EXCAVATION & TRENCHING

COMPETENT PERSON COURSE

PROFESSIONAL DEVELOPMENT COURSE

Technical Learning College

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Most of our students prefer to do the assignment in Word and e-mail or fax the assignment back to us. We also teach this course in a conventional hands-on class. Call us and schedule a class today.

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James Bevan, Water Quality Inspector S.M.E. Twenty years of experience in the environmental field dealing with all aspects of water regulations on the federal, state, and local levels. Experience in the water/wastewater industry includes operation of a wastewater facility, industrial pretreatment program compliance sampling, cross-connection control program management, storm water management, industrial and commercial facility inspections, writing inspection reports for industry, and technical reports per EPA permit requirements. Teacher and Proctor in Charge for Backflow Certification Testing at the ASETT Center in Tucson for the past 15 years and possess an Arizona Community College, Special Teaching Certificate in Environmental Studies. Extensive knowledge and experience in college course and assignment/assessment writing.

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Technical Learning College's Scope and Function

Welcome to the Program,

Technical Learning College (TLC) offers affordable continuing education for today's working professionals who need to maintain licenses or certifications. TLC holds several different governmental agency approvals for granting of continuing education credit.

TLC's delivery method of continuing education can include traditional types of classroom lectures and distance-based courses or independent study. TLC's distance based or independent study courses are offered in a print - based distance educational format. We will beat any other training competitor's price for the same CEU material or classroom training.

Our courses are designed to be flexible and for you do finish the material on your leisure. Students can also receive course materials through the mail. The CEU course or e-manual will contain all your lessons, activities and instruction to obtain the assignments. All of TLC's CEU courses allow students to submit assignments using e-mail or fax, or by postal mail. (See the course description for more information.)

Students have direct contact with their instructor—primarily by e-mail or telephone. TLC's CEU courses may use such technologies as the World Wide Web, e-mail, CD-ROMs, videotapes and hard copies. (See the course description.) Make sure you have access to the necessary equipment before enrolling, i.e., printer, Microsoft Word and/or Adobe Acrobat Reader. Some courses may require proctored closed-book exams depending upon your state or employer requirements.

Flexible Learning
At TLC, there are no scheduled online sessions or passwords you need contend with, nor are you required to participate in learning teams or groups designed for the "typical" younger campus based student. You can work at your own pace, completing assignments in time-frames that work best for you. TLC's method of flexible individualized instruction is designed to provide each student the guidance and support needed for successful course completion.

Course Structure
TLC's online courses combine the best of online delivery and traditional university textbooks. You can easily find the course syllabus, course content, assignments, and the post-exam (Assignment). This student friendly course design allows you the most flexibility in choosing when and where you will study.

Classroom of One
TLC offers you the best of both worlds. You learn on your own terms, on your own time, but you are never on your own. Once enrolled, you will be assigned a personal Student Service Representative who works with you on an individualized basis throughout your program of study. Course specific faculty members (S.M.E.) are assigned at the beginning of each course providing the academic support you need to successfully complete each course. Please call or email us for assistance.

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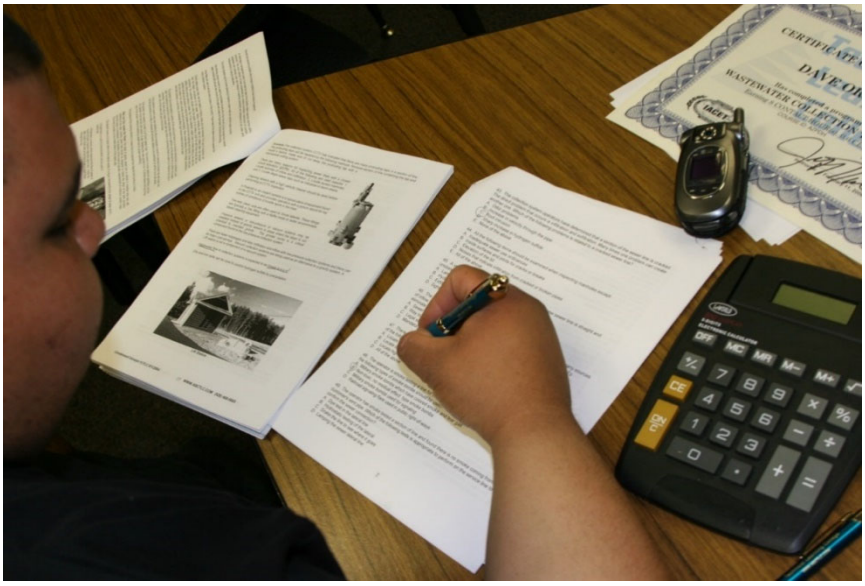
We have many years of experience, dealing with thousands of students. We assure you, our customer satisfaction is second to none. This is one reason we have taught more than 20,000 students.



We welcome you to do the electronic version of the assignment and submit the answer key and registration to us either by fax or e-mail. If you need this assignment graded and a certificate of completion within a 48-hour turn around, prepare to pay an additional rush charge of $50.

We welcome you to complete the assignment in Word.

Once we grade it, we will mail a certificate of completion to you. Call us if you need any help.

Contact Numbers

Fax (928) 468-0675
Email Info@tlch2o.com
Telephone (866) 557-1746

Course Description

EXCAVATION & TRENCHING CEU TRAINING COURSE

Review of the dangers of trenching and excavation and related safety fundamentals. This course will cover the basic requirements of OSHA's Competent Person 29 CFR 1926.650 Subpart F and other related federal safety rules. The Competent Person Program, as it is called, will require formal training and on-the-job experience.

The intent of the course is to ensure a qualified workforce and reduce the possibility of incidents caused by human error.

You will not need any other materials for this course.

Final Examination for Credit
Opportunity to pass the final comprehensive examination is limited to three attempts per course enrollment.

Course Procedures for Registration and Support
All of Technical Learning College's correspondence courses have complete registration and support services offered. Delivery of services will include, e-mail, web site, telephone, fax and mail support. TLC will attempt immediate and prompt service.

When a student registers for a distance or correspondence course, he/she is assigned a start date and an end date. It is the student's responsibility to note dates for assignments and keep up with the course work. If a student falls behind, he/she must contact TLC and request an end date extension in order to complete the course. It is the prerogative of TLC to decide whether to grant the request.

All students will be tracked by a unique number assigned to the student.

Instructions for Written Assignments
The Excavation & Trenching Training CEU training course (Competent Person) uses a fill-in-the-blank and multiple choice answer key.

You can write your answers in this manual or type out your own answer key. TLC would prefer that you type out and e-mail the final exam to TLC, but it is not required.

Feedback Mechanism (examination procedures)
Each student will receive a feedback form as part of their study packet. You will find this form in the front of the course assignment or lesson.

Security and Integrity
All students are required to do their own work. All lesson sheets and final exams are not returned to the student to discourage sharing of answers. Any fraud or deceit and the student will forfeit all fees and the appropriate agency will be notified.

Grading Criteria
TLC will offer the student either pass/fail or a standard letter grading assignment. If TLC is not notified, you will only receive a pass/fail notice.

Required Texts
The Excavation and Trenching CEU training course will not require any other materials. This course comes complete.

Recordkeeping and Reporting Practices

TLC will keep all student records for a minimum of seven years. It is the student's responsibility to give the completion certificate to the appropriate agencies.

ADA Compliance

TLC will make reasonable accommodations for persons with documented disabilities. Students should notify TLC and their instructors of any special needs.

Course content may vary from this outline to meet the needs of this particular group.

You will have 90 days from receipt of this manual to complete this course in order to receive your Continuing Education Units (**CEUs**) or Professional Development Hours (**PDHs**). A score of 70% or better is necessary to pass this course.

If you should need any assistance, please email all concerns and the final test to info@tlch2o.com.

Educational Mission

The educational mission of TLC is:

To provide TLC students with comprehensive and ongoing training in the theory and skills needed for the environmental education field,

To provide TLC students with opportunities to apply and understand the theory and skills needed for operator certification,

To provide opportunities for TLC students to learn and practice environmental educational skills with members of the community for the purpose of sharing diverse perspectives and experience,

To provide a forum in which students can exchange experiences and ideas related to environmental education,

To provide a forum for the collection and dissemination of current information related to environmental education, and to maintain an environment that nurtures academic and personal growth.

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New Confined Space Construction Standard

On May 4, 2015, OSHA issued a new standard for construction work in confined spaces, which became effective August 3, 2015. Confined spaces can present physical and atmospheric hazards that can be avoided if they are recognized and addressed prior to entering these spaces to perform work. The new standard, Subpart AA of 29 CFR 1926 will help prevent construction workers from being hurt or killed by eliminating and isolating hazards in confined spaces at construction sites similar to the way workers in other industries are already protected.

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OSHA's General Industry Regulation, §1910.146 Permit-required confined spaces, contains requirements for practices and procedures to protect employees in general industry from the hazards of entry into permit-required confined spaces. This regulation does not apply to construction.

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Excavation and Trenching Chapter

Section Focus: You will learn the basics of proper excavation and trenching safety. At the end of this section, you the student will be able to understand and describe commonly found trench safety procedures and devices. There is a post quiz at the end of this section to review your comprehension and a final examination in the Assignment for your contact hours.

Scope/Background: The OSHA SUBPART P - 29 CFR 1926.650-652 requires the employer to set up an excavation safety program to protect employees from cave-in and other excavation dangers.

Competent Person - Proper person

Everybody has an idea of what this phrase means, but for somebody in the EHS field – more specifically, for somebody whose career revolves in some way around OSHA – "Competent Person" has a very specific two-part meaning:

A Competent Person is somebody that has both the knowledge to recognize a hazard and the authority to correct it.

Consider the following example: You may be the most knowledgeable excavator on the planet. You may have 25 years of experience under your belt and a degree in soil mechanics, but if you need to pick up a phone to ask somebody to come instruct the backhoe operator to fix the slope of his trench, ***you are not a Competent Person***.

The converse is true as well: you could be the owner of the company strolling through the site with everybody quaking in fear at your feet, ready to heed your every command, but if you can't tell that the parallel fracturing at the top edges of your excavation indicate that a collapse is imminent, ***you are not a Competent Person***.

Normal day for an excavation professional, inadequate traffic barricades to crane operation. Be prepared, take the time and be safe.

A large, deep un-shored, unprotected trench.

OSHA SUBPART P - 29 CFR 1926.650-652

Competent Person Introduction

Anyone who has done excavation work will tell you that once the first bucket of dirt is out of the ground, you never know what surprises await. Tales of unmarked utilities, unexpected rock and other nightmares are common. The greatest variable, however, is the type of excavation or trenching will be done and how to protect yourself for a cave-in.

The OSHA excavation standard was revised because excavating is the most dangerous of all construction operations. More workers are killed or seriously injured in and around excavations than in any other construction work. The second reason that OSHA revised the existing standard was to clarify the requirements.

The revised standard makes the standard easier to understand. The new standard uses performance criteria where ever possible. This added flexibly provides employers with options when classifying soil and when selecting methods to protect the employee from cave-ins.

Although the standard has been clarified and employers have options when meeting some of the requirements, employers must realize that the employee must be protected at all times.

Some employers have a mindset of not needing this training until they are caught by OSHA, which is equivalent to buying car insurance only after a car collision.

Excavation decisions will have to be made right from the planning stages through completion of the work. Some sections of the standard require that documentation be kept. TLC will provide a sample of this type of documentation.

In some situations, professional engineers will be required to plan or design the excavation and/or method of protecting the worker (such as when an excavation exceeds 20 feet in depth).

The purpose of this session is to provide you with information about the OSHA excavation standard. This program is not designed or intended to provide participants with all the information, rules, regulations, and methods that they may need to know to perform all excavation work safety. Every plan involving excavation must be studied carefully to determine the specific hazards for each job.

Supporting Utilities is mandatory.

Major OSHA Violation. Do not operate equipment in unprotected trenches. This guy is trying hard to get to Heaven before his time is up.

Excavation Facts

Every year in the United States:

- ✓ **100 to 500 people are killed in an excavation cave-in.**
- ✓ **1000 to 5000 employees are seriously injured.**

The average worker that is killed by a cave-in is a 20 to 30-year-old male who has had little or no training at all. Most deaths occur in trenches 5 feet to 15 feet in depth.

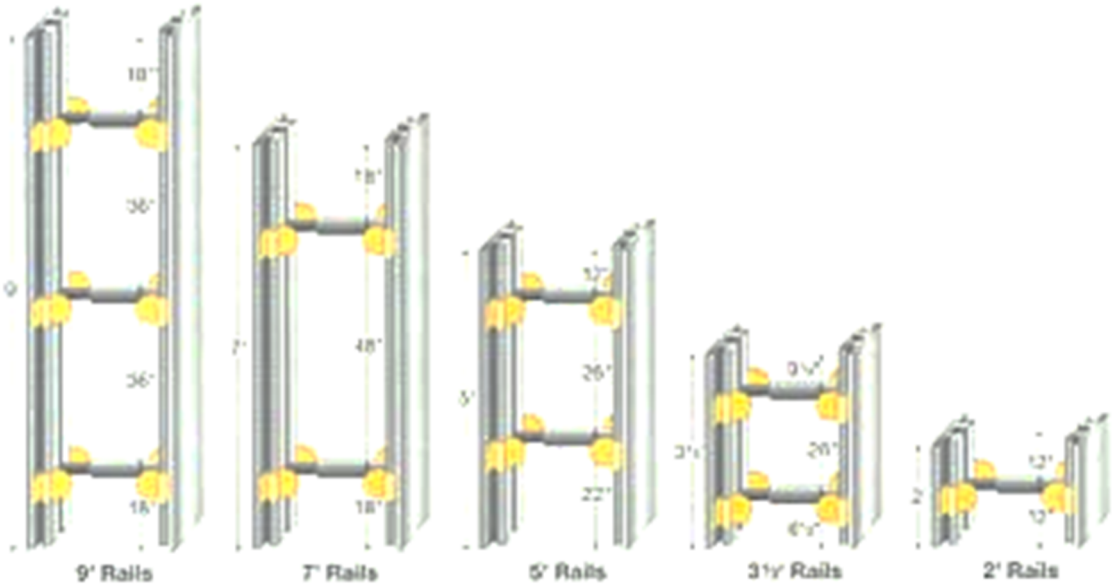
Cave-ins cause deaths and injuries by:

- ✓ **Suffocation**
- ✓ **Crushing**
- ✓ **Loss of circulation**
- ✓ **Falling objects**

One cubic foot (12" x 12" x 12") can weigh between 90 and 140 pounds. Therefore, one cubic yard (3' x 3' x 3') weights as much as a backhoe (approximately 3000 pounds).

Subpart P applies to all open excavations in the earth's surface**.**

- ✓ **All trenches are excavations.**
- ✓ **All excavations are not trenches.**



Notice that employees are wearing hard hats but no ladders are present. Spoil piles are too close to the hole. Almost looks like they over did the shores for the photograph but no ladder for miles.

Notice the ladder is partially properly tied down. Three rungs out and tied but not staked.

Competent Person - Defined

Competent person means one who is capable of identifying existing hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees and has authorization to take prompt corrective measures to eliminate them.

In order to be a "**Competent Person**" for the purpose of this standard, one must have specific training in and be knowledgeable about soils analysis, the use of protective systems and the requirements of 29 CFR Part 1926.650-652 Subpart P.

Rescue training exercises are essential. Everyone is required to practice once a year. Yes, once a year.

How would you make this excavation safe to work inside? The trench is 9 feet deep. OSHA Violations include no hard hats, no ladders, and no daily inspection form.

Competent Person Duties

- Performs daily inspections of the protective equipment, trench conditions, safety equipment and adjacent areas.
- Inspections shall be made prior to the start of work and as needed throughout the shift.
- Inspections shall be made after every rainstorm or other hazard occurrence.
- Knowledge of emergency contact methods, telephone or radio dispatch.
- Removes employees and all other personnel from hazardous conditions and makes all changes necessary to ensure their safety.
- Insures all employees have proper protective equipment, hard-hats, reflective vests, steel-toed boots, harnesses, eye protection, hearing protection and drinking water.
- Categorize soil conditions and conduct visual and manual tests.
- Determine the appropriate protection system to be used.
- Maintain on-site records of inspections and protective systems used.
- Maintain on-site Hazard Communication program, Material Safety Data Sheets and a Risk Management Plan, if necessary.
- Maintain current First Aid and CPR certifications. Maintain current Confined Space certification training.

Scope of Work

1. During excavation work a competent person shall be on the job site at all times when personnel are working within or around the excavation. This is necessary in order to monitor soil conditions, equipment and protection systems employed.
2. The estimated locations of utility installations, such as sewer, telephone, fuel, electric, water lines, or any other underground installation that reasonably may be expected to be encountered during excavation work, shall be determined prior to opening an excavation.
3. Adequate precautions shall be taken to protect employees working in excavations, against the hazards posed by water accumulation.
4. Employees shall be protected from excavated or other materials or equipment that could pose a hazard by falling or rolling into excavations. Protection shall be provided by placing and keeping such material or equipment at least two (2') feet from the edge of excavations.

5. A stairway, ladder, or ramp shall be used as a means of access or egress in trench excavations that are four (4') feet or more in depth. The ladder(s), stairway(s), or ramp shall be spaced so that no employee in the trench excavation is more than twenty-five (25') feet from a means of egress. When ladder(s) are employed, the top of the ladder shall extend a minimum of three (3') feet above the ground and shall be properly secured.

6. When excavations are exposed to vehicular traffic, each employee shall wear a warning vest made with reflective material or highly visibility material. All personnel within the construction area shall wear a hard-hat at all times.
7. Employees shall not be permitted underneath loads handled by lifting or digging equipment. Employees shall be required to stand away from any vehicle being loaded or unloaded to avoid being struck by any spillage or falling materials.
8. In excavations where oxygen deficiency or gaseous conditions exist, or could be reasonably expected to exist, air in the excavation shall be tested.
9. Where oxygen deficiency (atmospheres containing less than 19.5 percent oxygen) exists, the area must be continuously ventilated until the oxygen levels are above 19.5 percent.

10. Where a gaseous condition exists, the area shall be ventilated until the flammable gas concentration is below 20 percent of the lower flammable limit.
11. Whenever oxygen deficiency or gaseous conditions exist or could reasonably exist, the area shall be monitored continuously to assure that employees are protected.
12. Where the stability of adjoining buildings, walls or other structures are endangered by excavation operations, support systems such as shoring, bracing, or underpinning shall be provided to ensure the stability of such structures for the protection of employees.
13. Sidewalks, pavement and appurtenant structures shall not be undermined unless a support system such as shoring is provided to protect employees from the possible collapse of such structures.

Always wait for the buried utilities to be marked before excavation begins. Believe it or not, this crew dug 9 feet deep before the Locator showed up and marked fiber optics in the same trench.

Notice that the employees do not have hard hats, ladders, or any protective systems. Major OSHA violations.

Personnel Protective Systems

Employees in excavations shall be protected from cave-ins by an adequate protective system, which shall be inspected by a competent person.

The use of protective systems is required for all excavations, in excess of five (5') feet, except when excavation is within stable rock.

Trench excavation less than five (5') feet in depth may not require the use of protective systems, unless there is evidence of a potential cave-in. The competent person shall determine the need for the use of protective systems when such conditions exist.

When sloping, benching or protective systems are required, refer to requirements in CFR 1926.652 (**OSHA Construction Standards**).

Whenever support systems, shield systems, or other protective systems are being used, a copy of the manufacturer's specifications, recommendations, and limitations sheet shall be in written form and maintained at the job site.

This poor soul is probably going to be a short timer here on earth. He is sitting on the sewer main in a bell shaped hole under a steel plate which cars are driving over. No protection at all. There was a ladder in the trench was about 50 feet away. He wouldn't make it out of a cave-in unless he had wings.

Posing a Hazard

Excavation below the level of the base or footing of any foundation or retaining wall that could be reasonably expected to pose a hazard to employees shall not be permitted except when:

(i) A support system, such as underpinning, is provided to ensure the safety of employees and the stability of the structure; or

(ii) The excavation is in stable rock; or

(iii) A registered professional engineer has approved the determination that the structure is sufficiently removed from the excavation so as to be unaffected by the excavation activity; or

(iv) A registered professional engineer has approved the determination that such excavation work will not pose a hazard to employees.

Excavation Protection Systems

The three basic protective systems for excavations and trenches are sloping and benching systems, shoring, and shields. The protective systems shall have the capacity to resist without failure all loads that are intended or could reasonably be expected to be applied to or transmitted to the system. Every employee in an excavation shall be protected from cave-ins by an adequate protective system.

Exceptions to Using Protective System:

- Excavations are made entirely in stable rock.
- Excavations are less than 5 feet deep and declared safe by a competent person.

Sloping and Benching Systems

There are four options for sloping**:**

- Slope to the angle required by the standard for Type C, which is the most unstable soil type.
- The table provided in Appendix B of the standard may be used to determine the maximum allowable angle (after determining the soil type).
- Tabulated data prepared by a registered professional engineer can be utilized.
- A registered professional engineer can design a sloping plan for a specific job.

Sloping and benching systems for excavations five (5) to twenty (20) feet in depth must be constructed under the instruction of a designated competent person. Sloping and benching systems for excavations greater than twenty (20) feet must be designed and stamped by a registered professional engineer. Sloping and benching specifications can be found in Appendix B of the OSHA Standard (Subpart P).

Shoring Systems

Shoring is another protective system or support system. Shoring utilizes a framework of vertical members (uprights), horizontal members (whales), and cross braces to support the sides of the excavation to prevent a cave-in. Metal hydraulic, mechanical or timber shoring are common examples.

This is my favorite photo of all. Here are two men in a 30-foot-deep trench without any protection or ladders. They are lucky to have a rope. Please do not work in this dangerous environment.

The different examples of shoring are found in the OSHA Standard under these appendices:

APPENDIX C - Timber Shoring for Trenches
APPENDIX D - Aluminum Hydraulic Shoring for Trenches
APPENDIX E - Alternatives to Timber Shoring

Shield Systems (Trench Boxes)
Shielding is the third method of providing a safe workplace. Unlike sloping and shoring, shielding does not prevent a cave-in. Shields are designed to withstand the soil forces caused by a cave-in and protect the employees inside the structure. Most shields consist of two flat, parallel metal walls that are held apart by metal cross braces.

Shielding design and construction is not covered in the OSHA Standards. Shields must be certified in design by a registered professional engineer and must have either a registration plate on the shield or registration papers from the manufacturer on file at the jobsite office.

ANY REPAIRS OR MODIFICATIONS MUST BE APPROVED BY THE MANUFACTURER.

Safety Precautions for Shield Systems
- Shields must not have any lateral movement when installed.
- Employees will be protected from cave-ins when entering and exiting the shield (examples - ladder within the shield or a properly sloped ramp at the end).
- Employees are not allowed in the shield during installation, removal, or during any vertical movement.
- Shields can be 2 ft. above the bottom of an excavation if they are designed to resist loads at the full depth and if there are no indications of caving under or behind the shield.
- The shield must extend at least 18 inches above the point where proper sloping begins (the height of the shield must be greater than the depth of the excavation).

- The open end of the shield must be protected from the exposed excavation wall. The wall must be sloped, shored, or shielded. Engineer designed end plates can be mounted on the ends of the shield to prevent cave-ins.

Personal Protective Equipment
It is **OSHA** policy for you to wear a hard hat, safety glasses, and work boots on the jobsite. Because of the hazards involved with excavations, other personal protective equipment may be necessary, depending on the potential hazards present (examples-goggles, gloves, and respiratory equipment).

Excavation & Trenching Guidelines

This section outlines procedures and guidelines for the protection of employees working in and around excavations and trenches. This section requires compliance with OSHA Standards described in Subpart P (**CFR 1926.650**) for the construction industry.

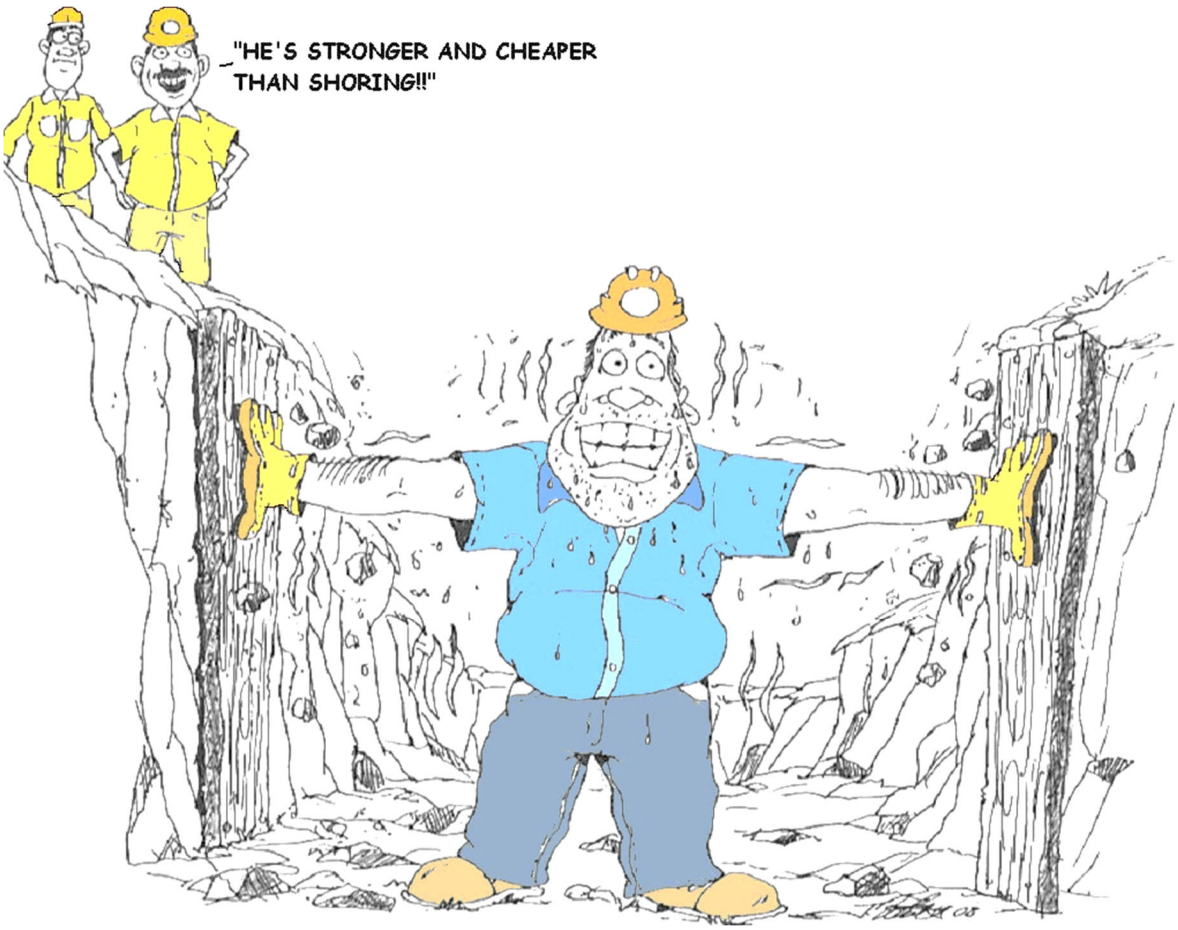
Safety compliance is mandatory to ensure employee protection when working in or around excavations.

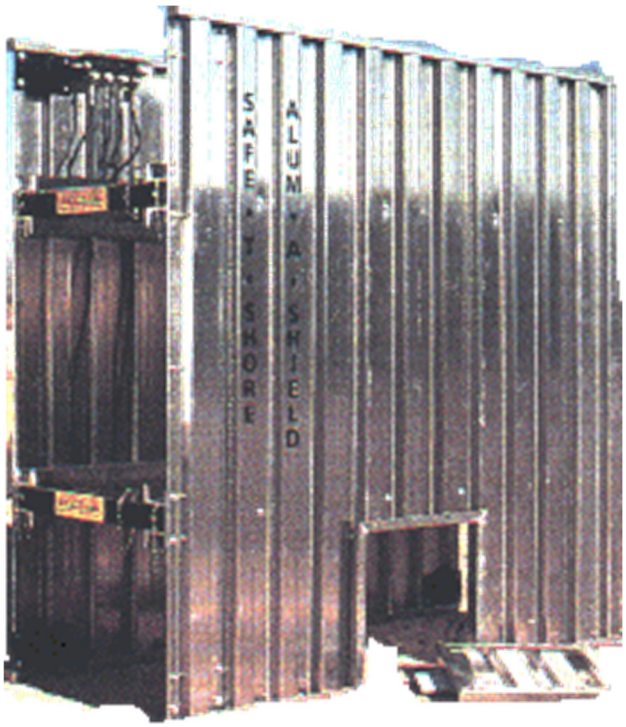
The competent person(s) must be trained in accordance with the OSHA Excavation Standard, and all other programs that may apply (examples Hazard Communication, Confined Space, and Respiratory Protection), and must demonstrate a thorough understanding and knowledge of the programs and the hazards associated.

All other employees working in and around the excavation must be trained in the recognition of hazards associated with trenching and excavating.

REFERENCES

- 29 CFR 1926.650, Subpart P - Excavations
- Excavation Equipment Manufacturer Safety Procedures





Trench Shields and Boxes

Shoring Systems

The word ***Shoring*** means a structure such as metal hydraulic, mechanical or timber-shoring system that supports the sides of an excavation and which is designed to prevent cave-ins. The key to this definition is the word "***supports***". Unlike other protective systems, shoring is meant by design, to exert enough force on the trench walls to prevent a cave-in.

As diagramed in the Soil Classification Chapter of this manual, unsupported trench walls have vertical, lateral and angled forces pressing toward the excavation.

Through proper employment of a shoring system, loads are placed back within the trench walls. In effect, the trench walls are deceived into "believing" that the excavation never took place.

Within the OSHA regulations are Appendixes C and D, with tables and limitations for use of timber shoring and aluminum hydraulic shoring as a support system. Other shoring systems may be used if they are accompanied by tabulated data signed by a registered professional engineer or a specific shoring plan has been developed and signed by a registered professional engineer.

Timber Shoring

Provisions have been made in Appendix C for the use of hardwood timber shoring systems within different soil classifications. The timber required is a mixed oak or equivalent with a bending strength not less than 850 psi.

Manufactured members of equivalent strength may be substituted for wood, but must also be accompanied by tabulated data or a shoring plan developed and signed by a registered professional engineer.

Installation of timber shoring shall begin from the top and proceed downward. In turn, removal must begin at the bottom and proceed to the top of the trench. When acquiring timber components, make certain that each piece meets the minimum required bending strength (850 psi) within the OSHA standards. Knots, holes or warping of each component may decrease required strength of individual lengths.

Complete Rule and further instructions are in the rear of this manual.

Carbon dioxide and argon, with specific gravities greater than air, may lie in a tank or manhole for hours or days after opening. Since these gases are colorless and odorless, they pose an immediate hazard to health unless appropriate oxygen measurements and ventilation are adequately carried out.

Aluminum Hydraulic Shoring Systems

Within the current OSHA Standards use Appendix D for the use of aluminum hydraulic shoring systems. In the early 1960's a former military airplane mechanic worked with a utility contractor to develop a more reliable means of shoring trench walls. Using a design incorporating aircraft aluminum alloys (6061-T6) and the use of hydraulic power, a secure method was invented that could often be installed and removed by one person. Installation and removal of aluminum hydraulic shoring takes place while personnel are above the excavation. It is the only shoring system that renders uniform preloading on the trench walls.

When the shores are hydraulically activated to the same pressure (psi) shown on the pump gauge, then each cylinder is exerting a uniform axial compressive load on the trench walls. For many types of cohesive soils, the load is dispersed within the trench walls into an arching effect. It is from this arching effect, used in conjunction with the rail strengths, that the horizontal and vertical distance between crossbraces (hydraulic cylinders) is calculated.

When using aluminum hydraulic shoring systems, maintain a copy of the manufacturer's tabulated data on the jobsite (see sample within manual). If that data is not available, use the tables in Appendix D of the OSHA excavation standards. Deviation from the specifications, recommendations and limitations issued by the manufacturer, other than the use of Appendix D, shall only be allowed after the manufacturer issues specific written approval. A competent person can use manufacturers' data in the design of an excavation safety plan.

Key Definitions

EXCAVATION. An **Excavation** is any man-made cut, cavity, trench, or depression in an earth surface that is formed by earth removal. A **Trench** is a narrow excavation (in relation to its length) made below the surface of the ground. In general, the depth of a trench is greater than its width, and the width (measured at the bottom) is not greater than 15 ft (4.6 m). If a form or other structure installed or constructed in an excavation reduces the distance between the form and the side of the excavation to 15 ft (4.6 m) or less (measured at the bottom of the excavation), the excavation is also considered to be a trench.

HAZARDOUS ATMOSPHERE is an atmosphere that, by reason of being explosive, flammable, poisonous, corrosive, oxidizing, irritating, oxygen-deficient, toxic, or otherwise harmful, may cause death, illness, or injury to persons exposed to it.

INGRESS AND EGRESS mean "entry" and "exit," respectively. In trenching and excavation operations, they refer to the provision of safe means for employees to enter or exit an excavation or trench.

PROTECTIVE SYSTEM refers to a method of protecting employees from cave-ins, from material that could fall or roll from an excavation face or into an excavation, and from the

collapse of adjacent structures. Protective systems include support systems, sloping and benching systems, shield systems, and other systems that provide the necessary protection.

OSHA Violation. Never utilize bent, cracked, or hydraulic shores as a ladder. Every one of these shores had a serious defect. Bent cross braces are not braces, they are hinges. Any bent or deformed structural member must be repaired or replaced according to the manufacturers' guidelines. We like to point out the fact that if an employee is injured or killed, you probably will be charged with a criminal offense as well as an OSHA violation. We have seen criminal fines in the million dollar range with prison sentences to boot.

Hazards

One of the reasons OSHA requires a competent person on-site during excavation & trenching are the numerous potential hazardous that may be encountered or created. Hazards include:

Electrocution
Gas Explosion
Entrapment
Struck by equipment
Suffocation

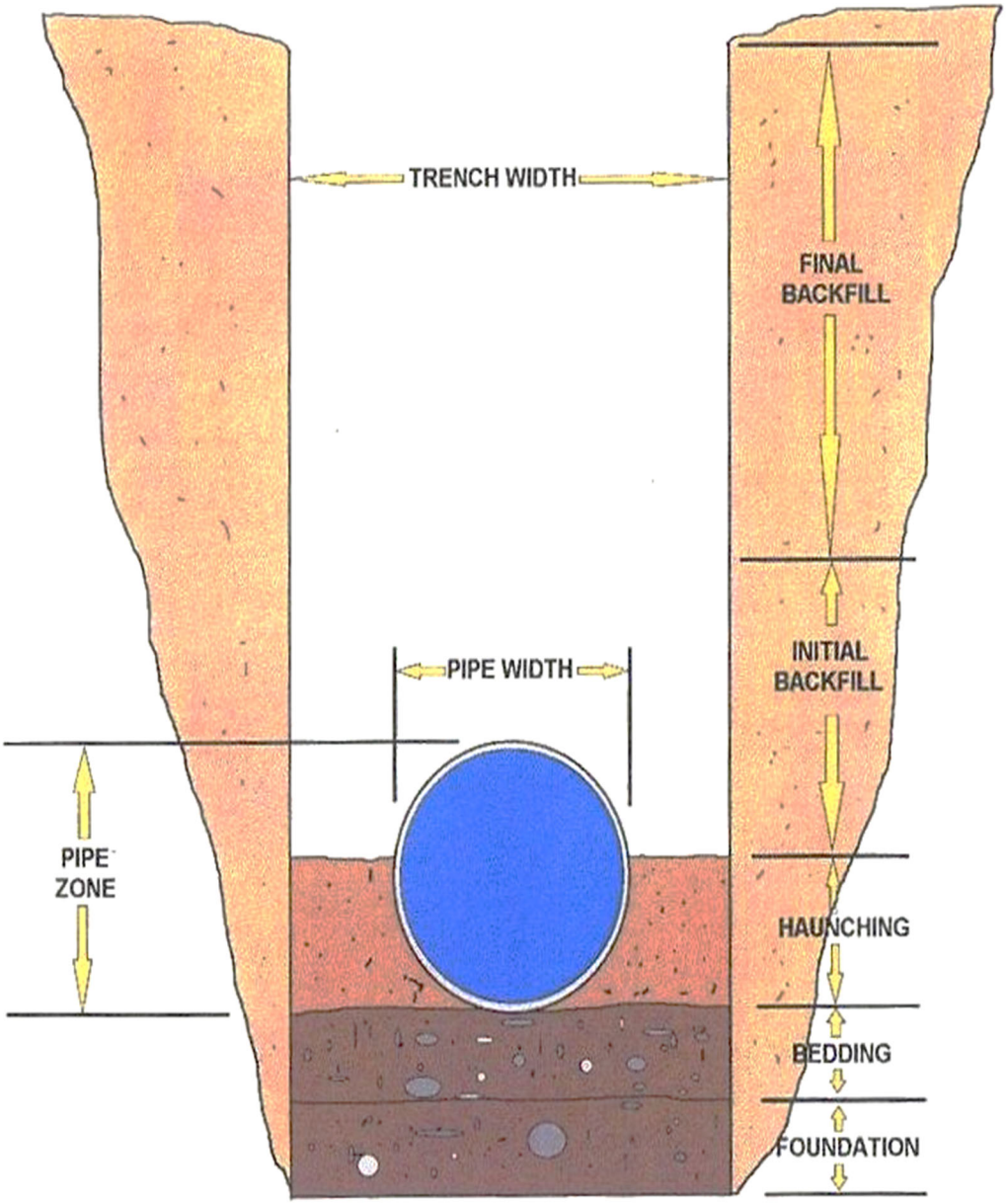
Hazard Controls

Before any work is performed and before any employees enter the excavation, a number of items must be checked and insured:

- Before any excavation, underground installations must be determined. This can be accomplished by either contacting the local utility companies or the local "**one-call'** center for the area. All underground utility locations must be documented on the proper forms. All overhead hazards (**surface encumbrances**) that create a hazard to employees must be removed or supported to eliminate the hazard.
- If the excavation is to be over 20 feet deep, it must be designed by a registered professional engineer who is registered in the state where the work will be performed.
- Adequate protective systems will be utilized to protect employees. This can be accomplished through sloping, shoring, or shielding.
- The worksite must be analyzed in order to design adequate protection systems and prevent cave-ins. There must also be an excavation safety plan developed to protect employees.
- Workers must be supplied with, and wear, any personal protective equipment deemed necessary to assure their protection.
- All spoil piles will be stored a minimum of **two (2) feet** from the sides of the excavation. The spoil pile must not block the safe means of egress.
- If a trench or excavation is 4 feet or deeper, stairways, ramps, or ladders will be used as a safe means of access and egress. For trenches, the employee must not have to travel any more than 25 feet of lateral travel to reach the stairway, ramp, or ladder.
- No employee will work in an excavation where water is accumulating unless adequate measures are used to protect the employees.
- A competent person will inspect all excavations and trenches daily, prior to employee exposure or entry, and after any rainfall, soil change, or any other time needed during the shift. The competent person must take prompt measures to eliminate any and all hazards.
- Excavations and trenches 4 feet or deeper that have the potential for toxic substances or hazardous atmospheres will be tested at least daily. If the atmosphere is inadequate, protective systems will be utilized.
- If work is in or around traffic, employees must be supplied with and wear orange reflective vests. Signs and barricades must be utilized to ensure the safety of employees, vehicular traffic, and pedestrians.

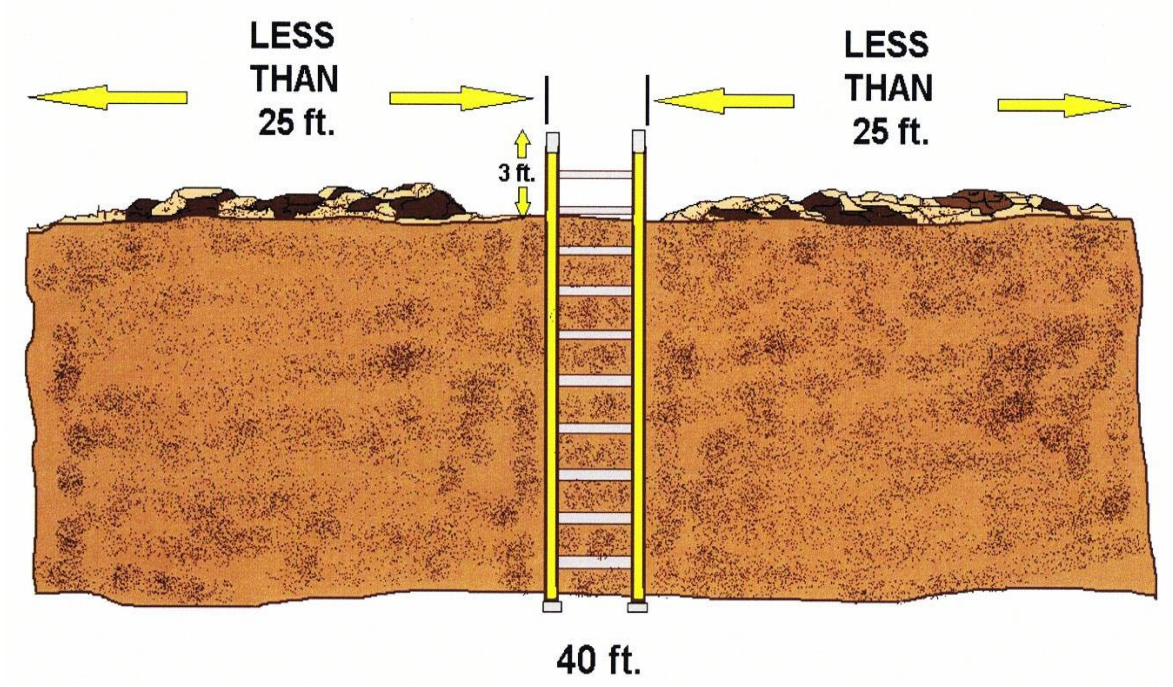
OSHA Violation--No ladders, but the best part is the homemade trench box using waterlines as the cross-braces. Remember, trench boxes and shields are a manufactured and engineered safety device that cannot be modified, especially by the competent person. This box collapsed in the hole. Workers must enter and leave the shield in a protected manner, such as by ladder within the shield or a properly sloped ramp at the end.

Shoring Diagram # 1



CROSS-SECTION OF A TRENCH

How many safety violations can you find in this photo?



Excavation Safety Plan

An excavation safety plan is required in written form. This plan is to be developed to the level necessary to insure complete compliance with the OSHA Excavation Safety Standard and state and local safety standards.

Excavation Safety Plan Factors:

- Utilization of the local one-call system.
- Determination of locations of all underground utilities.
- Consideration of confined space atmosphere potential.
- Proper soil protection systems and personal protective equipment and clothing.
- Determination of soil composition and classification.
- Determination of surface and subsurface water.
- Depth of excavation and length of time it will remain open.
- Proper adherence to all OSHA Standards, this excavation and trenching safety program, and any other coinciding safety programs.

1. Warning system for mobile equipment, methods to help prevent vehicles and equipment from falling in the trench can be accomplished by providing:

A. Barricades.
B. Hand or mechanical signals.
C. Stop logs.
D. Grade away from the excavation.

All equipment with an obstructed rear view is required to have a back-up alarm or an observer when backing {1926.601 (b) (4).}

2. Hazardous atmospheres, you must limit all exposures to hazardous atmospheres.

A. Oxygen deficient is anything less than 19.5% oxygen. Symptoms will include dizziness, increased heart rate or may experience a buzzing in the ears.
B. Normal is 21% oxygen.
C. Oxygen enriched atmospheres increase flammability of combustible materials.
D. Carbon monoxide causes oxygen starvation and can be fatal at a concentration of 1% for one minute. This is equal to 10,000 PPM. The Threshold Limit Value (**TLV**) is only 50 PPM.
E. If there is a possibility that a hazardous atmosphere exists or could be reasonably expected to exist, test the atmosphere before the employee enters an excavation. Some areas of concern include; digging near gas lines, sewers, landfills and near areas of high traffic.
F. Provide respirators or ventilation when needed. All personnel must be fit tested before wearing a respirator and all personnel must be training how to use ventilation.

The use of any respirator by employees will require a written respirator program form the employer {1926.103).

A. Ventilate trench if flammable gas exceeds 20% of the lower flammable limit.
B. Test the atmosphere often--this will ensure that the trench remains safe.
C. Perform regular maintenance on gas meters. Calibrate and change out filters regularly.
D. Never enter a hazardous atmosphere to rescue an employee unless you have been trained in rescue techniques and have proper rescue equipment. More than half the deaths occur while attempting a rescue.

3. Emergency rescue equipment must be available when a hazardous atmosphere exists or could be reasonably expected to exist.

A. Respirator must be suitable for the exposure. An air supplied or self-contained breathing apparatus is preferable

B. Harness and lifeline is required when an employee enters bellbottom piers and other deep confined spaces. The lifeline must be attended at all times.

Employees entering confined spaces must be trained. {1926.21 (b) (6) l}
Specific requirements for welding in confined spaces {1926.352 (g) and 1926.653 (b)}.

4. Protection from hazards associated with water accumulation is necessary to prevent cave-ins.

A. Methods for controlling accumulated water vary with each situation.

B. Employees are not permitted to work in trenches were water accumulation exists.

C. Special support system or shield systems may be used to protect employees from cave-ins.

D. Water removal equipment may be used and must be monitored by a competent person to prevent water accumulation.

E. Safety harness and lifeline may be used to protect employees.

F. Surface water must be diverted and controlled.

G. Trench must be inspected after rain.

5. Stability of adjacent structures to protect employees from cave-ins.

A. Support systems such as shoring, bracing, or underpinning must be used to support structures that may be unstable due to excavation operations.

B. Excavation below the base or footing of a foundation or wall is not permitted unless:
   i. Support system is provided to ensure the stability of the structure.
   ii. The excavation is in stable rock.
   iii. A Registered Professional Engineer approves the operation.

C. Support systems must be provided for sidewalks, pavements and other structures that may be affected by the excavation operations.

6. Protection of employees from loose rock or soil.

A. Employees must be protected from being struck by materials falling or rolling from the edge and the face of the trench.

B. Spoils and equipment must be set back at least 2 feet from the edge of the trench and/or a retaining device must be installed.

7. Fall protection is required for walkways and bridges over trenches. Other fall protection may also be required.

8. Remotely located excavations shall be backfilled, covered, or barricaded (for example wells, pits, shafts, etc.)

Inspections must be made:

A. Daily prior to starting work

B. As needed throughout the shift by a competent person.

C. After every rainstorm.

D. After other hazard increasing occurrence (snowstorm, windstorm, thaw, earthquake, etc.).

E. Inspect the trench for indications of possible cave-ins (fissures, tension cracks, sloughing, undercutting, water seepage, bulging at the bottom).

F. Inspect adjacent areas (spoil piles, structures).

G. To protective systems and their components (uprights, wales sheeting, shields hydraulics) before and after use.
H. Check for indications of a hazardous or potentially hazardous atmosphere.
I. Test the atmosphere if a hazard could reasonably be expected to exist.

Remove employees from the trench when there are indications of possible cave-ins, protective system failures, or other potentially hazardous conditions. Never work in water without proper protection. You will have to wear a Lifeline with a rope to drag your dead body out of these hazardous conditions.

It is not a legal place for ladder storage.

Protection of Employees in Excavations

I. All employees must be protected from cave-ins, by shields, sloping or shoring except:

1. When the excavations are made in solid rock that is not fractured.

2. Excavations are made less than five (5) feet deep and there is no indication of a possible cave-in as determined by a competent person.

    a. A competent person is required even when the trench is less than five (5) feet deep.

    b. Shallow trench cave-ins could be fatal or cause serious injuries.

A. Protective systems must have the strength to resist all intended or expected loads.

B. Employees must be protected from cave-ins when entering and exiting trenches and shields.

C. Employees are not permitted in shields when the shields are being installed, removed or moved vertically.

1. Employees may remain in the shield when the shield is moved horizontally without lifting it.

II. Design of sloping and benching systems must be selected and constructed by the employer or his designee when using one or more of the four alternative methods.

A. Option 1 – Allowable configurations and slopes.

1. Sloped at an angle of 34 degrees = 1½ to 1.

2. Use of other configurations described in Appendix B for Type C soil classifications.

B. Option 2 – Determination of sloping and benching configurations using Appendices A and B.

1. Soil and rock must be classified.

    a. Based on site and environmental conditions.

    b. Based on the composition of the soil.

    c. Based on acceptable visual and manual tests for classifying soils. Tests are described in Appendix A.

d. Select sloping or benching configuration from Appendix B based on soil type.

C. Option 3 – Designs using other tabulated data, such as tables and charts, may be used to select sloping and benching configurations.

1. Identity of the RPE who has approved the data must be stamped on the data.

2. The tabulated data must be in written form, describing detailed information on its use and limitations.

3. Tabulated data must be at the job site during the construction of the protective system.

4. After construction of the protective system, the tabulated data may be kept off-site, but it must be available for inspection.

D. Option 4 – Sloping and/or benching designs prepared and approved by a RPE may be used.

1. Identity of the RPE who has approved the data must be stamped on the sloping and/or benching designs.

2. Designs must clearly identify the project.

3. The configurations must be determined safe for the project.

4. Design must be at the job site during construction of the sloping and/or benching configuration.

5. After construction of the sloping configuration, the design may be kept off-site, but must be available for inspection.

III. Excavations greater than twenty (20) feet in depth must be designed by an RPE and the tabulated data and design must be available for inspection.

IV. Design of support systems, shield systems, and other protective systems must be selected and constructed by the employer or his designee using one or more of the alternative methods.

A. Option 1 – Designs using Appendices A, C, and D may be used by the competent person.

1. Timber shoring is designed by using Appendices A and C.

2. Appendix A and D may be used for hydraulic shoring if the manufacturer’s tabulated data is not available or cannot be used.

B. Option 2 – Designs using pre-manufactured protective systems (shoring, shields, or other) and components must be prepared using the manufacturer's tabulated data.

1. Deviations from the use of the manufacturer's specifications must be approved by the manufacturer.

2. Manufacturer's written approval to deviate from the specifications must be on-site during construction of the system.

3. After construction of the system, the written approval may be kept off site, but must be available for inspection.

C. Option 3 – Designs using other tabulated data, such as tables and charts, may be used to design support systems, shield systems, or other protective systems.

1. There must be enough information necessary to make an accurate selection of the protective system.

2. Identity of the RPE who has approved the data must be stamped on the data.

3. The tabulated data must be in written form, describing detailed information on its use and limitations.

4. Tabulated data must be at the jobsite during construction of the protective system.

5. After construction of the protective system, the tabulated data may be kept off-site, but must be available for inspection.

D. Option 4 – Protective systems designed and approved by an RPE may be used:

1. The plan must include the size, types, and configurations of the materials to be used.

2. Identity of the RPE who approved the data must be stamped on the sloping and/or benching designs.

3. Designs must identify the project.

4. The design configurations must be determined safe for the project.

5. Design must be at the jobsite during construction of the protective systems.

6. After construction of the protective system, the design may be kept off-site, but must be available for inspection.

V. Materials and equipment used for protective systems:

A. Must be free from damage or defects.

B. Must be maintained in good condition.

C. Damaged equipment or materials must be inspected by a competent person and removed from use if determined unsafe.

D. Once equipment or materials are determined by a competent person to be unsafe, an RPE must evaluate and approve the equipment or materials before returning the equipment to service.

VI. Installation and removal of supports.

A. Members of the support system securely connected together.

B. Employees must be protected from cave-ins and other hazards during installation and removal.

C. Members of the support system may not be overloaded.

D. Precautions must be taken to prevent cave-ins during removal of structural supports. Removal must start at the bottom.

E. Observe structure for indications of failure during removal of support systems.

F. Backfill as removal of support systems progress.

VII. Additional requirements for support systems for trench excavations:

A. Removal of materials to a depth two (2') feet below the bottom of the support system is permitted if:

1. The system is designed to resist loads at the full depth of the trench.

2. There are no indications of the possible collapse of soil from behind or below the bottom of the support system.

B. Support systems must be installed as the excavation of the trench proceeds.

VIII. Sloping and benching systems:

A. Employees are not permitted to work on the faces of sloped or benched excavations above other employees unless the employees at the lower levels are protected from being struck by materials or equipment.

IX. Shield systems (trench boxes)

A. Shall not be overloaded.

B. Lateral or hazardous movement restricted.

C. Employees must be protected from cave-ins when entering and exiting the shields.

D. Employees are not permitted in shields during installation, removal, or vertical movement.

E. Employees may remain in shield during horizontal movement as long as the shield is not lifted in any way.

F. Removal of materials to a depth two (2') feet below the bottom of the support system is permitted if:

1. The system is designed to resist loads at the full depth of the trench.

2. There are no indications of possible collapse of soil from behind or below the bottom of the support system.

Complete Rule and further instructions are in the rear of this manual.

OSHA Violation. It is difficult to see, but this poor soul is inside a death trap. He is in a deep trench sitting in a bell-shaped hole, sitting on a sewer main. He has good shade from a steel plate that is covering the road with cars driving on top. No protection at all. There was a ladder about 50 feet away. Good luck!

Various Trench Boxes

Daily inspections of excavations, the adjacent areas, and protective systems shall be made by a competent person for evidence of a situation that could result in possible cave-ins, indications of failure of protective systems, hazardous atmospheres, or other hazardous conditions. An inspection shall be conducted by the competent person prior to the start of work and as needed throughout the shift. Inspections shall also be made after every rainstorm or other hazard increasing occurrence. These inspections are only required when employee exposure can be reasonably anticipated.

Equipment and Injuries

If activation of electrical or mechanical equipment would cause injury, each piece of equipment should be manually isolated to prevent inadvertent activation before workers enter or while they work in a confined space.

The interplay of hazards associated with a confined space, such as the potential of flammable vapors or gases being present, and the build-up of static charge due to mechanical cleaning, such as abrasive blasting, all influence the precautions which must be taken.

Soil Classification and Identification

The OSHA Standards define soil classifications within the Simplified Soil Classification Systems, which consist of four categories: Stable rock, Type A, Type B, and Type C. Stability is greatest in stable rock and decreases through Type A and B to Type C, which is the least stable.

Appendix A of the standard provides soil mechanics terms and types of field tests used to determine soil classifications. Stable rock is defined as natural solid mineral matter that can be excavated with vertical sides and remain intact while exposed.

Type A soil is defined as:
- Cohesive soils with an unconfined compressive strength of 1.5 tons per square foot (**TSF**) or greater.
- Cemented soils like caliche and hardpan are considered Type A.

Soil is NOT Type A if:
- It is fissured.
- The soil is subject to vibration from heavy traffic, pile driving or similar effects.
- The soil has been previously disturbed.
- The material is subject to other factors that would require it to be classified as a less stable material.
- The exclusions for Type A most generally eliminate it from most construction situations.

Type B soil is defined as:
- Cohesive soil with an unconfined compressive strength greater than .5 TSF, but less than 1.5 TSF.
- Granular cohesion-less soil including angular gravel, silt, silt loam, and sandy loam.
- The soil has been previously disturbed except that soil classified as Type C soil.
- Soil that meets the unconfined compressive strength requirements of Type A soil, but is fissured or subject to vibration.
- Dry rock that is unstable.

Type C soil is defined as:
- Cohesive soil with an unconfined compressive strength of .5 TSF or less.
- Granular soils including gravel, sand and loamy sand.
- Submerged soil or soil from which water is freely seeping.
- Submerged rock that is not stable.

Soil Test & Identification

The competent person will classify the soil type in accordance with the definitions in Appendix A based on at least one visual and one manual analysis. These tests should be run on freshly excavated samples from the excavation and are designed to determine stability based on a number of criteria: the cohesiveness, the presence of fissures, the presence and amount of water, the unconfined compressive strength, and the duration of exposure, undermining, and the presence of layering, prior excavation and vibration.

The cohesion tests are based on methods to determine the presence of clay. Clay, silt, and sand are size classifications, with clay being the smallest sized particles, silt intermediate and sand the largest.

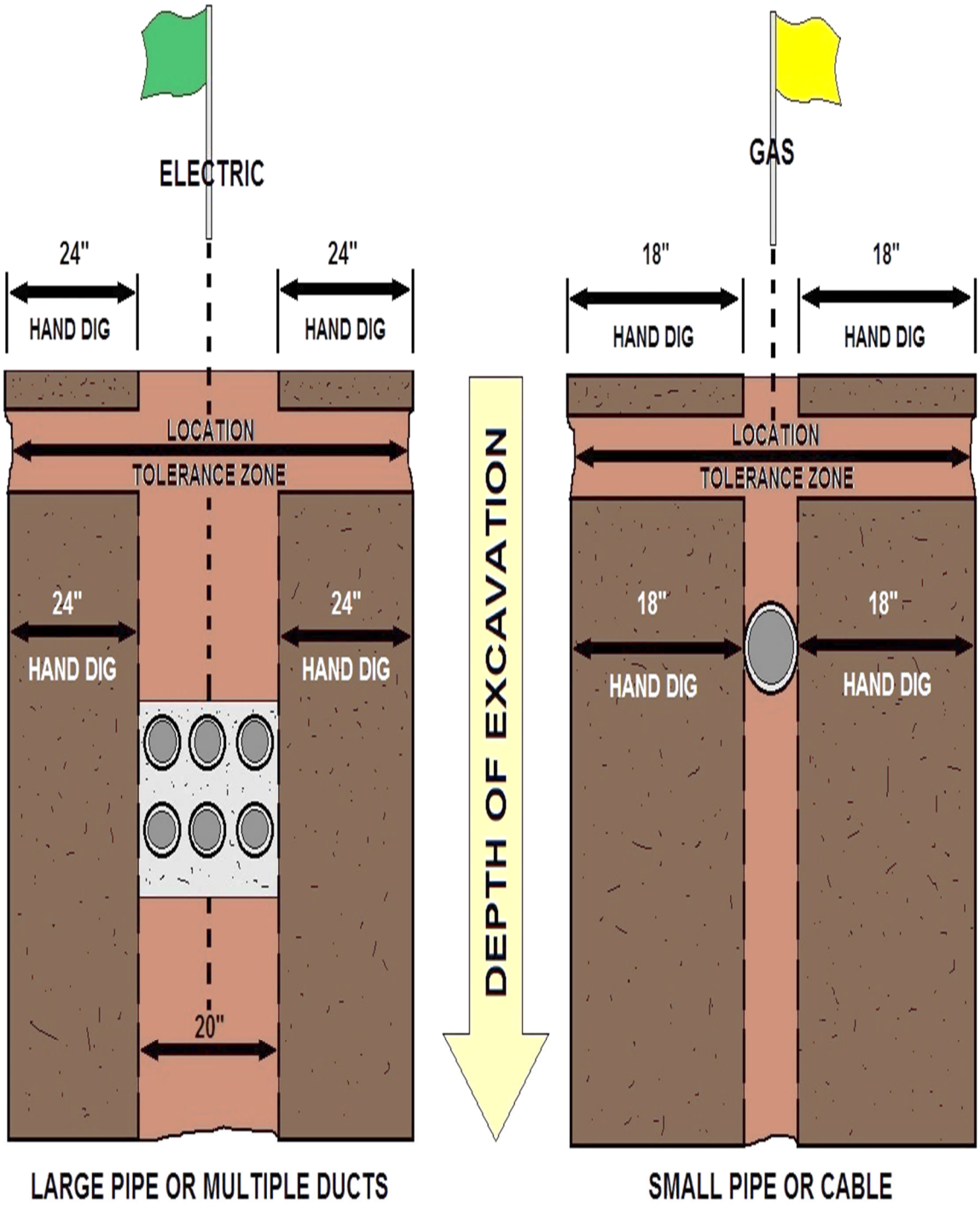
Clay minerals exhibit good cohesion and plasticity (can be molded). Sand exhibits no elasticity and virtually no cohesion unless surface wetting is present. The degree of cohesiveness and plasticity depend on the amounts of all three types and water.

When examining the soil, three questions must be asked: Is the sample granular or cohesive? Is it fissured or non-fissured? What is the unconfined compressive strength measured in TSF?

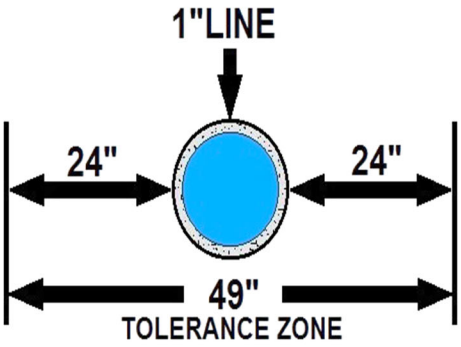
The competent person will perform several tests of the excavation to obtain consistent, supporting data along its depth and length. The soil is subject to change several times within the scope of an excavation and the moisture content will vary with weather and job conditions. The competent person must also determine the level of protection based on what conditions exist at the time of the test, and allow for changing conditions.

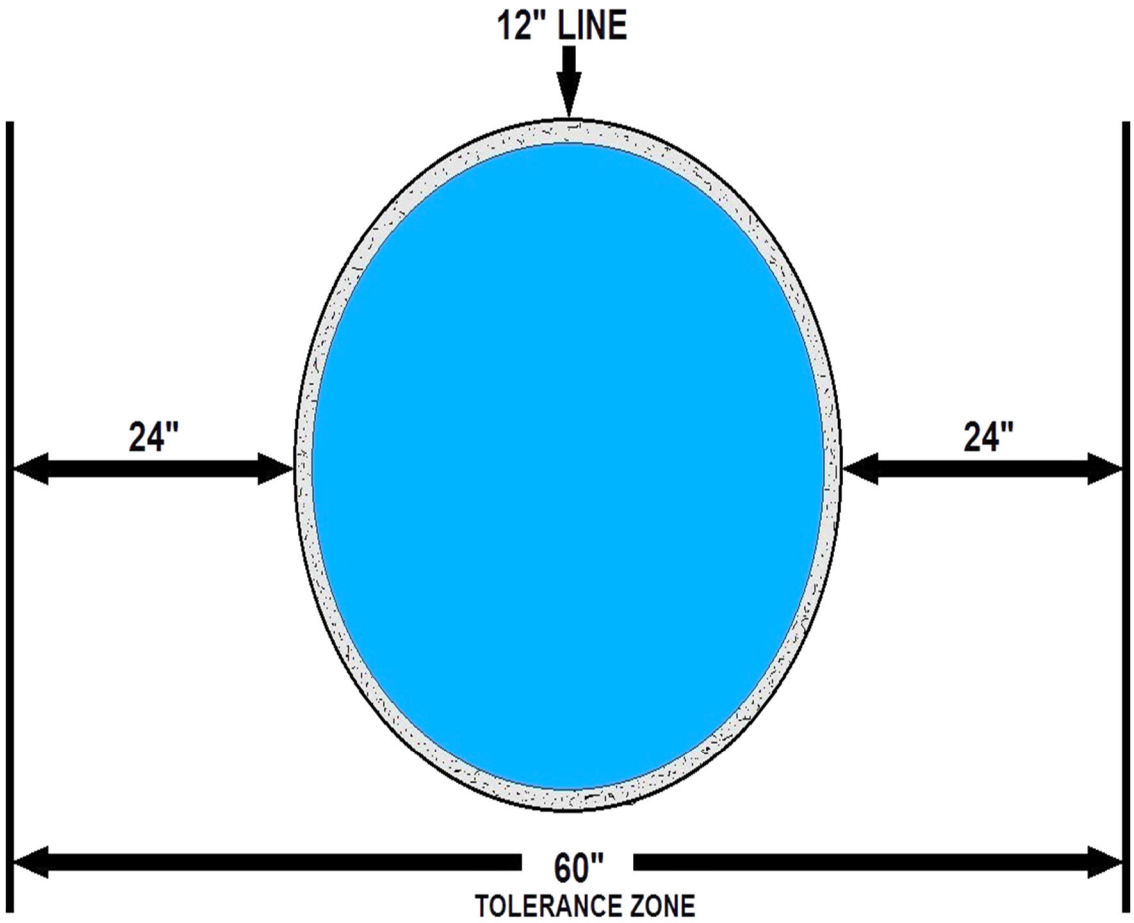
Ribbon Soil Test

Shoring Diagram #2



TOLERANCES FOR TRENCHING AROUND UTILITES





TOLERANCE ZONES USED TO AVOID HITTING UTILITES WHILE EXCAVATING

Sloping

MAXIMUM ALLOWABLE SLOPES

SOIL TYPE	SLOPE (H:V)	ANGLE(º)
Stable Rock	Vertical	90º
Type A	3/4 : 1	53º
Type B	1 : 1	45º
Type C	1 1/2 : 1	34º

MAXIMUM ALLOWABLE SLOPE means the steepest incline of an excavation face that is acceptable for the most favorable site conditions as protection against cave-ins and is expressed as the ratio of horizontal distance to vertical rise (**H:V**).

The tables and configurations within Appendix B may be used to a maximum depth of twenty (20') feet deep. Jobs more than twenty (20') feet in depth require the design of a sloping plan by a registered professional engineer (**RPE**). If configurations are used for depths less than 20 feet other than those found in Appendix B, they must also be designed by a registered professional engineer.

Shielding

The third method of providing a safe workplace in excavations is shielding. Shielding is different from shoring and sloping in that it does not prevent cave-ins. Instead, it protects the workers in the event of a cave-in. Its function is therefore somewhat similar to that of a bomb shelter.

Shields are simply devices that, when placed in an excavation, have sufficient structural strength to support the force of a cave-in should one occur. Shields take a number of different shapes and sizes. Most shields consist of two flat, parallel metal walls which are held apart by metal cross braces which are placed at the ends of the "**Box**" to allow for the installation of pipe within its interior dimensions.

These boxes are used to greatest effect in what is known as "cut and cover" operations where a contractor excavates just enough trench to install the shield, then sets a joint of pipe, then excavates further, then pulls the shield forward to install another joint while the first is being backfilled. This method is extremely cost effective in that it is fast, safe, requires minimum excavation and minimum open trench. It has become the preferred method of laying pipe in most instances. While original shields were quite large, smaller shields have gained in popularity with public works maintenance crews and contractors working in shallow excavations because of their ease of use. Recently, round shields, made of corrugated metal have appeared. The sizes, shapes and possibilities for the applications of shields are endless. If they are to be used, however, several points must be borne in mind.

1. Shield construction is not covered by the standard. Users must rely on manufacturers' requirements. For this reason, it is critical that you know your supplier. Reputable manufacturers supply boxes designed by registered professional engineers, and the standard requires that they are certified for their applications. Do not make the mistake of having the neighborhood welder fabricate one. A user must know that their shield is appropriate for the situation.

2. Bent cross braces are not braces, they are hinges. Any bent of deformed structural member must be repaired or replaced according to the manufactures' guidelines.

3. The manufacturer must approve any modification to the shields.

4. Shields must be installed so as to prevent lateral movement in the event of a cave-in.

5. Shields may ride two feet above the bottom of an excavation, provided they are calculated to support the full depth of the excavation and there is no caving under or behind the shield.

6. Workers must enter and leave the shield in a protected manner, such as by ladder within the shield or a properly sloped ramp at the end.

7. Workers may not remain in the shield during its installation, removal or during vertical movement.

8. Do not forget about the open end of the shield if it exposes a wall of the excavation. The wall should be sloped, shored or shielded off to prevent a cave-in from the end.

9. If the excavation is deeper than the shield is tall, attached shields of the correct specifications may be used or the excavation may be sloped back to maximum allowable angle from a point 18 inches below the top of the shield.

Complete Rule and further instructions are located in TLC's Competent Person Course.

All of this text is credited to OSHA.

Inspections

Daily inspection of excavations, the adjacent areas and protective systems shall be made by the competent person for evidence of a situation that could result in a cave-in, indications of failure of protective systems, hazardous atmospheres or other hazardous conditions.

- All inspections shall be conducted by the competent person prior to the start of work and as needed throughout the shift.
- Inspections will be made after every rainstorm or any other increasing hazard.
- All documented inspections will be kept on file in the jobsite safety files and forwarded to the Safety Director weekly.
- A copy of the ***Daily Excavation Inspection*** form is located at the end of this program.

The competent person(s) must be trained in accordance with the OSHA Excavation Standard, and all other programs that may apply (examples Hazard Communication, Confined Space, and Respiratory Protection), and must demonstrate a thorough understanding and knowledge of the programs and the hazards associated. All other employees working in and around the excavation must be trained in the recognition of hazards associated with trenching and excavating.

Two unsafe excavation examples: Top, notice the man in a 6-foot-deep trench with no ladder or shoring, and the placement of spoil. Bottom picture, utilities are marked after the excavation has begun, no hard hats, no ladders, no protective system, incorrect spoil placement.

DAILY EXCAVATION CHECKLIST

Client		**Date**	
Project Name		**Approx. Temp.**	
Project Location		**Approx. Wind Dir.**	
Job Number		**Safety Rep**	
Excavation Depth & Width		**Soil Classification**	
Protective System Used			
Activities In Excavation			
Competent Person			

Excavation > 4 feet deep? ___Yes ___No

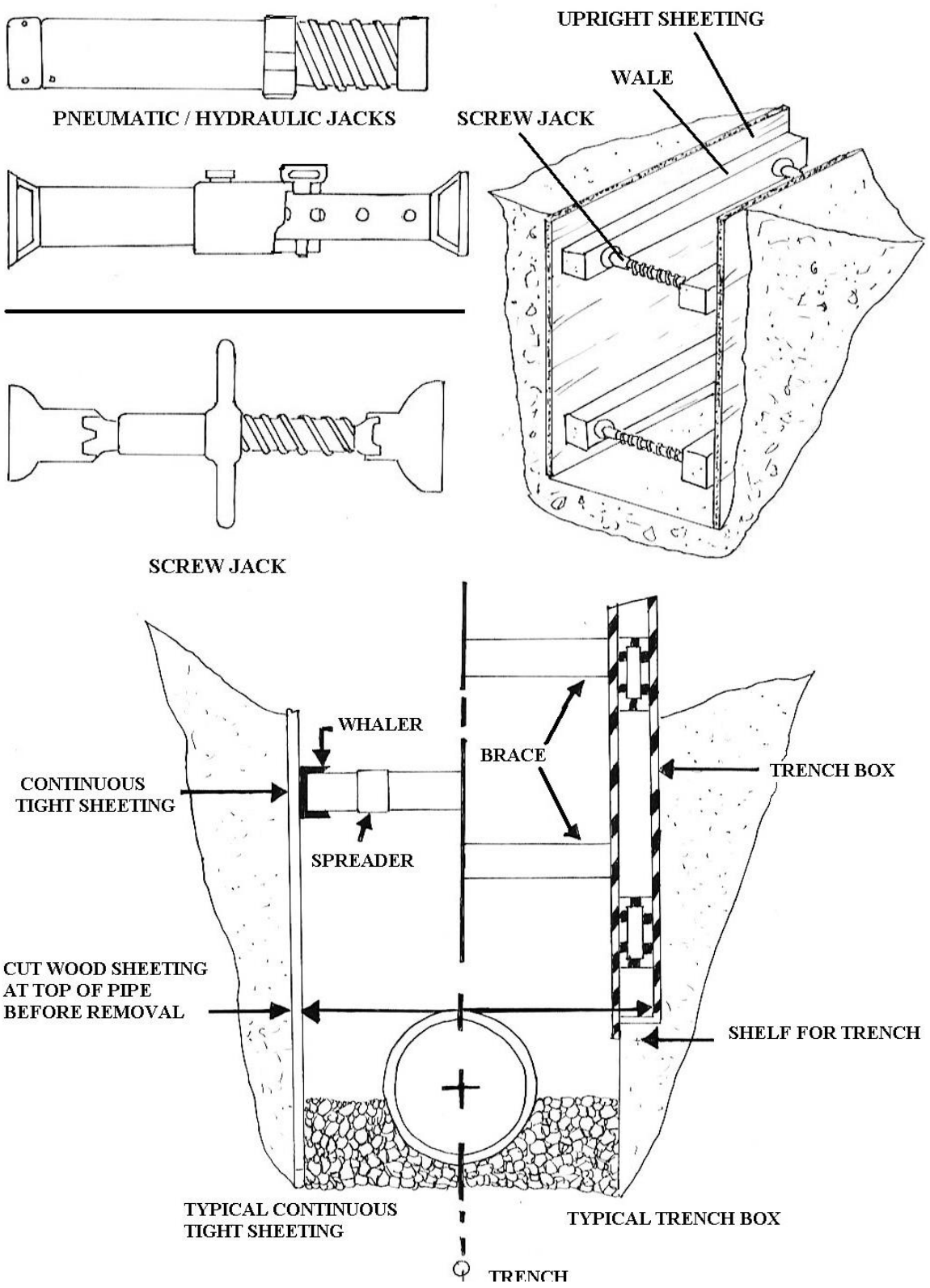
NOTE: **Trenches over 4 feet in depth are considered excavations. Any items marked *NO* on this form *MUST* be remediated prior to any employees entering the excavation.**

YES	NO	N/A	DESCRIPTION
			GENERAL
			Employees protected from cave-ins & loose rock/soil that could roll into the excavation
			Spoils, materials & equipment set back at least 2 feet from the edge of the excavation.
			Engineering designs for sheeting &/or manufacturer's data on trench box capabilities on site
			Adequate signs posted and barricades provided
			Training (toolbox meeting) conducted w/ employees prior to entering excavation
			UTILITIES
			Utility company contacted & given 24 hours' notice &/or utilities already located & marked
			Overhead lines located, noted and reviewed with the operator
			Utility locations reviewed with the operator, & precautions taken to ensure contact does not occur
			Utilities crossing the excavation supported, and protected from falling materials
			Underground installations protected, supported or removed when excavation is open
			WET CONDITIONS
			Precautions taken to protect employees from water accumulation (continuous dewatering)
			Surface water or runoff diverted /controlled to prevent accumulation in the excavation
			Inspection made after every rainstorm or other hazard increasing occurrence

HAZARDOUS ATMOSPHERES			
			Air in the excavation tested for oxygen deficiency, combustibles, other contaminants
			Ventilation used in atmospheres that are oxygen rich/deficient &/or contains hazardous substances
			Ventilation provided to keep LEL below 10 %
			Emergency equipment available where hazardous atmospheres could or do exist
			Safety harness and lifeline used
			Supplied air necessary (if yes, contact safety department)
ENTRY & EXIT			
			Exit (i.e. ladder, sloped wall) no further than 25 feet from ANY employee
			Ladders secured and extend 3 feet above the edge of the trench
			Wood ramps constructed of uniform material thickness, cleated together @ the bottom
			Employees protected from cave-ins when entering or exiting the excavation

Explain how you have secured the site and made it safe to work inside (if possible)

Shoring Diagram #3

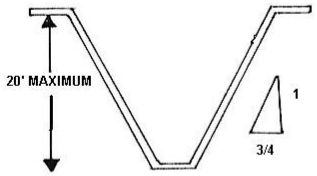


SLOPING

TYPE A SOIL

SIMPLE SLOPE EXCAVATION

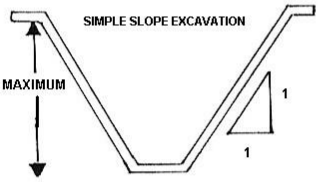
TYPE A: 3/4:1



TYPE B SOIL

SIMPLE SLOPE EXCAVATION

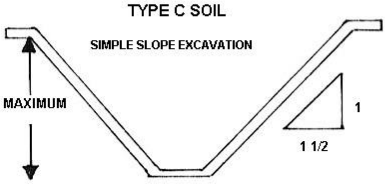
TYPE B: 1:1



TYPE C SOIL

SIMPLE SLOPE EXCAVATION

TYPE C: 1 1/2:1

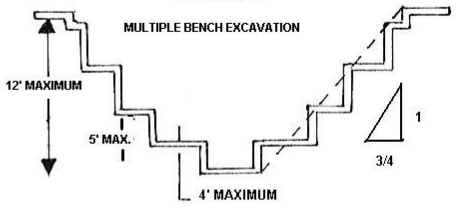


BENCHING

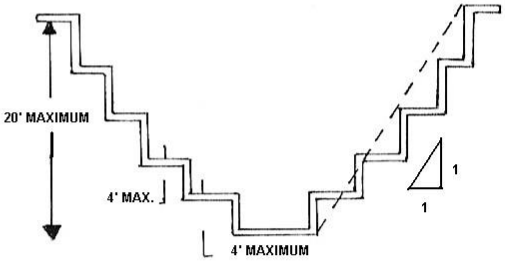
TYPE A

TYPE A SOIL

MULTIPLE BENCH EXCAVATION



TYPE B



TYPE C: N/A TYPE C SOIL CANNOT BE BENCHED

One-call Center or Bluestakes

You are required to locate or call for proper buried utility locations before you dig or excavate. You will usually need a 48-hour notice before you excavate. Please check with your local one-call system.

Red spray marks-Electricity, Yellow-Gas, Blue-Water

Orange spray marks - Telephone & Fiber Optics

One Call Program

According to federal safety statistics, damage from unauthorized digging is the major cause of natural gas pipeline failures. To prevent excavation damage to all utilities, including pipelines, all 50 states have instituted "***One Call***" Programs. The programs provide telephone numbers for excavation contractors to call before excavation begins.

The one-call operator will notify a pipeline company of any planned excavation in the vicinity of its pipeline so that the company can flag the location of the pipeline and assign personnel to be present during excavation, if necessary.

In a related effort, a joint government-industry team has developed a public education program entitled "***Dig Safely***". The team involved representatives from the U.S. Department of Transportation, gas and liquid pipeline companies, distribution companies, excavators, the insurance industry, one-call systems and the telecommunications industry. This campaign provides information to the general public concerning underground utilities and the danger of unknowingly digging into buried lines and cables.

The program has posters, brochures and other printed materials available for use by interested organizations. For more information, contact **www.digsafely.com**.

Telephone Cables, difficult to dig around, just as with as electrical lines.

One-Call Center, Underground Utilities

One Call Centers were established as a one-call notification system by underground facility owners to assist excavators with statutory requirements to notify underground facility owners prior to excavation. This damage prevention service is provided free of charge to any individual or company planning to excavate. By participating in the program and getting underground facilities located, you can:

- Comply with Federal Law
- Avoid Injuries
- Prevent costly damages and interruptions of facility services
- Save time and money
- Avoid hazards
- Eliminate construction delays

Color Codes for marking underground utility lines.

Red	**Electric Power**
Yellow	**Gas-Oil- Product Lines**
Orange	**Communication, Cable television**
Blue	**Water systems, slurry pipelines**
Green	**Sanitary sewer system**
Pink	**Temporary survey markings**

Example of a One-Call Center's Rules
Excavations: determining location of underground facilities; providing information; excavator marking; on-site representative; validity period of markings.

A. A person shall not make or begin any excavation in any public street, alley, right-of-way dedicated to the public use or utility easement or on any express or implied private property utility easement without first determining whether underground facilities will be encountered, and if so where they are located from each and every public utility, municipal corporation or other person having the right to bury such underground facilities within the public street, alley, right-of-way or utility easement and taking measures for control of the facilities in a careful and prudent manner.

B. Every public utility, municipal corporation or other person having the right to bury underground facilities shall file with the corporation commission the job title, address and telephone number of the person or persons from whom the necessary information may be obtained. Such person or persons shall be readily available during established business hours. The information on file shall also include the name, address and telephone number of each one-call notification center to which the owner of the facility belongs. Upon receipt of inquiry or notice from the excavator, the owner of the facility shall respond as promptly as practical, but in no event later than two days, by marking such facility with stakes, paint or in some customary manner. No person shall begin

excavating before the location and marking are complete or the excavator is notified that marking is unnecessary.

C. On a timely request by the owner of a facility, the excavator shall mark the boundaries of the location requested to be excavated in accordance with a color code designated by the commission or by applicable custom or standard in the industry. A request under this subsection for excavator marking does not alter any other requirement of this section.

D. In performing the marking required by subsection B of this section, the owner of an underground facility installed after December 31, 1988 in a public street, alley or right-of–way dedicated to public use, but not including any express or implied private property utility easement, shall locate the facility by referring to installation records of the facility and utilizing one of the following methods:

1. Vertical line or facility markers.
2. Locator strip or locator wire.
3. Signs or permanent markers.
4. Electronic or magnetic location or tracing techniques.
5. Electronic or magnetic sensors or markers.
6. Metal sensors or sensing techniques.
7. Sonar techniques.
8. Underground electrical or radio transmitters.
9. Manual location techniques, including pot-holing.
10. Surface extensions of underground facilities.
11. Any other surface or subsurface location technique at least as accurate as the other marking methods in this subsection not prohibited by the commission or by federal or state law.

E. For an underground facility other than one installed after December 31, 1988, in a public street, alley or right-of-way dedicated to public use, in performing the marking required by subsection B of this section, the owner may refer to installation or other records relating to the facility to assist in locating the facility and shall locate the facility utilizing one of the methods listed under subsection D of this section.

If an underground facility owner is unable to complete the location and marking within the time period provided by subsection B of this section, the facility owner shall satisfy the requirements of this section by proving prompt notice of these facts to the excavator.

Assigning one or more representatives to be present on the excavation site at all pertinent times as requested by the excavator to provide facility location services until the facilities have been located and marked.

The underground facility owner shall bear all of its costs associated with assigning representatives. If representatives are assigned under this subsection, the excavator is not responsible or liable for damage or repair of the owner’s underground facility while acting under the direction of an assigned representative of the owner, unless the damage or need for repair was caused by the excavator’s negligence.

Natural Gas Safety

That familiar blue flame that plays such an important role in our lives should, like other sources of energy, be treated with respect. Following a few simple guidelines can help ensure that you can safely enjoy all the benefits natural gas has to offer.

Natural gas is colorless and invisible. When it burns it should appear as a clear, blue flame. Because natural gas has no odor, a special chemical called mercaptan is added to make it easy to detect gas leaks from pipes or appliances. This odor is commonly described as a rotten-egg smell.

Natural gas is clean-burning. When burned completely, it produces only water vapor and carbon dioxide, just as you do when you breathe. Natural gas is such a safe and dependable fuel that it's easy to take for granted. But please, never take safety for granted. As with any source of energy, you should follow certain safety measures when using natural gas.

When it's taken from the ground, natural gas is tasteless, colorless and odorless. To make it easier to detect, a harmless but strong-smelling odorant is added, Ethyl Mercaptan. If you ever smell this "***rotten egg-like***" odor, it may mean there is a gas leak.

WHAT TO DO IF YOU SMELL GAS:

- Do not smoke. Do not use lighters or matches.
- Do not turn on/off any switches or appliances.
- Our personnel are available 24 hours a day to respond to any emergency call.

Carbon Monoxide

Carbon monoxide is produced when burning any fuel incompletely, such as charcoal, gasoline or wood. Carbon monoxide is highly poisonous and it has no odor, taste or color. If natural gas equipment is not maintained, adjusted and operated properly, it could produce carbon monoxide.

Your natural gas appliances should produce a clear, steady blue flame. If your gas appliances exhibit an unusual behavior or produce a yellowish-color flame, that may be a warning sign that your appliance is producing carbon monoxide.

A licensed professional should inspect appliances annually to insure safe operation. An inspection will accomplish the following:

- Make sure the appliance is installed properly and that it is in good working condition.
- Ensure that there is enough fresh air circulating for the fuel to burn properly.
- Check that vents are in good condition and are not blocked with debris.

Other helpful tips:

- The area surrounding your gas appliances should be clear from clutter or trash.
- Carbon monoxide detectors may be helpful in your home or business. But remember, a carbon monoxide detector should never be substituted for using equipment safely - which includes having your heating and cooking equipment inspected once a year by a trained professional.

OSHA's General Industry Regulation, §1910.146 Permit-required confined spaces, contains requirements for practices and procedures to protect employees in general industry from the hazards of entry into permit-required confined spaces. This regulation does not apply to construction.

On May 4, 2015, OSHA issued a new standard for construction work in confined spaces, which became effective August 3, 2015. Confined spaces can present physical and atmospheric hazards that can be avoided if they are recognized and addressed prior to entering these spaces to perform work. The new standard, Subpart AA of 29 CFR 1926 will help prevent construction workers from being hurt or killed by eliminating and isolating hazards in confined spaces at construction sites similar to the way workers in other industries are already protected.

Excavation Glossary

Barricades: Visible warning barriers that keep vehicles and pedestrians from entering a construction site.

Braces: Devices that hold or fasten two or more parts together or in place. Braces are diagonal or horizontal. They may be made of wood or metal.

Bracing System: A system of braces which applies pressure against trench walls to stabilize them. A bracing system is part of a trench shoring system used to prevent trench walls from collapsing.

Benching: A method of cutting back the sides of a trench into horizontal steps to prevent cave-ins.

Bulge: An outward swelling in the soil of a trench; may be a warning sign of trench failure.

Buried Structures: Manholes, junction boxes or catch basins beneath the ground or any other installations that may be encountered during trenching.

Clay: Fine-grained natural soil that is plastic when moist and hard and brittle when dry. Clay is made up of particles smaller than .0002 millimeters.

Clumps: Heavy lumps or thick groupings of soil.

Cohesion: The relative ability to clump together, the force holding two like substances together.

Cohesive: When a soil has grains that hold together and clump well.

Competent Person: One who is capable of identifying existing and predictable hazards in the surroundings, or working conditions which are unsanitary, hazardous or dangerous to employees. Has authorization to take prompt corrective measures to eliminate hazards. The Competent Person is trained and knowledgeable about soil analysis and the use of protective systems.

Confined Space: Has limited or restricted means of entry or exit, is large enough for an employee to enter and perform assigned work, and is not designed for continuous occupancy by the employee. These spaces may include, but are not limited to, underground vaults, tanks, storage bins, pits, and diked areas, vessels, and silos.

Diversion Ditches: A ditch cut around the work site to keep water from entering the trench.

Drainage System: Pumps, pipe or channel used to drain off rain or groundwater from inside the trench.

Excavation: Any man-made cut, cavity trench or depression in an earth surface, formed by earth removal.

Fissure: A long narrow opening or crack in the rock or soil. Fissures are often a sign of trench wall failure.

Grain: Particles that once were large rocks, but have been broken down through time and the effects of weathering. The size of the grain of a soil determines the stability and cohesiveness of a soil. The larger the grain is, the more unstable the soil is.

Gravel: A loose mixture of pebbles and rock fragments, which is coarser than sand.

Hardpan: A layer of hard subsoil or clay that does not allow water in. Hardpan is classified as a Type A soil.

Heaving: The swelling of a soil.

Jacks: Jacks are braces or supports within a shoring system. They are placed against beams to resist the pressure of the earth.

Loamy Sand: Soil composed of a mixture of sand, clay and silt, with more sand grains than clay or silt. It is classified as a Type C soil.

Manufacturer's Tabulated Data: Tables and charts approved by a registered professional engineer and used to design and construct a protective system.

Permit Required Confined Space: Meets the definition of a confined space and has one or more of these characteristics: (1) contains or has potential to contain a hazardous atmosphere, (2) contains a material that has the potential for engulfing an entrant, (3) has an internal configuration that might cause an entrant to be trapped or asphyxiated by inwardly converging walls or by a floor that slopes downward and tapers to a smaller cross section, and/or (4) contains any other recognized serious safety or health hazards.

Personal Protective Equipment: Safety goggles and glasses, reflective clothing, work gloves, hard hat, safety shoes, rubber boots, earplugs or protectors, face shield and face mask or respirator.

Registered Professional Engineer: A person who is registered as a professional engineer in the state where the work is to be performed.

Sand: A type C soil with small, loose grains of disintegrated rock.

Sandy Loam: Granular soil with enough silt and clay to make it slightly cohesive

Saturation: The process of a soil being filled to capacity with moisture.

Shear: A phenomenon which happens when a trench wall is subjected to stress. Fissured cracks widen until a portion of the trench wall breaks off and slides into the trench.

Sheeting: Durable sheets of metal or wood, which are held firmly against a trench wall to prevent it from caving-in. Sheeting is a component of a trench shoring system.

Shielding: A device which provides adequate protection from falling or collapsing earth loads. The trench box is a common form of shielding.

Shoring: Main method of stabilizing and supporting a trench wall to prevent cave-ins. It consists of uprights, stingers and braces.

Silt: A soil which contains fine particles and is very smooth.

Silty Clay: A plastic soil that will appear rough or broken when rubbed over the thumb and finger.

Sloping: The process of cutting back the sides of a trench to avoid a cave-in.

Sloughing: When loose soil begins to run in from the lower part of the wall into the excavation. It is the first step to a wall collapse.

Soil Type: A system of classifying soils and rock deposits. Soil must be classified by a qualified person as: Stable rock, Type-A, Type-B, Type-C.

Spall: When a soil begins to crack or flake due to pressure, or from moisture from within the trench.

Spoil Pile/Spoilage: Rock waste, banks and dumps from the excavation.

Supports: Part of a shoring system which helps to bear the weight of braces and other parts of the shoring system.

Trench Box: A prefabricated moveable box usually constructed of metal plates welded to a heavy steel frame. The box is moved along as work progresses. It is able to withstand the forces imposed on it by a cave-in and thereby protects trench workers.

Type-A Soil: The most stable and cohesive type of soil while working at a trench site. Examples are clay, silty clay and hardpan.

Type-B Soil: Type-B soil is next to the most stable soil. Silt, silt loam, sandy loam, medium clay and unstable rock would be good examples of Type-B soils.

Type-C Soil: The least stable type of soil. Examples of Type-C soils are gravel, loamy sand, soft clay, submerged silt and heavy unstable rock.

Unconfined Compressive Strength: Through a variety of tests, a soil's strength is found. The unconfined compressive strength is the soil's measure of bearing capacity and shearing resistance. Measured as the amount of weight per square foot needed to collapse a soil sample.

Uprights: Vertical members of a trench shoring system placed in context with the earth. These members usually are not placed in direct contact with one another.

Vibration: When a soil or excavation site trembles and shakes rapidly due to forces such as loud noises or heavy equipment or traffic.

Voids: Voids are empty spaces between particles of rocks.

Wales: Wales are parts of a shoring system. They are positioned horizontally and help to brace vertical beams and supports. Wales can be fastened to studs with nails, clips or brackets.

Wall Stability: The relative strength and capacity of walls of a trench.

SUBPART P – EXCAVATION RULE

Notes

Sec. 107, Contract Worker Hours and Safety Standards Act (Construction Safety Act) (40 U.S.C. 333); secs. 4, 6, 8, Occupational Safety and Health Act of 1970 (29 U.S.C. 653, 655, 657); Secretary of Labor's Order No. 12-71 (36 FR 8754), 8-76 (41 FR 25059), or 9-83 (48 FR 35736), as applicable, and 29 CFR part 1911.

§ 1926.650 Scope, application, and definitions applicable to this subpart.

(a) Scope and application. This subpart applies to all open excavations made in the earth's surface. Excavations are defined to include trenches.

(b) Definitions applicable to this subpart.

Accepted engineering practices means those requirements which are compatible with standards of practice required by a registered professional engineer.

Aluminum Hydraulic Shoring means a pre-engineered shoring system comprised of aluminum hydraulic cylinders (crossbraces) used in conjunction with vertical rails (uprights) or horizontal rails (walers). Such system is designed, specifically to support the sidewalls of an excavation and prevent cave-ins.

Bell-bottom pier hole means a type of shaft or footing excavation, the bottom of which is made larger than the cross section above to form a belled shape.

Benching (Benching system) means a method of protecting employees 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.

Cave-in means the separation of a mass of soil or rock material from the side of an excavation, or the loss of soil from under a trench shield or support system, and its sudden movement into the excavation, either by falling or sliding, in sufficient quantity so that it could entrap, bury, or otherwise injure and immobilize a person.

Competent person 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.

Cross braces mean the horizontal members of a shoring system installed perpendicular to the sides of the excavation, the ends of which bear against either uprights or wales.

Excavation means any man-made cut, cavity, trench, or depression in an earth surface, formed by earth removal.

Faces or sides means the vertical or inclined earth surfaces formed as a result of excavation work.

Failure means the breakage, displacement, or permanent deformation of a structural member or connection so as to reduce its structural integrity and its supportive capabilities.

Hazardous atmosphere means an atmosphere which by reason of being explosive, flammable, poisonous, corrosive, oxidizing, irritating, oxygen deficient, toxic, or otherwise harmful, may cause death, illness, or injury.

Kickout means the accidental release or failure of a cross brace.

Protective system means 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, shield systems, and other systems that provide the necessary protection.

Ramp means an inclined walking or working surface that is used to gain access to one point from another, and is constructed from earth or from structural materials such as steel or wood.

Registered Professional Engineer means a person who is registered as a professional engineer in the state where the work is to be performed. However, a professional engineer, registered in any state is deemed to be a "registered professional engineer" within the meaning of this standard when approving designs for "manufactured protective systems" or "tabulated data" to be used in interstate commerce.

Sheeting means the members of a shoring system that retain the earth in position and in turn are supported by other members of the shoring system.

Shield (Shield system) means a structure that is able to withstand the forces imposed on it by a cave-in and thereby protect employees within the structure. Shields can be permanent structures or can be designed to be portable and moved along as work progresses. Additionally, shields can be either premanufactured or job-built in accordance with § 1926.652 (c)(3) or (c)(4). Shields used in trenches are usually referred to as "trench boxes" or "trench shields."

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

Sides. See "Faces."

Sloping (Sloping system) means a method of protecting employees from cave-ins by excavating to form sides of an excavation that are inclined away from the excavation so as to prevent cave-ins. The angle of incline required to prevent a cave-in varies with differences in such factors as the soil type, environmental conditions of exposure, and application of surcharge loads.

Stable rock means natural solid mineral material that can be excavated with vertical sides and will remain intact while exposed. Unstable rock is considered to be stable when the rock material on the side or sides of the excavation is secured against caving-in or movement by rock bolts or by another protective system that has been designed by a registered professional engineer.

Structural ramp means a ramp built of steel or wood, usually used for vehicle access. Ramps made of soil or rock are not considered structural ramps.
Support system means a structure such as underpinning, bracing, or shoring, which provides support to an adjacent structure, underground installation, or the sides of an excavation.

Tabulated data means tables and charts approved by a registered professional engineer and used to design and construct a protective system.

Trench (Trench excavation) means a narrow excavation (in relation to its length) made below the surface of the ground. In general, the depth is greater than the width, but the width of a trench (measured at the bottom) is not greater than 15 feet (4.6 m). If forms or other structures are installed or constructed in an excavation so as to reduce the dimension measured from the forms or structure to the side of the

excavation to 15 feet (4.6 m) or less (measured at the bottom of the excavation), the excavation is also considered to be a trench.

Trench box. See "Shield."

Trench shield. See "Shield."

Uprights means the vertical members of a trench shoring system placed in contact with the earth and usually positioned so that individual members do not contact each other. Uprights placed so that individual members are closely spaced, in contact with or interconnected to each other, are often called "sheeting."

Wales means horizontal members of a shoring system placed parallel to the excavation face whose sides bear against the vertical members of the shoring system or earth.

§ 1926.651 Specific excavation requirements.

(a) Surface encumbrances. All surface encumbrances that are located so as to create a hazard to employees shall be removed or supported, as necessary, to safeguard employees.
(b) Underground installations. (1) The estimated location of utility installations, such as sewer, telephone, fuel, electric, water lines, or any other underground installations that reasonably may be expected to be encountered during excavation work, shall be determined prior to opening an excavation.
(2) Utility companies or owners shall be contacted within established or customary local response times, advised of the proposed work, and asked to establish the location of the utility underground installations prior to the start of actual excavation. When utility companies or owners cannot respond to a request to locate underground utility installations within 24 hours (unless a longer period is required by state or local law), or cannot establish the exact location of these installations, the employer may proceed, provided the employer does so with caution, and provided detection equipment or other acceptable means to locate utility installations are used.
(3) When excavation operations approach the estimated location of underground installations, the exact location of the installations shall be determined by safe and acceptable means.
(4) While the excavation is open, underground installations shall be protected, supported or removed as necessary to safeguard employees.
(c) Access and egress -- (1) Structural ramps. (i) Structural ramps that are used solely by employees as a means of access or egress from excavations shall be designed by a competent person. Structural ramps used for access or egress of equipment shall be designed by a competent person qualified in structural design, and shall be constructed in accordance with the design.
(ii) Ramps and runways constructed of two or more structural members shall have the structural members connected together to prevent displacement.
(iii) Structural members used for ramps and runways shall be of uniform thickness.
(iv) Cleats or other appropriate means used to connect runway structural members shall be attached to the bottom of the runway or shall be attached in a manner to prevent tripping.
(v) Structural ramps used in lieu of steps shall be provided with cleats or other surface treatments on the top surface to prevent slipping.
(2) Means of egress from trench excavations. A stairway, ladder, ramp or other safe means of egress shall be located in trench excavations that are 4 feet (1.22 m) or more in depth so as to require no more than 25 feet (7.62 m) of lateral travel for employees.
(d) Exposure to vehicular traffic. Employees exposed to public vehicular traffic shall be provided with, and shall wear, warning vests or other suitable garments marked with or made of reflectorized or high-visibility material.
(e) Exposure to falling loads. No employee shall be permitted underneath loads handled by lifting or digging equipment. Employees shall be required to stand away from any vehicle being loaded or unloaded to avoid being struck by any spillage or falling materials. Operators may remain in the cabs of vehicles being loaded or unloaded when the vehicles are equipped, in accordance with § 1926.601(b)(6), to provide adequate protection for the operator during loading and unloading operations.
(f) Warning system for mobile equipment. When mobile equipment is operated adjacent to an excavation, or when such equipment is required to approach the edge of an excavation, and the operator does not

have a clear and direct view of the edge of the excavation, a warning system shall be utilized such as barricades, hand or mechanical signals, or stop logs. If possible, the grade should be away from the excavation.
(g) Hazardous atmospheres -- (1) Testing and controls. In addition to the requirements set forth in subparts D and E of this part (29 CFR 1926.50-1926.107) to prevent exposure to harmful levels of atmospheric contaminants and to assure acceptable atmospheric conditions, the following requirements shall apply:
(i) Where oxygen deficiency (atmospheres containing less than 19.5 percent oxygen) or a hazardous atmosphere exists or could reasonably be expected to exist, such as in excavations in landfill areas or excavations in areas where hazardous substances are stored nearby, the atmospheres in the excavation shall be tested before employees enter excavations greater than 4 feet (1.22 m) in depth.
(ii) Adequate precautions shall be taken to prevent employee exposure to atmospheres containing less than 19.5 percent oxygen and other hazardous atmospheres. These precautions include providing proper respiratory protection or ventilation in accordance with subparts D and E of this part respectively.
(iii) Adequate precaution shall be taken such as providing ventilation, to prevent employee exposure to an atmosphere containing a concentration of a flammable gas in excess of 20 percent of the lower flammable limit of the gas.
(iv) When controls are used that are intended to reduce the level of atmospheric contaminants to acceptable levels, testing shall be conducted as often as necessary to ensure that the atmosphere remains safe.
(2) Emergency rescue equipment. (i) Emergency rescue equipment, such as breathing apparatus, a safety harness and line, or a basket stretcher, shall be readily available where hazardous atmospheric conditions exist or may reasonably be expected to develop during work in an excavation. This equipment shall be attended when in use.
(ii) Employees entering bell-bottom pier holes, or other similar deep and confined footing excavations, shall wear a harness with a life-line securely attached to it. The lifeline shall be separate from any line used to handle materials, and shall be individually attended at all times while the employee wearing the lifeline is in the excavation.
(h) Protection from hazards associated with water accumulation. (1) Employees shall not work in excavations in which there is accumulated water, or in excavations in which water is accumulating, unless adequate precautions have been taken to protect employees against the hazards posed by water accumulation. The precautions necessary to protect employees adequately vary with each situation, but could include special support or shield systems to protect from cave-ins, water removal to control the level of accumulating water, or use of a safety harness and lifeline.
(2) If water is controlled or prevented from accumulating by the use of water removal equipment, the water removal equipment and operations shall be monitored by a competent person to ensure proper operation.
(3) If excavation work interrupts the natural drainage of surface water (such as streams), diversion ditches, dikes, or other suitable means shall be used to prevent surface water from entering the excavation and to provide adequate drainage of the area adjacent to the excavation. Excavations subject to runoff from heavy rains will require an inspection by a competent person and compliance with paragraphs (h)(1) and (h)(2) of this section.
(i) Stability of adjacent structures. (1) Where the stability of adjoining buildings, walls, or other structures is endangered by excavation operations, support systems such as shoring, bracing, or underpinning shall be provided to ensure the stability of such structures for the protection of employees.
(2) Excavation below the level of the base or footing of any foundation or retaining wall that could be reasonably expected to pose a hazard to employees shall not be permitted except when:
(i) A support system, such as underpinning, is provided to ensure the safety of employees and the stability of the structure; or
(ii) The excavation is in stable rock; or
(iii) A registered professional engineer has approved the determination that the structure is sufficiently removed from the excavation so as to be unaffected by the excavation activity; or
(iv) A registered professional engineer has approved the determination that such excavation work will not pose a hazard to employees.
(3) Sidewalks, pavements, and appurtenant structure shall not be undermined unless a support system or another method of protection is provided to protect employees from the possible collapse of such structures.

(j) Protection of employees from loose rock or soil. (1) Adequate protection shall be provided to protect employees from loose rock or soil that could pose a hazard by falling or rolling from an excavation face. Such protection shall consist of scaling to remove loose material; installation of protective barricades at intervals as necessary on the face to stop and contain falling material; or other means that provide equivalent protection.
(2) Employees shall be protected from excavated or other materials or equipment that could pose a hazard by falling or rolling into excavations. Protection shall be provided by placing and keeping such materials or equipment at least 2 feet (.61 m) from the edge of excavations, or by the use of retaining devices that are sufficient to prevent materials or equipment from falling or rolling into excavations, or by a combination of both if necessary.
(k) Inspections. (1) Daily inspections of excavations, the adjacent areas, and protective systems shall be made by a competent person for evidence of a situation that could result in possible cave-ins, indications of failure of protective systems, hazardous atmospheres, or other hazardous conditions. An inspection shall be conducted by the competent person prior to the start of work and as needed throughout the shift. Inspections shall also be made after every rainstorm or other hazard increasing occurrence. These inspections are only required when employee exposure can be reasonably anticipated.
(2) Where the competent person finds evidence of a situation that could result in a possible cave-in, indications of failure of protective systems, hazardous atmospheres, or other hazardous conditions, exposed employees shall be removed from the hazardous area until the necessary precautions have been taken to ensure their safety.
(l) Walkways shall be provided where employees or equipment are required or permitted to cross over excavations. Guardrails which comply with § 1926.502(b) shall be provided where walkways are 6 feet (1.8 m) or more above lower levels.

§ 1926.652 Requirements for protective systems.

(a) Protection of employees in excavations. (1) Each employee in an excavation shall be protected from cave-ins by an adequate protective system designed in accordance with paragraph (b) or (c) of this section except when:
(i) Excavations are made entirely in stable rock; or
(ii) Excavations are less than 5 feet (1.52m) in depth and examination of the ground by a competent person provides no indication of a potential cave-in.
(2) Protective systems shall have the capacity to resist without failure all loads that are intended or could reasonably be expected to be applied or transmitted to the system.
(b) Design of sloping and benching systems. The slopes and configurations of sloping and benching systems shall be selected and constructed by the employer or his designee and shall be in accordance with the requirements of paragraph (b)(1); or, in the alternative, paragraph (b)(2); or, in the alternative, paragraph (b)(3), or, in the alternative, paragraph (b)(4), as follows:
(1) Option (1)--Allowable configurations and slopes. (i) Excavations shall be sloped at an angle not steeper than one and one-half horizontal to one vertical (34 degrees measured from the horizontal), unless the employer uses one of the other options listed below.
(ii) Slopes specified in paragraph (b)(1)(i) of this section, shall be excavated to form configurations that are in accordance with the slopes shown for Type C soil in Appendix B to this subpart.
(2) Option (2)--Determination of slopes and configurations using Appendices A and B. Maximum allowable slopes, and allowable configurations for sloping and benching systems, shall be determined in accordance with the conditions and requirements set forth in appendices A and B to this subpart.
(3) Option (3)--Designs using other tabulated data. (i) Designs of sloping or benching systems shall be selected from and be in accordance with tabulated data, such as tables and charts.
(ii) The tabulated data shall be in written form and shall include all of the following:
(A) Identification of the parameters that affect the selection of a sloping or benching system drawn from such data;
(B) Identification of the limits of use of the data, to include the magnitude and configuration of slopes determined to be safe;
(C) Explanatory information as may be necessary to aid the user in making a correct selection of a protective system from the data.

(iii) At least one copy of the tabulated data which identifies the registered professional engineer who approved the data, shall be maintained at the jobsite during construction of the protective system. After that time the data may be stored off the jobsite, but a copy of the data shall be made available to the Secretary upon request.
(4) Option (4)--Design by a registered professional engineer. (i) Sloping and benching systems not utilizing Option (1) or Option (2) or Option (3) under paragraph (b) of this section shall be approved by a registered professional engineer.
(ii) Designs shall be in written form and shall include at least the following:
(A) The magnitude of the slopes that were determined to be safe for the particular project;
(B) The configurations that were determined to be safe for the particular project; and
(C) The identity of the registered professional engineer approving the design.
(iii) At least one copy of the design shall be maintained at the jobsite while the slope is being constructed. After that time the design need not be at the jobsite, but a copy shall be made available to the Secretary upon request.
(c) Design of support systems, shield systems, and other protective systems. Designs of support systems shield systems, and other protective systems shall be selected and constructed by the employer or his designee and shall be in accordance with the requirements of paragraph (c)(1); or, in the alternative, paragraph (c)(2); or, in the alternative, paragraph (c)(3); or, in the alternative, paragraph (c)(4) as follows:
(1) Option (1)--Designs using appendices A, C and D. Designs for timber shoring in trenches shall be determined in accordance with the conditions and requirements set forth in appendices A and C to this subpart. Designs for aluminum hydraulic shoring shall be in accordance with paragraph (c)(2) of this section, but if manufacturer's tabulated data cannot be utilized, designs shall be in accordance with appendix D.
(2) Option (2)--Designs Using Manufacturer's Tabulated Data. (i) Design of support systems, shield systems, or other protective systems that are drawn from manufacturer's tabulated data shall be in accordance with all specifications, recommendations, and limitations issued or made by the manufacturer.
(ii) Deviation from the specifications, recommendations, and limitations issued or made by the manufacturer shall only be allowed after the manufacturer issues specific written approval.
(iii) Manufacturer's specifications, recommendations, and limitations, and manufacturer's approval to deviate from the specifications, recommendations, and limitations shall be in written form at the jobsite during construction of the protective system. After that time this data may be stored off the jobsite, but a copy shall be made available to the Secretary upon request.
(3) Option (3)--Designs using other tabulated data. (i) Designs of support systems, shield systems, or other protective systems shall be selected from and be in accordance with tabulated data, such as tables and charts.
(ii) The tabulated data shall be in written form and include all of the following:
(A) Identification of the parameters that affect the selection of a protective system drawn from such data;
(B) Identification of the limits of use of the data;
(C) Explanatory information as may be necessary to aid the user in making a correct selection of a protective system from the data.
(iii) At least one copy of the tabulated data, which identifies the registered professional engineer who approved the data, shall be maintained at the jobsite during construction of the protective system. After that time the data may be stored off the jobsite, but a copy of the data shall be made available to the Secretary upon request.
(4) Option (4)--Design by a registered professional engineer. (i) Support systems, shield systems, and other protective systems not utilizing Option 1, Option 2 or Option 3, above, shall be approved by a registered professional engineer.
(ii) Designs shall be in written form and shall include the following:
(A) A plan indicating the sizes, types, and configurations of the materials to be used in the protective system; and
(B) The identity of the registered professional engineer approving the design.
(iii) At least one copy of the design shall be maintained at the jobsite during construction of the protective system. After that time, the design may be stored off the jobsite, but a copy of the design shall be made available to the Secretary upon request.
(d) Materials and equipment. (1) Materials and equipment used for protective systems shall be free from damage or defects that might impair their proper function.

(2) Manufactured materials and equipment used for protective systems shall be used and maintained in a manner that is consistent with the recommendations of the manufacturer, and in a manner that will prevent employee exposure to hazards.
(3) When material or equipment that is used for protective systems is damaged, a competent person shall examine the material or equipment and evaluate its suitability for continued use. If the competent person cannot assure the material or equipment is able to support the intended loads or is otherwise suitable for safe use, then such material or equipment shall be removed from service, and shall be evaluated and approved by a registered professional engineer before being returned to service.
(e) Installation and removal of support--(1) General. (i) Members of support systems shall be securely connected together to prevent sliding, falling, kickouts, or other predictable failure.
(ii) Support systems shall be installed and removed in a manner that protects employees from cave-ins, structural collapses, or from being struck by members of the support system.
(iii) Individual members of support systems shall not be subjected to loads exceeding those which those members were designed to withstand.
(iv) Before temporary removal of individual members begins, additional precautions shall be taken to ensure the safety of employees, such as installing other structural members to carry the loads imposed on the support system.
(v) Removal shall begin at, and progress from, the bottom of the excavation. Members shall be released slowly so as to note any indication of possible failure of the remaining members of the structure or possible cave-in of the sides of the excavation.
(vi) Backfilling shall progress together with the removal of support systems from excavations.
(2) Additional requirements for support systems for trench excavations. (i) Excavation of material to a level no greater than 2 feet (.61 m) below the bottom of the members of a support system shall be permitted, but only if the system is designed to resist the forces calculated for the full depth of the trench, and there are no indications while the trench is open of a possible loss of soil from behind or below the bottom of the support system.
(ii) Installation of a support system shall be closely coordinated with the excavation of trenches.
(f) Sloping and benching systems. Employees shall not be permitted to work on the faces of sloped or benched excavations at levels above other employees except when employees at the lower levels are adequately protected from the hazard of falling, rolling, or sliding material or equipment.
(g) Shield systems--(1) General. (i) Shield systems shall not be subjected to loads exceeding those which the system was designed to withstand.
(ii) Shields shall be installed in a manner to restrict lateral or other hazardous movement of the shield in the event of the application of sudden lateral loads.
(iii) Employees shall be protected from the hazard of cave-ins when entering or exiting the areas protected by shields.
(iv) Employees shall not be allowed in shields when shields are being installed, removed, or moved vertically.
(2) Additional requirement for shield systems used in trench excavations. Excavations of earth material to a level not greater than 2 feet (.61 m) below the bottom of a shield shall be permitted, but only if the shield is designed to resist the forces calculated for the full depth of the trench, and there are no indications while the trench is open of a possible loss of soil from behind or below the bottom of the shield.

APPENDIX A -- SOIL CLASSIFICATION

(ii) Dry strength. If the soil is dry and crumbles on its own or with moderate pressure into individual grains or fine powder, it is granular (any combination of gravel, sand, or silt). If the soil is dry and falls into clumps which break up into smaller clumps, but the smaller clumps can only be broken up with difficulty, it may be clay in any combination with gravel, sand or silt. If the dry soil breaks into clumps which do not break up into small clumps and which can only be broken with difficulty, and there is no visual indication the soil is fissured, the soil may be considered unfissured.

(iii) Thumb penetration. The thumb penetration test can be used to estimate the unconfined compressive strength of cohesive soils. (This test is based on the thumb penetration test described in American Society for Testing and Materials (ASTM) Standard designation D2488 -- "Standard Recommended Practice for Description of Soils (Visual -- Manual Procedure).") Type A soils with an unconfined compressive strength of 1.5 tsf can be readily indented by the thumb; however, they can be penetrated by the thumb only with very great effort. Type C soils with an unconfined compressive strength of 0.5 tsf can be easily penetrated several inches by the thumb, and can be molded by light finger pressure. This test should be conducted on an undisturbed soil sample, such as a large clump of spoil, as soon as practicable after excavation to keep to a minimum the effects of exposure to drying influences. If the excavation is later exposed to wetting influences (rain, flooding), the classification of the soil must be changed accordingly.

(iv) Other strength tests. Estimates of unconfined compressive strength of soils can also be obtained by use of a pocket penetrometer or by using a hand-operated Shearvane.

(v) Drying test. The basic purpose of the drying test is to differentiate between cohesive material with fissures, unfissured cohesive material, and granular material. The procedure for the drying test involves drying a sample of soil that is approximately one inch thick (2.54 cm) and six inches (15.24 cm) in diameter until it is thoroughly dry:

(A) If the sample develops cracks as it dries, significant fissures are indicated.

(B) Samples that dry without cracking are to be broken by hand. If considerable force is necessary to break a sample, the soil has significant cohesive material content. The soil can be classified as a unfissured cohesive material and the unconfined compressive strength should be determined.

(C) If a sample breaks easily by hand, it is either a fissured cohesive material or a granular material. To distinguish between the two, pulverize the dried clumps of the sample by hand or by stepping on them. If the clumps do not pulverize easily, the material is cohesive with fissures. If they pulverize easily into very small fragments, the material is granular.

APPENDIX B -- SLOPING AND BENCHING

(a) Scope and application. This appendix contains specifications for sloping and benching when used as methods of protecting employees working in excavations from cave-ins. The requirements of this appendix apply when the design of sloping and benching protective systems is to be performed in accordance with the requirements set forth in § 1926.652(b)(2).

(b) Definitions.

Actual slope means the slope to which an excavation face is excavated.

Distress means that the soil is in a condition where a cave-in is imminent or is likely to occur. Distress is evidenced by such phenomena as the development of fissures in the face of or adjacent to an open excavation; the subsidence of the edge of an excavation; the slumping of material from the face or the bulging or heaving of material from the bottom of an excavation; the spalling of material from the face of an excavation; and raveling, i.e., small amounts of material such as pebbles or little clumps of material suddenly separating from the face of an excavation and trickling or rolling down into the excavation.

Maximum allowable slope means the steepest incline of an excavation face that is acceptable for the most favorable site conditions as protection against cave-ins, and is expressed as the ratio of horizontal distance to vertical rise (H:V).

Short term exposure means a period of time less than or equal to 24 hours that an excavation is open.

(c) Requirements -- (1) Soil classification. Soil and rock deposits shall be classified in accordance with appendix A to subpart P of part 1926.

(2) Maximum allowable slope. The maximum allowable slope for a soil or rock deposit shall be determined from Table B-1 of this appendix.

(3) Actual slope. (i) The actual slope shall not be steeper than the maximum allowable slope.

(ii) The actual slope shall be less steep than the maximum allowable slope, when there are signs of distress. If that situation occurs, the slope shall be cut back to an actual slope which is at least 1/2 horizontal to one vertical (1/2 H:1V) less steep than the maximum allowable slope.
(iii) When surcharge loads from stored material or equipment, operating equipment, or traffic are present, a competent person shall determine the degree to which the actual slope must be reduced below the maximum allowable slope, and shall assure that such reduction is achieved. Surcharge loads from adjacent structures shall be evaluated in accordance with § 1926.651(i).
(4) Configurations. Configurations of sloping and benching systems shall be in accordance with Figure B-1.

APPENDIX C -- TIMBER SHORING FOR TRENCHES

(B) When vertical loads imposed on cross braces exceed a 240-pound gravity load distributed on a one-foot section of the center of the crossbrace.
(C) When surcharge loads are present from equipment weighing in excess of 20,000 pounds.
(D) When only the lower portion of a trench is shored and the remaining portion of the trench is sloped or benched unless: The sloped portion is sloped at an angle less steep than three horizontal to one vertical; or the members are selected from the tables for use at a depth which is determined from the top of the overall trench, and not from the toe of the sloped portion.
(e) Use of Tables. The members of the shoring system that are to be selected using this information are the cross braces, the uprights, and the wales, where wales are required. Minimum sizes of members are specified for use in different types of soil. There are six tables of information, two for each soil type. The soil type must first be determined in accordance with the soil classification system described in appendix A to subpart P of part 1926. Using the appropriate table, the selection of the size and spacing of the members is then made. The selection is based on the depth and width of the trench where the members are to be installed and, in most instances, the selection is also based on the horizontal spacing of the crossbraces. Instances where a choice of horizontal spacing of crossbracing is available, the horizontal spacing of the crossbraces must be chosen by the user before the size of any member can be determined. When the soil type, the width and depth of the trench, and the horizontal spacing of the crossbraces are known, the size and vertical spacing of the crossbraces, the size and vertical spacing of the wales, and the size and horizontal spacing of the uprights can be read from the appropriate table.
(f) Examples to Illustrate the Use of Tables C-1.1 through C-1.3.
(1) Example 1.
A trench dug in Type A soil is 13 feet deep and five feet wide.
From Table C-1.1, for acceptable arrangements of timber can be used.
Arrangement #1
Space 4 X 4 crossbraces at six feet horizontally and four feet vertically.
Wales are not required.
Space 38 uprights at six feet horizontally. This arrangement is commonly called "skip shoring."
Arrangement #2
Space 4 X 6 crossbraces at eight feet horizontally and four feet vertically.
Space 8 X 8 wales at four feet vertically.
Space 2 X 6 uprights at four feet horizontally.
Arrangement #3
Space 6 X 6 crossbraces at 10 feet horizontally and four feet vertically.
Space 8 X 10 wales at four feet vertically.
Space 2 X 6 uprights at five feet horizontally.
Arrangement #4
Space 6 X 6 crossbraces at 12 feet horizontally and four feet vertically.
Space 10 X 10 wales at four feet vertically.
Spaces 3 X 8 uprights at six feet horizontally.
(2) Example 2.
A trench dug in Type B soil in 13 feet deep and five feet wide. From Table C-1.2 three acceptable arrangements of members are listed.
Arrangement #1
Space 6 X 6 crossbraces at six feet horizontally and five feet vertically.

Space 8 X 8 wales at five feet vertically.
Space 2 X 6 uprights at two feet horizontally.
Arrangement #2
Space 6 X 8 crossbraces at eight feet horizontally and five feet vertically.
Space 1010 wales at five feet vertically.
Space 2 X 6 uprights at two feet horizontally.
Arrangement #3
Space 8 X 8 crossbraces at 10 feet horizontally and five feet vertically.
Space 10 X 12 wales at five feet vertically.
Space 2 X 6 uprights at two feet vertically.
(3) Example 3.
A trench dug in Type C soil is 13 feet deep and five feet wide.
From Table C-1.3 two acceptable arrangements of members can be used.
Arrangement #1
Space 8 X 8 crossbraces at six feet horizontally and five feet vertically.
Space 10 X 12 wales at five feet vertically.
Position 2 X 6 uprights as closely together as possible.
If water must be retained use special tongue and groove uprights to form tight sheeting.
Arrangement #2
Space 8 X 10 crossbraces at eight feet horizontally and five feet vertically.
Space 12 X 12 wales at five feet vertically.
Position 2 X 6 uprights in a close sheeting configuration unless water pressure must be resisted. Tight sheeting must be used where water must be retained.
(4) Example 4.
A trench dug in Type C soil is 20 feet deep and 11 feet wide. The size and spacing of members for the section of trench that is over 15 feet in depth is determined using Table C-1.3. Only one arrangement of members is provided.
Space 8 X 10 crossbraces at six feet horizontally and five feet vertically.
Space 12 X 12 wales at five feet vertically.
Use 3 X 6 tight sheeting.
Use of Tables C-2.1 through C-2.3 would follow the same procedures.
(g) Notes for all Tables.
1. Member sizes at spacings other than indicated are to be determined as specified in § 1926.652(c), "Design of Protective Systems."
2. When conditions are saturated or submerged use Tight Sheeting. Tight Sheeting refers to the use of specially-edged timber planks (e.g., tongue and groove) at least three inches thick, steel sheet piling, or similar construction that when driven or placed in position provide a tight wall to resist the lateral pressure of water and to prevent the loss of backfill material. Close Sheeting refers to the placement of planks side-by-side allowing as little space as possible between them.
3. All spacing indicated is measured center to center.
4. Wales to be installed with greater dimension horizontal.
5. If the vertical distance from the center of the lowest crossbrace to the bottom of the trench exceeds two and one-half feet, uprights shall be firmly embedded or a mudsill shall be used. Where uprights are embedded, the vertical distance from the center of the lowest crossbrace to the bottom of the trench shall not exceed 36 inches. When mudsills are used, the vertical distance shall not exceed 42 inches. Mudsills are wales that are installed at the toe of the trench side.
6. Trench jacks may be used in lieu of or in combination with timber crossbraces.
7. Placement cf crossbraces. When the vertical spacing of crossbraces is four feet, place the top crossbrace no more than two feet below the top of the trench. When the vertical spacing of crossbraces is five feet, place the top crossbrace no more than 2.5 feet below the top of the trench.

OVERVIEW: SOIL MECHANICS

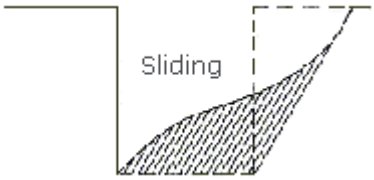
A number of stresses and deformations can occur in an open cut or trench. For example, increases or decreases in moisture content can adversely affect the stability of a trench or excavation. The following diagrams show some of the more frequently identified causes of trench failure.

TENSION CRACKS. Tension cracks usually form at a horizontal distance of 0.5 to 0.75 times the depth of the trench, measured from the top of the vertical face of the trench. See the accompanying drawing for additional details.

FIGURE 5:2-1. TENSION CRACK.

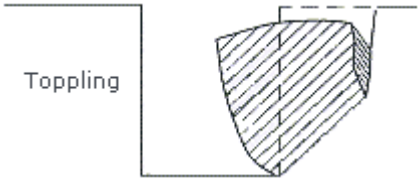
SLIDING or sluffing may occur as a result of tension cracks, as illustrated below.

FIGURE 5:2-2. SLIDING.



TOPPLING. 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.

FIGURE 5:2-3. TOPPLING.



SUBSIDENCE AND BULGING. 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 face failure and entrapment of workers in the trench.

FIGURE 5:2-4. SUBSIDENCE AND BULGING.

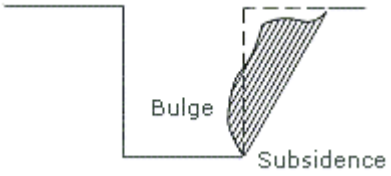


FIGURE 5:2-5. HEAVING OR SQUEEZING.

HEAVING OR SQUEEZING. Bottom heaving or squeezing is caused by the downward pressure created by the weight of adjoining soil. This pressure causes a bulge in the bottom of the cut, as illustrated in the drawing above. Heaving and squeezing can occur even when shoring or shielding has been properly installed.

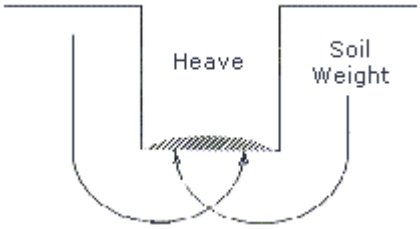
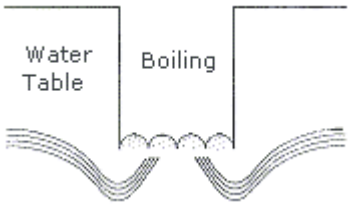


FIGURE 5:2-6. BOILING.

BOILING is evidenced by an upward water flow into the bottom of the cut. A high water table is one of the causes of boiling. Boiling produces a "quick" condition in the bottom of the cut, and can occur even when shoring or trench boxes are used.



UNIT WEIGHT OF SOILS refers to the weight of one unit of a particular soil. The weight of soil varies with type and moisture content. One cubic foot of soil can weigh from 110 pounds to 140 pounds or more, and one cubic meter (35.3 cubic feet) of soil can weigh more than 3,000 pounds.

DETERMINATION OF SOIL TYPE.

OSHA categorizes soil and rock deposits into four types, A through D, as follows:

STABLE ROCK is 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 are 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 4 horizontal to 1 vertical (4H:1V) or greater, or has seeping water.

TYPE B SOILS are 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 are 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.

TEST EQUIPMENT AND METHODS FOR EVALUATING SOIL TYPE.

Many kinds of equipment and methods are used to determine the type of soil prevailing in an area, as described below.

POCKET PENETROMETER. Penetrometers are direct-reading, spring-operated instruments used to determine the unconfined compressive strength of saturated cohesive soils. Once pushed into the soil, an indicator sleeve displays the reading. The instrument is calibrated in either tons per square foot (tsf) or kilograms per square centimeter (kPa). However, Penetrometers have error rates in the range of ± 20-40%.

Shearvane (Torvane). To determine the unconfined compressive strength of the soil with a shearvane, the blades of the vane are pressed into a level section of undisturbed soil, and the torsional knob is slowly turned until soil failure occurs. The direct instrument reading must be multiplied by 2 to provide results in tons per square foot (tsf) or kilograms per square centimeter (kPa).

Thumb Penetration Test. The thumb penetration procedure involves an attempt to press the thumb firmly into the soil in question. If the thumb makes an indentation in the soil only with great difficulty, the soil is probably Type A. If the thumb penetrates no further than the length of the thumb nail, it is probably Type B soil, and if the thumb penetrates the full length of the thumb, it is Type C soil. The thumb test is subjective and is therefore the least accurate of the three methods.

Dry Strength Test. Dry soil that crumbles freely or with moderate pressure into individual grains is granular. Dry soil that falls into clumps that subsequently break into smaller clumps (and the smaller clumps can be broken only with difficulty) is probably clay in combination with gravel, sand, or silt. If the soil breaks into clumps that do not break into smaller clumps (and the soil can be broken only with difficulty), the soil is considered unfissured unless there is visual indication of fissuring.

PLASTICITY OR WET THREAD TEST. This test is conducted by molding a moist sample of the soil into a ball and attempting to roll it into a thin thread approximately 1/8 inch (3 mm) in diameter (thick) by 2 inches (50 mm) in length. The soil sample is held by one end. If the sample does not break or tear, the soil is considered cohesive.

VISUAL TEST. A visual test is a qualitative evaluation of conditions around the site. In a visual test, the entire excavation site is observed, including the soil adjacent to the site and the soil being excavated. If the soil remains in clumps, it is cohesive; if it appears to be coarse-grained sand or gravel, it is considered granular. The evaluator also checks for any signs of vibration.

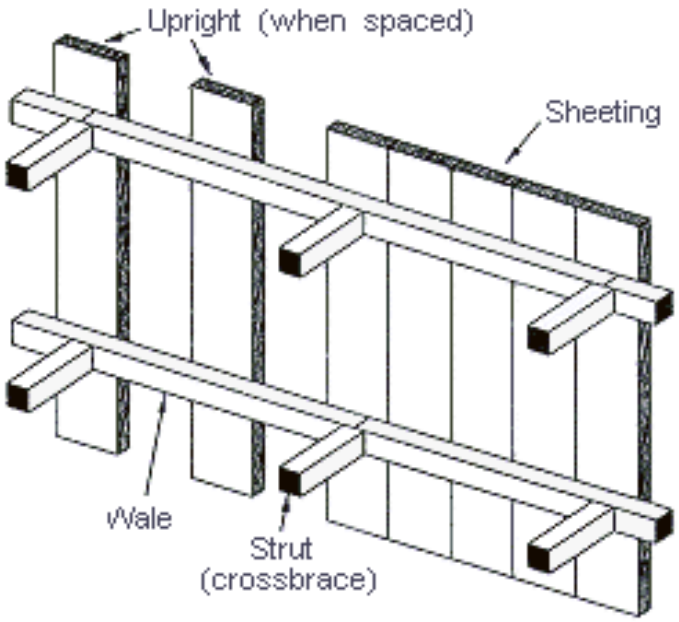
During a visual test, the evaluator should check for crack-line openings along the failure zone that would indicate tension cracks, look for existing utilities that indicate that the soil has previously been disturbed, and observe the open side of the excavation for indications of layered geologic structuring.

The evaluator should also look for signs of bulging, boiling, or sluffing, as well as for signs of surface water seeping from the sides of the excavation or from the water table. If there is standing water in the cut, the evaluator should check for "quick" conditions (see Paragraph III. F. in this chapter).

SHORING TYPES

Shoring is the provision of a support system for trench faces used to prevent movement of soil, underground utilities, roadways, and foundations. Shoring or shielding is used when the location or depth of the cut makes sloping back to the maximum allowable slope impractical. Shoring systems consist of posts, wales, struts, and sheeting. There are two basic types of shoring, timber and aluminum hydraulic.

FIGURE V:2-7. TIMBER SHORING.



HYDRAULIC SHORING. The trend today is toward the use of hydraulic shoring, a prefabricated strut and/or wale system manufactured of aluminum or steel. Hydraulic shoring provides a critical safety advantage over timber shoring because workers do not have to enter the trench to install or remove hydraulic shoring. Other advantages of most hydraulic systems are that they:

Are light enough to be installed by one worker;

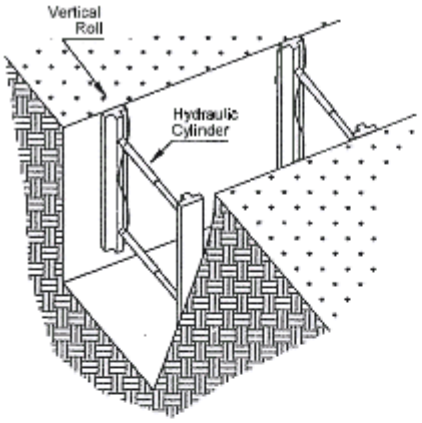
Are gauge-regulated to ensure even distribution of pressure along the trench line;

Can have their trench faces "*preloaded*" to use the soil's natural cohesion to prevent movement; and

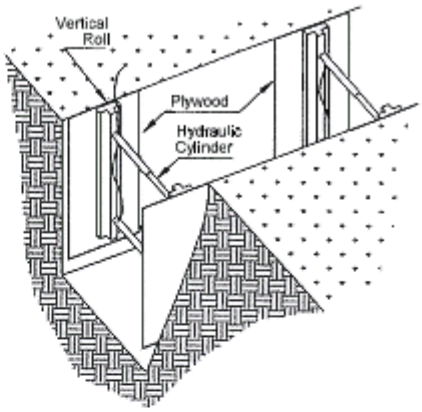
- Can be adapted easily to various trench depths and widths.
- All shoring should be installed from the top down and removed from the bottom up. Hydraulic shoring should be checked at least once per shift for leaking hoses and/or cylinders, broken connections, cracked nipples, bent bases, and any other damaged or defective parts.

SHORING VARIATIONS:

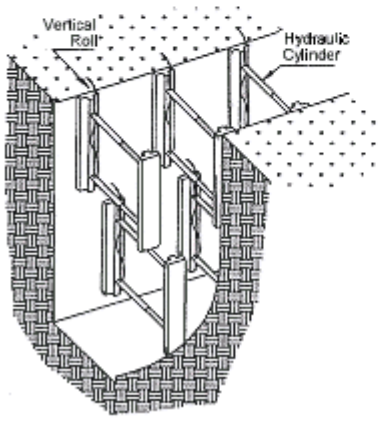
TYPICAL ALUMINUM HYDRAULIC SHORING INSTALLATIONS



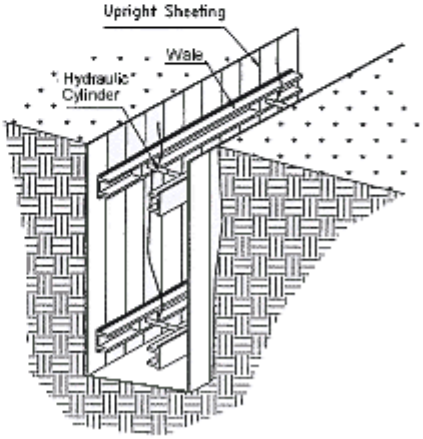
Vertical Aluminum Hydraulic Shoring
(Spot Bracing)



Vertical Aluminum Hydraulic Shoring
(With Plywood)



Vertical Aluminum Hydraulic Shoring
(Stacked)



Aluminum Hydraulic Shoring Waler System
(Typical)

PNEUMATIC SHORING works in a manner similar to hydraulic shoring. The primary difference is that pneumatic shoring uses air pressure in place of hydraulic pressure. A disadvantage to the use of pneumatic shoring is that an air compressor must be on site.

FIGURE V:2-13. SLOPE CONFIGURATIONS: EXCAVATIONS IN LAYERED SOILS.

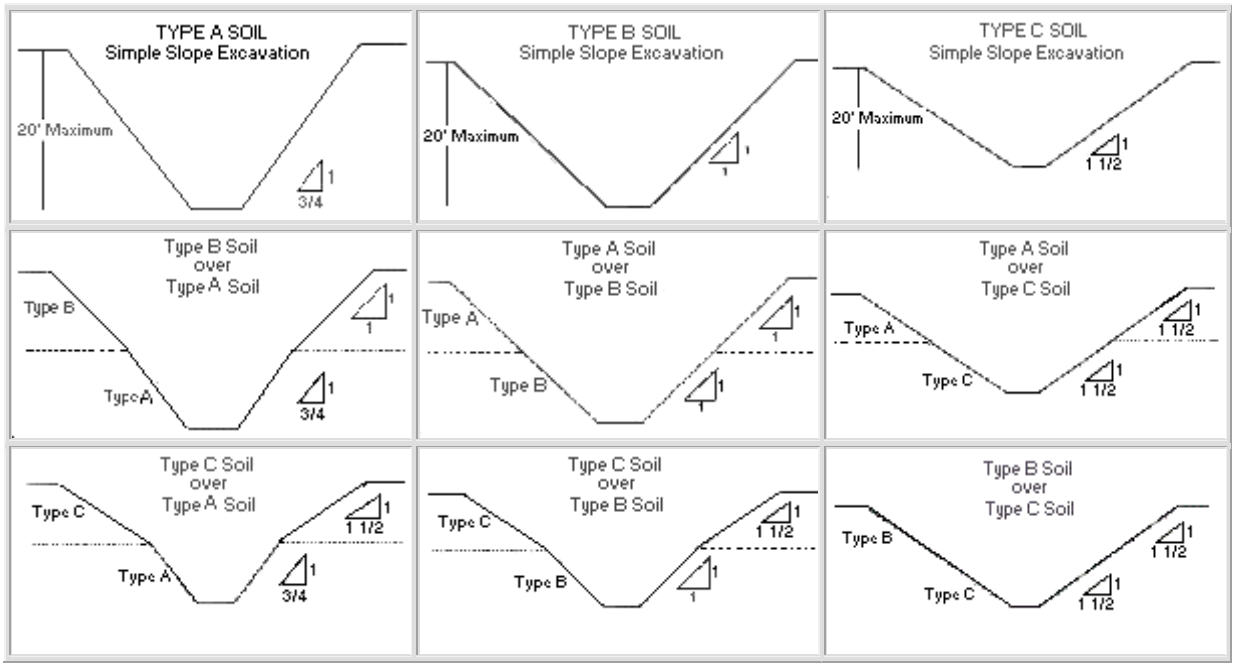
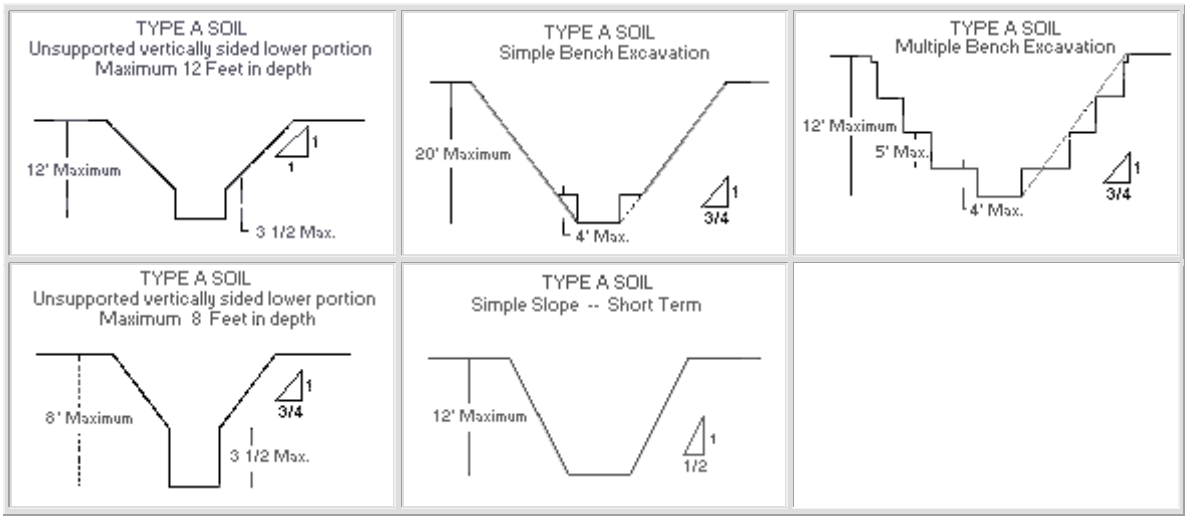


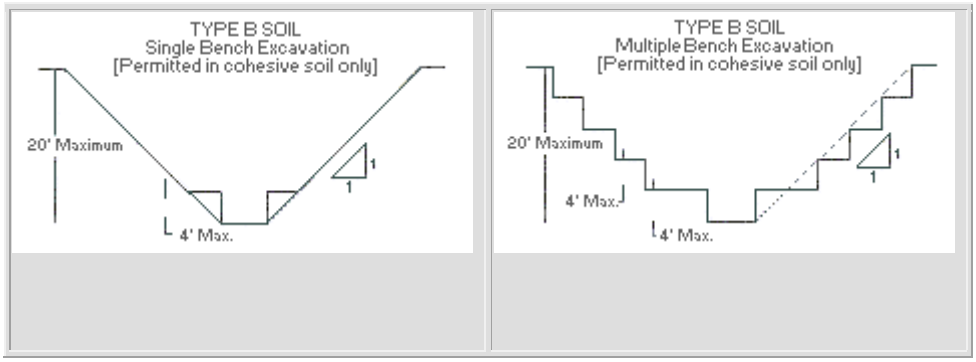
FIGURE V:2-14. EXCAVATIONS MADE IN TYPE A SOIL.



BENCHING. There are two basic types of benching, simple and multiple. The type of soil determines the horizontal to vertical ratio of the benched side.

As a general rule, the bottom vertical height of the trench must not exceed 4 ft (1.2 m) for the first bench. Subsequent benches may be up to a maximum of 5 ft (1.5 m) vertical in Type A soil and 4 ft (1.2 m) in Type B soil to a total trench depth of 20 ft (6.0 m). All subsequent benches must be below the maximum allowable slope for that soil type. For Type B soil the trench excavation is permitted in cohesive soil only.

FIGURE V:2-15. EXCAVATIONS MADE IN TYPE B SOIL.

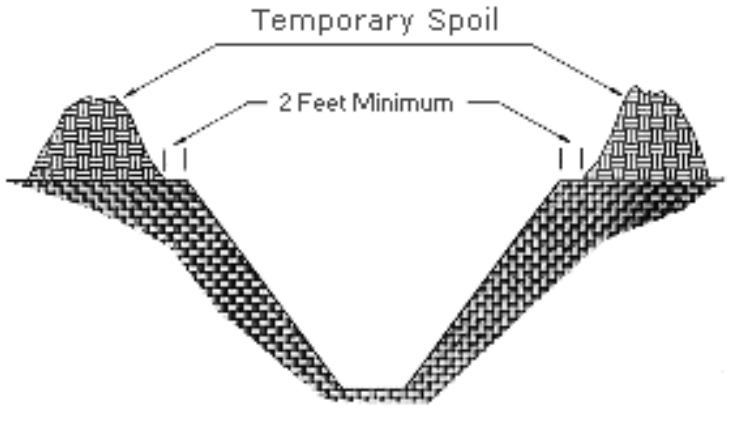


SPOIL

TEMPORARY SPOIL. Temporary spoil must be placed no closer than 2 ft (0.61 m) from the surface edge of the excavation, measured from the nearest base of the spoil to the cut. This distance should not be measured from the crown of the spoil deposit. This distance requirement ensures that loose rock or soil from the temporary spoil will not fall on employees in the trench.

Spoil should be placed so that it channels rainwater and other run-off water away from the excavation. Spoil should be placed so that it cannot accidentally run, slide, or fall back into the excavation.

FIGURE V:2-16. TEMPORARY SPOIL.



PERMANENT SPOIL. Permanent spoil should be placed at some distance from the excavation. Permanent spoil is often created where underpasses are built or utilities are buried. The improper placement of permanent spoil, i.e. insufficient distance from the working excavation, can cause an excavation to be out of compliance with the horizontal-to-vertical ratio requirement for a particular excavation. This can usually be determined through visual observation. Permanent spoil can change undisturbed soil to disturbed soil and dramatically alter slope requirements.

Excavation Chapter Post Quiz

Answers are found in the rear after the OSHA Rule Section
Internet Link to Assignment…
http://www.abctlc.com/downloads/PDF/Competant Person Assignment.pdf

1. A competent person is one who is capable of _____existing 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.

2. In order to be a "Competent Person" for the purpose of this standard, one must have specific training in and be _____about soils analysis, the use of protective systems and the requirements of 29 CFR Part 1926.650-652 Subpart P.

Competent Person Duties

3. _____daily inspections of the protective equipment, trench conditions, safety equipment and adjacent areas.

4. _____ shall be made prior to the start of work and as needed throughout the shift.

5. _____shall be made after every rainstorm or other hazard occurrence.

6. _____of emergency contact methods, telephone or radio dispatch.

7. _____ the appropriate protection system to be used.

8. _____on-site records of inspections and protective systems used.

9. _____ current First Aid and CPR certifications. Maintain current confined space certification training.

10. During excavation work, a competent person shall be on the job site at all times when personnel are working within or around the excavation. This is necessary in order to _____soil conditions, equipment and protection systems employed.

11. The estimated locations of utility installations, such as sewer, telephone, fuel, electric, water lines, or any other underground installation that reasonably may be expected to be encountered during excavation work, shall be _____ prior to opening an excavation.

12. Adequate _____shall be taken to protect employees working in excavations, against the hazards posed by water accumulation.

13. _____shall be protected from excavated or other materials, or equipment, that could pose a hazard by falling or rolling into excavations.

14. Protection shall be provided by placing and keeping such material or equipment at least two (2') feet from the edge of _____.

15. A stairway, ladder, or ramp shall be used as a means of _____in trench excavations that are four (4') feet or more in depth.

16. The ladder(s), stairway(s), or ramp shall be spaced so that no employee in the trench excavation is more than twenty (25') feet from a _____.

17. When ladder(s) are employed, the top of the ladder shall extend a minimum of three (3') feet above the ground and shall be _____.

18. When _____ are exposed to vehicular traffic, each employee shall wear a warning vest made with reflective material or high visibility material.

Excavation References

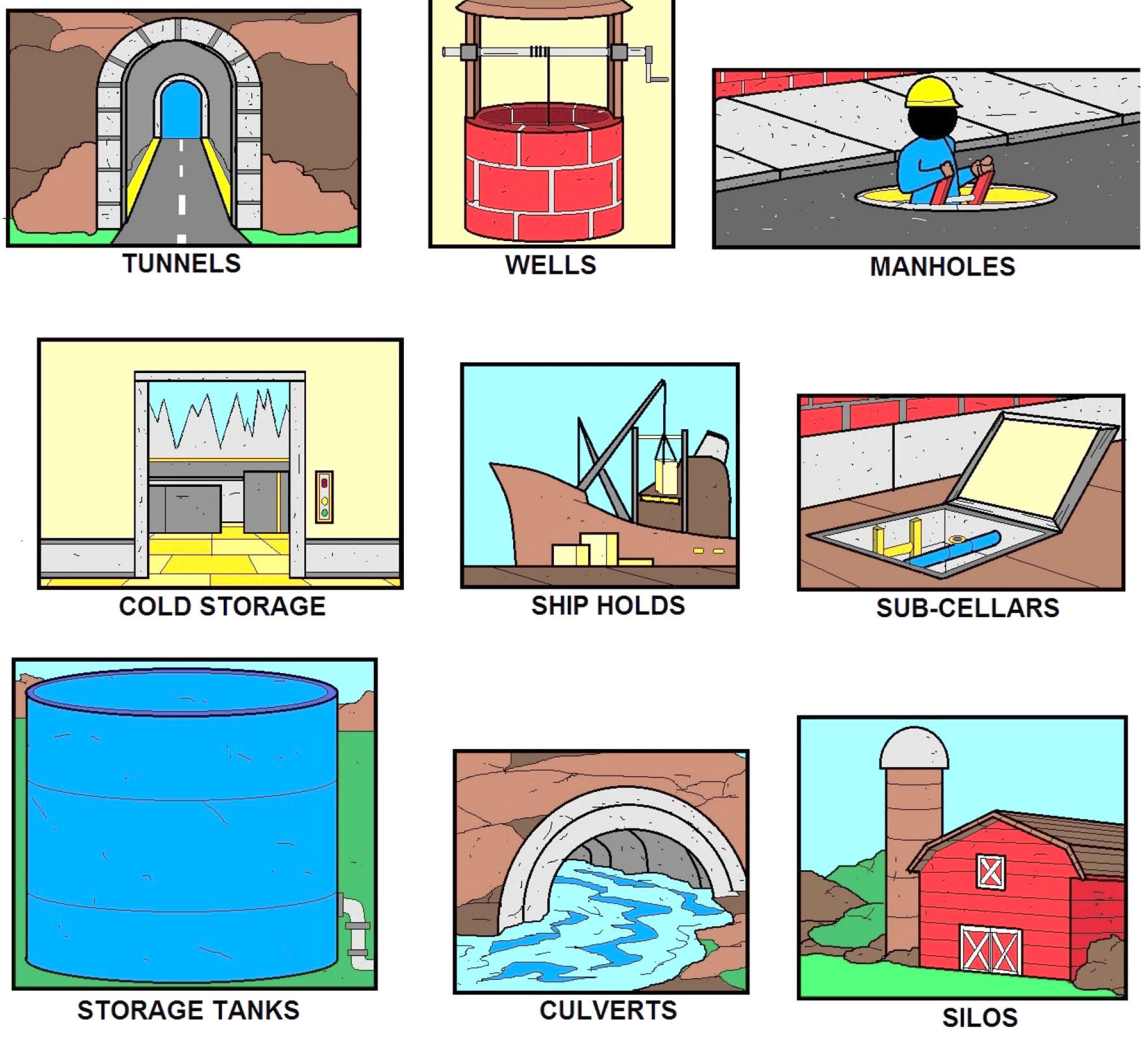
29 CFR 1926, Subpart P. *Excavations.*
Construction Safety Association of Ontario. *Trenching Safety.* 74 Victoria St., Toronto, Ontario, Canada M5C2A5.
International Labour Office (ILO). *Building Work: A Compendium of Occupational Safety and Health Practice.* International Occupational Safety and Health Information Centre (CIS): ILO, Geneva, Switzerland.
National Safety Council. *Accident Prevention Manual for Industrial Operations, Engineering and Technology,* 9th ed., Chicago, IL: National Safety Council.
National Safety Council. Protecting Worker's Lives: A Safety and Health Guide for Unions. Chicago, IL: National Safety Council.
National Safety Council. Industrial Data Sheets: I-482, *General Excavation,* and I-254, *Trench Excavation,* Chicago, IL: National Safety Council.
National Utility Contractors Association, *Competent Person Manual-1991.*
NBS/NIOSH, *Development of Draft Construction Safety Standards for Excavations.* Volume I, April 1983. NIOSH 83-103, Pub. No. 84-100-569. Volume II, April 1983. NIOSH 83-2693, Pub. No. 83-233-353.
Scardino, A.J., Jr. 1993. *Hazard Identification and Control--Trench Excavation.* Lagrange, TX: Carlton Press.

Melissa Durbin, Author and Dean of Instruction.

Confined Space Chapter

Section Focus: You will learn the basics of proper confined space entry. At the end of this section, you the student will be able to understand and describe confined space and permit required confined spaces. There is a post quiz at the end of this section to review your comprehension and a final examination in the Assignment for your contact hours.

Scope/Background: The Confined Space Entry Program is provided to protect authorized employees that will enter confined spaces and may be exposed to hazardous atmospheres, engulfment in materials, conditions which may trap or asphyxiate due to converging or sloping walls, or contains any other safety or health hazards.
Reference: OSHA-Permit-Required Confined Spaces (**29 CFR 1910.146**).



EXAMPLES OF CONFINED SPACES

Scenario. A fixed ladder drops deep inside a permit required or type II confined space. One man goes inside and passes out from hazardous fumes. A second man goes in and dies within seconds trying to help his buddy.

A third man goes in to save the others and dies on the spot. Only the first man survives, that is if you can say that being brain dead is surviving. Never try to rescue your buddies unless you are trained and have proper equipment. Never! Call 911 first. This scenario actually happened inside a sewer system. ***Don't be the next victim.***

Hazardous Incident Number 1

A man was overcome by carbon dioxide gas after entering a 4,500-liter wine vat containing crushed grape skins and seeds. He entered through a 15 inch opening at the top of the vat.

The juice from the crushed grapes had been drained off through the drainer at the bottom of the tank. The atmosphere was inert due to the presence of a large amount of carbon dioxide.

Carbon dioxide is added to the winemaking process as an antioxidant to displace oxygen during the winemaking process.

Contributing Factors

- Lack of atmospheric monitoring equipment to test the internal atmosphere in the wine vats. (Non-scientific methods such as the sniff test are not satisfactory and expose workers to harmful gases).
- The employee appeared to have a lack of appreciation of the risks associated with carbon dioxide; that is, the rapidity of symptoms, the onset of euphoria, loss of muscle control and was dead within four (4) minutes.

Confined Space Entry Permits

- ✓ Confined Space Entry Permits must be completed before any employee enters a permit-required confined space. The permit must be completed and signed by an authorized member of management before entry.
- ✓ Permits will expire before the completion of the shift or if any pre-entry conditions change.
- ✓ Permits will be maintained on file for 12 months.

Hazardous Incident Number 2 - Three Sanitation Workers and One Policeman Die in an Underground Pumping Station in Kentucky

Introduction
On July 5, 1985, a police officer and two sewer workers died in an attempt to rescue a third sewer worker, who had been overcome by sewer gas at the bottom of an underground pumping station. All four persons were pronounced dead upon removal from the station.

Synopsis of Events
On July 5, 1985, at approximately 10 a.m., two sewer workers (27 and 28 years of age) entered a 50-foot-deep underground pumping station. The station is 1 of 12 that pump sewage to the city's waste water treatment plant. The workers entered through a metal shaft (3 feet in diameter) on a fixed ladder that leads to an underground room (8 feet by 8 feet by 7 feet).

The ventilating fan was not functioning correctly. The workers were not wearing personal protective clothing or equipment.

The two workers proceeded to remove the bolts of an inspection plate from a check valve. The plate blew off, allowing raw sewage to flood the chamber, overwhelming one of the workers. The second worker exited the pumping station and radioed the police department, requesting assistance.

He again entered the station and was also overcome. Two police officers responded to the call at approximately 10:09 a.m. and one officer entered the pumping station. Later the sewage systems field manager arrived on the scene and followed the officer into the pumping station. None of the rescuers returned to the top of the ladder.

A construction worker, who was passing by the site, stopped and entered the station in a rescue attempt. After descending approximately 10 feet into the shaft, he called for help. The second police officer assisted the construction worker out of the shaft. None of the responding men wore respirators.

Fire department personnel arrived at the accident site at approximately 10:11 a.m. One fireman, wearing a self-contained breathing apparatus (**SCBA**), entered the shaft, but could not locate the four men. By this time sewage had completely flooded the underground room.

The fireman exited the pumping station. A second volunteer fireman (6'8", 240 lbs.) entered the shaft wearing a SCBA and a life line. As he began his descent he apparently slipped from the ladder and became wedged in the shaft approximately 20 feet down. (His body was folded with his head and feet facing upward.) Not being able to breathe, he removed the face mask and lost consciousness.

Rescuers at the site extricated the fireman after a 30-minute effort. No further rescue attempts were made, until professional divers were required to enter the station and removed the bodies. Autopsy results revealed a considerable amount of sewage in the lungs of the sewer workers and only a trace of sewage in the lungs of the field manager and police officer.

Recommendations/Discussion

Recommendation #1: Employers should develop proper work procedures and should adequately train employees to maintain and repair the sewage system. This training should include recognition of potential hazards associated with failures within those systems.

Discussion: The sewer workers did not have an understanding of the pumping station's design; therefore, mechanical failures and hazards associated with those failures were not adequately identified. Records were not kept of mechanical failures or repairs. The sewer workers "believed" that a malfunctioning valve had previously been repaired.

This valve permitted the pumping station to flood. The lack of training resulted in the employee not being able to properly isolate the work area from fumes and sewage seepage.

Recommendation #2: Employers should develop comprehensive policies and procedures for confined space entry.

Discussion: Prior to confined space entry, all procedures should be documented. All types of emergencies and potential hazardous conditions should be addressed.

These procedures should minimally include the following:
1. Air quality testing to assure adequate oxygen supply, adequate ventilation, and the absence of all toxic air contaminants;
2. Employee and supervisory training in the selection and usage of respiratory protection;
3. Development of site-specific working procedures and emergency access and egress plans;
4. Emergency rescue training;
5. Availability, storage, and maintenance of emergency rescue equipment.

The air quality was not determined before the sewer workers entered the confined space and the ventilation system was not functioning properly. One respirator was available for use; however, it was not appropriate for the chemical contamination (sewer gas) present. Life lines were not available.

Once confined space pre-entry procedures are developed, employees should be trained to follow them.

Recommendation #3: Fire fighters, police officers, and others responsible for emergency rescue should be trained for confined space rescue.

Discussion: A police officer died in the rescue attempt of the sewer workers. The police officer was not trained in confined space rescue techniques and did not recognize the hazards associated with the confined space.

The volunteer fireman, who attempted the rescue and wedged himself inside the shaft, should not have been allowed to enter. His size alone created a potential hazard for himself and the incident delayed possible rescue of the victims. Emergency rescue teams must be cognizant of all hazards associated with confined spaces, including rescue hindrances, and they should wear proper personal protection and devices for emergency egress.

Hazardous Incident Number 3
Unnecessary Confined Space Deaths

Two self-employed well cleaners (the victims) drowned while cleaning a residential well. Victim #1 was a 40-year-old male and victim #2 was a 43-year-old male. The well was 36 inches in diameter and 40-feet deep. Concrete casings supported the sides of the well, while the well floor was left as exposed soil to allow flow of ground water.

At the time of the incident, victim #1 was at the well bottom brushing down the concrete casings and shoveling muck from the well floor; he apparently became disoriented and was unable to exit the well. Victim #2 then entered the well in a rescue attempt. However, the two were unable to exit the well due to inadequate rescue equipment. The homeowner called 911 and emergency rescue units arrived within approximately 10 minutes. Victim #2 was removed from the well approximately 20 minutes after the first rescue unit arrived. He was transported to the local hospital and pronounced dead shortly after arrival.

Victim #1 was pulled from the well approximately 4 hours after the 911 call. He was pronounced dead at the scene. NIOSH investigators determined that, to prevent similar occurrences, employers, including the self-employed involved in well cleaning operations, should:

- Develop and implement a comprehensive confined space entry program.
- NIOSH investigators also determined, for the protection of rescue personnel, volunteer fire departments should:
- identify the types of confined spaces within their jurisdictions and develop and implement confined space entry and rescue programs
- develop and implement a respiratory protection program to protect firefighters from respiratory hazards
- Develop and implement a general safety program to help firefighters recognize, understand, and control hazards.

On May 1, 1993, two self-employed well cleaners (the victims) drowned while conducting well cleaning operations at a residential well site. On June 23, 1993, the Maryland Occupational Safety and Health Administration (**MOSH**), notified the Division of Safety Research (**DSR**) of these deaths and requested technical assistance. On July 12, 1993, an environmental health and safety specialist and an engineering intern from DSR conducted a field investigation of this incident.

Interviews were conducted with the MOSH investigator, the county confined space rescue team, the county volunteer fire department, and the son of victim #2. Photographs were obtained of the incident site. Medical examiner's reports for both victims were also obtained. No atmospheric testing was conducted as the well site had been filled in and sealed.

The investigation was complicated in part by certain factors: the time lapse between the incident and the investigation, the number of emergency responders, the particular sequence of events, and the time frames of these events, and differing perceptions of the series of events occurring in a crisis situation.

Therefore, a scenario of this incident was developed after carefully evaluating a diverse mixture of information. The victims in this incident worked part-time as self-employed well cleaners and grave diggers.

This was the only source of employment for victim #1. Victim #2 was employed full-time as a truck driver for the county in which the incident occurred. Neither victim had any safety or confined space training. However, both victims were aware that well cleaning was a dangerous job, according to the son of victim #2.

In summarizing this confined space investigation, there were three major hazards identified: (1) oxygen deficient atmosphere (NIOSH, 1979), (2) toxic (carbon monoxide) atmosphere (NIOSH, 1972), and (3) cold water exposure (Golden, 1976). The medical examiner listed the blood carboxyhemoglobin saturation levels as 37% in victim #1 and 13% in victim #2.

The bacterial action and biomass in the well could have been a source for a small percentage of the carbon monoxide. However, an external source was probably responsible for the largest percentage of carbon monoxide. Testing conducted by the volunteer fire unit indicated that the oxygen level (only gas tested) at the 20-foot level was 17% by volume. When the well was pumped to the bottom, the oxygen level would have likely decreased to 12 to 15% by volume. Under conditions of reduced ambient oxygen concentration, such as the reduced oxygen level in the well, the exposure to carbon monoxide was even more critical. The water temperature in the well was reported to be between 35 and 40 degrees F. Survival time in water at 32 degrees F is predicted to be less than 15 minutes (Golden, 1976).

Cause of Death
The medical examiner listed the cause of death for victim #1 as "drowning complicating carbon monoxide poisoning," and the cause of death for victim #2 as drowning.

Recommendation #1: Employers involved in well cleaning operations, including the self-employed, should develop and implement a comprehensive confined space entry program.

Discussion: There was no confined space entry program in effect at the residential well site at the time of the incident. The atmosphere was not tested before entry, no mechanical ventilation or respiratory protection was provided, and no rescue plans were developed.

Employers, even self-employed well cleaning operations, should develop and implement a written confined space entry program to address all provisions outlined in the following NIOSH Publications: Working in Confined Spaces: Criteria for a Recommended Standard (Pub. No. 80-106); NIOSH Alert, Request for Assistance in Preventing Occupational Fatalities in Confined Spaces (Pub. No. 86-110); A Guide to Safety in Confined Spaces (Pub. No. 87-113); and NIOSH Guide to Industrial Respiratory Protection (Pub. No. 87-116).

Most of this text is credited to OSHA.

Confined Spaces are

-large enough to allow entry of any body part, and
-limited or restricted entry or exit, and
-not designed for continuous employee occupancy

Permit Required Confined Spaces are confined spaces that have any of the following

-potential hazardous atmosphere
-material inside that may engulf or trap you
-internal design that could trap or asphyxiate you
-any other serious safety or health hazard

Entry Permits are required before you enter any "**Permit Required Confined Space**"

Hazards include

- Fire & Explosion
- Engulfment
- Asphyxiation
- Entrapment
- Slips & Falls
- Electric Shock
- Noise & Vibration
- Chemical Exposure
- Toxic Atmospheres
- Thermal / Chemical Burns

Engineering Controls

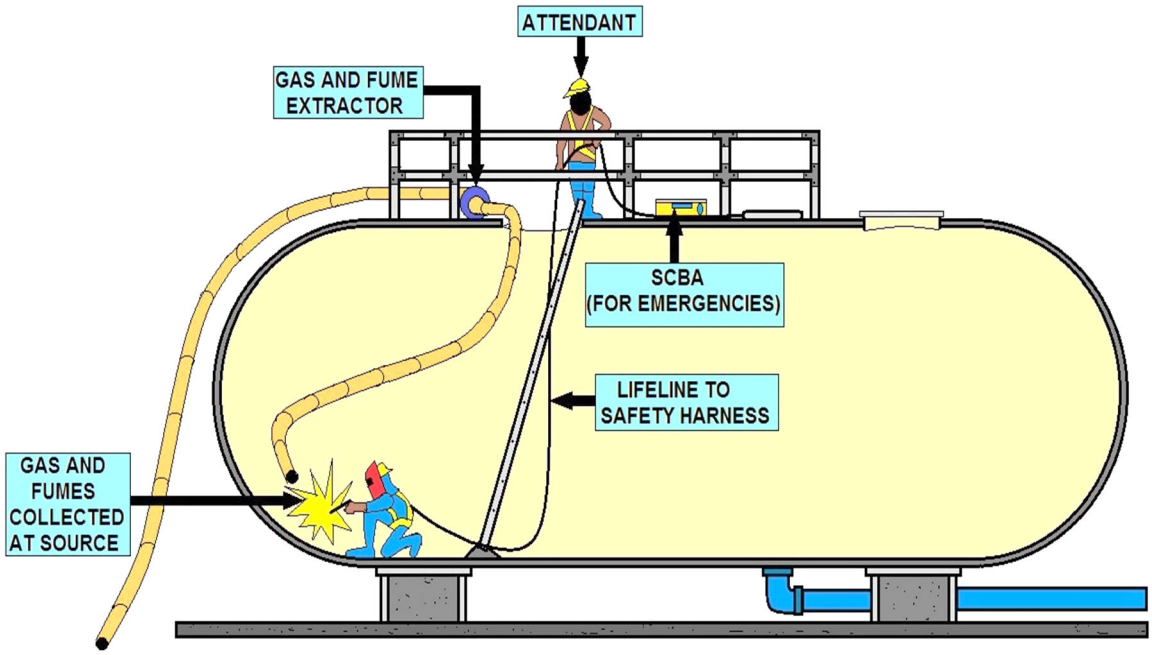
- ❑ Ventilation
- ❑ Locked Access
- ❑ Lighting

Administrative Controls

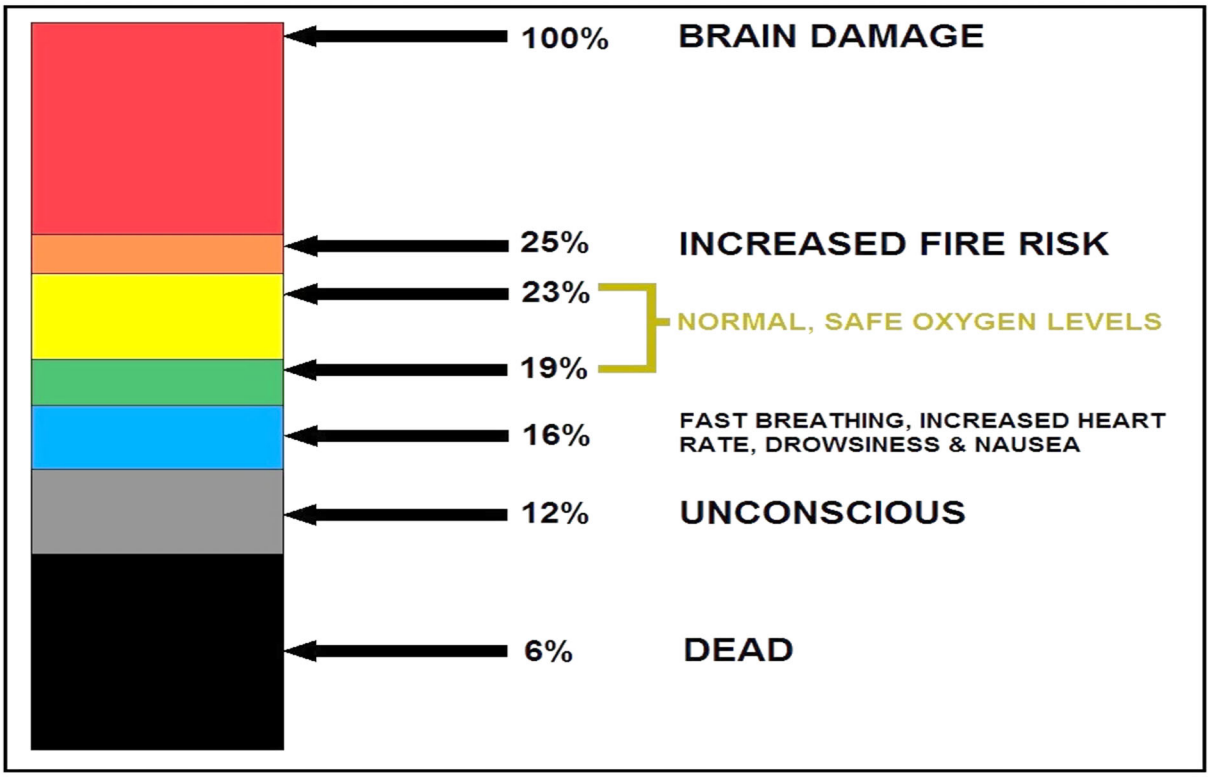
- ❑ Controlled Access
- ❑ Hazard Assessments
- ❑ Entry Permits & Procedures
- ❑ Signs & Lockout Tagout
- ❑ Training

Smart Safety Rules

Know what you are getting into.
Know how to get out in an emergency.
Know the hazards & how they are controlled.
Only authorized & trained personnel may enter a Confined Space or act as an attendant.
No smoking in Confined Space or near entrance or exit area.
Attendant must be present at all times.
Constant visual or voice communication must be maintained between the attendant and entrants.
No bottom or side entry will be made, or work conducted below the level any hanging material or material which could cause engulfment.
Air and oxygen monitoring is required before entering a Permit-Required Confined Space.
Ventilation & oxygen monitoring is required when welding is performed.



CONFINED SPACE DIAGRAM



RESULTS OF OXYGEN LEVELS IN CONFINED SPACES

Confined Space Terms

"Acceptable entry conditions" means the conditions that must exist in a permit space to allow entry and to ensure that employees involved with a permit-required confined space entry can safely enter into and work within the space.

"Attendant" means an individual stationed outside one or more permit spaces who monitors the authorized entrants and who performs all attendant's duties assigned in the employer's permit space program.

"Authorized entrant" means an employee who is authorized by the employer to enter a permit space.

"Blanking or blinding" means the absolute closure of a pipe, line, or duct by the fastening of a solid plate (such as a spectacle blind or a skillet blind) that completely covers the bore and that is capable of withstanding the maximum pressure of the pipe, line, or duct with no leakage beyond the plate.

"Confined space" means a space that:
(1) Is large enough and so configured that an employee can bodily enter and perform assigned work; and

(2) Has limited or restricted means for entry or exit (for example, tanks, vessels, silos, storage bins, hoppers, vaults, and pits are spaces that may have limited means of entry.); and

(3) Is not designed for continuous employee occupancy.

"Double block and bleed" means the closure of a line, duct, or pipe by closing and locking or tagging two in-line valves and by opening and locking or tagging a drain or vent valve in the line between the two closed valves.

"Emergency" means any occurrence (including any failure of hazard control or monitoring equipment) or event internal or external to the permit space that could endanger entrants.

"Engulfment" means the surrounding and effective capture of a person by a liquid or finely divided (flowable) solid substance that can be aspirated to cause death by filling or plugging the respiratory system or that can exert enough force on the body to cause death by strangulation, constriction, or crushing.

"Entry" means the action by which a person passes through an opening into a permit-required confined space. Entry includes ensuing work activities in that space and is considered to have occurred as soon as any part of the entrant's body breaks the plane of an opening into the space.

"Entry permit (permit)" means the written or printed document that is provided by the employer to allow and control entry into a permit space and that contains the information specified in paragraph (f) of this section.

"Entry supervisor" means the person (such as the employer, foreman, or crew chief) responsible for determining if acceptable entry conditions are present at a permit space where entry is planned, for authorizing entry and overseeing entry operations, and for terminating entry as required by this section.

NOTE: An entry supervisor also may serve as an attendant or as an authorized entrant, as long as that person is trained and equipped as required by this section for each role he or she fills. Also, the duties of entry supervisor may be passed from one individual to another during the course of an entry operation.

"Hazardous atmosphere" means an atmosphere that may expose employees to the risk of death, incapacitation, impairment of ability to self-rescue (that is, escape unaided from a permit space), injury, or acute illness from one or more of the following causes:

(1) Flammable gas, vapor, or mist in excess of 10 percent of its lower flammable limit (LFL);

(2) Airborne combustible dust at a concentration that meets or exceeds its LFL;

NOTE: This concentration may be approximated as a condition in which the dust obscures vision at a distance of 5 feet (1.52 m) or less.

(3) Atmospheric oxygen concentration below 19.5 percent or above 23.5 percent;

(4) Atmospheric concentration of any substance for which a dose or a permissible exposure limit is published in Subpart G, Occupational Health and Environmental Control, or in Subpart Z, Toxic and Hazardous Substances, of this Part and which could result in employee exposure in excess of its dose or permissible exposure limit;

NOTE: An atmospheric concentration of any substance that is not capable of causing death, incapacitation, impairment of ability to self-rescue, injury, or acute illness due to its health effects is not covered by this provision.

(5) Any other atmospheric condition that is immediately dangerous to life or health.

NOTE: For air contaminants for which OSHA has not determined a dose or permissible exposure limit, other sources of information, such as Material Safety Data Sheets that comply with the Hazard Communication Standard, section 1910.1200 of this Part, published information, and internal documents can provide guidance in establishing acceptable atmospheric conditions.

"Hot work permit" means the employer's written authorization to perform operations (for example, riveting, welding, cutting, burning, and heating) capable of providing a source of ignition.

"Immediately dangerous to life or health (IDLH)" means any condition that poses an immediate or delayed threat to life or that would cause irreversible adverse health effects or that would interfere with an individual's ability to escape unaided from a permit space.

NOTE: Some materials -- hydrogen fluoride gas and cadmium vapor, for example -- may produce immediate transient effects that, even if severe, may pass without medical attention, but are followed by sudden, possibly fatal collapse 12-72 hours after exposure. The victim "feels normal" from recovery from transient effects until collapse. Such materials in hazardous quantities are considered to be "immediately" dangerous to life or health.

"Inerting" means the displacement of the atmosphere in a permit space by a noncombustible gas (such as nitrogen) to such an extent that the resulting atmosphere is noncombustible.

NOTE: This procedure produces an IDLH oxygen-deficient atmosphere.

"Isolation" means the process by which a permit space is removed from service and completely protected against the release of energy and material into the space by such means as: blanking or blinding; misaligning or removing sections of lines, pipes, or ducts; a double block and bleed system; lockout or tagout of all sources of energy; or blocking or disconnecting all mechanical linkages.

"Line breaking" means the intentional opening of a pipe, line, or duct that is or has been carrying flammable, corrosive, or toxic material, an inert gas, or any fluid at a volume, pressure, or temperature capable of causing injury.

"Non-permit confined space" means a confined space that does not contain or, with respect to atmospheric hazards, have the potential to contain any hazard capable of causing death or serious physical harm.

"Oxygen deficient atmosphere" means an atmosphere containing less than 19.5 percent oxygen by volume.

"Oxygen enriched atmosphere" means an atmosphere containing more than 23.5 percent oxygen by volume.

"Permit-required confined space (permit space)" means a confined space that has one or more of the following characteristics:

(1) Contains or has a potential to contain a hazardous atmosphere;

(2) Contains a material that has the potential for engulfing an entrant;

(3) Has an internal configuration such that an entrant could be trapped or asphyxiated by inwardly converging walls or by a floor which slopes downward and tapers to a smaller cross-section; or

(4) Contains any other recognized serious safety or health hazard.

"Permit-required confined space program (permit space program)" means the employer's overall program for controlling, and, where appropriate, for protecting employees from, permit space hazards and for regulating employee entry into permit spaces.

"Permit system" means the employer's written procedure for preparing and issuing permits for entry and for returning the permit space to service following termination of entry.

"Prohibited condition" means any condition in a permit space that is not allowed by the permit during the period when entry is authorized.

"Rescue service" means the personnel designated to rescue employees from permit spaces.

"Retrieval system" means the equipment (including a retrieval line, chest or full-body harness, wristlets, if appropriate, and a lifting device or anchor) used for non-entry rescue of persons from permit spaces.

"Testing" means the process by which the hazards that may confront entrants of a permit space are identified and evaluated. Testing includes specifying the tests that are to be performed in the permit space.

Would you consider this a confined space? How about a permit required? Think about the various chemicals that we use inside confined spaces.

Confined Space Entry Program - Introduction

Purpose

The Confined Space Entry Program is provided to protect authorized employees that will enter confined spaces and may be exposed to hazardous atmospheres, engulfment in materials, conditions which may trap or asphyxiate due to converging or sloping walls, or contains any other safety or health hazards.

Reference: OSHA-Permit-Required Confined Spaces (**29 CFR 1910.146**).

Scope

You are required to recognize the dangers and hazards associated with confined spaces, and this program is designed to assist you in the safety of and compliance with the OSHA standards associated with such.

Most communities will utilize the Fire Department for all rescues and additional assistance dealing with confined spaces, understanding that most Fire Department operations utilize additional in house SOG's/SOP's pertaining to such operations.

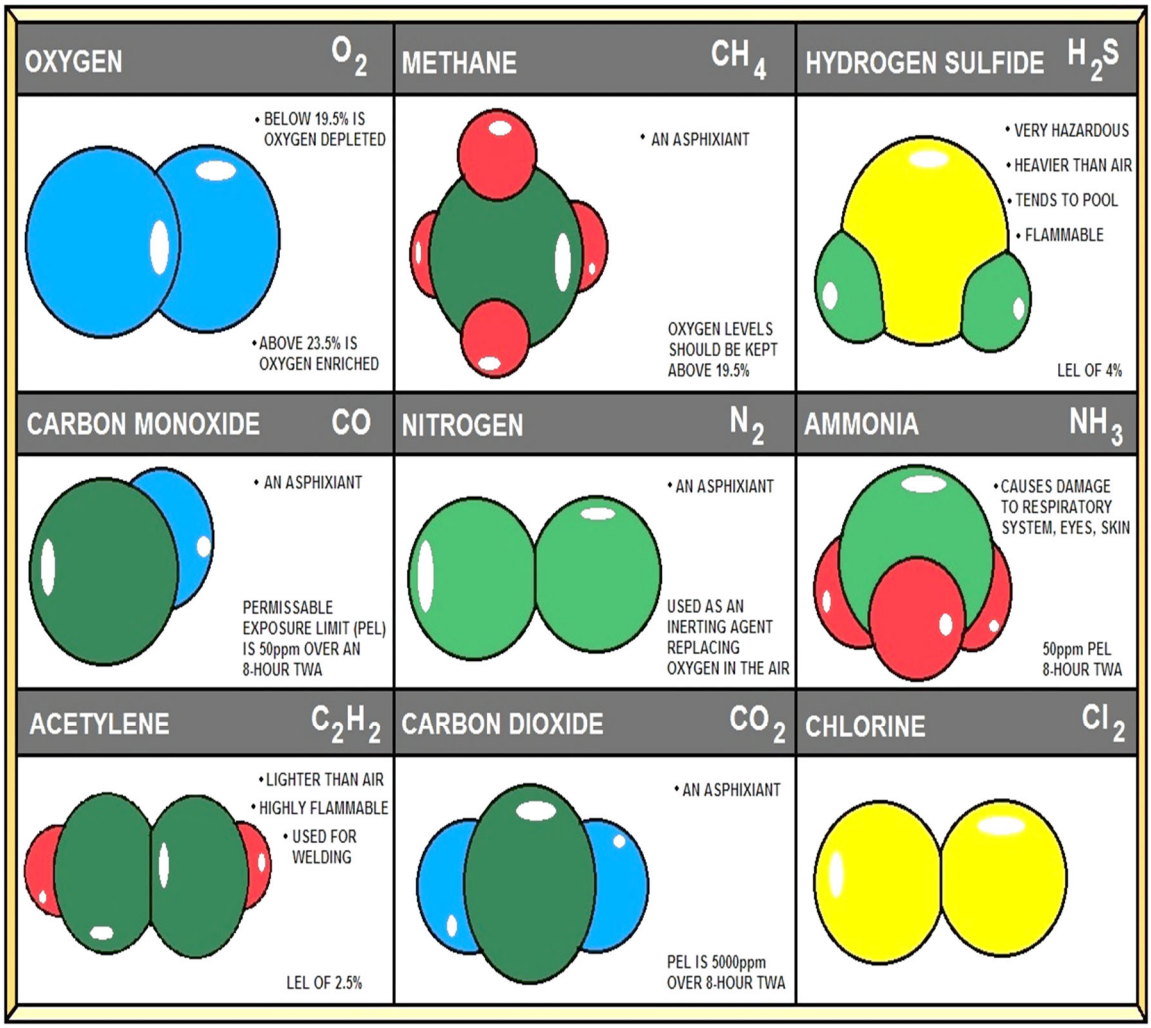
Definitions

Confined space:

- ✓ Is large enough or so configured that an employee can bodily enter and perform work.
- ✓ Has limited or restricted means for entry or exit (i.e. tanks, vessels, silos, storage bins, hoppers, vaults, and pits are spaces that may have limited means of entry).
- ✓ Is not designed for continuous employee occupancy.
- ✓ Permit required confined space (permit space), is a confined space that has one or more of the following characteristics:

1. Contains or has a potential to contain a hazardous atmosphere.
2. Contains a material that has the potential for engulfing an entrant.
3. Has an internal configuration such that an entrant could be trapped or asphyxiated by inwardly covering walls or by a floor which slopes downward and tapers to a smaller cross-section.
4. Contains any other recognized serious safety or health hazard.

Each Permit-Required Confined Space will be marked
"*Confined Space - Entry Permit Required*".
Most of this text is credited to OSHA.



COMMON GASES THAT CAN BE FOUND IN CONFINED SPACE

Confined Space Hazards

Fatalities and injuries constantly occur among construction workers who, during the course of their jobs, are required to enter confined spaces. In some circumstances, these workers are exposed to multiple hazards, any of which may cause bodily injury, illness, or death.

Newspaper and magazine articles abound with stories of workers injured and killed from a variety of atmospheric factors and physical agents. Throughout the construction jobsite, contractors and workers encounter both inherent and induced hazards within confined workspaces.

Inherent Hazards
Inherent hazards, such as electrical, thermal, chemical, mechanical, etc., are associated with specific types of equipment and the interactions among them.

Examples include high voltage (shock or corona discharge and the resulting burns), radiation generated by equipment, defective design, omission of protective features (no provision for grounding non-current-carrying conductive parts), high or low temperatures, high noise levels, and high-pressure vessels and lines (rupturing with resultant release of fragments, fluids, gases, etc.).

Inherent hazards usually cannot be eliminated without degrading the system or equipment, or without making them inoperative. Therefore, emphasis must be placed on hazard control methods.

Induced Hazards
Induced hazards arise, and are induced from, a multitude of incorrect decisions and actions that occur during the actual construction process. Some examples are: omission of protective features, physical arrangements that may cause unintentional worker contact with electrical energy sources, oxygen-deficient atmospheres created at the bottom of pits or shafts, lack of safety factors in structural strength, and flammable atmospheres.

Typical Examples of Confined Workspaces
Following are typical examples of confined workspaces in construction which contain both inherent and induced hazards.

Vaults
A variety of vaults are found on the construction jobsite. On various occasions, workers must enter these vaults to perform a number of functions.

The restricted nature of vaults and their frequently below-grade location can create an assortment of safety and health problems.

Oxygen-Deficient Atmosphere
One of the major problems confronting construction workers while working in vaults is the ever-present possibility of an oxygen-deficient atmosphere.

Explosive or Toxic Gases, Vapors, or Fumes
While working in an electrical vault, workers may be exposed to the build-up of explosive gases such as those used for heating (propane). Welding and soldering produce toxic fumes which are confined in the limited atmosphere.

Electrical Shock
Electrical shock is often encountered from power tools, line cords, etc. In many instances, such electrical shock results from the fact that the contractor has not provided an approved grounding system or the protection afforded by ground-fault circuit interrupters or low-voltage systems.

Purging
In some instances, purging agents such as nitrogen and argon may enter the vault from areas adjacent to it. These agents may displace the oxygen in the vault to the extent that it will asphyxiate workers almost immediately.

Materials Falling In and On
A hazard normally considered a problem associated with confined spaces is material or equipment which may fall into the vault or onto workers as they enter and leave the vault.

Vibration could cause the materials on top of the vault to roll off and strike workers. If the manhole covers were removed, or if they were not installed in the first place, materials could fall into the vault, causing injury to the workers inside.

Condenser Pits
A common confined space found in the construction of nuclear power plants is the condenser pit. Because of their large size, they are often overlooked as potentially hazardous confined spaces.

These below-grade areas create large containment areas for the accumulation of toxic fumes, gases, and so forth, or for the creation of oxygen-deficient atmospheres when purging with argon, Freon, and other inert gases.

Other hazards will be created by workers above dropping equipment, tools, and materials into the pit.

Manholes
Throughout the construction site, manholes are commonplace. As means of entry into and exit from vaults, tanks, pits, and so forth, manholes perform a necessary function. However, these confined spaces may present serious hazards which could cause injuries and fatalities.

A variety of hazards are associated with manholes. To begin with, the manhole could be a dangerous trap into which the worker could fall. Often covers are removed and not replaced, or else they are not provided in the first place.

Pipe Assemblies
One of the most frequently unrecognized types of confined spaces encountered throughout the construction site is the pipe assembly. Piping of sixteen to thirty-six inches in diameter is commonly used for a variety of purposes.

For any number of reasons, workers will enter the pipe. Once inside, they are faced with potential oxygen-deficient atmospheres, often caused by purging with argon or another inert gas. Welding fumes generated by the worker in the pipe, or by other workers operating outside the pipe at either end, subject the worker to toxic atmospheres.

The generally restricted dimensions of the pipe provide little room for the workers to move about and gain any degree of comfort while performing their tasks. Once inside the pipe, communication is extremely difficult. In situations where the pipe bends, communication and extrication become even more difficult. Electrical shock is another problem to which the worker is exposed.

Ungrounded tools and equipment or inadequate line cords are some of the causes. As well, heat within the pipe run may cause the worker to suffer heat prostration.

Ventilation Ducts
Ventilation ducts, like pipe runs, are very common at the construction site. These sheet metal enclosures create a complex network which moves heated and cooled air and exhaust fumes to desired locations in the plant.

Ventilation ducts may require that workers enter them to cut out access holes, install essential parts of the duct, etc. Depending on where these ducts are located, oxygen deficiency could exist. They usually possess many bends, which create difficult entry and exit and which also make it difficult for workers inside the duct to communicate with those outside it. Electrical shock hazards and heat stress are other problems associated with work inside ventilation ducts.

Tanks
Tanks are another type of confined workspace commonly found in construction. They are used for a variety of purposes, including the storage of water, chemicals, etc.

Tanks require entry for cleaning and repairs. Ventilation is always a problem. Oxygen-deficient atmospheres, along with toxic and explosive atmospheres created by the substances stored in the tanks, present hazards to workers. Heat, another problem in tanks, may cause heat prostration, particularly on a hot day.

Since electrical line cords are often taken into the tank, the hazard of electrical shock is always present. The nature of the tank's structure often dictates that workers must climb ladders to reach high places on the walls of the tank.

Sumps
Sumps are commonplace. They are used as collection places for water and other liquids. Workers entering sumps may encounter an oxygen-deficient atmosphere.

Also, because of the wet nature of the sump, electrical shock hazards are present when power tools are used inside. Sumps are often poorly illuminated. Inadequate lighting may create an accident situation.

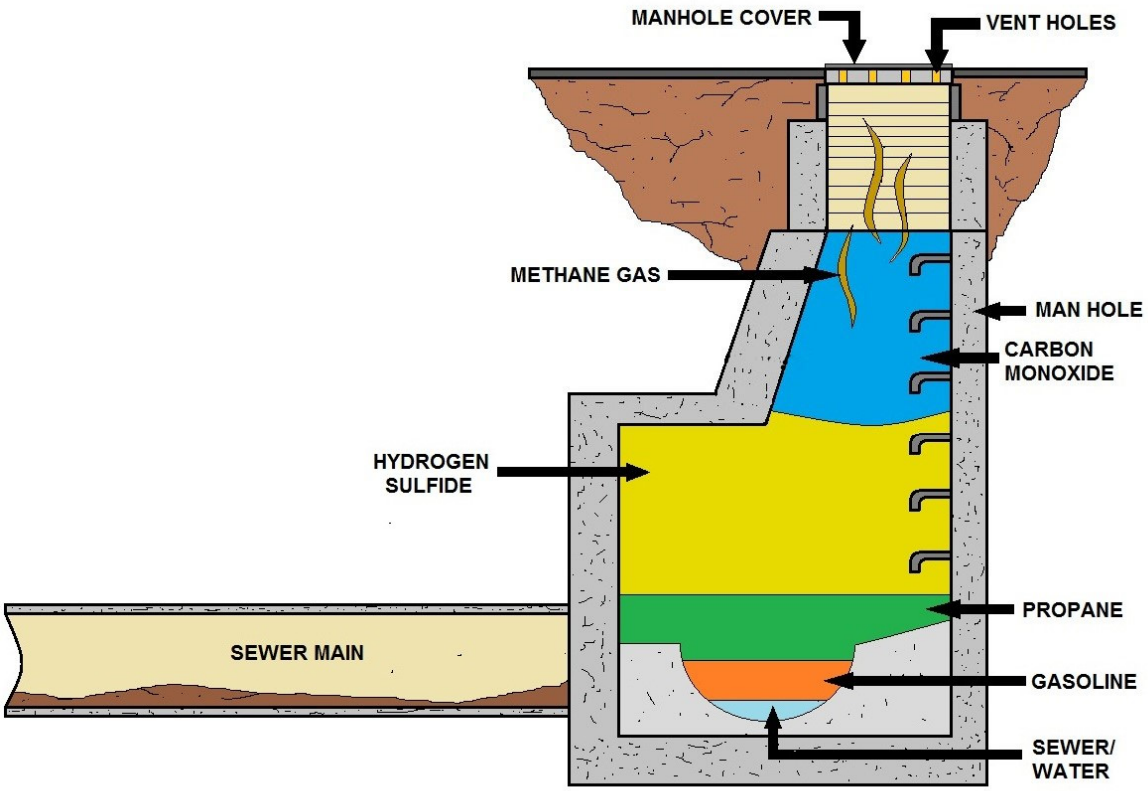
Containment Cavities
These large below-grade areas are characterized by little or no air movement. Ventilation is always a problem. In addition, the possibility of oxygen deficiency exists. As well, welding and other gases may easily collect in these areas, creating toxic atmospheres. As these structures near completion, more confined spaces will exist as rooms are built off the existing structure.

Electrical Transformers
Electrical transformers are located on the jobsite. They often contain a nitrogen purge or dry air. Before they are opened, they must be well vented by having air pumped in. Workers, particularly electricians and power plant operators, will enter these transformers through hatches on top for various work-related reasons. Testing for oxygen deficiency and for toxic atmospheres is mandatory.

Heat Sinks
These larger pit areas hold cooling water in the event that there is a problem with the pumps located at the water supply to the plant--normally a river or lake--which would prevent cooling water from reaching the reactor core.

When in the pits, workers are exposed to welding fumes and electrical hazards, particularly because water accumulates in the bottom of the sink.

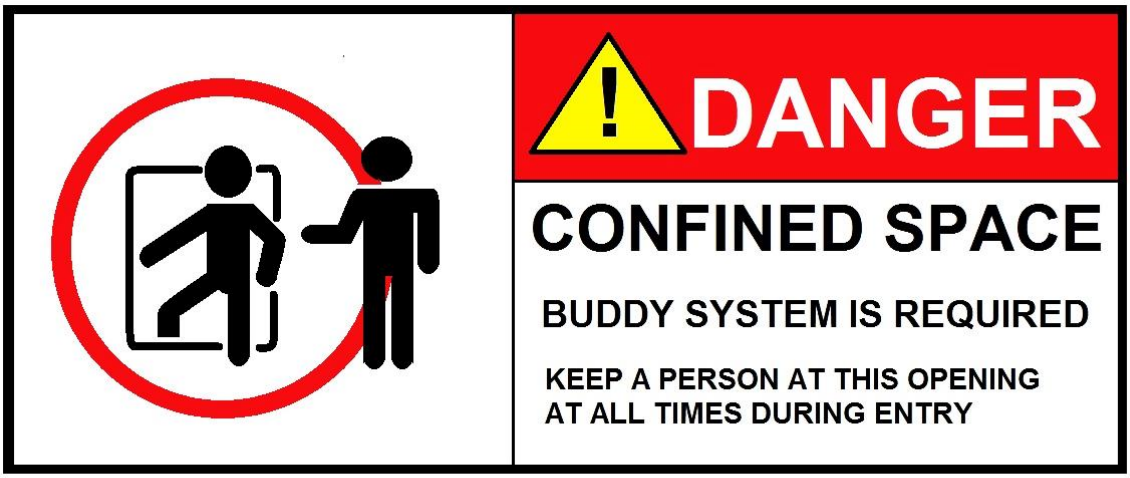
Generally, it is difficult to communicate with workers in the heat sink, because the rebar in the walls of the structure deaden radio signals.



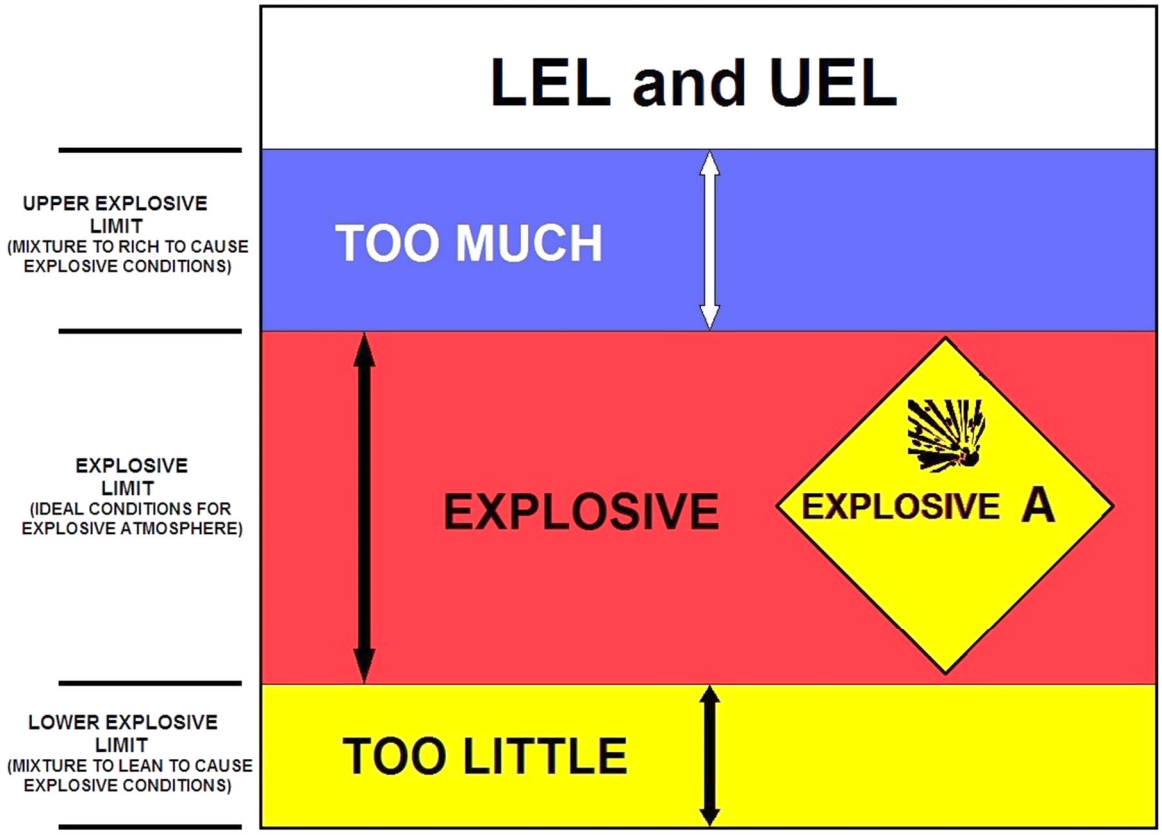
POSSIBLE HAZARDOUS ATMOSPHERES PRESENT IN A CONFINED SPACE (EXAMPLE IS OF A SEWER MAIN)

COMMON HAZARDOUS GASES THAT MAY BE PRESENT IN CONFINED SPACE					
SUBSTANCE *	8-HOUR TIME-WEIGHTED AVERAGE (TWA)	15-MINUTE SHORT-TERM EXPOSURE LIMIT (STEL)	CEILING LIMIT (Never To Be Exceeded)	IMMEDIATELY DANGEROUS TO LIFE AND HEALTH (IDLH)	RECOMMENDED ALARM SETTINGS (Low / High)
AMMONIA	25 ppm	35 ppm	—	300 ppm	13 ppm / 25 ppm
CARBON MONOXIDE	25 ppm	100 ppm	—	1200 ppm	13 ppm / 25 ppm
CHLORINE	0.5 ppm	1 ppm	—	10 ppm	0.25 ppm / 0.5 ppm
HYDROGEN SULFIDE	—	—	10 ppm	100 ppm	5 ppm / 10 ppm
METHANE	1000 ppm	—	—	—	500 ppm / 1000 ppm
NITROGEN DIOXIDE	—	—	1 ppm	20 ppm	0.5 ppm / 1 ppm
SULFUR DIOXIDE	2 ppm	5 ppm	—	100 ppm	1 ppm / 2 ppm
OXYGEN	—	—	—	—	20.5 % of Atmosphere
LOWER EXPLOSIVE LIMIT (LEL)	—	—	—	—	5 % LEL

EXAMPLE OF A CHART OF CONFINED SPACE GASES



EXAMPLE OF A CONFINED SPACE ENTRY DANGER SIGN



UNDERSTANDING UPPER (UEL) & LOWER (LEL) EXPLOSIVE LIMITS

Unusual Conditions

Confined Space within a Confined Space
By the very nature of construction, situations are created which illustrate one of the most hazardous confined spaces of all--a confined space within a confined space.

This situation appears as tanks within pits, pipe assemblies or vessels within pits, etc. In this situation, not only do the potential hazards associated with the outer confined space require testing, monitoring, and control, but those of the inner space also require similar procedures.

Often, only the outer space is evaluated. When workers enter the inner space, they are faced with potentially hazardous conditions.

A good example of a confined space within a confined space is a vessel with a nitrogen purge inside a filtering water access pit. Workers entering the pit and/or the vessel should do so only after both spaces have been evaluated and proper control measures established.

Hazards in One Space Entering another Space
During an examination of confined spaces in construction, one often encounters situations which are not always easy to evaluate or control. For instance, a room or area which classifies as a confined space may be relatively safe for work.

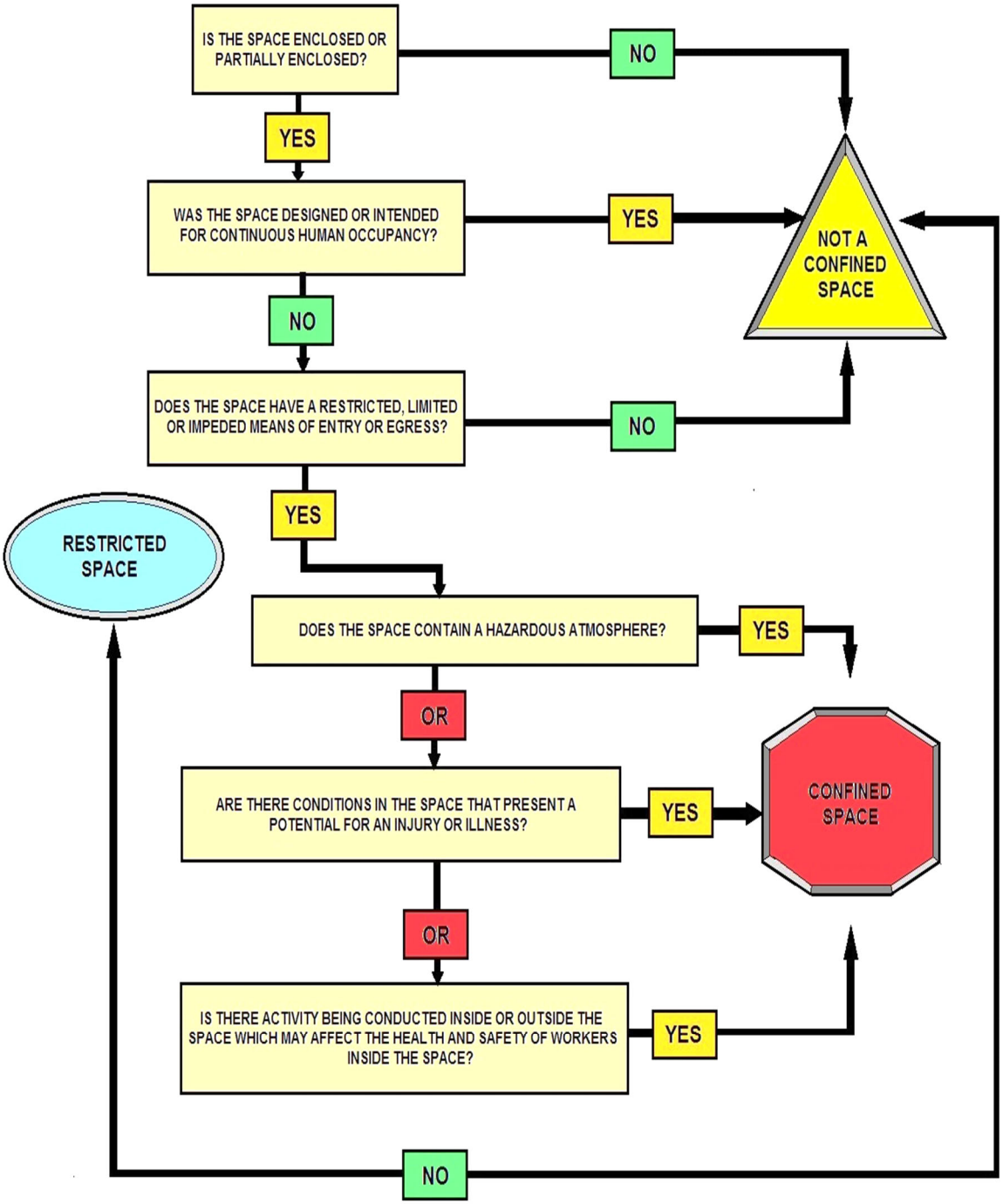
However, access passages from other areas outside or adjacent to the room could, at some point, allow the transfer of hazardous agents into the "***safe***" one. One such instance would be a pipe coming through a wall into a containment room.

Welding fumes and other toxic materials generated in one room may easily travel through the pipe into another area, causing it to change from a safe to an unsafe workplace.

A serious problem with a situation such as this is that workers working in the "**safe**" area are not aware of the hazards leaking into their area. Thus, they are not prepared to take action to avoid or control it.

Session Conclusion
In this discussion, we have defined inherent and induced hazards in confined spaces. We have examined typical confined spaces on construction sites and we have described representative hazards within these confined spaces.

Most of this text is credited to OSHA.



HOW TO DETERMINE CONFINED SPACES

Permitted Confined Space Entry Program

Definition of Confined Spaces Requiring an Entry Permit
Confined space:
- ✓ Is large enough or so configured that an employee can bodily enter and perform work.
- ✓ Has limited or restricted means for entry or exit (i.e. tanks, vessels, silos, storage bins, hoppers, vaults, and pits are spaces that may have limited means of entry).
- ✓ Is not designed for continuous employee occupancy.

Purpose
The Permit Required Space (**PRCS**) Program is provided to protect authorized employees that will enter confined spaces and may be exposed to hazardous atmospheres, engulfment in materials, conditions which may trap or asphyxiate due to converging or sloping walls, or contains any other safety or health hazards.

Many workplaces contain confined spaces not designed for human occupancy which due to their configuration hinder employee activities including entry, work and exit. Asphyxiation is the leading cause of death in confined spaces.

Subpart P applies to all open excavations in the earth's surface.
- ✓ All trenches are excavations.
- ✓ All excavations are not trenches.

Permit Required Confined Space Entry General Rules
During all confined space entries, the following safety rules must be strictly enforced:
1. Only authorized and trained employees may enter a confined space or act as safety watchmen/attendants.

2. No smoking is permitted in a confined space or near entrance/exit area.

3. During confined space entries, a watchmen or attendant must be present at all times.

4. Constant visual or voice communication will be maintained between the safety watchmen and employees entering a confined space.

5. No bottom or side entry will be made or work conducted below the level any hanging material or material which could cause engulfment.

6. Air and oxygen monitoring is required before entering any permit-required confined space. Oxygen levels in a confined space must be between 19.5 and 23.5 percent. Levels above or below will require the use of an SCBA or other approved air supplied respirator. Additional ventilation and oxygen level monitoring is required when welding is performed. The monitoring will check oxygen levels, explosive gas levels and carbon monoxide levels. Entry will not be permitted if explosive gas is detected above one-half the Lower Explosive Limit (**LEL**).

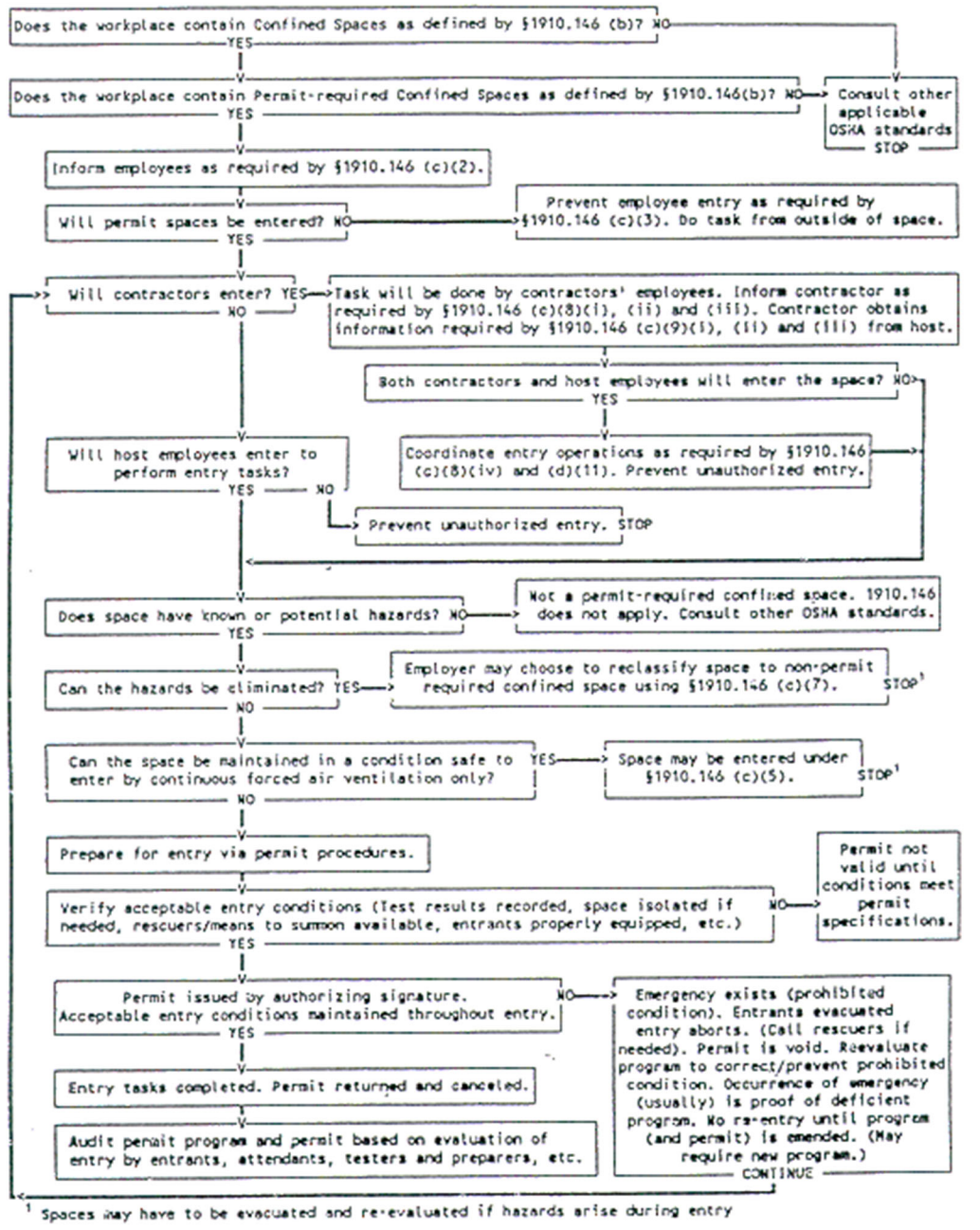
7. To prevent injuries to others, all openings to confined spaces will be protected by a barricade when covers are removed.

Appendix A to §1910.146

Permit-Required Confined Space Decision Flow Chart

Note: Appendices A through F serve to provide information and non-mandatory guidelines to assist employers and employees in complying with the appropriate requirements of this section.

APPENDIX A TO §1910.146—PERMIT-REQUIRED CONFINED SPACE DECISION FLOW CHART



[58 FR 4549, Jan. 14, 1993; 58 FR 34846, June 29, 1993; 63 FR 66039, Dec. 1, 1998]

Confined Space Entry Permit *Example*

Date & Time Issued		Date & time Expires	
Space I.D.		Supervisor	
Equipment Affected		Task	
Standby Team			
Pre-Entry Atmospheric Checks	Time (am - pm)		
	Oxygen		
	Explosive (% LEL)		
	Toxic (PPM)		
	Testers Signature		

Pre-entry Fluid System Isolation	Yes	No
Pumps /lines blinded, blocked, disconnected		
Ventilation Source Established		
Mechanical Forced Air		
Natural Ventilation		
Post Ventilation Pre-Entry Atmospheric Checks		
Time		
Oxygen (%)		
Explosive (% LEL		
Toxic (PPM)		
Tester Signature		
Communication Procedures Established per specific Confined Space SOP		
Rescue Procedures established per specific Confined Space SOP		

Training Verification - for the following persons & space to be entered					YES	NO	
All persons entering Confined Space							
All persons acting as Supervisor for the Entry							
All persons assigned backup positions							
All persons assigned to monitor access and interior activities							
All persons assigned to emergency rescue team							
Equipment on Scene	YES	NO	NA		YES	NO	NA
Gas Monitor				Life Line			
Safety Harness				Hoisting Equipment			
Fall Arrest Gear				Powered Comm Eq.			
SCBAs				Air Line Respirators			

Protective Clothing				Elect Gear Properly Rated			
Periodic Atmospheric Checks							
Time (am - pm)							
Oxygen							
Explosive (% LEL)							
Toxic (PPM)							
Testers Signature							

A review of the work authorized by this permit and the information contained on this Entry Permit. Written instructions and safety procedures have been received and are understood. Entry cannot be approved if any squares are marked in the "**No**" column. This permit is not valid unless all appropriate items are completed.

Permit Prepared By: (Supervisor) _____

Approved By: (Unit Supervisor) _____

This permit to be kept at job site.

Return job site copy to Safety Office following job completion.

Copies: Safety Office, Unit Supervisor, Job site

Confined Space Duties & Responsibilities

Examples of assignments
Employees

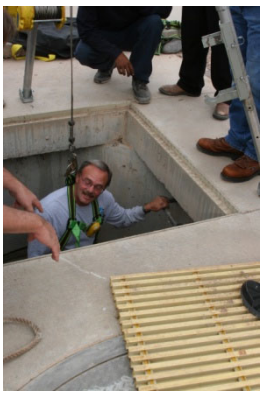
- Follow program requirements.
- Report any previously un-identified hazards associated with confined spaces.
- Do not enter any confined spaces that have not been evaluated for safety concerns.

Management

- Provide annual Confined Space training to all employees that may need confined space training.
- Ensure confined space assessments have been conducted.
- Annually review this program and all Entry Permits.

Rescue or Training Department

- Ensure proper training for entry & rescue teams.
- Provide proper equipment for entry & rescue teams.
- Ensure all permit required confined spaces are posted.
- Evaluate rescue teams and service to ensure they are adequately trained and prepared.
- Ensure rescue team at access during entry into spaces with Immediately Dangerous to Life or Health (IDLH) atmospheres.
- Provide annual confined space awareness training to all employees that may need confined space awareness training.



Entry Supervisor

Entry supervisors are responsible for the overall permit space entry and must coordinate all entry procedures, tests, permits, equipment and other relevant activities.

The following entry supervisor duties are required:

Know the hazards that may be faced during entry, including information on the mode, signs or symptoms, and consequences of the exposure.

Verify by checking that the appropriate entries have been made on the permit, all tests specified by the permit have been conducted, and that all procedures and equipment specified by the permit are in place before endorsing the permit and allowing entry to begin.

Terminate the entry and cancel the permit when the entry is complete or there is a need for terminating the permit.

Verify that rescue services are available and that the means for summoning them are operable.

Remove unauthorized persons who enter or attempt to enter the space during entry operations.
Determine whenever responsibility for a permit space entry operation is transferred and at intervals dictated by the hazards and operations performed within the space that entry operations remain consistent with the permit terms and that acceptable entry conditions are maintained.

Entry Attendants

At least one attendant is required outside the permit space into which entry is authorized for the duration of the entry operation.

Responsibilities include:

- To know the hazards that may be faced during entry, including information on the mode, signs or symptoms, and consequences of the exposure
- To be aware of possible behavioral effects of hazard exposure on entrants
- To continuously maintain an accurate count of entrants in the permit space and ensures a means to accurately identify authorized entrants
- To remain outside the permit space during entry operations until relieved by another attendant (once properly relieved, they may participate in other permit space activities, including rescue if they are properly trained and equipped).
- To communicate with entrants as necessary to monitor entrant status and alert entrants of the need to evacuate.
- To monitor activities inside and outside the space to determine if it is safe for entrants to remain in the space; orders the entrants to immediately evacuate if: the attendant detects a prohibited condition, detects entrant behavioral effects of hazard exposure, detects a situation outside the space that could endanger the entrants; or if the attendant cannot effectively and safely perform all the attendant duties.
- To summon rescue and other emergency services as soon as the attendant determines the entrants need assistance to escape the permit space hazards.
- To perform non-entry rescues as specified by that rescue procedure and entry supervisor and not to perform duties that might interfere with the attendants' primary duty to monitor and protect the entrants.

Most of this text is credited to OSHA.

Is Entry Necessary?
Can the task be accomplished from the outside? For example, measures that eliminate the need for employees to enter confined spaces should be carefully evaluated and implemented if at all possible before considering human entry into confined spaces to perform non-emergency tasks.

CONFINED SPACE ENTRY CHECKLIST EXAMPLE

New Confined Space Construction Standard

On May 4, 2015, OSHA issued a new standard for construction work in confined spaces, which became effective August 3, 2015. Confined spaces can present physical and atmospheric hazards that can be avoided if they are recognized and addressed prior to entering these spaces to perform work. The new standard, Subpart AA of 29 CFR 1926 will help prevent construction workers from being hurt or killed by eliminating and isolating hazards in confined spaces at construction sites similar to the way workers in other industries are already protected.

The new standard, Subpart AA of 29 CFR 1926, will help prevent construction workers from being hurt or killed by eliminating and isolating hazards in confined spaces at construction sites similar to the way workers in other industries are already protected.

Training requirements

Employers must provide training to each employee whose work is regulated by this standard, at no cost to the employee, and ensure that employees possess the understanding, knowledge and skills necessary to safely perform the duties assigned under this standard. Training must result in an understanding of the hazards in the permit space and the methods used to isolate, control or in other ways protect employees from these hazards. For employees not authorized to perform entry rescues, it must convey the dangers of attempting such rescues.

Affected employees must be trained:

- In both a language and vocabulary that the employee can understand;
- Before the employee is first assigned duties under this standard;
- Before there is a change in assigned duties;
- Whenever there is a change in permit space entry operations that presents a hazard about which an employee has not previously been trained; and
- Whenever there is any evidence of a deviation from the permit space entry procedures required by paragraph §1926.1204(c) of this standard or there are inadequacies in the employee's knowledge or use of these procedures.

The training must establish employee proficiency in the duties required by this standard and must introduce new or revised procedures, as necessary, for compliance.
The employer must maintain training records to show required training has taken place. Training records must contain each employee's name, the name of the trainers, and the dates of training. Documentation must be available for inspection by employees and their authorized representatives, for the period of time the worker is employed by that employer.

Common questions

To assist employers in complying with the new standard, here are some frequently asked questions and answers outline by on its website at www.osha.gov:

How do I know whether to follow the general industry or construction confined space rule?

If you are doing construction work – such as building a new structure or upgrading an old one – then you must follow the construction confined space rule.

Why did OSHA believe that the former standard needed to be changed?
Previously the only requirement for confined spaces in construction was training. OSHA concluded this was inadequate as injuries and fatalities continued to occur.

How does the new final rule differ from the rules that previously applied to construction work performed in confined spaces?
The rule requires employers to determine what kinds of spaces their workers are in, what hazards could be there, how those hazards should be made safe, what training workers should receive, and how to rescue those workers if anything goes wrong.

Where can I find the final rule for Confined Spaces in Construction?
Information on the new confined spaces standard can be found on the Confined Spaces page at www.osha.gov/confinedspaces/index.html.

How can I contact OSHA if I have questions about the final rule?
For compliance assistance regarding application of the final rule contact: Directorate of Construction, Room N3468, OSHA, U.S. Department of Labor, 200 Constitution Avenue NW, Washington, DC 20210; telephone (202)-693-2020 or fax (202)-693-1689.

Who is affected by Subpart AA?
All construction employers whose workers may be exposed to confined space hazards.

Do I need to do anything if there are permit spaces at the worksite, but my employees will not need to enter the permit space?
Yes, you must take effective steps to prevent your employees from entering the space.

What standard should I follow if my workers are doing construction AND general industry work in confined spaces?
An employer whose workers are engaged in both construction and general industry work in confined spaces will meet OSHA requirements if that employer meets the requirements of 29 CFR 1926 Subpart AA - Confined Spaces in Construction.

Entering a Confined Space Procedures

This space requires an emergency retrieval system, continuous air monitoring, and safety watch or two-way communication for safe entry.

Donning the personal protective equipment (**PPE**) necessary for confined space entry.
The full-body harness provides fully adjustable leg and shoulder straps for worker comfort and proper fit. Stamped steel sliding back D-ring and sub-pelvic strap provide optimum force distribution.

Example of a "***D-Ring***" and fall protection harness used when entering a confined space. The D-Ring provides a compatible anchor point for connecting devices such as lanyards or retractable lifelines. The shock absorbing lanyard provides a deceleration distance during a fall to reduce fall arrest forces for extra protection against injury.

Tripod-retrieval assembly in use for an entry into one of the many confined spaces.

Checking the cable tension and inertial locking mechanism of the retrieval assembly.

Correct use of this device prevents free-falls greater than 2 feet.

The entrant descends into the space as the attendant critiques the operation.

Dramatic rescue simulation using the tripod-retrieval system.

The entrant is now safely out of the space and is ready to return to his many other projects after this simulated exercise.

Duties of the Person Authorizing or in Charge of the Entry

The person who authorizes or is in charge of the permit entry confined space must comply with the following:

1. Make certain that all pre-entry requirements as outlined on the permit have been completed before any worker is allowed to enter the confined space.
2. Make certain that any required pre-entry conditions are present.
3. If an in-plant/facility rescue team is to be used in the event of an emergency, make sure they would be available. If your Employer does not maintain an in-plant rescue team, dial 911 on any telephone for the Rescue Squad.
4. Make sure that any communication equipment which would be used to summon either the in-plant rescue team or other emergency assistance is operating correctly.
5. Terminate the entry upon becoming aware of a condition or set of conditions whose hazard potential exceeds the limits authorized by the entry permit.

If the person who would otherwise issue an entry permit is in charge of the entry and present during the entire entry, then a written permit is not required if that person uses a checklist as provided in the section on "***Permits***".

This person may also serve as the attendant at the site.

Special Considerations During A Permit Required Entry

Certain work being performed in a permit entry confined space could cause the atmosphere in the space to change.

Examples of this are welding, drilling, or sludge removal. In these situations, air monitoring of the confined space should be conducted on a continuous basis throughout the time of the entry.

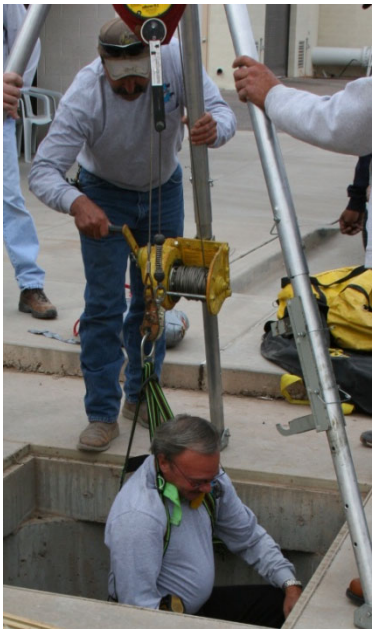
If the workers leave the confined space for any significant period of time, such as for a lunch or other break, the atmosphere of the confined space must be retested before the workers reenter the confined space.

Unauthorized Persons

Take the following actions when unauthorized persons approach or enter a permit space while entry is under way:

1. Warn the unauthorized persons that they must stay away from the permit space,
2. Advise unauthorized persons that they must exit immediately if they have entered the space, and
3. Inform the authorized entrants and the entry supervisor if unauthorized persons have entered the permit space.

Entrants



All entrants must be authorized by the entry supervisor to enter permit spaces, have received the required training, have used the proper equipment, and observed the entry procedures and permit requirements.

The following entrant duties are required:
Know the hazards that may be faced during entry, including information on the mode, signs or symptoms, and consequences of the exposure;

Properly use the equipment required for safe entry;
Communicate with the attendant as necessary to enable the attendant to monitor the status of the entrants and to enable the attendant to alert the entrants of the need to evacuate the space if necessary;

Alert the attendant whenever; the entrant recognizes any warning signs or symptoms of exposure to a dangerous situation, or any prohibited condition is detected; and Exit the permit space as quickly as possible whenever the attendant or entry supervisor gives an order to evacuate the permit space, the entrant recognizes any warning signs or symptoms of exposure to a dangerous situation, the entrant detects a prohibited condition, or an evacuation alarm is activated.

Hazards

- ✓ **Explosive / Flammable Atmospheres**
- ✓ **Toxic Atmospheres**
- ✓ **Engulfment**
- ✓ **Asphyxiation**
- ✓ **Entrapment**
- ✓ **Slips & falls**
- ✓ **Chemical Exposure**
- ✓ **Electric Shock**
- ✓ **Thermal / Chemical Burns**
- ✓ **Noise & Vibration**

Hazard Control

Engineering Controls

- Locked entry points
- Temporary ventilation
- Temporary Lighting

Administrative Controls

- Signs
- Employee training
- Entry procedures
- Atmospheric Monitoring
- Rescue procedures
- Use of prescribed Personal Protective Equipment

Entry Standard Operating Procedures

This program outlines:

- Hazards
- Hazard Control & Abatement
- Acceptable Entry Conditions
- Means of Entry
- Entry Equipment Required
- Emergency Procedures

FRONT

CONFINED SPACE ENTRY PERMIT

DATE & TIME OF ISSUE

EQUIPMENT I.D.

EQUIPMENT LOCATION

EXPIRATION

WORK TO BE DONE _____

CONFINED SPACE APPROVAL

QUALIFIED PERSON _____

OTHER QUALIFIED PERSON _____

EMPLOYEE(S) TO ENTER _____

SUPERVISOR _____

CHECKLIST ON OTHER SIDE MUST BE COMPLETED BEFORE APPROVAL

BACK

CHECKLIST

SPECIAL REQUIREMENTS	YES	NO
LOCKOUT - DE-ENERGIZER		
LINES BROKEN - CAPPED OR BLANKED		
PURGE - FLUSH AND VENT		
VENTILATION		
SECURE AREA		
BREATHING APPARATUS (SCBA)		
RESUCITATOR - INHALATOR		
ESCAPE HARNESS		
TRIPOD EMERGENCY ESCAPE UNIT		
LIFELINES		
FIRE EXTINGUISHERS		
LIGHTING		
PROTECTIVE CLOTHING (PPE)		

	P.E.L.	YES	NO
% OF OXYGEN	19.5% - 23.5%		
% OF L.E.L.	ANY % OVER 10		
CARBON MONOXIDE	35ppm		
HYDROGEN SULFIDE	10ppm		

EXAMPLE OF A CONFINED SPACE TAG

Permit Required Confined Space Entry General Rules

During all confined space entries, the following safety rules must be strictly enforced:

1. Only authorized and trained employees may enter a confined space or act as safety watchman/attendant.

2. No smoking is permitted in a confined space or near entrance/exit area.

3. During confined space entries, a watchman must be present at all times.

4. Constant visual or voice communication will be maintained between the safety watchman/attendant and employees entering a confined space.

5. No bottom or side entry will be made or work conducted below the level of any hanging material or material which could cause engulfment.

6. Air and oxygen monitoring is required before entering any permit-required confined space. Oxygen levels in a confined space must be between 19.5 and 23.5 percent. Levels above or below will require the use of an SCBA or other approved air supplied respirator.

Additional ventilation and oxygen level monitoring is required when welding is performed. The monitoring will check oxygen levels, explosive gas levels and carbon monoxide levels. Entry will not be permitted if explosive gas is detected above one-half the Lower Explosive Limit (**LEL**), or 10% of a specific gas explosive limit.

7. To prevent injuries to others, all openings to confined spaces will be protected by a barricade when covers are removed.

Confined Space Entry Procedures

Each employee who enters or is involved in the entry must:

1. Understand the procedures for confined space entry
2. Know the Hazards of the specific space
3. Review the specific procedures for each entry
4. Understand how to use entry and rescue equipment

Confined Space Entry Permits

- ✓ Confined Space Entry Permits must be completed before any employee enters a permit-required confined space. The permit must be completed and signed by an authorized member of management before entry.
- ✓ Permits will expire before the completion of the shift or if any pre-entry conditions change.
- ✓ Permits will be maintained on file for 12 months.

Contractor Entry

All work by non-company employees that involves the entry into confined spaces will follow the procedures of this program. The information of this program and specific hazards of the confined spaces to be entered will be provided to contractor management prior to commencing entry or work.

Important Rescue Service Questions

What is the availability of the rescue service?

Is it unavailable at certain times of the day or in certain situations?

What is the likelihood that key personnel of the rescue service might be unavailable at times?

If the rescue service becomes unavailable while an entry is underway, does it have the capability of notifying the employer so that the employer can instruct the attendant to abort the entry immediately?

Confined Space Training

Training for Confined Space Entry includes:

1. Duties of entry supervisor, entrant and attendants
2. Confined space entry permits
3. Hazards of confined spaces
4. Use of air monitoring equipment
5. First aid and CPR training
6. Emergency action & rescue procedures
7. Confined space entry & rescue equipment
8. Rescue training, including entry and removal from representative spaces

Confined Space Training and Education

OSHA's General Industry Regulation, §1910.146 Permit-required confined spaces, contains requirements for practices and procedures to protect employees in general industry from the hazards of entry into permit-required confined spaces. This regulation does not apply to construction.

OSHA's Construction Safety and Health Regulations Part 1926 do not contain a permit-required confined space regulation. Subpart C, §1926.21 Safety training and education specifies training for personnel who are required to enter confined spaces and defines a "***confined or enclosed space***." These requirements are shown below.

§1926.21 Safety training and education. (Partial)

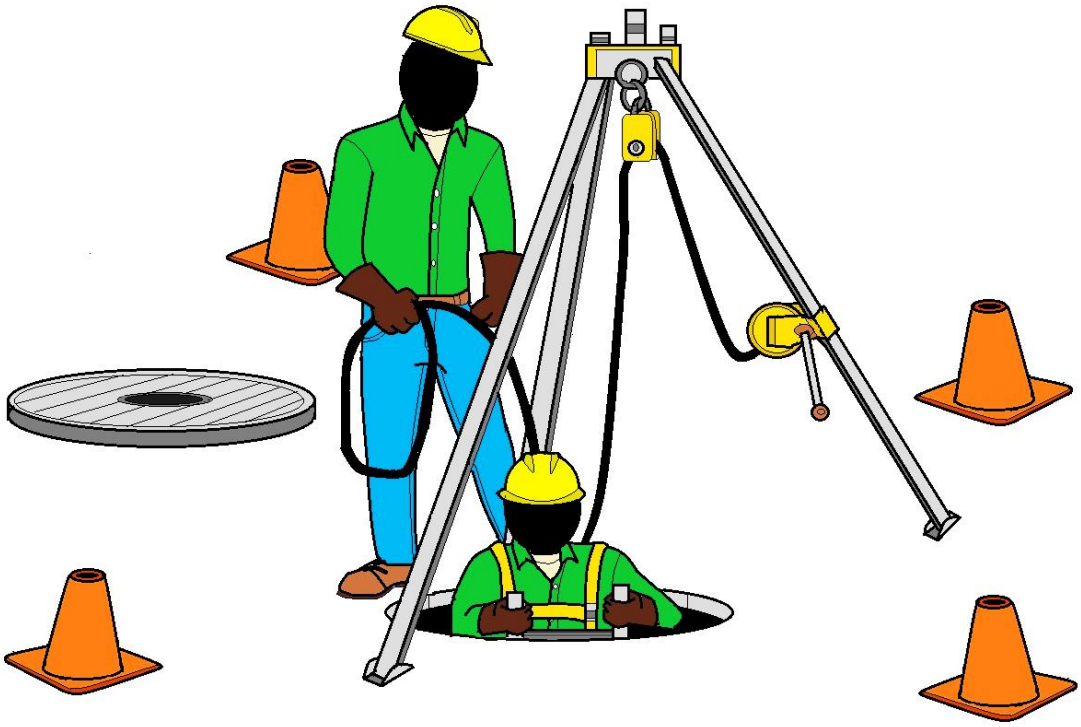
(b)(6)(i) All employees required to enter into confined or enclosed spaces shall be instructed as to the nature of the hazards involved, the necessary precautions to be taken, and in the use of protective and emergency equipment required. The employer shall comply with any specific regulations that apply to work in dangerous or potentially dangerous areas.

(ii) For purposes of paragraph (b)(6)(i) of this section, "***confined or enclosed space***" means any space having a limited means of egress, which is subject to the accumulation of toxic or flammable contaminants or has an oxygen deficient atmosphere. Confined or enclosed spaces include, but are not limited to, storage tanks, process vessels, bins, boilers, ventilation or exhaust ducts, sewers, underground utility vaults, tunnels pipelines, and open top spaces more than 4 feet in depth such as pits, tubs, vaults, and vessels.

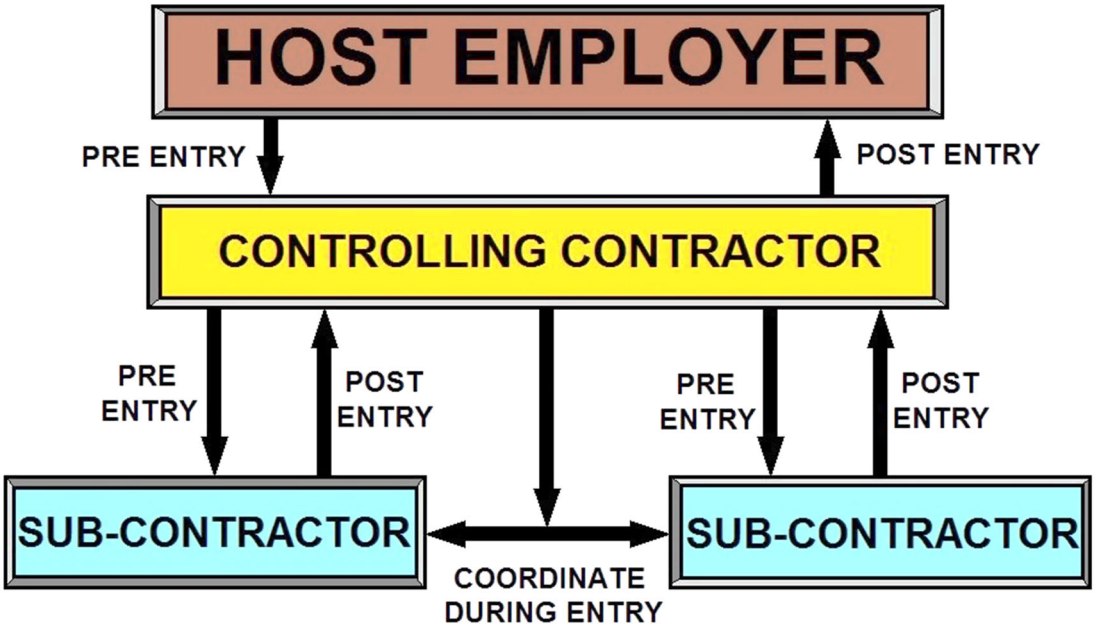
OSHA's Construction Regulations also contain requirements dealing with confined space hazards in underground construction (Subpart S), underground electric transmission and distribution work (§1926.956), excavations (Subpart P), and welding and cutting (Subpart J).

Further guidance may be obtained from American National Standard ANSI Z117.1-1989, Safety Requirements for Confined Spaces. This standard provides minimum safety requirements to be followed while entering, exiting and working in confined spaces at normal atmospheric pressure.

This standard does not pertain to underground mining, tunneling, caisson work or other similar tasks that have established national consensus standards.



ENTERING A CONFINED SPACE



COORDINATING CONFINED SPACE ENTRY ON JOBSITES

Your Employer is Responsible for Certain Training Requirements

These are as follows:

1. **GENERAL:** As an employer, your employer must ensure that all workers who must enter a permit entry confined space in the course of their work are informed of appropriate procedures and controls for entry into such spaces. These workers must be made aware of the fact that an unauthorized entry could be fatal, and that their senses are unable to detect and evaluate the severity of atmospheric hazards.

2. **TRAINING FOR AUTHORIZED ENTRANTS:** Your employer must ensure that all authorized entrants know the emergency action plan and have received training covering the following subjects prior to entering any permit entry confined space:

a**. Hazard Recognition**: Each worker must understand the nature of the hazard before entering and the need to perform appropriate testing to determine if it is safe to enter.

b. **Use of Personal Protective Equipment**: Each employee must be taught the proper use of all personal protective equipment required for entry or rescue, and the proper use of protective barriers and shields.

c. **Self-Rescue**: Each worker must be trained to get out of the confined space as rapidly as possible without help whenever an order to evacuate is given by the attendant, whenever an automatic evacuation alarm is activated, or whenever workers recognize the warning signs of exposure to substances that could be found in the confined space.

They must also be made aware of the toxic effects or symptoms of exposure to hazardous materials he could encounter in the confined space. This includes anything that could be absorbed through the skin or which could be carried through the skin by any solvents that are used. They must be trained to relay an alarm to the attendant and to attempt self- rescue immediately upon becoming aware of these effects.

d. **Special Work Practices or Procedures**: Each worker must be trained in any modifications of normal work practices that are necessary for permit entry confined space work.

3. **TRAINING FOR PERSONS AUTHORIZING OR IN CHARGE OF ENTRY:** In addition to other requirements already covered, the person authorizing or in charge of entry shall be trained to recognize the effects of exposure to hazards that could be in the confined space. They must also carry out all duties that the permit assigns to them.

Rescue practice training. This photo is showing a sand bag being utilized as a dummy.

4. **TRAINING FOR ATTENDANT** Any worker functioning as an attendant at a permit entry confined space must be trained in the company's emergency action plan, the duties of the attendant, and in;

a. Proper use of the communications equipment furnished for communicating with authorized workers entering the confined space or for summoning emergency or rescue services.

b. Authorized procedures for summoning rescue or other emergency services.

c. Recognition of the unusual actions of a worker which could indicate that they could be experiencing a toxic reaction to contaminants that could be present in the space.

d. Any training for rescuers, if the attendant will function as a rescuer also.

e. Any training for workers who enter the confined space, if the permit specifies that the duty of the attendant will rotate among the workers authorized to enter the confined space.

CONFINED SPACE AUTHORIZED ENTRANT'S LOG EXAMPLE

CONFINED SPACE: **DATE:**
TIME:

ENTRANT'S NAME (PRINT)	TIME IN	TIME OUT

ENTRY Attendant:

ENTRY Supervisor Review:

What do you think? Is this a dangerous confined space? Would you weld inside a large pipe all alone? I am sure he is paid well, but is he safe and sound?

Confined Space Entry Procedure

Space _____ Date Last Modified _____

Place check mark in all applicable areas

	Hazards			Personal Protective Equipment
	Explosive / Combustion Hazard			Air supplied Respirator
	Exposed Electrical Circuits			Air Purifying Respirator
	Unguarded Machine Parts			Welding Protection
	Atmospheric Hazard			Gloves
	Potential Atmospheric Hazard			Hard Hat
	Thermal Hazard			**Ventilation Requirements**
	Chemical Hazard			Continuous ___cu.ft/min Note*: See Ventilation Guidelines for Confined Spaces for typical ventilation configurations and formulas.*
	Fall Hazard			
	Engulfment hazard		Note: *Additional ventilation may be required for hot work, grinding or other operations that would produce airborne fumes, mist or dust. Entry Supervisor must assess additional ventilation requirements base on tasks to be performed in the space*	
	Converging Walls			
	Floors slope-small cross-section			
	Slip Hazard			
	Entry Path			Vent Exhaust Point:
	Side entry			Vent Supply Point:
	Bottom entry			Space Volume
	Door			**Initial Purge Time=** 7.5 X (space volume) / Effective Blower Capacity
	Top open entry			
	Top manhole entry			**20 Air Changes per Hour (ACH) for duration of entry**
	Hinged hatch			**Minimum initial Purge Time= 20 Minutes**
	Entry & Rescue Equipment			**Adequate Blower Capacity (ABC) = _____** ABC = Space Volume x 20 ACH / 60 minutes
	Life Line			
	Floor level opening barrier			**Acceptable Entry Conditions**
	Body Harness			Confined Space Entry permit posted
	Tripod			Oxygen 19.5 23.5%
	Man Winch			Lower Explosive Level %
	Fall Arrest Unit			Toxic fumes/vapors Less than PEL
	Emerg Retrieval Line			No engulfing material in space
	Atmospheric Monitor			No hazardous chemicals or material
	Blower /Saddle / Trunks			Drained - Flushed
	Drop Light			Rescue Team Available on Site
	Communication Gear			Ventilation Established & Maintained
	Ladder			LOTO Electrical components in space
	Hand held radios			LOTO Mechanical Components in space
	Portable Lighting			LOTO All pipes to and from space

Other Hazards

Flammable Atmospheres
A flammable atmosphere generally arises from enriched oxygen atmospheres, vaporization of flammable liquids, byproducts of work, chemical reactions, concentrations of combustible dusts, and desorption of chemical from inner surfaces of the confined space.

An atmosphere becomes flammable when the ratio of oxygen to combustible material in the air is neither too rich nor too lean for combustion to occur. Combustible gases or vapors will accumulate when there is inadequate ventilation in areas such as a confined space.

Flammable gases such as acetylene, butane, propane, hydrogen, methane, natural or manufactured gases or vapors from liquid hydrocarbons can be trapped in confined spaces, and since many gases are heavier than air, they will seek lower levels as in pits, sewers, and various types of storage tanks and vessels. In a closed top tank, it should also be noted that lighter than air gases may rise and develop a flammable concentration if trapped above the opening.

The byproducts of work procedures can generate flammable or explosive conditions within a confined space. Specific kinds of work such as spray painting can result in the release of explosive gases or vapors. Welding in a confined space is a major cause of explosions in areas that contain combustible gas.

Chemical reactions forming flammable atmospheres occur when surfaces are initially exposed to the atmosphere, or when chemicals combine to form flammable gases. This condition arises when dilute sulfuric acid reacts with iron to form hydrogen or when calcium carbide makes contact with water to form acetylene.

Other examples of spontaneous chemical reactions that may produce explosions from small amounts of unstable compounds are acetylene-metal compounds, peroxides, and nitrates. In a dry state, these compounds have the potential to explode upon percussion or exposure to increased temperature.

Another class of chemical reactions that form flammable atmospheres arise from deposits of pyrophoric substances (carbon, ferrous oxide, ferrous sulfate, iron, etc.) that can be found in tanks used by the chemical and petroleum industry. These tanks containing flammable deposits will spontaneously ignite upon exposure to air.

Combustible dust concentrations are usually found during the process of loading, unloading, and conveying grain products, nitrated fertilizers, finely ground chemical products, and any other combustible material.

High charges of static electricity, which rapidly accumulate during periods of relatively low humidity (below 50%) can cause certain substances to accumulate electrostatic charges of sufficient energy to produce sparks and ignite a flammable atmosphere.

These sparks may also cause explosions when the right air or oxygen to dust or gas mixture is present.

Toxic Atmospheres

The substances to be regarded as toxic in a confined space can cover the entire spectrum of gases, vapors, and finely-divided airborne dust in industry. The sources of toxic atmospheres encountered may arise from the following:

1. The manufacturing process (for example, in producing polyvinyl chloride, hydrogen chloride is used as well as vinyl chloride monomer, which is carcinogenic).
2. The product stored [removing decomposed organic material from a tank can liberate toxic substances, such as hydrogen sulfide (**H_2S**)].
3. The operation performed in the confined space (for example, welding or brazing with metals capable of producing toxic fumes).

During loading, unloading, formulation, and production, mechanical and/or human error may also produce toxic gases which are not part of the planned operation.

Carbon monoxide (**CO**) is a hazardous gas that may build up in a confined space. This odorless, colorless gas that has approximately the same density as air is formed from incomplete combustion of organic materials such as wood, coal, gas, oil, and gasoline; it can be formed from microbial decomposition of organic matter in sewers, silos, and fermentation tanks.

CO is an insidious toxic gas because of its poor warning properties. Early stages of CO intoxication are nausea and headache. CO may be fatal at as little as 1000 ppm or 10% in air, and is considered dangerous at 200 ppm or 2%, because it forms Carboxyhemoglobin in the blood which prevents the distribution of oxygen in the body.

CO is a relatively abundant colorless, odorless gas. Therefore, any untested atmosphere must be suspect. It must also be noted that a safe reading on a combustible gas indicator does not ensure that CO is not present. CO must be tested for specifically.

The formation of CO may result from chemical reactions or work activities, therefore fatalities due to CO poisoning are not confined to any particular industry. There have been fatal accidents in sewage treatment plants due to decomposition products and lack of ventilation in confined spaces.

Another area where CO results as a product of decomposition is in the formation of silo gas in grain storage elevators. In another area, the paint industry, varnish is manufactured by introducing the various ingredients into a kettle, and heating them in an inert atmosphere, usually town gas, which is a mixture of carbon dioxide and nitrogen.

In welding operations, oxides of nitrogen and ozone are gases of major toxicological importance, and incomplete oxidation may occur and carbon monoxide can form as a byproduct.

Another poor work practice, which has led to fatalities, is the recirculation of diesel exhaust emissions. Increased CO levels can be prevented by strict control of the ventilation and the use of catalytic converters.

Procedures for Atmospheric Testing. - 1910.146 App B
OSHA Requirement

Sub-Part Title: General Environmental Controls

Atmospheric testing is required for two distinct purposes:
evaluation of the hazards of the permit space and verification that acceptable entry conditions for entry into that space exist.

(1) Evaluation testing. The atmosphere of a confined space should be analyzed using equipment of sufficient sensitivity and specificity to identify and evaluate any hazardous atmospheres that may exist or arise, so that appropriate permit entry procedures can be developed and acceptable entry conditions stipulated for that space.

Evaluation and interpretation of these data, and development of the entry procedure, should be done by, or reviewed by, a technically qualified professional (e.g., OSHA consultation service, or certified industrial hygienist, registered safety engineer, certified safety professional, certified marine chemist, etc.) based on evaluation of all serious hazards.

(2) Verification testing. The atmosphere of a permit space which may contain a hazardous atmosphere should be tested for residues of all contaminants identified by evaluation testing using permit specified equipment to determine that residual concentrations at the time of testing and entry are within the range of acceptable entry conditions.

Results of testing (i.e., actual concentration, etc.) should be recorded on the permit in the space provided adjacent to the stipulated acceptable entry condition.

(3) Duration of testing. Measurement of values for each atmospheric parameter should be made for at least the minimum response time of the test instrument specified by the manufacturer.

(4) Testing stratified atmospheres. When monitoring for entries involving a descent into atmospheres that may be stratified, the atmospheric envelope should be tested a distance of approximately 4 feet (1.22 m) in the direction of travel and to each side. If a sampling probe is used, the entrant's rate of progress should be slowed to accommodate the sampling speed and detector response.

(5) Order of testing. A test for oxygen is performed first because most combustible gas meters are oxygen dependent and will not provide reliable readings in an oxygen deficient atmosphere.

Combustible gases are tested for next because the threat of fire or explosion is both more immediate and more life threatening, in most cases, than exposure to toxic gases and vapors. If tests for toxic gases and vapors are necessary, they are performed last.

This is a ten-minute escape air pack or emergency air supply. The plastic bag with go over your head during an emergency and provide enough air to get out of the hole. There are smaller versions of this system.

Functional Buttons:

On/Off	Press black button and hold until display tells you to RELEASE. Turn on in a clean-air environment.
Mode	Press "mode" button at display prompt.
E Button	Press (E) button at display prompt.
Alarm Mode	Red lights flash and unit beeps. Beeps are more frequent at higher contaminant levels, or lower oxygen level.

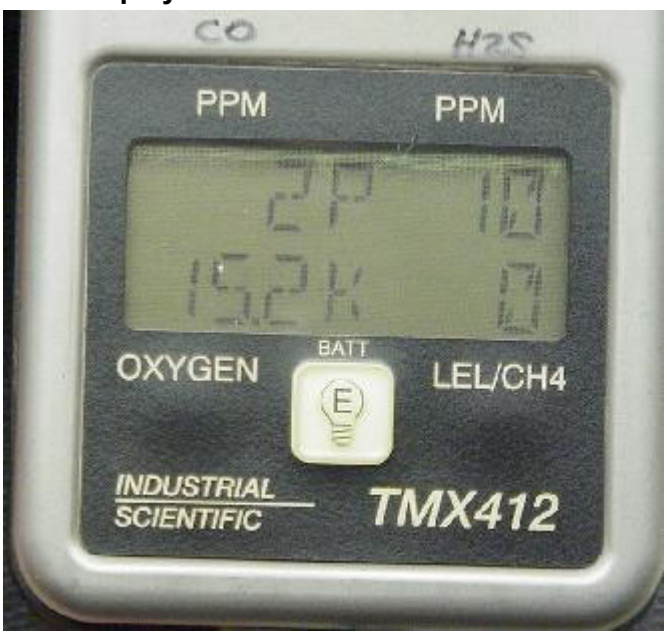
Forced air ventilation with a disposable air shaft.

Typical Display of the TMX412

Location of gases on display.

Example of a clean air display. Carbon monoxide (**CO**) and hydrogen sulfide (**H_2S**) are in ppm; oxygen (**O_2**) and lower explosive limit (**LEL**) readings are percentage values. The battery-life indicator is just right of the oxygen display (i.e., 20.9); each line represents about one hour of service remaining.

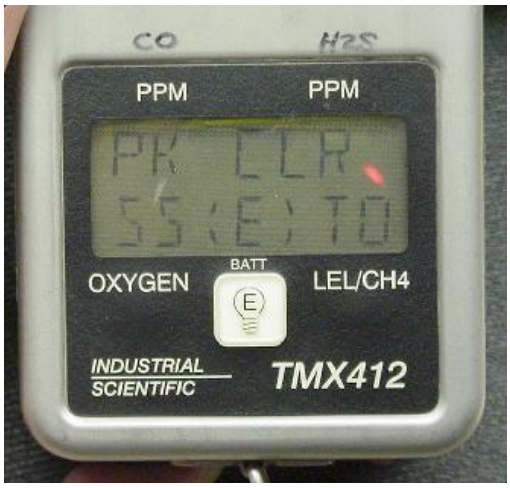
Peak Display Function



Example Display for Peak Mode: The display reads 2 ppm peak value for CO and 10 ppm peak value for H_2S (top line);
15.2 % for oxygen and 0 % for LEL (bottom line).

- Use the PEAK function to display highest recorded readings for CO, H2S, and LEL, and the lowest reading for O2.
- Readings are not erased when you turn the unit off. You must use the PEAK CLEAR function to erase the memory.
- Make sure you check the peak readings have been cleared before you start your monitoring session.
- Press mode button until display reads "P" (top line), and "K" (bottom line) (see photo).

Peak Clear Function



- Use the **PEAK CLEAR** function to clear peak readings from the internal memory. Readings are not erased when you turn the unit off. You must use the **PEAK CLEAR** function to erase the memory.
- Press mode button until display reads "**PK CLR PRESS (E) TO RESET**". After you press the (E) button, press mode button again until peak reading appears. Unit should now read 0,0 (top line), and 21, 0 (bottom line) assuming this was performed in a clean-air environment.

Zero Function and Calibration Function:

- Zero and Calibration Functions are performed by Attendant or as specified by the Supervisor or manufacturer.
- Special equipment and experience is necessary to properly perform these functions.

Documentation and Training:

- Make sure you are familiar with all of our confined space entry equipment, including the multi-gas monitor, before use.
- Make sure to document your air monitoring data (e.g., peak values and other relevant data) on the Confined Space Air Monitoring Data Form.

You need continued atmospheric monitoring during the entry in any confined space. Most entrants will carry two gas monitors for increased safety.

Atmospheric Testing Policy *Example*

Before entry, it is necessary to test the atmosphere in the confined space for oxygen levels, flammability, and/or any contaminants that have a potential to be present in that confined space. This testing must be done by a qualified person using equipment which has been approved for use in such areas.

The testing equipment itself should be checked to make sure it is working properly before using it. Follow the manufacturer's recommended procedures.

Testing of the confined spaces should be conducted throughout the entire portion of the space that workers will occupy during the entry. This testing shall be done without the use of ventilation systems.

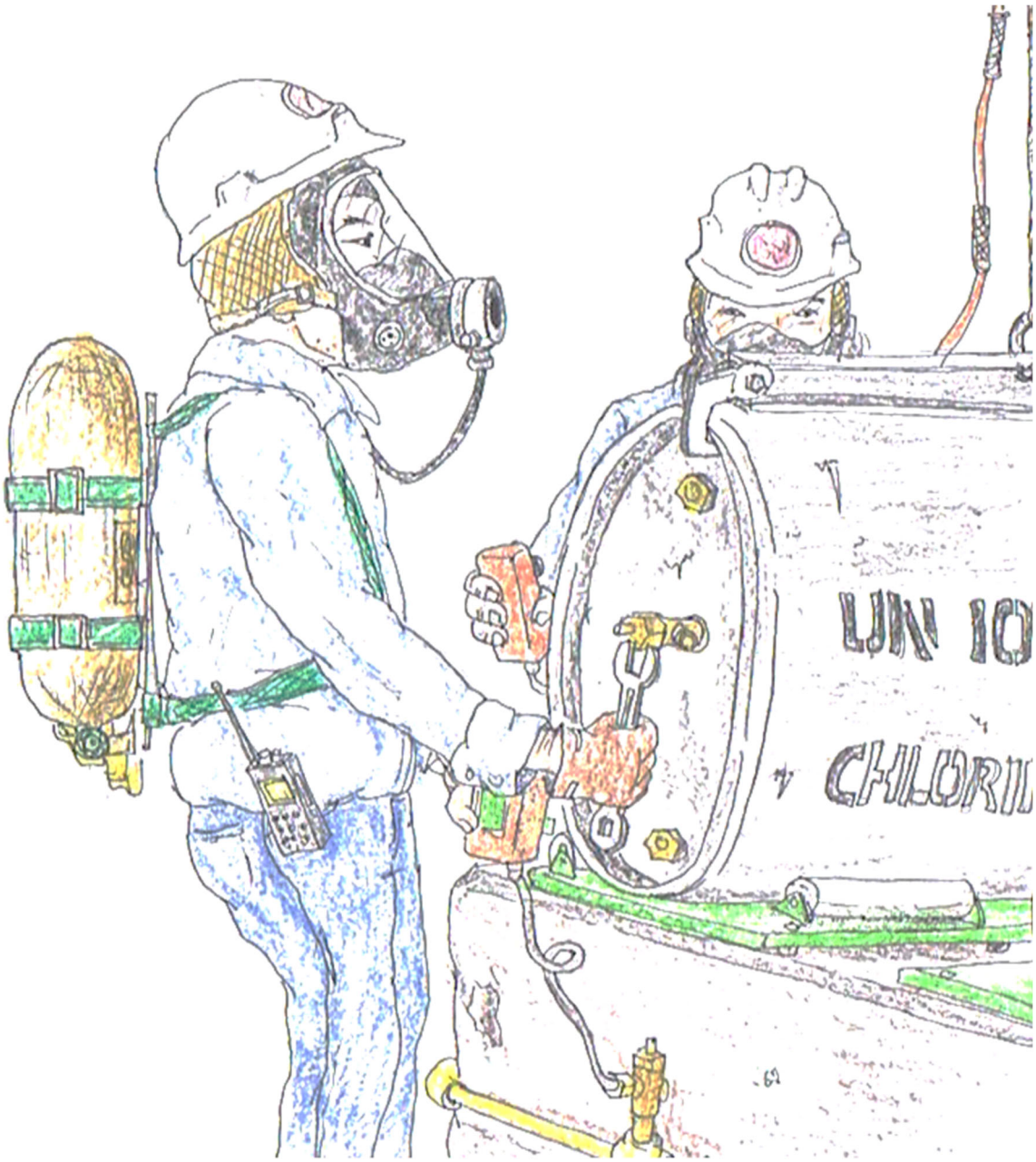
Where the entry is vertical into the confined space, it is recommended that remote probes be used to measure the atmosphere at various levels. This is necessary because some gases and vapors are lighter or heavier than air and can accumulate at different levels in the confined space. Test outside the confined space to make sure the surrounding air is not contaminated.

Atmospheric conditions are considered unacceptable if oxygen levels are less than 19.5% or greater than 23.5%. Regulations define the following unacceptable levels of other hazards monitored:

1. A flammable gas, vapor or mist greater than 10% of its lower flammable limit (**LFL**). LFL means the minimum concentration of the flammable material which will ignite if an ignition source is present.
2. An airborne combustible dust at a concentration that obscures vision at a distance of five feet or less.
3. An atmospheric concentration of a substance greater than the allowed limit in the Material Safety Data Sheet for that substance.

If test results conclude that the atmospheric condition of the confined space is unacceptable, entry is prohibited until such conditions are brought into acceptable limits. This may be done by purging, cleaning and/or ventilating the space.
Purging refers to the method by which gases, vapors, or other airborne impurities are displaced from a confined space.

The confined space may also be made non-flammable, non-explosive or otherwise chemically non-reactive by displacing or diluting the original atmosphere with steam or gas that is non-reactive with respect to that space, a process referred to as "***inerting***".



Fire, Explosion, and Reactivity Hazards

Some chemicals present physical hazards such as the potential for fire, explosion, and reactivity. The SDS formerly called the MSDS explains these physical hazards.
Flammable chemicals—catch fire easily. The SDS will tell if it's flammable.
Flash point—the minimum temperature at which a liquid gives off enough vapors to burn. The lower the flash point, the more flammable the substance.
Flammable limits—the range of concentration of a substance in the air within which a substance can readily catch fire. Concentrations below or above the limits are less likely to ignite or burn.

Irritant (Corrosive) Atmospheres

Irritant or corrosive atmospheres can be divided into primary and secondary groups. The primary irritants exert no systemic toxic effects (effects on the entire body).

Examples of primary irritants are chlorine, ozone, hydrochloric acid, hydrofluoric acid, sulfuric acid, nitrogen dioxide, ammonia, and sulfur dioxide. A secondary irritant is one that may produce systemic toxic effects in addition to surface irritation. Examples of secondary irritants include benzene, carbon tetrachloride, ethyl chloride, trichloroethane, trichloroethylene, and chloropropene.

Irritant gases vary widely among all areas of industrial activity. They can be found in plastics plants, chemical plants, the petroleum industry, tanneries, refrigeration industries, paint manufacturing, and mining operations.

Prolonged exposure at irritant or corrosive concentrations in a confined space may produce little or no evidence of irritation. This may result in a general weakening of the defense reflexes from changes in sensitivity. The danger in this situation is that the worker is usually not aware of any increase in his/her exposure to toxic substances.

Asphyxiating Atmospheres
The normal atmosphere is composed approximately of 20.9% oxygen and 78.1% nitrogen, and 1% argon with small amounts of various other gases. Reduction of oxygen in a confined space may be the result of either consumption or displacement.

The consumption of oxygen takes place during combustion of flammable substances, as in welding, heating, cutting, and brazing. A more subtle consumption of oxygen occurs during bacterial action, as in the fermentation process.

Oxygen may also be consumed during chemical reactions as in the formation of rust on the exposed surface of the confined space (iron oxide). The number of people working in a confined space and the amount of their physical activity will also influence the oxygen consumption rate.

A second factor in oxygen deficiency is displacement by another gas. Examples of gases that are used to displace air, and therefore reduce the oxygen level are helium, argon, and nitrogen.

Carbon dioxide may also be used to displace air and can occur naturally in sewers, storage bins, wells, tunnels, wine vats, and grain elevators.

Aside from the natural development of these gases, or their use in the chemical process, certain gases are also used as inerting agents to displace flammable substances and retard pyrophoric reactions.

Gases such as nitrogen, argon, helium, and carbon dioxide, are frequently referred to as non-toxic inert gases but have claimed many lives. The use of nitrogen to inert a confined space has claimed more lives than carbon dioxide.

The total displacement of oxygen by nitrogen will cause immediate collapse and death.

Carbon Dioxide
Carbon dioxide and argon, with specific gravities greater than air, may lie in a tank or manhole for hours or days after opening. Since these gases are colorless and odorless, they pose an immediate hazard to health unless appropriate oxygen measurements and ventilation are adequately carried out.

Oxygen Deprivation
Oxygen deprivation is one form of asphyxiation. While it is desirable to maintain the atmospheric oxygen level at 21% by volume, the body can tolerate deviation from this ideal. When the oxygen level falls to 17%, the first sign of hypoxia is deterioration to night vision, which is not noticeable until a normal oxygen concentration is restored.

Physiologic effects are increased breathing volume and accelerated heartbeat.

Between 14-16% physiologic effects are increased breathing volume, accelerated heartbeat, very poor muscular coordination, rapid fatigue, and intermittent respiration.

Between 6-10% the effects are nausea, vomiting, inability to perform, and unconsciousness. Less than 6%, the effects are spasmodic breathing, convulsive movements, and death in minutes.

Mechanical Hazards
If activation of electrical or mechanical equipment would cause injury, each piece of equipment should be manually isolated to prevent inadvertent activation before workers enter or while they work in a confined space. The interplay of hazards associated with a confined space, such as the potential of flammable vapors or gases being present, and the build-up of static charge due to mechanical cleaning, such as abrasive blasting, all influence the precautions which must be taken.

To prevent vapor leaks, flashbacks, and other hazards, workers should completely isolate the space. To completely isolate a confined space, the closing of valves is not sufficient.

All pipes must be physically disconnected or isolation blanks bolted in place. Other special precautions must be taken in cases where flammable liquids or vapors may re-contaminate the confined space.

The pipes blanked or disconnected should be inspected and tested for leakage to check the effectiveness of the procedure. Other areas of concern are steam valves, pressure lines, and chemical transfer pipes. A less apparent hazard is the space referred to as a void, such as double walled vessels, which must be given special consideration in blanking off and inerting.

Thermal Effects
Four factors influence the interchange of heat between people and their environment. They are: (1) air temperature, (2) air velocity, (3) moisture contained in the air, and (4) radiant heat. Because of the nature and design of most confined spaces, moisture content and radiant heat are difficult to control.

As the body temperature rises progressively, workers will continue to function until the body temperature reaches approximately 102^{o}F.

When this body temperature is exceeded, the workers are less efficient, and are prone to heat exhaustion, heat cramps, or heat stroke. In a cold environment, certain physiologic mechanisms come into play, which tend to limit heat loss and increase heat production.

The most severe strain in cold conditions is chilling of the extremities so that activity is restricted. Special precautions must be taken in cold environments to prevent frostbite, trench foot, and general hypothermia.

Proper signage is essential.

What types of dangerous gases are inside this sewer manhole? Who knows unless you have a gas meter.

Protective Insulated Clothing

Protective insulated clothing for both hot and cold environments will add additional bulk to the worker and must be considered in allowing for movement in the confined space and exit time. Therefore, air temperature of the environment becomes an important consideration when evaluating working conditions in confined spaces.

Noise
Noise problems are usually intensified in confined spaces because the interior tends to cause sound to reverberate and thus expose the worker to higher sound levels than those found in an open environment.

This intensified noise increases the risk of hearing damage to workers, which could result in temporary or permanent loss of hearing. Noise in a confined space which may not be intense enough to cause hearing damage may still disrupt verbal communication with the emergency standby person on the exterior of the confined space.

If the workers inside are not able to hear commands or danger signals due to excessive noise, the probability of severe accidents can increase.

Vibration
Whole body vibration may affect multiple body parts and organs, depending upon the vibration characteristics. Segmental vibration, unlike whole body vibration, appears to be more localized in creating injury to the fingers and hands of workers using tools, such as pneumatic hammers, rotary grinders or other hand tools which cause vibration.

Other Hazards
Some physical hazards cannot be eliminated because of the nature of the confined space or the work to be performed. These hazards include such items as scaffolding, surface residues, and structural hazards.

The use of scaffolding in confined spaces has contributed too many accidents caused by workers or materials falling, improper use of guard rails, and lack of maintenance to insure worker safety.

The choice of material used for scaffolding depends upon the type of work to be performed, the calculated weight to be supported, and the surface on which the scaffolding is placed, as well as the substance previously stored in the confined space.

Surface residues in confined spaces can increase the already hazardous conditions of electrical shock, reaction of incompatible materials, liberation of toxic substances, and bodily injury due to slips and falls. Without protective clothing, additional hazards to health may arise due to surface residues.

Structural hazards within a confined space such as baffles in horizontal tanks, trays in vertical towers, bends in tunnels, overhead structural members, or scaffolding installed for maintenance constitute physical hazards, which are exacerbated by the physical surroundings. In dealing with structural hazards, workers must review and enforce safety precautions to assure safety.

Abbreviations:
PEL - permissible exposure limit: Average concentration that must not be exceeded during 8-hour work shift of a 40-hour workweek.
STEL - Short-term exposure limit: 15-minute exposure limit that must not be exceeded during the workday.
REL - Recommended exposure limit: Average concentration limit recommended for up to a 10-hour workday during a 40-hour workweek.
IDLH - Immediately dangerous to life or health: Maximum concentration from which person could escape (in event of respiratory failure) without permanent or escape-impairing effects within 30 minutes.

SCBA Storage Box

Required Confined Space Equipment Policy *Example*

Air Testing Equipment
All air-testing equipment should be calibrated in accordance with the manufacturer's instruction.

Oxygen Meters and Monitors
The oxygen content of the air in a confined space is the first and most important constituent to measure before entry is made. The acceptable range of oxygen is between 19.5 and 23.5 percent. This content is measured before flammability is tested because rich mixtures of flammable gases or vapors give erroneous measurement results.

For example, a mixture of 90 percent methane and 10 percent air will test nonflammable because there is not enough oxygen to support the combustion process in the flammability meters. This mixture will not support life and will soon become explosive if ventilation is provided to the space. Before entry, spaces must be ventilated until both oxygen content and flammability are acceptable.

Flammability Meters
Flammability meters are used to measure the amount of flammable vapors or gases in the atmosphere as a percent of the LEL/LFL. The oxygen content must be near 21 percent for results to be meaningful.

Toxic Air Contamination Testers
Tests for toxic contaminants must be specific for the target toxin. The instrument manufacturer should be consulted for interferences. Therefore, it is important to know the history of the confined space so proper tests can be performed. Part of hazard assessment is to identify all possible contaminants that could be in the confined space.

Protective Devices

Fall-Protection Equipment
Fall-protection equipment for confined spaces should be the chest-waist harness type to minimize injuries from uncontrolled movements when it arrests a worker's fall. This type of harness also permits easier retrieval from a confined space than a waist belt. Adjustable lanyards should be used to limit free fall to two feet before arrest.

Respirators
An industrial hygienist should select respirators on the basis of his or her evaluation of possible confined-space hazards. NIOSH-approved respirators should be identified in the approved procedure required by the confined-space entry permit. It is important to note that air-purifying respirators cannot be used in an oxygen deficient atmosphere.

Lockout/Tagout Devices
Lockout/tagout devices permit employees to work safely on de-energized equipment without fear that the devices will be accidentally removed. Lock and tag devices are required to withstand a 50-pound pull without failure.

Devices used to block or restrain stored mechanical energy devices must be engineered for safety.

Safety Barriers
Safety barriers separate workers from hazards that cannot reasonably be eliminated by other engineering controls.

Required barriers will be identified in the approved confined-space entry procedure.

Ground Fault Circuit Interrupters
Ground fault circuit interrupter must be used for all portable electrical tools and equipment in confined spaces because most workers will be in contact with grounded surroundings.

Emergency Response Equipment

Fire Extinguishers
"***Hot work***" inside a confined space requires that an approved fire extinguisher and a person trained in its use be stationed in the confined space or in a suitable vantage point where he or she could effectively suppress any fire that might result from the work.

First Aid Equipment
Blankets, first-aid kit, Stokes stretchers, and any other equipment that may be needed for first-response treatment must be available just outside the confined space. Medical and safety professionals should select equipment on the basis of their evaluations of the potential hazards in the confined space.

Retrieval Equipment
A tripod or another suitable anchorage, hoisting device, harnesses, wristlets, ropes, and any other equipment that may be needed to make a rescue must be identified in the confined-space safe-entry procedures.

It is important that this equipment be available for immediate use. Harnesses and retrieval ropes must be worn by entrants unless they would increase hazards to the entrants or impede their rescue.

Summary
A Confined Space Entry Program
Should Include the Following:

- Written confined space entry procedures
- Evaluation to determine whether entry is necessary
- Issuance of a confined space entry permit
- Evaluation of the confined space by a qualified person
- Testing and monitoring the air quality in the confined space to ensure:
- Oxygen level is at least 19.5%
- Flammable range is less than 10% of the LFL (lower flammable limit)
- Training of workers and supervisors in the selection and use of:
    - *safe entry procedures*
    - *respiratory protection*
    - *lifelines and retrieval systems*
    - *protective clothing*
- Training of employees in safe work procedures in and around confined spaces
- Training of employees in confined space rescue procedures
- Conducting safety meetings to discuss confined space safety
- Availability and use of proper ventilation equipment
- Monitoring the air quality while workers are in the confined space.

Recommendation #2: Employers should identify the types of confined spaces within their jurisdiction and develop and implement confined space entry and rescue programs.

Discussion: Employers may be required to enter confined spaces to perform either non-emergency tasks or emergency rescue.

Therefore, employers should identify the types of confined spaces within their jurisdiction and develop and implement confined space entry and rescue programs that include written emergency rescue guidelines and procedures for entering confined spaces. A confined space program, as outlined in NIOSH Publications 80-106 and 87-113, should be implemented. At a minimum, the following should be addressed:

1. Is entry necessary? Can the task be accomplished from the outside? For example, measures that eliminate the need for employees to enter confined spaces should be carefully evaluated and implemented if at all possible before considering human entry into confined spaces to perform non-emergency tasks.

2. If entry is to be made, has the air quality in the confined space been tested for safety based on the following:
- oxygen supply at least 19.5%
- flammable range for all explosive gases less than 10% of the lower flammable limit
- absence of toxic air contaminants?

3. Is ventilation equipment available and/or used?

4. Is appropriate rescue equipment available?

5. Are supervisors being continuously trained in the selection and use of appropriate rescue equipment such as:

- SCBA's
- lifelines
- human hoist systems offering mechanical advantage
- protective clothing
- ventilation systems

6. Are employees being properly trained in confined space entry procedures?

7.Are confined space safe work practices discussed in safety meetings?

8. Are employees trained in confined space rescue procedures?

9. Is the air quality monitored when the ventilation equipment is operating?

The American National Standards Institute (ANSI) Standard Z117.1-1989 (Safety Requirements for Confined Spaces), 3.2 and 3.2.1 state, "***Hazards shall be identified for each confined space. The hazard identification process shall include, ... the past and current uses of the confined space which may adversely affect the atmosphere of the confined space; ... The hazard identification process should consider items such as ... the operation of gasoline engine powered equipment in or around the confined space***."

D-Ring on the rear of the harness is necessary for the entrant to be retrieved from the confined space.

Confined Space Post Quiz

Confined Space Hazards

1. Fatalities and injuries constantly occur among construction workers who are required to enter _____.

2. _____ are associated with specific types of equipment and the interactions among them. These hazards can be electrical, thermal, chemical, mechanical, etc.

Confined space:

3. A confined space is large enough or so configured that an employee can _____.

4. A confined space is not designed for _____.

5. A permit required confined space (permit space) contains a material that has _____.

Typical Examples of Confined Workspaces

6. Confined workspaces in construction contain _____.

7. Workers must enter _____ found on the construction jobsite to perform a number of functions.

8. The ever-present possibility of _____ is one of the major problems confronting construction workers while working in vaults.

9. According to the text, a _____ normally considered a problem associated with confined spaces is material or equipment which may fall into the vault.

10. Manholes are necessary to provide a means of entry into and exit from vaults, tanks, and pits, but these confined spaces may present _____ which could cause injuries and fatalities.

11. The pipe assembly is one of the _____ encountered throughout the construction site,

12. Once inside a pipe assembly, workers are faced with _____, often caused by purging with argon or another inert gas.

13. _____ is another problem to which the worker is exposed when inside a pipe assembly.

14. The worker may suffer _____ caused by heat within the pipe run.

15. Tanks are _____ that are used for a variety of purposes, including the storage of water and chemicals.

16. According to the text, oxygen-deficient atmospheres, along with toxic and explosive atmospheres created by the substances stored in the tanks, present hazards to workers.
A. True B. False

17. Heat in tanks may cause _____, particularly on a hot day.

18. Entry supervisors must coordinate all entry procedures, tests, _____, equipment, and other activities related to the permit space entry.

19. Before endorsing the permit and allowing entry to begin, the _____ must check that all appropriate entries have been made on the permit, all tests specified by the permit have been conducted, and that all procedures and equipment specified by the permit are in place.

20. A responsibility of the entry attendant is to know the hazards that may be faced during entry, including information on the mode, signs or symptoms, and consequences of the exposure.
A. True B. False

OSHA Construction Confined Space Standard

On May 4, 2015, OSHA issued a new standard for construction work in confined spaces, which became effective August 3, 2015. Confined spaces can present physical and atmospheric hazards that can be avoided if they are recognized and addressed prior to entering these spaces to perform work. The new standard, Subpart AA of 29 CFR 1926 will help prevent construction workers from being hurt or killed by eliminating and isolating hazards in confined spaces at construction sites similar to the way workers in other industries are already protected.

§1926.1203 General requirements.
(a) Before it begins work at a worksite, each employer must ensure that a competent person identifies all confined spaces in which one or more of the employees it directs may work, and identifies each space that is a permit space, through consideration and evaluation of the elements of that space, including testing as necessary.
(b) If the workplace contains one or more permit spaces, the employer who identifies, or who receives notice of, a permit space must:
(1) Inform exposed employees by posting danger signs or by any other equally effective means, of the existence and location of, and the danger posed by, each permit space; and
Note to paragraph §1926.1203(b)(1). A sign reading “DANGER -- PERMITREQUIRED CONFINED SPACE, DO NOT ENTER” or using other similar language would satisfy the requirement for a sign.
(2) Inform, in a timely manner and in a manner other than posting, its employees’ authorized representatives and the controlling contractor of the existence and location of, and the danger posed by, each permit space.
(c) Each employer who identifies, or receives notice of, a permit space and has not authorized employees it directs to work in that space must take effective measures to prevent those employees from entering that permit space, in addition to complying with all other applicable requirements of this standard.
(d) If any employer decides that employees it directs will enter a permit space, that employer must have a written permit space program that complies with §1926.1204 implemented at the construction site. The written program must be made available prior to and during entry operations for inspection by employees and their authorized representatives.
(e) An employer may use the alternate procedures specified in paragraph §1926.1203(e)(2) for entering a permit space only under the conditions set forth in paragraph §1926.1203(e)(1).
(1) An employer whose employees enter a permit space need not comply with §§1926.1204 through 1206 and §§1926.1208 through 1211, provided that all of the following conditions are met:
(i) The employer can demonstrate that all physical hazards in the space are eliminated or isolated through engineering controls so that the only hazard posed by the permit space is an actual or potential hazardous atmosphere;
(ii) The employer can demonstrate that continuous forced air ventilation alone is sufficient to maintain that permit space safe for entry, and that, in the event the ventilation system stops working, entrants can exit the space safely;

(iii) The employer develops monitoring and inspection data that supports the demonstrations required by paragraphs §1926.1203(e)(1)(i) and §1926.1203(e)(1)(ii);
(iv) If an initial entry of the permit space is necessary to obtain the data required by paragraph §1926.1203(e)(1)(iii), the entry is performed in compliance with §§1926.1204 through 1211 of this standard;
(v) The determinations and supporting data required by paragraphs §1926.1203(e)(1)(i), (e)(1)(ii), and (e)(1)(iii) are documented by the employer and are made available to each employee who enters the permit space under the terms of paragraph §1926.1203(e) or to that employee's authorized representative; and
(vi) Entry into the permit space under the terms of paragraph §1926.1203(e)(1) is performed in accordance with the requirements of paragraph §1926.1203(e)(2).
Note to paragraph §1926.1203(e)(1). See paragraph §1926.1203(g) for reclassification of a permit space after all hazards within the space have been eliminated.
(2) The following requirements apply to entry into permit spaces that meet the conditions set forth in paragraph §1926.1203(e)(1):
(i) Any conditions making it unsafe to remove an entrance cover must be eliminated before the cover is removed.
(ii) When entrance covers are removed, the opening must be immediately guarded by a railing, temporary cover, or other temporary barrier that will prevent an accidental fall through the opening and that will protect each employee working in the space from foreign objects entering the space.
(iii) Before an employee enters the space, the internal atmosphere must be tested, with a calibrated direct-reading instrument, for oxygen content, for flammable gases and vapors, and for potential toxic air contaminants, in that order. Any employee who enters the space, or that employee's authorized representative, must be provided an opportunity to observe the pre-entry testing required by this paragraph.
(iv) No hazardous atmosphere is permitted within the space whenever any employee is inside the space.
(v) Continuous forced air ventilation must be used, as follows:
(A) An employee must not enter the space until the forced air ventilation has eliminated any hazardous atmosphere;
(B) The forced air ventilation must be so directed as to ventilate the immediate areas where an employee is or will be present within the space and must continue until all employees have left the space;
(C) The air supply for the forced air ventilation must be from a clean source and must not increase the hazards in the space.
(vi) The atmosphere within the space must be continuously monitored unless the entry employer can demonstrate that equipment for continuous monitoring is not commercially available or periodic monitoring is sufficient. If continuous monitoring is used, the employer must ensure that
the monitoring equipment has an alarm that will notify all entrants if a specified atmospheric threshold is achieved, or that an employee will check the monitor with sufficient frequency to ensure that entrants have adequate time to escape. If continuous monitoring is not used, periodic monitoring is required. All monitoring must ensure that the continuous forced air ventilation is preventing the accumulation of a hazardous atmosphere. Any employee who enters the space, or that employee's authorized representative, must be provided with an opportunity to observe the testing required by this paragraph.
(vii) If a hazard is detected during entry:

(A) Each employee must leave the space immediately;
(B) The space must be evaluated to determine how the hazard developed; and
(C) The employer must implement measures to protect employees from the hazard before any subsequent entry takes place.
(viii) The employer must ensure a safe method of entering and exiting the space.
If a hoisting system is used, it must be designed and manufactured for personnel hoisting; however, a job-made hoisting system is permissible if it is approved for personnel hoisting by a registered professional engineer, in writing, prior to use.
(ix) The employer must verify that the space is safe for entry and that the pre-entry measures required by paragraph §1926.1203(e)(2) have been taken, through a written certification that contains the date, the location of the space, and the signature of the person providing the certification. The certification must be made before entry and must be made available to each employee entering the space or to that employee's authorized representative.
(f) When there are changes in the use or configuration of a non-permit confined space that might increase the hazards to entrants, or some indication that the initial evaluation of the space may not have been adequate, each entry employer must have a competent person re-evaluate that space and, if necessary, reclassify it as a permit required confined space.
(g) A space classified by an employer as a permit-required confined space may only be reclassified as a non-permit confined space when a competent person determines that all of the applicable requirements in paragraphs §1926.1203(g)(1) through (g)(4) have been met:
(1) If the permit space poses no actual or potential atmospheric hazards and if all hazards within the space are eliminated or isolated without entry into the space (unless the employer can demonstrate that doing so without entry is infeasible), the permit space may be reclassified as a non-permit confined space for as long as the non-atmospheric hazards remain eliminated or isolated;
(2) The entry employer must eliminate or isolate the hazards without entering the space, unless it can demonstrate that this is infeasible. If it is necessary to enter the permit space to eliminate or isolate hazards, such entry must be performed under §§1926.1204 through 1211 of this standard. If testing and inspection during that entry demonstrate that the hazards within the permit space have been eliminated or isolated, the permit space may be reclassified as a non-permit confined space for as long as the hazards remain eliminated or isolated; Note to paragraph §1926.1203(g)(2). Control of atmospheric hazards through forced air ventilation does not constitute elimination or isolation of the hazards. Paragraph §1926.1203(e) covers permit space entry where the employer can demonstrate that forced air ventilation alone will control all hazards in the space.
(3) The entry employer must document the basis for determining that all hazards in a permit space have been eliminated or isolated, through a certification that contains the date, the location of the space, and the signature of the person making the determination. The certification must be made available to each employee entering the space or to that employee's authorized representative; and
(4) If hazards arise within a permit space that has been reclassified as a non-permit space under paragraph §1926.1203(g), each employee in the space must exit the space. The entry employer must then reevaluate the space and reclassify it as a permit space as appropriate in accordance with all other applicable provisions of this standard.
(h) Permit Space Entry Communication and Coordination:

(1) Before entry operations begin, the host employer must provide the following information, if it has it, to the controlling contractor:
(i) The location of each known permit space;
(ii) The hazards or potential hazards in each space or the reason it is a permit space; and
(iii) Any precautions that the host employer or any previous controlling contractor or entry employer implemented for the protection of employees in the permit space.
(2) Before entry operations begin, the controlling contractor must:
(i) Obtain the host employer's information about the permit space hazards and previous entry operations; and
(ii) Provide the following information to each entity entering a permit space and any other entity at the worksite whose activities could foreseeably result in a hazard in the permit space:
(A) The information received from the host employer;
(B) Any additional information the controlling contractor has about the subjects listed in paragraph (h)(1) of this section; and
(C) The precautions that the host employer, controlling contractor, or other entry employers implemented for the protection of employees in the permit spaces.
(3) Before entry operations begin, each entry employer must:
(i) Obtain all of the controlling contractor's information regarding permit space hazards and entry operations; and
(ii) Inform the controlling contractor of the permit space program that the entry employer will follow, including any hazards likely to be confronted or created in each permit space.
(4) The controlling contractor and entry employer(s) must coordinate entry operations when:
(i) More than one entity performs permit space entry at the same time; or
(ii) Permit space entry is performed at the same time that any activities that could foreseeably result in a hazard in the permit space are performed.
(5) After entry operations:
(i) The controlling contractor must debrief each entity that entered a permit space regarding the permit space program followed and any hazards confronted or created in the permit space(s) during entry operations;
(ii) The entry employer must inform the controlling contractor in a timely manner of the permit space program followed and of any hazards confronted or created in the permit space(s) during entry operations; and
(iii) The controlling contractor must apprise the host employer of the information exchanged with the entry entities pursuant to this subparagraph.
Note to paragraph §1926.1203(h). Unless a host employer or controlling contractor has or will have employees in a confined space, it is not required to enter any confined space to collect the information specified in this paragraph (h).
(iv) If there is no controlling contractor present at the worksite, the requirements for, and role of, controlling contactors in §1926.1203 must be fulfilled by the host employer or other employer who arranges to have employees of another employer perform work that involves permit space
entry.

§1926.1204 Permit-Required Confined Space Program.

Each entry employer must:

(a) Implement the measures necessary to prevent unauthorized entry;

(b) Identify and evaluate the hazards of permit spaces before employees enter them;

(c) Develop and implement the means, procedures, and practices necessary for safe permit space entry operations, including, but not limited to, the following:

(1) Specifying acceptable entry conditions;

(2) Providing each authorized entrant or that employee's authorized representative with the opportunity to observe any monitoring or testing of permit spaces;

(3) Isolating the permit space and physical hazard(s) within the space;

(4) Purging, inerting, flushing, or ventilating the permit space as necessary to eliminate or control atmospheric hazards;

Note to paragraph §1204(c)(4). When an employer is unable to reduce the atmosphere below 10 percent LFL, the employer may only enter if the employer inerts the space so as to render the entire atmosphere in the space noncombustible, and the employees use PPE to address any other atmospheric hazards (such as oxygen deficiency), and the employer eliminates or isolates all physical hazards in the space.

(5) Determining that, in the event the ventilation system stops working, the monitoring procedures will detect an increase in atmospheric hazard levels in sufficient time for the entrants to safely exit the permit space;

(6) Providing pedestrian, vehicle, or other barriers as necessary to protect entrants from external hazards;

(7) Verifying that conditions in the permit space are acceptable for entry throughout the duration of an authorized entry, and ensuring that employees are not allowed to enter into, or remain in, a permit space with a hazardous atmosphere unless the employer can demonstrate that personal protective equipment (PPE) will provide effective protection for each employee in the permit space and provides the appropriate PPE to each employee; and

(8) Eliminating any conditions (for example, high pressure) that could make it unsafe to remove an entrance cover.

(d) Provide the following equipment (specified in paragraphs §1926.1204(d)(1) through (d)(9)) at no cost to each employee, maintain that equipment properly, and ensure that each employee uses that equipment properly:

(1) Testing and monitoring equipment needed to comply with paragraph §1926.1204(e);

(2) Ventilating equipment needed to obtain acceptable entry conditions;

(3) Communications equipment necessary for compliance with paragraphs §1926.1208(c) and §1926.1209(e), including any necessary electronic communication equipment for attendants assessing entrants' status in multiple spaces;

(4) Personal protective equipment insofar as feasible engineering and work-practice controls do not adequately protect employees;

Note to paragraph §1926.1204(d)(4). The requirements of subpart E of this part and other PPE requirements continue to apply to the use of PPE in a permit space. For example, if employees use respirators, then the respirator requirements in §1926.103 (Respiratory protection) must be met.

(5) Lighting equipment that meets the minimum illumination requirements in §1926.56, that is approved for the ignitable or combustible properties of the specific gas, vapor, dust, or fiber that will be present, and that is sufficient to enable employees to see well enough to work safely and to exit the space quickly in an emergency;

(6) Barriers and shields as required by paragraph §1926.1204(c)(4);
(7) Equipment, such as ladders, needed for safe ingress and egress by authorized entrants;
(8) Rescue and emergency equipment needed to comply with paragraph §1926.1204(i), except to the extent that the equipment is provided by rescue services; and
(9) Any other equipment necessary for safe entry into, safe exit from, and rescue from, permit spaces.
(e) Evaluate permit space conditions in accordance with the following paragraphs (e)(1) through (6) of this section when entry operations are conducted:
(1) Test conditions in the permit space to determine if acceptable entry conditions exist before changes to the space's natural ventilation are made, and before entry is authorized to begin, except that, if an employer demonstrates that isolation of the space is infeasible because the space is large or is part of a continuous system (such as a sewer), the employer must:
(i) Perform pre-entry testing to the extent feasible before entry is authorized;
and,
(ii) If entry is authorized, continuously monitor entry conditions in the areas where authorized entrants are working, except that employers may use periodic monitoring in accordance with paragraph §1926.1204(e)(2) for monitoring an atmospheric hazard if they can demonstrate that equipment for continuously monitoring that hazard is not commercially available;
(iii) Provide an early-warning system that continuously monitors for non-isolated engulfment hazards. The system must alert authorized entrants and attendants in sufficient time for the authorized entrants to safely exit the space.
(2) Continuously monitor atmospheric hazards unless the employer can demonstrate that the equipment for continuously monitoring a hazard is not commercially available or that periodic monitoring is of sufficient frequency to ensure that the atmospheric hazard is being controlled at safe levels. If continuous monitoring is not used, periodic monitoring is required with sufficient frequency to ensure that acceptable entry conditions are being maintained during the course of entry operations;
(3) When testing for atmospheric hazards, test first for oxygen, then for combustible gases and vapors, and then for toxic gases and vapors;
(4) Provide each authorized entrant or that employee's authorized representative an opportunity to observe the pre-entry and any subsequent testing or monitoring of permit spaces;
(5) Reevaluate the permit space in the presence of any authorized entrant or that employee's authorized representative who requests that the employer conduct such reevaluation because there is some indication that the evaluation of that space may not have been adequate; and
(6) Immediately provide each authorized entrant or that employee's authorized representative with the results of any testing conducted in accordance with §1926.1204 of this standard.
(f) Provide at least one attendant outside the permit space into which entry is authorized for the duration of entry operations;
(1) Attendants may be assigned to more than one permit space provided the duties described in §1926.1209 of this standard can be effectively performed for each permit space.
(2) Attendants may be stationed at any location outside the permit space as long as the duties described in §1926.1209 of this standard can be effectively performed for each permit space to which the attendant is assigned.
(g) If multiple spaces are to be assigned to a single attendant, include in the permit program the means and procedures to enable the attendant to respond to an emergency affecting one or more of those permit spaces without distraction from the attendant's responsibilities under §1926.1209 of this standard;

(h) Designate each person who is to have an active role (as, for example, authorized entrants, attendants, entry supervisors, or persons who test or monitor the atmosphere in a permit space) in entry operations, identify the duties of each such employee, and provide each such employee with the training required by §1926.1207 of this standard;
(i) Develop and implement procedures for summoning rescue and emergency services (including procedures for summoning emergency assistance in the event of a failed non-entry rescue), for rescuing entrants from permit spaces, for providing necessary emergency services to rescued employees, and for preventing unauthorized personnel from attempting a rescue;
(j) Develop and implement a system for the preparation, issuance, use, and cancellation of entry permits as required by this standard, including the safe termination of entry operations under both planned and emergency conditions;
(k) Develop and implement procedures to coordinate entry operations, in consultation with the controlling contractor, when employees of more than one employer are working simultaneously in a permit space or elsewhere on the worksite where their activities could, either alone or in conjunction with the activities within a permit space, foreseeably result in a hazard within the confined space, so that employees of one employer do not endanger the employees of any other employer;
(l) Develop and implement procedures (such as closing off a permit space and canceling the permit) necessary for concluding the entry after entry operations have been completed;
(m) Review entry operations when the measures taken under the permit space program may not protect employees and revise the program to correct deficiencies found to exist before subsequent entries are authorized; and
Note to paragraph §1926.1204(m). Examples of circumstances requiring the review of the permit space program include, but are not limited to: any unauthorized entry of a permit space, the detection of a permit space hazard not covered by the permit, the detection of a condition prohibited by the permit, the occurrence of an injury or near-miss during entry, a change in the use or configuration of a permit space, and employee complaints about the effectiveness of the program.
(n) Review the permit space program, using the canceled permits retained under paragraph §1926.1205(f), within 1 year after each entry and revise the program as necessary to ensure that employees participating in entry operations are protected from permit space hazards.
Note to paragraph §1926.1204(n). Employers may perform a single annual review covering all entries performed during a 12-month period. If no entry is performed during a 12-month period, no review is necessary.

§1926.1205 Permitting Process.
(a) Before entry is authorized, each entry employer must document the completion of measures required by paragraph §1926.1204(c) of this standard by preparing an entry permit.
(b) Before entry begins, the entry supervisor identified on the permit must sign the entry permit to authorize entry.
(c) The completed permit must be made available at the time of entry to all authorized entrants or their authorized representatives, by posting it at the entry portal or by any other equally effective means, so that the entrants can confirm that pre-entry preparations have been completed.
(d) The duration of the permit may not exceed the time required to complete the assigned task or job identified on the permit in accordance with paragraph §1926.1206(b) of this standard.
(e) The entry supervisor must terminate entry and take the following action when any of the following apply:
(1) Cancel the entry permit when the entry operations covered by the entry permit have been completed; or
(2) Suspend or cancel the entry permit and fully reassess the space before allowing reentry when a condition that is not allowed under the entry permit arises in or near the permit space and that condition is temporary in nature and does not change the configuration of the space or create any new hazards within it; and
(3) Cancel the entry permit when a condition that is not allowed under the entry permit arises in or near the permit space and that condition is not covered by subparagraph (e)(2) of this section.
(f) The entry employer must retain each canceled entry permit for at least 1 year to facilitate the review of the permit-required confined space program required by paragraph §1926.1204(n) of this standard. Any problems encountered during an entry operation must be noted on the pertinent permit so that appropriate revisions to the permit space program can be made.

§1926.1206 Entry permit.
The entry permit that documents compliance with this section and authorizes entry to a permit space must identify:
(a) The permit space to be entered;
(b) The purpose of the entry;
(c) The date and the authorized duration of the entry permit;
(d) The authorized entrants within the permit space, by name or by such other means (for example, through the use of rosters or tracking systems) as will enable the attendant to determine quickly and accurately, for the duration of the permit, which authorized entrants are inside the permit space;
Note to paragraph §1926.1206(d). This requirement may be met by inserting a reference on the entry permit as to the means used, such as a roster or tracking system, to keep track of the authorized entrants within the permit space.
(e) Means of detecting an increase in atmospheric hazard levels in the event the ventilation system stops working;
(f) Each person, by name, currently serving as an attendant;
(g) The individual, by name, currently serving as entry supervisor, and the signature or initials of each entry supervisor who authorizes entry;
(h) The hazards of the permit space to be entered;

(i) The measures used to isolate the permit space and to eliminate or control permit space hazards before entry;
Note to paragraph §1926.1206(i). Those measures can include, but are not limited to, the lockout or tagging of equipment and procedures for purging, inerting, ventilating, and flushing permit spaces.
(j) The acceptable entry conditions;
(k) The results of tests and monitoring performed under paragraph §1926.1204(e) of this standard, accompanied by the names or initials of the testers and by an indication of when the tests were performed;
(l) The rescue and emergency services that can be summoned and the means (such as the equipment to use and the numbers to call) for summoning those services;
(m) The communication procedures used by authorized entrants and attendants to maintain contact during the entry;
(n) Equipment, such as personal protective equipment, testing equipment, communications equipment, alarm systems, and rescue equipment, to be provided for compliance with this standard;
(o) Any other information necessary, given the circumstances of the particular confined space, to ensure employee safety; and
(p) Any additional permits, such as for hot work, that have been issued to authorize work in the permit space.

§1926.1207 Training.
(a) The employer must provide training to each employee whose work is regulated by this standard, at no cost to the employee, and ensure that the employee possesses the understanding, knowledge, and skills necessary for the safe performance of the duties assigned under this standard. This training must result in an understanding of the hazards in the permit space and the methods used to isolate, control or in other ways protect employees from these hazards, and for those employees not authorized to perform entry rescues, in the dangers of attempting such rescues.
(b) Training required by this section must be provided to each affected employee:
(1) In both a language and vocabulary that the employee can understand;
(2) Before the employee is first assigned duties under this standard;
(3) Before there is a change in assigned duties;
(4) Whenever there is a change in permit space entry operations that presents a hazard about which an employee has not previously been trained; and
(5) Whenever there is any evidence of a deviation from the permit space entry procedures required by paragraph §1926.1204(c) of this standard or there are inadequacies in the employee's knowledge or use of these procedures.
(c) The training must establish employee proficiency in the duties required by this standard and must introduce new or revised procedures, as necessary, for compliance with this standard.
(d) The employer must maintain training records to show that the training required by paragraphs §1926.1207(a) through (c) of this standard has been accomplished. The training records must contain each employee's name, the name of the trainers, and the dates of training. The documentation must be available for inspection by employees and their authorized representatives, for the period of time the employee is employed by that employer.

§1926.1208 Duties of authorized entrants.
The entry employer must ensure that all authorized entrants:
(a) Are familiar with and understand the hazards that may be faced during entry, including information on the mode, signs or symptoms, and consequences of the exposure;
(b) Properly use equipment as required by paragraph §1926.1204(d) of this standard;
(c) Communicate with the attendant as necessary to enable the attendant to assess entrant status and to enable the attendant to alert entrants of the need to evacuate the space as required by paragraph §1926.1209(f) of this standard;
(d) Alert the attendant whenever:
(1) There is any warning sign or symptom of exposure to a dangerous situation; or
(2) The entrant detects a prohibited condition; and
(e) Exit from the permit space as quickly as possible whenever:
(1) An order to evacuate is given by the attendant or the entry supervisor;
(2) There is any warning sign or symptom of exposure to a dangerous situation;
(3) The entrant detects a prohibited condition; or
(4) An evacuation alarm is activated.

§1926.1209 Duties of attendants.
The entry employer must ensure that each attendant:
(a) Is familiar with and understands the hazards that may be faced during entry, including information on the mode, signs or symptoms, and consequences of the exposure;
(b) Is aware of possible behavioral effects of hazard exposure in authorized entrants;
(c) Continuously maintains an accurate count of authorized entrants in the permit space and ensures that the means used to identify authorized entrants under paragraph 1926.1206(d) of this standard accurately identifies who is in the permit space;
(d) Remains outside the permit space during entry operations until relieved by another attendant;
Note to paragraph §1926.1209(d). Once an attendant has been relieved by another attendant, the relieved attendant may enter a permit space to attempt a rescue when the employer's permit space program allows attendant entry for rescue and the attendant has been trained and equipped for rescue operations as required by paragraph §1926.1211(a).
(e) Communicates with authorized entrants as necessary to assess entrant status and to alert entrants of the need to evacuate the space under paragraph §1926.1208(e);
(f) Assesses activities and conditions inside and outside the space to determine if it is safe for entrants to remain in the space and orders the authorized entrants to evacuate the permit space immediately under any of the following conditions:
(1) If there is a prohibited condition;
(2) If the behavioral effects of hazard exposure are apparent in an authorized entrant;
(3) If there is a situation outside the space that could endanger the authorized entrants; or
(4) If the attendant cannot effectively and safely perform all the duties required under §1926.1209 of this standard;
(g) Summons rescue and other emergency services as soon as the attendant determines that authorized entrants may need assistance to escape from permit space hazards;
(h) Takes the following actions when unauthorized persons approach or enter a permit space while entry is underway:

(1) Warns the unauthorized persons that they must stay away from the permit space;
(2) Advises the unauthorized persons that they must exit immediately if they have entered the permit space; and (3) Informs the authorized entrants and the entry supervisor if unauthorized persons
have entered the permit space;
(i) Performs non-entry rescues as specified by the employer's rescue procedure; and
(j) Performs no duties that might interfere with the attendant's primary duty to assess and protect the authorized entrants.

§1926.1210 Duties of entry supervisors.
The entry employer must ensure that each entry supervisor:
(a) Is familiar with and understands the hazards that may be faced during entry, including information on the mode, signs or symptoms, and consequences of the exposure;
(b) Verifies, by checking that the appropriate entries have been made on the permit, that all tests specified by the permit have been conducted and that all procedures and equipment specified by the permit are in place before endorsing the permit and allowing entry to begin;
(c) Terminates the entry and cancels or suspends the permit as required by paragraph 1926.1205(e) of this standard;
(d) Verifies that rescue services are available and that the means for summoning them are operable, and that the employer will be notified as soon as the services become unavailable;
(e) Removes unauthorized individuals who enter or who attempt to enter the permit space during entry operations; and
(f) Determines, whenever responsibility for a permit space entry operation is transferred, and at intervals dictated by the hazards and operations performed within the space, that entry operations remain consistent with terms of the entry permit and that acceptable entry conditions are maintained.

§1926.1211 Rescue and emergency services.
(a) An employer who designates rescue and emergency services, pursuant to paragraph §1926.1204(i) of this standard, must:
(1) Evaluate a prospective rescuer's ability to respond to a rescue summons in a timely manner, considering the hazard(s) identified;
Note to paragraph §1926.1211(a)(1). What will be considered timely will vary according to the specific hazards involved in each entry.

For example, §1926.103—Respiratory Protection requires that employers provide a standby person or persons capable of immediate action to rescue employee(s) wearing respiratory protection while in work areas defined as IDLH atmospheres.
(2) Evaluate a prospective rescue service's ability, in terms of proficiency with rescue-related tasks and equipment, to function appropriately while rescuing entrants from the particular permit space or types of permit spaces identified;
(3) Select a rescue team or service from those evaluated that:
(i) Has the capability to reach the victim(s) within a time frame that is appropriate for the permit space hazard(s) identified;
(ii) Is equipped for, and proficient in, performing the needed rescue services;

(iii) Agrees to notify the employer immediately in the event that the rescue service becomes unavailable;
(4) Inform each rescue team or service of the hazards they may confront when called on to perform rescue at the site; and
(5) Provide the rescue team or service selected with access to all permit spaces from which rescue may be necessary so that the rescue team or service can develop appropriate rescue plans and practice rescue operations.
(b) An employer whose employees have been designated to provide permit space rescue and/or emergency services must take the following measures and provide all equipment and training at no cost to those employees:
(1) Provide each affected employee with the personal protective equipment (PPE) needed to conduct permit space rescues safely and train each affected employee so the employee is proficient in the use of that PPE;
(2) Train each affected employee to perform assigned rescue duties. The employer must ensure that such employees successfully complete the training required and establish proficiency as authorized entrants, as provided by §§1926.1207 and 1926.1208 of this standard;
(3) Train each affected employee in basic first aid and cardiopulmonary resuscitation (CPR). The employer must ensure that at least one member of the rescue team or service holding a current certification in basic first aid and CPR is available; and
(4) Ensure that affected employees practice making permit space rescues before attempting an actual rescue, and at least once every 12 months, by means of simulated rescue operations in which they remove dummies, manikins, or actual persons from the actual permit spaces or from representative permit spaces, except practice rescue is not required where the affected employees properly performed a rescue operation during the last 12 months in the same permit space the authorized entrant will enter, or in a similar permit space. Representative permit spaces must, with respect to opening size, configuration, and accessibility, simulate the types of permit spaces from which rescue is to be performed.
(c) Non-entry rescue is required unless the retrieval equipment would increase the overall risk of entry or would not contribute to the rescue of the entrant. The employer must designate an entry rescue service whenever non-entry rescue is not selected. Whenever non-entry rescue is selected, the entry employer must ensure that retrieval systems or methods are used whenever an authorized entrant enters a permit space, and must confirm, prior to entry, that emergency assistance would be available in the event that non-entry rescue fails. Retrieval systems must meet the following requirements:
(1) Each authorized entrant must use a chest or full body harness, with a retrieval line attached at the center of the entrant’s back near shoulder level, above the entrant’s head, or at another point which the employer can establish presents a profile small enough for the successful removal of the entrant. Wristlets or anklets may be used in lieu of the chest or full body harness if the employer can demonstrate that the use of a chest or full body harness is infeasible or creates a greater hazard and that the use of wristlets or anklets is the safest and most
effective alternative.
(2) The other end of the retrieval line must be attached to a mechanical device or fixed point outside the permit space in such a manner that rescue can begin as soon as the rescuer becomes aware that rescue is necessary. A mechanical device must be available to retrieve personnel from vertical type permit spaces more than 5 feet (1.52 meters) deep.

(3) Equipment that is unsuitable for retrieval must not be used, including, but not limited to, retrieval lines that have a reasonable probability of becoming entangled with the retrieval lines used by other authorized entrants, or retrieval lines that will not work due to the internal configuration of the permit space.
(d) If an injured entrant is exposed to a substance for which a Safety Data Sheet (SDS) or other similar written information is required to be kept at the worksite, that SDS or written information must be made available to the medical facility treating the exposed entrant.

§1926.1212 Employee participation.
(a) Employers must consult with affected employees and their authorized representatives on the development and implementation of all aspects of the permit space program required by §1926.1203 of this standard.
(b) Employers must make available to each affected employee and his/her authorized representatives all information required to be developed by this standard.

§1926.1213 Provision of documents to Secretary.
For each document required to be retained in this standard, the retaining employer must make the document available on request to the Secretary of Labor or the Secretary's designee.

Post Quiz Answers

Excavation Chapter Post Quiz Answers

1. Identifying, 2. Knowledgeable, 3. Inspection(s) or Inspect, 4. Performs, 5. Inspection(s) or Inspect, 6. Knowledge, 7. Determine(s), 8. Maintain(s), 9. Maintain(s), 10. Monitor, 11. Determine(d), 12. Precautions,13. Employees, 14. Excavation(s), 15. Access or egress, 16. Means of egress, 17. Properly secured, 18. Excavation(s)

Confined Space Chapter Answers

1. Confined spaces, 2. Inherent hazards, 3. Bodily enter and perform work, 4. Continuous employee occupancy, 5. The potential for engulfing an entrant, 6. Both inherent and induced hazards, 7. A variety of vaults,8. An oxygen-deficient atmosphere, 9. Hazard, 10. Serious hazards, 11. Most frequently unrecognized types of confined spaces, 12. Potential oxygen-deficient atmospheres, 13. Electrical shock, 14. Heat prostration, 15. Another type of confined workspace, 16. True, 17. Heat prostration, 18. Permits, 19. Entry supervisor, 20. True

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