Plumbing Safety

Overview

Unsafe acts and unsafe conditions lead to accidents, and while they may result in death or personal injury, accidents also cost companies time and money. The majority of accidents, however, can and should be prevented. There are many important safety measures that help plumbers remain safe on the job site.

Module 02102

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02102 V4.5

02102
Plumbing Safety

Objectives

Successful completion of this module prepares trainees to:

1. Describe the causes and impacts of accidents.
   a. Identify the causes of accidents.
   b. Describe the costs and impacts of accidents.
2. Identify methods for preventing accidents.
   a. Explain the purpose of various types of personal protective equipment in preventing accidents.
   b. Explain the role of hazard communication in preventing accidents.
   c. Identify methods used to establish work zone safety.
3. Identify the safety precautions required when using hand and power tools.
   a. Describe the safety precautions associated with hand tools.
   b. Describe the safety precautions associated with power tools.
4. Identify the safety precautions associated with various work areas.
   a. Describe the safety precautions associated with work in trenches.
   b. Describe the safety precautions associated with confined spaces.
   c. Identify the safety precautions associated with underground work.
   d. Demonstrate a lockout/tagout procedure.
   e. Describe jobsite safeguards and emergency response procedures.

Performance Tasks

Under the supervision of your instructor, you should be able to do the following:

1. Inspect the following personal protective equipment:
   - Gloves
   - Body harness
   - Hard hat
   - Safety glasses
   - Safety shoes
   - Hearing protection
2. Put on the following personal protective equipment:
   - Hard hat
   - Body harness
   - Eye protection
   - Gloves
   - Hearing protection
   - Safety shoes
3. Demonstrate proper use of ladders.
4. Inspect power tools (corded and cordless) to ensure they are safe to use.
5. Inspect hand tools to ensure they are safe to use.
6. Demonstrate/simulate the proper methods of lockout/tagout for energy sources.

Trade Terms

Apparatus
Asbestos
Atmospheric hazards
Benching
Bladed tools
Combustible
Competent person
Confined spaces
Decibels (dB)
Electrically powered tools
Energy-isolating device
Energy sources
Fire watch
Gassy operations
Guards
Guy wires
Hazard Communication (HazCom) Standard
Hypothermia
Impact tools
Liquid-fuel tools
Lockout
Lockout devices
Lockout/tagout procedures
NFPA warning diamond
Nonpermit-required confined space
Occupational Safety and Health Administration (OSHA)
Oxygen-deficient atmosphere
Oxygen-enriched atmosphere
Permit-required confined space
Power tools
Protective system
Safety data sheet (SDS)
Shoring
Subsidence
Tagout devices
Trench shields

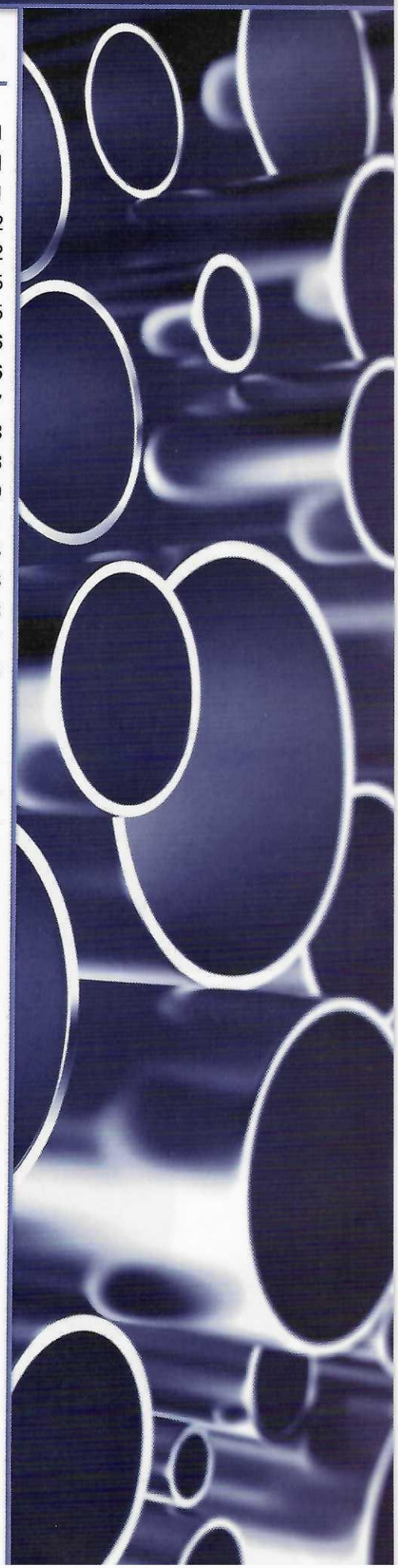
Industry Recognized Credentials

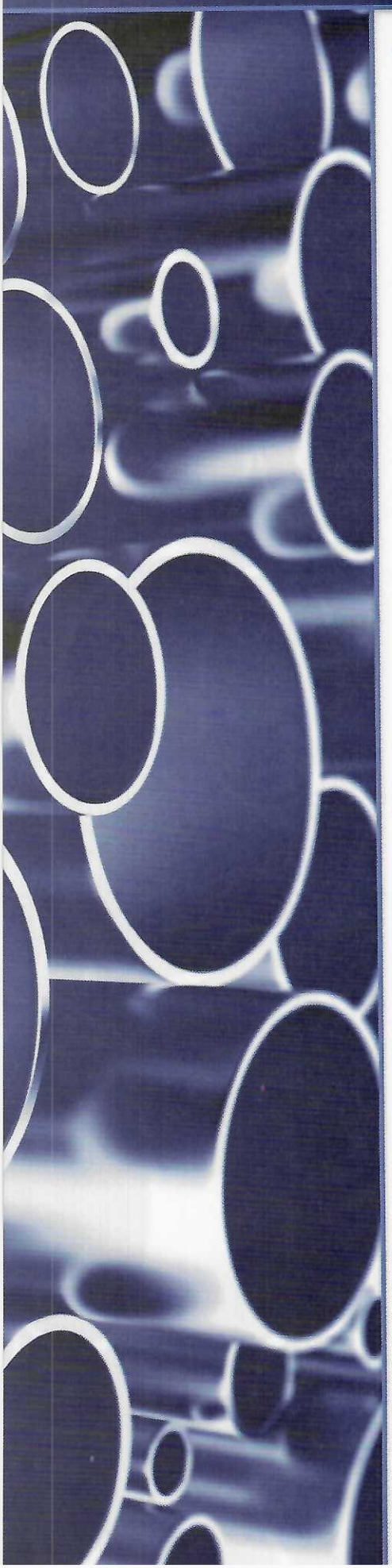
If you're training through an NCCER-accredited sponsor you may be eligible for credentials from NCCER's Registry. The ID number for this module is 02102. Note that this module may have been used in other NCCER curricula and may apply to other level completions. Contact NCCER's Registry at 888.622.3720 or go to *www.nccer.org* for more information.

CODE NOTE

Codes vary among jurisdictions. Because of the variations in code, consult the applicable code whenever regulations are in question. Referencing an incorrect set of codes can cause as much trouble as failing to reference codes altogether. Obtain, review, and familiarize yourself with your local adopted code. Safety codes are developed by the US Occupational Safety and Health Administration (OSHA).

Contents





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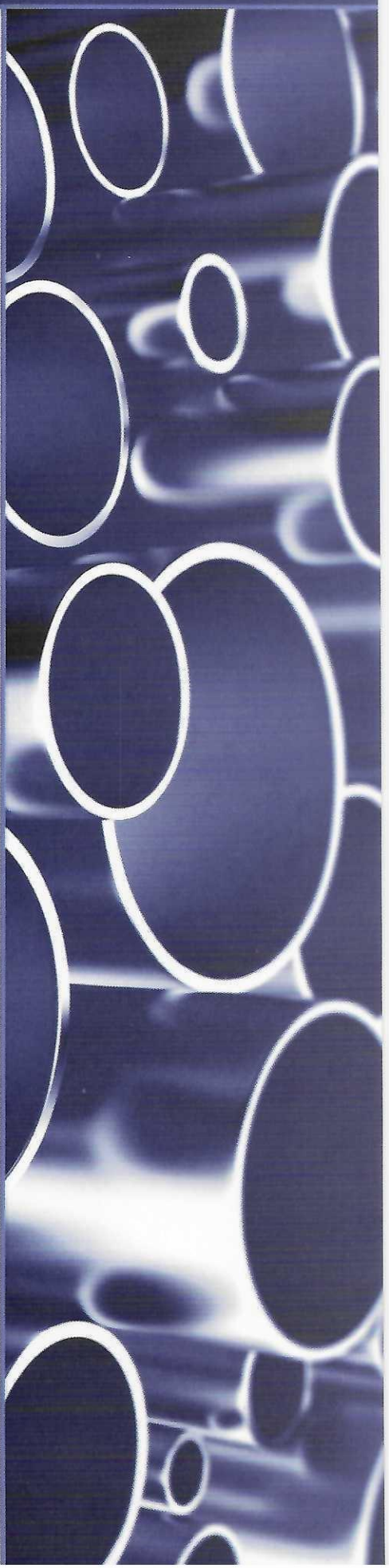

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SECTION ONE

1.0.0 CAUSES AND IMPACTS OF ACCIDENTS

Objective

Describe the causes and impacts of accidents.

a. Identify the causes of accidents.
b. Describe the costs and impacts of accidents.

Trade Terms

Competent person: An individual who is capable of identifying existing and predictable hazards or working conditions that are hazardous, unsanitary, or dangerous to employees, and who has authorization to take prompt, corrective measures to eliminate or control these hazards and conditions.

Hazard Communication (HazCom) Standard: A federal OSHA regulation requiring employers to educate and inform workers about chemical hazards on the job site (*29 CFR 1910.1200*).

Occupational Safety and Health Administration (OSHA): The division of the US Department of Labor mandated to ensure a safe and healthy environment in the workplace.

Most plumbing-related accidents and injuries are caused by worker carelessness, poor safety planning, lack of training, or failure of the employer or employee to follow safety regulations. Accidents do not only affect plumbers and their employers; they can also affect the health and safety of the public. Diseases, contamination, and flooding are just a few of the ways.

To help prevent accidents, your company must have a safety program. This program will provide you with the rules and safeguards you need to work safely. Safety must be part of all phases of the job and must involve employees at every level, including management. The US Department of Labor's **Occupational Safety and Health Administration (OSHA)** requires that a company-appointed **competent person** be on site before you start any job. OSHA's regulation *CFR 1926.32* defines a competent person as one who is capable of identifying existing and predictable hazards in the surroundings or working conditions that are unsanitary or dangerous to employees and who is authorized to take prompt, corrective measures to eliminate them. A competent person has experience and training for the job and knows the job's hazards, as well as the rules and regulations associated with the job.

In addition to its own rules, your company must comply with many local, state, and national regulations. For example, OSHA requires the following:

- An employer "shall furnish to each of his employees employment and a place of employment which are free from recognized hazards that are causing or are likely to cause death or serious physical harm to his employees."
- An employer "shall comply with occupational safety and health standards" established in the federal Occupational Safety and Health Act.
- An employee "shall comply with occupational safety and health standards and all rules, regulations, and orders issued pursuant to this Act which are applicable to his own actions and conduct."

This is called OSHA's "general duty clause." OSHA also says that employees have a duty to fix a recognizable hazard when they see one. Safety regulations like these are intended to make work sites safe and accident-free. Safety policies and procedures are available to help you and your company comply with these regulations. Remember that there is a good reason for each regulation. Following good safety practices helps to save lives.

1.1.0 Causes of Safety Accidents

Accidents and injuries cause pain and suffering that could be avoided, as well as financial hardship for employees, their families, and their companies. All workers on a site, including plumbers, have a moral, legal, and financial obligation to prevent accidents and injuries. To do this, you must understand that unsafe acts and conditions cause accidents. Unsafe acts are things you do or do not do that can cause an accident. Unsafe conditions are factors that make the work area dangerous.

1.1.1 Unsafe Acts

Unsafe acts often lead to serious injury and sometimes death. You can prevent unsafe acts by changing your behavior. It is your responsibility to recognize unsafe acts and stop them immediately. This can mean telling your co-workers to stop what they are doing. If your co-workers do not stop acting in an unsafe manner, stop what you are doing and move as far away from them as possible. In some cases, you may need to inform

your supervisor of the problem. Here are some examples of the most common unsafe acts:

- Operating equipment at improper speeds
- Operating equipment without authority
- Using defective equipment
- Disabling a safety device
- Servicing equipment while it is in motion or energized
- Using equipment improperly
- Failing to use personal protective equipment (PPE)
- Failing to warn co-workers of a dangerous or potentially dangerous situation
- Working in an improper position
- Working while impaired by alcohol or illegal drugs
- Operating tools or equipment when taking certain types of prescription drugs
- Lifting loads improperly
- Loading or placing equipment or supplies improperly
- Horseplay (see *Figure 1*)

An unsafe act can also be defined as work that is not done correctly. Workers who fail to use proper PPE, follow safety procedures, or warn co-workers of potentially hazardous conditions can cause or worsen accidents. Keep yourself safe, look out for the safety of others, always follow safety rules, and use the right equipment for the job.

1.1.2 Unsafe Conditions

Unsafe working conditions cause many accidents and injuries. Environmental factors such as noise, extreme heat or cold, poor lighting, and poor air circulation can create unsafe conditions by impairing your reactions or limiting your movements. Poor housekeeping is also a hazard. Clutter in walkways, spills, and improper waste disposal can make simply walking on a construction site dangerous.

To work safely, you must be able to hear, see, breathe, and keep your balance. Before you start a job, look for and correct any unsafe working conditions. Pick up and properly store loose pipes and fittings and keep your work area clean and free of debris that could cause accidents. Keep glue cans closed to reduce the amount of toxic fumes in the air. Check the ground for standing water that could be an electrical hazard. The toxic, biological, and electrical hazards affecting plumbers are covered later in this module.

Figure 1 Horseplay is dangerous.

1.2.0 Costs and Impacts of Accidents

Accidents are very costly. When they happen, everyone involved loses, including the company and its employees. You may not believe that all accidents will cost you money. Think about it this way: If there is an accident on a job site, the company will have to pay higher insurance rates, costs for medical care and/or repairs, downtime, and the cost of investigations or fines. If the company is paying for these things, it has less money to spend on raises and performance bonuses and to hire replacement workers. What that means to you is more work without an increase in pay. You are a part of the company (see *Figure 2*), and jobsite accidents will affect you, even if you are not directly involved.

Accident costs can be classified as direct (insured) and indirect (uninsured). The costs associated with accidents can be compared to an iceberg (see *Figure 3*). The tip of the iceberg represents the direct costs, such as medical bills, compensation, and insurance premiums. The larger, indirect costs are unseen. They include property and equipment damage, production delays, and lost

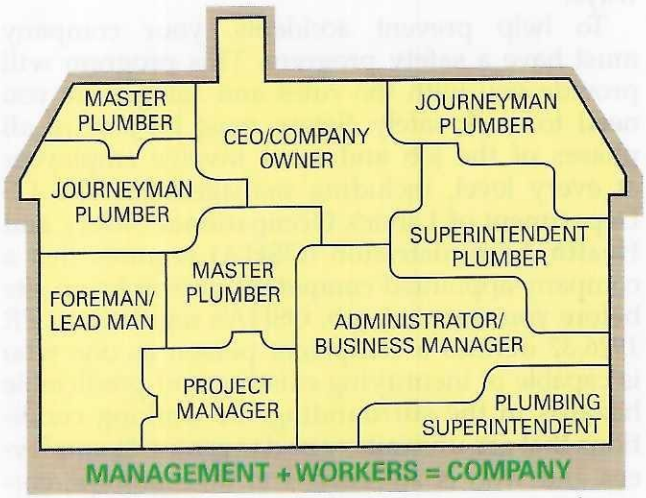


Figure 2 Companies are a combination of workers and management.

time. Injuries that occur off the job may equally delay production and involve other costs for the employers. A high incident rate can affect your company's ability to secure future work.

Did You Know?

The average cost of an eye injury is $1,463. That figure includes both the direct and indirect costs, but it does not take into account the long-term effects on the health of the worker, which is priceless.

Source: Occupational Safety and Health Administration

OSHA, part of the US Department of Labor, is a government agency that protects millions of workers each year. Its mission is to ensure a safe and healthy workplace. Since the agency was created in 1971, workplace deaths have been cut in half, and injury and illness rates have declined 40 percent. At the same time, the number of people working has increased. In fact, since 1971, the number of people working in the United States has doubled, from 56 million workers at 3.5 million work sites to 111 million workers at 7 million sites.

OSHA adopts and enforces safety regulations known as standards. Some, like the **Hazard Communication (HazCom) Standard**, apply to all industries. Others apply only to a specific industry. In addition to general industry standards, OSHA has a series of standards for plumbing construction. Twenty-six states have their own OSHA programs. The state regulations must be at least as strict as the national standards. Find out which regulations apply to your job site. The federal and state OSHA programs keep workplaces safe through accident investigation, inspections, and outreach.

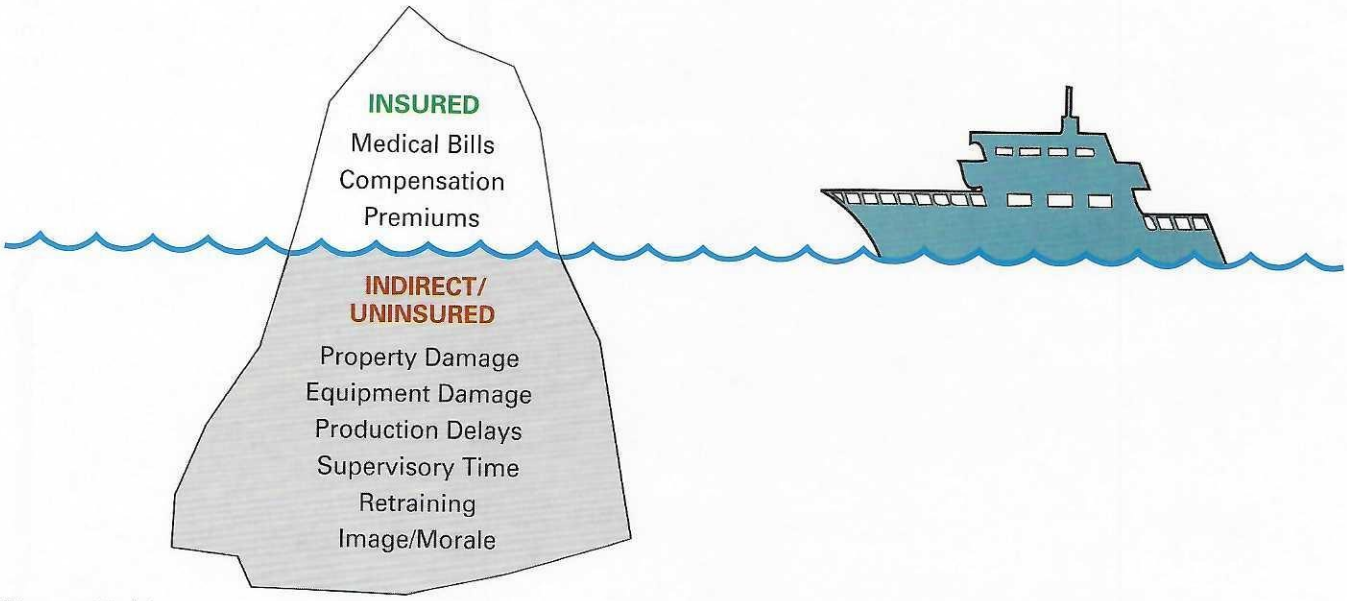


Figure 3 Hidden costs of accidents.

Additional Resources

Environmental Protection Agency. *www.epa.gov.*

National Safety Council. *www.nsc.org.*

OSHA. *www.osha.gov.*

1.0.0 Section Review

1. You see a co-worker fooling around on the work site. Your first course of action is to _____.
   a. tell your supervisor
   b. tell your co-worker to stop
   c. move as far away from your co-worker as possible
   d. complain to other co-workers about this person's actions

2. OSHA's mission is to protect _____.
   a. the economy
   b. employers
   c. workers
   d. the whole workplace environment

Section Two

2.0.0 Preventing Accidents

Objective

Identify methods for preventing accidents.

a. Explain the purpose of various types of personal protective equipment in preventing accidents.
b. Explain the role of hazard communication in preventing accidents.
c. Identify methods used to establish work zone safety.

Performance Tasks

1. Inspect the following personal protective equipment:
   - Gloves
   - Body harness
   - Hard hat
   - Safety glasses
   - Safety shoes
   - Hearing protection
2. Put on the following personal protective equipment:
   - Hard hat
   - Body harness
   - Eye protection
   - Gloves
   - Hearing protection
   - Safety shoes
3. Demonstrate proper use of ladders.

Trade Terms

Apparatus: One tool, which combines a variety of functions, to perform a particular job.

Asbestos: A fibrous, fire-resistant substance used in pipe insulation, shingles, wallboard, floor coverings, and certain types of insulation. Now banned by government regulation as a health hazard.

Confined spaces: Spaces that, by design and/or configuration, have limited openings for entry and exit, have unfavorable natural ventilation, may contain or produce hazardous substances, and are not intended for continuous employee occupancy.

Decibels (dB): A measure of sound intensity or loudness. The higher the decibel level, the louder and more potentially damaging the sound is.

Guards: Devices that protect tool operators from dangerous moving parts, such as blades, gears, and pulleys.

Guy wires: Ropes, chains, cables, or rods attached to something as a brace or guide.

Lockout/tagout procedures: Processes for identifying hazardous equipment, locking it so that no workers can use it until it is certified for safe use, and placing a tag on the equipment that describes the problem and warns against use.

NFPA warning diamond: A four-color diamond label placed on containers or doors to alert people to specific safety hazards in a product, room, or building.

Oxygen-deficient atmosphere: An atmosphere in which there is not enough oxygen to support life. Usually considered less than 19.5 percent oxygen by volume.

Power tools: Tools that require a power source, such as electricity, hydraulics, or pneumatics, to operate.

Safety data sheet (SDS): A document that must accompany any hazardous material. The SDS identifies the material and gives the exposure limits, the physical and chemical characteristics, the kind of hazard it presents, precautions for safe handling and use, and specific control measures.

There are many tools and safeguards that are used to prevent injury on a job site. The first line of defense is to remove the hazard itself. For example, do not work at elevation if the work can be done at ground level and the finished piece brought up to the installed location. If a hazard cannot be eliminated, appropriate personal protective equipment (PPE) must be worn. Workers must be advised of the hazard through effective communication, and a safe work zone must be established.

2.1.0 Personal Protective Equipment

PPE is designed to protect you from injury. Many plumbers are injured on the job because they are not using PPE.

You won't see all the potentially dangerous conditions on a job site just by looking around. Before doing any job, stop and consider what types of accidents could happen. Using common sense and PPE greatly reduces your chances of getting hurt. The best PPE is of no use unless you do the following four things:

- Inspect it regularly, and replace any PPE that is damaged or worn.

- Care for it properly.
- Use it correctly when it is needed.
- Avoid altering or modifying it in any way.

As a plumber, you will most commonly use the following types of PPE:

- Hard hats
- Eye and face protection
- Gloves
- Safety shoes
- Hearing protection
- Fall protection
- Respiratory protection
- Proper clothing

NOTE

The safety harness and lanyard are parts of a system that is known as the personal fall arrest system. Workers must know how to properly inspect, don, and maintain their system.

NOTE

Accidents and incidents are defined differently by OSHA. When reporting injuries, always use the word accident, not incident.

2.1.1 Hard Hats

Figure 4 shows a typical hard hat. The outer shell of the hat protects your head during a fall or from a flying object. The webbing inside the hat maintains a space between the shell and your head. When wearing a hard hat, adjust the headband, not the hard hat, so that the webbing fits your head and there is at least 1 inch of space between your head and the shell.

