## Trenching, Shoring, Excavation

1. **Purpose**

The purpose of this section is to provide guidelines for compliance with OSHA, Client, and Utility and Public Service Systems regulations and recommendations when engaged in earthen excavations of any kind.

1. **General Requirements**

**Surface Encumbrances**

All surface encumbrances that are located so as to create a hazard to the employee shall be removed or supported.

* Removal of surface fixtures such as street signs and objects that shall later be replaced should be done with care to reduce the need to entirely replace the fixture.
* Demolished concrete and other like surfaces shall be placed so as not to create a hazard near the excavation by falling as well as a trip hazard to pedestrians and traffic hazard to motorist.
* Support shall be provided to all structures and fixtures that cannot be removed. Fire hydrants shall be secured and protected from accidental contact with heavy equipment.
* Where the boundaries of the excavation are in close proximity with unsupported concrete pavement care shall be taken to support the structure. If possible the area in question should be relieved of traffic to reduce load and vibration hazards.

**Underground Installations**

* The estimated location of utility installations, such as sewer, telephone, fuel, electric, water lines, cable communications, or any other underground installations that may be expected to be encountered during excavation work, shall be determined prior or opening the excavation.
* Utility companies and owners shall be contacted within established or customary local time allowances, advised of the proposed work, and asked to establish the location of the utility underground installations prior to start of the actual excavation.
* When the utility companies cannot respond to a request to locate underground utility installations within 24 hours (unless a longer period is required by law) or cannot establish the exact location of the installations, the Superintendent may proceed provided it is done so with caution and provided detection equipment or other acceptable means to locate installations are used.
* When excavation operations approach the estimated location of underground installations, the exact location is to be determined by a safe and acceptable means.
* While the excavation is open underground installations shall be protected, supported or removed as necessary to safeguard employees.

1. **Access and Egress**

A stairway, ladder ramp or other safe means of egress shall be located in trench excavations that are 4 ft. or more in depth so as to require no more than 25 ft. of lateral travel for the employees.

* Trenches greater than 4 ft in depth shall have a ladder or other safe means for the employee to access, spaced no more than 25 feet apart. Ladders and other devices should be secured from slipping. The side rails of the ladder should extend at least 36 inches above the resting point.
* If ramps are used for means of egress they shall be constructed and installed in compliance with 1926.651 (4) (c).

1. **Vehicular Traffic**

Employees exposed to vehicular traffic shall be provided with, and shall wear, warning vest made of reflective or highly visible material. A uniform traffic safety vest is required by the Safety Dept. anytime an employee is subject to exposure to traffic.

1. **Falling Loads**

No employee shall be permitted underneath loads handled by lifting or digging equipment. Employees will be required to stand away from vehicles being loaded or unloaded to avoid being struck by spillage.

Operators may remain in cabs of vehicles being loaded or unloaded when equipped to provide protection from falling loads as prescribed in 1926. 651 (b)(6).

1. **Warning System for Mobile Equipment**

When mobile equipment is operated adjacent to an excavation, or when operating or required to approach the edge of the excavation:

* A warning system such as barricades, hand or mechanical signals must be used.
* Stop logs may be used to insure the safe distance of the equipment from the edge of the excavation.
* If possible the grade should be away from the excavation.

1. **Falling Material and Spoil Placement**

* All spoil and excavated material shall be placed a minimum of 2 ft. from the edge of the excavation. Many Clients, such as refineries and chemical plants request greater distance or immediate removal of excavated materials to insure against material falling back into the excavation.
* Where possible excavated material shall not be piled in such a manner as to pose a falling hazard to the employees working in the excavation, including piling the material too high to be consistently stable.
* Where it is not possible to pile excavated material 2 ft or more from the edge of the excavation the material shall be removed and/or placed behind an adequate retainer barrier to prevent it from falling on employees in the excavation.
* Where possible equipment shall be kept a minimum of two feet from the edge of the excavation to prevent shifting and/or material from falling on employees working in the excavation by means suggested above.

1. **Fall Protection**

* Where employees are required or permitted to cross over excavations, walkways or bridges with standard handrails shall be provided.
* Where walkways are six feel or more above lower levels, guardrails shall be provided.
* Adequate barrier protection shall be provided on all remote excavations. All wells, pits, and shafts shall be barricaded.
* Temporary excavations and exploratory excavations shall be back filled as soon as possible.

