clothing.

### Moving equipment from hole to hole.

Frostbite from cold, wet equipment.	Dress appropriately.
Burns from a hot ice auger muffler.	Always be aware of the hot muffler when transporting the ice auger.
Strains from moving heavy equipment.	Use proper lifting techniques. Use an equipment sled to transport equipment from site to site.

### Leaving the worksite.

Slipping on ice- or snow-covered riverbanks.	Wear non-slip boots or ice cleats.
Packing equipment	Use proper lifting techniques. Properly secure equipment in vehicle.
Truck won't start because of the cold weather or a weak battery.	Ensure vehicles used in cold weather have been properly maintained. Carry a cell phone, satellite phone, or two-way radio and extra batteries. Carry jumper cables. Keep extra car keys in an easily accessible location on the vehicle. Carry cold-weather survival gear, food, and extra warm clothing.

## Topic 22. Ladders

Falls from ladders are a major source of serious injury. Be aware of the hazards and take proper precautions to prevent falling.

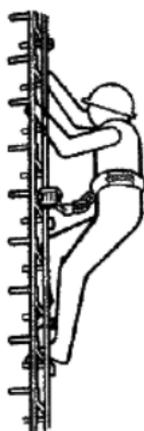
### Portable Ladders

Before using a portable ladder,

- Inspect the ladder before and after each use.
- Reject and tag any ladders that have defects. Have faulty ladders repaired or thrown out.
- Use a ladder designed for your task. Consider the strength, type, and length.
- Get help when handling a heavy or long ladder.
- Keep ladders away from electrical wires.
- Tie off ladders at the top and secure bottom to prevent them from slipping.
- Set up barricades and warning signs when using a ladder in a doorway or passageway.
- Before mounting a ladder, clean the boot soles if they are muddy or slippery. Avoid climbing with wet soles. Ensure that footwear is in good condition.
- Face the ladder when going up or down and when working from it.
- Keep the center of your body within the side rails.

What you should avoid when using a portable ladder.

- DO NOT use a ladder in a horizontal position as a scaffold plank or runway.
- DO NOT carry objects in your hands while on a ladder. Hoist materials or attach tools to a belt.
- DO NOT work from top three rungs. The higher a person goes on a ladder, the greater the possibility that the ladder will slip out at the base.
- DO NOT use items such as a chair, barrel, or box as a makeshift ladder.

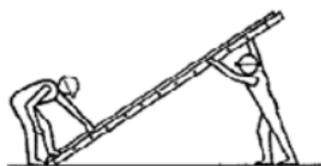


**Climbing a fixed ladder with a safety device.**

- DO NOT use a portable ladder when other equipment is available. Replace a ladder with a fixed stairway or scaffold.
- DO NOT join two short ladders to make a longer ladder. Side rails are not strong enough to support the extra load.
- DO NOT paint wooden ladders. Defects may be hidden by the paint. Wood preservatives or clear coatings may be used.

## Extension Ladders

When setting up an extension ladder, use the following method to avoid straining muscles or losing control of a ladder. With ladders weighing more than 55 pounds, or where conditions complicate the task, have two persons set up a ladder, step by step, as follows:



**Raising an extension ladder.**

- Lay a ladder on the ground close to the intended location.
- Brace ladder base using helpers' feet.
- Grasp the top rung with both hands, raise the top end over your head and walk toward the base of a ladder. Grasp the center of the rungs to maintain stability.
- Move the erect ladder to the desired location. Lean it forward against the resting point.

One person can erect a short ladder, step by step, as follows:

- Place the bottom of a ladder firmly against the base of a building or stationary object.
- Lift the top of a ladder and pull upwards to raise a ladder to a vertical position.
- Transfer a ladder to its required position when it is erect.
- Keep a ladder upright and close to the body; maintain a firm grip.

The method for lowering any ladder is the reverse procedure for erecting it.

### *How to secure extension ladders.*

- Place ladders on a firm, level surface and ensure the footing is secure.
- Erect extension ladders so that the upper section rests on (in front of) the bottom section. This means the bottom section "faces" a wall or other supporting surface.

- Place the ladder feet so that the horizontal distance between the feet and the top support is 1/4 of the working length of the ladder. The ladder will be leaning at a 75 degree angle from the ground.
- Raise and lower ladders from the ground. Ensure that locking ladder hooks are secure before climbing.
- Erect ladders so that a minimum of 3 feet extends above a landing platform. Tie the top at support points.
- Brace or tie off the ladder near the base. If there is no structure to tie off to, use a stake in the ground.
- Leave all tie-off devices in place until they must be removed before taking the ladder down.
- Maintain the minimum overlap of sections as shown on a ladder label.

*What you should avoid when using an extension ladder:*

- DO NOT use ladders near electrical wire.
- DO NOT set up or take a ladder down when it is extended.
- DO NOT overextend. Maintain minimum overlap of sections.
- DO NOT climb higher than the fourth rung from the top of a ladder.
- DO NOT use ladders on ice, snow, or other slippery surfaces without securing ladders' feet.
- DO NOT extend top section of a ladder from above or by "bouncing" on a ladder.
- DO NOT leave ladders unattended.

## **Stepladders**

- Use a stepladder that is about 3 feet shorter than the highest point you have to reach. This gives a wider, more stable base and places the shelf at a convenient working height.
- Open the stepladder spreaders and shelf fully.
- Check stability. Ensure that all ladder feet are on a firm, level and non-slippery surface.
- Place a stepladder at right angles to the work, with either the front or back of the steps facing the work.
- Keep the stepladder close to the work.

- Avoid pushing or pulling stepladders from the side. Repeated sideways movement can make ladders wobbly; the ladders are weaker and less stable in those directions.
- Face the stepladder when climbing up or down. Keep your body centered between side rails. You have climbed too high if your knees are above the top of the stepladder or if you cannot maintain a handhold on the ladder.
- Maintain a firm grip. Use both hands when climbing.

*What you should avoid when using a stepladder.*

- DO NOT overreach. Move a stepladder when needed.
- DO NOT “shift” or “walk” a stepladder when standing on it.
- DO NOT stand, climb, or sit on the stepladder top or pail shelf.
- DO NOT overload. Stepladders are meant for one person.
- DO NOT use a stepladder as a brace or as a support for a work platform or plank.
- DO NOT climb a stepladder that is leaning against a wall. Use a straight ladder instead.
- DO NOT use stepladders on slippery surfaces.
- DO NOT use stepladders on soft ground where one leg may sink farther into the ground than others.
- DO NOT place stepladders on boxes, unstable bases, or on scaffolds to gain additional height.
- DO NOT climb the back of a stepladder.
- DO NOT push or pull stepladders sideways.
- DO NOT use ladders in passageways, doorways, driveways, or other locations where a person or vehicle can hit it. Set up suitable barriers or lock doors shut.

## **Fixed Ladders**

*Inspect fixed ladders for:*

- Loose, worn, and damaged rungs or side rails.
- Damaged or a corroded cage.
- Corroded guard, bolts, and rivet heads.
- Damaged or corroded handrails and brackets on platforms.
- Broken or loose anchorages.
- Weakened or damaged rungs on brick or concrete slabs.

- Defects in climbing devices, including loose or damaged carrier rails or ropes.
- Slippery surfaces from oil and ice.
- Clutter obstructing the base of the ladder or platform.

*When climbing a fixed ladder,*

- Wait until the other person exits before ascending or descending.
- Use the appropriate safety devices (for example, a restraint belt or traveling fixture).
- Maintain three-point contact by keeping two hands and one foot, or two feet and one hand on a ladder always.
- Face the ladder and use both hands to grip the rungs firmly.
- Place feet firmly on each rung.
- Wear footwear with heels. Ensure that footwear is in good condition.
- Clean muddy or slippery boot soles before mounting a ladder.
- Rise or lower tools and materials using a hand-line.

*What you should avoid when climbing a fixed ladder:*

- Avoid climbing with wet soles.
- Do not carry tools or materials in your hand while climbing. Carry small tools in a tool pouch.
- Do not jump from a ladder. Check footing before descending a ladder.
- Do not hurry up or slide down a ladder.

## **Inspecting Ladders**

*Ladders should be inspected:*

- When new upon receipt.
- Before each use.
- If they have been dropped or have fallen.

*Look for the following:*

- Missing or loose steps or rungs (they are loose if you can move them by hand).
- Damaged or worn non-slip feet.
- Loose nails, screws, bolts, or nuts.

- Loose or faulty spreaders, locks, and other metal parts in poor repair.
- Rot, decay, or warped rails in wooden ladders.
- Cracks and exposed fiberglass in fiberglass ladders.
- Cracked, split, worn, or broken rails, braces, steps or rungs.
- Sharp edges on rails and rungs.
- Rough or splintered surfaces.
- Corrosion, rust, oxidization, and excessive wear, especially on treads.
- Twisted or distorted rails. Check ladders for distortion by sighting along the rails. Using a twisted or bowed ladder is hazardous.
- Missing identification labels.

*In addition, when inspecting extension ladders, look for:*

- Loose, broken, or missing extension locks.
- Defective locks that do not seat properly when the ladder is extended.
- Sufficient lubrication of working parts.
- Defective cords, chains, and ropes.
- Missing or defective pads or sleeves.

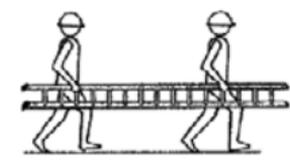
*After inspecting a ladder,*

- Tag any defective ladders and take them out of service.
- Clean fiberglass ladders every 3 months. Spray lightly with a clear lacquer or paste wax.
- Protect wooden ladders with a clear sealer or wood preservative.
- Replace worn or frayed ropes on extension ladders.
- Lubricate pulleys on extension ladders regularly.
- DO NOT make temporary or makeshift repairs.
- DO NOT try to straighten or use bent or bowed ladders.

## **Storing Ladders**

- Return ladders to storage area after use.
- Store ladders where they are protected from the weather.
- Support ladders horizontally on racks. To prevent sagging, support ladders every 6 feet.
- Keep ladders clean and free of foreign materials.

