Gas Operations & Engineering Safety Considerations

A Publication for AGA Members

Prepared by the Safety and Occupational Health Committee
400 North Capitol St., N.W., Suite 450
Washington, DC 20001
U.S.A.
Phone: (202) 824-7000
Fax: (202) 824-7082
Web site: www.aga.org

December 2024

DISCLAIMER AND COPYRIGHT

The American Gas Association's (AGA) Safety, Operations and Engineering Section provides a forum for industry experts to bring their collective knowledge together to continuously improve the areas of operating, engineering and technological aspects of producing, gathering, transporting, storing, distributing, measuring and utilizing natural gas.

Through its publications, of which this is one, AGA provides for the exchange of educational information within the natural gas industry and scientific, trade and governmental organizations. Many AGA publications are prepared or sponsored by an AGA Operations and Engineering Section technical committee. While AGA may administer the process, neither AGA nor the technical committee independently tests, evaluates or verifies the accuracy of any information or the soundness of any judgments contained therein.

AGA disclaims liability for any personal injury, property or other damages of any nature whatsoever, whether special, indirect, consequential or compensatory, directly or indirectly resulting from the publication, use of or reliance on AGA publications. AGA makes no guaranty or warranty as to the accuracy and completeness of any information published therein. The information contained therein is provided on an "as is" basis and AGA makes no representations or warranties including any expressed or implied warranty of merchantability or fitness for a particular purpose.

In issuing and making this document available, AGA is not undertaking to render professional or other services for or on behalf of any person or entity. Nor is AGA undertaking to perform any duty owed by any person or entity to someone else. Anyone using this document should rely on his or her own independent judgment or, as appropriate, seek the advice of a competent professional in determining the exercise of reasonable care in any given circumstances. Information on the topics covered by this publication may be available from other sources, which the user may wish to consult for additional views or information not covered by this publication.

AGA has no power, nor does it undertake, to police or enforce compliance with the contents of this document. Nor does AGA list, certify, test or inspect products, designs or installations for compliance with this document. Any certification or other statement of compliance is solely the responsibility of the certifier or maker of the statement. Any reference to trade names or specific commercial products, methods, commodities or services in this document does not represent or constitute an endorsement, recommendation or favoring nor disapproval, disparagement or disfavoring by AGA or any other person of the specific commercial product, commodity or service.

AGA does not take any position with respect to the validity of any patent rights asserted in connection with any items that are mentioned in or are the subject of AGA publications, and AGA disclaims liability for the infringement of any patent resulting from the use of or reliance on its publications. Users of these publications are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, is entirely their own responsibility.

Users of this publication should consult applicable federal, state and local laws and regulations. AGA does not, through its publications intend to urge action that is not in compliance with applicable laws, and its publications may not be construed as doing so.

Changes to this document may become necessary from time to time. If changes are believed appropriate by any person or entity, such suggested changes should be communicated to AGA in writing and sent to:

Safety, Operations, & Engineering Section, American Gas Association, 400 North Capitol Street, NW, 4th Floor, Washington, DC 20001, U.S.A. Suggested changes must include: contact information, including name, address and any corporate affiliation; full name of the document; suggested revisions to the text of the document; the rationale for the suggested revisions; and permission to use the suggested revisions in an amended publication of the document.

Contents

Chapter 3 - SAFETY CONSIDERATIONS

1. Introduction

The American Gas Association's Gas Engineering and Operation Practices (GEOP) series is an eleven-part series of texts addressing various technical aspects of natural gas supply, transmission, distribution, measurement, utilization, and other technical services subjects. These documents are subject to periodic updates that reflect recent developments in knowledge, technologies, and practices related to the operations of natural gas utilities. This document constitutes the latest revisions to "Chapter 3 - Gas Operations and Engineering Safety Practices" and is the culmination of a year-long effort by AGA's Operations and Engineering Section's Safety & Occupational Health Committee to revise and update this GEOP chapter with current information regarding technology and industry practices. This document improves and expands upon the contents of the previous GEOP publication and supersedes all prior versions.

AGA's member companies are steadfastly dedicated to the continued delivery of natural gas in a safe and reliable fashion to the communities they serve. We are committed to sharing leading practices and lessons learned across our industry in order to enhance our collective performance. Many of the leading practices described in this document are currently implemented at natural gas utilities but they are not uniformly applicable to all systems nor exclusive. The determination of whether to adopt any of the items contained in this document is individual to each company, and the need to implement every practice and the timing of any implementation of the practices described in this document will vary with each natural gas utility and the specific environment in which they operate. The actions within this document should be evaluated in light of each operator's system, geographic variables, the operator's independent integrity assessment, risk analysis and mitigation strategy and what has been deemed reasonable and prudent by their state regulators. Therefore, not all of the practices described in this document will be applicable to all operators. As used herein, the term "should" is not mandatory but is to be acted upon as appropriate.

This document is intended to provide guidance for Safety Professionals, Field Personnel, Supervisors and Managers at all levels to help ensure worker safety during pipeline system operations from hazards visible and non-visible.

This document is intended to simulate the flow of work/job progression. Consideration should be given to the type of event or job that will be performed: routine/planned work or emergency response work. While many of the safety considerations will remain the same, emergency work response should initiate the activation of the Operator's Emergency Response Plan. In each of the sections, the reader must understand that considerations and workflows will vary between routine work and emergency response work, depending on the situation. The

Emergency Response Plan, specific to each Operator, should include scalable incident command/unified command structure, notification requirements, processes, and procedures for addressing the emergency. Reference API Recommended Practice 1173 – Pipeline Safety Management Systems, sub element 12: Emergency Preparedness and Response for more information.

2. Job Briefing

Hazard recognition is a vital first step in managing employee safety. Identifying hazards and providing work procedures, job training, tools to reduce risk, and personal protective equipment are important measures to prevent injuries that may occur while performing work. There are many facets to becoming fully informed and prepared to safely perform work, including:

- Operator Qualification (OQ) training and testing,
- Occupational Safety and Health Administration (OSHA) safety standards,
- company policies and procedures, and
- emergency preparedness instruction that covers
    - fire extinguisher use,
    - first aid
    - cardiopulmonary resuscitation (CPR) training, and
    - automatic external defibrillator (AED) training.

Acquiring the skillset to mitigate unnecessary risks, to prevent injuries and circumvent emergencies is a long-term process. Safety information must be provided in a planned, structured manner that is effective for adult learning.

2.1 Hazardous Materials and Materials of Trade

Under the U.S. Department of Transportation's Pipeline and Hazardous Materials Safety Administration (PHMSA), the transportation of materials with physical and health hazards is regulated, and in many cases, restricted or even prohibited.

Under PHMSA's standard, *Hazardous Material* means a substance or material that the Secretary of Transportation has determined is capable of posing an unreasonable risk to health, safety, and property when transported in commerce and has been designated as hazardous under Section 5103 of Federal Hazardous Materials Transportation Law (49 U.S.C. 5103). The term includes hazardous substances, hazardous wastes, marine pollutants, elevated temperature materials, materials designated as hazardous in the Hazardous Materials Table (see 49 CFR 172.101), and materials that meet the defining criteria for hazard classes and divisions in Part 173 of Subchapter C.

These standards also require employee and driver training, along with proper labeling and identification for packaging, vessels, and vehicles when hazardous materials are transported over the road, or by rail, air, or ship. Under the Materials of Trade Exceptions section (49 CFR 173.6), drivers transporting limited quantities of

hazardous materials are exempted from the general requirements of the standard, provided, 1) the materials are not transported in commerce, but for the use of the driver or owner of the vehicle, and 2) specific quantity limits of the materials transported meet the requirements of this section. For example, this may include fuel needed for powered equipment used in the field, spray paints for utility marking, or compressed gases used for purging pipeline during field work.

2.2 Hazard Communication

OSHA's Hazard Communication Standard (1910.1200) pertains to protecting employees from the effects of physical and health exposures to hazardous materials encountered on the job. The concept is to know the materials used in work processes and understand the hazards of exposure. Physical exposures include flammability, reactivity, radioactivity, or volatility. Health hazards include any effects to the human body upon exposure through routes of entry, inhalation, ingestion, or absorption. Toxicity, poisoning, corrosiveness to eyes and skin, carcinogenic, and other adverse or altering effects are included.

Once materials are inventoried and hazards are known, employees must be provided open access to this information, as well as the means to protect against the hazards.[1] There are various tools for worker protection, such as mechanical ventilation, combustible gas indicators, detection sensors, and other technologies. Additionally, there is the (common) use of personal protective equipment (PPE).

The evaluation and recognition of hazards present in raw materials, processing materials, finished products and wastes are an important step in protecting employees. However, the elimination or substitution of a highly hazardous material with a material or process that is less hazardous would be an example of mitigation. This sort of mitigation is far more effective than wearing PPE.

2.3 Safety Data Sheets

Manufacturers and suppliers of hazardous materials (or potentially hazardous materials) are responsible to provide SDS documents to customers for the purpose of complying with the Hazard Communication Standard and protecting employees from exposure risks. An SDS may be obtained by request from the supplier if it is not readily available via the company's website.

Operators must train employees regarding hazardous chemicals at their work site per 29 CFR 1910.1200 (h). Safety Data Sheets, along with container labels and markings (such as Globally Harmonized System (GHS) classification labels), provide information for users to quickly understand exposure risks and protect themselves from harmful materials.

3. Job Site Considerations

During the Job Briefing, while reviewing potential hazards and mitigation measures, consideration should be given to how the job will progress. This includes the types of duties that will be performed and needs of the workers at the site for safety. The following sections cover some of the typical considerations needed to perform work safely.

3.1 Arriving On Scene

It is possible for operators to experience significant safety events associated with the first task of a job: arriving on scene and establishing the job site. This is important because at least one operator has experienced employee injury due to failure of communication of hazards between the onsite resources and arriving resources: an employee fell in a utility access hole that was opened to vent escaping gas during a nighttime emergency.[2]

Before establishing the job site, consider the following:

- Research the site.
- Plan the route.
- Ensure that communication has been established with any onsite personnel.
- Perform a preliminary job briefing.

Situational awareness is a key factor in mitigating the potential hazards associated with hostile customers. Employees should perform an assessment of their surroundings and the conditions of the job before exiting their vehicle. Items to consider during the assessment include:

- Is there a history of crime or violence in the general geographic area?
- Is there a history of negative customer relations with those expected to encounter?
- Is the area where I am parking well-lit to increase visibility?
- Am I always leaving myself means of escaping a potentially dangerous situation?
- Does the situation feel safe?

Employees should be trained with verbal and non-verbal skills to address customers that may be aggravated. Aggravation could occur due to a perception of property intrusion or privacy invasion, customer inconveniences, property damage, and utility service outages. Employees should be encouraged to request security services if a hostile atmosphere is observed or anticipated. Employees should also be equipped with public contact information for a supervisor or customer complaint department that can be given to a customer who is escalating the perceived issue.

3.1.1 Vehicle Placement

For on scene vehicle placement, consider:

- Potential gas migrations paths when responding to an odor complaint (gas leak call). Park upwind of potential gas blows and avoid parking over manhole or vault covers.
- Parking to accommodate additional worksite vehicles and/or equipment and avoid obstruction of egress paths or muster zones. Evaluate how an ambulance, ambulatory helicopter, and other emergency vehicle may need to access and egress the jobsite.
- Proximity to fixed objects – could the vehicle be moved without impacting other vehicles, equipment, or assets (backing into and striking fixed objects are two of the most common motor vehicle safety incidents).

Vehicles should "pull-through" or back into parking spaces where possible to limit risk of contact with unseen obstructions when driving away.

- Using emergency brake and/or wheel chocks to prevent rolls.