Never wear a baseball cap under a hard hat. The knob on the top of the cap will impede the hard hat's function if impacted. Additionally, pull back long hair (longer than 4 inches), which can easily get caught in machinery. You should not

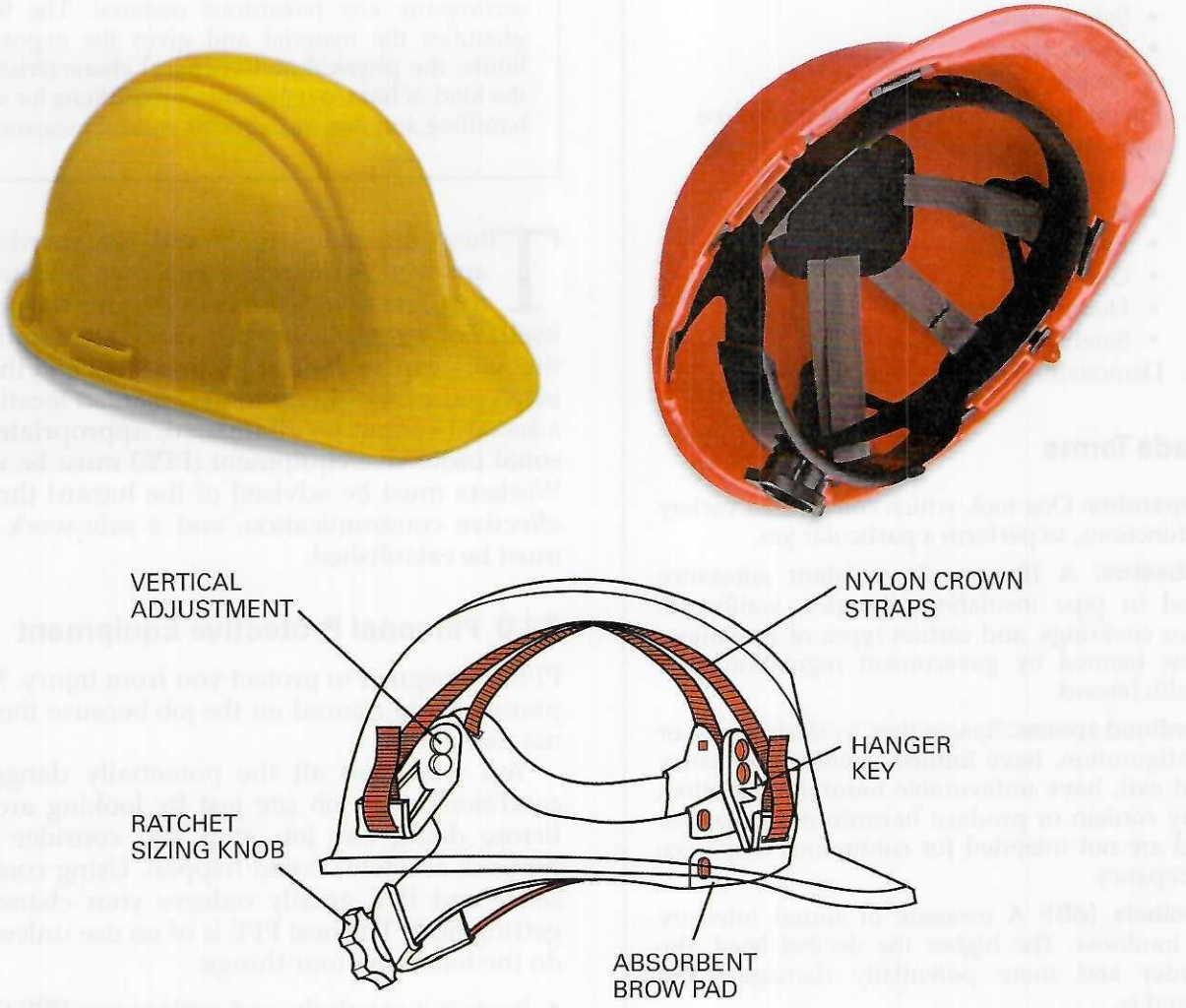


Figure 4 Typical hard hat.

SAFETY GOGGLES

PRESCRIPTION GLASSES WITH SIDE SHIELDS

Figure 5 Typical safety goggles and glasses.

be required to cut your hair, but you may need to cover it with a bandana or hair net under your hard hat. Always ensure that the hard hat that you use has not exceeded its life expectancy.

Case History

Hard-Hat Safety

You won't get the protection that a hard hat is designed to provide if you do not wear it correctly. In one reported accident, a worker who was wearing his hard hat backwards was pulling down a piece of 6-inch pipe when the pipe began falling. As the pipe fell, and because the brim of his hat was turned backward couldn't deflect falling objects, the pipe hit him on the forehead. The worker suffered brain damage as a result and could not work again.

The Bottom Line: Always wear your hard hat correctly.

You must wear your hat correctly. Notice that hard hats have a short, sturdy brim at the front. This brim is designed to deflect falling objects, so never wear the hat backward or pushed back from your face. Doing so eliminates the protection provided by the brim.

2.1.2 Safety Glasses, Goggles, and Face Shields

Wear eye protection (*Figure 5*) whenever there is even the slightest chance of an eye injury. Areas where there are potential eye hazards from falling or flying objects are usually identified, but you should always be on the lookout for other possible hazards, such as sewage and pressurized water.

There are different types of eye protection. Safety goggles give your eyes the best protection from all directions. Regular safety glasses protect you from objects flying at you from the front, such as large chips, particles, sand, or dust, but you can add side shields for further protection. Do not wear contact lenses because the lenses can burn your eyes. You may, however, substitute prescription safety glasses if they provide the same protection as regular safety glasses. If welding is part of your job, you must use safety goggles with tinted lenses or a welding hood. Tinted lenses protect your eyes from the bright welding arc or flame.

CAUTION

Never wear tinted glasses indoors.

Case History

Eye Safety

In one reported accident, a plumber suffered a serious eye injury after debris from the work he was doing blew into his eyes. A supervisor had told this plumber several times to wear safety glasses. Had he listened to his supervisor, the plumber would not have been injured, nor would he have had to take time off from work to recover.

The Bottom Line: Always wear eye protection while on the job site.

Eye Protection

If you must wear corrective glasses, OSHA regulations state that your eyes must be protected by one of the following ways:

- Spectacles whose protective lenses provide optical correction
- Goggles that can be worn over corrective spectacles without disturbing the adjustment of the spectacles
- Goggles that incorporate corrective lenses mounted behind the protective lenses

Your optometrist can provide the required eyewear.

Source: Occupational Safety and Health Administration *CFR 1926.102*

2.1.3 Gloves

On many jobs, you must wear heavy-duty gloves (*Figure 6*) to protect your hands from cuts, chemical burns, or exposure to raw sewage. Work gloves are usually made of cloth, canvas, or leather, but they may also be made of metal mesh or a material called Kevlar®, which protects against metal cuts. Never wear cloth gloves around rotating or moving equipment. Inspect your gloves every day to ensure that they are in good condition. Immediately replace gloves that are worn, torn, or no longer fit.

In addition to a visual test, an effective way to check rubber gloves is to conduct an air test. The following steps are outlined in *29 CFR 1910.137*:

Step 1 Hold the glove by its cuff, flip it several times to make a seal, and roll the glove toward its fingers. An air pocket will form inside the glove.

Step 2 Hold the rolled portion of the glove tightly. Inspect the inflated exterior of the glove for cracks or degradation of the insulating material surface. Forcing air into the glove will expose damage to the insulation that cannot be seen during visual inspections.

Step 3 Inspect the glove for holes in the insulating material. Hold the glove close to your ear. If you hear air escaping from the glove or if the glove does not hold pressure, the glove is damaged. Damaged gloves must be removed from service.

CAUTION

Protective equipment that is good one day may be damaged the next. Always do a daily visual inspection of PPE to prevent injuries from defective or worn equipment.

Figure 6 Work gloves.

WARNING!

Always thoroughly wash and disinfect your hands if you have been exposed to sewage, even if you were wearing gloves. Doing so can prevent disease or illness. In general, it is best to use an alcohol gel instead of an antibacterial cleaner. Recent research indicates that overuse of antibacterial cleaners may make bacteria more resistant.

2.1.4 Safety Shoes

To protect your feet from falling objects and punctures, wear steel-toed, steel-soled safety shoes (*Figure 7*). The steel toe protects your toes from falling objects. The steel sole keeps nails and other sharp objects from puncturing your foot. You are required to wear this type of safety shoe when using tamping equipment or jackhammers. If electrical hazards are present, wear metal-free shoes or boots. Welding jobs call for boots or other sturdy shoes without laces or eyelets to prevent hot metals or sparks from becoming trapped in the shoes. Do not wear oil-soaked shoes if you are welding. Doing so increases the risk of fire.

It is also important to consider how your shoes will be affected by water, especially the soles. Many injuries have occurred as a result of a slip on a wet surface. When working on wet or icy surfaces, wear rubber boots or shoes with skid-resistant soles. Always replace boots or shoes when the sole tread becomes worn or the shoes have holes, even if the holes are on top. To reduce the possibility of falls or injury to the feet, never wear open-toed shoes or open-heeled shoes because increases.

2.1.5 Hearing Protection

Damage to most parts of the body causes pain. Ear damage, however, does not always cause pain. Exposure to loud noise over a long period can cause hearing loss, even if the noise is not loud enough to cause pain. Most companies follow OSHA's rules for when workers must use hearing protection. Specially designed earplugs that fit into your ears and filter out noise are one type of hearing protection (*Figure 8*). You must clean earplugs regularly with soap and water to prevent ear infections. Because earplugs are made in different sizes, make sure you use earplugs that fit properly.

Figure 7 Safety shoes.

Another type of hearing protection is earmuffs, which are large, padded covers for the entire ear (*Figure 9*). You must adjust the headband on earmuffs for a snug fit. If the noise level is very high, you may need to wear both earplugs and earmuffs.

You can prevent noise-induced hearing loss by limiting exposure and using appropriate PPE. *Table 1* shows the maximum safe exposure to sound levels rated 90 **decibels (dB)** and higher.

Some kits also come with tourniquets, splints, safety whistles, safety streamers, safety pins, and garbage sacks. Always keep the first-aid kit stocked. That way, when someone needs to use the kit, the necessary items are available. It may also be helpful to keep an accident report and a pencil in your first-aid kit.

Never attempt to treat serious injuries yourself. Always call 911 in an emergency. Check your company's policy for administering medications. Some companies may prohibit the distribution of medications.

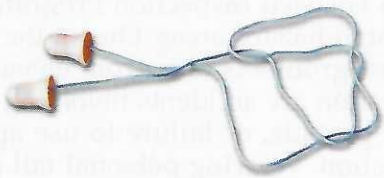


Figure 8 Earplugs.

Figure 9 Earmuffs.

Did You Know?

Statistics compiled by the National Institute of Occupational Safety and Health (NIOSH) indicate that 48 percent of plumbers report some hearing loss due to the use of noisy electric machinery in tight places.

Table 1 Maximum Noise Levels

Sound Level (decibels)	Maximum Hours of Continuous Exposure per Day	Examples
90	8	Power lawn mower
92	6	Belt sander
95	4	Tractor
97	3	Hand drill
100	2	Chop saw
102	1.5	Impact wrench
105	1	Spray painter
110	0.5	Power shovel
115	0.25 or less	Hammer drill

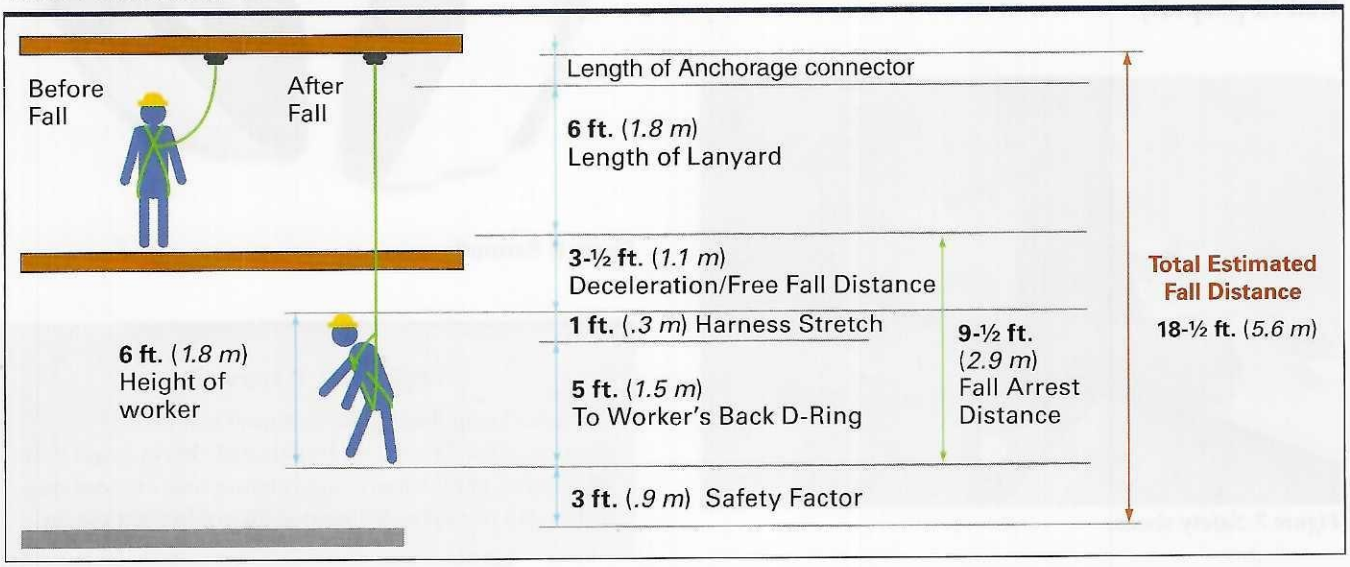
2.1.6 Fall Protection

OSHA requires workers to wear and be trained in the proper use of personal fall protection equipment in certain workplace situations. OSHA developed a Focused Inspection Program to target the four high-hazard areas. One of the four leading hazard groups is falls from elevation. Falls from elevation are accidents involving failure of, failure to provide, or failure to use appropriate fall protection. Wearing personal fall protection equipment can help to prevent these accidents. This equipment usually includes a safety harness and a lanyard. Refer to *Table 2* to determine the proper length of fall protection equipment for a specified height. For fall clearances less than 18-½ feet, use a self-retracting lifeline. For fall clearances over 18-½ feet, use a shock-absorbing lanyard or a self-retracting lifeline.

Fall protection equipment incorporates embedded red threads that will appear if the equipment has been stretched, torn, or otherwise damaged. If you see these red threads on your equipment, do not use it. Never write your name on the webbing of your fall protection equipment using a marker. The ink in the marker could react with the webbing material, causing it to corrode and degrade. Never attach a retractable lanyard to a fixed lanyard.

The safety harness (*Figure 10*) is an extra-heavy-duty harness that fits over your body and includes leg, shoulder, chest, and pelvic straps. The lanyard (*Figure 11*) is an engineered system that protects against free falls greater than 3 feet, with reinforced ends with D-rings snapped onto them. One D-ring attaches to the safety harness, and the other is attached to an anchor point above the work area. OSHA requires that anchors must be able to support 5,000 pounds per each person.

Table 2 Calculating Fall Distance



First-Aid Kits

Always keep a first-aid kit handy. Minor injuries can be treated easily when the necessary items are available. A complete first-aid kit should include the following items:

- Self-adhesive bandages
- Sterile dressing
- Gauze bandages
- First-aid tape
- Moleskin
- First-aid scissors
- Tweezers
- Surgical gloves
- Iodine and/or alcohol swabs
- Ibuprofen or other anti-inflammatory aids
- Antibiotic ointment
- Aspirin or other pain reliever

A qualified person will tell you where a strong anchor point is. The lanyard should be long enough to allow you to perform your tasks but short enough to bring you to a complete stop and limit the greatest distance that you can travel to 3.5 feet, and be strong enough to withstand twice the potential impact energy if you were to free fall 6 feet or the distance permitted by the manufacturer.

Fall protection includes covers or guardrail systems to prevent you from falling off any surface that is 6 feet or higher above a lower surface or into a hole or excavation that is 6 feet deep or more. Covers for holes also protect you from objects that may fall from above the work area. Use of fall protection equipment is required when working in these areas:

WARNING!

Never use a safety harness and lanyard for anything except their intended purpose. Always follow the manufacturer's instructions for hooking up a safety harness or lanyard. More than 70 percent of reported job-site accidents are caused by improper use of the lanyard and harness.

- More than 4 feet above the ground or the next lower surface, or 10 feet if on a scaffold (refer to your local applicable standards)
- Near openings in floors (for example, a stairwell, elevator shaft, chimney, or plumbing stack opening)
- Near holes or excavations deeper than 6 feet

Figure 10 Typical safety harness.

Figure 11 Lanyard.

Always tie off your fall protection equipment. Never tie off when leaning, as this will result in a miscalculation of the length required.

Keep your safety harnesses and lanyards in good working order. Before using this equipment, inspect it for damage, such as wear on the harness straps and buckles, or D-rings that are bent or deeply scratched. Check the harness for any cuts or rough spots. Do not use fall protection equipment that shows these signs of wear or damage. If you find any damage, turn in the harness for testing or replacement.

CAUTION

Always follow the manufacturer's instructions when wearing a harness. Know and follow your company's safety procedures when working on roofs, ladders, and scaffolds.

All companies are required by law to have a written Fall Protection Plan that addresses site-specific fall hazards and the steps taken to prevent each hazard. This information will normally be included in your training or regularly scheduled safety meetings. If you are unsure of your company's plan, or have questions about it, ask your supervisor before performing any aerial work.

2.1.7 Respiratory Protection

Wherever there is danger of suffocation or other breathing hazards, you must use a respirator. You must also wear a respirator when working with or near fire-resistant **asbestos** or where hazardous molds are growing. Special training is required for the use of respirators. It is important to do the following:

- Use the proper type of respiratory protection for the hazard.
- Pass a cardiopulmonary fitness test before using respiratory protection.
- Conduct a fit test with the respiratory protection equipment prior to use to ensure that it fits properly.

Federal law specifies which type of respirator to use for various breathing hazards. Respirators are grouped into three main types, based on how they protect the wearer from contaminants.

WARNING!

EPA's *Renovation, Repair & Painting Final Rule 40CFR 745* requires that, "renovations conducted for compensation must be performed by Certified Firms using Certified Renovators if the home was built prior to 1978, if they qualify as a child-occupied facility and if the renovation disturbs over 6 square feet of lead paint per interior room area or 20 square feet of exterior area per wall." All plumbers working on pre-1978 homes are affected by this rule and need to be aware of their surroundings and test for the presence of lead in their work area.

CAUTION

OSHA regulations require that workers undergo a cardiopulmonary test before using respiratory protection. Refer to your local applicable standards.

WARNING!

If you encounter asbestos or mold, do not handle them or attempt to remove them. Tell your supervisor about the presence of these materials immediately. Asbestos and mold are linked to long-term illnesses. Only trained personnel who have the proper equipment for handling and disposing of these materials can deal with such situations.

Air-purifying respirators—Air-purifying respirators provide the lowest level of protection. They are made for use only in atmospheres that have enough oxygen to sustain life (at least 19.5 percent). Air-purifying respirators are chemical-specific. They use special filters and cartridges to remove specific gases, vapors, and particles from the air. The respirator cartridges contain charcoal, which absorbs certain toxic or deadly vapors and gases. When the wearer detects any taste or smell, it indicates the charcoal's absorption capacity has been reached. This means the cartridge can no longer remove the contaminants. The respirator filters remove particles such as dust, mists, and metal fumes, by trapping them within the filter material. Filters should be changed when breathing becomes difficult.

Respirator manufacturers typically classify air-purifying respirators into four groups:

- No maintenance
- Low maintenance
- Reusable
- Powered air-purifying respirators (PAPRs)

Reusable respirators (*Figure 12*) are made in half-mask and full-facepiece styles. These respirators require the replacement of cartridges, filters, and respirator parts. Their use also requires a complete respirator maintenance program. Half-mask air-purifying respirators have several limitations, so be sure to refer to the manufacturer's instructions before using.

Powered air-purifying respirators (PAPRs) (*Figure 13*) are made in half-mask, full-facepiece, and hood styles. They use battery-operated blowers to pull air through the cartridges and filters attached to the respirator. The blower motors can be either mask- or belt-mounted. Depending on the cartridges used, PAPRs can filter particles, dust, fumes, and mists

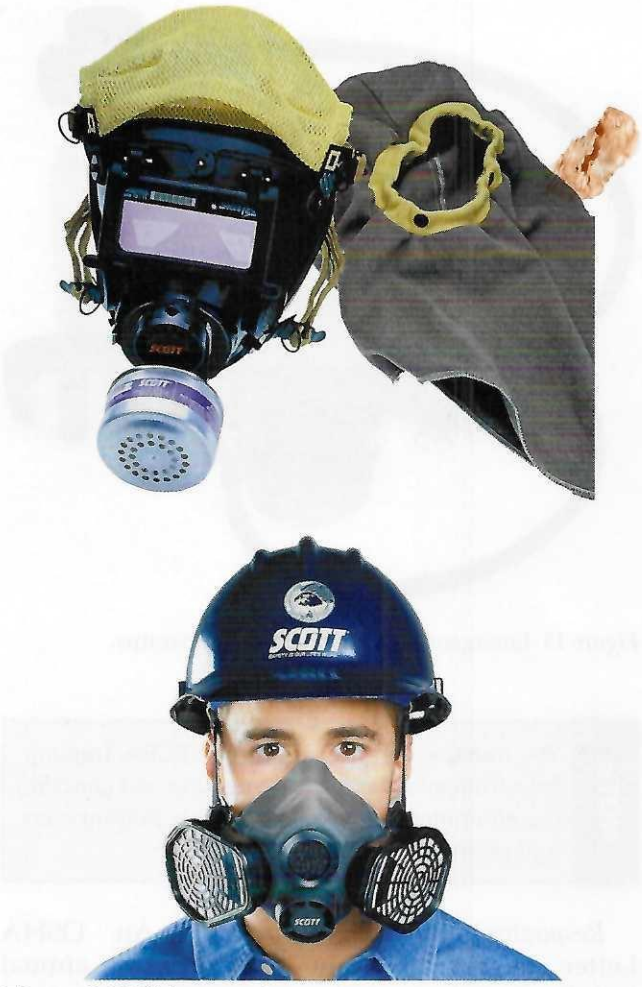


Figure 12 Half-face respirator.

along with certain gases and vapors. Other than units with the blower mounted in the mask, PAPRs have a belt-mounted, powered air-purifier unit connected to the mask by a breathing tube. Many

Asbestos

Asbestos is a hazardous, fibrous substance that causes lung diseases, including cancer. It was once used regularly in construction. Pipe insulation, shingles, wallboard, floor covering, and blown-in insulation are just a few products that may contain asbestos.

The federal government stopped production of most asbestos products in the early 1970s. However, installation of these products continued through the late 1970s and early 1980s. Today, asbestos fibers can be released during renovations of older buildings. Breathing asbestos dust can have chronic and lasting effects.

Source: Agency for Toxic Substances and Disease Registry

Figure 13 Full-face powered air-purifying respirator.

models have an audible and visible alarm that is activated as soon as the airflow falls below the required minimum level. This feature alerts the user to a loaded filter or low battery charge.

Supplied-air respirators—Supplied-air respirators (*Figure 14*) provide air for extended periods through a high-pressure hose connected to an external source of air, such as a compressor, compressed air cylinder, or pump. They provide protection in atmospheres where air-purifying respirators are not adequate. Supplied-air respirators are typically used in toxic atmospheres. Some can be used in atmospheres that are immediately dangerous to life and health (IDLH),

Figure 14 Supplied-air respirator.

as long as they are equipped with an air cylinder for emergency escape. An atmosphere is considered IDLH if it poses an immediate hazard to life or produces immediate, irreversible, and debilitating effects on health. There are two types of supplied-air respirators: continuous flow and pressure demand.

Continuous-flow, supplied-air respirators provide air to the user in a constant stream. One or two hoses deliver the air from the source to the facepiece. Unless the compressor or pump is specially designed to filter the air, or a portable air-filtering system is used, the unit must be located where there is breathable air. Pressure-demand, supplied-air respirators are similar to continuous-flow respirators except that they supply air to the user's facepiece via a pressure-demand valve as the user inhales.

Self-contained breathing apparatus (SCBA)—SCBAs provide the highest level of respiratory protection. They can be used in an **oxygen-deficient atmosphere** (below 19.5 percent oxygen), in poorly ventilated or **confined spaces**, which have limited openings, and in IDLH atmospheres. These respirators supply air for about 30 to 60 minutes from a compressed-air cylinder worn on the user's back. An emergency escape breathing **apparatus** (EEBA) is a smaller version of an SCBA cylinder (see *Figure 15*). EEBAs are used to escape from hazardous environments and generally provide a 5- to 10-minute air supply.

Respirators

OSHA regulations (*29 CFR 1910.134*) require employees who use respirators in the workplace to be trained on an annual basis. Employees must complete the training before they are required to use a respirator. According to OSHA, "The training must be comprehensive, understandable, and recur annually, and more often if necessary." Additional training may be required if earlier training becomes obsolete or if the employee has not mastered the use of a respirator and demonstrates difficulty using a respirator.

Figure 15 Emergency escape breathing apparatus.

NOTE You must be certified to wear an SCBA. Training for certification covers maintaining and checking the equipment, as well as correctly putting it on and removing it.

Respirator training requirements—An OSHA Letter of Interpretation clarified the annual training requirement for respiratory protection. "Annual means that training and fit testing must be conducted every year, before or on the anniversary date of the employee's previous training and fit test; for example, if the employee is trained or fit tested on February 1, 2011, then the employee must be trained or fit tested before or on February 1, 2012." If the anniversary date is missed, the reason for the delay and the expected date of completion should be noted in the employee's file.

Trained employees must be able to demonstrate knowledge in the following areas:

- Why a respirator is necessary, and the consequences of improper fit, use, or maintenance
- The limitations and capabilities of respirators
- How to use the respirator effectively in emergency situations, including when the respirator malfunctions
- How to inspect, put on, remove, use, and check the seals of the respirator
- The procedures for maintaining and storing respirators

- How to recognize medical signs and symptoms that may limit or prevent the effective use of respirators
- The information in *OSHA Standard 29 CFR 1910.134*

Respirator selection—A respirator must be selected based on the contaminant present and its concentration level. It must be fitted and used properly, in accordance with the manufacturer's instructions. It must be worn during all times of exposure.

Employers must have a respiratory protection program with the following components:

- Standard operating procedures for selection and use
- Employee training
- Regular cleaning and disinfecting
- Sanitary storage
- Regular inspection
- Annual fit testing
- Pulmonary function testing

Always check the cartridge on your respirator to ensure that it is the correct type for the air conditions and contaminants on your job site. In certain concentrations, vapors or fumes can be eliminated by the use of air-purifying devices as long as the oxygen levels are acceptable. Smoke billowing from a fire and the fumes generated when welding are examples.

When selecting a respirator to wear while working with specific materials, you must first determine the hazardous ingredients in the material and their exposure levels. Always read the **safety data sheet (SDS)**, which is often located in a binder in the project manager's or supervisor's office. SDSs identify the hazardous ingredients and should list the type of respirator and cartridge recommended for use with the material. You will learn more about SDSs later in this module.

WARNING!

If breathing becomes difficult, if you become dizzy or nauseated, if you smell or taste the chemical, or if you have other noticeable effects of exposure, leave the area immediately. Get to an area with fresh air and seek any necessary assistance. You must have at least one other worker with you when working in a confined space. You will learn more about working in confined spaces later in this module.