1. **Accumulated Water in Excavations**

Employees shall not work in excavations where there is accumulated water or in excavations where water is accumulating, unless adequate precautions are taken to protect employees from the hazards posed by the water accumulation. The control methods vary from one project to the next, but include:

* Special support and shoring devices and shielding shall be provided in the event of a cave-in caused by weakening of the excavation walls.
* De-watering of the excavation to prevent/remove accumulated water and to control it while the excavation is occupied by employees. This may be accomplished by use of pumps, drainage trenches or other adequate means to remove and control the water.
* Employees entering the excavation to facilitate De-watering activities, or entering the excavation with accumulated water present shall wear a lifeline and body harness.
* Excavations which are subject to water accumulation from storm run-off or which interrupts natural or man-made drainage diversion ditches, dikes, or canals require an inspection by a competent person and compliance with 1926.651 must be accomplished. Special shoring and control methods must be utilized.
* Stock piles or excavated material, jobsite shacks and construction equipment shall be stored in a manner and height so as not to block the vision of motorist entering street intersections or crossroads etc.

1. **Stability of Adjacent Structures**

* 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 for the protection of the employees.
* Excavation below the level of the base or footing of any foundation or retaining wall that could pose a hazard to employees shall not be permitted without a registered engineer who has determined and approved that the structure is sufficiently removed from the excavation as not to pose a hazard or that such excavation work shall not pose a hazard to employees. Structures on stable rock are excluded.
* Sidewalks, pavements and appurtenant structures shall not be undermined unless a support system or other method of protection is provided to protect employees from the possible collapse of such structures.

1. **Hazardous Atmospheres in Excavations**

Excavations are susceptible to both inadequate oxygen levels due to poor ventilation, and the introduction and harboring of gases capable of displacing air and or toxic gases which have a tendency to be heavier than air and accumulate in excavations, trenches and other low lying areas.

The corporate CONFINED SPACE ENTRY PROGRAM must be implemented on any excavation that by dimension, location and potential for a hazardous atmosphere exist. Such excavations require special permitting, atmosphere testing, employee training and record maintenance that the Safety Dept. can assist you with.

1. **Operation of Heavy Equipment**

The specific guidelines for safe operation of heavy equipment, while being mentioned in this section, shall be addressed both in the Manufacturer’s Operator Manual and the Operation of Heavy Equipment Sectionof this manual.

* Care should be taken to inspect the area adjacent to the excavation, as well as the excavation itself for signs of weakening and instability prior to approaching the site with the equipment.
* Prior to approaching the excavation for work, the operator shall establish a means of communication and signals with the employee/flagmen engaged in the work.
* In the event an employee attempts to walk or is in a position to be under a load, the operator shall avoid the employee by grounding the load if possible, or avoiding the employee by another route.
* The operator shall inspect the machine prior to all excavation activity daily.
* The operator shall use care in extending and placement of outriggers to ensure stability of the equipment and protection of the edge of the excavation.
* The operator shall not allow employees to work near, under or around the machine in such close proximity as to present a hazard to the employee.
* The lifting of underground items such as sewer pipe and other utilities for removal shall be done only after it is established that the maximum load is within the safe limits for the machine being used. Proper rigging shall be used and attached appropriately.

1. **Fuel and Combustible Liquids**

The storage of fuel tanks and/or fuel containers greater than 5 gallon capacity shall not be allowed within 50 ft of the excavation whenever possible. Care and provisions should be made to protect the storage area against inadvertent damage and leaks that could drain into the excavation.

Whenever it is suspected that hazardous conditions are present in an excavation all employees shall be evacuated immediately. The excavation shall be tested before work resumes insuring there are no hazards present.

1. **Additional Protective Measures**

The project Supervisor shall conduct regular tool box meeting which shall include reviewing the signs of imminent failure of trench and excavation walls, the dangers of accumulated water. The personal safety of the employees working in close proximity with equipment, as well as the special requirements of the specific project and client required topics.

The Project Supervisor and/or Foreman shall conduct periodic and frequent review of the employees’ compliance with the use of personal protective equipment, excavation standards, client required standards and special methods of performance not outlined in this section.