- Ensure that storage areas are easy to reach.
- Keep wooden ladders in a well-ventilated location, away from dampness and excessive heat.
- Avoid long overhangs beyond support points when transporting ladders on vehicles.
- Pad racks on vehicles with soft material to reduce wear and road shocks.
- Tie ladders to each support point to reduce damage.
- Mark ladders that overhang vehicles with a red or orange flag.
- Grasp ladders near the center when carrying them.
- Use caution when carrying ladders through passageways, doorways, or anyplace where your view is obstructed.
- Use a partner to help carry long or heavy ladders.
- Ensure that you and your partner are on the same side when carrying a ladder. Stay in step. Work out in advance any hand or voice signals to coordinate stopping or changing direction.



**Use a partner to help carry long or heavy ladders.**

*What you should avoid when storing a ladder.*

- DO NOT hang ladders from rails or rungs.
- DO NOT store materials on ladders.
- DO NOT expose fiberglass ladders to excessive temperatures (above 200 degrees Fahrenheit).
- DO NOT hold the front of ladders at head level when carrying them.
- DO NOT expose plastic-reinforced ladders to excessive sunlight. Ultraviolet light may cause the plastic resins to degrade. If the strength of the ladder is questionable, replace the ladder.

For more details, see

- 29 CFR 1910.25, Portable wood ladders.
- 29 CFR 1910.26, Portable metal ladders.
- 29 CFR 1910.27, Fixed ladders.



## Topic 23. Lightning

There is no safe place outside when thunderstorms are in the area. If you hear thunder, you are likely within striking distance of the storm. Remember, “When Thunder Roars, Go Indoors.”

A lightning bolt is a million times more powerful than household current, carrying up to 100 million volts of electricity. When someone is struck by lightning, an electrical shock occurs that can cause burns and even stop the person’s breathing.



**Lightning.**

### Behavior

Knowing how lightning behaves can help you plan for an approaching storm.

- Lightning tends to strike higher ground and prominent objects, especially materials that are good conductors of electricity, such as metal.
- Thunder can be a good indicator of lightning—loud crackling means it’s close, whereas rumbling means the storm is further away.
- Because light travels faster than sound, you will see lightning before you hear the thunder.
- Count the seconds between the flash and the thunderclap. Every 5 seconds equals about 1 mile.
- If you can hear thunder, you are within striking distance. Immediately go to the nearest well-constructed building or a fully enclosed, metal-topped vehicle.
- There is NO safe place to be outside in a thunderstorm.

### Preparation

Protection from lightning begins before the storm. Paying attention to weather conditions and forecasts allows time to plan for threatening weather and to react appropriately.

## Shelters

The safest place to be during a thunderstorm is in a well-constructed building. A well-constructed building is one that is fully enclosed with a roof, walls, and floor with electrical wiring, plumbing, telephone line, or antennas to ground the lightning should the building be hit directly.

Even when inside the building, there are safety precautions to take.

- Keep as many walls as possible between you and the outside. Stay away from doors, windows, and fireplaces.
- Stay away from anything that will conduct electricity such as radiators, stoves, sinks, and metal pipes.
- Use battery-operated appliances only. Avoid handling electrical appliances and regular telephones (cordless phones and cell phones do not increase the risk of a lightning strike).

The next best place for shelter is an enclosed metal car, truck, or van but NOT a tractor, golf cart, topless or soft-top vehicle.

- Make sure the vehicle is not parked near trees or other tall objects that could fall over during a storm.
- When inside a vehicle during a lightning storm, roll up the windows and sit with your hands in your lap and wait out the storm.
- Don't touch any part of the metal frame or any wired device in the vehicle (including the steering wheel or plugged-in cell phone).
- A direct strike to your car will flow through the frame of the vehicle and usually jump over or through the tires to reach ground.
- Be aware of downed power lines that may be touching your car. You are safe inside the car, but you may receive a shock if you step outside.

Unsafe shelters are buildings or structures without electricity or plumbing to ground the lightning, as they do not provide any lightning protection. Shelters that are unsafe include covered picnic shelters, carports, tents, baseball dugouts, as well as other small, non-metal buildings (sheds and greenhouses).

*What if you cannot find shelter?* There is no safe place to be outdoors during a thunderstorm. However, there are areas that might be less

dangerous and help reduce the risk of being struck by lightning when outside.

- Stay away from things that are tall (trees, flagpoles, or posts), water, and other objects that conduct electricity (tractors, metal fences, lawn mowers, golf clubs).
- You do not want to become a prime target by being the highest object on the landscape. Take shelter in low-lying areas such as valleys or ditches, but watch for flooding.
- If you are with a group of people in the open, spread out well apart from one another.
- If you get caught in a level field far from shelter, crouch down on the balls of your feet immediately, with feet together, place your arms around your knees and bend forward. Be the smallest target possible, and at the same time, minimize your contact with the ground. Don't lie flat.

*What if someone is hit by lightning?*

- Lightning victims are safe to touch.
- Bystanders shouldn't hesitate to save a life by calling for help.
- If breathing has stopped, administer mouth-to-mouth resuscitation.
- If the victim is not breathing and he or she does not have a pulse, a trained rescuer should administer cardiopulmonary resuscitation (CPR).

*What if you hear thunder?*

- When a storm warning is issued or if you can already hear thunder, take shelter from the storm and protect yourself.
- Commercially available personal lightning detection devices can be carried to help warn about how close a storm is.
- Preparedness for a storm is essential. Listen to your local forecast for the possibility of thunderstorm activity.
- Keep an eye on the sky. If the sky suddenly darkens, be prepared to take shelter.

## **After the Storm**

After the last rumble of thunder, wait 30 minutes before going outside.



## Topic 24. Lockout/Tagout

Lockout/tagout addresses the practices and procedures necessary to disable machinery or equipment, thereby preventing the release of hazardous energy while employees perform servicing and maintenance activities. The standard outlines measures for controlling hazardous energies such as electrical, mechanical, hydraulic, pneumatic, chemical, thermal, and other energy sources.



**Lock and tag.**

### Written Lockout Procedures

Each type of machine or equipment that uses or may store hazardous energy must have a written procedure, including:

- Statement of the intended use of the procedure.
- Steps for shutting down, isolating, blocking, and securing machines or equipment to control hazardous energy.
- Steps for the placement, removal, and transfer of lockout devices or tagout devices and the responsibility for them.
- Requirements for testing a machine or equipment to determine and verify the effectiveness of lockout devices, tagout devices, and other energy control measures.

Written procedures are not required for work on cord- and plug-connected electric equipment for which exposure to the hazards of unexpected energization or startup of the equipment is controlled by the unplugging of the equipment. However, the cord must be unplugged and the plug kept under the exclusive control of the employee performing the servicing or maintenance.

### Training

- Certified training is required for authorized employees and affected employees.
- All other employees whose work operations are or may be in an area where energy control procedures may be utilized must be instructed about the procedure, and about the prohibition relating to attempts to restart or reenergize machines or equipment that are locked out or tagged out.
- Retraining is required for authorized and affected employees when there is a change in:
  - Their job assignments.

- Machines, equipment, or processes that present a new hazard.
- The energy control procedures.

### **Periodic inspection**

A periodic inspection of the energy control procedure must be performed at least annually to ensure that the procedures and the requirements are being followed.

For more details, see

- SM 445-2-H Chapter 37—Lock Out/Tag Out Program.
- 29 CFR 1910.147, The control of hazardous energy (lockout/tagout).

## Topic 25. Mine Safety

The Mine Safety and Health Administration (MSHA) regulates the safety and health of mines.

- 30 CFR Part 46 applies to miners working at surface mines (shell dredging, sand, gravel, surface stone, surface clay, colloidal phosphate, surface limestone, marble, granite, sandstone, slate, shale, traprock, kaolin, cement, feldspar, and lime).
  - Government officials visiting a mine site are not required to receive Part 46 training.
  - However, MSHA expects those government agencies whose personnel visit mine sites will ensure that their employees are provided with appropriate personal protective equipment, and receive adequate instruction and training.
  - Where training is not provided, such government officials should be accompanied by an experienced miner.
- 30 CFR Part 48 applies to coal mines, underground metal and nonmetal mines, surface metal mines, and certain surface nonmetal mines that are not covered by Part 46. Employees working in a scientific capacity in an underground mine must:
  - Complete hazard training required by 30 CFR 48.11.
  - Be accompanied at all times while underground by an experienced miner, as defined in 30 CFR 48.2(b).

Government officials visiting a mine site are not required to receive Part 46 training. However, MSHA expects those government agencies whose personnel visit mine sites will ensure that their employees are provided with appropriate personal protective equipment and receive adequate instruction and training. Where training is not provided, such government officials should be accompanied by an experienced miner.

### Training

*Hazard training* must include the following instruction as applicable to assigned duties:

- Hazard recognition and avoidance.
- Emergency and evacuation procedures.

- Health and safety standards, safety rules, and safe working procedures.
- Use of self-rescue and respiratory devices, including:
  - Hands-on training in the complete donning of all types of self-contained self-rescue devices used at the mine, which includes assuming a donning position, opening the device, activating the device, inserting the mouthpiece, and putting on the nose clip.
  - Hands-on training in transferring between all applicable self-rescue devices.
- Other instruction as may be required by the MSHA District Manager based on circumstances and conditions at the mine.

Employees that perform scientific work in mines must receive the instruction required by this section at least once every 12 months.

Certificates of training must be maintained.

*Annual retraining.*—A minimum of 8 hours of annual refresher training is required. The annual refresher training program must include the following courses of instruction:

- Mandatory health and safety standards.
- Transportation controls and communication systems. Escape and emergency evacuation plans; fire warning and firefighting.
- Ground control; working in areas of high walls, water hazards, pits, and spoil banks; illumination and night work.
- First aid.
- Electrical hazards.
- Prevention of accidents.
- Health.
- Explosives.
- Self-rescue and respiratory devices.