Did You Know?

The United Nations Globally Harmonized System of Classification and Labeling of Chemicals (GHS) is an international standard for safety data sheets (SDSs). Its purpose is to define and communicate the health, physical, and environmental hazards of chemicals as well as the necessary protective measures on labels and SDSs.

Respirator fit testing—Respirators are useless unless properly fit tested to each wearer. To obtain the best protection from your respirator, you must perform positive and negative fit checks each time you wear it. Repeat these fit checks until you have obtained a good face seal.

Use the following steps to perform a positive fit check:

Step 1 Adjust the facepiece for the best fit, then adjust the head and neck straps to ensure good fit and comfort.

Step 2 Block the exhalation valve with your hand or other material.

Step 3 Breathe out into the mask.

Step 4 Check for air leakage around the edges of the facepiece.

Step 5 If the facepiece puffs out slightly for a few seconds, you have a good face seal.

Perform a negative fit check using the following steps:

Step 1 Block the inhalation valve with your hand or other material.

Step 2 Attempt to inhale.

Step 3 Check for air leakage around the edges of the facepiece.

Step 4 If the facepiece caves in slightly for a few seconds, you have a good face seal.

Ensure that your respirator is clean and in good condition and that all of its parts are in place. Otherwise, it will not protect you. Respirators must be cleaned every day. Failure to do so will limit their effectiveness, and they will offer little or no protection. For example, suppose you wore a respirator for two weeks and did not clean it. The bacteria that accumulated as you breathed into the respirator, plus the airborne contaminants that managed to enter the facepiece, would make the inside of your respirator very unsanitary. Continued use could do you more harm than good. Remember, only a clean and complete respirator will give you the necessary protection. Use the following general guidelines for taking care of your respirator:

- Inspect your respirator before and after each use.
- Do not wear a respirator if the facepiece is distorted or if it is worn and cracked. You will not be able to get a proper face seal.
- Do not wear a respirator if any part is missing. Replace worn straps or missing parts before use.
- Do not expose respirators to excessive heat or cold, chemicals, or sunlight.
- Clean and wash your respirator each day.
- Sanitize your respirator each week.

Clean your respirator daily. OSHA's Respirator Cleaning Procedures (Mandatory) are located in *Appendix B* of *CFR 1910.134*. Cleaning your respirator is an easy task that helps to ensure its safe use. Briefly, the procedures include the following steps:

Step 1 Remove filters, cartridges, or canisters. Disassemble facepieces and discard or repair any defective parts.

Step 2 Wash components in warm water with a mild detergent. Use a stiff bristle (not wire) brush to remove dirt.

Step 3 Rinse components thoroughly in clean, warm water. Drain.

Step 4 If your cleaner does not contain a disinfecting agent, immerse components for two minutes in one of the following: hypochlorite solution, aqueous solution of iodine, or other commercially available cleansers of equivalent disinfectant quality.

Step 5 Rinse components thoroughly in clean, warm water.

Step 6 Air-dry components or hand-dry them with a clean, lint-free cloth.

Step 7 Reassemble facepiece, replacing filters, cartridges, and canisters where necessary.

Step 8 Test the respirator to ensure that all components work properly.

2.1.8 Proper Clothing and Grooming

Except for PPE, OSHA has not set a standard for proper workplace clothing and personal grooming. However, proper clothing and good grooming can be as important to your safety as PPE. Treat your work clothing the same way you treat your PPE: inspect it often for signs of wear that could cause problems and keep it clean.

Avoid wearing clothing that is too tight or too loose. Tight clothing can restrict your ability to move quickly; loose clothing can catch in machinery or equipment. Make sure that your clothing does not have flaps, strings, or ragged edges that could be tangled in **power tools**, or tools that require a power source to operate. Don't wear pants that drag on the floor or shirts or jackets with sleeves that are too long. Leg chaps and kneepads can also provide increased protection to your legs. When welding, you must not wear pants with cuffs into which bits of molten metal or sparks may fall.

Do not wear jewelry, which can catch in machinery. If your hair or beard is long, be sure to keep it out of your way while working. Long hair falling into your eyes can affect your ability to see clearly. Like jewelry, long hair can get caught in machinery. Tie back, wrap, or cover long hair. Dressing and grooming in a way that is appropriate for your job will not only help to keep you safe but will also reflect well on you as an employee.

Beards and Respirators

If you wear a beard, you may not be able to seal a respirator facepiece properly. There are, however, loose-fitting respirators that are available for routine or emergency use. According to OSHA, these respirators can be used by bearded workers because facial hair does not interfere with the facepiece seal of these units. Your employer may determine whether the respirator is acceptable for your use.

2.2.0 Hazard Communication

Exposure to hazardous chemicals and materials, such as sealants, asbestos, cleansers, and compressed gas, can cause both environmental and health problems. Health problems can include skin or eye irritation, breathing difficulty, allergic reactions, and cancer. Environmental hazards can include fire, corrosion, and reactivity (explosions).

The types of hazardous materials on a site can range from chemicals to radiation. Sewage is also considered hazardous. Radiation is probably the least thought-about hazard because it cannot be seen or tasted. Radiation is present during radiographic testing of welds in piping, vessels, medical equipment, or pumps.

Chemicals present a significant danger because they exist in many different forms. Chemicals are not only liquids. They can also be solids, gases, fumes, and mists. Many common products contain several chemicals. For example, some paints contain cadmium and lead. Many chemicals pose health hazards, such as disease or burns. Others pose physical hazards, including fire or explosion. Some pose both health and physical hazards. A strong HazCom program that includes SDSs will help you identify the hazards and understand how to protect yourself. You have the right to know the hazards of all the chemicals you will be exposed to on the job.

2.2.1 Right to Know

OSHA directs employers to tell workers about hazardous materials on the job site through HazCom. You may have heard it called the worker right-to-know program. Everyone on site must be educated about the hazardous materials they might use on the job. This is done through a written HazCom program and training. In addition, all materials must have proper labels and SDSs. Labels and SDSs provide information about health hazards, safety precautions, and emergency responses. You need to understand this information in order to protect yourself. The final responsibility for your safety rests with you. Plumbers have the following responsibilities when it comes to HazCom:

- Learn to recognize hazardous materials labels.
- Know where SDSs are kept on your job site.
- Report any hazards you spot on the job site to your supervisor.
- Know the physical and health hazards of the materials you use.

Did You Know?

In a 1999 study of 459 workers in various construction trades, plumbers had particularly high levels of lead in their blood. Experts have linked the high levels of lead to contact with water pipelines containing lead and to dismantling lead joints.

- Know how to protect yourself from hazards.
- Know what to do in an emergency.
- Understand your employer's HazCom program.

2.2.2 Labels

On a construction site, all materials in containers must have a label. Labels describe what is in a container. They also warn you of chemical hazards.

The HazCom Standard states that hazardous material containers must be labeled, tagged, or marked. The label must include the name of the material, the appropriate hazard warnings, and the name and address of the manufacturer.

OSHA does not require specific labels. Label information can be any type of message using words, pictures, or symbols. However, labels must describe the hazards present. Labels must also be readable and easy to see.

Common HazCom labels come from the National Fire Protection Association (NFPA), the National Paint and Coatings Association (NPCA), and the US Department of Transportation (DOT). The NFPA's hazardous materials classification system is often referred to as the **NFPA warning diamond** (*Figure 16*). The four-color diamond can be a container label. It is also used on doors to note the hazards in a room or building to aid firefighters and emergency responders. Each section and color represents a hazard: health, flammability, stability, and specific hazards. Numbers from zero to four indicate increasing hazards.

The ACA's Hazardous Materials Information System (HMIS®) (*Figure 17*), like the NFPA warning diamond, uses a color coding system to identify the hazards associated with a particular product and assigns numbers to each section to reflect the degree of hazard. HMIS® is meant for alerting employees to potential hazards.

The DOT requires labels for hazardous materials shipments (*Figure 17*). Either of these labels can be part of your company's HazCom labeling program. You may see these labels at your job site.

Hazardous materials at the site must be properly labeled. If the material is transferred from a labeled container, the new container must be labeled with all of the information from the original label. Make sure that any materials you work with are labeled. Be sure that you understand your company's labels.

2.2.3 Safety Data Sheets

Each product on a construction site must have an SDS, a facts sheet prepared by the product's manufacturer or importer. An SDS describes the substance and its hazards, safe handling requirements, first-aid needs, and emergency spill procedures. OSHA does not have a mandatory form, but it does require inclusion of specific information. The Chemical Manufacturers Association has developed a standard form that meets national and international standards. Most chemical manufacturers use this form. The sections of the form include the following:

- Chemical product and company information
- Composition/information on ingredients
- Hazard identification
- First-aid measures
- Firefighting information
- Accidental release measures
- Handling and storage
- Exposure controls/personal protection
- Physical and chemical properties
- Stability and reactivity
- Toxicological properties
- Ecological properties
- Disposal considerations
- Transportation information
- Regulatory information
- Other information related to the chemical

An SDS can be difficult to read. The scientific information is fairly technical. *Figure 18A* and *Figure 18B* show an SDS for a PVC cement. Look for the following important information on an SDS:

- Specific hazards
- Personal protection requirements
- Handling procedures
- First-aid information
- The 24-hour emergency-response telephone number

Using *Figure 18A* and *Figure 18B*, try to find the information you would need to use the chemical described on the SDS. First locate the hazards. Section 2 of the SDS shows that this cement poses a hazard to the skin and eyes. Next, find out how to minimize these hazards. Section 8 explains the appropriate eye, skin, and respiratory protection to use. To find out how to handle and store this adhesive, check Section 7. Now you have the facts you need to protect your health and that of your co-workers.

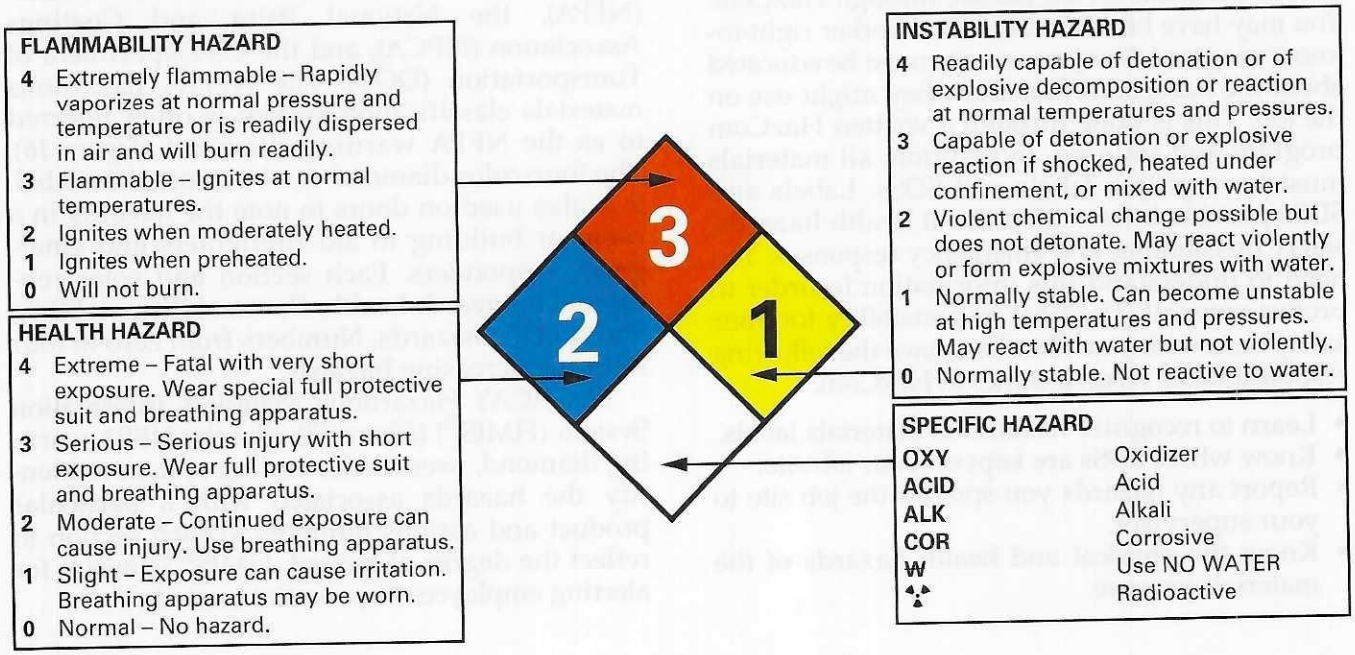
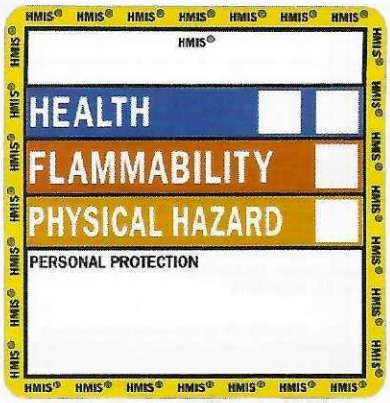


Figure 16 NFPA warning diamond.



NPCA HAZARDOUS MATERIALS INFORMATION SYSTEM (HMIS®)

DOT HAZARDOUS MATERIALS LABELS

Figure 17 HazCom labels.

Section 4 lists the first-aid measures for inhalation, eye contact, skin contact, and ingestion. Section 5 explains fire hazards and firefighting measures. Section 6 provides accidental release measures. You will find the emergency telephone number in Section 1. Now you have the information you need in case of an emergency. All SDSs must be kept on site. Ask your supervisor to tell you where the SDSs are and to point out the sections that relate to your job. Your health and safety and that of your co-workers depend on it.

2.2.4 Responding to Emergencies

Every job site should have an emergency-response plan. Planning should be coordinated well and communicated to everyone involved. If you are told by your supervisor to evacuate a work site, go to a safe location and wait until you are notified that conditions are safe. Being prepared can reduce the severity of an emergency. Planning is especially important if the accident happens in a remote area that does not have a telephone. Be aware of the location of nearby eye wash stations, including portable stations in vehicles. Eye wash stations are marked with signs (*Figure 19*).

Make sure you know your employer's emergency plan. Find out whom to call in an emergency and what you need to do to protect yourself. Know where your emergency hospital is and where you and your co-workers should go in an emergency. Response plans will vary from company to company. At a minimum, all plans should include the name of the nearest emergency hospital, safety meeting points, and an emergency point of contact. If your company does not have a plan, see to it that one is made.

2.3.0 Work Zones

Plumbing work is often done at construction sites in or near public areas. Creating a clear work zone is an important part of working safely. Barricades, fencing, caution tape, signs, and cones mark a construction work zone. To ensure everyone's safety, you must keep the public and their vehicles away from your work area.

WELD-ON

GHS SAFETY DATA SHEET

Date Revised: **DEC 2011**
Supersedes: **FEB 2010**

WELD-ON® 705™ Low VOC Cements for PVC Plastic Pipe

SECTION I - PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME: **WELD-ON® 705™ Low VOC Cements for PVC Plastic Pipe**

PRODUCT USE: Low VOC Solvent Cement for PVC Plastic Pipe

SUPPLIER:

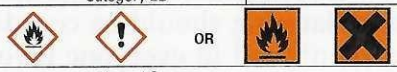
MANUFACTURER: IPS Corporation
17109 South Main Street, Carson, CA 90248-3127
P.O. Box 379, Gardena, CA 90247-0379
Tel. 1-310-898-3300

EMERGENCY: Transportation: CHEMTEL Tel. 800.255-3924, 813-248-0585 (International) **Medical:** Tel. 800.451.8346, 760.602.8703 3E Company (International)

SECTION 2 - HAZARDS IDENTIFICATION

GHS CLASSIFICATION:

Health		Environmental		Physical	
Acute Toxicity:	Category 4	Acute Toxicity:	None Known	Flammable Liquid	Category 2
Skin Irritation:	Category 3	Chronic Toxicity:	None Known		
Skin Sensitization:	NO				
Eye:	Category 2B				

GHS LABEL:  OR

Signal Word: **Danger**

WHMIS CLASSIFICATION: CLASS B, DIVISION 2

Hazard Statements	Precautionary Statements
H225: Highly flammable liquid and vapor	P210: Keep away from heat/sparks/open flames/hot surfaces – No smoking
H319: Causes serious eye irritation	P261: Avoid breathing dust/fume/gas/mist/vapors/spray
H332: Harmful if inhaled	P280: Wear protective gloves/protective clothing/eye protection/face protection
H335: May cause respiratory irritation	P304+P340: IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing
H336: May cause drowsiness or dizziness	P403+P233: Store in a well ventilated place. Keep container tightly closed
EUH019: May form explosive peroxides	P501: Dispose of contents/container in accordance with local regulation

SECTION 3 - COMPOSITION/INFORMATION ON INGREDIENTS

	CAS#	EINECS #	REACH Pre-registration Number	CONCENTRATION % by Weight
Tetrahydrofuran (THF)	109-99-9	203-726-8	05-2116297729-22-0000	25 - 50
Methyl Ethyl Ketone (MEK)	78-93-3	201-159-0	05-2116297728-24-0000	5 - 36
Cyclohexanone	108-94-1	203-631-1	05-2116297718-25-0000	15 - 30

All of the constituents of this adhesive product are listed on the TSCA inventory of chemical substances maintained by the US EPA, or are exempt from that listing.
* Indicates this chemical is subject to the reporting requirements of Section 313 of the Emergency Planning and Community Right-to-Know Act of 1986 (40CFR372).
# indicates that this chemical is found on Proposition 65's List of chemicals known to the State of California to cause cancer or reproductive toxicity.

SECTION 4 - FIRST AID MEASURES

Contact with eyes: Flush eyes immediately with plenty of water for 15 minutes and seek medical advice immediately.
Skin contact: Remove contaminated clothing and shoes. Wash skin thoroughly with soap and water. If irritation develops, seek medical advice.
Inhalation: Remove to fresh air. If breathing is stopped, give artificial respiration. If breathing is difficult, give oxygen. Seek medical advice.
Ingestion: Rinse mouth with water. Give 1 or 2 glasses of water or milk to dilute. Do not induce vomiting. Seek medical advice immediately.

SECTION 5 - FIREFIGHTING MEASURES

Suitable Extinguishing Media: Dry chemical powder, carbon dioxide gas, foam, Halon, water fog.
Unsuitable Extinguishing Media: Water spray or stream.
Exposure Hazards: Inhalation and dermal contact
Combustion Products: Oxides of carbon, hydrogen chloride and smoke

	HMIS	NFPA	
Health	2	2	0-Minimal
Flammability	3	3	1-Slight
Reactivity	0	0	2-Moderate
PPE	B		3-Serious
			4-Severe

Protection for Firefighters: Self-contained breathing apparatus or full-face positive pressure airline masks.

SECTION 6 - ACCIDENTAL RELEASE MEASURES

Personal precautions: Keep away from heat, sparks and open flame.
Provide sufficient ventilation, use explosion-proof exhaust ventilation equipment or wear suitable respiratory protective equipment.
Prevent contact with skin or eyes (see section 8).
Environmental Precautions: Prevent product or liquids contaminated with product from entering sewers, drains, soil or open water course.
Methods for Cleaning up: Clean up with sand or other inert absorbent material. Transfer to a closable steel vessel.
Materials not to be used for clean up: Aluminum or plastic containers

SECTION 7 - HANDLING AND STORAGE

Handling: Avoid breathing of vapor, avoid contact with eyes, skin and clothing.
Keep away from ignition sources, use only electrically grounded handling equipment and ensure adequate ventilation/fume exhaust hoods.
Do not eat, drink or smoke while handling.
Storage: Store in ventilated room or shade below 44°C (110°F) and away from direct sunlight.
Keep away from ignition sources and incompatible materials: caustics, ammonia, inorganic acids, chlorinated compounds, strong oxidizers and isocyanates.
Follow all precautionary information on container label, product bulletins and solvent cementing literature.

SECTION 8 - PRECAUTIONS TO CONTROL EXPOSURE / PERSONAL PROTECTION

EXPOSURE LIMITS:

Component	ACGIH TLV	ACGIH STEL	OSHA PEL	OSHA STEL:
Tetrahydrofuran (THF)	50 ppm	100 ppm	200 ppm	
Methyl Ethyl Ketone (MEK)	200 ppm	300 ppm	200 ppm	
Cyclohexanone	20 ppm	50 ppm	50 ppm	

Engineering Controls: Use local exhaust as needed.
Monitoring: Maintain breathing zone airborne concentrations below exposure limits.
Personal Protective Equipment (PPE):
Eye Protection: Avoid contact with eyes, wear splash-proof chemical goggles, face shield, safety glasses (spectacles) with brow guards and side shields, etc. as may be appropriate for the exposure.
Skin Protection: Prevent contact with the skin as much as possible. Butyl rubber gloves should be used for frequent immersion.
Use of solvent-resistant gloves or solvent-resistant barrier cream should provide adequate protection when normal adhesive application practices and procedures are used for making structural bonds.
Respiratory Protection: Prevent inhalation of the solvents. Use in a well-ventilated room. Open doors and/or windows to ensure airflow and air changes. Use local exhaust ventilation to remove airborne contaminants from employee breathing zone and to keep contaminants below levels listed above.
With normal use, the Exposure Limit Value will not

Figure 18A Typical SDS.

WELD-ON

GHS SAFETY DATA SHEET

WELD-ON® 705™ Low VOC Cements for PVC Plastic Pipe

Date Revised: **DEC 2011**
Supersedes: **FEB 2010**

SECTION 9 - PHYSICAL AND CHEMICAL PROPERTIES

Appearance:	Clear or gray, medium syrupy liquid		
Odor:	Ketone	**Odor Threshold:**	0.88 ppm (Cyclohexanone)
pH:	Not Applicable		
Melting/Freezing Point:	-108.5°C (-163.3°F) Based on first melting component: THF	**Boiling Range:**	66°C (151°F) to 156°C (313°F)
Boiling Point:	66°C (151°F) Based on first boiling component: THF	**Evaporation Rate:**	> 1.0 (BUAC = 1)
Flash Point:	-20°C (-4°F) TCC based on THF	**Flammability:**	Category 2
Specific Gravity:	0.9611 @23°C (73°F)	**Flammability Limits:**	**LEL:** 1.1% based on Cyclohexanone
Solubility:	Solvent portion soluble in water. Resin portion separates out.		**UEL:** 11.8% based on THF
Partition Coefficient n-octanol/water:	Not Available	**Vapor Pressure:**	129 mm Hg @ 20°C (68°F)based on THF
Auto-ignition Temperature:	321°C (610°F) based on THF	**Vapor Density:**	>2 (Air = 1)
Decomposition Temperature:	Not Applicable	**Other Data: Viscosity:**	Medium bodied
VOC Content:	When applied as directed, per SCAQMD Rule 1168, Test Method 316A,VOC content is: < 510 g/l.		

SECTION 10 - STABILITY AND REACTIVITY

Stability: Stable

Hazardous decomposition products: None in normal use. When forced to burn, this product gives off oxides of carbon, hydrogen chloride and smoke.

Conditions to avoid: Keep away from heat, sparks, open flame and other ignition sources.

Incompatible Materials: Oxidizers, strong acids and bases, amines, ammonia

SECTION 11 - TOXICOLOGICAL INFORMATION

Likely Routes of Exposure: Inhalation, Eye and Skin Contact

Acute symptoms and effects:

Inhalation: Severe overexposure may result in nausea, dizziness, headache. Can cause drowsiness, irritation of eyes and nasal passages.

Eye Contact: Vapors slightly uncomfortable. Overexposure may result in severe eye injury with corneal or conjunctival inflammation on contact with the liquid.

Skin Contact: Liquid contact may remove natural skin oils resulting in skin irritation. Dermatitis may occur with prolonged contact.

Ingestion: May cause nausea, vomiting, diarrhea and mental sluggishness.

Chronic (long-term) effects: None known to humans

Toxicity:	LD_{50}	LC_{50}
Tetrahydrofuran (THF)	Oral: 2842 mg/kg (rat)	Inhalation 3 hrs. 21,000 mg/m^3 (rat)
Methyl Ethyl Ketone (MEK)	Oral: 2737 mg/kg (rat), Dermal: 6480 mg/kg (rabbit)	Inhalation 8 hrs. 23,500 mg/m^3 (rat)
Cyclohexanone	Oral: 1535 mg/kg (rat), Dermal: 948 mg/kg (rabbit)	Inhalation 4 hrs. 8,000 PPM (rat)

Reproductive Effects	Teratogenicity	Mutagenicity	Embryotoxicity	Sensitization to Product	Synergistic Products
Not Established	Not Established	Not Established	Not Established	Not Established	Not Established

SECTION 12 - ECOLOGICAL INFORMATION

Ecotoxicity: None Known

Mobility: In normal use, emission of volatile organic compounds (VOC's) to the air takes place, typically at a rate of ≤ 510 g/l.

Degradability: Biodegradable

Bioaccumulation: Minimal to none.

SECTION 13 - WASTE DISPOSAL CONSIDERATIONS

Follow local and national regulations. Consult disposal expert.

SECTION 14 - TRANSPORT INFORMATION

Proper Shipping Name: Adhesives
Hazard Class: 3
Secondary Risk: None
Identification Number: UN 1133
Packing Group: PG II
Label Required: Class 3 Flammable Liquid
Marine Pollutant: NO

EXCEPTION for Ground Shipping
DOT Limited Quantity: Up to 5L per inner packaging, 30 kg gross weight per package.
Consumer Commodity: Depending on packaging, these quantities may qualify under DOT as "ORM-D" .