1. **Trenches and Trench Sloping Procedures**

**Trenches** are defined as 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 the trench (measured at the bottom) is no greater than 15 feet. If forms or other structures are installed or constructed in an excavation so as to reduce the dimensions from the forms or structure to the side of the excavation to 15 feet or less the excavation is considered to be a trench.

**Cave-Ins** means the separation of a mass of soil or 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 an excavation either by sliding or falling, in sufficient quantity so that it could entrap, bury, or otherwise injure or immobilize a person.

**Cave-Ins** may be caused by:

* Hydrostatic pressures from thawing and freezing
* Vibration and load bearing stress from vehicles working in or near the excavation.
* Improper sloping of trench walls
* Failure to remove spoil, equipment, or materials to a safe distance from the edge of the excavation.
* Failure to shore and to brace trench walls
* Failure to inspect walls and shoring of excavations on a frequent basis
* The failure to use shoring on a temporary short-term excavation.

**Warning Signals**

The detection of a potential cave in shall be assessed and appropriate and required protection provided by means of soil test and site assessment by a competent person as part of the initial trenching and excavation survey. On those projects measures to include special shielding, shoring and sloping methods are taken prior to the opening of the excavation.

Each employee should be instructed, as a matter of course, to identify basic signs of an imminent failure of an excavation edge or wall by reviewing recognition of:

* Tension cracks
* Moisture, leaching ground water
* Changes in soil texture
* Minor failures increasing in size or number at the edges of the excavation.
* Shifting of shoring, obvious displacement of retaining devices
* Spreading or bulging of retainment walls, shoring

1. **Requirements for Protective Sloping and Benching for Trenches**

Each employee in an excavation shall be protected from cave-ins by an adequate protective system designed in accordance with OSHA 29CFR1926 652 (b) or (c) except when:

* Excavations are made entirely in solid rock
* Excavations are less than 5 feet in depth and examination by a competent person provides no indication for potential cave-in.

1. **Design of Sloping and Benching Systems**

The design of sloping and benching systems to be used shall be accomplished by a competent person as defined using methods developed and stated in 29CFR 1926.652 (b) using the alternatives provided and allowed to provide an adequate and feasible protective system defined in subpart (b) (1) (2) (3) or (4) as required by the specific nature of the excavation.

1. **Installation and Removal of Support Devices and Systems**

* Members of support systems shall be securely connected together to prevent sliding, falling, kick outs, or other predictable failure.
* Support systems shall be installed and removed in a manner which protects employees from cave ins, structural collapses or from being struck by members of the support system.
* Individual members of the support system shall not be subjected to loads exceeding those they were not designed to withstand.
* Before removal of individual members of the system, additional precautions shall be taken to ensure the safety of the employees, such as installing other structural members to carry the loads imposed on the system.
* Removal shall begin at the bottom of the excavation and progress from the bottom of the excavation. Members shall be release 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.
* Backfilling will progress with the removal of the support system.
* If a member is damaged it shall be removed from service prior to installation. If it is damaged during removal it shall be noted and not be reused until repaired as required.
* The use of taglines during the removal of structural members of the system is required (sheet piling etc.).
* If a vibrating hammer is used to install or remove members of the system care shall be taken to comply with the **Hearing Conservation Program** of this manual if needed.
* Where the installation or removal of support system members is performed on a natural or man-made body of water such as a work barge driving sheet piling, provisions shall be made to comply with all personal protective and rescue requirements for working over or near water.
* Where excavation of material below the support system is required, it shall not exceed more than 2 ft. from the bottom of the support system. The support system must be capable to resist the forces calculated to the full depth of the excavation, and there are no indications of a possible loss of soil from behind or below the bottom of the support.
* All structural and support systems shall be frequently inspected for damaged members, signs of stress, distress and potential failure. A competent person shall accomplish this.
* Depending on the support system utilized under subpart b, any changes to an engineered support system must be approved by the certified engineer prior to effecting those changes, including, but not limited to removal of any member of the system for any reason.