## Conveyors

Think of a moving conveyor as something that could kill you. Serious injuries and death have resulted from items getting caught by a conveyor and pulling the miner into the pinch point between the



**Conveyor with pinch points.**

roller and the belting. Things you might not even think about get caught. The following are examples that have been mentioned in accident reports:

- Loose-fitting clothing.
- Long hair (including beards).
- Jewelry, such as chains and watches.
- Personal light cords and shoe strings.
- Air and water hoses, electric cables and extension cords.
- Tools, including pry bars, shovels, walking sticks, wrenches, hammers, hoes, brooms.

Here are a few things you can do to avoid conveyor accidents:

- Avoid wearing clothes like sweat suits and shirts or jackets with hoods. Band the ends of sleeves and pant legs.
- If you have long hair, "tuck it or cut it."
- Leave jewelry at home or in the change room.
- Be careful when moving hoses or cable from place to place—stay as far from the conveyor as possible.
- **NEVER ATTEMPT TO CLEAN MATERIAL OFF A MOVING ROLLER.**
- Virtually any tool, when it comes into contact with the conveyor, will be grabbed and you cannot react fast enough to let go.
- **NEVER POKE AROUND** a moving conveyor with any tool.
- When shoveling, make sure your shovel is not too long that it could get caught in a pinch point between the belting and an idler. Place shoveled material on the moving belt in the direction that would prevent the shovel from being wedged back into you if it contacts the belt.

## Mobile Equipment

When you dismount mobile equipment you become the pedestrian. Unless you are in a designated area for parking and dismounting your equipment, do not dismount. A person outside a mobile equipment cab is exposed to numerous hazards, including other mobile equipment, stockpile sloughing, and material falling from a loader bucket or off trucks or conveyor belts. Pedestrians should notify all equipment operators of their location at all times before they enter the operating area of the mobile equipment. **NEVER ASSUME**

## **YOU ARE IN THE VIEW OF THE OPERATOR. MAKE EYE CONTACT.**

### **Drill Entanglements**

Many accidents occur when employees come into contact with rotating drills. In some cases, the employees tried to manually thread drill steels on, unplug clogged suction hoses, or just got too close to the rotating steels when the accident occurred. Whatever the reason, these accidents can be avoided if you follow these best practices.

- Follow the manufacturer's procedures when adding drill steels.
- Never manually thread drill steels when the drill head is rotating.
- Do not wear loose fitting clothing when working around drills.
- Long hair that can become entangled must be tied back and close to the head.
- Never override or bypass the safety features on the equipment.
- Know where your emergency stop switches are and ensure they are functional.
- Provide safe routing of hoses and cables so they are not close to the rotation of the drill.
- Shut down the drill when making any repairs to the drill head.
- Make the drill operator aware of your presence when approaching.
- Provide adequate lighting at night when drilling.

### **Emergency—Seek Shelter**

If you are working in a mine that just experienced an emergency and you try but are unable to escape from the mine, **YOU MUST SEEK SHELTER.**

During your Emergency Evacuation training, you are taught to seek shelter inside of refuge alternatives and await rescue because **HELP IS ON THE WAY.** You are trained in the deployment and operation of the refuges in your mine. The refuge alternative is provided with enough breathable air, food, and water to sustain you for 96 hours. You should consider bringing the following additional items when you enter the refuge alternative:

- *Spare self-contained self rescuer (SCSR).*—The SCSRs may be needed if it becomes necessary to leave the safety of the refuge alternative.
- *Spare gas detectors.*—The refuge alternative is equipped with instruments to monitor the air inside and outside of the shelter. Extra detectors provide added monitoring, especially when monitoring the purging of the air lock during deployment and initial entry.
- *Spare cap lights.*—Extra lights provide additional lights inside the unit.
- *Medications.*—Each employee should bring enough medication, such as insulin, to last for at least 96 hours.

Other considerations:

- *Drinking water.*—The refuge alternative is stocked with enough water for 96 hours for all occupants.
- *Dinner buckets.*—After removing medications and other personnel items, dinner buckets may not be necessary since the refuge alternative is supplied with enough food necessary for all occupants.
- *Tools.*—The refuge alternative is provided with the tools necessary to make any repairs to the unit. **Tools hanging from belts have caused damage to the tent when employees entered the structure.** Remove mine belts before entering the refuge alternative.

## Miner in Distress

A “miner in distress” call feature is available on many communication and tracking systems, including portable radios carried by many miners. Employees have been injured, unable to summon help, and were not found for an extended time. This feature is designed to improve emergency response should an employee working alone or out of sight of others become incapacitated or entrapped and require immediate assistance.

For the “miner in distress” feature to work, the employee must be within a wireless coverage area. If an employee is carrying a handheld radio and is involved in an accident, there is a chance that the radio could be dropped and not be within arm’s reach. Police and firefighters position the activation button on a vest or in the chest area. The “miner in distress” feature is ineffective if the activation button is out of reach of the miner.

Once the system is deployed at a mine, training should be provided on the proper location of the activation button and how to respond to a “miner in distress” call.

## Roof Evaluation and Examination

Many roof and rib accidents occur during roof testing and scaling. To safely conduct a roof evaluation and examination, these practices should be followed:

- Know your immediate roof (from the roof control plan).
- Be aware of geological features in the area.
- Constantly observe and test the roof for adverse conditions.
- Always make a visual examination of the area before testing or scaling the roof. If hazardous conditions are observed, testing is not required.
- Wear safety glasses when sounding the roof.
- Keep all lines of communication open with all coworkers regarding adverse roof and rib conditions.
- When a hazard is observed, eliminate the condition as soon as possible; do not depend on others.
- If the roof or ribs are hazardous, support them or remove the hazard by pulling down the hazardous material.
- Always stand under the supported top when scaling and testing a roof.
- Use proper equipment, such as a scaling bar of sufficient length, when scaling roof. **(Pry Up, Not Down!)**
- To prevent hand injuries while using a scaling bar, one method is to slip a piece of water hose about halfway onto the bar; it is deflected away from the hands.
- Communicate with the roof bolter operator about the condition of the roof he or she has been drilling (so an adverse roof can be identified).
- Frequently use test hole information for roof evaluation.

## Extended Cuts

Follow these practices when mining extended cuts:

- Include extended cut procedures and precautions in the training plan. All affected persons should receive this instruction prior to beginning extended cut mining and in task training and annual refresher training.

- Do not go inby (within or inside) the last two rows of permanent support except for gas checks, and then only to the last row of bolts.
- Identify the next to last row of bolts by reflectors, lights, etc., to prevent persons from inadvertently going inby a supported top.
- Take extended cuts only in areas with competent roof conditions.
- Know and follow the roof control plan requirements for taking extended cuts, especially the maximum depth of the cut.
- Place a reference mark on the continuous miner to show when the maximum cut depth has been reached.
- Do not leave extended cuts standing unsupported for prolonged periods of time.
- Use additional roof supports within the last two rows of supports to prevent an unexpected fall from overriding these supports. These include extra bolts, planks, or straps.
- Wear reflective clothing as outer garments.
- Take shorter cuts when roof conditions are adverse.

Do not go inby the continuous miner operator except when required to operate the coal haulage equipment at the face.

- Be aware of the location of haulage equipment when they approach the continuous miner.
- Always be sure that everyone is in a safe location when starting the continuous miner.
- Do not position yourself anywhere beside the continuous miner during tramming operations. This should keep persons away from any possible pinch points.
- Ensure that all persons are beyond the continuous miner's turning radius during remote control tramming.
- Be aware that wet and muddy floor conditions, dips, and rolls can cause sudden, unexpected movement of any machine.
- Avoid visibility problems when tramming the miner.
- Don't set the remote control unit on the continuous miner while operating it.
- Ensure that all remote control continuous miners on the section are on separate frequencies. This applies to all remote control equipment on a section.

- Make sure any spare transmitter kept underground is in a secure location to avoid inadvertent operation.
- Take extra precautions when taking the first lift of a crosscut; operator position is critical.
- Ensure a crosscut is permanently supported (roof bolted) prior to taking a cut-in by or starting the proposed opposite crosscut. No work or travel is to be completed by an unsupported crosscut other than when required for safety exams.
- If a continuous miner breaks down inby permanent roof support, properly support the roof before repairs are made.
- Lock, tag out, and block all mining equipment before attempting repairs.

## Topic 26. Near, On, In, or Over Water

### Requirements

- Over-the-water training is required for employees working near, on, in, or over water.
- Personal floatation devices (PFDs) are required to be worn by employees working near, on, in, or over water unless a site-specific job hazard analysis (JHA) defines the conditions for an exception and details “equivalent measures” taken to mitigate the hazard(s).
- A properly fitting PFD must be worn when working near, on, in, or over water on a cableway, bridge, or water retention or control structure; on ice; in a boat; or wading in streams. For work conducted in a boat, U.S. Coast Guard approved PFDs must be worn.
- When working on bridges, near or over water, employees must wear high-visibility clothing that meets the current American National Standards Institute (ANSI) 107 standard for Class 3 apparel in addition to a PFD. A PFD with an ANSI Class 3 label meets this requirement.

### Exceptions

- In those cases where site-specific JHA defines the conditions for an exception, the JHA must be signed by the science center director and reviewed annually.
- Most exceptions to the PFD rule are for conditions in which wearing a PFD may create a greater hazard.
- Exceptions may apply for underwater diving operations and below deck on large vessels.

### Also see

- SM 445-2-H Chapter 15—Job Hazard Analyses.
- SM 445-2-H Chapter 26—Personal Protective Equipment.
- SM 445-2-H Chapter 28—Underwater Diving Safety.
- SM 445-2-H Chapter 31—Watercraft Safety for descriptions of selection and care of PFDs.



## Topic 27. Snorkeling and Free Diving

Breath-hold diving activities include snorkeling and free diving.

- Breath-hold diving is water immersion with a mask and a snorkel with or without fins, but with no pressurized gas supply. It occurs at underwater depths from zero to 30 feet.
- Snorkeling is water immersion that is surface focused. Vertical migration is limited to the body length of the snorkeler. Basically, a snorkeler breathes all the time.
- Free diving is water immersion in which vertical migration is greater than the length of the free diver to maximum depths of 30 feet. A free diver spends most of his time holding his breath because he is under water.