3.1.2 Secure Site / Set up Work Site & Traffic Control

The work site should be secured to limit violations of the work zone by public pedestrians, bicycles, and vehicles. Consider the impact of work on pedestrian traffic and those with disabilities (Americans with Disabilities Act). Provide alternative routes or divert traffic where necessary to accommodate the volumes of public movement and minimize disruptions.

Vehicular traffic control patterns should follow Temporary Traffic Controls standards within the Manual for Uniform Traffic Control Devices (MUTCD). High visibility signs, traffic cones/delineators, and arrow boards should all be employed to divert traffic flow around the work site. When utilizing flaggers to control traffic flow, ensure that competent, trained/certified individuals are utilized. Additionally, ensure traffic patterns are compliant with local traffic regulations and permitting requirements. Some permits require submitting a traffic control plan.

WorkZoneSafety.org is a clearinghouse of resources for roadway safety and worker safety. It may be referenced for standards, practices, and state requirements for road/traffic safety and worker requirements.

When used, flaggers must be positioned in a visible, well lighted area and be able to communicate efficiently with other flaggers and workers. Flaggers are to be focused on oncoming traffic and prepared to warn work zone workers of potential public vehicle encroachments. The ANSI A10.47 consensus standard applies to workers engaged in construction, utility work, maintenance, or repair activities on any area of a highway. The standard covers practices including Flagger Safety, Runover/Backover Prevention, Equipment Operator Safety, Illumination, and Personal Protective Equipment. Air horns/whistles should be employed to warn workers of a public vehicle driver who disobeys traffic commands or violates the work zone.

Consider placing work vehicles and/or equipment between the flow of traffic and work area. This gives a protective buffer for site workers against distracted or impaired drivers who violate the work zone. Fatalities have occurred at job sites where distracted public drivers veered, unobstructed, into active work zones.

Consider using positive barriers such as fencing (or panels), horizontal cones, water filled barriers or "jersey" concrete barriers to limit public intrusion into the worksite. These barriers should be designed with retro reflective paint/tape and high visibility color patterns. Lighted beacons and flashing lights improve visibility and encourage awareness and speed reduction with the public.

3.1.3 Loading/Unloading Equipment

During transport, always secure equipment and material. The Department of Transportation may have specific securement requirements and anchorage points based on the weights and/or configuration of material and equipment being transported. Always inspect loads to ensure stability prior to removing bands, straps, or anchors.

Ensure that employees are properly trained and/or authorized per OSHA standards to operate the equipment prior to unloading and knowledgeable of equipment operating zone. Relevant OSHA Standards include (but are not limited to):

- 29 CFR § 1926.1427, Cranes and Derricks in Construction
- 29 CFR § 1910.178, Powered Industrial Trucks/Forklifts
- 29 CFR §1926.453, Aerial Lifts

Some equipment may require operator certifications. Several operators have reported significant injuries and even fatalities that have resulted from falls off equipment or unsecured loads. Consider utilizing specialized equipment, such as vacuum pipe clamp, to limit employee exposure.

When loading or unloading equipment:

- Establish the required operating radius and height of equipment booms (cranes, side booms, backhoes, excavators)
- Observe the site conditions for overhead hazards such as electrical power lines, communication lines, signs, building overhangs, etc. Consider the use of proximity sensors and alarms to alert operators when approaching electrical power lines.
- Use appropriately trained, dedicated spotters for transitions under/near overhead power and communications lines. Provide spotters with one or more means of communication with the equipment operators: direct visual, radio communication, warning horns, etc.
- Employees must not position themselves on or in the "drop zone" of material to be unloaded.

Unloading of equipment and material requires extensive communication, and careful planning by experienced equipment operators. Operators have experienced serious injuries related to trailer unloading operations, such as workers struck by boom swings, pipe loading/unloading/rigging, and workers operating within the drop zones of lifting equipment.

3.2 Personal Protective Equipment

Personal Protective equipment (PPE) is the last line of defense against unmitigated hazards, but it is also the least effective hazard control method, as illustrated in Figure 1.

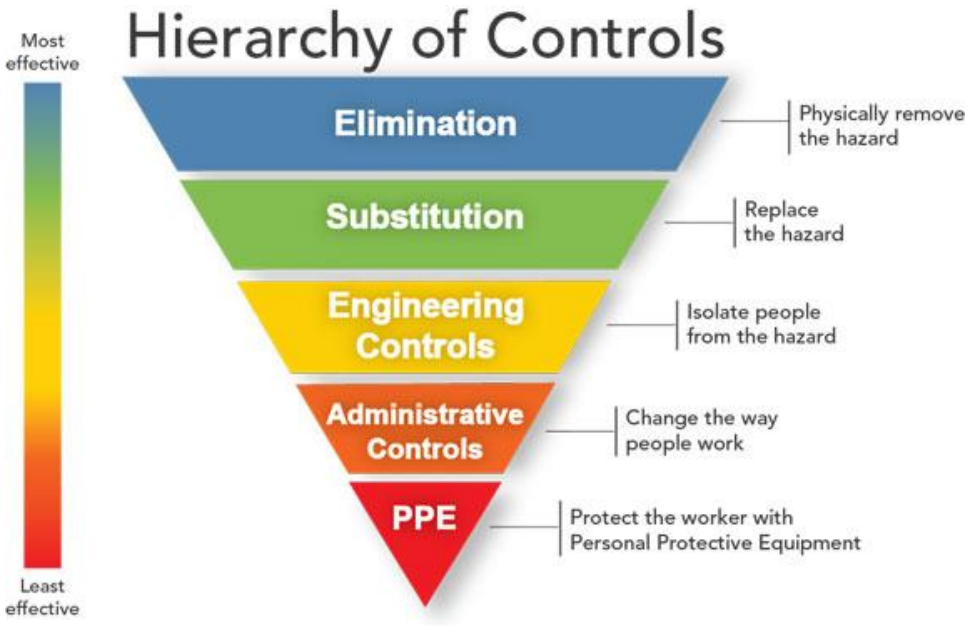

Figure 1: *Hierarchy of Controls- Source OSHA.gov.*[3]

As part of the Hazard Assessment performed during the job briefing, the PPE selected should match the potential hazards of exposure. However, operators should review each task to determine if other control methods can be used to eliminate or reduce the exposure rather than simply trying to protect against it. Consider this ordered, example thought process of using the Hierarchy of Controls in Figure 2.

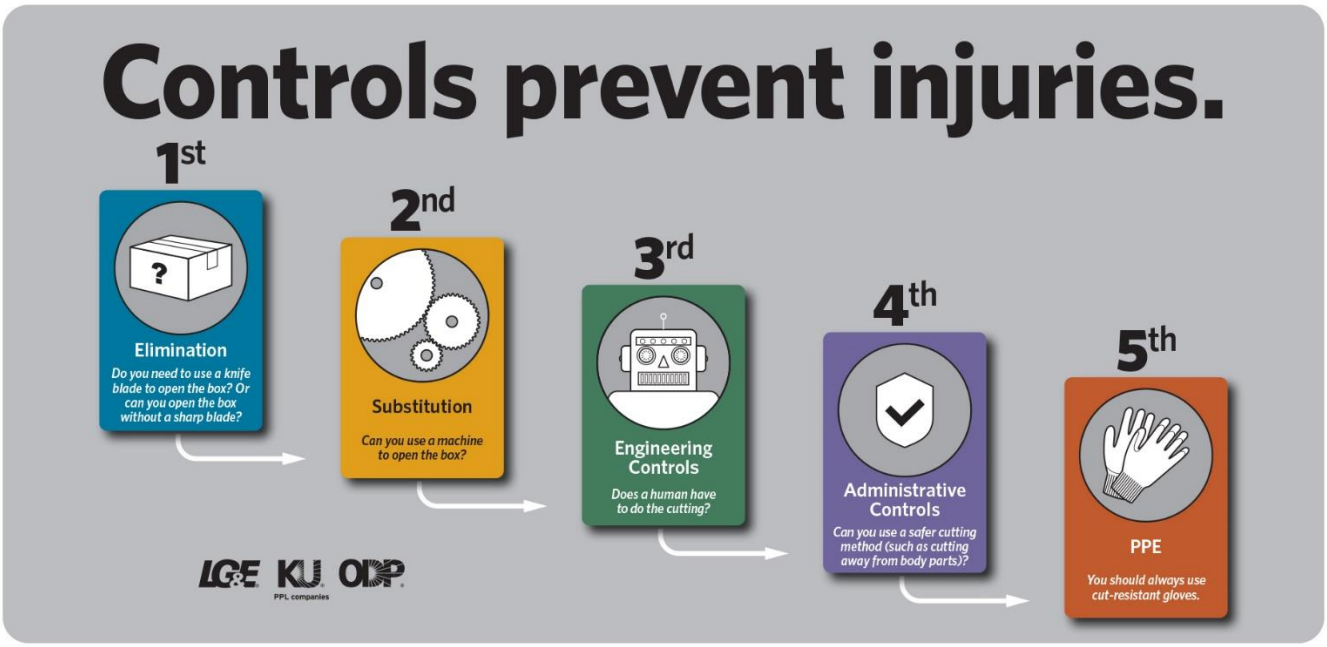

Figure 2: *Hierarchy of Controls Process.*[4] *Image provided by and republished with the permission of Louisville Gas &Electric (LG&E)*

It is important for operators to consider establishing minimum PPE guidelines based on simple, relatable scenarios for effective employee deployment. Please note that OSHA 1910.132 requires employers to perform a hazard assessment and PPE selection based on the hazards. Reference OSHA technical document 3151: Personal Protective Equipment for more information.

3.2.1 High Visibility Garments

Visibility (Traffic and Construction) traffic "safety" vests and high visibility apparel should be worn in construction and traffic exposure areas in accordance with the Manual on Uniform Traffic Control Devices (MUTCD) Chapter 6 and 29 CFR 1296.20. When selecting garments, review any additional local ordinances or requirements to ensure compliance; Operators should review the need for Flame Resistant High Visibility garments as part of the PPE strategy.

- OSHA requires traffic flaggers (see 29 CFR §1926.201) to wear high visibility clothing during the day and retroreflective clothing at night. Additionally, 23 CFR § 634 requires all workers exposed to construction or vehicle traffic in many Federal-Aid rights-of-way to wear high visibility safety apparel (ANSI 107 Class II or III).
- To enhance visibility and safety of the work force, consistent with the MUTCD, Operators should consider requiring safety apparel for all workers that meet a minimum conformance of ANSI 107 Class II when vehicle speeds are less than or equal to 50 mph. Class III vests shall be worn at speeds greater than 50 mph.

- Consideration should be given to requiring Class III for activities between Dusk and Dawn regardless of vehicle speed. Class III clothing has more high visibility and retroreflective surface area than Class II.

3.2.2 Flash Fire, Arc Flash Protection, Thermal Protection – Flame Resistant Clothing

Flame (and Arc) resistant clothing helps mitigate the potential for thermal injury. To achieve that mitigation, the clothing must be sufficiently designed, tested, and configured (layered) to meet the specific types of hazardous energy anticipated to be encountered.

For Natural Gas Workers exposed to potential atmospheric ignition (flash fires), flame resistant clothing that meets NFPA 2112 standard should be worn as an outer layer. Garments and undergarments under this protection layer must be made of FR or natural fibers (cotton, wool, etc.) to minimize potential for burns. Even under FR outer layers, synthetic materials will melt or ignite when exposed to flash fires. Additional underlayers may add thermal protection Operators should consider a tested configuration of fabrics and/or inherently FR fabrics for certain job tasks with higher risk of flash fires. Garment weight has not been shown to be a reliable predictor of FR performance for blended or FR treated fabrics. Reference the AGA white paper: Natural Gas Workers and Natural Gas Fires (Observations and Analysis of Heat Intensity, Escape Time, Extinguish Time and Flame Resistance Garments) published 2018 for additional considerations regarding flame resistant clothing.