1. **Shield Systems / Trench Boxes**

* Shield systems shall not be subjected to loads exceeding those that the system was designed to withstand.
* Shield systems shall be installed in a manner to restrict lateral or other hazardous movement of the shield in the event of application of sudden lateral loads.
* Employees shall be protected from the hazards of cave-ins when entering or exiting the area protected by the shields.
* Employees shall not be allowed in shields when shields are being installed, removed, or moved vertically.
* Shield systems shall be inspected daily, prior to use.
* Any damaged member shall be repaired/replaced by a competent person prior to returning it to service it must be tested.
* All applicable requirements of this section shall be complied with during any excavation project including those using shield systems.
* The selection of, design and use of a shield system on any project shall follow and comply with 1926 CFR 652 particularly appendix (b) as it applies to minimum design and selection procedures.

1. **Inspections**

Competent Person-A designated “competent person” is capable of identifying existing and predictable hazards in the surrounding or working conditions which are unsanitary, hazardous, or dangerous, to employees, and who has authorization to take prompt corrective measures to eliminate them.

All foreman and superintendents have gone through trenching and shoring safety training. Also refresher training is given yearly on trenching and shoring safety. All foremen and superintendents have the authority to stop or correct and unsafe condition or unsafe act.

* Inspections shall be performed prior to the commencement of work by a competent person on a daily basis and after any incident that has the potential to change the integrity of the excavation as described:
  + Any sign of a potential failure or cave-in
  + Indication of a failure of a protective system
  + Indication of a hazardous environment
  + Accumulated water
* An inspection shall be performed as needed throughout the shift and also made:
  + After every rainstorm.
  + After every incident with the potential to change the integrity of the excavation

1. **Warnings and Potential Problems**

Evaluation of the soil, support system and drainage or other steps taken in trenching operations does not remove the need for continuous inspection for signs of trouble. Even the most carefully planned and executed installations can be effected by changes in any number of factors.

* Subsidence of the ground surface adjacent to the walls of a cut is a sign of trouble. However slowly it may occur, if subsidence progresses it is very serious.
* Inspect for tension cracks that form in the ground surface parallel to the trench, thus delineating the most critical zone.
* Spilling of small chunks of material from the face of the excavation wall should be investigated by a competent person immediately and the potential for cave-in evaluated as a possibility.
* Walls and bottoms should be thoroughly inspected after dewatering activities, where a quick bottom occurs ordinarily after dewatering a persisting condition requires further evaluation of the need for a supportive system and more frequent inspection.
* During late winter and early spring water tables tend to be high, significantly effecting excavation and trench wall strength. Additionally, high yield of inch per hour rainstorms in the summer can produce the equivalent of flash flood conditions when an open excavation is attractive to drain off. All excavations are subject to storm runoff and accumulation of storm water. After every storm it is important to thoroughly inspect and re-evaluate the condition of the project.

Trouble signs call for immediate action to be taken. The installation of a support system, approved reinforcing of the present system, addition of bracing, improved dewatering activity, and the evacuation of non-essential personnel from the area are all options to be considered. The use of harnesses and lifelines on essential personnel enacting revisions to the system must also be considered as part of a prudent and safe undertaking. The use of and benefits that support systems offer to the protection of human life and the profitability of any excavation project is reliant upon the total cooperation and dedication to these regulations and procedures. The manufacturer’s guidelines, design limits, methods of installation and removal should be acquired, complied with and maintained as record on the jobsite where the system is in place. All record keeping shall be maintained on the project.

1. **Sloping and Benching Procedures**

**MAXIMUM ALLOWABLE SLOPES**

**SOIL/ROCK TYPE (H:V)**   **DEGREES**

**SOLID ROCK VERTICAL 90**

**TYPE A 3/4 : 1 53**

**TYPE B 1 : 1 45**

**TYPE C 1.5 : 1 34**

\* SLOPING OR BENCHING FOR EXCAVATIONS GREATER THAN 20 FT. IN DEPTH SHALL BE DESIGNED BY A REGISTERED PROFESSIONAL ENGINEER.

1. **Soil Classification**

OSHA 29 CFR 1926. 652 appendix A to subpart B requires specific guidelines and disciplines to be applied to classification of soil for the purpose of selection and design of supportive systems, shoring, sloping and benching and timber shoring of excavations and trenches.

The classification of the soil must be determined prior to a specific system or angle of repose can be effectively determined to be adequate in the protection of employees against cave-in.