**Snorkeler.**

All breath-hold diving activities must adhere to the buddy system.

### Hazards

- **Hypothermia** is a condition in which the body's core temperature drops below the required temperature for normal metabolism and body functions, which is defined as 95.0 degrees Fahrenheit.
- **Cerebral hypoxia** is a reduced supply of oxygen to the brain.
- **Cerebral anoxia** is when the brain is completely deprived of oxygen.
- **Near drowning** is the survival of a drowning event involving unconsciousness or water inhalation, which can lead to serious secondary complications after the event.
- **Exhaustion** or fatigue is the transient inability of muscles to maintain optimal physical performance.
- **Shallow water blackout** is a loss of consciousness caused by cerebral hypoxia towards the end of a breath-hold dive in water typically shallower than 16 feet. It can be caused by taking several very deep breaths, or hyperventilating, just before a dive. Victims are often established practitioners of breath-hold diving, are fit, strong swimmers, and have not experienced problems before.

## Training

### *Beginner level.*

Employees must meet the following minimum requirements to participate in Bureau snorkeling activities in still or slow current waters:

- Hold current cardiopulmonary resuscitation (CPR) certification.
- Hold current first aid certification.
- Demonstrate to the employee's manager or the manager's designee the ability to do the following in a pool or confined water:
  - Clear a snorkel.
  - Clear a mask underwater.
  - Swim 250 yards on the surface in 10 minutes or less using mask, fins, and snorkel.
  - Using no swim aids, tread water for 5 minutes with hands, or for 2 minutes without the use of hands.
  - Demonstrate rescue techniques. Self-rescue techniques include the HELP position, cramp release, overcoming fatigue, and the ability to back float. Buddy-rescue techniques include towing another person of equal size a distance of 25 yards in the water without the use of swim aids.
- Demonstrate knowledge of the following via passing a written exam:
  - Breath-hold diving equipment.
  - Environmental conditions and hazards common to breath-hold diving, including shallow water blackout.
  - Physiological hazards (for example, hypothermia, hypoxia, anoxia, near drowning, exhaustion).
  - Breath-hold diving safe practices.
  - Emergency management.
- Obtain manager's authorization to participate in breath-hold diving activities based upon the completion of the requirements listed above.

### *Advanced level.*

- Certain environmental conditions may require more advanced training or skills beyond the beginner level requirements. Conditions will be evaluated on a site-specific basis.

- A job hazard analysis will be conducted and documented.
- Based on the job hazard analysis, employees must have additional training in order to safely proceed in the conditions identified.
- Conditions that may require advanced training include:
  - Swift currents.
  - Night operations.
  - Extreme air or water temperatures.
  - Strong currents or tides.
  - Working off of boats.
  - Hazardous wildlife.
  - Invasive species.
- Due to local conditions, the breath-hold diver may have to identify and be proficient in advanced rescue.

*Reauthorization.*—A breath-hold diver must

- Perform breath-hold diving activities within the previous 12 months, or
- Be reauthorized by the center manager after performing the pool practicals.

## Equipment

*Snorkeling Gear.*—Minimum equipment for snorkeling includes:

- Professional grade diving mask and snorkel.
- Fins or other appropriate foot protection such as wading boots.
- Apparel with adequate thermal protection.
- Cutting device (knife, scissors or line cutter). A line cutter is recommended.
- Inflatable swim vest if not using a wetsuit or drysuit.



**Inflatable swim vest.**

*Breath-hold diving gear.*—Minimum equipment for breath-hold divers includes:

- Professional grade mask and snorkel.
- Fins.

- Apparel with adequate thermal protection.
- Depth gauge.
- Cutting device (knife, scissors or line cutter).
- Inflatable swim vest if not using a wetsuit or drysuit.
- Timing device (optional).

*First aid kit.*—A first aid kit should include the following supplies:

- Gauze pads (at least 4 x 4 inches).
- Two large gauze pads (at least 8 x 10 inches).
- Box adhesive bandages (band-aids).
- One package gauze roller bandage at least 2 inches wide.
- Wound cleaning agent such as sealed moistened towelettes.
- Scissors.
- At least one blanket.
- Tweezers.
- Adhesive tape.
- Nitrile gloves.
- Resuscitation equipment such as resuscitation bag, airway, or pocket mask.
- Two elastic wraps.
- Splint.
- Directions for requesting emergency assistance.

*Dive flag.*—If breath-hold diving occurs in navigable waters, a diver flag will be displayed within 100 feet of the breath-hold activity.

## **Communication**

- A method for diver recall must be available.
  - Diver recall is used to contact a diver in the event of an emergency.
  - A diver recall method can be rapping on the hull of a boat, blowing a whistle or boat horn, an air-driven “squawker,” or any other type of audible signal that would be effective in the given environment.
- A means to contact emergency services must be available at locations where breath-hold diving is performed.

## Requirements

### *Depth.*

- Although breath diving may extend up to 30 feet in depth, the depth of a free dive must be limited by visibility in the water. A breath diver must be able to see his buddy.
- Drysuit training is required if the breath diver plans to wear a drysuit to free dive to a depth greater than 10 feet. Controlling the air inside a drysuit requires training and experience to prevent trapped air in the suit's legs forcing the diver to ascend feet first.

### *Documentation and reporting.*

- The manager must document that beginner level training requirements were met (written test and the in-water practicals), as well as any advanced training completed beyond the minimum requirements.
- The manager must review and either accept or reject a work plan prior to the initiation of breath-hold diving activities.
- Written plans must include the following. (See Breath-Hold Plan Form below.)
  - Breath-hold diver name.
  - Breath-hold diving certification level.
  - Estimated in-water time.
  - Anticipated depths.
  - Location of breath-hold dive sites.
  - Known or anticipated hazardous conditions.
  - Name, telephone number, and relationship of emergency contact person for each breath-hold diver.
  - Breath-hold diver recall methods.
  - Communication methods.
  - Available evacuation methods.
  - Nearest accessible hospital and the emergency room telephone number.
- A job hazard analysis must be completed for every project that includes breath diving. The job hazard analysis must address the project and site-specific risks prior to the project commencing, including existing hazards and potential risks.
- Report breath-hold diving accidents to the manager, as well documenting them in the Safety Management Information System.

- Maintain a copy of the current CPR and first aid certification.

*Solo breath-hold diving prohibition.*

- Solo breath-hold diving for any reason is strictly prohibited.
- A snorkeling team must be made up of no less than two persons that are both trained as snorkelers. A buddy pair may be comprised of one snorkeler in the water with a surface support person as long as that person can access and assist the snorkeler in an emergency situation.
- Two snorkelers may both be in the water at the same time and act as observer and assistant for each other if they remain close enough to render immediate assistance if necessary.
- A free diving team must be made up of no less than two persons who are both trained as free divers. While the first buddy team member dives, the second buddy will remain at the surface until the first diver returns to the surface.

*Refusal to breath-hold dive.*

- The decision to breath-hold dive is at the discretion of each individual breath-hold diver. Breath-hold divers may refuse to breath-hold dive, without fear of penalty, whenever the diver feels it is unsafe to breath-hold dive.
- While the employer has ultimate responsibility for safety in the workplace, divers are responsible for their own safety and share responsibility for the safety of their buddy. Part of this responsibility is the requirement to refuse to dive if in the diver's judgment:
  - Conditions are unsafe or unfavorable;
  - They are not in good physical or mental condition for diving; or
  - They would violate the dictates of their training or their agency regulations, policies, or procedures.
- Breath-hold divers are also responsible for:
  - Reporting any signs or symptoms of diving maladies to their manager;
  - Reporting any unsafe acts that could jeopardize their or their fellow divers' health and safety; and
  - Using and maintaining their diving equipment properly.

*Termination of breath-hold dive.*

- It is the responsibility of the breath-hold diver to terminate the breath-hold dive, without fear of penalty, whenever the

diver feels it is unsafe to continue the breath-hold dive, unless it compromises the safety of another breath-hold diver already in the water.

- Examples of such situations include:
  - Diver loses contact with buddy for more than 1 minute.
  - There is an equipment malfunction.
  - Changing conditions (such as weather or water) warrant dive termination.
  - An emergency diver recall is initiated.
- Surface support personnel identify a problem.

#### *Emergencies and deviations.*

- Any breath-hold diver may deviate from these requirements to the extent necessary to prevent or minimize a situation that is likely to cause death, serious physical harm, or major environmental damage.
- A written report of such actions must be submitted to the manager explaining the circumstances and justifications.

## **Procedures**

*Planning.*—At a minimum, pre-breath-hold diving must:

- Ensure project documentation is completed.
- Conduct a site evaluation and prepare a site-specific job hazard analysis.
- Hold a project briefing that outlines methods to be used, risks, communication pathways, and emergency procedures.
- Conduct gear check.
- Ensure breath-hold divers are fit to go into the water.
- Plan operations around the competency of the least experienced breath-hold diver.

#### *Post activities.*

- A post-activity debriefing must be conducted at the conclusion of each dive.
- At a minimum, debriefings must include:
  - Verify fitness of breath-hold divers.
  - Record hazards and problems that may assist in future project planning.

For more information on diving using compressed air/gases (SCUBA, supplied air or rebreathers), see SM 445-2-H Chapter 28—Underwater Diving Safety.

### Breath-Hold Plan Form

Project: \_\_\_\_\_

Location(s) of breath-hold dive sites: \_\_\_\_\_

Known or anticipated hazardous conditions: \_\_\_\_\_

Job hazard analysis completed? [ ] Yes [ ] No

Name of breath-hold diver	Level (beginner/advanced/special)

Estimated in-water time: \_\_\_\_\_

Anticipated depths: \_\_\_\_\_

Breath-hold diver recall method(s): \_\_\_\_\_

Communication method(s): \_\_\_\_\_

Available evacuation method(s): \_\_\_\_\_

Breath-hold diver	Emergency contact: name, telephone number, and relationship

Nearest accessible hospital: \_\_\_\_\_

Emergency room telephone number: \_\_\_\_\_

## Topic 28. Technical Information for the A-55 Reel Drag Brake

### Introduction

This is a drag brake for use with the USGS-type A-55 reel. The brake is designed to eliminate sounding-line overload if a sounding weight is snagged by large debris carried in a fast-moving flow. It can also be manually slipped to control the descent of a suspended load, eliminating the work of cranking the reel to lower the suspended instruments.