TDG INFORMATION	
TDG CLASS:	FLAMMABLE LIQUID 3
SHIPPING NAME:	ADHESIVES
UN NUMBER/PACKING GROUP:	UN 1133, PG II

SECTION 15 - REGULATORY INFORMATION

Precautionary Label Information: Highly Flammable, Irritant
Symbols: F, Xi
Risk Phrases: R11: Highly flammable.
R20: Harmful by inhalation.
R36/37: Irritating to eyes and respiratory system.
R66: Repeated exposure may cause skin dryness or cr
R67: Vapors may cause drowsiness and dizziness

Ingredient Listings: USA TSCA, Europe EINECS, Canada DSL, Australia AICS, Korea ECL/TCCL, Japan MITI (ENCS)

Safety Phrases: S9: Keep container in a well-ventilated place.
S16: Keep away from sources of ignition - No smoking.
S25: Avoid contact with eyes.
S26: In case of contact with eyes, rinse immediately with plenty of water and seek medical advice.
S33: Take precautionary measures against static discharges.
S46: If swallowed, seek medical advise immediately and show this container or label.

SECTION 16 - OTHER INFORMATION

Specification Information:
Department issuing data sheet: IPS, Safety Health & Environmental Affairs
E-mail address: <EHSinfo@ipscorp.com>

All ingredients are compliant with the requirements of the European Directive on RoHS (Restriction of Hazardous Substances).

Training necessary: Yes, training in practices and procedures contained in product literature.
Reissue date / reason for reissue: 12/14/2011 / Updated GHS Standard Format
Intended Use of Product: Solvent Cement for PVC Plastic Pipe

This product is intended for use by skilled individuals at their own risk. The information contained herein is based on data considered accurate based on current state of knowledge and experience. However, no warranty is expressed or implied regarding the accuracy of this data or the results to be obtained from the use thereof.

Figure 18B Typical SDS.

Figure 19 Eye wash station sign.

Signs, tags, and color codes in the workplace protect workers from hazardous conditions and help them respond to emergencies (*Figure 20*). For signs, tags, and color codes to be effective, all workers must understand what they mean and know what action they are required to take. This reduces confusion and ensures their effectiveness.

Emergency Preparedness

Your company expects you to be prepared in case of an emergency. Therefore, you must read and understand the company's emergency-response plan. Many companies have guidelines for employees to follow during an emergency. These guidelines are designed to prevent panic and to protect people, property, and the environment:

- Stay calm, and quickly evaluate the situation.
- Notify affected personnel.
- Follow company safety procedures to protect personnel, property, and the environment.
- Submit any required reports.

OSHA requires reports for certain emergency situations. These requirements are detailed in *29 CFR 1904*. Although you may not be the person submitting the report, you may be asked to provide information to the reporting authority.

Signals, such as alarms, bells, buzzers, whistles, and horns, also communicate hazards to workers. For example, backup alarms are used on forklifts, construction equipment, and trucks. Fire alarms are used to clear work areas. Conveyer belt lines have buzzers, bells, or whistles to let workers know they are about to be started.

Barricades are another way to warn of danger. They are used on construction sites to keep out unauthorized personnel and control traffic (*Figure 21*). Barricades are also used to control pedestrian traffic outside, or in rooms or hallways that have been recently washed or waxed.

It's important to recognize all of the signs and signals on your job site and make sure they are placed properly and working correctly. Doing this can save a life.

2.3.1 Signs

All work sites have specific markings and signs to identify hazards. Signs can also provide emergency information (*Figure 22*). Common signs on a site include danger signs, caution signs, informational signs, and safety instruction signs or tags.

Danger signs—Danger signs are usually red, black, and white. They tell workers that an immediate hazard exists, such as high voltage or flammable materials. Danger signs also have specific precautions that must be observed to avoid an accident (*Figure 23*). Examples of danger signs include No Smoking and Keep Out.

Caution signs—Caution signs are yellow with black letters. Caution signs warn workers about potential hazards or unsafe practices (*Figure 24*). When you see a caution sign, take action to protect yourself. Common examples include Do Not Operate, Keep Aisles Clear, and Electric Fence.

Yellow is the basic color used for caution. It identifies places where physical hazards may be caused by striking against objects; stumbling, falling, tripping; or being caught between obstacles. Solid yellow, yellow and black stripes, or yellow and black checkers caution workers against these hazards.

Caution signs for piping systems that contain dangerous materials are also yellow. Yellow warns workers against starting machinery that is under repair. Painted barriers and flags should be at the starting point of the work area or the power source. Signs and barriers should be displayed so that workers notice them easily on such things as electrical controls, ladders, scaffolds, vaults, valves, dryers, boilers, elevators, and tanks.

INFORMATION SIGN SAFETY SIGN CAUTION SIGN DANGER SIGN

Figure 20 Work zone signs and tags.

Figure 21 Typical uses of barricades.

Figure 22 Work zone signs.

Informational signs—Informational signs provide general information that is not related to safety (*Figure 25*). The standard color is blue. The background, the entire sign, or just a panel may be blue. Common examples include No Admittance, No Trespassing, and Employees Only.

Informational signs can also be black and white. These signs are used as traffic and housekeeping markers. They identify information such as the following:

- Dead ends of aisles or passageways
- Location of trash cans
- Location and width of aisles
- Rooms or passageways
- Stairways (risers, direction, borders)
- Drinking fountains and food-dispensing machines

Safety instruction signs—Safety instruction signs are used for general instructions and suggestions related to safety measures (*Figure 26*). The background and lettering on these signs are often white and green, but they can vary depending on the message and the location of the sign. Any letters used against the white background are black. Common examples include Report All Unsafe Conditions To Your Supervisor; Walk, Don't Run; and Help Keep This Plant Safe and Clean.

Safety tags—Safety tags are used as a temporary warning about immediate and potential hazards (*Figure 27*). They are similar to signs, but they are not designed to be used in place of signs or as a permanent means of protection. For example, an Out of Order tag may be used on damaged equipment until it can be disposed of or repaired.

Figure 23 Typical danger sign.

Figure 24 Typical caution sign.

Figure 25 Common informational sign.

Figure 26 Common safety sign.

A Do Not Start tag may be placed on machinery during **lockout/tagout procedures**, which identify hazardous equipment and prevent their use until they have been certified as safe. Tags and the devices used to attach them must meet specific requirements to ensure their durability and effectiveness.

2.3.2 Signals

Signals are used to inform workers of potential dangers. Types of signals include alarms, bells, buzzers, whistles, horns, and hand signals. Hand signals control vehicle traffic, guide the handling of materials, and assist equipment operators. All affected workers must know what each hand signal means before it is used. The meaning should be confirmed between the equipment operator and spotter or person giving the operator the signals before a task is started.

Figure 27 Examples of safety tags.

2.3.3 Barricades and Barriers

Any opening in a wall, floor, or the ground is a safety hazard. There are two types of protection for these openings: guarded or covered. You should cover a hole whenever possible, but when it is not practical to cover a hole, use barricades. If the bottom edge of a wall opening is less than 3 feet above the floor and would allow someone to fall 4 feet or more, place **guards** around the opening. For instance, you would place guards around a window opening several stories up to prevent a worker from sitting on the opening and falling out the window. The two most commonly used guard methods are railings and warning barricades. Typical warning barricades are made of plastic tape or rope strung from wire or between posts. The tape or rope is color-coded red, yellow, or yellow and purple.

Red means danger. No one may enter an area with a red warning barricade. A red barricade is used when there is danger from falling objects or when a load is suspended over an area.

Yellow means caution. You may enter an area with a yellow barricade, but you must know what the hazard is and be careful. Yellow barricades are used around wet areas or areas containing loose dust. Yellow with black lettering warns of physical hazards, such as bumping into something, stumbling, or falling.

Yellow and purple indicates a radiation warning. No one may pass a yellow and purple barricade. These barricades are often used where piping welds are being X-rayed.

Hazardous Environments

On some work sites, you need to be aware of radiation and biological hazards. Be on the lookout for signs indicating these hazards.

Protective barricades provide both a visual warning and protection from injury. They can be posts, rails, chain, or cable. People cannot get past protective barricades. Blinking lights are placed on barricades so they can be seen at night.

2.3.4 Walking and Working Surfaces

Slips, trips, and falls on walking and working surfaces cause 15 percent of all accidental deaths in the construction industry. Some accidents occur because of environmental conditions, such as snow, ice, or wet surfaces. Others happen because of poor housekeeping and careless behavior, such as leaving tools, materials, and equipment out and unattended. Such accidents can be avoided if workers are aware of their surroundings and follow the rules on the site. It is your responsibility to keep all walking and working surfaces clean and dry.

Floors—Floors can be a hazard in a number of ways. Ice, grease, oil, or wet processes can make them slippery. Tools, equipment, materials, or litter can clutter them. Unguarded openings in the floor or ground can cause fatal falls. Some of the types of openings to be aware of on a work site include stairs, hatches, chutes, trapdoors, and maintenance access holes (manholes). You can avoid slips, trips, and falls on floors by making sure the surface is free of ice, snow, moisture, and clutter. If you cannot remove the ice, wear shoes with skid-resistant cleats. If wet processes are used in the work area, make sure there is proper drainage, grating, and mats. Keep the floor clear of tools, equipment, materials, or litter that you could trip over or would cause you to slip. Avoid openings in floors unless they are properly guarded or covered.

Walls—Openings in walls, such as windows, doors, and chutes, are generally at eye level and seem easy to avoid. However, wall openings are dangerous when the openings are not protected by guardrails or fences. Any rain entering the opening may cause a slipping hazard. For example, if you lose your balance and fall near an unguarded wall opening, you could slip through the opening and fall to the ground or a lower work area. Tools or materials that fall through the opening can seriously injure those below. If you are working near a wall opening, make sure it is barricaded and that the work area is dry and free of clutter.

Platforms—Platforms are work areas elevated above the floor or ground. Platforms may be located above dangerous equipment, such as galvanizing tanks or degreasing units. Many platforms do not have guardrails. These platforms, called open-sided platforms, are hazardous because they do not protect workers from falling over the edge. To help prevent accidents, make sure platforms are dry and clear of materials and debris before stepping onto them.

Ramps and runways—The hazards of ramps and runways are similar to those of floors. Workers can trip on tools and equipment or slip on wet or icy surfaces. Ramps and runways can be more dangerous, however, because they are sloped. When slips, trips, and falls happen at a downhill angle, the worker slides or rolls down the ramp or runway more quickly and hits the ground harder. The resulting injuries are often more serious. Imagine if a worker were carrying a tool with a sharp blade or edge during such an accident. It is likely that the worker would be injured from the blade or edge of the tool, as well as the fall. You can avoid slips, trips, and falls on ramps and runways by following these guidelines:

- Check the surface before using it. If the ramp or runway is icy or wet, don't use it until it is dry and free of ice. If the ice cannot be removed, wear shoes with skid-resistant cleats.
- Make sure the ramp is clear of tools, equipment, materials, or debris.
- Make sure any tools or equipment you are carrying are turned off and secured. This will help prevent injuries if you fall.

Stairs—Workers use stairs to travel between levels, in and out of pits, and on and off platforms. Stairs can be wet, icy, or slippery depending on the location. They can also be damaged or cluttered with tools and equipment. All of these conditions can cause workers to slip, trip, or fall. Don't use stairs if you notice any of these conditions or if the stairs do not have a guardrail.

Ladders—The greatest hazard of using a ladder is falling. Workers can fall from the ladder, or the ladder can slip out from under them. Most falls occur when the ground or ladder is wet (*Figure 28*) or icy, or the ladder is not properly secured. Serious injuries or death can result. These safe practices can help prevent slips and falls from ladders:

- Use appropriate fall protection.

- Wear safe, strong work boots that are in good condition.
- Watch where you step. Be sure your footing is secure.
- Maintain clean, smooth walking and working surfaces. Fill holes, ruts, and cracks.
- Clean up slippery material.
- Pick up litter.
- If you must climb to reach something, use a sound ladder that has been safely set up and properly secured at the top and bottom (*Figure 29*).
- When climbing a ladder, always face the ladder and use both hands.
- Always maintain three-point contact with the ladder: one hand and two feet or two hands and one foot.
- Don't overreach from a ladder. Climb down and move the ladder to the desired position.
- Don't walk a ladder.

WARNING!

Metal ladders conduct electricity. Never use metal ladders around electrical equipment. Although wooden ladders do not conduct electricity, you must not use them around electrical equipment if the wood is wet or damp. Even a small amount of water will act as a conductor.

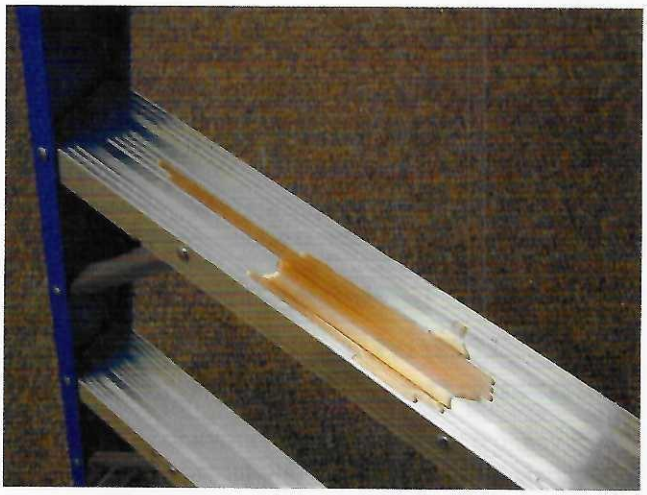
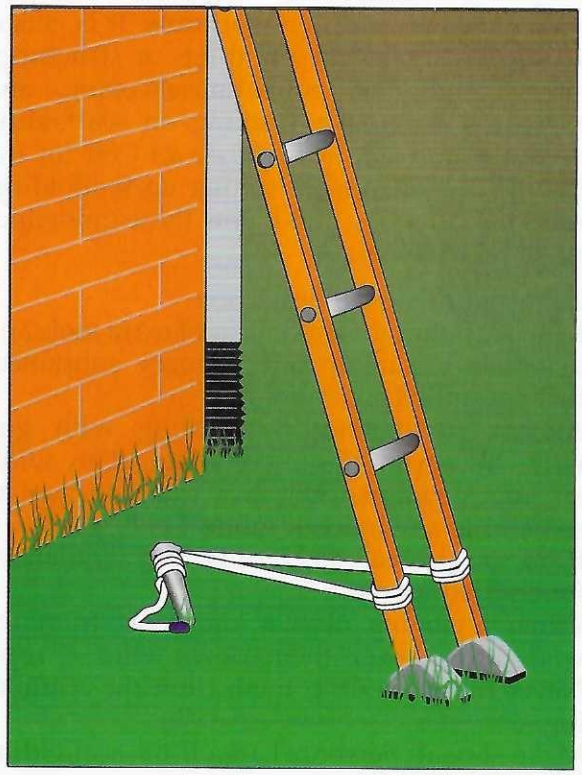
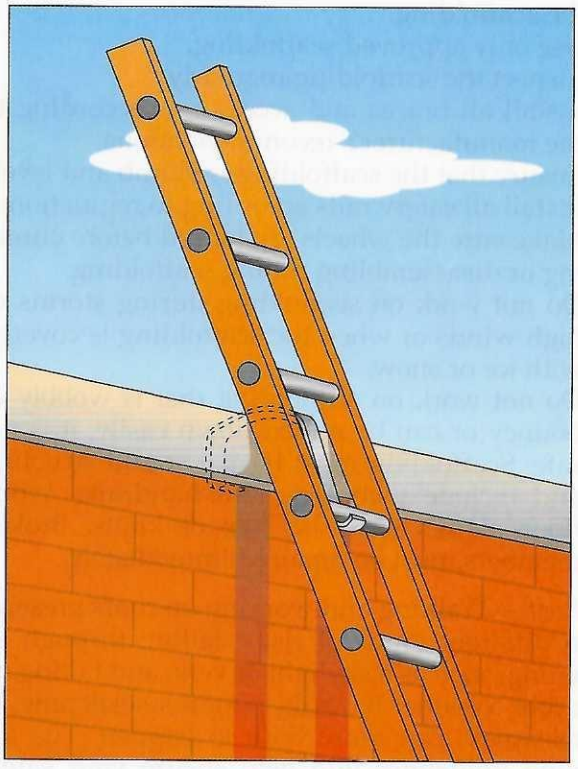


Figure 28 Liquid on a stepladder.



BOTTOM SECURED



TOP SECURED

Figure 29 Properly secured ladders.

Scaffolding—Scaffolding supports workers and materials on elevated platforms. It is generally used on multistory buildings or structures. Weather conditions, poor housekeeping, and carelessness can make working on scaffolding very dangerous. Always refer to *29 CFR* for detailed instructions before setting up scaffolding. Always pay attention and follow these guidelines to avoid injury or death:

- Use appropriate fall protection.
- Keep scaffolding planks clear of extra tools and materials. Clean up any slippery substances that get spilled on scaffolding.
- Anchor freestanding scaffolding with **guy wires** to prevent tipping or sliding. Guy wires are ropes, chains, cables, or rods attached to something as a brace or guide.
- Read the posted safety rules and regulations for scaffolding use.
- When removing objects and tools from the work area, lower them down with a rope. Never throw or drop them from the scaffolding.
- Make sure all personnel are off the scaffolding before moving it.
- Keep tools and materials back from the edge of the scaffolding.
- Use only approved scaffolding.
- Inspect the scaffolding regularly.
- Install all braces and accessories according to the manufacturer's recommendations.
- Ensure that the scaffolding is plumb and level.
- Install all safety rails according to regulations.
- Make sure the wheels are locked before climbing or disassembling rolling scaffolding.
- Do not work on scaffolding during storms or high winds or when the scaffolding is covered with ice or snow.
- Do not work on scaffolding that is wobbly or bouncy or can be pulled down easily; it is not safe. Scaffolding must have a sound structure and include toeboards and handrails. Wood floor planks must be free of knots. Broken members must be repaired immediately.

Roofs—Walking and working on roofs presents two different kinds of risks: falling through an opening, such as a skylight or vent, and falling off the roof. Weather hazards, poor housekeeping, or carelessness can cause both to happen. The following guidelines will help ensure your safety when working on a roof:

- Wear appropriate fall protection, even on shallow-pitch roofs.
- Wear boots or shoes with rubber or crepe soles that are in good condition.
- Rain, frost, and snow are all dangerous because they make a roof slippery. If possible, wait until the roof is dry. Otherwise, wear special roof shoes with skid-resistant cleats in addition to wearing fall protection.
- Brush or sweep the roof periodically to remove any accumulated dirt or debris.
- Remove any unused tools, cords, and other loose items from the roof. They can be a serious hazard.
- Be alert to any other potential hazards, such as live power lines.
- Use common sense. Taking chances can lead to injury or death.

WARNING!

When working 6 feet or more above ground, you must tie off and wear appropriate fall protection. Failure to do so can result in falls that lead to severe injury or even death.

Always use caution when walking or working on or near these surfaces, especially if there are other hazards in the area.

2.3.5 Motorized Vehicles

Your ability to get and keep a job in the plumbing industry depends partly on your ability to maintain an acceptable driving record. According to experts, motor vehicle accidents are a top issue for plumbing contractors. Auto liability losses account for 43 percent of all contractor insurance losses and 30 percent of the dollars paid to settle these losses. One of your responsibilities is to operate motorized vehicles safely on construction sites and on the road.

Case History

Pay Attention to Warnings

A 21-year-old laborer had been throwing old roofing materials off a roof with six unguarded skylights. During a work break, he sat down on one of the skylights, which began to break under his weight. He tried to raise himself from the skylight with his arms, but the plastic dome collapsed. He was killed when he fell 27 feet to the concrete floor below. The victim had been warned by his supervisor and coworkers not to sit on the skylights.

The Bottom Line: Ignoring safety warnings can be fatal.

Source: National Institute of Occupational Safety and Health

Motorized vehicles include trucks, vans, forklifts, backhoes, and cranes. Motorized equipment includes portable equipment, such as generators, compressors, and pumps, and larger equipment, such as earth-moving equipment and personnel platform. A piece of motorized equipment is considered portable if it can be transported from job site to job site or to different areas on the same job site. Whether you are operating one of these vehicles on the construction site, working nearby, or driving a vehicle on the roadways, you must adhere to the safety precautions outlined in this section.

Many motor vehicle accidents can be prevented. It is your responsibility to be aware of the necessary safety measures to protect yourself and your co-workers. The following are some personal safety guidelines:

- Do not work if you are taking a prescription medicine that could impair your motor or thinking skills.
- Never drink alcohol prior to work or during work hours. Never drink alcohol before or when driving.
- Never, under any circumstances, use illegal drugs.
- Buckle up. Always wear your safety belt and ensure that any passengers wear theirs.
- Ensure that all passengers are seated in a firmly secured seat. Do not allow anyone to ride in a truck bed.

Just as you routinely check your PPE, you should also routinely check any vehicle you are responsible for operating. Use the following guidelines to ensure vehicle safety:

- Ensure that safety devices such as the horn, backup alarm, mirrors, and brakes are in good working order. (Brakes include trailer brake connections, parking system or hand brakes, and emergency brakes.)
- Keep windshields, side windows, mirrors, and lights clean and functional. Keep windshield washer wells supplied with cleaning fluid.
- Always shut off the engine before fueling.
- Never run motorized vehicles in an enclosed, unventilated area.
- Ensure that the area behind your vehicle is clear before backing up. Safe backing tips are presented later in this section.
- Carry safety equipment, such as flares and fire extinguishers.
- Tie down or secure truck bed loads, and secure rear gates.
- Never remain in a truck that is being loaded by excavating equipment. Stand clear of the area until the loading is completed and the load is secured.

Reckless Driving

Reckless driving is a common cause of accidents. It is also one of the most preventable. The following are some examples of reckless driving:

- Driving too fast for conditions
- Not looking in the direction of travel
- Stopping, starting, or turning suddenly

To avoid these and other hazards, always observe the following rules:

- Adjust speed for driving conditions. Slow down on wet, bumpy, or slippery surfaces.
- Drive with the load as low as possible and tilted back.
- Look in the direction of travel; this includes backing up.
- Make smooth, deliberate starts, stops, and turns. Sudden movements can cause load shifts or vehicle instability.
- Watch for people and other vehicles.

- Ensure that levers used to control hoisting or dumping are latched when not in use to prevent accidental starting or tripping of the mechanism.
- Stand clear of levers used to control hoisting or dumping while these devices are in operation.
- Always turn off the engine and set the brakes before leaving the vehicle.
- Immediately report any unsafe conditions on vehicles to your supervisor.

When you drive a company-owned vehicle, you must use it only for your assigned tasks. Most companies have a written policy governing the use of company-owned vehicles. Employees who do not follow the policy may be, and should be, disciplined or fired. Although specific rules vary from one company to another, in general, they cover the following areas:

- If you operate a licensed vehicle owned or controlled by the company, you must maintain a current driver's license as required by federal or state regulations.
- Do not transport non-employee passengers. Do not allow non-employees or unqualified employees to use company vehicles, unless an authorized official of the company has given permission.
- Inspect your company vehicles at the beginning of each workday and keep them clean.

- Obey all traffic laws. All fines are your responsibility. Report any traffic citations to your supervisor in writing. Repeated violations may result in suspension or dismissal.
- Wear your seat belt at all times, and be sure that others in the vehicle wear theirs.
- When you leave a vehicle unattended, remove the keys, set the brakes, roll up the windows, and lock the doors.
- Consumption of alcohol or nonprescription drugs is grounds for immediate dismissal, whether ingested before work or while on the job. If you are taking prescribed medication that may affect your ability to perform your duties safely, you must notify your supervisors when you report to work.
- Tell your safety director or supervisor immediately about any incidents involving damage to company property, property of others, personal injury, or injury to others. Failure to report accidents involving a company vehicle is grounds for termination.
- Do not use radar-detection equipment in any company vehicle.
- Be courteous to other motorists. You and the vehicle are a rolling billboard for your company.
- Be trained in and use good defensive driving techniques while operating company vehicles. Employees should follow all insurance requirements.
- Remember that you are also responsible for all tools and equipment assigned to your company vehicle.
- Be sure your vehicle is equipped with an appropriate fire extinguisher and a first-aid kit.

You must take extra precautions when backing up construction vehicles. Whenever possible, avoid backing to avoid the increased risks that come with reduced visibility behind any vehicle. Find a parking spot that allows you to leave the site without backing up. However, many sites have tight or constricted turning areas, and you are not always able to avoid backing up. In those cases, follow these backing safety guidelines:

- Avoid blocking the rearward inside view with equipment and stock.
- Walk completely around the vehicle first, to check for hazards you may encounter when backing up. Don't forget to look up for overhangs and electrical wires.
- Before backing up, roll down the window and turn off the radio. Check all mirrors and look over both shoulders. Sound the horn twice or activate the backup alarm to warn others. Back up slowly.
- Whenever possible, have a co-worker guide you. The use of a radio can also be helpful when communicating with the guide. The guide should stand at the rear driver's side of the vehicle (if there is room) and use full-motion arm signals, not hand signals. If you lose sight of your guide, stop immediately. Do not start again until your guide is visible.
- When parking in an area from which you will have to back up, place orange traffic cones behind the vehicle to ensure that this area remains clear.

WARNING!

Operating a motorized vehicle in an indoor location without proper ventilation can sicken or even kill you. All motorized vehicles emit carbon monoxide as part of their exhaust. You cannot see, smell, or taste carbon monoxide, and you will not know when it is in the air. Never leave your vehicle running when it is not being used. Do not leave keys in an unattended vehicle. Only use approved vehicles indoors, and do so under the supervision of a competent person.

WARNING!

Construction sites can be extremely noisy. Noise on the site may prevent you from hearing a back-up alarm. Use your eyes as well as your ears when operating or working around motorized vehicles to prevent being struck by a motorized vehicle, lever, crane, or load.

Defensive Driving

Your best protection against a motor vehicle accident is to become a defensive driver. Defensive drivers stay focused on the road, on road conditions, and on the other drivers around them. Here are some tips (in addition to the safety guidelines included in this section) to help you stay focused and be a good defensive driver:

- Avoid long cell phone calls while driving. Even with a hands-free unit, you can become distracted. Pull over to complete your calls.
- Get in the habit of checking your blind spots frequently.
- Avoid eating, drinking, talking on the cell phone, or smoking while driving. Hot burning ashes or spills of hot or cold food or liquids can all distract you momentarily, which is enough time for an accident to happen.
- Clean off the dashboard and seats. Papers, clipboards, empty paper cups, small tools, and other debris on your dashboard and seats will slide around while you are driving and can distract you. If you have to make a sudden stop, those items will become airborne and could cause injuries.
- Know where you are going before you start your vehicle. If you must consult a map, pull over. Do not try to navigate and drive at the same time.
- Become a weather-wise driver. When the weather includes ice, snow, fog, or wet pavements, change your driving pattern to accommodate the conditions. Slow down and be especially watchful of the cars around you. Be prepared to take defensive actions to protect yourself.

Remember, most accidents happen while the vehicle is being backed up. Always check your rearview and sideview mirrors, use backup alarms, and be sure that your path is clear.

Additional Resources

Environmental Protection Agency. *www.epa.gov.*

National Safety Council. *www.nsc.org.*

OSHA. *www.osha.gov.*

2.0.0 Section Review

1. When welding, you must wear _____.
   a. safety glasses
   b. safety glasses with side shields
   c. tinted goggles or a hood
   d. safety goggles with a wrap-around strap

2. The color blue on an NFPA warning diamond indicates a(n) _____.
   a. fire hazard
   b. health hazard
   c. explosion hazard
   d. radioactive hazard

3. The sign or tag that is used to tell workers that an immediate hazard exists and that specific precautions must be observed to avoid an accident is a(n) _____.
   a. danger sign
   b. caution sign
   c. informational sign
   d. safety instruction sign

SECTION THREE

3.0.0 SAFETY PRECAUTIONS FOR USING TOOLS

Objective

Identify the safety precautions required when using hand and power tools.

a. Describe the safety precautions associated with hand tools.
b. Describe the safety precautions associated with power tools.

Performance Tasks

4. Inspect power tools (corded and cordless) to ensure they are safe to use.
5. Inspect hand tools to ensure they are safe to use.

Trade Terms

Bladed tools: Tools that use sharp edges to accomplish their tasks. Bladed tools include saws, knives, scissors, tin snips, and wire cutters.

Electrically powered tools: Tools that use electrical current to operate.

Fire watch: One or more people who are responsible for preventing and extinguishing fires and notifying the fire department and/or occupants in the event of a fire emergency.

Impact tools: Tools that must strike or be struck to accomplish their task. They include hammers, chisels, and taps.

Liquid-fuel tools: Tools that use a liquid fuel, such as gasoline or liquid propane, to operate.

Tools are used every day on a job site, and it is easy to forget that they can pose serious safety risks. The types of injuries that occur vary. Some are the result of workers tripping on tools, electrical shock, sharp edges, or fire. Others are due to carelessness or lack of training. The following list demonstrates the types of injuries that occur as a result of hand and power tool accidents:

- Burns
- Cuts
- Sprains
- Electrical shock
- Eye injuries
- Hearing loss
- Broken bones

3.1.0 Hand Tools

Hand tools are nonpowered tools that require the worker's strength and force to operate. Hand tools become dangerous when they are misused or improperly maintained. **Bladed tools** (tools with sharp edges) and **impact tools** (tools that must be hit or struck) present a great risk of injury because of the force needed to operate them. The best way to reduce hand-tool accidents is to inspect and maintain tools regularly and always wear appropriate PPE.

3.1.1 Bladed Tools

Bladed tools (*Figure 30*), such as saws and utility knives, present the risks of cutting, slicing, snipping, and stabbing. These injuries can be as minor as a small cut or as severe as an amputation or stab wound. To minimize these risks, adhere to the following:

- Use bladed tools with the blades and points aimed away from yourself and others.
- Direct bladed tools away from aisles.
- Store bladed tools properly; use the sheath or protective covering if there is one.
- Keep blades sharp and inspect them regularly. Dull blades are hard to use and control and can be far more dangerous than sharp blades.

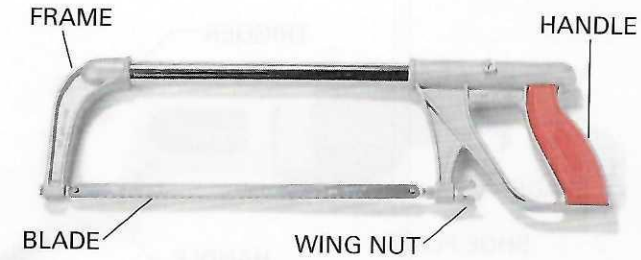
3.1.2 Impact Tools

Impact tools (*Figure 31*), such as chisels and punches, work by striking them with a hammer. The most common types of injuries caused by impact tools are hammer strikes and eye injuries from flying tool fragments. Getting struck by a hammer is usually the result of carelessness or not paying attention. If you are using a hammer, keep your eyes and your mind on what you're doing.

You can prevent injuries caused by tool fragments flying off damaged tools by inspecting the tool before using it. Look for mushroomed heads, cracks, chips, or other signs of damage or weakness. Wear proper eye protection while using impact tools.

3.1.3 Dust and Suspended Particles

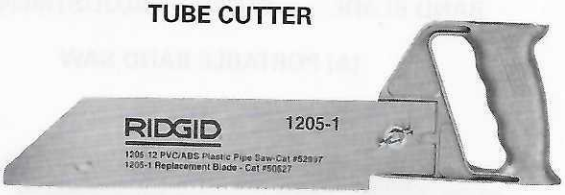
Some hand tools create a lot of airborne dust and particles. Sandpaper, planes, files, and saws, for example, may create a lot of sawdust or drywall powder. Short-term exposure to these particles may cause minor irritation of the eyes, nose, or sinuses. In some people, exposure may trigger a



HACKSAW

TUBE CUTTER

UTILITY KNIFE



ALL PURPOSE (PVC) SAW

Figure 30 Bladed tools.

more serious reaction, such as an asthma attack. Long-term exposure over the course of a career can affect your lungs, possibly causing lung disorders. To help prevent these conditions, wear filtering masks and eye protection when you are using a tool that creates dust.

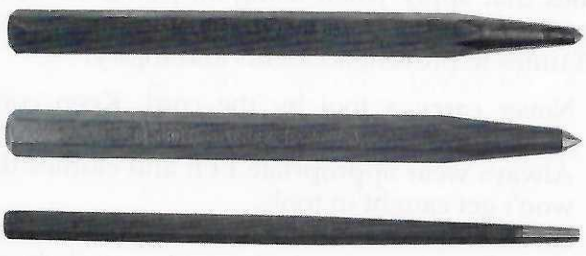
3.2.0 Power Tools

Power tools, as explained above, are powered by electricity, pressurized air, or fuel (*Figure 32*). They can be hazardous when they are improperly used or poorly maintained. Most of the risks associated with hand tools are also associated with power tools. Adding a power source to a tool increases the risk factors. For example, a radial saw arm is far more dangerous than a hand-powered saw.

Power tools are powered by different sources. Power sources for those used in plumbing include electricity and fuel, such as propane gas.

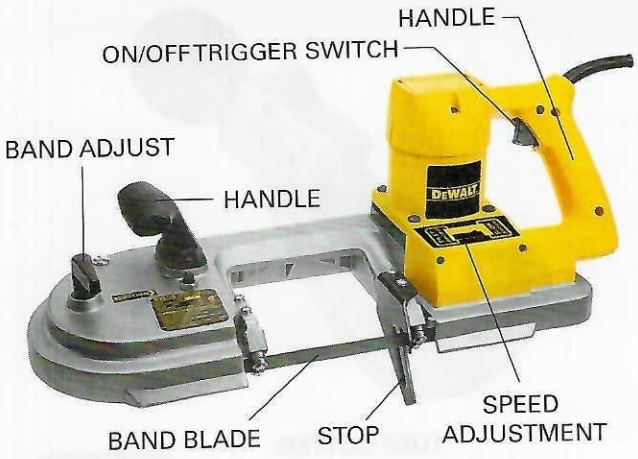
You should know the safety rules and operating procedures and be properly trained for each tool you use. The user's manual supplied by the tool's manufacturer provides specific operating procedures and safety rules. Before operating any power tool for the first time, always read the manual to become familiar with the tool. If the manual is missing, contact the manufacturer for a replacement.

CHISELS

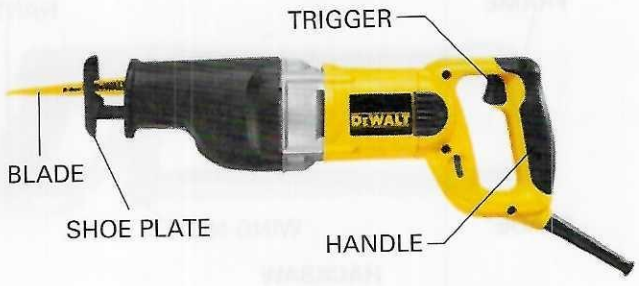


PUNCHES

Figure 31 Impact tools.



(A) PORTABLE BAND SAW



(B) RECIPROCATING SAW

(C) HAMMER DRILL

(D) ROTARY HAMMER DRILL

Figure 32 Power tools.

It's important to understand the general safety rules that apply when using all power tools, regardless of type. Use the following safeguards at all times to prevent accidents and injury:

- Never carry a tool by the cord. Keep cords away from heat, oil, and sharp edges.
- Always wear appropriate PPE and clothes that won't get caught in tools.
- Do not distract others or let anyone distract you; do not engage in horseplay; and do not run or throw objects.
- Never leave a power tool running unattended.
- Secure work with clamps or a vise, leaving both hands free to operate the tool.
- Be sure that an electrical power tool is properly grounded and connected to a ground fault circuit interrupter (GFCI) before using it (see *Figure 33*).
- Do not use dull or broken tools or accessories. Never use tools with frayed cords.
- Never use a power tool with guards or safety devices removed or disabled. Use electric extension cords of sufficient size to service the power tool you are using.
- Never operate a power tool if your hands or feet are wet. Keep the work area clean at all times.
- Keep a firm grip on the power tool at all times.
- Report unsafe conditions to your instructor or supervisor. Remove damaged tools from use and tag out with Do Not Use tags.

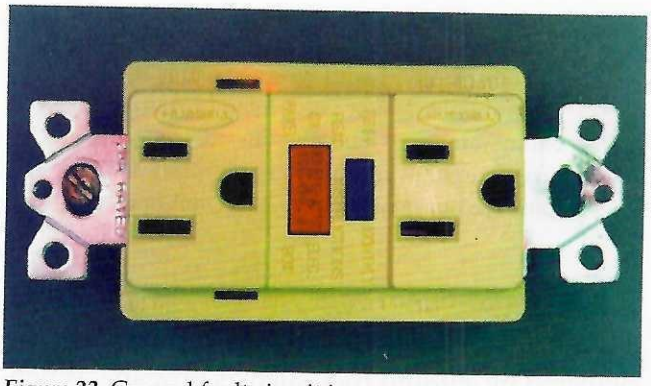


Figure 33 Ground fault circuit interrupter.

3.2.1 Electrically Powered Tools

A serious danger in using **electrically powered tools** is electrocution. The electricity that powers the tool can cause burns, shocks, explosions, electrocution, and fires. Electrical shocks can be minor and uncomfortable or they can be severe, causing burns or death. Even a small amount of current can cause the heart to stop pumping in rhythm. If not corrected, this condition will result in death. Electrical shock can also cause a loss of balance, muscle control, or consciousness, which could then cause the victim to fall or drop a tool. A fall from a ladder or scaffolding can be quite serious. To prevent electrical shock, tools must provide at least one of the following types of protection:

- *Double insulated*—Double insulation is more convenient than three-wire cords. The user and tools are protected in two ways: by normal insulation on the wires inside and by a housing that cannot conduct electricity to the user in the event of a malfunction.
- *Powered by a low-voltage isolation transformer*—If your electrically powered tools do not have either a ground plug or double insulation, check with your supervisor to make sure that you are protected by a low-voltage isolation transformer.
- *Grounded with a three-wire cord*—Three-wire cords have two current-carrying conductors and one grounding conductor. You are probably familiar with the three-prong plug common on electrically powered tools. When there is a three-prong cord, that means the tool is powered by a grounded three-wire cord, and it should only be plugged into a three-prong, grounded receptacle. Never remove the third prong (grounding conductor) from a plug. If you are using a three-prong extension cord, make sure that it is properly grounded at its source. The tool being used must be protected by a GFCI or a generator.
- *Twist locks*—Twist locks on tool plugs ensure the power source matches the tool's voltage rating. The arrangement of the plug conductors can only fit into receptacles that are wired to the appropriate voltage. A second advantage is that the plugs, once inserted, don't pull out. Twist locks have a high impact resistance.

You can avoid accidents and injury when using electrically powered tools. Follow these guidelines to protect yourself and your co-workers:

- Use the right tools for the job, and use them the right way.
- Wear all appropriate PPE, such as gloves and safety footwear.
- Store power tools in a dry place when not in use.
- Never use electrically powered tools in damp or wet places.
- Work only in well-lit work areas.
- Consult local codes before working with electrical equipment.

Because malfunctioning electrically powered tools can cause sparks, these tools can cause fires and explosions. Make sure you are aware of any fire hazards in your work area. Avoid using electrically powered tools around flammable materials, fumes, and gases.

Finally, electrical cords and extension cords pose a tripping hazard. Extension cords should be brightly colored to make them more visible. Cords and cables should be run somewhere other than walkways, or at least along a wall, rather than in the middle of a walkway or across a walkway. Avoid running cables and cords across elevated work areas and scaffolding. Occasionally, it may be necessary to run a cord or cable across a walkway. If so, either tape the cord down and put a carpet over it, or place it in a cord runner designed to minimize the tripping hazard. When electrical and extension cords are no longer in use, always hang the cords according to OSHA standards for keeping floors clear. To avoid creating tripping hazards, workspaces, walkways, and similar paths must be clear of cords. Never use worn or frayed cables (*Figure 34*). Turn in any frayed cords that you encounter to your supervisor.

CAUTION

Do not run a cord through doorways or through holes in ceilings, walls, and floors, which might pinch the cord. Check to see whether there are sharp corners along the cord's path. Any of these situations can lead to cord damage. Extension cords are a tripping hazard. They should never be left unattended and should always be put away when not in use.

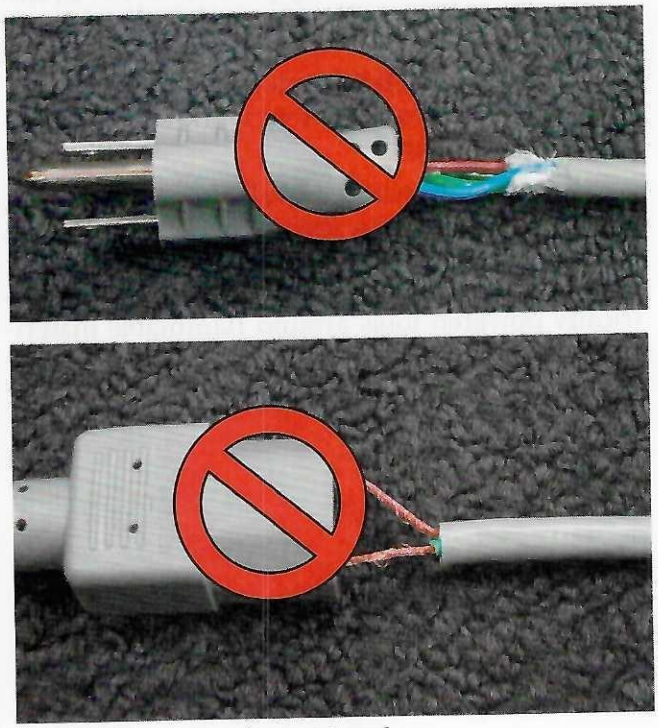


Figure 34 Never use damaged cords.

CAUTION

Frayed electrical cords can cause electrocution. Never use a power tool if the cord is frayed or damaged. Never use frayed or damaged extension cords. Follow your company's procedures for removing equipment with damaged or frayed cords from service.

3.2.2 Liquid-Fuel Tools

Some power tools, like torches (see *Figure 35*), are powered by a liquid fuel, such as propane. Whenever a torch is used, a fire extinguisher must be nearby. The most serious hazard with fuel-powered tools comes from fuel vapors that can burn or explode. Burning liquid fuel also gives off exhaust fumes, which can be dangerous. Here are a few tips on using **liquid-fuel tools** safely:

- Always wear the appropriate PPE, including eye protection, gloves, and respirators, if necessary.
- Handle, transport, and store the fuel only in approved flammable-liquid containers.

Figure 35 Acetylene torch kit and tank on rolling cart.

- Before refilling the tank for a liquid-fuel powered tool, shut down the engine and allow it to cool. This reduces the risk of a hot tool igniting fuel vapors.
- If you are using a liquid-fueled tool inside a closed area, there must be adequate ventilation and/or respirators in use so you can avoid breathing dangerous exhaust fumes.
- When you are using a liquid-fuel powered tool, make sure fire extinguishers are available nearby.
- When using torches, a **fire watch** (people who are responsible for preventing and putting out fires) should be maintained.

WARNING!

Propane gas is heavier than air. When there is no ventilation, leaking propane will settle in low places, such as along floors or at the bottom of a trench. You must not strike a match or operate electrical equipment near a propane leak, as this may cause an explosion. Propane will replace oxygen and may cause suffocation in confined spaces.

Case History

Added Oxygen Causes Death

A welder entered a 24-inch-diameter steel pipe to grind a bad weld on a valve about 30 feet from the entry point. Before he entered, other crew members decided to add oxygen to the pipe near the bad weld to make sure the air was safe. The welder had been grinding off and on for about five minutes when a fire broke out. The fire covered his clothing. He was pulled from the pipe, and the fire was put out. The burns were so serious that the welder died the next day.

The Bottom Line: This accident could have been avoided. It happened because of poor communication among workers and unsafe work practices.

Source: Occupational Safety and Health Administration

Additional Resources

OSHA website. *www.osha.gov.*

3.0.0 Section Review

1. A bladed hand tool is safest if it is _____.
   a. slightly dull to prevent serious cuts
   b. inspected and sharpened regularly
   c. well oiled
   d. kept warm to prevent shattering

2. Liquid-fuel tools could start a fire when the _____.
   a. fuel vapor comes into contact with a hot tool
   b. power cord comes into contact with fuel vapor
   c. operator is using the tool while standing in water
   d. air hose is not grounded

SECTION FOUR

4.0.0 SAFETY PRECAUTIONS FOR SPECIFIC WORK AREAS

Objective

Identify the safety precautions associated with various work areas.

a. Describe the safety precautions associated with work in trenches.
b. Describe the safety precautions associated with confined spaces.
c. Identify the safety precautions associated with underground work.
d. Demonstrate a lockout/tagout procedure.
e. Describe jobsite safeguards and emergency response procedures.

Performance Tasks

6. Demonstrate/simulate the proper methods of lockout/tagout for energy sources.

Trade Terms

Atmospheric hazards: Potential dangers in the air or conditions of poor air quality.

Benching: A method of protecting workers from cave-ins by excavating the sides of an excavation to form one or a series of horizontal levels or steps, usually with vertical or near-vertical surfaces between levels.

Combustible: Air or materials that can explode and cause a fire.

Energy-isolating device: Any mechanical device that physically prevents the transmission or release of energy. Can include manually operated electrical circuit breakers, disconnect switches, line valves, and blocks.

Energy sources: Any sources of electrical, mechanical, hydraulic, pneumatic, chemical, thermal, or other energy.

Gassy operations: Working conditions in which one or more of the following conditions exist: higher than minimum levels of methane or explosive gases are present; a gas ignition has previously occurred there; or the area is connected to an underground area designated a gassy operation.

Hypothermia: A life-threatening condition caused by exposure to very cold temperatures.

Lockout: The placement of a lockout device on an energy-isolating device, in accordance with an established procedure, ensuring that the energy-isolating device and the equipment being controlled cannot be operated until the lockout device is removed.

Lockout devices: Any devices that use positive means such as a lock to hold an energy-isolating device in a safe position, thereby preventing the energizing of machinery or equipment.

Nonpermit-required confined space: A confined workspace free of any atmospheric, physical, electrical, and mechanical hazards that can cause injury or death.

Oxygen-enriched atmosphere: An atmosphere in which there is too much oxygen. Usually considered more than 23.5 percent oxygen by volume.

Permit-required confined space: A confined space that has actual or possible hazards. These hazards can be atmospheric, physical, electrical, or mechanical.

Protective system: A method of protecting employees from cave-ins, from material that could fall or roll from an excavation face or into an excavation, or from the collapse of adjacent structures. Protective systems include support systems, sloping and benching systems, and shielding systems.

Shoring: A structure such as a metal hydraulic, mechanical, or timber system that supports the sides of an excavation and is designed to prevent cave-ins.

Subsidence: A depression in the earth that is caused by unbalanced stresses in the soil surrounding an excavation.

Tagout devices: Any prominent warning devices, such as a tag and a means of attachment that can be fastened securely to an energy-isolating device in accordance with an established procedure. The tag indicates that the machine or equipment to which it is attached is not to be operated until the tagout device is removed in accordance with the energy-control procedure.

Trench shields: Structures that are able to withstand the forces imposed on them by a cave-in and can thereby protect employees within the excavation. Shields can be permanent structures or portable and moved along as work progresses. Shields can be either premanufactured or job-built in accordance with *29 CFR 1926.652 (c)(3) or (c)(4).*

Certain work areas have hazards that require special safety precautions. These areas include work in trenches, confined spaces, and underground areas. In addition, work in areas of operating equipment or stored energy systems will require the use of appropriate lockout/tagout procedures. All workers must be aware of the specific safeguards and emergency response procedures for each job site.

4.1.0 Trenching

Safety is crucial during any excavation job. Safety precautions must be exercised at all times to prevent injury to yourself or other workers. Always use the most recent edition of the OSHA manual as the governing standards for excavation safety.

Excavations are done for a number of reasons, including laying pipe and locating utility and sewage lines. During an excavation, earth is removed from the ground, creating a narrow excavation made below the surface of the ground called a trench. The trench width, and usually the depth, are limited to 15 feet. The soil that is removed from the ground is called spoil. When soil is removed from the ground, extreme pressures may be generated on the trench walls. If the walls are not properly secured by **shoring** (a structure that supports the sides of an excavation), sloping, or shielding, they will collapse (*Figure 36*). The collapse of unsupported trench walls can instantly crush and bury workers. This type of collapse happens because not enough material is available to support the walls of an excavation.

Excavation Safety

Federal and state safety regulations have established standards for protecting those who work in excavations. *OSHA 29 CFR 1926* defines the trench protective devices that are acceptable. OSHA mandates how the protective devices must be used. In accordance with OSHA regulations, using appropriate manufactured and engineered trench-shielding and -shoring devices or sloping trench walls to angles that eliminate the risk of cave-ins other than in a stable location is required for excavations 5 feet or deeper.

Figure 36 Trench shield.

Case History

Ditch Collapse

A plumber was laying sewer lines in a ditch 2-½ feet wide and 8 feet deep. When he stood up to stretch his legs, the ditch collapsed. Dirt from the inadequately supported ditch buried him past his hat. Luckily, another plumber was nearby to uncover his head quickly. A backhoe was then used to free him.

The plumber was seriously injured. He suffered a skull fracture, broken jaw, damaged hips, and minor brain damage. He recovered from the accident but now has two artificial hips and a neurological disorder.

The Bottom Line: This plumber would not have been injured if he had followed OSHA's requirements for trenching. Be aware of your surroundings and follow OSHA regulations.

4.1.1 Trenching Hazards

Working in and around excavations is one of the most hazardous jobs you will ever do. The design of the excavation may not be your responsibility, but you should be aware of the safety hazards involved in the placement and design of the excavation. You must take safety precautions at all times to prevent injury to yourself and others. Some of the hazards you may encounter during an excavation include the following:

- Surface encumbrances (buildings, vegetation, rocks, or other objects along the surface area of the trench that can hinder operations and block sightlines)
- Underground installations (sewer, telephone, fuel, electric, water lines)

- Flooding from broken water or sewer mains
- Hazardous atmospheres (toxic liquid or gas leaks)
- Cave-ins due to trench failure
- Falls from employees working too close to the trench edge
- Electrical shock from striking electrical cable in the trench or striking overhead lines
- Auto traffic, if the excavation site is near a highway
- Exposure to falling loads
- Collapse of walls or buildings adjacent to the trench
- Loose soil or rock inside the trench
- Exposure to hazardous atmospheres

The type of soil in and around a trench contributes to the collapse of trench walls. Soil type is a major factor to consider in trenching operations. Although you should be aware that soil type plays a role in the safe construction of trenches, only a competent person has enough experience, training, and education to determine whether the soil in and around a trench is safe and stable.

4.1.2 Guidelines for Working in and Around Trenches

Working in a trench exposes a worker to many potential hazards. The most obvious hazard is a trench failure. However, there are other situations you should be aware of when working in a trench. You must always use caution when working near the edge of a trench. A trench wall could suddenly give way, sending you to the bottom of the trench.

When you are working in a trench, flooding can be a concern. If a water or sewer main is ruptured while excavating, the trench can quickly fill with water. A little less obvious but just as dangerous are those conditions where a natural water supply has been dammed off. Tons of water may be held back, and if the dam fails, the trench could be quickly flooded.

Electrical shock is also a potential hazard in the trench. While excavating you could accidentally pierce the insulation of an electrical cable in the trench. If overhead electrical lines are near the trench, there is always the danger that the excavator will come into contact with the electrical lines.

When working near highways, vehicle traffic is a potential hazard. Always check for traffic as you move about the job site. Wear appropriate PPE at all times. Sometimes, trenches can fill with dangerous gases, or oxygen can be displaced from the bottom of the trench. This can happen if the trench is near facilities that store large volumes of chemicals. The liquids or gases could flow or leak into the trench.

Finally, you must be aware of the possibility of injury from objects falling into the trench. Chunks of dirt from the excavator bucket, parts of the bucket, or dirt and stone from the excavation can unexpectedly fall into the trench. Never enter the trench without appropriate PPE.

OSHA requires that a competent person inspect excavations, the adjacent areas, and fall protection and shielding devices daily. The competent person must perform these inspections at the following times:

- Before the start of work
- As needed throughout the shift
- After every rainstorm or other occurrence that increases hazards to workers

When working in or around any excavation or trench, you are responsible for your personal safety. You are also responsible for the safety of others in the trench. According to OSHA, the primary hazard in trenching and excavation is injury resulting from collapse. To prevent that, soil analysis is conducted to determine the appropriate sloping, **benching** (stepped excavation), and shoring. Be aware of the potential for additional hazard when working with heavy machinery, manually handling materials, and working in proximity to traffic. Overhead and underground power lines and underground utilities such as natural gas represent hazards as well.

Workers need a safe and reliable way of entering and exiting excavations. OSHA refers to this as access (getting into a trench) and egress (getting back out). Several methods are available, including ramps, stairways, and ladders (see *Figure 37*).

Did You Know?

Violations of scaffolding and trenching regulations are the two most frequent citations issued by OSHA. These violations are fined per person.

When structural ramps are used, a competent person must design them. The ramps must be constructed so that each section fits together well to prevent displacement of the soil in the excavation. *Table 3* shows the categories of rock and soil as determined by OSHA. In addition to proper displacement of soil, the surface of ramps must provide enough traction so that workers will not slip. Guardrails on ramps and stairways must be

Figure 37 Ladder in a trench.

smooth enough to protect workers from punctures, lacerations, and snagging of clothing.

The following are additional safety measures for access/egress:

- Ladders, ramps, or stairways are required in trench excavations that are more than 4 feet deep.
- Ladders, ramps, or stairways used as exits must be located every 25 feet in any trench that is more than 4 feet deep.
- Ladder side rails must extend a minimum of 3 feet above the landing or top of the trench.
- Ladders must have nonconductive side rails if work will be performed near equipment or systems using electricity.
- Two or more ladders must be used when 25 or more workers are working in an excavation in which ladders are the primary means of entry and exit or are used for two-way traffic in and out of the trench.
- All ladders must be inspected before each use for signs of damage or defects.
- Damaged ladders should be labeled Do Not Use and removed from service until repaired.
- Use ladders only on stable or level surfaces.
- Secure ladders when they are used in any location where they could be displaced by excavation activities or traffic.
- While on a ladder, do not carry any object or load that could cause you to lose your balance.
- Exercise caution whenever using a trench ladder.

4.1.3 Indications of an Unstable Trench

A number of stresses and weaknesses can occur in an open trench or excavation. For example, increases or decreases in moisture content can affect the stability of a trench or excavation. The following sections discuss some of the more frequent causes of trench failure. These conditions are illustrated in *Figure 38*.

Tension cracks usually occur from one-quarter to half the distance from the top of a trench. Sliding or slipping may occur as a result of tension cracks. In addition to sliding, tension cracks can cause toppling. Toppling occurs when the trench's vertical face shears along the tension crack line and topples into the excavation. An unsupported excavation can create an unbalanced stress in the soil, which in turn causes **subsidence** at the surface and bulging of the vertical face of the trench. If uncorrected, this condition can cause wall failure and trap workers in the trench or greatly stress the **protective system** used to protect workers from harm in the event of a cave-in, collapses, or other occurrence. Bottom heaving is caused by downward pressure created by the weight of adjoining soil. This pressure causes a bulge in the bottom of the cut. Heaving and squeezing can occur even when shoring and shielding are properly installed.

Another indication of an unstable trench is boiling. Boiling is when water flows upward into the bottom of the cut. A high water table is one cause of boiling. Boiling can happen quickly and can occur even when shoring or trench boxes are used. If boiling starts, leave the trench immediately.

4.1.4 Trench Failure

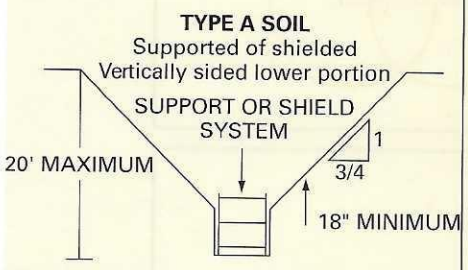
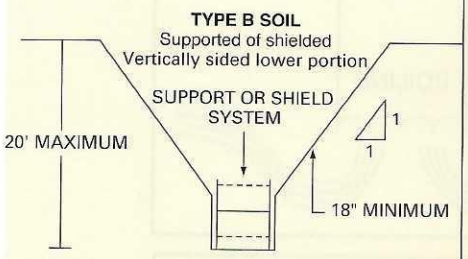
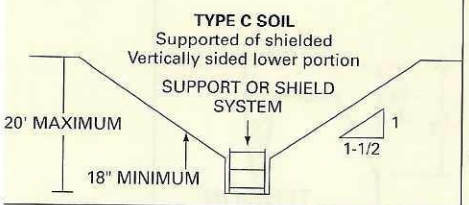
The most common hazard during an excavation is trench failure or cave-in. Using common sense and following all applicable safety precautions makes the trench a safer place to work.

To understand the seriousness of trench failure, consider what can happen when there is a shift in the earth that surrounds an unsupported trench. Workers could be buried when any of the following events happen:

- One or both edges of the trench cave in
- One or both walls slide in
- One or both walls shear away and collapse

Failure of unsupported trench walls is not the only cause of burial. Tons of dirt can be dumped on workers if the spoil pile or excavated earth slides into the trench. Such slides occur when the pile is placed too close to the edge of the trench or when the ground beneath the pile gives way.

Table 3 Determination of Soil Type

Category/Type	Description
Stable rock	Natural solid mineral matter that can be excavated with vertical sides and remain intact while exposed. It is usually identified by a rock name such as granite or sandstone. Determining whether a deposit is of this type may be difficult unless it is known whether cracks exist and whether or not the cracks run into or away from the excavation.
Type A soils 	Cohesive soils with an unconfined compressive strength of 1.5 tons per square foot (tsf) (144 kPa) or greater. Examples of Type A cohesive soils are often clay, silty clay, sandy clay, clay loam, and, in some cases, silty clay loam and sandy clay loam. (No soil is Type A if it is fissured; is subject to vibration of any type; has previously been disturbed; is part of a sloped, layered system where the layers dip into the excavation on a slope of four horizontal to one vertical [4H:1V] or greater; or has seeping water.)
Type B soils 	Cohesive soils with an unconfined compressive strength greater than 0.5 tsf (48 kPa) but less than 1.5 tsf (144 kPa). Examples of other Type B soils are angular gravel; silt; silt loam; previously disturbed soils unless otherwise classified as Type C; soils that meet the unconfined compressive strength or cementation requirements of Type A soils but are fissured or subject to vibration; dry unstable rock; and layered systems sloping into the trench at a slope less than 4H:1V (only if the material would be classified as a Type B soil).
Type C soils 	Cohesive soils with an unconfined compressive strength of 0.5 tsf (48 kPa) or less. Other Type C soils include granular soils such as gravel, sand and loamy sand, submerged soil, soil from which water is freely seeping, and submerged rock that is not stable. Also included in this classification is material in a sloped, layered system where the layers dip into the excavation or have a slope of four horizontal to one vertical (4H:1V) or greater.
Layered geological strata	Where soils are configured in layers (i.e., where a layered geologic structure exists), the soil must be classified on the basis of the soil classification of the weakest soil layer. Each layer may be classified individually if a more stable layer lies below a less stable layer (i.e., where a Type C soil rests on top of stable rock).

Source: Occupational Safety and Health Administration website. "OSHA Technical Manual, Section V, Chapter 2. Excavations: Hazard Recognition in Trenching and Shoring," *www.osha.gov*, reviewed February 23, 2004.

There must be a minimum of 2 feet between the trench wall and the spoil pile. This area must also be kept free of any tools and materials.

The following conditions will likely lead to a trench cave-in. If you notice any of these conditions, immediately inform your supervisor. The conditions are listed in order of seriousness:

- Disturbed soil from previously excavated ground
- Trench intersections where large corners of earth can break away
- A narrow right-of-way, causing heavy equipment to be too close to the edge of the trench
- Vibrations from construction equipment, nearby traffic, or trains
- Increased subsurface water that causes soil to become saturated and therefore unstable

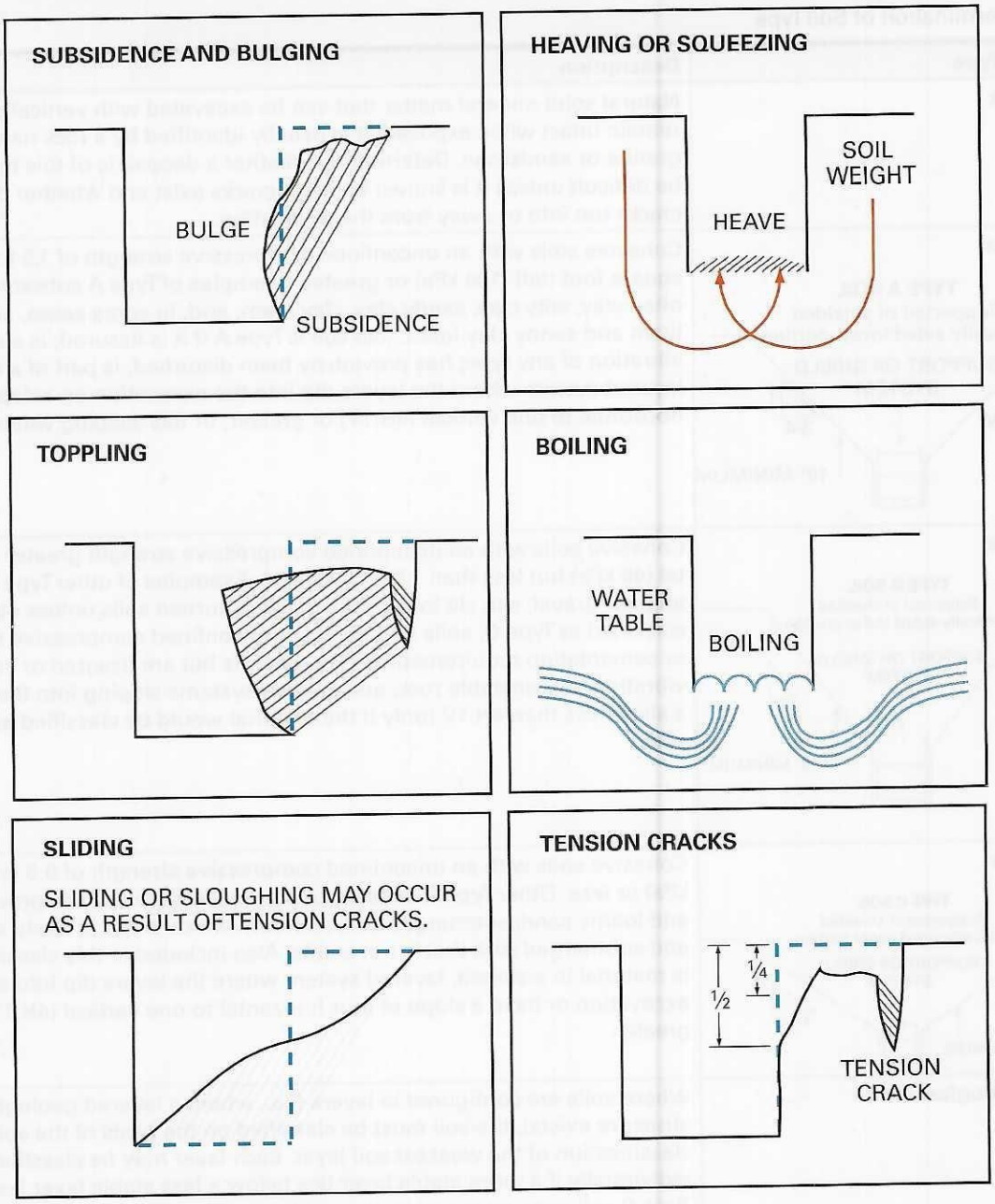


Figure 38 Indications of an unstable trench.

- Drying of exposed trench walls, which causes the natural moisture that binds together soil particles to be lost
- Inclined layers of soil dipping into the trench, causing layers of different types of soil to slide on each other and cause the trench walls to collapse

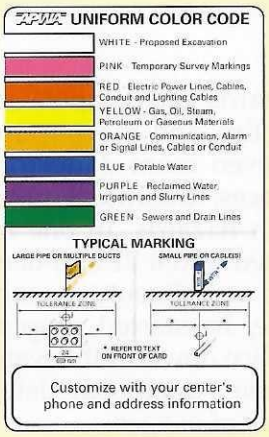
4.1.5 Making the Trench Safer

There are several ways to make the trench a safer place to work (see *Figure 39*). Trench shoring, shielding, and sloping are used to protect workers and equipment. It is important that you recognize the differences among them.

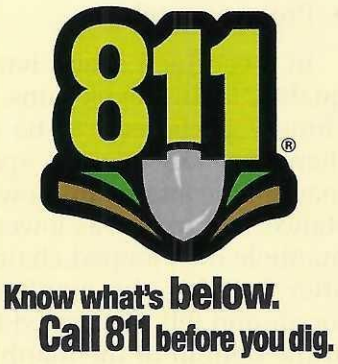
- *Shoring*—Shoring supports the walls of a trench and prevents wall movement and collapse. Shoring does more than provide a safe environment for workers in a trench. Because it restrains the movement of trench walls, shoring also stops the shifting of adjacent soil formations containing buried utilities or on which sidewalks, streets, building foundations, or other structures are built.
- *Trench shields*—**Trench shields**, also called trench boxes, are placed in unshored excavations to protect workers from wall collapse.

One-Call Notification

States operate one-call notification centers to notify the owners of underground utilities prior to digging activities. These "Call Before You Dig" programs provide a toll-free telephone number that can be called to request utility owners to visit the site and mark all underground lines using paint, chalk, flags or whiskers according to a standardized color code. One-call centers help prevent damage to lines and injury to workers as a result of digging into a buried utility line.



(A) APWA COLOR CODE



(B) ONE-CALL CENTER LOGO

They provide no support to trench walls or surrounding soil, but for specific depths and soil conditions, they withstand the side weight of a collapsing trench wall.

- *Sloping*—Sloping an excavation means cutting its walls back at an angle to its floor. OSHA regulations (*CFR 1926*) give companies two options for setting a safe and appropriate angle: Companies may use the tables and charts recommended by OSHA, which are included in *CFR 1926*, or they may use a sloping design that has been developed by a registered, professional engineer.

Many large excavations require the use of walkways so that workers can cross from one side of the excavation to the other. Where these walkways are 6 feet or more above the ground or lower work levels, OSHA requires the installation of guardrails and, when necessary, safety nets. *CFR 1926.502* outlines the specifications for the type of guardrail systems to be used for various types of projects. In general, guardrails must comply with the following provisions:

- The top rail must be 42 inches (plus or minus 3 inches) above the walking/working level.
- When midrails are used, they must be installed midway between the top rail and the walking/working level.
- When screens and mesh are used, they must extend from the top rail to the walking/working level and along the entire opening between rail supports.
- Balusters between posts must not be more than 19 inches apart.

(A) BENCHING

(B) SLOPING

(C) SHORING

Figure 39 Shoring methods.

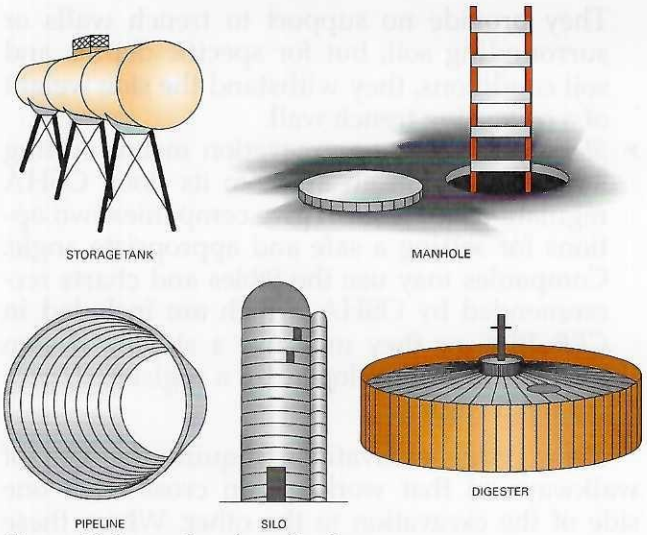


Figure 40 Examples of confined spaces.

- The surface of guardrail systems should be smooth to prevent punctures, lacerations, and snagging of clothing.
- Where safety nets are required, the nets must be inspected at least once a week for wear or damage and must meet the requirements set forth in *CFR 1926.502*.

4.2.0 Confined Spaces

Spaces on a job site are considered confined when their size and shape restrict the movement of anyone who must enter, work in, and exit the space (*Figure 40*). Confined spaces often have poor ventilation and are difficult to enter and exit. For example, employees who work in process vessels generally must squeeze in and out through narrow openings and perform their tasks in a cramped or awkward position. In some cases, confinement itself creates a hazard.

Case History

The Dangers of Gas in Confined Spaces

At the end of a workday, a worker put away his Presto-Lite acetylene torch without completely shutting the regulator valve. The torch remained sealed in its box, as the gas slowly leaked through the night. The next morning, as the worker lit a cigarette, he also opened the box. When the lid opened, the gas escaped and caught the flame, causing an explosion. Fortunately, the worker was only singed, but he was lucky.

The Bottom Line: Always check gas valves to ensure that they are completely closed. Failure to do so can result in severe burns or death.

Confined spaces are entered for inspection, equipment testing, repair, cleaning, or emergencies. They should be entered only for short periods of time. Some of the confined spaces you may work in include the following:

- Manholes
- Boilers
- Trenches
- Tunnels
- Sewers
- Underground utility vaults
- Pipelines
- Pits
- Air ducts
- Process vessels

In a confined space, hazards such as poor air quality, toxins, explosions, fire, and moving machinery parts tend to be even more dangerous than they are in open spaces. Confined spaces may also contain unknown hazards. In one instance, a worker was lowered into a 21-foot-deep manhole on a looped chain seat. Twenty seconds after entering the manhole, he started gasping for air and fell. He landed face down in the water at the bottom of the manhole. An autopsy determined that he died from lack of oxygen.

WARNING!

Often more than one worker is killed in manhole accidents. Never enter a manhole to rescue a co-worker. You may also be overcome or killed by toxic gases. To keep safe when working in or around manholes, follow these rules:

- The worker inside the manhole should wear a safety harness so that co-workers can quickly pull him or her out if necessary.
- The worker inside the manhole should whistle, sing, or keep up a steady stream of conversation so that co-workers know that person is all right.
- If the worker inside the manhole falls silent, co-workers should immediately pull that worker out.
- Always test for gases before going into a manhole.

Most confined spaces have restricted entrances and exits. Workers are often injured as they enter or exit through small doors and hatches. It can also be difficult to move around in a confined space, and workers can be struck by moving equipment. Escapes and rescues are much more difficult in confined spaces.

Case History

Confined Space Ventilation

A worker was using a liquid propane blowtorch in the bilge area of a construction barge. The torch flamed out, and the worker left the area without turning off the flow of gas. The worker was killed when he returned and lit the torch, igniting the accumulated gas.

The Bottom Line: Always provide adequate ventilation in confined spaces. Never leave a liquid-fuel tool without checking that the flow of fuel has been turned off.

Source: Occupational Safety and Health Administration

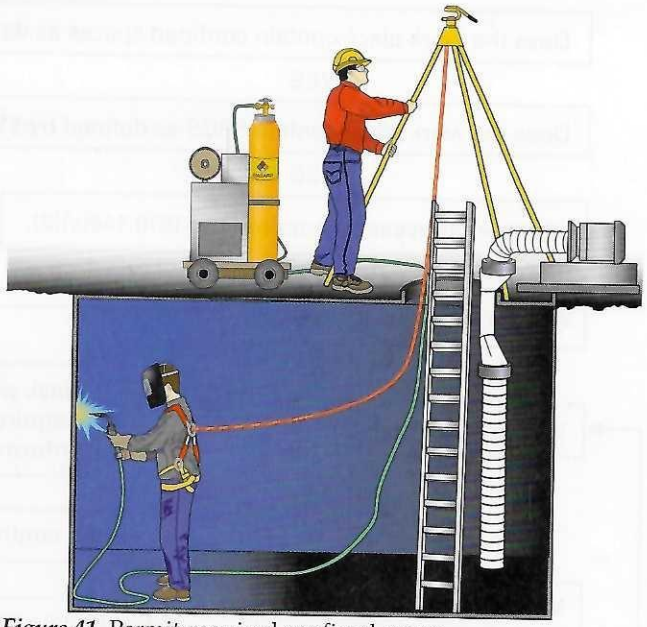


Figure 41 Permit-required confined space.

Management typically develops written confined-space entry programs to protect workers. These programs identify the hazards and specify the equipment or support that is needed to avoid injury. All industrial and some construction sites have written confined-space entry programs. It is your responsibility to know and follow your company's program. Never work alone in a confined space. OSHA requires an attendant to remain outside a **permit-required confined space**, which is a space that has potential or actual hazards. The attendant monitors entry, work, and exit (*Figure 41*). Refer to the OSHA flowchart in *Figure 42* when determining whether a space requires permitting.

4.2.1 Confined-Space Classification

All confined spaces must be inspected before work can begin. Inspection helps to identify possible hazards. After an inspection by a company-authorized person, the confined space is classified based on any hazards that are present. The two classifications are nonpermit required and permit required (*CFR 1910.146*).

A **nonpermit-required confined space** is a workspace free of any mechanical, physical, electrical, or **atmospheric hazards** (airborne danger or air quality problem) that can cause death or injury. After a space has been classified as nonpermit required, workers can enter using the appropriate PPE for the type of work to be performed. Always check with your supervisor if you are not sure which PPE is required.

A permit-required confined space, as noted above, has actual or possible hazards. These hazards can be atmospheric, physical, electrical, or mechanical. *OSHA CFR 1910.146* defines a permit-required confined space as having one or more of the following characteristics:

- Contains or has the potential to contain a hazardous atmosphere
- Contains a material that has the potential for engulfing (overwhelming) an employee who enters the confined space
- Has an internal configuration such that an employee entering the space could be trapped or asphyxiated by inwardly converging walls or by a floor that slopes downward and tapers to a small cross-section
- Contains any other recognized serious safety or health hazard

The job-site supervisor must issue and sign an entry permit before anyone enters the confined space. No one is allowed to enter a confined space without a valid entry permit. The permit is to be kept at the confined space while work is being done. Always check with your supervisor if you are not sure whether you need a permit to enter a confined space.

4.2.2 Entry Permits

Confined spaces can be extremely dangerous. Entry into the space begins when any part of your body passes the entrance or opening of the space. Before entering a permit-required confined space, you must have an entry permit (*Figure 43A* and *Figure 43B*).

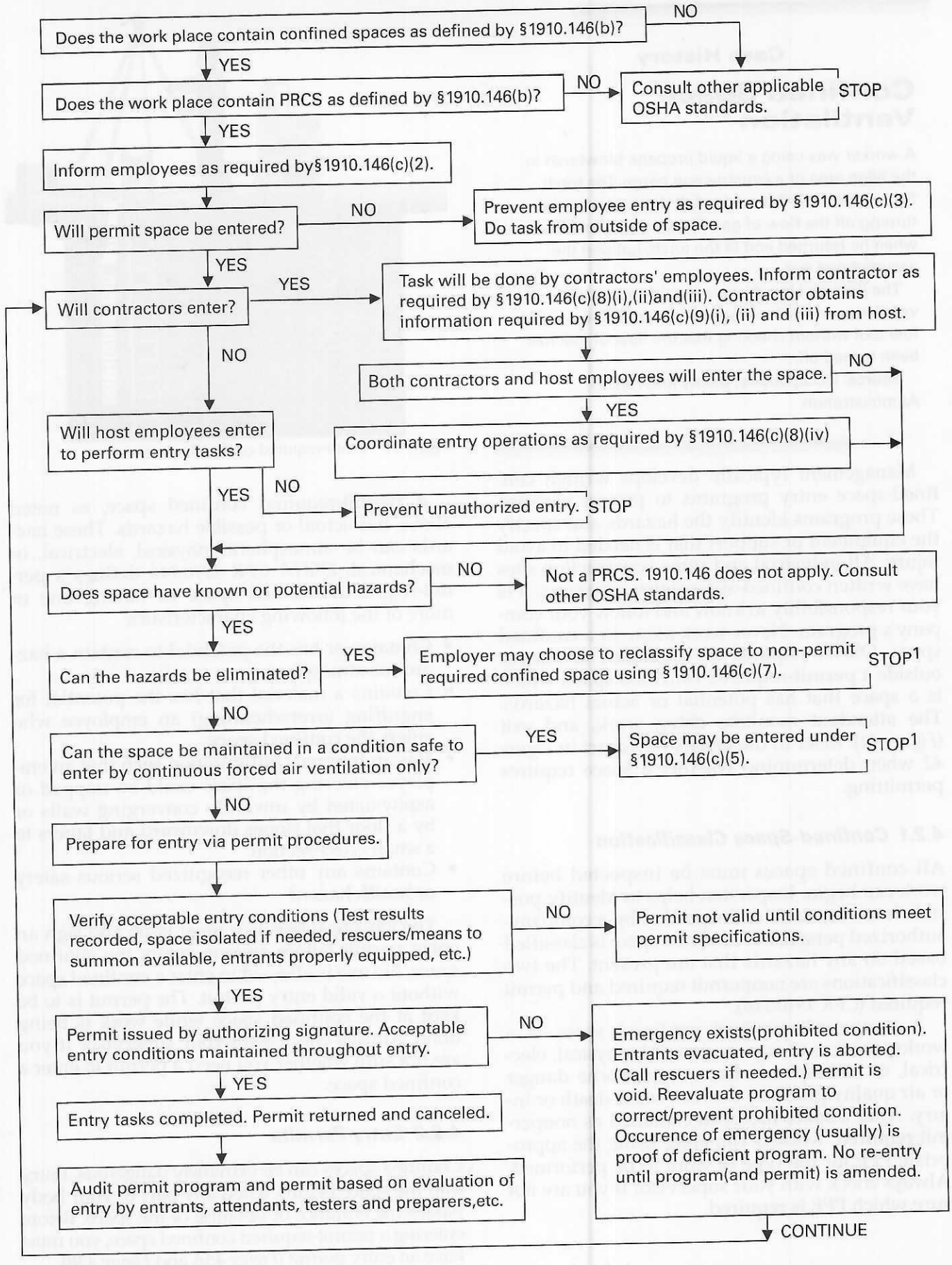


Figure 42 Permit-required confined space decision flow chart.

Attachment 16 – 2
Confined-Space Entry Permit

Master Card / Safe Work Ticket No. _____

1. **Work Description:** _____
   Equip. Name / Number & Location or Area _____
   Purpose of Entry _____
   Valid Start Date _____ **Duration Time** _____ to _____

2. **Hazardous Materials:**
   What did the equipment last contain? _____
   Will the work generate a hazardous atmosphere? ☐ Yes ☐ No If yes, specify hazards and controls.
   _____

3. **Rescue Requirements:**
   ☐ External, by attendant ☐ Complex Rescue, by rescue team at point of entry
   ☐ Non-IDLH and/or Simple Rescue, by rescue team on-site ☐ IDLH, by rescue team at point of entry
   Has the rescue team been notified of the entry? ☐ Yes ☐ N/A Time of notification _____
   How will the rescue team be summonsed for an emergency? ☐ Radio Channel: ___ ☐ Other: _____

4. **Gas Test Requirements:**
   LEL/0_2 - Instrument Mfg./No. _____/_____ Bump Check Time/Gas Tester - _____/_____
   Toxicity - Instrument Mfg./No. _____/_____ Bump Check Time/Gas Tester - _____/_____
   Frequency of Testing: ☐ Continuous ☐ Other - Specify - _____
   - Continuous monitoring results must be recorded every three hours

Acceptable Levels	Results	Time	Initials	Results	Time	Initials	Results	Time	Initials
Oxygen: 19.5%-23.5%									
Combustible Gas: %LEL - <10%									
Other _____ < PEL* _____									
Other _____ < PEL* _____									
Other _____ < PEL* _____									

   - Entry in excess of the PEL will require appropriate PPE.

5. **Ventilation / Exhaust Equipment:**
   ☐ None required, natural ventilation adequate ☐ Forced air ventilation ☐ Exhaust ventilation
   Equipment Type: ☐ Air powered horn ☐ Electric blower Volume Required - _____ cfm

6. **Personal Protection:**
   ☐ Gloves (type) _____ ☐ Respirator (type) _____
   ☐ Goggles or face shield ☐ Self Contained Breathing Equipment
   ☐ Lifelines Attached to Harness ☐ Other, specify: _____
   ☐ Chemical Resistant Suit, Specify Type _____

7. **Fire Protection:** ☐ None required ☐ Portable Fire Extinguisher – type and size:_____
   ☐ Fire Watch ☐ Other, specify: _____

Figure 43A Entry permit.

8. Condition of Area and Equipment:

Required Yes	Required N/A	THESE KEY POINTS MUST BE CHECKED
		a. Equipment locked and tagged out?
		b. Piping is disconnected, capped or plugged and/or blinded.
		c. Equipment emptied, washed, purged and ventilated?
		d. Low voltage or GFCI protected equipment provided?
		e. Explosion proof electrical equipment provided?
		f. Provisions are made to barricade or post signs at entry points when attendant is not on duty.

Other Requirements:

9. Special Instructions: ☐ None ☐ Check with issuer before starting work

10. Approval	Permit			Permit Acceptance		
	Supt. / Area Supv.	Date	Time	Maint. Supv. / Engineer / Contractor Supv.	Date	
Issued by						
Endorsed by						
Endorsed by						

11. Individual Review / Entrant Roster: I have been instructed in the proper Work Permit, Confined Space Entry, Lockout/Tagout Procedures, associated physical and atmospheric hazards and have reviewed the gas-testing results

Entrants	Date	Time In / Out	Time In / Out	Time In / Out	Time In / Out	Time In / Out

I have been informed of the duties and responsibilities for an attendant, the associated physical and atmospheric hazards, and have reviewed the gas-testing results.

Attendants	Date	Time On / Off	Time On / Off	Time On / Off

12. Job Completion:

☐ Yes ☐ N/A Has the rescue team been notified?
☐ Yes ☐ No Is the work on equipment complete and the confined space ready to return to service?
☐ Yes ☐ No Has the worksite been cleaned and made safe?
Workers answering above questions: _____

13. Post Job Review: Were any hazards encountered or created during entry operations?
☐ Yes ☐ No If yes, describe: _____
Possible solutions: _____

Forward to job file within 7 days of job completion.

Figure 43B Entry permit.

An entry permit is a job checklist that verifies that the space has been inspected. It also tells everyone on the site about the hazards of the job. The supervisor must fill out and sign all entry permits before anyone enters the space. The permit must be posted at the entrance to the confined space and be available for workers to review. Entry permits must include the following information:

- A description of the space and the type of work to be done
- The date the permit is valid and how long it lasts
- Test results of all atmospheric testing, including oxygen, toxin, and flammable material levels
- The name and signature of the person who did the tests
- The name and signature of the entry supervisor
- A list of all workers, including supervisors, who are authorized to enter the site
- The means by which workers and supervisors will communicate with each other
- Special equipment and procedures that are to be used during the job
- Other permits needed for work done in the space, such as welding
- The contact information for the emergency-response rescue team

4.2.3 Atmospheric Hazards

Atmospheric hazards are the most common type of hazard in a confined space. In a hazardous atmosphere, the air can have either too little or too much oxygen, be explosive or flammable, or contain toxic gases. The atmosphere in a confined space must be monitored constantly. Special meters are used to detect atmospheric hazards (see *Figure 44*). These meters must be calibrated and operated according to the manufacturer's instructions. In addition, meters must be able to detect oxygen and **combustible** gases at the levels specified in *OSHA 29 CFR 1910.146*.

A confined space that does not have enough oxygen is called an oxygen-deficient atmosphere. A confined space with too much oxygen is called an **oxygen-enriched atmosphere**. For safe working conditions, the oxygen level in a confined space must range between 19.5 and 23.5 percent by volume, with 21 percent considered the normal level. Oxygen concentrations below 19.5 percent by volume are considered oxygen-deficient; those above 23.5 percent are considered oxygen-enriched. Portable, battery-operated gas meters can be used to measure oxygen levels.

Many of the processes that occur in a confined space use oxygen and may reduce the percentage of oxygen to an unsafe level. These processes include the following:

- Burning
- Rusting of metal
- Breaking down of plants or garbage
- Oxygen mixing with other gases

When the oxygen in a confined space is reduced, it becomes harder for a worker to breathe. The symptoms of insufficient oxygen happen in this order:

1. Fast breathing and heartbeat
2. Impaired mental judgment
3. Extreme emotional reaction
4. Unusual fatigue
5. Nausea and vomiting
6. Inability to move your body freely
7. Loss of consciousness
8. Death

Figure 44 Detection meter.

4.2.4 Explosion Hazards

Too much oxygen in a confined space is a fire hazard and can cause explosions. Materials like clothing and hair are highly flammable and burn rapidly in oxygen-enriched atmospheres. Fires can start easily in a confined space with an oxygen-enriched atmosphere. Air in a confined space becomes combustible when chemicals or gases reach a certain concentration. Flammable gases can be trapped in confined spaces. Flammable gases include, but are not limited to, acetylene, butane, propane, and methane. Dust and work by-products from spray painting or welding can also form a combustible atmosphere.

Some flammable gases are lighter than air and concentrate at the top of a confined space. Vapors from fuels are generally heavier than air and will concentrate at the bottom of the space. A spark or flame will cause an explosion in a combustible atmosphere.

4.2.5 Toxic Atmospheres

Toxic gases and vapors come from many sources. They can be deadly when they are inhaled or absorbed through the skin above certain concentration levels. In spaces with no ventilation, high concentrations can gather and quickly become toxic. Even in lesser amounts, some chemicals can seriously affect your breathing and brain functions.

The effects of toxic gases and vapors vary. Many toxic gases, such as carbon monoxide, cannot be seen or smelled. Some toxic gases have harmful effects that may not show up until years after contact. Others, such as nitric oxide, can kill quickly.

Special meters, which are calibrated to detect toxic gases and vapors, sound an alarm to alert workers of a toxic atmosphere. These meters must be set and operated according to the manufacturer's instructions.

Did You Know?

Generally, a mixture of flammable gas and air must be 5 to 15 percent gas and 85 to 95 percent air for the gas to explode. A mixture of gas and air that does not have enough gas to explode is below the lower explosive limit. This mixture is too lean to explode. A mixture with more than the maximum amount of gas is above the upper explosive limit. This mixture is too rich to explode.

4.2.6 Additional Hazards

In addition to atmospheric hazards, there are several other physical and environmental hazards in confined spaces. Be aware of and take precautions against the following dangers:

- *Electric shock*—Electric shock can occur when power tools and line cords are used where there are wet floors or surfaces. Always ground tools and equipment, or use a GFCI when working in a confined space.
- *Purging*—Purging happens when toxic, corrosive, or natural gases enter and mix with the air in a confined space. Purging most often occurs in pipelines. Purging gases are used to clean pipelines. These gases can create an oxygen imbalance in the space that can suffocate workers almost immediately. Once purging is complete, appropriate ventilation must be established to render the atmosphere safe. Air monitoring is necessary to verify air quality.
- *Falling objects*—Materials or equipment can fall into confined spaces and strike workers. This usually happens when another worker enters or exits a confined space with a topside opening, such as a manhole. Vibrations can also cause materials or tools to fall.
- *Engulfment*—Engulfment occurs when a worker is buried alive by a liquid or material that enters a confined space. Small, loose material stored in bins and hoppers, such as grain, sand, or coal, can engulf and suffocate a worker. Heavier materials or liquids that enter a confined space can crush or strangle a worker. Even when a worker is engulfed only up to the waist, death may result from the massive pressure of the materials and constriction of the body.
- *Extreme temperatures*—Confined spaces that are too hot or too cold can be hazardous. Spaces that are too hot can cause heat stroke or heat exhaustion. Spaces that are too cold can cause **hypothermia**, a condition in which your body temperature is too low. Another temperature-related hazard in a confined space is steam. Steam is extremely hot and can cause severe or fatal burns.
- *Noise*—Noise in a confined space can be very loud. This is because the sound bounces off the walls of a small space. Too much noise, or noise that is too loud, can permanently damage hearing. It can also prevent workers from communicating. If this happens, you could miss an evacuation warning.
- *Slick or wet surfaces*—Workers can be seriously hurt by slips and falls on slick or wet surfaces. Wet surfaces also add to the chance

of electrocution from electrical circuits, equipment, and power tools.
- *Moving parts*—Workers can get struck or trapped by moving parts, such as augers or belts. This usually happens when a worker slips or falls. It also can happen if the operator of the moving machinery is wearing loose clothing or jewelry.

It is important to understand how to protect yourself and your co-workers in a confined space. Everyone must be aware of what is happening on the site and understand how to work safely. These are the most common safeguards to follow during confined-space operations:

- Monitoring and testing
- Ventilation
- PPE
- Communications
- Training

4.2.7 Monitoring and Testing

The air in a confined space must be tested before any workers enter and continuously monitored while workers are in the space. Testing must be done by a properly trained, qualified person, called the confined-space attendant. This person must be company-approved or otherwise designated. The confined-space attendant tests the air for oxygen content, explosive gases or vapors, and toxic gases or vapors.

The atmosphere in a confined space may need to be monitored during the entire job. This is done by attaching monitors to workers entering the confined space or by using outside devices. When the atmosphere is monitored, workers can be assured that the air quality is good and that they will know immediately about changes in the atmosphere that would require them to leave. The confined-space attendant always remains outside the workspace to monitor the workers and their environment. The attendant does not enter the space even to perform rescues but is responsible for calling for evacuation when needed.

Workers who are trained and authorized to monitor the air in a confined space must do the following:

- Read and understand the operating and maintenance manual provided by the monitor's manufacturer.
- Maintain monitors according to the manufacturer's instructions.
- Inspect, test, and calibrate monitors according to the manufacturer's instructions.
- Verify that batteries for battery-operated monitors are working properly.
- Test the atmosphere in a confined space before employees enter the space.
- Continuously monitor the air in the confined space while employees are in the space.
- Carry out the company's safety procedures regarding hazardous atmospheres or emergency situations that may arise.
- Complete any reports required by company policy or OSHA standards (*CFR 1904*).
- Seek retraining or update training as necessary.

4.2.8 Ventilation

If the air in a confined space is hazardous or may become dangerous, the space must be ventilated immediately to remove toxic gases or vapors and to replace lost oxygen. Ventilators blow clean air into the space. They must stay on as long as workers are in the space.

Just because air is being blown into or out of the space, it doesn't mean that the space is being ventilated. Toxic gases can hide in confined spaces. Make sure the attendant has carefully tested the entire space before you enter it.

4.2.9 Personal Protective Equipment

Every job requires some type of PPE. Standard PPE includes hard hats, safety goggles and glasses, boots, and gloves. In a confined space, the following items may also be needed:

- Full-body harness
- Lifelines
- Air-purifying respirator
- Air-supplying respirator

4.2.10 Communication

All workers on a site must be able to communicate with one another. It is especially important for attendants and workers entering the site to be able to communicate. This allows attendants to warn workers about dangers and order an evacuation when necessary. Communication among workers is another way to monitor the confined space.

WARNING! When combustible gases or vapors are present, sparks from communication devices can cause an explosion. Therefore, you must not operate electrical equipment, including telephones or cell phones that are not classified as intrinsically safe/explosion-proof.

4.2.11 Training

Entering a confined space requires specialized training. No one is allowed to enter a confined space without the proper training and authorization from the site supervisor. Training gives workers the knowledge to complete their jobs safely and efficiently. If you have not been properly trained, do not enter any confined space.

Explosion-Proof Equipment

Some tasks require workers to use intrinsically safe/explosion-proof electrical equipment. An intrinsically safe (I-safe) communication device is one that has been certified for use in hazardous environments. This equipment is designed to protect workers from explosions caused by sparks. Such equipment includes certified I-safe phones, mobile computers, and portable data terminals. It must be certified to meet the following requirements of the National Electrical Code:

- Outside air cannot penetrate the casing.
- The casing must be strong enough to contain an explosion inside the equipment without igniting the surrounding air.
- The interior must be filled with nonflammable powder or inert gas to prevent ignition.

4.3.0 Underground Safety

Tunnels, shafts, chambers, and passages located underground have their own special safety requirements. Because underground workspaces are completely enclosed except for access and equipment tunnels, the results of an accidental release of gas, fire, and other hazards are magnified accordingly. Plumbers installing lines in underground locations should follow the OSHA requirements outlined in *29 CFR 1926.800* very closely.

Before going underground, ensure that the proper safety precautions are in place both aboveground and in the workspace. Once underground, familiarize yourself with the location of safety equipment, potential hazards, and escape routes. Be prepared, so that in an emergency you can take the correct action immediately to protect yourself and your co-workers from injury and death.

Employers are responsible for ensuring that their employees who work underground receive proper training on underground hazards and safety, including the following elements when appropriate:

- Access
- Air monitoring
- Ventilation
- Illumination
- Communications
- PPE
- Explosives
- Fire prevention and protection
- Emergency procedures

4.3.1 Access

OSHA regulations specify the number and placement of access shafts for personnel and equipment. Hoisting mechanisms are used in shafts to provide access for workers. These hoists must be able to operate safely and effectively in an emergency. They must be able to operate even if the power fails in the rest of the underground workplace. Independent power sources for personnel hoists should meet all safety requirements for the underground workspace.

4.3.2 Air Monitoring and Ventilation

Fresh air must be supplied to underground work areas in sufficient quantities to prevent the build-up of harmful dust, fumes, mist, vapors, or gases. OSHA regulations specify the use of mechanical ventilation in cases where natural ventilation is insufficient to provide fresh air to the workers. Refer to your local applicable code for the minimum safe airflow requirements. Ensure that all machines used in an underground space are properly vented. OSHA regulations require a minimum of 200 cubic feet of fresh air per minute for each employee underground.

The site supervisor is responsible for designating a competent person to perform air-monitoring tests in an underground work site. The atmosphere in an underground workplace must be the same content and pressure as normal surface air. Air-monitoring tests check for oxygen content and contaminants. If flammable or noxious gases or other contaminants are present at higher-than-permitted levels, OSHA regulations specify the correct response.

Working conditions are classified as **gassy operations** when air monitoring shows one or more of the following:

- The level of methane or explosive gases in the air exceeds minimum acceptable levels.
- A gas ignition has occurred previously in the underground space.

- The underground work area is connected to another area that has been classified as a gassy operation.

Vent all fan and compressor exhausts to ensure that they do not contaminate the underground air. If air monitoring shows that conditions are dangerous to life, evacuate the underground work area, post signs by the entrances, and take all other necessary precautions as specified in OSHA regulations and in your emergency plan.

WARNING!

If the levels of methane or other explosive gases reach 5 percent of the lower explosive limit (LEL), increase ventilation to remove the gases. If the levels reach 10 percent of the LEL, immediately suspend all hot work in an underground workspace. If the levels reach 20 percent of the LEL, immediately evacuate all workers who are not required to deal with the situation, and disconnect all non-emergency electrical equipment. Otherwise, a fire or explosion could result, causing injury or death.

4.3.3 Illumination

Refer to your local code and the OSHA regulations for proper lighting requirements. Use only approved lighting equipment when working underground. All employees working underground should have a portable lamp (either handheld or attached to a hard hat) for emergency use, unless there is sufficient natural light or an emergency lighting system is in place.

4.3.4 Communications

Use radios, walkie-talkies, or other approved communications equipment when voice communications are not effective within the workspace or between the workspace and the surface. OSHA regulations require at least two communication methods, one of which must be voice, for use near shafts when hoisting or transferring personnel. Ensure that powered communications systems are able to operate even if one of the units breaks down. Test radios and other communication equipment before going into the underground workplace.

A specially designated person must be on duty on the surface whenever a worker or workers are in the underground workplace. That person is responsible for calling in aid if needed and keeping an accurate count of all employees working underground.

At the end of your shift, notify the incoming shift about any safety occurrences on your shift, such as cave-ins, gas leaks, or equipment failures. Ensure that people on the rest of the job site coordinate their activities with the underground work so as to avoid conflicts.

4.3.5 Personal Protective Equipment

Refer to your local applicable code and site safety regulations to determine the appropriate PPE to be used. Use only NIOSH-approved respirators when working underground. Ensure that all respirators and other safety devices are properly maintained according to the manufacturer's specifications. Employers are responsible for training all workers in the proper use of PPE. PPE and safety equipment that is not worn, such as respirators, must be located in easily accessed areas near workstations where smoke or gas is a risk.

4.3.6 Explosion and Fire Hazards

Open flames and fires are not permitted underground. Smoking is also prohibited, and all ignition sources, such as matches and lighters, must be collected before workers are allowed to descend underground. Ensure that appropriate warning signs are posted where fire and explosion hazards are present. Never use or store gasoline underground. Diesel fuel can be used, though you must be sure to follow local code and the manufacturer's specifications when pumping diesel fuel to and from an underground space.

When using gas such as acetylene and liquid petroleum gas (LPG) for hot work, refer to the local applicable code and the OSHA regulations for proper storage and handling. When fuels and gases are not in use, ensure that all fuel containers are sealed and gas tank valves are shut tight. On the surface, flammable and explosive materials must be stored at least 100 feet away from underground entrances.

Clearly mark all entrances and ventilation shafts with signs or other approved indicators. When hot work is being performed underground, post fire watches according to OSHA regulations.

4.3.7 Emergency Procedures

Employers must ensure that rescue teams are on site or available to respond to an emergency within 30 minutes. According to OSHA regulations, when 25 or more people are working underground, two 5-person rescue teams must be available. One team must be on site or no more than 30 minutes away. The other team cannot be more than two hours away. With fewer than

25 workers, only one team is required on site or within 30 minutes of the work site.

Emergency team members must be qualified in rescue procedures, in the use of breathing apparatuses, and in firefighting. Employers are responsible for ensuring that rescue teams are familiar with the layout of the work site.

4.4.0 Lockout/Tagout

Lockout devices and **tagout devices** protect workers from all possible sources of energy, including water or other liquids. In a **lockout**, an **energy-isolating device** that prevents the transmission or release of energy, such as a stop valve, a disconnect switch, or a circuit breaker, is placed in the Off position and locked. Lockout devices can be used with key or combination locks. Multiple lockout devices (*Figure 45*) are used when more than one person has access to the equipment. In some instances, as with work involving valves, a chain and lock can be used to hold the valve in place and keep it from being turned.

In a tagout, components that allow the flow of water or power equipment and machinery, such as switches or valves, are set in a safe position, and a written warning or tagout device is attached to them (*Figure 46*). An effective lockout/tagout program should include the following:

- An inspection of equipment by a trained person who is thoroughly familiar with the equipment operation and associated hazards
- Identification and labeling of lockout devices
- The purchase of locks, tags, and blocks
- A standard written operating procedure that all employees follow

The exact procedures for lockout/tagout may vary at different companies and job sites. Ask your supervisor to explain the lockout/tagout procedure on your job site. You must know and follow this procedure. This is for your safety and the safety of your co-workers. If you have questions about lockout/tagout procedures, ask your supervisor. Each foreman should have a kit.

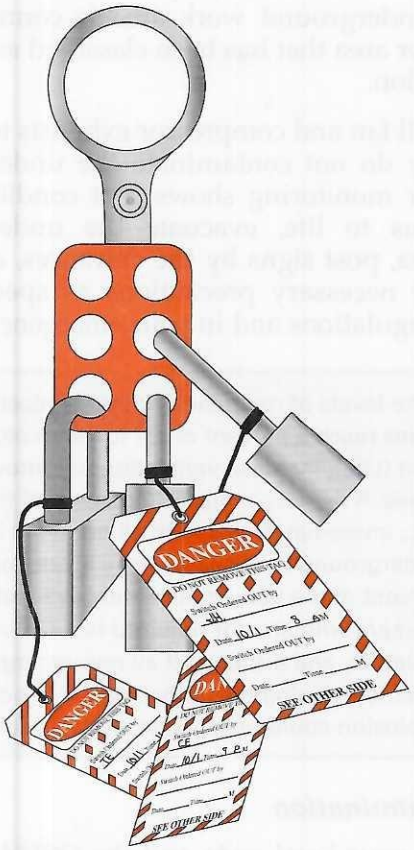


Figure 45 Multiple lockout device.

A typical lockout/tagout procedure is made up of these three steps:

- Sequence for lockout/tagout
- Restoring energy
- Emergency removal authorization

Did You Know?

Using P.R.O.P.E.R. lockout/tagout procedures is the best way to prevent accidents, injury, and death.

P—**P**rocess (shut down process)
R—**R**ecognize (identify energy sources such as electrical panels, disconnect switches, and switchboards)
O—**O**ff (shut off energy sources)
P—**P**lace (locks and tags in place)
E—**E**nergy (release stored energy)
R—**R**eturn (controls are returned to neutral)

Case History

Follow Lockout/Tagout Procedures

The threaded male end of a pressure-relief valve on a sprinkler system riser broke off during an attempt to re-pipe the discharge side of the valve. This caused approximately 550 gallons of water to be discharged into a utility closet and surrounding office areas. There were no injuries as a result of this accident, but there was significant property damage.

The Bottom Line: A lockout/tagout should have been performed on the sprinkler system.

4.4.1 Sequence for Lockout/Tagout

A typical lockout/tagout program sets out a sequence of events that must occur during the procedure. A typical lockout/tagout follows these steps:

Step 1 Check the procedures to ensure that no changes have been made since you last used a lockout/tagout.

Step 2 Identify all authorized and affected employees involved with the pending lockout/tagout.

Step 3 Notify all authorized and affected personnel that a lockout/tagout is to be used and explain why it is necessary.

Figure 46 Placing a lockout/tagout device.

Step 4 Shut down the equipment or system using the normal Off or Stop procedures.

Step 5 Lock out all energy sources, which provide power to the device, and test disconnects to be sure they cannot be moved to the On position. Next, open the control cutout switch. If there is no cutout switch, block the magnet in the switch Open position before working on electrically operated equipment or apparatus such as motors or relays. Remove the control wire.

Step 6 Lock and tag the required switches or valves in the Open position. Each employee who is authorized to use the equipment has to have a lock.

Step 7 Dissipate any stored energy.

Step 8 Verify that the test equipment is functional using a known power source.

Step 9 Confirm that all switches are in the Open position, and use test equipment to verify that all components are de-energized.

Step 10 If you have to leave the area temporarily, upon returning retest to ensure that the equipment or system is still de-energized.

4.4.2 Restoration of Energy

Once work is done on the machinery or equipment, energy can be restored. The following steps are typically used to restore energy:

Step 1 Completely reassemble and secure the equipment or system.

Step 2 Confirm that all equipment and tools, including shorting probes, are accounted for and removed from the equipment or system.

Step 3 Replace and reactivate all of the safety controls.

Step 4 Remove the locks and tags from the isolation switches. All employees must remove only their own lock and tag. Notify all affected personnel that the lockout/tagout has ended and that the equipment or system will be re-energized.

Step 5 Operate or close the isolation switches to restore energy.

4.4.3 Emergency Removal Authorization

OSHA regulations (*CFR 1019.147*) state that only the employee who applied a lockout/tagout device is authorized to remove it. However, there are times when emergency removal of a lockout/tagout device is required. For example, the employee who applied the device may be absent. Therefore, OSHA allows an exception to this rule, provided the company follows these additional rules:

- Verify that the authorized employee who applied the lockout/tagout device is not at the facility.
- Make a reasonable effort to inform the authorized employee that the lockout/tagout device has been removed.
- Ensure that the authorized employee knows this before resuming work at the facility.

OSHA regulations require employers to have specific procedures and training in place to handle emergency removal. This training and procedures should be part of the company's energy control program. Some companies may have additional requirements. For example, a company may require that a written record of the emergency removal procedure be made and signed by authorized personnel.

Did You Know?

OSHA provides a basic lockout procedure form that is available for free on its website. The form is designed to help employers develop their lockout/tagout procedures so that they will meet the OSHA requirements. The website address is *www.oshacfr.com*. The form is titled *Typical Minimal Lockout Procedure, 1910.147, Appendix A.*

4.5.0 Safeguards and Emergency Response

It is important to know how to protect yourself and your co-workers on the job. Everyone must be aware of the activities taking place on the site and understand how to perform them safely. Some common safeguards to keep the job site safe include the following:

- Never operate any device, valve, switch, or piece of equipment that has a lock or a tag attached to it.
- Use only tags that have been approved for your job site.
- If a device, valve, switch, or piece of equipment is locked out, make sure the proper tag is attached.
- Lock out and tag all electrical systems.
- Lock out and tag pipelines containing acids, explosive fluids, and high-pressure steam.
- Lock and tag motorized vehicles and equipment when they require repair or are being replaced. Disconnect or disable any starting devices.

You can avoid accidents, injuries, or contamination by making sure you are properly trained, by working safely, and by following the rules. When accidents do happen, it is important to stay calm and tell your supervisor immediately. A worker who is trained in first aid should evaluate the injury and decide on the best treatment plan. For example, if the injury is a minor cut, a bandage can be applied. If the cut is deep and requires stitches, the worker should be taken to the hospital. If the cut is severe and an extreme loss of blood or amputation is involved, immediately call 911 or your local emergency response number.

Many companies, regardless of their size, have an emergency action plan (*Figure 47*). An emergency action plan describes the actions employees should take to ensure their safety in an emergency situation. A company appointed competent person or emergency action plan coordinator is responsible for creating an emergency action plan. Plans vary by company. In general, most plans include some or all of the following items:

- Trainees must not perform emergency actions that they are not trained to do
- Conditions under which an evacuation would be necessary
- A clear chain of command
- Person authorized to order an evacuation
- Evacuation procedures and emergency escape route assignments (*Figure 48*)
- Designated meeting area outside of the building
- Procedures for helping visitors to evacuate
- Procedures for helping those with disabilities or difficulty understanding English
- Procedures for workers who remain to operate critical plant operations before evacuating
- Procedures for accounting for workers after the evacuation
- Designated rescue and first-aid personnel
- The location and telephone numbers of local emergency agencies, such as hospitals and fire and police departments (generally, calling 911 is the most appropriate response)

If you are unsure about the action plan at your job site, ask your supervisor to explain it to you. It can mean the difference between life and death.

EMERGENCY ACTION PLAN

In the event of a fire or other emergency situation on the project that warrants emergency response or evacuation, the following procedures will be strictly adhered to:

1. **SOUND THE ALARM** by shouting loudly and repeatedly the description of the emergency situation you have observed, for example:
   - **FIRE, FIRE, FIRE**
   - **EMPLOYEE INJURED, EMPLOYEE INJURED, EMPLOYEE INJURED**
   - **NEED PARAMEDICS, NEED PARAMEDICS, NEED PARAMEDICS**
   - **EVACUATE, EVACUATE, EVACUATE**

   Make sure that at least one other employee has heard and understood the alarm.

2. **CALL 911 AND NOTIFY THE EMERGENCY OPERATOR.** The employee first observing the emergency will travel to the closest telephone or cellular phone, **DIAL 911** and **REPORT THE EMERGENCY**. State the following:

   THERE IS AN EMERGENCY SITUATION AT _____

   IN THE EVENT OF A REQUEST FOR PARAMEDIC RESPONSE, THE EMPLOYEE REPORTING THE EMERGENCY SHALL TRAVEL TO THE PROJECT ENTRY POINT AND STAND BY TO DIRECT EMERGENCY RESPONSE PERSONNEL.

3. In the event of an **INJURED EMPLOYEE ALARM**, personnel trained, capable, and prepared to render first aid may respond to the scene of the accident and render the assistance required to sustain the injured employee, until such time as the paramedics arrive. Assist if and ONLY when your assistance may be rendered without personal risk to you, the first-aid provider, due to hazards present in the accident area.

4. In the event of an uncontrollable fire or other emergency that warrants evacuation, **EVACUATE!** Select the closest, safest route to exit the building and proceed in an orderly and expeditious manner outside. While en route to the exit, assist in the notification of other employees by re-sounding the alarm to evacuate. Yell loudly and repeatedly:

   FIRE, EVACUATE! FIRE, EVACUATE! FIRE, EVACUATE!

5. **ASSEMBLE:** As you exit the building, select the closest and safest route, and proceed in an orderly manner to the DESIGNATED ASSEMBLY AREA, where a head count will be taken to ensure that everyone has safely evacuated. Remain in the assembly area until released to return to work or instructed otherwise.

   DESIGNATED ASSEMBLY AREA FOR THE JOB SITE:

   _____

Note: Each individual subcontractor is responsible for taking head counts for his or her employees and for reporting to emergency response personnel if or when employees are unaccounted for.

Figure 47 Sample emergency action plan.

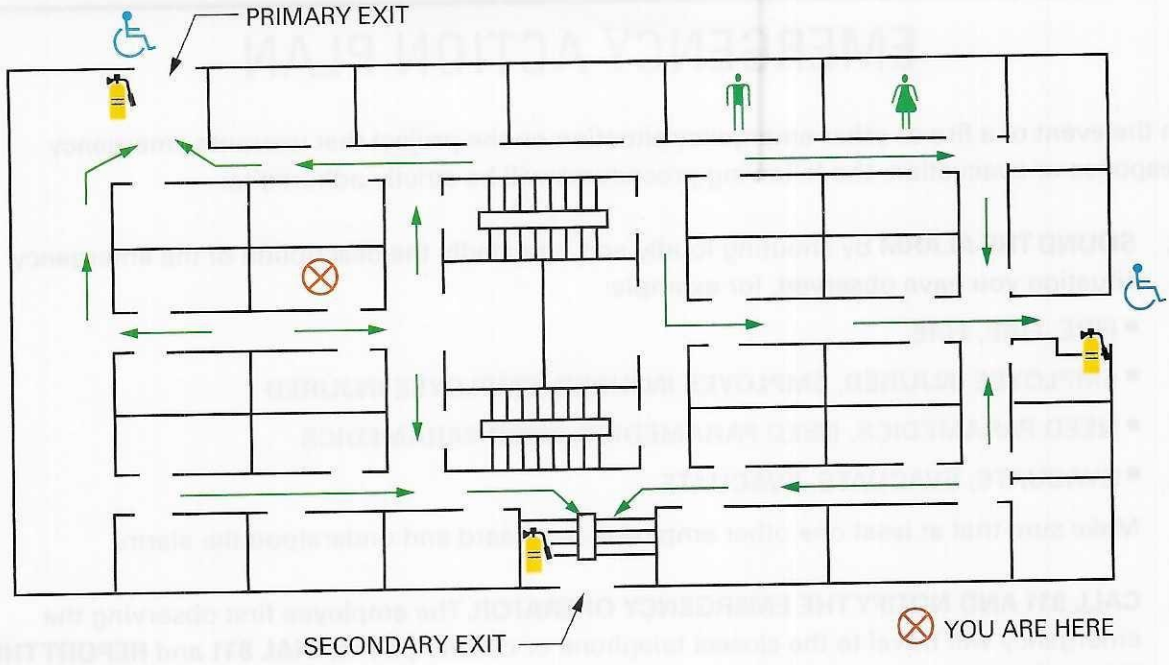


Figure 48 Typical emergency escape plan.

If you are working in a facility where escape maps are necessary, study the map carefully. This is especially important if you are working in a large building. Memorize the route. It is best, of course, to use an exit nearest your location. However, the closest exit may be blocked by fire or debris. Therefore, always know alternate escape routes so that you have more than one way to evacuate.

Alarms

At most job sites, the person responsible for coordinating the company's emergency action plan may have to consider the needs of workers with disabilities or workers for whom English is a second language. For example, sound alarms may also have bright flashing lights, and warning and exit signs may be written in more than one language.

Additional Resources

Environmental Protection Agency. *www.epa.gov.*

Managing Electrical Hazards, Latest edition. NCCER. New York, NY: Pearson.

OSHA. *www.osha.gov.*

4.0.0 Section Review

1. You see construction workers cutting back the walls of an excavation at an angle to its floor. This is called _____.
   a. sloping
   b. shoring
   c. shielding
   d. trenching
2. For working conditions in a confined space to be considered safe, the oxygen level by volume must range between _____.
   a. 6.5 and 10.5 percent
   b. 11.5 and 14.5 percent
   c. 19.5 and 23.5 percent
   d. 24.5 and 28.5 percent
3. The minimum amount of fresh air for each employee working underground required by OSHA is _____.
   a. 100 cubic feet per minute
   b. 100 cubic feet per hour
   c. 200 cubic feet per hour
   d. 200 cubic feet per minute
4. Stop valves, disconnect switches, and circuit breakers are examples of _____.
   a. energy-isolating devices
   b. energy removal devices
   c. lockout/tagout devices
   d. multiple lockout devices
5. If you are unsure about the emergency action plan at your job site, the person you should ask to explain it to you is your _____.
   a. OSHA representative
   b. local fire department
   c. co-worker
   d. supervisor

SUMMARY

Serious accidents and injuries can occur on a work site. Whether you work for a large contractor or you are a subcontractor, you have a responsibility to work safely and follow the rules and regulations of the site. You also have a responsibility to be aware of what's going on around you and to notice the behavior of your co-workers. Personal injury and damage to equipment is less likely to happen when you do so. It is also important that everyone on a job site knows and follows the company's emergency-response plan.

Review Questions

1. According to OSHA, a competent person is _____.
   a. a worker who has been trained to use tools properly
   b. a worker who can identify hazards
   c. a worker who can identify hazards and is authorized to take prompt corrective measures
   d. any foreman or supervisor on the job site

2. OSHA stands for _____.
   a. Occupational Standards for Health Act
   b. Occupational Services and Health Administration
   c. Office of Safety and Health Administration
   d. Occupational Safety and Health Administration

3. One simple way to help ensure a safe work site is to _____.
   a. check the job site periodically and remove any clutter
   b. purchase your own first-aid kit
   c. keep foul weather gear stored in your truck
   d. avoid working in cold weather

4. When you wear a hard hat, the space between your head and the shell of the hard hat should be _____.
   a. $\frac{1}{4}$ inch
   b. $\frac{1}{2}$ inch
   c. 1 inch
   d. 2 inches

5. Air-purifying respirator cartridges absorb certain toxic vapors from the air through _____.
   a. a treated fiber
   b. a baffle chamber
   c. filters filled with baking soda
   d. charcoal

6. The highest level of respiratory protection is provided by _____.
   a. air-purifying respirators
   b. supplied-air respirators
   c. self-contained breathing apparatus
   d. exhaust hoods

7. To obtain the best protection from a respirator, you must perform a positive and negative fit check _____.
   a. the first time you wear it
   b. every time you wear it
   c. after you have worn it for at least 20 minutes
   d. once or twice a week

8. The SDS is a fact sheet prepared by _____.
   a. OSHA
   b. the product's manufacturer or importer
   c. the National Fire Protection Agency
   d. local authorities according to local codes

9. The most important things to look for on an SDS are the _____.
   a. specific hazards, personal protection requirements, handling procedures, first-aid information, and the emergency-response telephone number
   b. chemical hazards, explosive properties, personal protection requirements, and ecological information
   c. chemical composition, toxicological properties, and disposal and transportation information
   d. accidental-release measures, handling and storage requirements, transportation and regulatory information, and the emergency-response telephone number

10. Section 4 of an SDS _____.
    a. provides the manufacturer's contact information
    b. lists firefighting measures
    c. provides general handling and storage information
    d. lists first-aid measures

11. If your supervisor tells you to evacuate the work site, you should _____.
    a. return to work the next day
    b. go to a safe location and wait until you are notified that conditions are safe
    c. walk at least 50 feet away from the site and wait there for further instructions
    d. gather up all of your belongings before leaving the work site

12. The sign or tag that is used to tell workers about potential hazards or unsafe practices is a(n) _____.
    a. danger sign
    b. caution sign
    c. informational sign
    d. safety instruction sign

13. The sign or tag that is used to tell workers about general information not related to safety is a(n) _____.
    a. danger sign
    b. caution sign
    c. informational sign
    d. safety instruction sign

14. The sign or tag that is used for general instructions and suggestions related to safety measures is a(n) _____.
    a. danger sign
    b. caution sign
    c. informational sign
    d. safety instruction sign

15. The two types of protection for openings in walls, floors, or the ground are _____.
    a. guards and covers
    b. poles and screens
    c. ropes and planks
    d. blocks and berms

16. The percent of all accidental deaths in the construction industry caused by slips, trips, and falls is _____.
    a. 10
    b. 15
    c. 20
    d. 25

17. When job site surfaces are wet or icy, you should _____.
    a. delay the job until conditions improve
    b. wear shoes with cleats
    c. spread gravel or other granular material
    d. move to another work area

18. Walking and working surfaces that are located aboveground and sometimes over large equipment are called _____.
    a. ceilings
    b. floors
    c. platforms
    d. ramps

19. To remove tools from scaffolding, it is best to _____.
    a. lower them to the ground using a rope
    b. lower the height of the scaffolding to hip level and then remove the tools
    c. use the buddy system, and pass each tool from one person to another
    d. toss them gently into a strong net set up below the scaffold

20. When working on a roof, it is necessary to _____.
    a. build a flat holding pen to store necessary tools and equipment
    b. erect a wooden wind break
    c. periodically sweep the roof to remove dirt and debris
    d. mount temporary lightning rods on all gable ends

21. Chisels, wedges, and punches are designed to be used with a _____.
    a. wedge
    b. spud wrench
    c. hammer
    d. burring tool

22. When inspecting an impact tool, an indication that the tool may be dangerous is _____.
    a. a mushroomed head
    b. a missing guard
    c. a two-prong plug
    d. no insulation

23. A trench is a narrow excavation in which the depth is greater than the width and the width does not exceed _____.
    a. 10 feet
    b. 15 feet
    c. 20 feet
    d. 25 feet

24. To protect workers from the collapse of an excavation wall in an unshored excavation, install a(n) _____.
    a. cantilever
    b. ladder
    c. trench shield
    d. brace

25. Lockout and tagout devices are used to _____.
    a. prevent the theft of construction tools and equipment
    b. help keep inventory of construction tools and equipment
    c. protect workers from all possible sources of energy
    d. allow only inspectors to gain access to energy sources

Trade Terms Quiz

Fill in the blank with the correct term that you learned from your study of this module.

1. _____ is a condition that occurs when body temperature is too low.
2. A(n) _____ provides information about hazardous chemicals and materials.
3. _____ are structures used in unshored trenches to protect workers from cave-ins.
4. The _____ is a four-color label placed on containers or doors to alert people to specific safety hazards in a product, room, or building.
5. _____ operate using a power source.
6. Confined workspaces that are free of any mechanical, physical, electrical, or atmospheric hazards are _____.
7. When working with or near _____ or hazardous mold, you must always wear a respirator.
8. _____ restrains the movement of trench walls.
9. Acetylene, butane, propane, and methane are considered _____ gases.
10. Torches are considered _____.
11. An unbalanced stress in the soil causes _____ at the surface.
12. Electrocution is the most serious hazard of using _____.
13. _____ is a method of cave-in protection that uses horizontal steps in an excavation.
14. _____ are written warnings to protect workers from energy sources.
15. Safety standards are enforced by the _____.
16. Hazards in a(n) _____ can include chemical, mechanical, electrical, and physical hazards.
17. Subsidence can cause great stress on a trench's _____.
18. _____ tools have sharp edges.
19. When an atmosphere has less than 19.5 percent oxygen, it is considered to be a(n) _____.
20. Tags are placed on machinery and equipment during a(n) _____.
21. A stop valve is considered a(n) _____.
22. A(n) _____ has the training, experience, and authority to stop a job if it is not being done safely.
23. A confined space containing too much oxygen is referred to as a(n) _____.
24. Hammer strikes are a common injury when using _____.
25. The _____ requires employers to tell workers about hazardous materials on the job site.
26. _____ can be used with key or combination locks.
27. Too much or too little oxygen in a confined space creates a(n) _____.
28. Ventilation is essential if you are working in _____.
29. _____ should be locked out and disconnected to make sure they are not powered on.
30. SCBA stands for self-contained breathing _____.
31. _____ are also called barricades and barriers.
32. When air monitoring shows that an underground work area contains higher-than-minimum levels of methane or explosive gases, the work areas are classified as _____.
33. Sound is measured in _____.
34. Freestanding scaffolding must be anchored with _____.
35. A stop valve, a disconnect, or a circuit breaker is placed in the Off position during a(n) _____.
36. Always post a(n) _____ when using torches.

Trade Terms

Apparatus
Asbestos
Atmospheric hazards
Benching
Bladed tools
Combustible
Competent person
Confined spaces
Decibels (dB)
Electrically powered tools
Energy-isolating device
Energy sources
Fire watch
Gassy operations
Guards
Guy wires
Hazard Communication (HazCom) Standard
Hypothermia
Impact tools
Liquid-fuel tools
Lockout
Lockout devices
Lockout/tagout procedures
NFPA warning diamond
Nonpermit-required confined space
Occupational Safety and Health Administration (OSHA)
Oxygen-deficient atmosphere
Oxygen-enriched atmosphere
Permit-required confined space
Power tools
Protective system
Safety data sheet (SDS)
Shoring
Subsidence
Tagout devices
Trench shields

Steve Guy

President, Wat-Kem Mechanical, Inc.

How did you choose a career in the plumbing field?

My grandfather and father were both master plumbers, and I grew up in the trade for as far back as I can remember. I worked during summer vacations from school with my dad. I tried college (chemical engineering) and found that I missed working in the field. After military duty, I went into the apprenticeship program for plumbing and pipefitting.

Tell us about your apprenticeship experience.

I completed a four-year registered plumber and pipefitter apprenticeship program through the UA Local #162. It was a good training program, which prepared me for a career in construction. However, the NCCER apprenticeship training programs now rival or surpass the organized trades apprenticeship programs.

What positions have you held in the industry?

Laborer, helper, apprentice, journeyman, foreman, superintendent, project manager, and corporate management. In other words: the full spectrum.

What would you say is the primary factor in achieving success?

Hard work and learning something every day. Training and preparation can make the road to success a shorter journey.

What does your current job involve?

Managing the business operations and managing individual projects.

Do you have any advice for someone just entering the trade?

Start each day with a good attitude and a willingness to learn. Be at work on time and ready to work. Ask questions and learn from your mistakes. Be a part of the solution, not a part of the problem.

Trade Terms Introduced in This Module

Apparatus: One tool, which combines a variety of functions, to perform a particular job.

Asbestos: A fibrous, fire-resistant substance used in pipe insulation, shingles, wallboard, floor coverings, and certain types of insulation. Now banned by government regulation as a health hazard.

Atmospheric hazards: Potential dangers in the air or conditions of poor air quality.

Benching: A method of protecting workers from cave-ins by excavating the sides of an excavation to form one or a series of horizontal levels or steps, usually with vertical or near-vertical surfaces between levels.

Bladed tools: Tools that use sharp edges to accomplish their tasks. Bladed tools include saws, knives, scissors, tin snips, and wire cutters.

Combustible: Air or materials that can explode and cause a fire.

Competent person: An individual who is capable of identifying existing and predictable hazards or working conditions that are hazardous, unsanitary, or dangerous to employees, and who has authorization to take prompt, corrective measures to eliminate or control these hazards and conditions.

Confined spaces: Spaces that, by design and/or configuration, have limited openings for entry and exit, have unfavorable natural ventilation, may contain or produce hazardous substances, and are not intended for continuous employee occupancy.

Decibels (dB): A measure of sound intensity or loudness. The higher the decibel level, the louder and more potentially damaging the sound is.

Electrically powered tools: Tools that use electrical current to operate.

Energy-isolating device: Any mechanical device that physically prevents the transmission or release of energy. Can include manually operated electrical circuit breakers, disconnect switches, line valves, and blocks.

Energy sources: Any sources of electrical, mechanical, hydraulic, pneumatic, chemical, thermal, or other energy.

Fire watch: One or more people who are responsible for preventing and extinguishing fires and notifying the fire department and/or occupants in the event of a fire emergency.

Gassy operations: Working conditions in which one or more of the following conditions exist: higher than minimum levels of methane or explosive gases are present; a gas ignition has previously occurred there; or the area is connected to an underground area designated a gassy operation.

Guards: Devices that protect tool operators from dangerous moving parts, such as blades, gears, and pulleys.

Guy wires: Ropes, chains, cables, or rods attached to something as a brace or guide.

Hazard Communication (HazCom) Standard: A federal OSHA regulation requiring employers to educate and inform workers about chemical hazards on the job site (*29 CFR 1910.1200*).

Hypothermia: A life-threatening condition caused by exposure to very cold temperatures.

Impact tools: Tools that must strike or be struck to accomplish their task. They include hammers, chisels, and taps.

Liquid-fuel tools: Tools that use a liquid fuel, such as gasoline or liquid propane, to operate.

Lockout: The placement of a lockout device on an energy-isolating device, in accordance with an established procedure, ensuring that the energy-isolating device and the equipment being controlled cannot be operated until the lockout device is removed.

Lockout devices: Any devices that use positive means such as a lock to hold an energy-isolating device in a safe position, thereby preventing the energizing of machinery or equipment.

Lockout/tagout procedures: Processes for identifying hazardous equipment, locking it so that no workers can use it until it is certified for safe use, and placing a tag on the equipment that describes the problem and warns against use.

NFPA warning diamond: A four-color diamond label placed on containers or doors to alert people to specific safety hazards in a product, room, or building.

Nonpermit-required confined space: A confined workspace free of any atmospheric, physical, electrical, and mechanical hazards that can cause injury or death.

Occupational Safety and Health Administration (OSHA): The division of the US Department of Labor mandated to ensure a safe and healthy environment in the workplace.

Oxygen-deficient atmosphere: An atmosphere in which there is not enough oxygen to support life. Usually considered less than 19.5 percent oxygen by volume.

Oxygen-enriched atmosphere: An atmosphere in which there is too much oxygen. Usually considered more than 23.5 percent oxygen by volume.

Permit-required confined space: A confined space that has actual or possible hazards. These hazards can be atmospheric, physical, electrical, or mechanical.

Power tools: Tools that require a power source, such as electricity, hydraulics, or pneumatics, to operate.

Protective system: A method of protecting employees from cave-ins, from material that could fall or roll from an excavation face or into an excavation, or from the collapse of adjacent structures. Protective systems include support systems, sloping and benching systems, and shielding systems.

Safety data sheet (SDS): A document that must accompany any hazardous material. The SDS identifies the material and gives the exposure limits, the physical and chemical characteristics, the kind of hazard it presents, precautions for safe handling and use, and specific control measures.

Shoring: A structure such as a metal hydraulic, mechanical, or timber system that supports the sides of an excavation and is designed to prevent cave-ins.

Subsidence: A depression in the earth that is caused by unbalanced stresses in the soil surrounding an excavation.

Tagout devices: Any prominent warning devices, such as a tag and a means of attachment that can be fastened securely to an energy-isolating device in accordance with an established procedure. The tag indicates that the machine or equipment to which it is attached is not to be operated until the tagout device is removed in accordance with the energy-control procedure.

Trench shields: Structures that are able to withstand the forces imposed on them by a cave-in and can thereby protect employees within the excavation. Shields can be permanent structures or portable and moved along as work progresses. Shields can be either premanufactured or job-built in accordance with *29 CFR 1926.652 (c)(3) or (c)(4).*

Additional Resources

This module presents thorough resources for task training. The following resource material is suggested for further study.

Environmental Protection Agency. *www.epa.gov*.

Managing Electrical Hazards, Latest edition. NCCER. New York, NY: Pearson.

National Safety Council. *www.nsc.org*.

OSHA. *www.osha.gov*.

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Sperian Protection, Figures 4, 5, 11

Majestic Glove, Figure 6

Anna Meade, Figure 7

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North Safety Products USA, Figure 41

Draeger Safety, Inc., Figure 46

Richard Kerzetski, Figure 47

Section Review Answer Key

SECTION 1.0.0

Answer	Section Reference	Objective
1. b	1.1.1	1a
2. d	1.2.0	1b

SECTION 2.0.0

Answer	Section Reference	Objective
1. c	2.1.2	2a
2. b	2.2.2; Figure 16	2b
3. a	2.3.1	2c

SECTION 3.0.0

Answer	Section Reference	Objective
1. b	3.1.1	3a
2. a	3.2.2	3b

SECTION 4.0.0

Answer	Section Reference	Objective
1. a	4.1.5	4a
2. c	4.2.3	4b
3. d	4.3.2	4c
4. a	4.4.0	4d
5. d	4.5.0	4e

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