Operators whose workers may be exposed to hazards from electrically energized conductors or equipment should review NFPA 70E and OSHA's 1910.269 standards for applicability and proper protective clothing. Static and other ignition source controls are critical to hazard mitigation. For more information, reference Section 7: Electrically Induced Hazards.

Operators should review, at a minimum, the following industry guidance on Flame Resistant Garments:

- AGA Whitepaper: Natural Gas Workers and Natural Gas Fires - American Gas Association (aga.org)
- NFPA 1971: Protective Hood for Structural Fire Fighting
- NFPA 2112: Standard on Flame-Resistant Clothing for Protection of Industrial Personnel Against Short-Duration Thermal Exposures from Fire
- NFPA 2113: Standard on Selection, Care, Use, and Maintenance of Flame-Resistant Garments for Protection of Industrial Personnel Against Short-Duration Thermal Exposures from Fire
- NFPA 70E: Standard for Electrical Safety in the Workplace

3.2.3 Eye/ Face Protection

General eye protection should conform with the latest addition of ANSI Z87. Consideration should be given to tinting for outdoor work and a prohibition against using dark tinted glass while indoors or operating at nighttime.

Individuals with prescription/corrective lenses should be provided options for utilizing such lenses with eye protection. Operators should consider hazards before wearing contact lenses when interacting with chemical and other hazardous exposures. Contact lenses may react/melt/entrap when exposed.

Goggles may be necessary to ensure adequate protection for liquid, gas, and/or vapor exposures, and/or when other exposures (blowing sand, dust, or abrasive blasting material) or site conditions may warrant. Another option for protection against dust and particulates are tight fitting goggle style safety glasses. Reference company's safety plan to determine what is required on the job.

Face shields may be required to supplement general eye protection but should conform to ANSI Z87.

Welding shields should meet minimum tinting shade requirements established in OSHA §29 CFR 1910.133 for protection against radiant energy.

3.2.4 Hand Protection

Consideration should be given to the type of hazards present before selecting the appropriate gloves. Additionally, employees should be trained on proper glove selection. Typical glove ratings include rating for: OSHA 1910.138(a). There are at least two common industry standards related to hand protection selection criterion and rating categorization: American National Standards Institute ANSI 105 (&138 for impact resistance) and European Standard EN 388. In general, the higher numbers associated with these standards, the more protection the gloves provide in that category. Several commercial glove manufacturers offer tabulated data detailing which products meet which standards and at what level.

For additional reference points on chemical resistance, see OSHA technical document 3151 Personal Protective Equipment. In addition, consider following ANSI standard 105 and manufacturers recommendations when implementing PPE.

1. Abrasion resistance
2. Cut/Tear resistance
3. Puncture resistance
4. Chemical resistance (will vary by chemical)
5. Thermal resistance
6. Impact resistance

3.2.5 Head Protection OSHA 1910.135.

Head protection is required when workers are exposed to energized conductors (electric contact hazard) and falling objects. Industry consensus standard ANSI Z89 is commonly referenced for compliance. Operators should:

- Review hardhat manufacturer guidelines on wear and inspection.
- Inform employees of the danger of compromised hat shells and suspension.
- Conduct regular inspections of hardhat liners and shell for cracks, discoloration or tear which could compromise the integrity of equipment.

3.2.6 Foot and Leg Protection

Workers should be provided foot protection from falling objects, rolling objects, and/or sole piercing. Footwear selection should consider material and tread options based on environmental conditions (mud, hard scape, oil, water, electrical shock/conductivity hazards) and surface traction needs. ASTM F2412 and ANSI Z41 are commonly referenced as manufactured standards for protective footwear / "safety toe boots". Please review OSHA 1910.136 for additional requirements.

Legs should be protected from abrasions, punctures and environmental hazards. This includes hazards such as poison ivy, poison oak, thorns, brambles and thistles, ditch walls, insect bites/stings, and animal bites. Operators typically require full length pants to provide a base level of protection from these hazards.

Additional considerations for leg and foot protection include:

- Toe / Metatarsal guards worn when operating power tools such as handheld pacing breakers, jumping jacks, and pneumatic spades.
- Ankle stability (such as ankle high, laced boots) for protection when walking on uneven surfaces or terrain.
- Chaps when operating a chainsaw.
- Dielectric PPE when step-potential electrical hazards exist.

3.2.7 Hearing Protection

Workers need to be protected against noise levels at 85 decibels and above over an 8-hour time weighted average. Sound studies may need to be conducted during performance of various tasks to determine the level of noise encountered and review potential controls and PPE selection. Evaluate the work environment to determine what forms of noise protection should be offered. Additionally, allowing employees to choose among appropriate types of protection may be a good way to ensure participation and wear among employees. In certain situations, multiple types of protection may need to be worn. An example of this is over earmuffs along with in-ear plugs. Consider referencing OSHA 1910.95 for more information.

3.2.8 Fall from Height Protection

Consider heights above 4 feet that may require fall protection and or restraint systems. Please see Section 6.4: Walking and Working Surface for more information.

3.3 Water Safety

When working on or near waterways, consideration should be given to personal flotation and rescue equipment selection. The waterway work requirements may be covered by one or more regulatory jurisdictional bodies such as OSHA, US Coast Guard, Army Corp of Engineers, and/or other Tribal or Local jurisdictional elements.

It may also become necessary to combine fall arrest systems and systems described in the Walking Working Surfaces Section with flotation and rescue equipment. Please note that the jurisdictional body that oversees the waterway may require specific types of hazard controls including PPE.

Commercial Diving operations are also covered by specific subparts in OSHA standards 1910 and 1926, among others. These subparts detail specific considerations for both the Commercial Divers and the host employers. Operators should review medical certifications, training, certifications, and hazard mitigation plans to ensure regulatory compliance, as applicable, with commercial diving work.

3.3.1 Flood Water Considerations

After a major flood, it is often difficult to maintain good hygiene during cleanup operations. To avoid waterborne disease, it is important to wash your hands with soap and clean, running water, especially before work breaks, meal breaks, and at the end of the work shift. Workers should assume that any water in flooded or surrounding areas is not safe (for consumption and/or washing) unless the local or state authorities have specifically declared it to be safe.

- If no safe water supply is available for washing, use bottled water, water that has been boiled for at least 10 minutes or chemically disinfected water. (To disinfect water, use 5 drops of liquid household bleach to each gallon of water and let it sit for at least 30 minutes for disinfection to be completed). Water storage containers should be rinsed periodically with a household bleach solution.
- If water is suspected of being contaminated with hazardous chemicals, cleanup workers may need to wear special chemical resistant outer clothing and protective goggles. Before entering a contaminated area that has been flooded, you should don plastic or rubber gloves, boots, and other protective clothing needed to avoid contact with floodwater.
- Decrease the risk of mosquito and other insect bites by wearing long-sleeved shirts, long pants, and by using insect repellants
- When driving to or arriving on scene during a flood, never drive through water with unknown depths.

- Operators should consider pre-emptive measures based on weather forecasting and historical flood data to limit personnel entry into flood waters. Employees who may enter flooded waters should be adequately trained for swift water entry and equipped with life safety measures to prevent drowning. Team operation is recommended. Coordination with local emergency response agencies is recommended.
    - Considerations for Man entry:
        - Wildlife (see Insect, Vermin and Wildlife Hazards section below)
        - Flood water contamination: hazardous materials/sharps/biohazards
        - Displaced manhole covers and other sewer/drain intake points
        - Debris in current
        - Speed of current
        - Availability of resources to provide rescue services for employees in distress
        - Electrical hazards (i.e. downed power lines)

3.4 Respiratory Protection

Proper respiratory protection must be worn when exposed to hazardous levels of airborne contaminants or oxygen-deficient air (i.e., when performing scaling or sandblasting). Note that respiratory equipment users must be medically qualified by a Physician or other licensed health care professional (PLHCP) in accordance with §29 CFR 1910.134 prior to use.

3.5 Insect, Vermin, and Wildlife Hazards

Employees should be encouraged to wear protective clothing and gloves when moving, operating, or working near equipment that may have become a shelter for wildlife.

Employees should be provided with appropriate deterrent measures for aggressive wildlife. Operators should consider appropriate repellent sprays and/or counter measures suitable to protect employees. FR PPE/Clothing will likely require some form of non-DEET insect spray.

All wildlife has the potential to cause unexpected injuries on the job sites. Bees, wasps, ticks, venomous snakes, spiders, scorpions, snapping turtles, feral cats, dogs, bears, various birds (including geese) may be some of the more common insect and vermin hazards.

Prompt first aid treatment, and continued measures to prevent secondary infections, are critical steps for all insect bites and/or stings. Employees should be encouraged to communicate any sensitivities, fears, and/or allergies to their co-workers to ensure appropriate measures are taken if an insect or vermin hazard is identified.

4. Hazard Identification, Assessment, & Mitigation

Every job should be reviewed and broken down into tasks to better understand the safety risks associated. A Job Hazard Analysis should be created to educate employees on the hazards and the controls for those hazards.

Companies should review and document the engineering controls, administrative controls, and as a last line of defense, the PPE controls for each task. For more information, see OSHA form 3071. Special consideration should be given to tasks that involve high energy and high consequences to ensure direct controls are applied. A direct control is defined as one that is specifically targeted to the high energy source; effectively mitigates exposure ot the high-energy source when installed, verified, and used properly; and is effective even if there is unintentional human error during the work (unrelated to the installation of the control).

4.1 Ergonomics

Field ergonomics should be addressed and evaluated for the work performed. OSHA recommends involving field workers to help identify risks regarding ergonomics and to include with the mitigation. In addition to field ergonomics, it is recommended to assess office employees, along with employees working from home, that work at desks for long periods of time. Please see OSHA's overview, "Prevention of Musculoskeletal Disorders in the Workplace" or the "Ergonomics" Safety and Health topic on OSHA's webpage.

4.2 Control of Hazardous Energy

Lockout/tagout (LOTO) is a general industry OSHA standard that describes requirements for controlling hazardous energy to protect workers while they are servicing or performing maintenance on machines/equipment. This includes hazardous energy such as explosive gases, electricity, hydraulics, compressed air, steam, or even gravity. While many machines/types of equipment can be de-energized simply by unplugging them from the energy source, extra precautions using lockout devices on the energy isolating devices (EID) and tags must be used for machines/equipment that do not operate by plug and cord. For more information on LOTO, review 29 CFR § 1910.147 or the "Control of Hazardous Energy (Lockout/Tagout)" Safety and Health topic on OSHA's webpage.

4.3 Atmosphere Breathing levels, O2 H2S, CO

Atmosphere must be tested as required with a properly calibrated instrument and take adequate precautions to protect life and property. This includes measures such as improving ventilation, donning respiratory protection, or wearing appropriate PPE. Monitor the atmosphere, continuously when appropriate, to verify conditions and take appropriate actions if the conditions change.

Oxygen levels below 19.5 percent is an oxygen-deficient atmosphere according to 29 CFR § 1910.134 and should be considered immediately dangerous to life and health (IDLH).

Hydrogen sulfide (H2S) is a hazardous gas that is colorless, flammable and toxic. It has a strong "rotten egg" odor which can deaden sense of smell. Please refer to OSHA's Hydrogen Sulfide chemical identification table for additional information on exposure limits. At low concentrations the material can cause irritation. At higher concentrations it can cause asphyxiation. A concentration at or above 100 ppm is IDLH.