The drag brake consists of a crank and ratchet wheel assembly (with a drag brake built into the ratchet wheel housing) and a new ratchet pawl (figure 1; figures are at the end of this section). It is a bolt-on replacement for the existing A-55 crank handle, ratchet wheel, and ratchet-pawl assembly. The operator turns a collar to select a line tension at which the brake will slip. If that tension is reached, the brake will slip, maintaining the set amount of tension while allowing the line to pay out from the reel drum.

The drag brake is of the multi-disc type (figure 2). Cranking force from the operator is transmitted through the crank to the ratchet housing. If the ratchet pawl is engaged, holding torque from the ratchet pawl is transmitted to the ratchet teeth on the housing. There are two “keyway” slots cut into the bore of the housing. Inside the housing are several metal discs. Each metal disc has two tabs, or “keys” that engage the keyway slots in the bore of the housing. Torque is transmitted by the “keys” and “keyways” from the housing to the internal metal discs. The crank arm, ratchet housing, and metal discs always turn together.

Alternating with the metal discs are discs made of a hard fibrous “brake-pad” friction material. Each fiber disc has a square hole in the center that engages the square portion of the hub. The hub attaches to the reel axle shaft.

The fiber discs, the hub, the reel-axle shaft, and the reel drum always turn together.

The collar, acting through a Belleville-type dished-spring washer, presses the metal discs and the fiber discs together. Torque is transmitted between the metal and fiber discs using the friction of the disc surfaces. When the applied torque (from cable tension) is greater than the friction between the discs, the metal and fiber discs will slip. This

slippage appears to the operator as movement of the reel drum, cable, and axle relative to the crank handle and ratchet wheel.

Turning the adjustment collar adjusts the preload on the Belleville spring, and so adjusts the pressure that the spring applies to the discs, the friction between the discs, and the torque at which the brake slips. As the line tension is proportional to the torque, adjusting the slip torque also adjusts the line tension at which the disc slips.

Once the brake begins to slip, it holds a constant tension on the line while allowing the line to pay out.

Tightening the collar squeezes the discs against each other so that there is a friction resistance between the discs. The tighter the collar, the more clamping pressure and friction between the discs, and the more torque is needed to make the brake slip. This translates to more line tension before the brake slips.

Loosening the collar reduces the clamping pressure, which reduces the friction between the discs, and the line tension at which the brake will slip.

Completely loosening the adjusting collar eliminates the clamping pressure on the discs. With no clamping pressure, there is very little friction between the discs, and the hub and fiber discs are free to rotate within the housing. This allows the reel shaft and drum to rotate freely even though the crank and ratchet housing are stationary.

## **Initial Installation**

*Unpack and identify installation kit components.*—The list numbers below correspond to the diagram numbers in figure 3. Some items are shown in two views. The kit to install the Drag Brake to the A-55 reel consists of:

1. Bearing-retainer plate.
2. Crank-arm, ratchet-wheel housing and brake assembly.
3. 5/16-inch diameter by 1-1/2 inch long coarse-thread wingbolt with nylon collar to retain the drag brake.
4. Detachable crank handle.
5. 1/2-inch coarse-thread wingnut to retain the crank handle.
6. 3/8-inch-diameter by 2-inch-long fine-thread hex-head bolt (used as a level wind pivot to retain plunger bracket).
7. Ball-plunger bracket assembly (bracket, ball plunger, and lock-nut).
8. 3/8-inch fine-thread hex nut.

9. Pawl anchor stud.
10. Pawl return spring.
11. Ratchet pawl.
12. 5/16-inch by 1/2-inch long coarse-thread slotted-head screw, to retain the pawl.
  - A small tube of “Loctite” retaining compound (not shown).
  - A small tube of grease for the threaded collar (not shown).

*Remove the existing ratchet assembly.*

- Remove the existing crank from the reel axle, if installed.
- Unbolt and remove the existing ratchet pawl (the brass “finger” that engages the teeth on the ratchet wheel) and pawl spring from the reel. Unhook the pawl spring from the brass stud that serves as the spring anchor, then remove the hex nut (inside the reel frame) from the pawl anchor stud and unscrew the pawl anchor stud from the threaded hole in the frame.
- Loosen the set screw in the existing brass ratchet wheel and remove the ratchet wheel, shaft key, and shaft spacer from the reel axle shaft. Removing the brass ratchet wheel exposes the right-hand-side axle bearing retainer plate.

*Replace the bearing retainer plate.*

- Remove the four flathead screws that secure the bearing retainer plate, and remove the plate from the reel frame (figure 4).
- Install the new bearing retainer plate to the reel, using the four flathead screws from the old retainer plate. (The new retainer plate has a larger hole through its center than the old one.)

*Replace the spring anchor and anti-backlash roller pivot.*

- Remove the hex nut, outside of the reel frame, from the brass stud that is used as the ratchet pawl spring anchor.
- Turn the reel upside down. You will see that the brass stud used for the spring anchor is also used as the pivot pin for one of the arms for the anti-backlash roller. Unscrew and remove the brass stud in the direction toward the center of the reel.
- Install the 3/8-inch-diameter by 2-inch-long fine-thread hex-head bolt from the kit in place of the brass stud. Insert the

bolt from the direction of the center of the reel, through the hole in the arm of the anti-backlash roller, through the roller torsion spring, and screw it into and through the threaded hole in the side of the reel housing until it extends about 1/2 inch beyond the outside of the reel housing.

- Check that the anti-backlash roller pivots freely on the bolt.
- Turn the reel right-side-up.

*Install the new ratchet pawl assembly (see figs. 4 and 5).*

- Place the ball-plunger bracket over the end of the 3/8-inch bolt that replaces the brass stud.
- Install the threaded end of the pawl anchor stud through the ball-plunger bracket and into the 1/2-inch threaded hole in the reel housing from which the old pawl anchor bolt was removed.
- Install the 3/8-inch fine-thread hex nut to the end of the 3/8-inch bolt.
- Tighten the pawl anchor stud and the 3/8-inch hex nut securely.
- Install the new pawl and pawl spring to the pawl anchor (figure 5).
- When installed, the coils of the pawl spring go around the hex portion of the pawl anchor stud. The hook on the long end of the spring goes around the arm of the pawl, and the hook on the short end of the spring goes under the head of the small screw welded into the ball-plunger bracket (fig. 5).
- Check that the pawl can rotate freely within its range of movement on the pawl anchor. The spring should easily raise the pawl lever until the lever contacts the rim of the reel drum.
- Install the 5/16-inch by 1/2-inch-long coarse-thread slotted screw into the end of the pawl anchor to secure the pawl.
- Check that the pawl can still rotate freely within its range of movement on the pawl anchor. If it does not rotate freely, remove the screw, remove the pawl, check for burrs on the mating surfaces, and smooth them with a fine-tooth file.
- Reinstall the screw and check again to make sure that the pawl can rotate freely.
- Remove the slotted screw from the pawl anchor. Apply a drop or two of Loctite to the threads of the screw. Reinstall

the screw into the end of the pawl anchor stud and tighten securely.

*Adjust the pawl disengagement ball plunger.*

- Adjust the ball plunger (in the plunger bracket) that retains the pawl in the “disengaged” position. Loosen the 1/4-inch locknut on the ball plunger (figure 6) slightly and insert a small straight-blade screwdriver into the slot on the end of the ball plunger, then turn the plunger to screw it in or out of the bracket until the spring-loaded ball in the end of the plunger contacts the lip of the pawl with enough force to hold the pawl in the disengaged position.
- Adjust the plunger position for the desired amount of force needed to move the pawl between the “engaged” and “disengaged” positions.
- Hold the plunger in position as you retighten the 1/4-inch hex nut on the threaded body of the plunger to lock the plunger in position.

*Fit the drag brake assembly to the reel axle shaft.*

- Inspect the reel axle shaft (fig. 7) for any raised areas or burrs. Use a fine-tooth flat file to smooth down any raised areas or burrs that you find.
- Latch the pawl in the “disengaged” position.
- Check the fit of the brake assembly (the brake crank arm and ratchet wheel with its internal drag brake) on the reel axle shaft (without the key) by sliding the brake onto the axle. It should slide on easily, without excessive effort. If it does not slide on easily, carefully inspect the shaft for and remove any dirt, varnish, or additional raised areas or burrs.
- Double-check that the brake assembly can easily slide on and off the reel axle shaft.
- Make sure that the keyway on the shaft is clean, and that the shaft key is also clean and does not have any raised burrs.
- Make sure the key will slide freely into the keyway in the bore of the brake hub. If it does not fit freely, check for raised areas or burrs on the key, and remove them with a fine-tooth flat file.
- Check the fit of the shaft key into the reel axle shaft keyway (tight or loose), then install the key to the axle shaft using the appropriate procedure as follows:

- Installing a tight-fitting shaft key to the reel axle shaft (fig. 7).
  - If the key is a tight fit in the keyway, (tight enough so that you have to press-fit it into place and it will not fall out during shipping and handling with the brake removed).
  - Make sure the key is straight in the keyway, pad the key and the shaft with pieces of hard wood or hard plastic to avoid burring or distorting the shaft or the key, and press the key all the way to the bottom of the groove with a large pair of vise grip pliers, a bench vise, C-clamp, or similar tool. An alternate method is to use a small hammer (and a piece of hard wood or hard plastic against the key as a driver to prevent distorting the key) to drive the key all the way down to the bottom of the keyway.
  - The end of the key should remain approximately flush with the end of the reel axle shaft. Check that the key is bottomed all the way into the keyway for its entire length.
- Installing and retaining a loose-fitting key to the axle shaft (fig. 7).
  - If the key is a loose fit in the shaft keyway, such that the key may fall out during handling with the brake assembly removed, then remove the key from the axle keyway.
  - Clean the keyway and key with solvent to remove any dirt, grit, varnish, or film of oil or grease.
  - Apply Loctite to the shaft keyway, then rein stall the key to the reel shaft. Pad the shaft and key with a couple of pieces of wood, plastic, or wrap a cloth around the shaft and key, then use a C-clamp or a pair of Vise-Grip pliers to clamp the key completely down into the bottom of the keyway. Make sure that the key is bottomed completely in the keyway for its entire length. The end of the key should be approximately flush with the end of the reel axle shaft.
  - Allow sufficient time for the Loctite down in the joint to completely cure (perhaps a couple of hours in warm

weather, or overnight in cool weather) then remove the clamp and remove any excess Loctite from the key and keyway outside the joint. (Loctite will harden inside a close-fitting joint, but will remain liquid when exposed to air.)

- Check the fit of the brake assembly to the axle shaft key.
  - Rotate the brake assembly so that the keyway in the brake hub lines up with the key installed to the reel axle shaft. Check that the brake assembly can slide onto the shaft and key fairly easily, without excessive effort. As the brake has already been checked that it can fit freely onto the bare shaft, any problem installing the brake at this point should be due to interference between the brake and the shaft key.
  - Carefully inspect the keyway in the brake hub and the key installed to the shaft for raised areas, burrs, or other causes of interference. Remove any raised areas or burrs with a fine-tooth file. After making sure that the brake slides easily on and off the reel axle shaft, remove the brake from the reel axle.
  - Double check that the brake assembly will easily slide on and off the reel axle shaft.
  - Check that the key is secure and cannot fall out of the shaft keyway. (If the key falls out and is lost, the reel is out of service until you obtain a new key.)

### *Assembly for service.*

**Note:** The Drag Brake Assembly has to be removed from the A-55 reel, and the handle has to be removed from the crank arm on the Drag Brake Assembly in order to fit all the parts into the steel A-55 shipping box.

- Press the pawl handle down until the pawl latches in the “disengaged” position.
- Slide the brake assembly, consisting of the crank handle and ratchet housing with its internal parts, onto the reel shaft all the way until it contacts the axle bearing.
- Install the 5/16-inch coarse-thread wing bolt with its nylon collar into the threaded hole in the end of the reel axle shaft,

and tighten it firmly to secure the brake assembly onto the reel axle shaft.

- Install the crank handle to the end of the crank arm by inserting the threaded end of the handle pin into the arm until the square boss on the bushing engages the square hole in the arm.
- Install the 1/2-inch wing nut onto the protruding threaded part of the handle pin and tighten it against the arm to secure the handle to the crank arm.

## Operation

Normal operation of the A-55 reel with the drag brake is similar to using the reel without the drag brake, with the following changes:

- Adjust the collar on the drag-brake until the brake slips at the approximate desired line tension. This can be easily varied from near zero to a tension of well over 100 pounds line pull by turning the collar by hand. If the operator wants to set the slip tension at a greater value, the collar can be tightened further with a large pair of Channel-lock pliers; however, be sure to pad the collar with a rag so that you do not put a burr on the knurled collar, and use care that you do not distort the collar.
- Some users may wish to use the brake for a controlled descent of the sounding weight. To do this, tighten the collar by hand until the brake transmits just enough torque to pick up the sounding weight. Use the reel to pick up the weight, position the weight for descent, then loosen the collar enough for the brake to slip and the weight to descend. Tighten the collar to slow and stop the weight's fall.
- The new pawl handle extends around to the back of the reel so that the operator does not have to insert his/her fingers between the reel body and the crank arm to engage or disengage the ratchet.
- Rotate the crank arm to raise the weight a bit and relieve the pressure on the pawl, then press the pawl lever down to disengage the ratchet. There is a ball-plunger to retain the ratchet pawl in the disengaged position. Push the handle down until you feel the pawl pop past the spring-loaded ball in the plunger, and the ratchet pawl should stay disengaged.
- To re-engage the ratchet, lift the lever to pop the pawl past the spring-loaded ball on the plunger. From there, the pawl

spring should raise the handle and keep the ratchet pawl engaged.

- If the ball plunger does not properly hold or release the pawl, loosen the locking nut on the ball plunger and screw the plunger in or out to adjust the force needed to “pop” the edge of the pawl past the plunger ball.

## Maintenance

**IMPORTANT**—Occasionally apply a thin film of grease to the screw threads where the collar attaches to the ratchet housing. Both parts are aluminum to save weight, and grease is needed to prevent the aluminum-on-aluminum threads from galling and seizing, which will ruin both parts. To do this,

- Unscrew and remove the threaded collar from the housing,
- Apply a thin film of regular No. 2 grease (the same type used in a typical grease gun) to the threads of the collar, making sure that the grease is applied all the way down into the threads, and
- Carefully reassemble the collar to the housing.
- Please read the following notice! The collar threads are a very fine pitch to give a large amount of clamping force (and braking action) for the degree of hand tightening on the collar.
- The best way to start the threaded collar back into the housing is to gently hold it in position against the housing, then slowly turn it in the direction to loosen it until you feel a slight “pop” as the ends of the threads pass each other. Stop, then turn the collar gently in the direction to tighten it into the housing, and the threads should engage with no problem. Be careful that you do not get a “false start” as the end of the thread on the collar passes the two large “keyways” cut into the bore of the housing. If you cross-thread the collar in the housing, you can easily damage the threads, making it very difficult to reassemble.
- Do not allow the grease to contaminate the brake disc friction surfaces inside the drag brake housing. Occasionally squirt a small amount of oil into the oil hole (figure 5) in the ratchet pawl to lubricate the pawl as it rotates on the anchor stud.

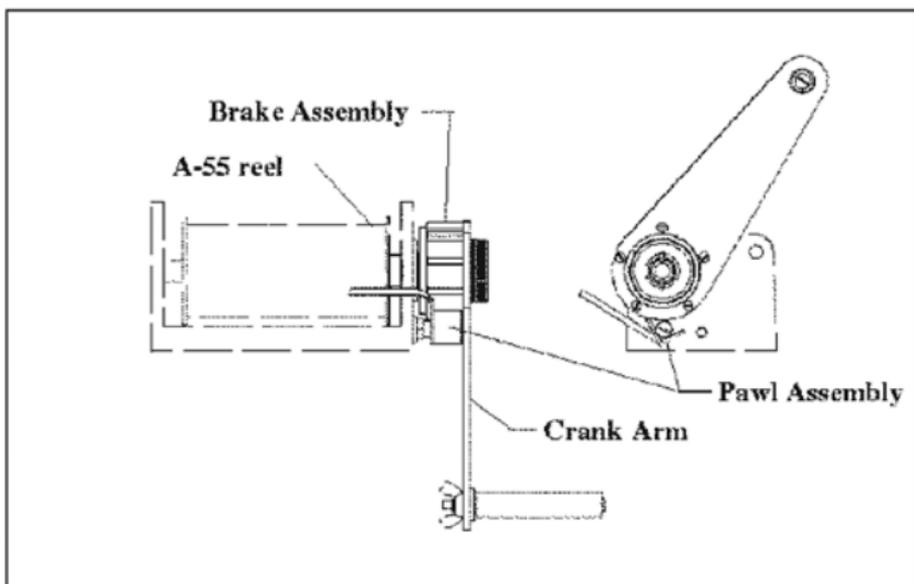


Figure 1. Drag brake.

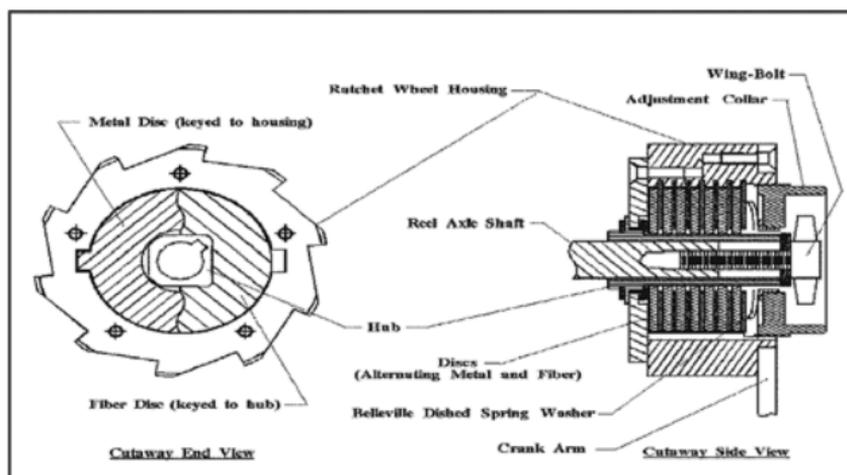
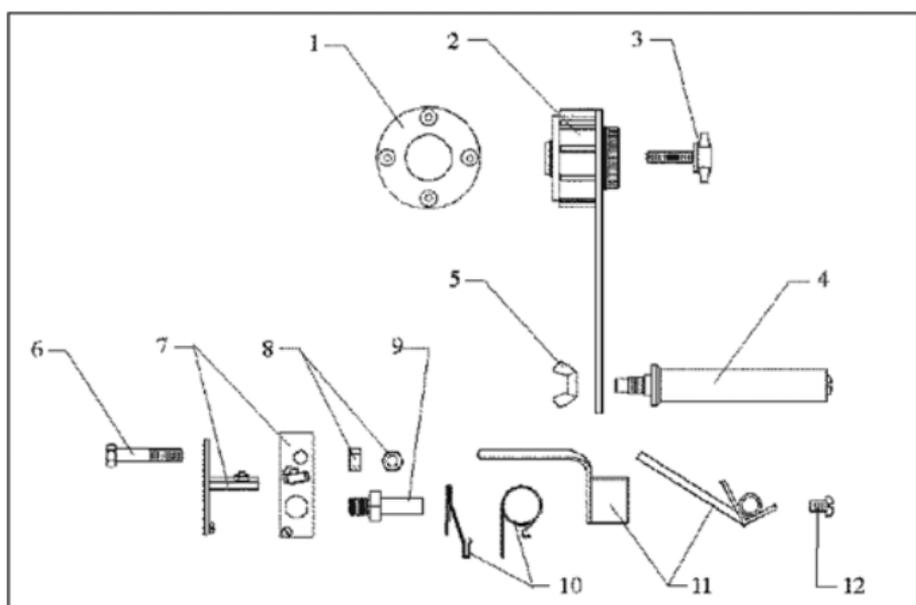
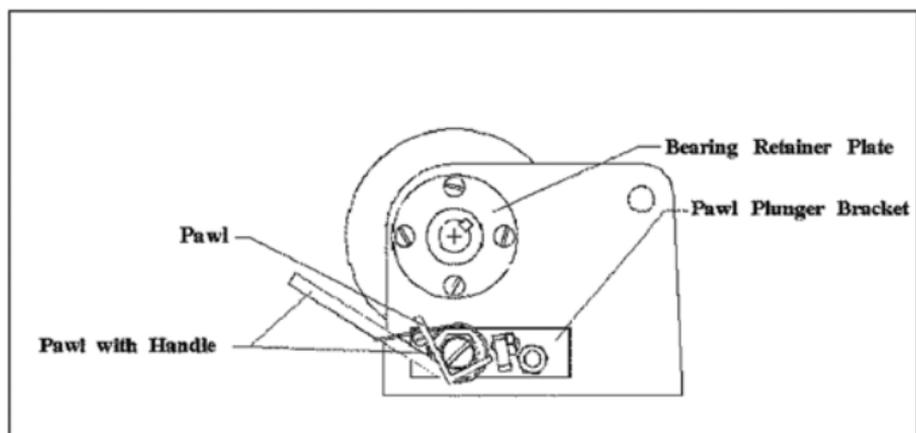