Carbon Monoxide (CO) is also colorless, poisonous, and tasteless. The OSHA permissible exposure limit (PEL) for CO is 50 ppm. OSHA standards prohibit more than 50 ppm during an 8-hour period.

Employees engaged in other operations that may create fumes or dust such as coating applications, welding fumes, etc., may consider monitoring for those exposures.

4.3.1 Respiratory Issues and Hazards

Multiple hazards can cause respiratory concerns for gas workers. Particulate respirators should be used whenever hazardous airborne particles are present. Other airborne contaminants such as asbestos, silica and natural gas may require a higher level of respiratory protection.

Asbestos is a naturally occurring mineral composed of long and thin fibrous crystals and can cause long term health concerns. Asbestos containing materials can be found in coal tar pipe wrap, transit siding, and gaskets. An Asbestos program that complies with OSHA and EPA regulations should be created.

Silica is a naturally occurring mineral found within the earth's crust. Common silica-containing materials include sand, stone, concrete, asphalt, coal, ash, and brick. Inhalation of silica can cause long term health concerns. Utilizing wet methods to control the silica-containing material is an effective control.

If respirators are required for tasks, ensure employees are properly fitted and that there is a respiratory program developed. For more information, see 29 CFR §1910.134, 29 CFR § 1926.103, or the "Respiratory Protection" Safety and Health Topic on OSHA's webpage. Operators should consider creating an airborne contaminant program that, at a minimum, complies with OSHA regulations.

4.4 Noise Consideration

Excessive noise in the workplace can lead to temporary or permanent hearing loss. OSHA PEL for noise is 90 dBA for all workers for an 8-hour day. Hearing protective devices should be worn in work areas with sound levels 85 dBA and over. Utilize the hierarchy of controls when evaluating noise (Elimination, Substitution, engineering, administrative, PPE). When evaluating selected PPE, understand the ratings to determine if it mitigates appropriately. Sampling of worksite noise levels should be conducted, and, in some cases, the installment of a hearing conservation program will be required. For more information, see 29 CFR §1910.95, 29 CFR § 1926.52 or the "Occupational Noise Exposure" Safety and Health Topic on OSHA's webpage.

When using hearing protection, communication measures should be discussed as it can affect how employees communicate at the job site. Consider technology that protects employees' hearing but allows communication among workers. Some manufacturers offer active hearing protection that allows for ambient environmental input (surround sound), that is integrated into radio headphones and microphone systems. Ensure that technology is appropriate for any atmospheric hazards such as a gaseous environment.

4.5 Weather Conditions

Weather can play a significant role in workplace safety. From hot to cold and from dry to wet, mitigation efforts should be shared and used. It is recommended to have a program around heat stress, winter work, and storm work. For each risk, it is recommended to evaluate the expectations for the workforce and determine a mitigation plan

to ensure safety during all weather conditions. For more information regarding weather conditions, see the Safety and Health Topics such as the "Heat" and "Winter Weather" on OSHA's webpage. Consider methods to provide employees with emergency notifications/alerts to help prepare for hazardous weather conditions. For example, government agencies such as FEMA or the National Weather Service may offer applications for weather updates.

4.6 Slips, Trips, or Falls

Slips, Trips, and Falls are the leading causes of injuries within the workforce. Some areas that should be focused on to mitigate this risk are proper housekeeping, proper footwear, and a walk down of the job site during pre-job briefings. These simple steps can greatly reduce injuries. For more information, reference Section 5: Walking and Working Surfaces.

4.7 Lighting Conditions:

Worksites should be illuminated by at least 5 foot-candles, comparable to a commercial store parking lot. Depending on the work being performed and the location, additional illumination should be provided. Examples of this are flagging stations and detailed tasks for which proper illumination is needed to safely execute the work. For more information, please review§29 CFR § 1926.56.

5. Excavation Safety

Trench collapses, or cave-ins, are a serious threat and pose a great risk to workers' lives. When done safely, trenching operations can reduce worker exposure to other potential hazards including falls, falling loads, hazardous atmospheres, and incidents involving mobile equipment.

The Pipeline and Hazardous Materials Safety Administration (PHMSA) issued an Advisory Bulletin (ADB-06-01) that covered the use of Qualified Personnel to oversee all Excavations and Backfilling Operations[5]. Excavation is considered a covered task, for additional information, refer to the PHMSA's Operator Qualification Enforcement Guidance document. There are many important considerations in utility excavation and trenching affecting both employee and public safety. However, the emphasis in this section is employee safety in excavations.

5.1 Excavation Safety Considerations

PPE will vary depending on the task being performed during the excavation. Always refer to company practices, policies, safety protocols, and construction manuals for guidance.

Below is a non-exclusive list of common PPE used when performing excavation tasks for natural gas pipelines:

Head Protection (hard hat)	§1910.135, §1926.100
Safety Glasses (side shields) / Goggles / Face Masks	§1910.133, §1926.102
Hearing Protection	§1926.101
Safety Gloves (heavy duty)	§1910.138
Footwear (ANSI approved steel / composite toe)	§1926.96
Respirators (N, R, or P-95) / Breathing Apparatus (SCBA)	§1926.103, §1926.(g)(2)((i)
Safety Vest / Shirt / Jacket (reflective markings)	§1926.651(d)
Fall Protection	§1910.140, §1926.104, §1926.500-503
Flame Protection Clothing	§1910.252(b)(3)

Table 1: *Recommendation of PPE Equipment.*

Below is a non-exclusive list of safety equipment used when performing excavation tasks for natural gas pipelines:

Fire Extinguisher / Water Drums / Water Hose	§1926.150, §1910.157, §1910.158
De-Watering Equipment (sump pump)	§1926.651(h)
Vehicular Protection (cones, barrels, bollards, and barriers)	§1915.173, §1926.1424

Table 2: *Recommendation of Safety Equipment.*

5.2 Fire Safety Considerations

Suitable fire extinguishing equipment shall readily be available for instant use during an excavation. Such fire extinguishing equipment may consist of pails of water, buckets of sand, hose or portable fire extinguishers depending on combustible material exposed. Typically, a minimum 20 lbs. Class B fire extinguisher is used for flammable gases such as propane and methane. However, a Class B, ABC powder fire extinguisher can be used as well (see 29 CFR §§ 1910.252(a)(2),1910.157, and 1926.150). Fire extinguishers (B:C rating NFPA 10) should

be readily available whenever the possibility of escaping gas or fire is present. Position fire extinguishers upwind of work areas. Based on tested observations, it appears 5.4 seconds to 6.8 seconds is typically required to escape from excavations. [6]

Below is language from29 CFR § 1910.252(a)(2)(iii):

> Fire Watch(ers) shall be required whenever welding or cutting is performed in locations where other than a minor fire might develop. Fire Watch(ers) shall have fire extinguishing equipment readily available and be trained in its use. A Fire Watch shall not be given any other tasks while performing a fire watch and shall stay on site for at least a half hour after completion of welding or cutting operations.

NOTE: Some fires should be allowed to continue burning until the flow of gas can be shut off. This would depend upon the threat to human life, probability of gas accumulation, risk of explosion, and other factors.

5.3 "One-Call System"

Before beginning any excavation, a request must be made to an available one-call system to obtain locating and marking to ensure that underground pipelines are not damaged by excavation (49 CFR §§192.614 and 198.37).

Requirements before you dig:

- Each excavator must call their State's one-call system to prevent damage to existing utilities in the area of excavation.
- Each excavator must wait the required time for location of utilities to be marked before any excavation may begin.
- Each excavator operator is responsible for maintaining utility markings throughout construction.

For more information, visit www.call811.com.

5.4 Soil Conditions (Appendix A to Subpart P of Part 1926)

Knowing the type of soil conditions is important to determine the right protective system to keep safe while working. Areas of excavations may require the soil to be tested for contaminants. There are several manual tests that can be conducted to classify soil type such as: Plasticity test, Dry Strength test, and Thumb Penetration test (most common).[7] During the inspection by a competent person, soil conditions must be noted. Additionally, employees who work on excavations must be trained on the following soil classification types:

- Stable Rock: Most Stable
    - Natural solid mineral matter that can be excavated with vertical sides and remain intact while exposed.
- Type A: Very Stable
    - Cohesive, plastic soils with unconfined compressive strength greater that 1.5 ton per square foot.
- Type B: Stable

- Cohesive soils with unconfined compressive strength between 0.5-1.5 ton per square foot. Unstable dry rock.

- Type C: Least Stable
  - Granular soils or cohesive soils with unconfined compressive strength less than 0.5 tons per square foot. Any submerged or freely seeping soil.

5.5 Accumulation of Water (§1926.651(h))

Water in an excavation can undermine the sides of the excavation and make it more difficult for workers to exit. Additionally, the presence of water will affect the performance of shoring and should be addressed by a "competent person".

OSHA standards prohibit employers from allowing workers to enter an excavation where water has accumulated, or is accumulating, unless adequate precautions are taken to protect workers. Such precautions can include special support or shield systems to prevent cave-ins, water removal to control the water level, or the use of a safety harness and lifeline.

Drainage of water into excavations must be considered during any construction project. Water is often removed by use of pumps. The pump (if submersible type) or suction hose should be placed at the lowest point in the excavation. If an employer uses water removal equipment to control or prevent water accumulation, the equipment and operations must be monitored by a competent person to ensure proper use. If excavation work interrupts the natural drainage of surface water, the OSHA standards also require the use of diversion ditches, dikes, or other suitable means to prevent surface water from entering the excavation and to provide adequate drainage of the adjacent area.

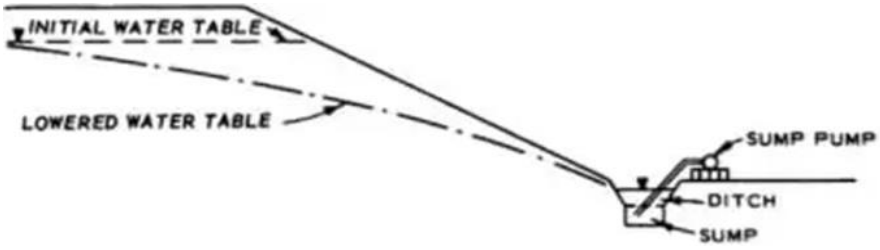

Figure 3: *Dewatering by Sumps, Sump pumps, and Ditching.*[8]

Warning*:* Do not operate your sump pump under any conditions other than those for which it is specified. Failure to observe operational precautions can lead to electrical shock, current leakage, fire, water leakage, or other problems. Check to make sure what liquids other than water can be pumped, and do not use in the vicinity of explosive or flammable materials. Always Follow Manufacturer's Instructions.

In addition, a competent person must inspect excavations subject to runoffs from heavy rains. Excavations subject to such runoffs are subject to the requirements described previously in this paragraph.

In high water table areas, other methods of dewatering may be necessary. A common method is to drive well points into the ground around the work site and evacuate the water from these points by connecting them to manifold and pump. By pumping from a system of deep drainage points, water levels in the surrounding ground can be lowered sufficiently to enable excavation to take place in dry ground.

The depth to which the water table may be lowered depends on soil conditions and is generally limited to about 20 feet (6 meters) with a single stage system. For greater depth, multistage systems are employed. Well points must be installed in advance of an excavation so that the ground can be dewatered.

5.6 Erosion and Sediment Control

Excavation work increases the likelihood of erosion. Soil can be moved from trenches by wind and water and run into gutters, storm drains, and waterways. Soil washed or tracked onto roadways can result in complaints and possible governmental intervention.

Geology and local regulations dictate the requirements for control of erosion. Control measures include, but are not limited to the following:

- Use of straw bales, stones, and sediment traps to prevent gutter blockage from trench spoil.
- Proper backfill and compaction; planting of vegetation or paving.
- Soil fences (membranes).

5.7 Hazardous Atmospheres

It may be necessary to test for low oxygen, dangerous fumes, and toxic gases accumulating in the excavation as a result of fuel driven equipment, contaminated soil, or leaking hazardous commodities.

5.8 Access or Egress

Ensure there is a safe way to enter and exit the excavation. Stairways, ladders, ramps, and other safe means of egress shall be located in trench excavations that are 4 feet or more in depth so as to require no more than 25 feet of lateral travel for employees. (See 29 CFR § 1926.651(c))

In addition to proper soil classification training, the “2 through 5 and 25” rule will help ensure employees make the proper and safest decisions in an excavation situation.

- Keep tools, material, equipment, and spoils 2 feet from the edge of an excavation.
- Three feet of a ladder (3 rungs) must extend above the edge of an excavation for proper ingress/egress.
- At a depth of 4 feet, a ladder or other means of ingress/egress is required.
- At a depth of 5 feet or more, proper shoring or sloping techniques shall be utilized.
- An employee shall not travel farther than 25 feet to reach a ladder.

5.9 Materials, Equipment, Tools, and Vehicles

Many on-the-job incidents result from inadequate planning. Placement of materials, equipment, tools, and vehicles must be considered for safety when performing any type of excavation. Soil (and tools/equipment) must be placed a minimum safe distance (2 feet) from the edge of excavation to prevent collapse. A common rule of thumb is depth of trench equals distance soil needs to be away from the edge of trench (See 29 CFR * 1926.651(j)(2)).

When mobile equipment is operated adjacent to an excavation, or when such equipment is required to approach the edge, and the operator does not have a clear and direct view of the edge of the excavation, a warning system shall be utilized such as barricades, hand / mechanical signals, or stop logs. If possible, the grade should be away from the excavation (See 29 CFR § 1926.651(f)).

Adjacent Structure Stability needs to be inspected prior to any excavation. Adjacent Structures close to the excavation may change soil conditions, or other potential hazards that may extend into the excavation zone. The need may arise to tie off, underpin, barricade, or hold up any utility that potentially could cause harm to employees during excavation (See 29 CFR § 1926.651(i)).

To better protect employees from being injured or killed by vehicle traffic provide employees with warning garments such as vests with high-visibility materials. Use a trained flag person along with signs and barricades to alert drivers when required. Please see section 3.2.1 Visibility Garments, above, for additional information.

5.10 Inspections (§1926.651(k)(1)(2))

Never enter a trench unless it has been properly inspected by a competent person. A competent person must inspect the excavation site before any work begins and then multiple times during the day. If original conditions change, such as the weather and /or hazardous conditions increase during the excavation, a re-inspection by a competent person must take place to ensure worker safety.

Note: A competent person, as defined by OSHA, means one who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees and who has authorization to take prompt corrective measures to eliminate them. (See 29 CFR § 1926.32(f))

Inspection Considerations:

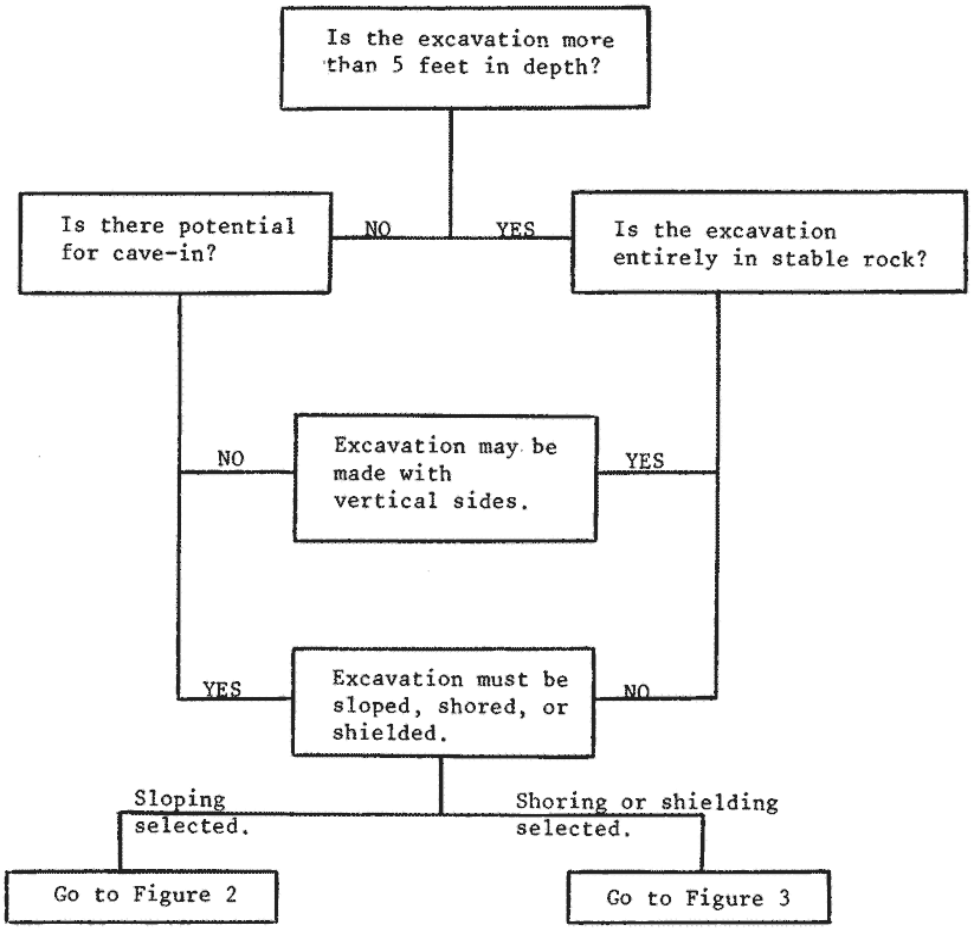

FIGURE 1 - PRELIMINARY DECISIONS

Figure 4: *Inspection Considerations Decision Tree- Image available at* OSHA.gov[9]

5.11 Protective Systems

Protective Systems are designed to protect personnel from cave-ins by resisting without failure all loads that are intended or reasonably expected to be applied or transmitted to the system.

- Any excavation required to be greater than 5 feet, and not made entirely of solid rock, must have a protective system in place and be inspected by a competent person, to ensure safety of personnel.

- Any excavation where entry is being made must be inspected by a competent person to ensure no indication of a potential cave-in (See 29 CFR § 1926.652(a)).
- Any excavation greater than 20 feet requires a professional engineer to design the proactive system (See 29 CFR §§ 1926.652(b) and 1926.652(c)).

Selection of a particular protective system is by determined depth, type of soil, and task required.

5.12 Sloping and Benching (§29 CFR 1926.652 Appendix B)

5.12.1 Sloping (System)

The sides of excavations 5 feet or more in depth must be shored, sheeted, braced, sloped, benched, or otherwise supported. Excavations less than 5 feet in depth should be shored or sloped when examination of the ground indicates the likelihood of hazardous ground movement caused by unstable or soft material. The design of a sloping protective system requirements is found in 29 CFR § 1926.652(b)(2).

TABLE B-1
MAXIMUM ALLOWABLE SLOPES

SOIL OR ROCK TYPE	MAXIMUM ALLOWABLE SLOPES (H:V) [1] FOR EXCAVATIONS LESS THAN 20 FEET DEEP [3]
STABLE ROCK TYPE A [2] TYPE B TYPE C	VERTICAL (90°) 3/4 : 1 (53°) 1:1 (45°) 1½: 1 (34°)

NOTES:

1. Numbers shown in parentheses next to maximum allowable slopes are angles expressed in degrees from the horizontal. Angles have been rounded off.
2. A short-term maximum allowable slope of 1/2H:1V (63°) is allowed in excavations in Type A soil that are 12 feet (3.67 m) or less in depth. Short-term maximum allowable slopes for excavations greater than 12 feet (3.67 m) in depth shall be 3/4H:1V (53°).
3. Sloping or benching for excavations greater than 20 feet deep shall be designed by a registered professional engineer.

Figure 5: *Maximum Allowable Slopes available at OSHA.gov.*[10]

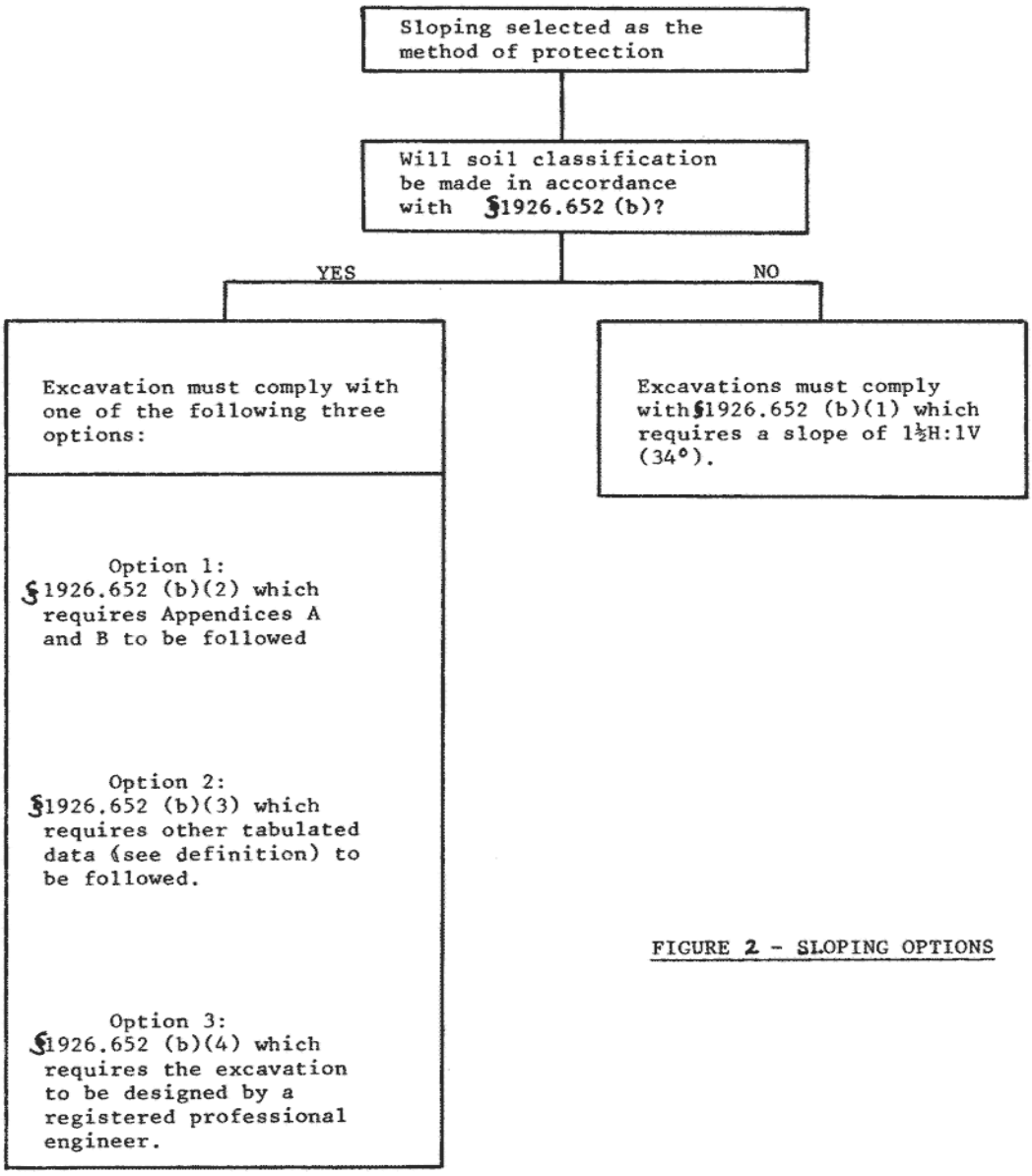

FIGURE 2 - SLOPING OPTIONS

Figure 6: *Sloping Options- available at OSHA.gov.*[11]

Distressed soil (soil that is in a condition where a cave-in is imminent) will require sloped sides to be recut to make the sides less steep.

The size of the excavation, soil material, type of equipment used, and other factors will determine the need for shoring, bracing, jacks, etc. to protect facilities from damage.

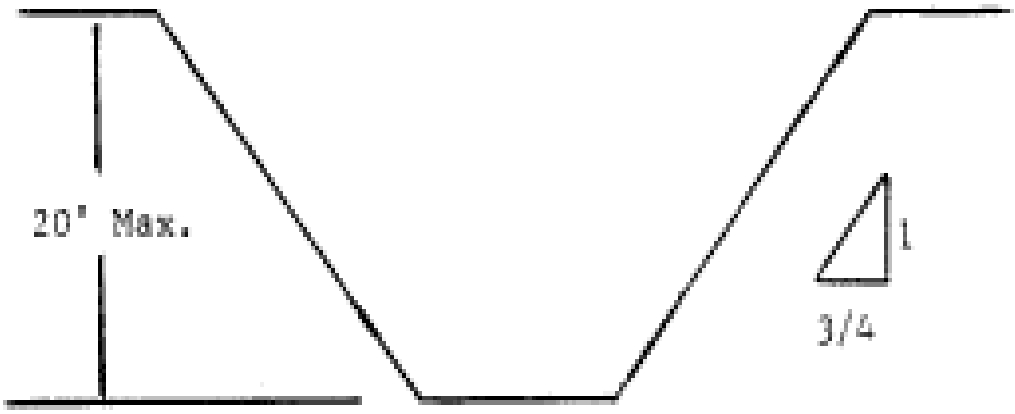

***Figure 7**: Simple Slope - General in Type A Soil- available at OSHA.gov.*[12]

5.12.2 Benching (System) (See 29 CFR §1926.652 Appendix B)

An alternative method to sloping is benching or stair-stepping the excavation where conditions permit. Shallow excavations can be made without supporting the sidewalls if there is adequate space to establish sloping sides that will remain in place. The steepness of the benching sides depends upon the type of soil, moisture content, depth, and the length of time the excavation must remain open. Figures 8 and 9 are diagrams of benching protective systems in Type A soil.

Note: It is not safe to cut steps into a slope of Type C soil because the soil's lack of cohesion is likely to cause the steps to crumble when an employee steps on them.

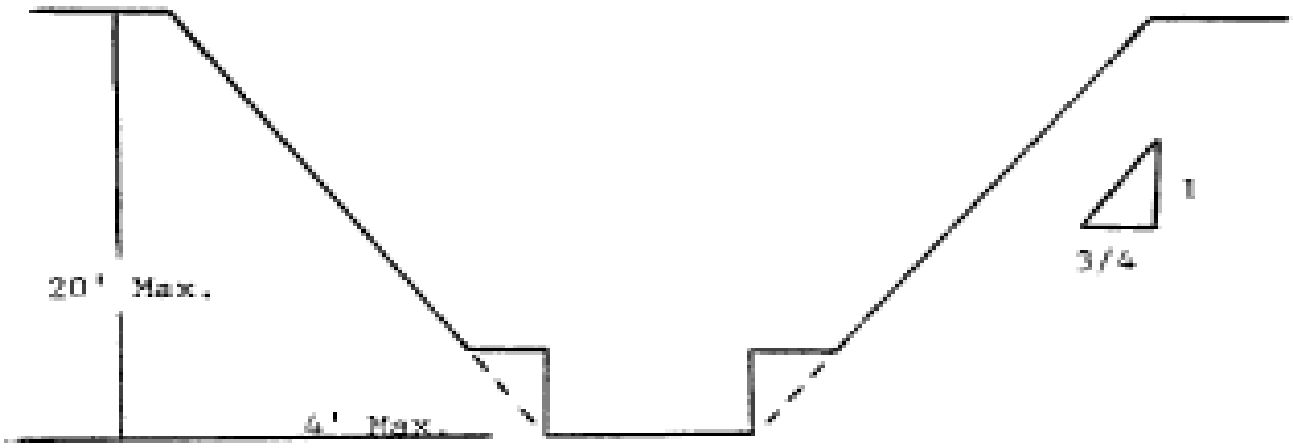

Figure 8: *Simple Bench available at OSHA.gov.*[13]

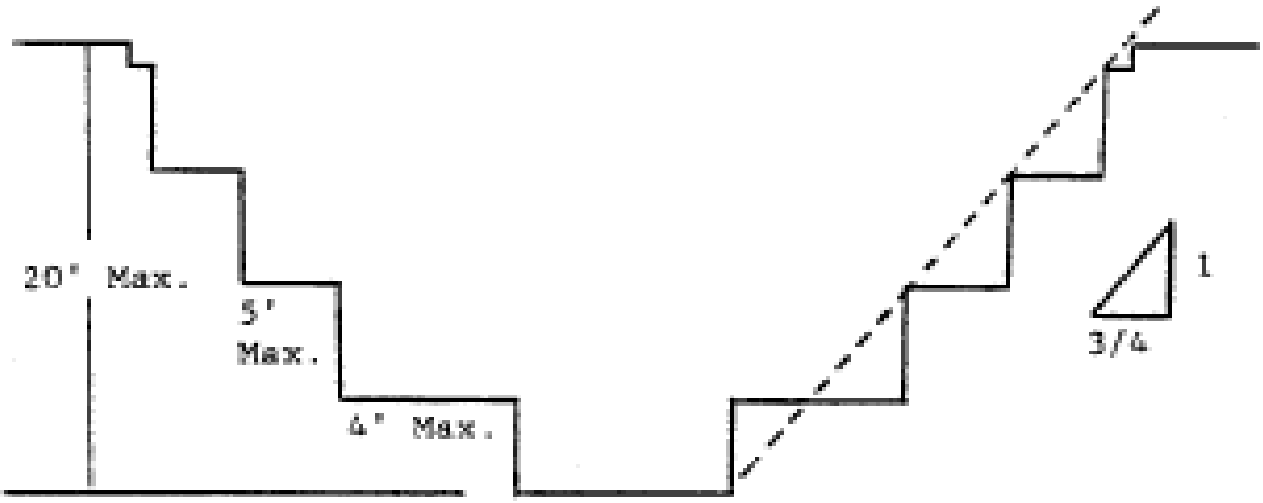

Figure 9: *Multiple Bench available at OSHA.gov.*[14]

Permanently exposed slopes of about 1 vertical to 1 ½ horizontal are usually considered standard for sandy soils. Short-term construction slopes as steep as 1 vertical to ½ horizontal are not uncommon.

5.12.3 Shoring (System) (See 29 CFR § 1926.652 Appendix C and Appendix D)

Design of support systems such as Shoring, shall be selected and constructed by the employer or his designee and shall be in accordance with the requirements of §1926.652.

Shoring materials such as timber shoring, aluminum trench shields (not to exceed depths over 20 feet), bracing with hydraulic and pneumatic systems placed or driven down on each side of the excavation. These are then secured with stringers or whalers and braced across the ditch. Steel plates or other suitable material may also be used.

Trench bracing jacks, actuated by hydraulic or air pressure, used in conjunction with suitable sidewall retaining materials (sheeting or sheathing) can provide effective shoring. A variety of prefabricated shoring units are also available. These devices are generally faster to install than conventional shoring.

Sheeting can be added as the dirt is being excavated. It is also good practice to allow for additional bracing, ties, stringers, etc., in the event part of the shoring may have to be temporarily removed for pipe installation or that equipment must be used near the edge of the excavation.

OSHA standards specify that a "competent person" must be on location along with tabulated data approved by a registered Professional Engineer for the type of sheeting system being used.

Proper shoring practice can be found in 29 CFR§§1926.650 through 1926.653 State and local codes should also be reviewed.

When using tight sheathing or sheet piling in deep excavations or where certain other problems exist, such as water, a competent person should design an appropriate retaining system.

Regardless of the method of protection used, that method should be designed so that it is effective completely to the bottom of the excavation.

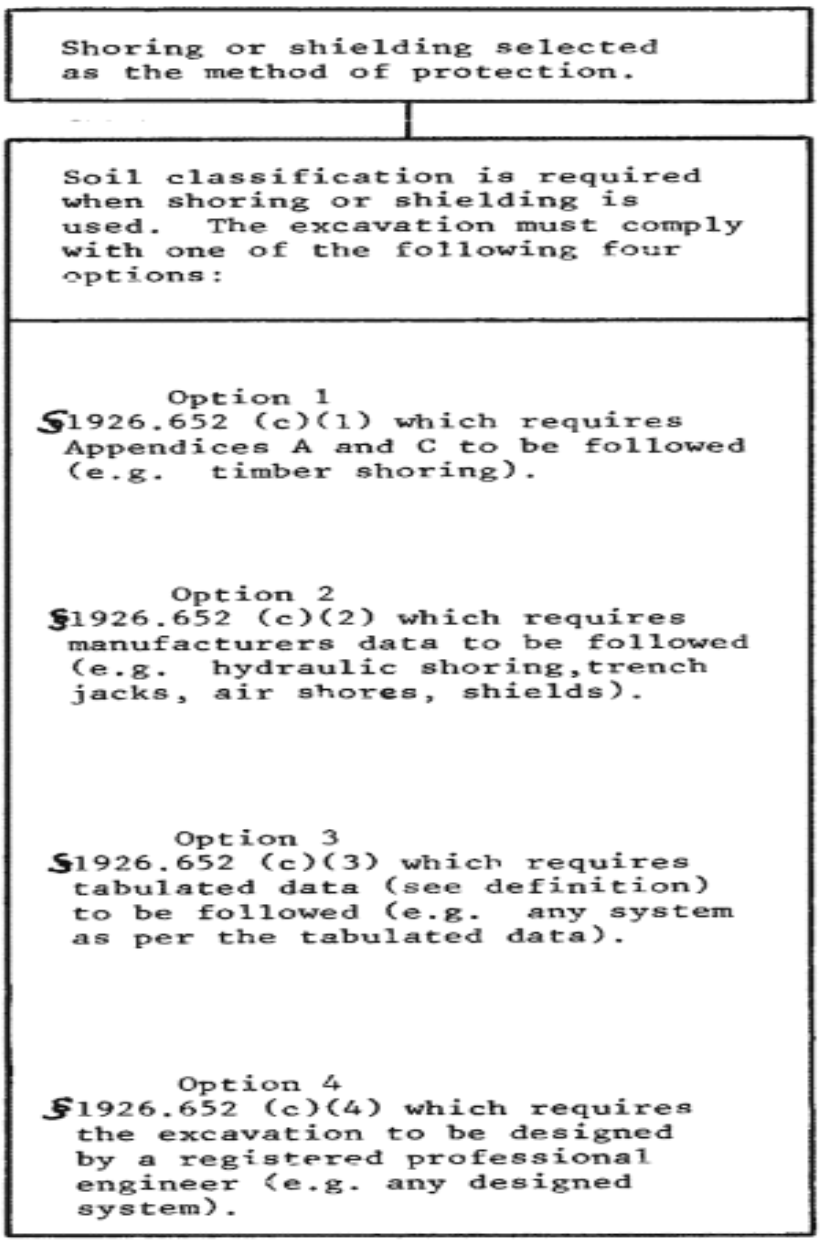

FIGURE 3 - SHORING AND SHIELDING OPTIONS

Figure 10: *Shoring/Shielding Options- available at OSHA.gov.*[15]

6. Walking and Working Surfaces

Walking / working surfaces can be defined as those surfaces employees walk, climb, and work on. Improperly maintained walking and working surfaces are a leading cause of slip, trip, and fall injuries. Preventing these types of injuries can be accomplished by performing inspections and hazard assessments of surfaces to identify hazards and taking action to eliminate, mitigate, or protect against those hazards.

Walking or working surfaces are often not at the forefront of employees' minds. It is easy to become absorbed in a task or have one's view blocked while carrying materials. However, the condition of walking surfaces can change frequently, especially from environmental exposure. This can lead to a slip, trip, or fall injury. Therefore, there are important points to remember when on walking or working surfaces. For example, it is helpful to remember the three physical sensations and use them to consider the surroundings:

Sight 	Scan travel paths BEFORE to identify hazards • Oily, greasy, or slippery surfaces - Polished or painted floor, vinyl/tile/painted stairs. • Poor Lighting • Uneven, missing stairs, or handrail • Sump pump or other holes on walking surface • Look for obstacles and clear path • Look out for signs of a pet • Icy conditions, black ice • Downspouts • In construction areas watch for mud, scrap material, nails, and siding • Electrified fences - look for Electrical Warning Signs
Sound 	• Barking dogs • Machinery • Traffic
Touch 	• Locked fence gate • Temperature • Loose gravel, soft soil

Table 3: *Tools for Gaining Situational Awareness.*

Additional walking/working surface safety points include:

Identify any possible hazards:

- Weather conditions
- Visibility
- Structures or Obstacles
- Personnel in the area
- Other work activities in the area
- Slippery surfaces
- Uneven surfaces
- Anticipated changes to the environment
- Footwear with insufficient tread

Plan the Travel Path:

- Discuss the plan with all personnel involved (i.e., Job Briefing)
- If on private property, avoid the hazard or work with owner to eliminate the hazard.
- AVOID walking on an icy surface. Wear footwear with gripping devices. Shorten steps and slow your stride.
- Bring additional types of footwear to adapt to changing conditions – Consider overshoes or other boots that provide proper footing.

Stop the Job if:

- You cannot remove or control hazards.
- You do not have adequate lighting.
- You cannot follow your plan for any reason.
- Any conditions change after the plan is determined.
- A fence gate cannot be unlocked.
- Electric fence is NOT de-energized.

Execute the Plan:

- Put on appropriate PPE.
- Wear proper footwear for the conditions.
- Bring flashlight for poorly-lit spaces.
- Use Proper walking techniques
- Avoid obstacles by following pre-determined safe path. Avoid taking short cuts.
- Complete planned walk

6.1 Workspace Maintenance

Proper workspace maintenance in work areas, vehicles, and on jobsites is an important prevention measure in eliminating slip, trip, and fall hazards.

- All working areas should be kept reasonably free of debris and tools, and materials shall be so stored (i.e., piled) as not to present a hazard to employees.
- Keep work locations clean and orderly. This includes inside and outside buildings and vehicles.
- In elevated positions, take precautions to prevent objects from falling on persons below.
- Adequate aisles and passageways are important to all work areas. All staging platforms, ramps, stairways, walkways, aisles, and passageways should be kept clear of all debris, tools, and materials.
- Hose and electrical conductors should be elevated over or placed under the walkway or working surfaces or covered by adequate crossover planks.
- Proper lighting in all work areas and passageways always properly maintained.
- Slippery conditions on walkways or working surfaces should be eliminated as they occur.
- Uneven working surfaces should be eliminated when possible.
- Free access must be maintained to all ladders, stairways, exits and to all fire-alarm boxes or fire-extinguishing equipment, electrical panels, eye wash stations and safety showers.

6.2 Ladder Use

In general:

- Ladders need to be kept free of oil, grease, mud, and other slippery substances.
- For uneven surfaces, ladder leveling devices need to be used.
- Placing Ladder Near a Door – Never put a ladder in front of a door that opens toward the ladder unless the door is either open, locked closed, guarded, or barricaded.
- When climbing up or down a ladder, face the ladder and never carry objects in hands.
    - Always maintain three-point touch contact while climbing
    - Never skip steps or jump from the ladder.
- When working from ladder always keep both feet on the ladder. Never straddle between it and another object.
    - Always work only within an arm's length of the ladder and keep body inside rails of the ladder.
    - Only one person at a time is allowed to work from a ladder unless it is specifically designed for multiple-person use.
    - If work requires employee to place body outside of rail, use fall protection or ladder safety device (with a secure ladder) that limits fall to < 2 feet.
- Never use a ladder as a scaffold platform unless it is designed for this purpose.
- Never use boxes, chairs etc. as a substitute for a ladder.
- Do not load over the ladder duty rating (your weight plus the weight you are carrying)

6.2.1 Portable Ladders

Use ladders that meet the following ANSI Standards:

- Material
  - ANSI A.14.1 - Wood
  - ANSI A.14.5 - Fiberglass
- Duty Rating
  - ANSI Duty Rating 1 - 250#
  - ANSI Duty Rating 1A - 300#
  - ANSI Duty Rating 1AA - 375#

All ladders need to be labeled to indicate the manufacturer's name, model number, type and rated capacity.

Portable ladders need to be maintained in good condition, with tight joints, securely attached hardware and fittings, and freely operating movable parts. Inspect portable ladders prior to each use and if any of the following defects are found, remove the ladder from service:

- Broken, missing or crushed rungs, steps, platforms or tops.
- Damage to rails, or loose rungs or steps.
- Broken/missing/bent guides, spreaders, locks or safety feet.
- When transporting or storing ladders on vehicles ladders must be fastened securely, to minimize chaffing and prevent loss during stops and bumps.

6.2.2 Straight and Extension Ladders

- Bases/Feet – Portable straight ladders need to have nonskid bases or safety feet.
- Placement and Support –
  - To prevent slipping or falling from a ladder, securely place, hold or tie ladder to a secure object before use.
  - To prevent a ladder from moving or toppling, never overreach, push or pull.
  - Place the ladder so the distance between its base and the base of the support point is about 1/4 of the ladder length. Example: Keep the base of a 12' ladder 3' from the support wall.
  - Never put a ladder against an unsafe support.
  - Never stand on the top two rungs or within 3' of the top of a ladder.
  - When using a ladder to go from one landing to another, the ladder must extend at least 3' above the upper landing.
  - Never splice ladders together to form a longer ladder.
  - Ladder must be kept at least 10' from any energized conductor or equipment.

6.2.3 Stepladders

- Never stand on the next to the top or top step unless using a platform ladder.
- Always spread the ladder legs and lock the spreading bars in place.
- Stepladders must not be used as a straight ladder.

6.2.4 Fixed Ladders

Fixed ladders should be inspected annually. Inspect overall condition including:

- Corrosion
- Structural damage
- Loose rungs/cleats/anchors
- Climbing surfaces for slip resistance.
- Hand holds (such as side rails, rungs) for burrs, sharp edges, and splinters.
- Anchor point welds, concrete, and other materials for cracks, corrosion, and deterioration.

6.3 Scaffolds and Work Platforms

6.3.1 General

- Employees must be trained by a qualified person to build or climb scaffolds.
- Employees shall not stand or walk under overhead work unless the task requires their presence to complete the job. In the limited cases where this might occur it shall be done with extreme caution, with the knowledge of the employees working overhead, and while in direct communication with the employees working overhead.

6.3.2 Inspecting

- Prior to use, scaffold shall be inspected for defects at the start of each shift.
- Visually inspect wire rope and rigging at the start of each shift, and after any occurrence that could affect the structural integrity.
- Before moving mobile scaffolding, persons, loose tools, and other materials and equipment must be removed.
- If persons need to work or pass under the scaffold, a screen shall be placed along the sides of the scaffold from the toe board to the top rail.

6.3.3 Self-Propelled Work Platforms

- Only properly trained personnel may operate self-propelled work platforms.
- Before using:
    - Read and understand the manufacturer instructions.

    - Understand all Fall Protection Requirements.
    - Inspect the platform for defects prior to use, at least once per shift.
- Changing Locations
    - Lower the platform before moving it.

6.3.4 Aerial Work Platform

6.3.4.1 Operation

- Employees shall be trained to operate aerial lifts and follow all applicable rules.
- When moving the vehicle, do not ride in the aerial bucket (does not apply to self-propelled work platform with mobile controls at work platform).
- Wear an approved body harness with an approved lanyard and attach to the designated anchor point on the aerial lift device. If an anchor point is not provided by the manufacturer, then fall restraint is not required (i.e., scissor lift).
- Do not sit or stand on edge of bucket except to transfer to or from structure.
- Maintain firm footing on floor of platform. Do not use objects such as boards or boxes to increase working height.
- Limit total load including material, tools, and workers to placarded capacity.
- Do not work from the cab guard of an aerial lift device.
- Do not belt off to pole or structure while working from aerial lift.
- Minimum clearance distances must be used when working near energized lines or equipment.
- The route of travel and the work location shall be inspected prior to moving the lift.
- Consider establishing a working safe zone
- Consider prohibiting working in windy conditions due to possible tip over or movement.

6.3.4.2 Outriggers

- When properly equipped, extend and firmly set outriggers. Use outrigger pads as required for vehicle stability or to avoid property damage.
- During extension or retraction, maintain a clear view of outriggers. If you cannot see outriggers, be sure other persons are beyond the range of outrigger motion and use of safety watcher.

6.3.4.3 Daily Inspection

Each day before use (at least once per shift):

- Inspect and operate the unit to ensure all pedestal controls operate properly.
- Fully extend and rotate the boom, checking joints, pins, nuts, hydraulic hoses, cables, etc. If you cannot see them, use pedestal controls to get a view.
- Report defects for repair.

6.3.4.4 Setup and Take-Down

- On an incline, install wheel chocks.
- When equipped, use inclinometer mounted on vehicle for use on inclines and do not go beyond manufacturers recommendations.
- Cradle boom or platform in travel position before moving the vehicle (does not apply to self-propelled work platform with mobile controls at work platform).
- Never install wrap on scissors or lattice type lifts to block wind as this can cause a sail effect making the lift unstable.

6.3.4.5 Insulation

- Consider boom-tips as conductive and having electrical continuity between various parts.
- Maintain Minimum Approach Distance between boom-tip and conductors and structures.
- Position boom to use insulating value of boom insert.
- Clean boom insulating inserts and buckets when dirty, but not less than once each quarter.
- Only trained persons shall operate an aerial work platform.
- Inspect the aerial lift before it is used. Remove service.

6.4 Fall Protection

Fall protection is required when:

- OSHA requires fall protection to be provided at elevations of four feet in general industry and six feet in construction industry. Refer to the relevant OSHA Standard for specific requirements on each type of fall hazard (i.e., walking and working surfaces, excavations, roofs, etc.).
- Employees have the potential for a fall from a walking or working surface with an unprotected side or edge that is 4 feet or more above the lower level
- When employees can fall on or into hazardous equipment from any height.
- General Industry only @ 4ft; 6 ft in Construction and exception of the requirement for excavations.

Where there is a fall hazard, fall protection is required. The type of fall protection used is specific to the location and type of operation being performed. Types of fall protection may include guardrail systems, personal fall arrest systems, controlled access zones and safety nets.

Items to consider when creating a fall protection plan:

- Anchor Points
- Body Harnesses and Lanyards
- Connection Hardware
- Vertical Lifeline Systems

- Horizontal Lifeline Systems
- Rescue Plan
- Working on Roofs

ANSI Z359 is commonly referenced for safety harness and lanyard systems. Protective systems should be inspected periodically and before use. Employees should be trained on how to wear protective systems, limitations, and dangers of improper wear (loose fitting harness).

6.4.1 Guardrail Systems

- Guardrail systems shall comply with the following requirements:
- Top edge height of top rails shall be 42 inches above the walking/working level.
- Mid-rails, screens, mesh, or intermediate members (such as balusters) shall be installed between the top edge of the guardrail system and the walking/working surface when there is no wall at least 21 inches high.
- Mid-rails, when used, shall be installed at a height midway between the top edge of the guardrail system and the walking/working level.
- Screens and mesh, when used, shall extend from the top rail to the walking/working level along the entire opening between top rail supports.
- If screens or mesh are not used, a 4-inch toe board must be used.
- Intermediate members (such as balusters) shall not be more than 19 inches apart when used between posts.
- Guardrail systems shall be capable of withstanding a force of at least 200 pounds applied within two (2) inches of the top edge in any outward or downward direction, at any point along the edge.
- When a 200-pound force is applied in the downward direction, the top edge of the guardrail shall not deflect to a height less than 39 inches above the walking/working level.
- Mid-rails, screens, mesh, and intermediate vertical members shall be capable of withstanding a force of at least 150 pounds applied in a downward or outward direction at any point along the mid-rail or other member.
- Temporary guardrail systems, which may be used for manhole or other temporary floor openings, shall comply with the following requirements:
    - Temporary guardrails shall consist of a freestanding frame of stanchions 42 inches high with a top and mid-rail of wooden 2x4s, two-inch pipes, or 3/8-inch chain.
    - Temporary guardrails shall be identified by a warning device, including (but not limited to) a light, flags, or colors to warn persons of a hazardous area.
    - Where material may fall into the floor opening and onto persons working/passing below, moving machinery or other equipment that could create a hazard, a toe board shall also be required.

6.5 Covers and Hatches

Covers and hatches for holes in floors, roofs, and other walking/working surfaces shall meet the following requirements:

- Covers and hatches located in roadways and vehicular aisles shall be capable of supporting, without failure, at least a truck rear axle load of 24,000 pounds or three times the maximum axle load of the largest vehicle expected to cross over the cover (whichever is largest).
- All other covers and hatches must be capable of supporting at least three times the weight of employees, equipment, and materials that may be imposed on the cover at any one time.
- Any covers or hatches not meeting these requirements must be conspicuously marked with the maximum allowable load and clearly identified (e.g., marked with black and yellow alternating stripes).
- All covers shall be secured when installed to prevent accidental displacement by the wind, equipment, or employees.

7. Electrically Induced Hazards

Electrically induced hazards on natural gas facilities, either in service or under construction, require special precautions. The forms for which these hazards can present themselves come in various ways, such as stray currents, static electricity, A.C. and/or D.C. currents, joint trench awareness, and energized facilities.

Above ground facilities are frequented most by technicians and are susceptible to electrically induced hazards caused by various unseen reasons. Before performing any type of maintenance and/or work on an above ground facility, it is important to remember to verify that the above ground facility is not energized. This can be done by utilizing contactless voltage detectors, voltmeter, or other approved contactless detection tools.

7.1 Static Electricity

Static electricity is one of the most common forms of electrically induced hazards that presents itself when working on a gas facility. Static electricity can generate in a multitude of ways. The most common form of generation comes from the friction of differing cloth materials and the high flow of gas, causing buildup both on the inside and outside of plastic pipe.

To help eliminate static electricity from being a potential ignition source leading to fire and/or explosion, there are several precautionary measures to safely discharge the potential. One of the more common practices is by using a wet method. This entails using cloth soaked in a soapy solution encompassing the pipe from the dirt towards the damage/squeeze point. The cloth material must be kept wet during this process.

Other means to help safely discharge static electricity are by utilizing commercial anti-static systems and static discharge kits. These kits consist of static spray and a roll of material used to wrap around the plastic facility. When utilizing these methods, ground rods may be required to be installed to connect the material to the trench adjacent to the gas facility. Operators should follow the manufacturers' instructions.

Excessive gas flow from a damaged facility can cause static electricity to build on the inside of plastic pipe. When this scenario occurs, it is best practice to consider shutting down the flow of gas. It is recommended to be done with utilizing remote engineering controls, such as shutting off valves or exposing the facility in a remote location

a safe distance from the damage for squeeze points. If no other option is available and the flow of gas must be shut down in a hazardous environment, remember to follow proper PPE guidelines with a trained technician dedicated to handling a fire extinguisher.

The use of tools is often necessary to complete the safe shutdown of a damaged facility. It is important to remember to ground these tools. Doing so creates a path for any charge on the inside or outside of the pipe to discharge safely away from the tool being used.

7.2 Steel Facilities

Steel facilities are susceptible to electrically induced hazards as well, which can form in several ways. When working on a steel facility, it is important to check for stray currents utilizing a contactless detection tool. Stray currents can come from many unseen causes, such as defective electrical installations on customers premises, paralleling a high-voltage electric transmission line, faulty cathodic protection rectifiers, and joint trenches.

When performing work on a steel facility that is to be separated, temporary bonding conductors should be installed on the gas facility maintaining a path for stray electrical current to follow.

8. Confined Spaces

Confined spaces are structures that store, transfer, process materials, or house a process. Confined spaces are physical spaces that are large enough for a worker to bodily enter and perform assigned work, have limited or restricted means for entry and exit, and are not designed for continuous human occupancy. The dangers of workers entering a confined space often include a hazardous atmosphere from the presence of gases or vapors, the lack of oxygen, or other materials or physical configuration that may cause engulfment, entrapment, asphyxiation, or a fall to a lower level. There are many cases of workers entering confined spaces to perform work and then losing consciousness and are unable to escape or be rescued. According to the U.S. Bureau of Labor Statistics, over 1,000 workers have died in occupational injuries in confined space incidents from 2011-2018.[16]

The OSHA Standards for entering confined spaces provide a framework to assess the hazards of the space, train and equip workers to perform the work safely, prevent incidents (such as ignition of vapors while in the space, and plan and prepare for an effective rescue in the case of a mishap), to protect workers and reduce the number of confined space injuries and fatalities. The General Industry Standard, 29 CFR 1910.146 "Permit-required Confined Spaces", and the Construction Standard 29CFR 1926 Subpart AA, "Confined Spaces in Construction" are primary sources of safety compliance information for assuring a safe entry and exit will be achieved.

A list of common structures that constitute confined spaces may include tanks, vessels, silos, storage bins, hoppers, vaults, pits, manholes, tunnels, equipment housing, ductwork, pipelines, crawl spaces, attics, and similar above-ground or below-ground enclosures. Please reference the AGA white paper: Safe Work Practices for Attics, Crawl Spaces and Basements published March 2023 for additional considerations regarding potential confined spaces.

8.1 Entry into Confined Spaces

Prior to allowing entry into any confined space per the construction standard, the employer must have a competent person evaluate the spaces employees would enter to perform work.[17] This includes a two-step process for the evaluation of, 1) evaluate whether a space meets the definition of a confined space (29 CFR § 1926.1202), and if so, 2) identify any confined spaces that are permit required confined spaces through consideration and evaluation of the space, including testing of the space as necessary.

Serious hazards may include an altered atmosphere, exposed live electrical conductors or wires, engulfment hazards, chemical exposure hazards, fall hazards or any other condition that can interfere with a worker's ability to leave the space without assistance. Other unsafe conditions can include rodent or insect infestation, recent insecticides application, burst/leaking water pipe, sewer overflow, friable asbestos, etc. Hazard recognition is important in determining the safeguards needed to make the entry a safe process.

8.2 Permit-Required Confined Space

OSHA defines a Permit-Required Confined Space (PRCS) in 29 CFR § 1910.146 and 29 CFR §1926.1202 as being a confined space that may contain a hazardous or potentially hazardous atmosphere, may contain a material which can engulf an entrant, may contain walls that converge inward or floors that slope downward and taper into a smaller area which could trap or asphyxiate an entrant, or, may contain any other serious physical hazards such as unguarded machines or exposed live wires.

Allowing entry into a PRCS requires a written plan for safely entering and exiting the space, with a means for emergency rescue of the entrants, a permit to enter process which requires an authoritative review and approval, training to understand PRCS hazards and safeguards for the entrants, entry supervisor and the entry attendant, and recordkeeping of the program content, employee training and authorization and entry records.

Not all confined spaces require an entry permit. When atmospheric monitoring and assessment of conditions show that no atmospheric abnormalities and no physical or other recognized hazards exist, the entry to perform work may be conducted. Crawl spaces and attics are common spaces where conditions may vary and monitoring air and examining the space for hazards is necessary. If entry into a crawl space or attics is necessary, the exercise of stepping through a hazard identification checklist may be useful to improve the situational awareness of the gas utility worker.

8.3 Testing for Hazardous Atmosphere

In 1994, OSHA and the AGA agreed upon a clarification of the PRCS standard, stating that under existing U.S. Department of Transportation's Office of Pipeline Safety (OPS) regulations contain requirements for adequately ventilating large vaults/pits and for providing a means for testing the atmospheres of sealed vaults/pits prior to entry. Periodically inspect vault equipment for repairing leaking or faulty equipment, to minimize the danger of fire, or explosion in any structure or area in which gas might be present. Pipeline Operators must report to OPS any incident involving a death or serious injury associated with the release of gas from a pipeline. While these provisions are primarily directed to the hazards of fire and explosion, they are sufficiently related to the general

problem of hazardous vault atmospheres to preempt all OSHA regulation of such hazards under the PRCS, including fire, explosions, toxicity and oxygen deficiency. OSHA recognizes that the application of the PRCS standard to atmospheric hazards in vaults, even if limited to hazards such as toxicity or oxygen deficiency, could impair a pipeline operator's ability to respond quickly to protect the public safety in a gas emergency, a result in apparent conflict with OPS's overall scheme. For these reasons, OSHA does not enforce the PRCS standard in vaults to the extent that such enforcement would be based on hazards that relate to gas or other hazards that are addressed by DOT/OPS regulations.

Endnotes

[1] Materials inventoried/hazards know are typically through information provided from the manufacturer or supplier on container labeling or the Safety Data Sheet (SDS).
[2] For job site considerations in an emergency, follow company's emergency response guidance.
[3] Figure provided with permission from NIOSH/CDC.
[4] Figure provided with permission from LG&E/KU Communications.
[5] "Notification on Safe Excavation Practices", 2006
[6] 2018 AGA White Paper, "Natural Gas Workers and Natural Gas Fires: Observations and Analysis of Heat Intensity, Escape Time, Extinguish Time, and Flame-Resistant Garments".
[7] See 29 CFR – Subtitle B – Chapter XVII – Part 1926 – Subpart P – Appendix A (d)(2).
[8] Pumps & Systems. (2021, February 25). Wellpoint Systems Adapt to Most Site Dewatering Needs. Retrieved March 3, 2023, from https://www.pumpsandsystems.com/wellpoint-systems-adapt-most-site-dewatering-needs
[9] OSHA. (n.d.). Subpart P - Excavations. Appendix B to Subpart P - Sloping and Benching. Retrieved March 3, 2023, from https://www.osha.gov/laws-regs/regulations/standardnumber/1926/1926SubpartPAppB
[10] Ibid.
[11] Ibid.
[12] Ibid.
[13] Ibid.
[14] Ibid.
[15] Ibid.
[16] Source – US Department of Labor BLS, www.bls.gov/iif/oshwc/cfoi/confined-spaces-2011-2018.htm
[17] 29 CFR Part 1926.1202 defines *competent person* to mean one who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has the authorization to take prompt corrective measures to eliminate them.