Figure 2. Brake internal parts.



**Figure 3.** Kit parts.



**Figure 4.** Pawl assembly on reel.

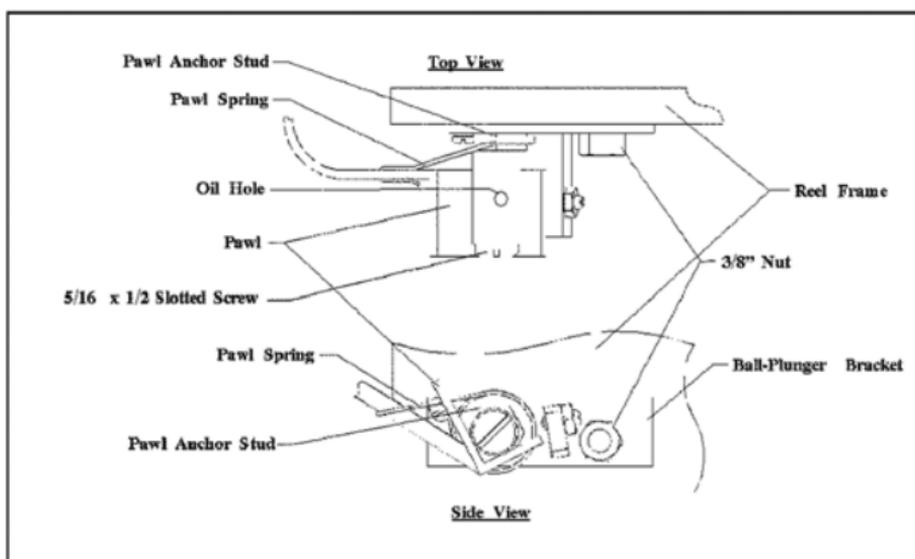


Figure 5. Pawl assembly details.

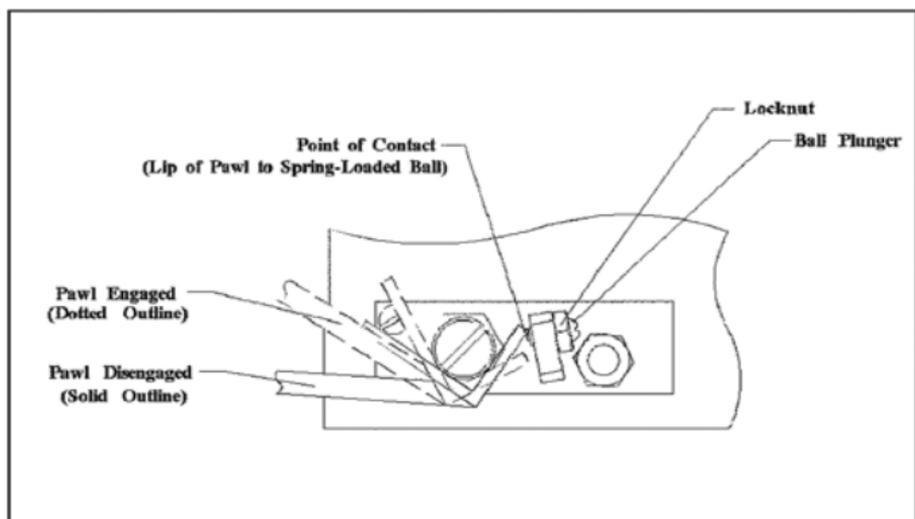
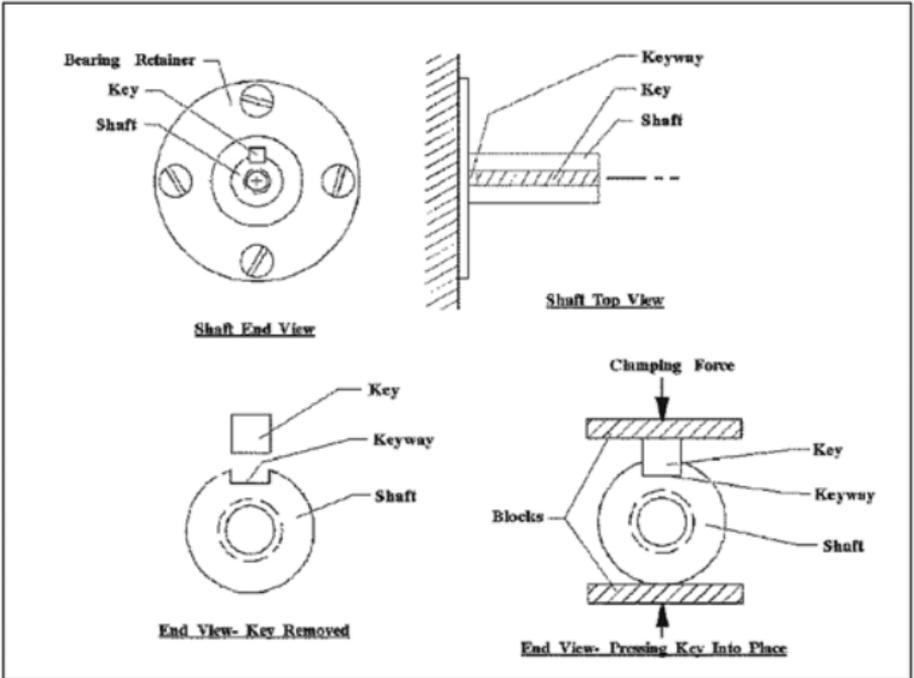
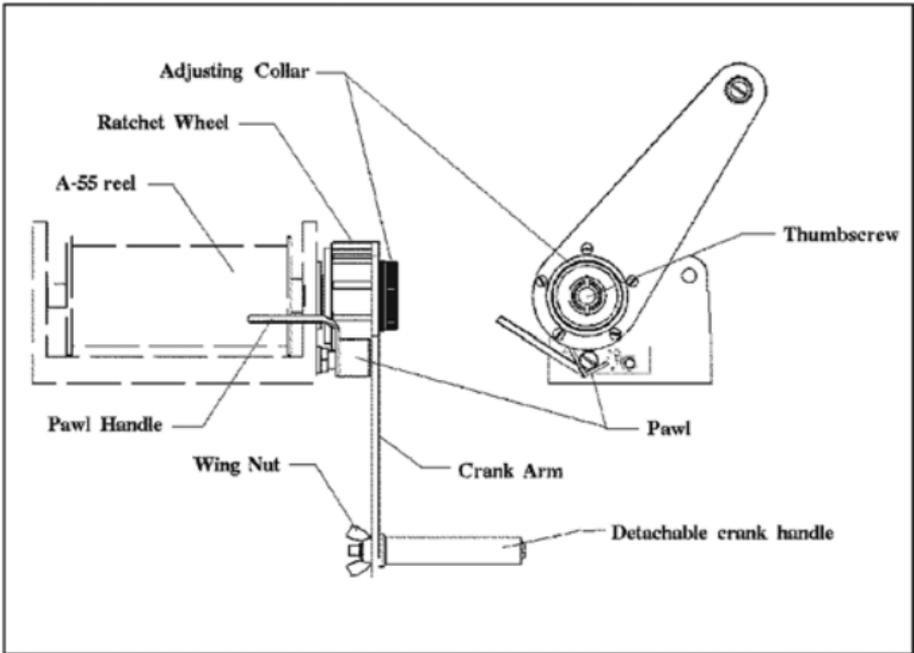


Figure 6. Adjusting the ball plunger.



**Figure 7.** Reed axle shaft and key.



**Figure 8.** Drag brake external parts.



## Topic 29. Welding

Welding is a joining process in which metals, or sometimes plastics, are heated, melted, and mixed to produce a joint with properties similar to those of the materials being joined. Three main components are needed to create a weld. These are:



**Welder.**

- A heat source such as an electric arc, a flame, pressure, or friction. The most common heat source is an electric arc. An arc is the physical gap between the end of the electrode and the base metal. The physical gap causes heat due to resistance of current flow and arc rays. The arc melts the metals to create the joint.
- Shielding, which is the use of gas, or another substance to protect the weld from air as the weld is being formed. Oxygen from the air makes welds brittle and porous.
- Filler material, which is the material used to join the two pieces together.

Other processes that join metals together include:

- Brazing, which is the joining of metals with a filler metal having a melting point above 842 degrees Fahrenheit, but below the melting point of base metals.
- Soldering, which is the joining of metals using a filler metal with a melting point below 842 degrees Fahrenheit. The joined metals can be different metals. The filler metals commonly used in soldering are lead-tin alloys. (This process is not included in this section.)

Metals can be cut or separated by a flame or an electric arc, or removed by “gouging” with an electric arc.

### Welding Processes

Some of the more common welding processes are:

- Shielded Metal Arc Welding (SMAW), also known as Manual Metal Arc Welding, MMAW.
- Gas Tungsten Arc Welding (GTAW) or Tungsten Inert Gas (TIG) Welding.
- Flux Cored Arc Welding (FCAW).

- Gas Metal Arc Welding (GMAW), also known as Metal Inert Gas (MIG) Welding or hard wire welding.
- Plasma Arc Welding (PAW), Plasma Arc Cutting (PAC), and Gouging.
- Submerged Arc Welding (SAW).
- Resistance Welding (RW) or spot welding.
- Air Carbon Arc Cutting and Gouging.
- Oxyfuel Welding, Cutting and Heating (oxygen-acetylene [oxyacetylene] or oxygen-propane [oxy-propane] mixtures are the most common fuel mixtures used).

## Hazards

Welding hazards include: fires, explosions, burns, electric shock, toxic fumes and gases, hearing loss, ultraviolet light injuries and illnesses, ergonomic stressors due to awkward positions and repetitive motions, heat stress, foreign particles in eyes, cuts, crushed feet and hands, head injuries, slips and trips on welding rods and other materials on the floor, and falls from higher levels.

## Personal Protective Equipment

- *Head.*—Cover your head with a fabric cap to protect the scalp from ultraviolet light radiation and to prevent hair from catching on fire. A hard hat may be required for overhead hazards.
- *Eyes and face.*—The welding process produces ultraviolet light, which can cause conjunctivitis, an inflammation of the mucous membrane of the front of the eye, also called “arc eye,” “welders’ eye” or “arc flash.” Long-term exposure to ultraviolet light can produce cataracts. A welding helmet or welding goggles must be worn by the welder and any helper to protect from ultraviolet light. The type and the shade number of the helmet or goggles depend on the welding process, the type of base material, and the thickness of the base material. An auto darkening welding helmet takes the guesswork out of selecting the right shade number and generally improves the quality of welds. Safety glasses or goggles must be worn under a welding helmet to protect from flying debris when slag is cleaned.
- *Ears.*—Ear muffs or ear plugs may be required for noisy work, especially for carbon arc cutting and gouging. Use fire resistant ear plugs where sparks or splatter may enter the ear.

- *Hands*.—Wear welding gloves to protect against heat, burns, fire, and electric shock.
- *Skin*.—Wear fire/flame resistant clothing to protect against heat, burns, and ultraviolet light. Wear long pants that have no cuffs. Wear long-sleeved shirts with flaps over the pockets or tape the pockets closed. Keep the fabrics clean and free of combustible materials that could be ignited by a spark.
- *Feet*.—Safety shoes or boots with insulated soles must be worn. Laces should be covered to prevent sparks or splatter from entering.
- *Lungs*.—Respirators may be required depending on the base metals, fillers, coatings, nearby chemicals, and ventilation. If a respirator is required, it is recommended that a powered air purifying respirator or a supplied air respirator with a vortex to reduce the risk of heat stress. (See additional requirements for use of respirators in SM 445-2-H Chapter 18—Respiratory Protection Program.)

## General Rules

- Employees and contractors who perform welding operations must be trained in the operation, maintenance, hazards, and controls of the equipment and process to be used.
- Before welding, verify hot work is safe. (See the section on Hot Work.)
- Store, transport, and use compressed gas cylinders safely. (See the section on Compressed Gases.)
- Do not wear rings or other jewelry.
- Do not wear clothing made from synthetic or synthetic blends. Synthetic fabrics can burn vigorously and melt into your skin, causing severe burns.
- Avoid standing in water, on wet surfaces, or working with wet hands or wearing sweaty garments. Changing into dry clothes could save your life.
- Small shocks could surprise you and cause you to slip and fall, possibly from a high place.
- Welding activities should be performed in well ventilated areas and away from flammable and combustible materials.

- If welding must be performed in a confined or enclosed space, the following requirements apply:
  - The space must be classified as a permit-required confined space.
  - A trained permit-required confined space entry supervisor must evaluate the space, identify conditions for entry, and sign the permit.
  - Entrants must be trained in permit-required confined space entry.
  - A trained permit-required confined space attendant must monitor the space during the entry. Atmospheric conditions will change quickly during a welding operation in a confined or enclosed space.
  - If forced ventilation is not used during the welding operation, then a supplied air respirator must be worn.
  - A retrieval system must be used in the event of an emergency for non-entry rescue unless its use would create a greater hazard. An example of a retrieval system is a retrieval line, full-body harness, and a lifting device.
  - Rescue and emergency services for permit-required confined spaces must be either standing by or can be summoned to arrive within 10 minutes.
- Keep sparks and flames away from cylinders and hose lines. All flammable or explosive material in the areas of welding operations must be removed.
- Keep the correct type of fire-extinguishing equipment easily accessible at all times during any welding operation.
- Before cutting into tanks or drums:
  - Determine the present or previous contents.
  - Drain, steam clean, and thoroughly dry if they held oil, gasoline, or other highly flammable fluids. Fill with water up to the point to be welded.
  - Leave an opening for steam generated during welding to escape. If you do not leave an opening, the container will EXPLODE.
- If possible, use point-of-operation exhaust ventilation when welding on metals containing, or coated with, paint or other coatings that contain lead, cadmium, arsenic, or zinc, or when welding brass. Fumes from these metals are toxic. Adequate exhaust systems must be provided to ensure

removal of injurious fumes and gases. If adequate ventilation is not available, a supplied air respirator must be worn.

- Remove coatings from the weld area to minimize the fume. The removal of coating will also improve weld quality.
- Use wet slurry vacuum removal techniques for removing very toxic coatings.
- Do not grind coatings. Grinding dust may be toxic.
- Inspect hose lines and/or power cables frequently. Replace or repair damaged items.
- Curtains or screens must be used around all welding areas where it is possible for employees, contractors, or the public to view the arc.
- Avoid awkward body positions that cause fatigue, reduce concentration, and lead to poor welds, which may need to be repeated.
- Use your hand to lower your helmet. Do not use a “jerking” motion of your neck and head.
- Position yourself in a stable, comfortable posture with the welding item as flat as possible, on a horizontal surface, between waist and elbow height.
- Store materials and tools within normal reach.
- Use positioning aids to accommodate work posture.
- Select matt finishes for welding area to avoid reflection of welding arc light and to obtain a satisfactory level of lighting.
- Choose any color except blue or turquoise. They reflect ultraviolet light.

For more details, see 29 CFR 1910 Subpart Q, Welding, Cutting, and Brazing.



## Topic 30. Work Zones

Transportation incidents and employees struck by vehicles or mobile equipment account for the highest number of fatal work injuries, according to the Bureau of Labor Statistics. Work zones are used to move traffic in an approved direction and are typically identified by signs, cones, barrels, and barriers.

There must be a traffic control plan for the movement of vehicles in areas where employees are conducting other tasks. Drivers, employees on foot, and pedestrians must be able to see and understand the routes they are to follow. The authority in charge, Federal, State, or local, will determine the configuration of the temporary traffic control zone for motorists and pedestrians. When several projects are involved, coordinated vehicle routes and communication will reduce vehicular struck-by incidents.

### Signs

Standard highway signs for information, speed limits, and work zones will assist drivers in identifying, in designated traffic paths, such directives as: REDUCED SPEED AHEAD and ROAD CLOSED. Using standard highway signs for internal construction worksite traffic control will assist employees in recognizing the route they are to use at the construction site.

### Traffic Control Devices

Standard traffic control devices, signals, and message boards will instruct drivers to follow a path away from where work is being done. The authority in charge will determine the approved traffic control devices such as cones, barrels, barricades, and delineator posts that will be used as part of the traffic control plan. These standard devices should also be used inside the work zone.

### Work Zone Protections

Various styles of concrete, water, sand, collapsible barriers, crash cushions, and truck-mounted attenuators are available to limit motorist intrusions into the construction work zone.

### Flagging

Flaggers and others providing temporary traffic control must wear high-visibility clothing as described in the Personal Protective Equipment topic. This personal protective equipment will make the

employee visible for at least 1,000 feet so that the employee can be seen from any direction and make the employee stand out from the background. Drivers must be warned in advance with signs that there will be a flagger ahead. Flaggers should use STOP/SLOW paddles, paddles with lights, or flags. (Flags should be used only in emergencies.) The STOP sign should be octagonal with a red background and white letters and border. The SLOW sign is the same shape, with an orange background and black letters and a border.

## **Lighting**

Flagger stations should be illuminated. Lighting for employees on foot and equipment operators is to be at least 5 foot-candles or greater. Where available lighting is not sufficient, flares or chemical lighting should be used. Glare affecting employees and motorists should be controlled or eliminated.

## **Training**

Flaggers must be trained and use the signaling methods required by the authority in charge. Employees on foot, equipment operators, and drivers in internal work zones need to know the routes that vehicles will use. Equipment operators and signal persons need to know the hand signals used on the worksite. Operators and employees on foot need to know the visibility limits and the “blind spots” for each vehicle onsite. Employees on foot must wear high-visibility safety garments as described in the Personal Protective Equipment topic. Employees should be made aware of the ways in which shiftwork and night work may affect their performance.

## **Driving**

Seat belts and rollover protection must be used on equipment, if available.

## Typical Diagrams for Work Zones and Meaning of Symbols.

	Arrow panel
	Arrow panel support of trailer (shown facing down)
	Changeable message sign or support trailer
	Channelizing devices
	Crash cushion
	Direction of temporary traffic detour
	Direction of traffic
	Flagger
	High-level warning device (flag tree)
	Luminaire
	Pavement markings that should be removed for a long-term project
	Sign (shown facing left)
	Surveyor
	Temporary barrier
	Temporary barrier with warning lights
	Traffic or pedestrian signal
	Truck-mounted attenuator
	Type III barricade
	Warning lights
	Work space
	Work vehicle

### Example of short-duration work zone or mobile operation on shoulder of road:

