EXCAVATION SAFETY

STUDENT WORKBOOK

VERSION 3.1

D2000 Safety, Inc.
(800) 551-8763
www.d2000safety.com

EXCAVATION SAFETY

TRAINING

STUDENT WORKBOOK

Version 3.1

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IMPORTANT NOTE: This manual is intended to supplement, not replace, the policies and procedures used in the students' work environment. While we have made every effort to ensure the accuracy of the information in this manual, different work environments pose distinct and different work challenges. The policies and procedures developed by the students' employer take precedence over any information in this manual.

(800) 551-8763

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Notes

Course Objectives and Outline

Course Objectives

Upon completion of this course, you should be able to:

- Define and perform the duties of a competent person.
- Understand OSHA regulations pertaining to excavation safety.
- Identify types of excavations & trench components.
- Describe the various ways that soil fails.
- Recognize the factors that cause or contribute to cave-ins.
- Test and classify soils according to OSHA specifications.
- Identify the proper protective system based on soil type and conditions.
- Identify hazards, both in and around the excavation, that affect the safety of employees or the general public.
- Describe the elements of an excavation safety program.
- Complete a Competent Person excavation inspection.

Course Outline

I. Excavation Safety Basics

II. Soil Mechanics

III. Soil Classification

IV. Protective Systems

V. Excavation Safety Planning

VI. Emergency Planning

I. Excavation Safety Basics

The Competent Person

OSHA defines a Competent Person as:

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.

Comp. Person Must Understand:

- Soil mechanics & analysis,
- Trench failure patterns,
- Protective systems, and
- General requirements for working safely below ground.

Hazards and Statistics

Hazards

Entrapment ______________________________

Electrocution ______________________________

Explosion ______________________________

Suffocation ______________________________

Toxins/Corrosives ______________________________

Vehicles ______________________________

Falling Loads ______________________________

Falls ______________________________

In spite of OSHA regulations governing excavations, about:

- 100 people die each year due to cave-ins and other hazards.
- Thousands more are injured.
- Fatality rate is 112% higher than general construction.

35% Sewer ____

15% Water systems ______________________________________

94% of cave-ins: No sloping, shielding, shoring ____________________

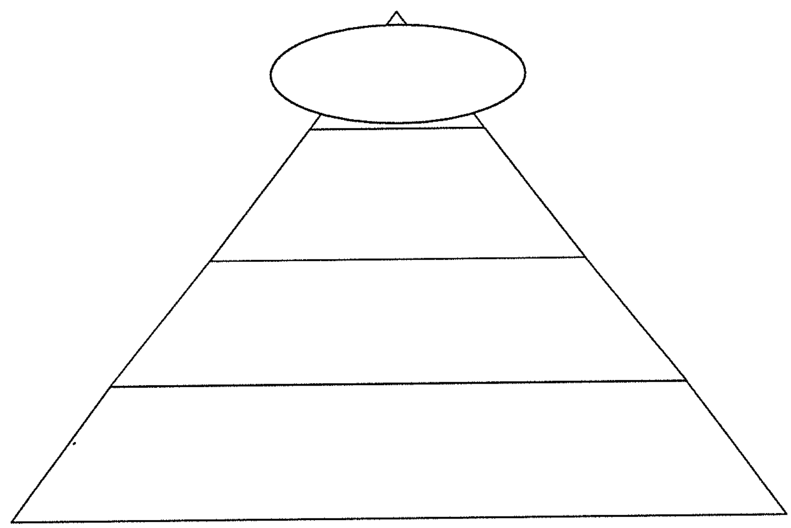
60% No competent person inspection __________________________

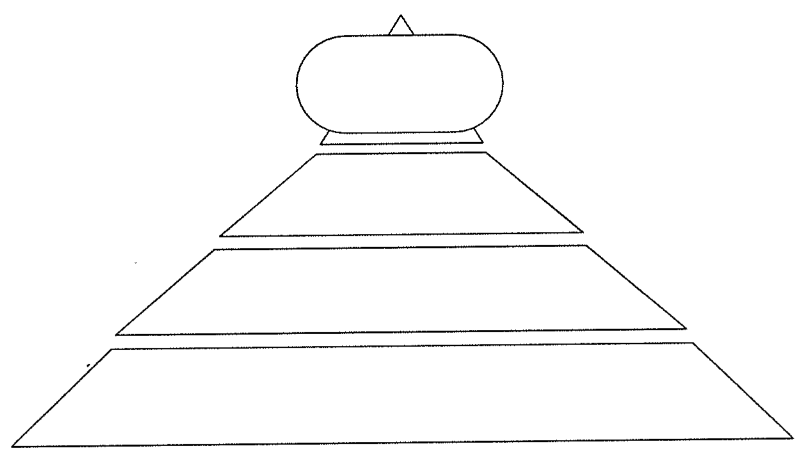
98% Non-union workers ___________________________________

37% Trenches 0 – 5 feet. __________________________________

FACE Analysis, Lew, Abram, 2002

Two Pyramids





1926 Subpart P

- 1926.650 Scope, Applications, Definitions
- 1926.651 Specific Excavation Requirements
- 1926.652 Requirements for Protective Systems
- Appendices

1926.650 Scope, Application, Definitions

Accepted Engineering Practices: ______________________________

____

Aluminum Hydraulic Shoring: ______________________________

____

Bell-bottom pier hole: ______________________________

Benching: ______________________________

Cave-in: ______________________________

____

Competent Person: ______________________________

Cross Braces: ______________________________

Excavation: ______________________________

____

Faces or Sides: ______________________________

Failure: ______________________________

Hazardous atmospheres: ______________________________

____

Kickout: ______________________________

Protective System: ____________________

Ramp: ____________________

Registered Professional Engineer: ____________________

Sheeting: ____________________

Shield: ____________________

Shoring: ____________________

Sloping: ____________________

Stable Rock: ____________________

Structural Ramp: ____________________

Support System: ____________________

Tabulated Data: ____________________

Trench: ____________________

Trench Box/Trench Shield: ____________________

Uprights: ____________________

Wales (Walers): ____________________

Other Useful Definitions

Affected Zone: ____________________

Distress: ____________________

Fissures: ____________________

Lateral Earth Pressure: ____________________

Sloping: ____________________

Spalls: ____________________

Surface Encumbrances: ____________________

Tunnels: ____________________

1926.651: Specific Excavation Requirements

(a) Surface Encumbrances

___

(b) Underground Installations

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___

(c) Access and Egress

___

___

___

___

(d) Exposure to Vehicular Traffic

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___

(e) Exposure to Falling Loads

___

___

(f) Warning System for Mobile Equipment

___

___

(g) Hazardous Atmospheres

(h) Protection from Water Accumulation Hazards

(i) Stability of Adjacent Structures

(j) Protection from Loose Rock or Soil

(k) Inspections

(l) Fall Protection

II. Soil Mechanics

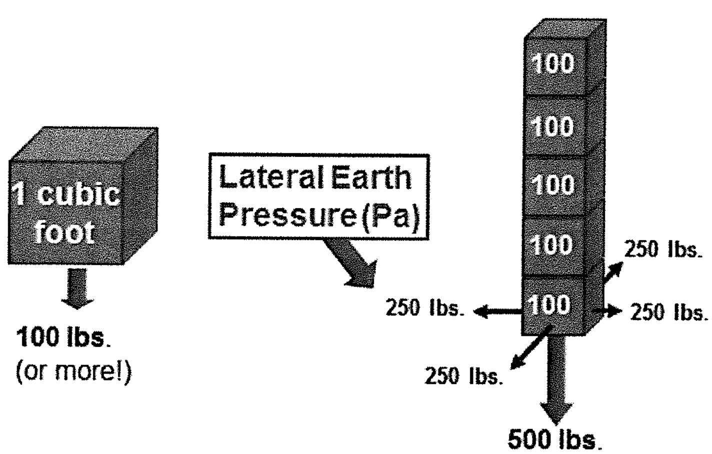
Soil is a complex mix of: ______________________________

____

Soil Weight

Soil Type	Weight (lbs./ft³)	Sat. Weight (lbs./ft³)
Sand, loose and uniform	90	118
Sand, dense and uniform	109	130
Sand, loose and well graded	99	124
Sand, dense and well graded	116	135
Clay, soft	76	110
Clay, stiff	106	125

Lateral Earth Pressure



Forces Resisting Pa:

Friction

____

Cohesion

____

Forces Enhancing Pa:

- Depth
- Surcharge Loads
- Vibration
- Water
- Duration

Calculating Lateral Earth Pressure (Pa)

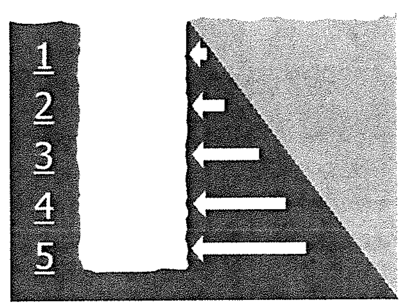
Pa = Soil Type Factor times trench depth plus the Pa from the spoil pile (height of the spoil times 36).

Type A Soil

Soil Type Factor = 25

____

____

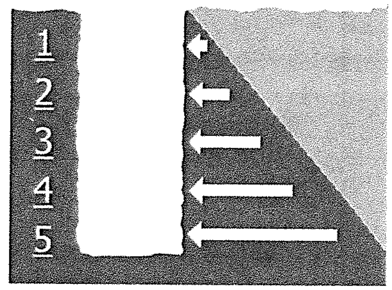


Type B Soil

Soil Type = 45

____

____

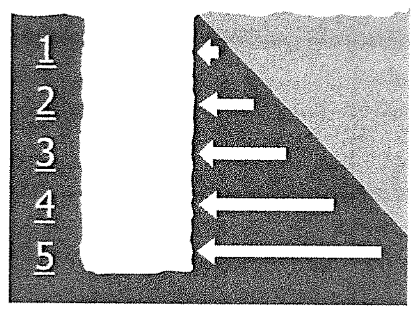


Type C Soil

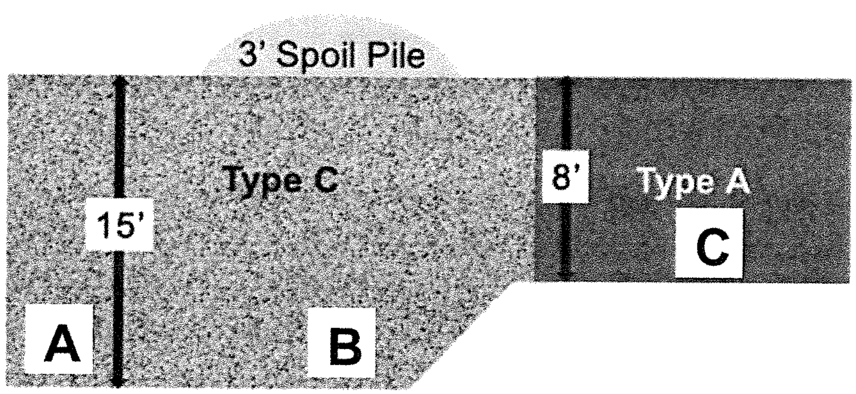
Soil Type = 80

____

____



Calculate the Pa

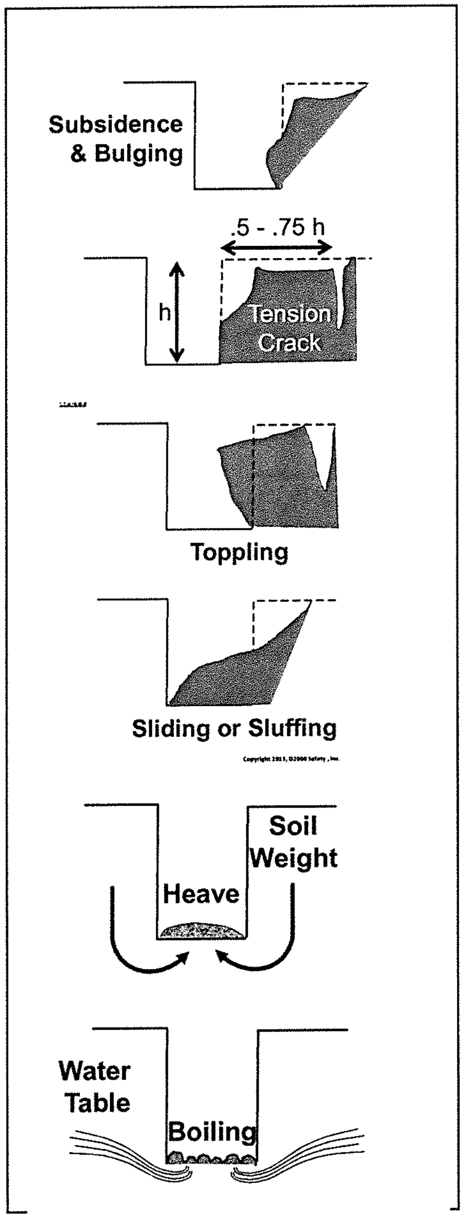


Pa at A: ____

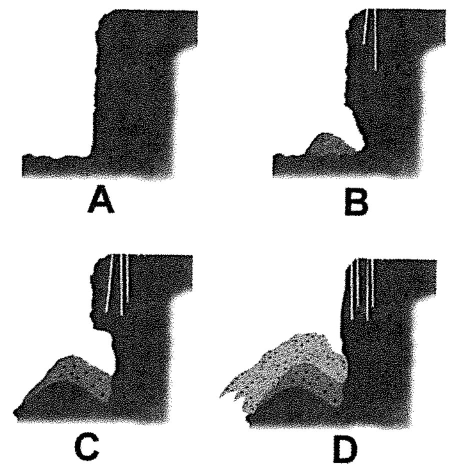
Pa at B: ____

Pa at C: ____

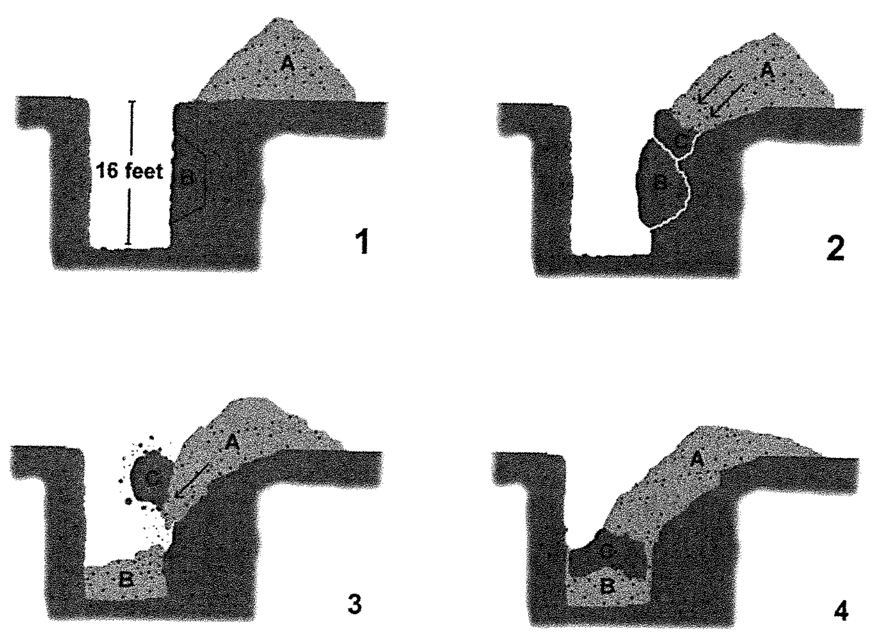
Soil Failure Patterns



Step by Step Failure



Sudden Failure

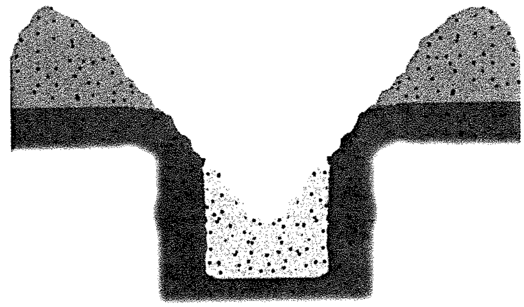


Other Collapse Patterns

Spoil-In

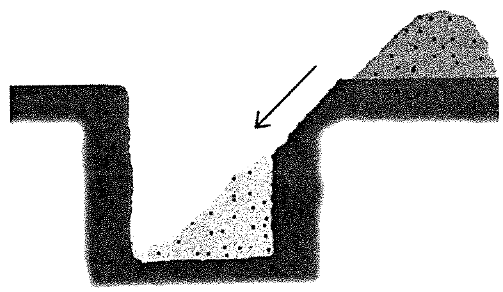
To prevent spoil-ins, spoils must be:

- Sloped to less than 30 degrees
- Kept at least two feet from the lip
- Limited in height.



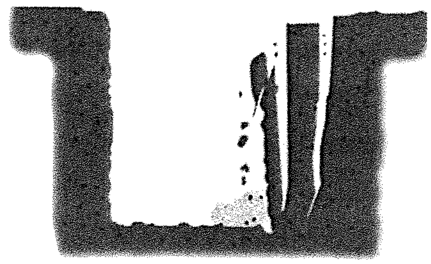
Lip-In

A Lip-In collapse occurs when the lip shears off and slides into the excavation. It is usually caused by surcharge loads which result in edge failure.



Shear-In

A Shear-In occurs when vertical fractures open up in the soil and slabs fall into the excavation.

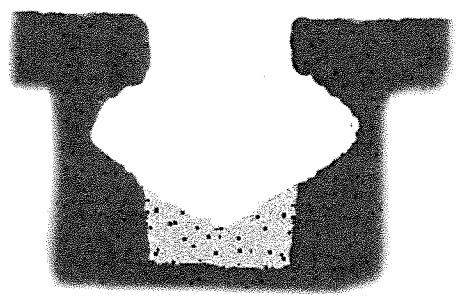


This condition is often caused by a loss of moisture, which causes the soil particles to contract.

This type or cave-in often occurs at trench intersections but may happen anywhere.

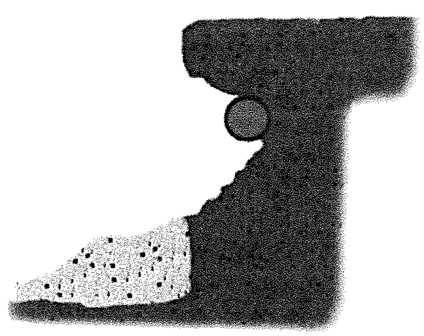
Sluff-in

A sluff-in can have many causes. In these types of collapses the soil fails, not at the foot, but in the trench wall.

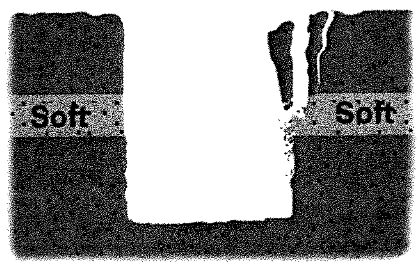


Sluff-ins often occur in previously disturbed soil that was not compacted properly after the excavation was filled in.

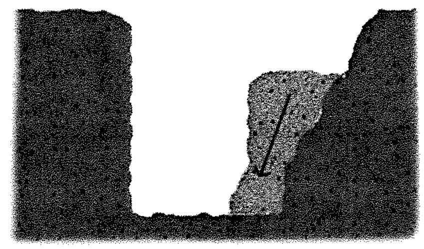
Trenches near buried utilities (cables and pipes) may also be subject to slough-in due to the changes in soil strength caused when the utility lines were first buried.



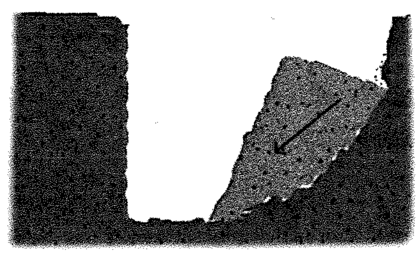
Other Collapse Patterns



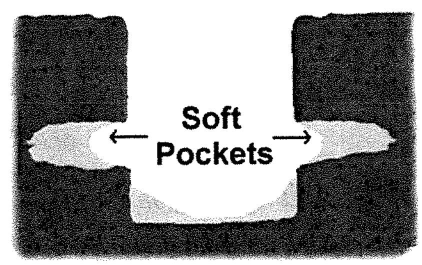
Soft Zone Failure



Wedge Failure

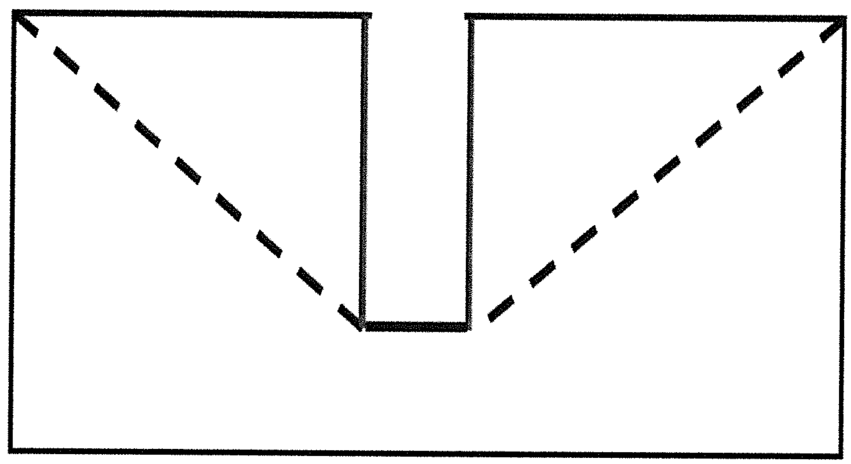


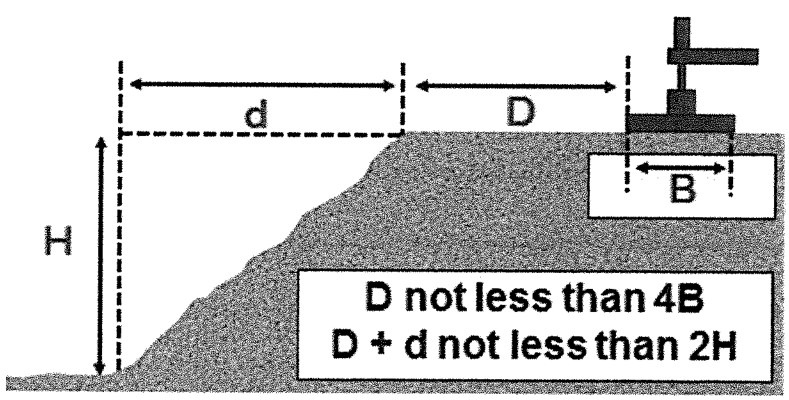
Rotational Failure



Soft Pocket Failure

Affected Zone and Surcharge Loads





Notes

III. Soil Classification

Soil analysis is performed by the *Competent Person.*

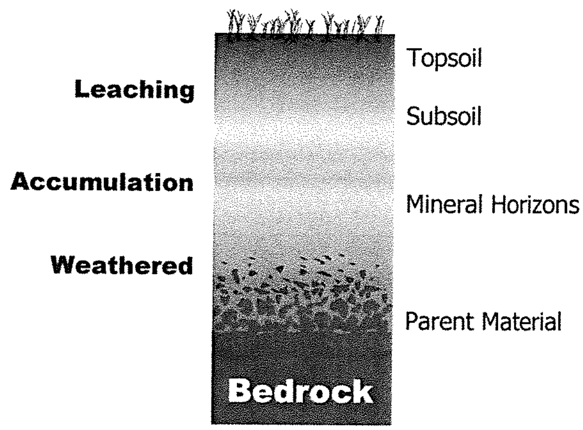
The Competent Person determines the soil:

____

which can be defined as the resistance to cave-in.

The stability of the soil, however, can:

____



Soils are classified as either solid rock or type A, B, or C.

Soil Types

Solid Rock ____________________

Type A ____________________

Type B ____________________

Type C ____________________

Why Classify?

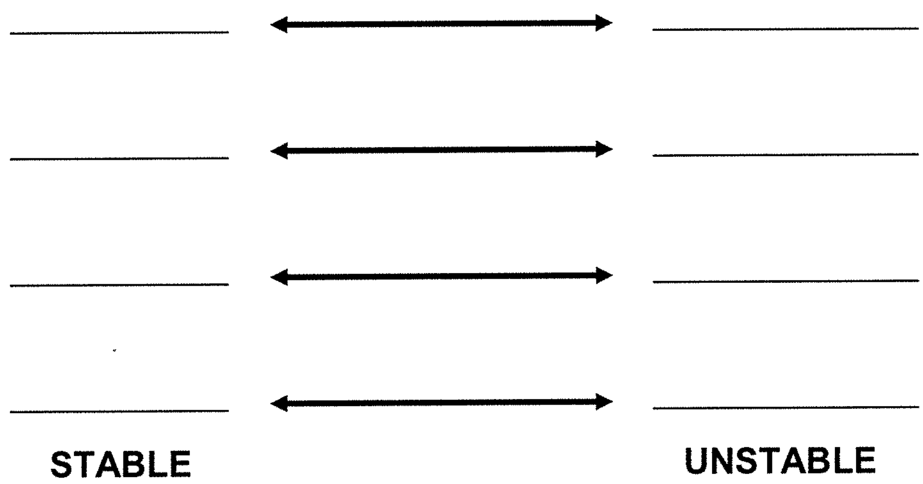
Solid Rock ____________________

Type A ____________________

Type B ____________________

Type C ____________________

Is the Soil?



Cohesive or Granular?

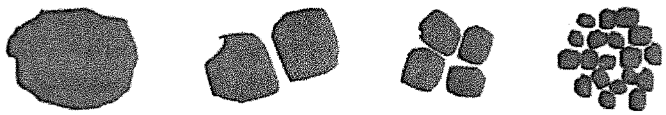
	Appearance	Water Response	When Moist	When Dry
Granular Fine sands and silts.	Coarse grains can be seen. Feels gritty when rubbed between fingers.	When water and soil are shaken in palm of hand, they mix. When shaking is stopped, they separate.	Very little or no plasticity.	Little or no cohesive strength when dry. Soil sample will crumble easily.
Cohesive Mixes and clays	Grains cannot be seen by naked eye. Feels smooth and greasy when rubbed between fingers.	When water and soil are shaken in palm of hand, they will not mix.	Plastic and sticky. Can be rolled.	Has high strength when dry. Crumbles with difficulty. Slow saturation in water.

Causes of Cohesion

Cement ____

Apparent Cohesion ____________________________________

Electrostatic Forces ___________________________________



	Size	Area / Mass
Sand	2.0 – 0.05 mm	44
Silt	0.05 – 0.002 mm	11,000
Clay	< 0.002 mm	740,000

Strong or Weak?

Unconfined compressive strength is defined as the load per unit area at which a soil will fail in compression and is the basis for many types of soil classification.

____

____

Fissured or Not Fissured?

Fissured means soil that has a tendency to break along definite planes of fracture with little resistance, or a material that exhibits open cracks.

____

Layered or Not Layered?

Soil layers need to be considered when the layer dips into the excavation at a slope of more than: ______ to ________

____

____

Type A Soils

Type A soils are defined as cohesive soils (meaning the particles stick to each other) with an unconfined compressive strength of 1.5 tons per square foot (tsf) (144 kPa) or greater.

Type A soils can be readily indented by the thumb; however, they can be penetrated by the thumb only with very great effort.

Examples of cohesive soils are: clay, silty clay, sandy clay, clay loam, and in some cases silty clay loam and sandy clay loam. Cemented soils such as caliche and hardpan are also considered type A.

No soil is type A if:

1. The soil is fissured (cracked).
2. The soil is or may be subject to vibration from heavy traffic, pile driving or other causes.
3. The soil has been previously disturbed.
4. The soil is part of a sloped, layered system where the layers dip into the excavation on a slope of 4:1 (horizontal: vertical) or greater.
5. The material is subject to other factors that would require it to be classified as a less stable material.

Type B Soils

Type B soils are defined as cohesive soils with an unconfined compressive strength greater that 0.5 tsf (144kPa) but less than 1.5 tsf. Type B soils also include granular soils with no cohesion such as angular gravel (similar to crushed rock), silt, silt loam, sandy loam, and in some cases silty clay loam, sandy clay loam.

Other types of soils classified as Type B include:

1. Previously disturbed soils except those which would otherwise be classified as Type C soil.
2. Soil that meets the unconfined compressive strength or cementation requirements for Type A, but is fissured or subject to vibration.
3. Dry rock that is not stable.
4. Material that is part of a sloped layered system where the layers dip into the excavation on a slope less steep than 4 Horizontal to 1 Vertical, but only if the material would otherwise be classified as Type B.

____

____

Type C Soils

These types of soils are cohesive with an unconfined compressive strength of 0.5 tsf (48 kPa) or less or granular soils including gravel, sand, and loamy sand. They can be easily penetrated by a thumb to a depth of several inches and molded using light finger pressure.

Other types of soils classified as Type C include:

1. Submerged soil or soil from which water is freely seeping.
2. Submerged rock that is not stable.
3. Material in a sloped, layered system where the layers dip into the excavation on a slope of 4:1 (horizontal: vertical) or steeper.

____

____

Determining Soil Types

_________________ and _________________ tests are conducted by a competent person.

The tests must take into account the fact that the soils may be layered and that each layer may consist of a different type of soil. In these situations the system is classified according to its weakest layer.

Changes in the _________________________, such as a change in the water table, can change the soil classification and the likelihood of a cave-in.

If after classifying a deposit, the properties, factors, or conditions affecting its classification change in any way, the changes must be evaluated by a competent person.

Visual Tests

To conduct a visual test, the competent person must:

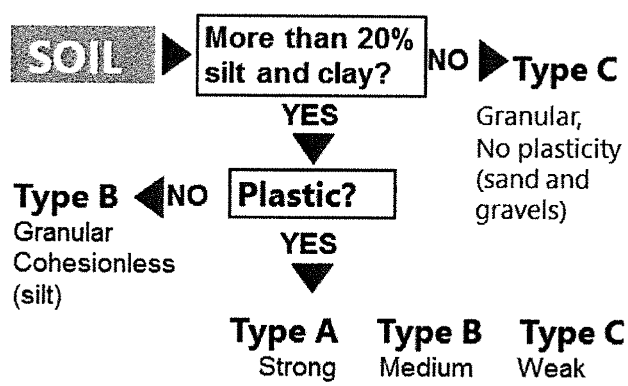
> **Spall Defined**
>
> ***Spall*: n.** A flake or chip, esp. of stone **1.** to break up or split **2.** to break off in layers parallel to the surface

1. Observe the excavated soil. Does it form clumps (cohesive)? Do the clumps break up easily (granular)?
2. Observe the entire excavation area. Tension cracks could indicate fissured material. Spalls indicate fissures or soil movement.
3. Observe the area adjacent to the excavation and the excavation itself for evidence of existing utility and other underground structures, and to identify previously disturbed soil.
4. Observe the open side of the excavation to identify layered systems. Examine layered systems to identify if the layers slope toward the excavation. Estimate the degree of slope of the layers.
5. Observe the area adjacent to the excavation and the sides of the open excavation for evidence of surface water, water seeping from the sides of the excavation, or the location of the level of the water table.
6. Observe the area adjacent to the excavation and the area within the excavation for sources of vibration that may affect the stability of the excavation face.

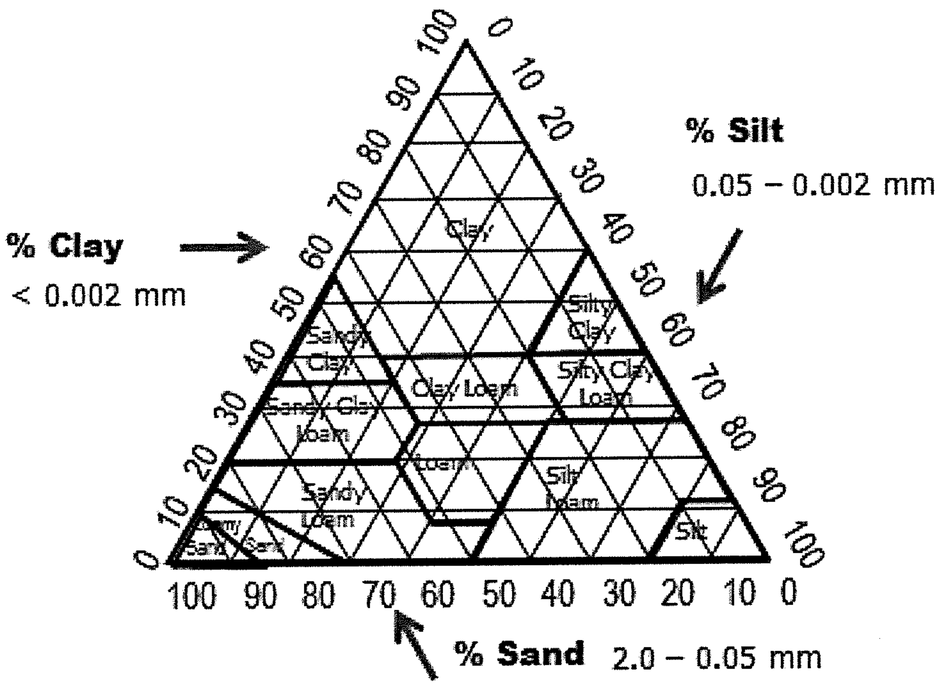
Manual Soil Testing

The Competent Person must perform at least one manual test.

- Plasticity
- Dry Strength
- Thumb Penetration and Other Strength Tests
- Drying test
- Sedimentation (Olive Jar)
- Shaking
- Dry Hand
- Hand Cleaning



Soil Triangle



Sedimentation (Olive Jar)

- Clear jar, straight sides, flat bottom.
- # 10 sieve or 1/8 inch hardware cloth
- Marker and watch.
- Shake
- Mark the level after 30 seconds.
- Measure the sand.
- Determine the percent.

____

____

Plasticity

- Mold a moist or wet sample of soil into a ball and then attempt to roll it into threads as thin as 1/8 inch in diameter.
- Cohesive material can be successfully rolled into threads without crumbling.
- If at least a two-inch (50 mm) length of 1/8 inch thread can be held on one end without tearing, the soil is cohesive.

____

____

____

Thumb Penetration Test

The thumb penetration test is performed by pressing your thumb into the soil and can be used to estimate the unconfined compression strength of cohesive soils. This test is based on the thumb penetrations test described in American Society for Testing and Materials (ASTM) Standard designated D2488 – "Standard Recommended for Description of Soils (Visual-Manual Procedures)."

- **Type A Soil:** 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 B Soil:** Soils with an unconfined compressive strength of greater that 0.5 tsf can be readily indented by the thumb; however, they can be penetrated by the thumb ¾ of an inch with effort.

- **Type C Soil:** Soils with an unconfined compressive strength of 0.5 tsf can be easily penetrated several inches by the thumb, and cannot be molded with light finger pressure because of the lack of clay.

Other Strength Tests

Pocket Penetrometer ______________________________

Shear Vane ______________________________

Dry Strength

Take a soil sample and:

- 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 that, in turn, break up into smaller clumps that 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.

____

____

____

____

Drying test

- Dampen a soil sample and form into a disk which is one-inch thick and six inches in diameter.
- Allow to dry thoroughly in the air.
- Look for cracks which indicate ____________________
- If no cracks, break the sample. If considerable force is required the sample is unfissured, cohesive.
- If it breaks easily it is fissured cohesive or granular.

____

____

Shaking

- Golf ball-sized sample
- Knead and moisten until mushy. Jiggle while tapping.
- Shiny and wet?
- Shake and squeeze.

Dry Hand

- Smear mud on hand.
- Allow to dry.
- Rub hands and see how easily the mud comes off.

____

____

____

Hand Cleaning

- Smear mud on hand.
- Rinse hands.
- Silt washes off easily. Clay adheres to hands.

Soil Classification Worksheet

Weather (Temp and precip):							Date	Location
	Y	**N**	**✓**	**Observations / Tests**	**Y**	**N**	**✓**	**Open Excavation**
Site	Y	N	✓	Soil frozen?	Y	N	✓	Bulging walls?
	Y	N	✓	Disturbed soil?	Y	N	✓	Parallel cracks?
	Y	N	✓	Water conditions:	Y	N	✓	Spalling?
	Y	N	✓	Vibration sources:	Y	N	✓	Slumping?
	Y	N	✓	Other:	Y	N	✓	Layered soils?
Visual	Y	N	✓	Primarily composed of fine grained? (cohesive)				
	Y	N	✓	Primarily composed of coarse grained? (sand or gravel)				
	Y	N	✓	Clumps easily? (cohesive)				
	Y	N	✓	Breaks up easily? (granular)				
	Y	N	✓	Visual Test Results: ❑ A ❑ B ❑ C				

Manual

Plasticity: 1/8" Thread length:________ ❑ Granular (< 2") ❑ Cohesive (> 2")

Dry strength.

❑ A (Breaks into clumps which are broken with difficulty)
❑ B (Crumbles on own or with slight pressure, angular grains and fissures seen)
❑ C (Falls in clumps, breaks into smaller clumps, forms rounded grains or fine powder)

Thumb penetration: ❑ A (Great effort) ❑ B (Effort) ❑ C (Easy)

Test instrument: ❑ Penetrometer ❑ Shear Vane
Readings: ____
Average tsf: __________ ❑ A (> 1.5) ❑ B (0.5 – 1.5) ❑ C (< 0.5)

Drying test: ❑ Cracks (B or C, fissured) ❑ No cracks, breaks with force (A, unfissured, cohesive)
❑ Pulverize with difficulty (B, cohesive, fissured)

Sedimentation: Granular height ______ in. Total height _____ in. Percent granular _____ %

Shake: Jiggle soil: ❑ Shiny, wet surface (sand/silt) ❑ No change (clay)
Shake/squeeze: ❑ Moisture quick appear, disappear (sand/silt) ❑ No moisture (clay)

Dry Hand: ❑ Dusty, gritty, rubbing removes most (silt) ❑ Hard crust, tough to remove (clay)

Hand Cleaning: ❑ Rinses easily (silt) ❑ Greasy, difficult to remove (clay)

Results: Soil Type Based on Manual Tests: ❑ A ❑ B ❑ C

1926 Appendix A: Soil Classification

(a) Scope and Application

(b) Definitions

(c) Requirements

(d) Acceptable Visual and Manual tests

Excavation Safety – Soil Classification Exercise

Match the items in the Column A with those in Column B.

Column A

____ Fissured

____ Granular soil

____ Saturated soil

____ Stable rock

____ Cohesive soil

____ Type A

____ Type B

____ Type C

____ Plasticity test

____ Plastic

____ Observing for sources of vibration

____ Pocket penetrometer

Column B

A. Natural, solid mineral that can be excavated with vertical sides.

B. Provides an estimate of unconfined compressive strength.

C. Gravel, sand or silt with little or no clay

D. Previously disturbed soils that aren't classified as Type C.

E. Cohesive with an unconfined compressive strength of 1.5 tsf.

F. Voids filled with water, but flow is not required.

G. Breaks along definite planes of fracture

H. Submerged rock that isn't stable.

I. Primarily composed of fine grained material. Remains in clumps.

J. Visual test

K. Mold a moist or wet sample into a ball and roll it into threads.

L. Soil that can be deformed or molded without cracking or volume change.

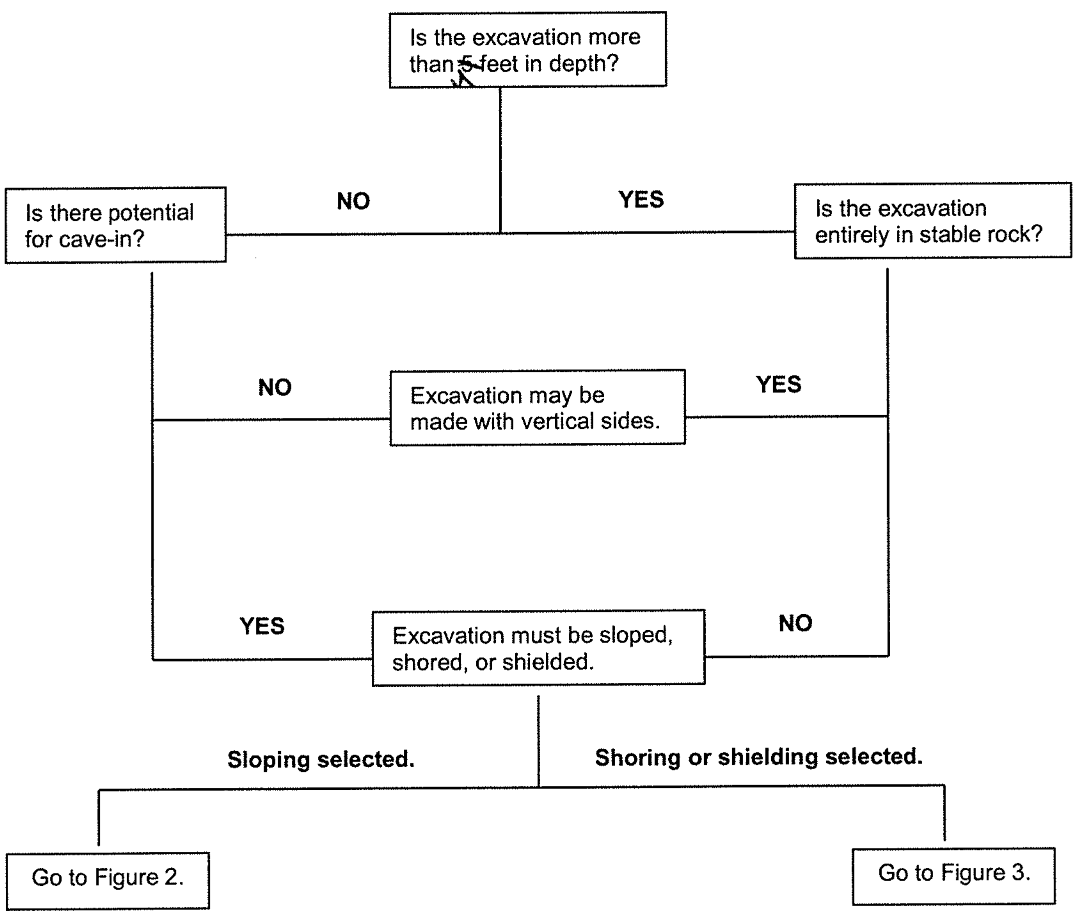
IV. Protective Systems

Protective systems include shoring and shields. The selection, construction and removal of these systems must conform to specifications found in the following sections of Subpart P.

1926 Subpart P Appendix F: Selection of Protective Systems

The following figures summarize the requirements contained in subpart P for excavations 20 feet or less in depth. Protective systems for use in excavations more than 20 feet in depth must be designed by a registered professional engineer in accordance with § 1926.652 (b) and (c).

FIGURE 1: Preliminary Decisions



1926.652: Requirements for Protective Systems

(a) Protection of Employees in Excavations

(b) Design of Sloping and Benching Systems

(c) Design of Support, Shield and Other Protective Systems

(d) Materials and Equipment

(e) Installation and Removal of Support

(f) Sloping and Benching Systems

(g) Shield Systems

Sloping

A common method of preventing cave-ins is to slope the walls of the excavation so that they do not pose the possibility of collapse. Different soils must be sloped to different angles.

Angle of Repose

One important concept relates to the angle of repose of soil particles. The angle of repose is defined as the angle which a pile of soil particles makes (with respect to the ground) when piled up. Different soils have different angles of repose as seen below.

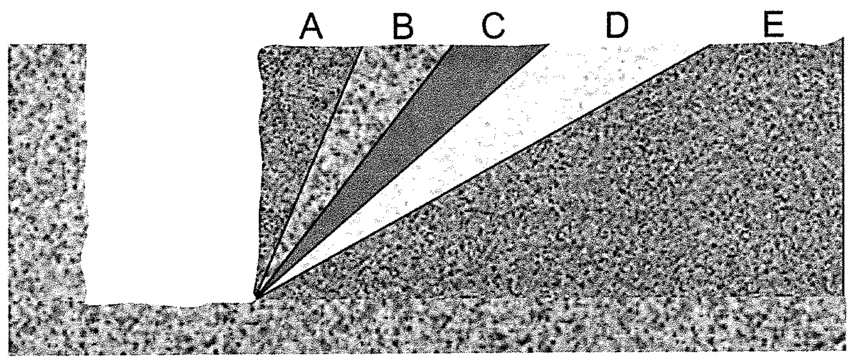


Figure 20: Various Angles of Repose

In this cross sectional view of a trench, we can see that different soils have different angles of repose as follows:

A: 90° Solid rock, cemented sands or gravels.

B: 63° Compacted angular gravels.

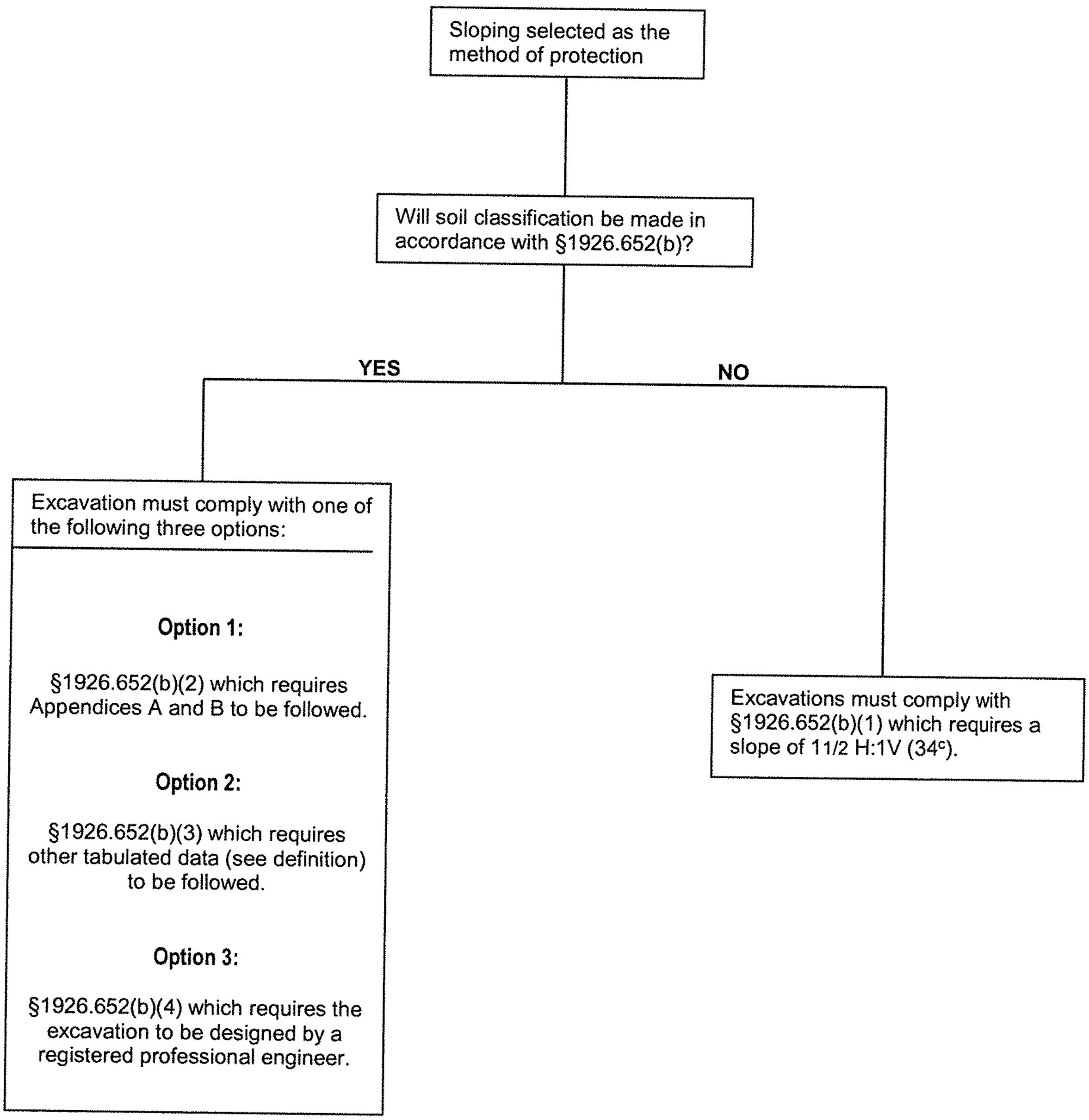
C: 45° Average soils

D: 33° Compacted, sharp sand.

E: 27° Rounded, loose sand.

The term, angle of repose, has been excluded from the OSHA regulations but remains a useful concept when trying to understand soil stability.

Appendix F - FIGURE 2: Sloping Options



1926 Subpart P Appendix B: Sloping and Benching

Definitions

Actual Slope ______________________________

____

Distress ______________________________

____

____

____

Maximum Allowable Slope ______________________________

____

Short Term Exposure ______________________________

____

(c) Requirements

____

____

(c) (4)Configurations

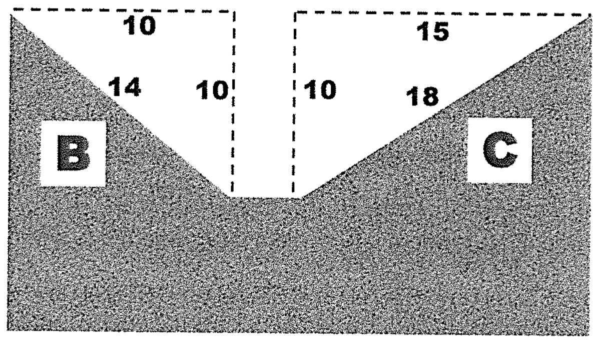
____

____

____

Costs of C versus B

Area of a triangle = ½ b h



Shoring and Shielding

APPENDIX F - FIGURE 3: Shoring and Shielding Options

Shoring or shielding selected as the method of protection.

Soil classification is required when shoring or shielding is used. The excavation must comply with one of the following four options:

Option 1:

§1926.652(c)(1) which requires Appendices A and C to be followed (e.g. timber shoring).

Option 2:

§1926.652(c)(2) which requires manufacturers data to be followed (e.g., hydraulic shoring, trench jacks, air shores, shields).

Option 3:

§1926.652(c)(3) which requires tabulated data (see definition) to be followed (e.g., any system as per the tabulated data).

Option 4:

§1926.652(c)(4) which requires the excavation to be designed by a registered professional engineer (e.g. any designed system).

Hydraulic Shoring

Speed Shore – Sample Tabulated Data

1.0 SCOPE

1.1 Speed Shore's Tabulated Data complies with the O.S.H.A. standards *as* stated in the Code of Federal Regulations 29, Part 1926, Subpart P - Excavations, Section 1926.652(c)(2). This data shall only be used by the contractor's ***competent person in*** the selection of spacing, size of cylinders and sheeting requirements for Speed Shore Vertical Shores. The ***competent person*** shall be experienced and knowledgeable in trenching and excavation procedures, soil identification and in the use of Speed Shore Vertical Shores.

1.2 All personnel involved in the installation, removal and use of Vertical Shores shall be trained in their use and advised of appropriate safety procedures. All operating instructions must be followed.

1.3 Tables VS-1, VS-2 and VS-3 are based upon requirements stated in CFR 29, Part 1926 and applicable portions of CFR 29, Part 1910. The ***competent person*** shall know and understand the requirements of those parts before using this data.

1.4 Whenever there a is variance between this Tabulated Data and CFR 29, Part 1926, Subpart P - Excavations, this Tabulated Data shall take precedence. Whenever a topic or subject *is* not contained in this Tabulated Data, the ***competent person*** shall refer to CFR 29, Part 1926, Subpart P - Excavations.

1.5 This data refers to the Code of Federal Regulations, 29, Parts 1910 and 1926. In states that have their own state 0.S.H.A. refer to similar regulations in the current construction rules published by the state office of Occupational Safety and Health.

1.6 Tables VS-1, VS-2 and VS-3 shall be used only in typical excavations with soil conditions as noted. Tables VS-1, VS-2 and VS-3 are for depths to 25 feet. For other soil and excavation conditions and depths, site-specific engineered designs are required. Contact Speed Shore Corporation for assistance.

1.7 This Tabulated Data is applicable for standard products manufactured exclusively by Speed Shore Corporation and may only be used with Speed Shore manufactured products. Any modification or repair of Speed Shore products not specifically authorized by Speed Shore Corporation voids this data.

2.0 DEFINITIONS (RE: CFR 29, Part 1926.32 Definitions) - RESTATED FOR EMPHASIS

2.1 1926.32 (f) "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.

2.2 1926.32 (p) "Shall" means mandatory.

2.3 1926.32 (q) "Should" means recommended.

3.0 SOIL CLASSIFICATIONS

3.1 In order to use the data presented in Tables VS-1 and VS-2, the soil type, or types, in which the excavation is cut shall first be determined by the *competent person* according to the O.S.H.A. soil classifications as set forth in CFR 29, Part 1926, Subpart P, Appendix A.

3.2 Table VS-3 is for Vertical Shore use in Type C-60 soil *(see* 3.3 for definition).

3.3 Type C-60 soil is a moist, cohesive soil or a moist dense granular soil which does not fit into Type A or Type B classifications, and is not flowing or submerged. This material can be cut with near vertical sidewalls and will stand unsupported long enough to allow the Vertical Shores to be properly installed. The ***competent person*** must monitor the excavation for signs of deterioration of the soil as indicated by, but not limited to, freely seeping water or flowing soil entering the excavation around or below the sheeting. An alternate design for less stable Type C soil will be required where there is evidence of deterioration.

4.0 PRESENTATION OF INFORMATION

4.1 Information is presented in tabular form in Tables VS-I, VS-2 and VS-3. Each table presents the maximum vertical and horizontal spacing that may be used with Vertical Shores for the indicated soil type. Table VS-I is for O.S.H.A. Type A Soil, Table VS-2 is for O.S.H.A. Type B Soil and Table VS-3 is for Vertical Shore use in Type C-60 soil (see 3.3 for definition).

4.2 Tables VS-1, VS-2 and VS-3 are not considered adequate when loads imposed by structures or by stored material adjacent to the trench weigh in excess of the load imposed by 3 feet of soil surcharge. The term "adjacent·' as used here means the area within a horizontal distance from the edge of the trench equal to the depth of the trench.

4.3 Using the appropriate table, the *competent person* selects the horizontal spacing of the vertical shores and the sheeting required, if any. The selection is based on the depth and width of the trench in varying soil conditions. In these tables, the vertical spacing of the cylinders is held constant at a maximum of 4 feet on center. The horizontal spacing of the hydraulic cylinders is the same as the horizontal spacing of the vertical rails.

5.0 BASIS AND LIMITATIONS OF THE DATA

5.1 Sheeting is used only to prevent local raveling or sloughing of the trench face between the Vertical Shores. Sheeting shall be one of the following or an approved equal:

- Aluminum: Speed Shore's Aluminum Sheeting
- Steel: 0.5 inch or thicker Steel Plate
- Plywood: 3/4 inch Finn Form
- 3/4 inch Omni Form
- 3/4 inch Combi Exterior Plywood
- 3/4 inch Plyform American Plywood Association, Plyform, B - B, Class I Exterior
- 3/4 inch HDO American Plywood Association, High Density Overlay, Exterior 3/4 inch
- 14 Ply Arctic White Birch
- 1and 3/8 inch CDX
- Two sheets of 3/4 inch thick CDX Plywood

5.2 When sheeting is used it shall extend to the top of the excavation and to within 2 feet of the bottom of the excavation; except in Table VS-3 for excavation depths 0 - 25 feet, where the sheeting shall extend to the bottom of the excavation. If there is an indication of a possible loss of soil from behind or below the support system, sheeting must extend to the bottom of the excavation.

5.3 All spacings indicated are measured from center to center of the members.

5.4 The center line of the top hydraulic cylinder shall be a minimum of 12 inches and a maximum of 24 inches below the top of the excavation.

5.5 The center line of the bottom hydraulic cylinder shall be a maximum of 4 feet above the bottom of the excavation.

5.6 In excavations 6 feet deep or less, only 1 hydraulic cylinder (Single Shore) is required in each vertical plane. The cylinder shall be no more than 4 feet above the bottom of the excavation, and no more than 2 feet below the top of the excavation. In excavations 6 feet to 10 feet deep there shall be a minimum of 2 hydraulic cylinders in each vertical plane. The horizontal spacing shall be as shown in the tables.

5.7 The vertical rails directly behind each hydraulic cylinder pad must bear on firm soil or a solid and stable filler to distribute the cylinder load to the face of the excavation. Do not butt rails back to back across an excavation.

5.8 Two single shores may be substituted for a Vertical Shore.

5.9 The aluminum rails are designed to be used vertically, however they may be orientated horizontally or diagonally if all other provisions of this data are satisfied.

5.10 The maximum vertical spacing between center lines of hydraulic cylinders shall be 4 feet.

5.11 The faces of the excavation must be cut near vertical and straight.

5.12 There shall be a minimum of 3 consecutive shores in a row, at the horizontal spacing indicated (or less), to form a shoring system. In trenches over 12 feet deep, and whenever possible. a minimum of 4 shores should be used. For excavations that are too short to place 3 or 4 shores at the required spacing, the shores shall be placed at the required spacing from end to end of the excavation with a minimum of 2 shores. There shall be a shore within 2 feet of each end of the excavation.

5.13 The ends of trenches shall be shored or sloped in accordance with Appendix B of CFR 29, Part 1926 Subpart P -Excavations.

5.14 No vertical or lateral loads shall be applied to the hydraulic cylinders.

5.15 Water flowing into an excavation, from either above or below ground, will cause a decrease in the stability of the soil. Therefore, the *competent person* shall take action to prevent water from entering the excavation and promptly remove any water that accumulates in the excavation. Closer monitoring of the soil is required under wet conditions, particularly in the less cohesive (weaker) soil conditions. A small amount of water, or flowing conditions, may downgrade the soil classification to a less stable classification. A large amount of water, or flowing conditions, may downgrade all soils to OSHA Type C. Speed Shore shoring and shielding systems may be used safely in wet conditions when the excavation is monitored by the ***competent person.*** Example: When repairing a leak in utility lines, it is often difficult or even impossible to keep water out of the excavation.

5.16 If shores are installed on the seam between 2 adjacent sheets of plywood, each plywood sheet shall bear a minimum of 4 inches on each vertical rail.

5.17 Tables VS-1, VS-2 and VS-3 shall be used only for selecting the spacings and excavation depths for Single Shores, Vertical Shores, and Multi-Shores. Normally, a Single Shore has 1 hydraulic cylinder, a Vertical Shore has 2 hydraulic cylinders and Multi-Shores have 3 or more hydraulic cylinders. All three types may be used and may be mixed if the provisions of this Tabulated Data are followed.

6.0 INSPECTION

6.1 The *competent person* must evaluate the soils to assure the rated capacity of the Vertical Shores is not exceeded by the lateral pressure of the soil. Soils shall be evaluated in accordance with Part 3.0.

6.2 The *competent person* shall monitor all phases of the assembly, installation and use of this product to evaluate and eliminate any methods which could endanger employees utilizing this product.

6.3 Daily inspections of the Vertical Shores and accessories must be performed by the *competent person* and deficiencies corrected.

6.4 Inspections shall be conducted as necessary for hazards associated with: water accumulation, changing soil conditions or changing site weather conditions.

7.0 EXAMPLE TO ILLUSTRATE THE USE OF TABLES VS-1, VS-2 AND VS-3:

Problem: Design a trench safety system using Speed Shore Vertical Shores for an excavation 8 feet deep and 4 feet wide in O.S.H.A. Type B soil.

Study tables: Select Table VS-2 for Type B soil. Look in the column "Depth of Excavation" on line 0 to 15 feet. Next, read across and find under "Hydraulic Cylinders", "Maximum Horizontal Spacing" at 8 feet and "Maximum Vertical Spacing" at 4 feet. Next, locate the hydraulic cylinder size under "Width of Excavation', 0 to 8 feet": 2 inch diameter. Finally, under "Sheeting", Notes 2 and 3 apply.

Conclusion: Install Speed Shore Vertical Shores with 2 inch diameter cylinders at 8 feet intervals with or without plywood sheeting, depending upon the *competent person's* judgment of the raveling or sloughing of the excavation face (See Notes 2 and 3).

TABLE VS-1 TYPE "A" SOIL

Depth of Excavation *Feet*	HYDRAULIC CYLINDERS					Sheeting (Note 3)
	Maximum Horizontal Spacing *Feet*	Maximum Vertical Spacing (Note 6) *Feet*	Width of Excavation *FEET*			
			0 to 8	8 to 12	12 to 15	
0 to 15	8	4	2" dia.	2" dia.	2" dia. *(Note 1)*	(Note 2)
0 to 25	8	4	2" dia.	2" dia. *(Note 1)*	2" dia. *(Note 1)*	(Note 2)

TABLE VS-2 TYPE "B" SOIL

Depth of Excavation *Feet*	HYDRAULIC CYLINDERS					Sheeting (Note 3)
	Maximum Horizontal Spacing *Feet*	Maximum Vertical Spacing (Note 6) *Feet*	Width of Excavation *FEET*			
			0 to 8	8 to 12	12 to 15	
0 to 15	8	4	2" dia.	2" dia.	2" dia. *(Note 1)*	(Note 2)
0 to 20	6	4	2" dia.	2" dia. *(Note 1)*	2" dia. *(Note 1)*	(Note 2)
0 to 25	5	4	2" dia.	2" dia. *(Note 1)*	2" dia. *(Note 1)*	(Note 7)

TABLE VS-3 TYPE "C-60" SOIL (See 3.3 for definition of C-60 Soil)

Depth of Excavation *Feet*	HYDRAULIC CYLINDERS					Sheeting *(Note 4)*
	Maximum Horizontal Spacing *Feet*	Maximum Vertical Spacing (Note 6) *Feet*	Width of Excavation *FEET*			
			0 to 8	8 to 12	12 to 15	
0 to 10	6 *(Note 5)*	4	2" dia.	2" dia.	2" dia. *(Note 1)*	*(Note 2)*
0 to 20	4	4	2" dia.	2" dia. *(Note 1)*	2" dia. *(Note 1)*	*(Note 7)*
0 to 25	4	4	2" dia.	2" dia. *(Note 1)*	N/A	*(Note 7)*

NOTES TO TABLES VS-1, VS-2 and VS-3

1. Two inch diameter cylinders shall have a structural steel tube oversleeve 3.5 x 3.5 x 0.1875 inches extension (installed over the aluminum oversleeve extension) or a *steel tube* oversleeve 3 x 3 x 0.1875 inch extension (installed without the aluminum oversleeve) that extends the full retracted length of the cylinder. CAUTION: In either case, *the* aluminum load transfer plug and the aluminum innersleeve shall be used or a steel load transfer plug shall be welded securely in place inside the steel oversleeve to transfer the load through the steel oversleeve to the socket pad. Other Speed Shore approved oversleeves may be used.
2. The bottom of the sheeting shall extend within 2 feet of the bottom of the excavation. If there is an indication of a possible loss of soil from behind or below the support system, sheeting must extend to the bottom of the excavation.
3. Four feet wide sheeting *is* required at each Vertical Shore if raveling or sloughing of the excavation face appears likely to occur.
4. Four feet wide sheeting shall be used.
5. When 4 feet horizontal spacing is exceeded, the open spaces between the sheeting must be monitored for sloughing and raveling of the excavation face.
6. The bottom hydraulic cylinder shall be a maximum of 4 feet above the bottom of the excavation.
7. Sheeting shall extend to the bottom of the excavation.

Shields

- 18" above ground sloping toward trench
- Rated for full depth
- End panels if ends aren't sloped
- Prevent hazardous lateral movement

Ultra Shield – Sample Tabulated Data

Classifications of the particle makeup of soils as A, B, or C is not required when using the shield for the entire depth of the excavations up 12' deep.

psf = pounds per square foot vf = vertical foot

MAXIMUM BURY DEPTHS for each model listed EXCLUDING SURCHARGE LOADS

Soil Description	Soil Lateral Earth pressure	Model S24-84 (1600psf)	Model S48-84 (950psf)	Model S24-60 (1600psf)	Model S48-60 (1100psf)
Hard and Solid Soils – OSHA "A" Soils					
Dry stable Material	25psf/vf	12 vf	12 vf	12 vf	12 vf
Soils Likely to crack or crumble, soft, sandy, filled, or loose soils – OSHA "B" and "C" soils					
Dry to moist, fine sand	35psf/vf	12 vf	12 vf	12 vf	12 vf
Clays and gravels	45psf/vf	12 vf	12 vf	12 vf	12 vf
Very moist	55psf/vf	12 vf	12 vf	12 vf	12 vf
Wet materials	65psf/vf	12 vf	12 vf	12 vf	12 vf
Mucky materials	75psf/vf	12 vf	12 vf	12 vf	12 vf
Note: The above depths can be exceeded if a qualified person evaluates the maximum earth pressure at the bottom of the trench. See example below.					
Free flowing saturated or submerged soils	85 psf/vf	**Ultra Shore strongly suggests consulting an Engineer for use in the category.**			

- Shields allowable depth of bury is determined by dividing the shield psf rating by the lateral earth pressure rating.
- Spoil surcharge loads should be valued at 36psf/vf of spoil height.
- This surcharge load must be subtracted from the shield psf rating before any depth calculation.

Example: *Calculate maximum depth for model S48-84 very moist soil and 5 feet of spoil.*

1. Surcharge for 5' of spoil: 5vf x 36psf/vf =180psf
2. 950psf shield capacity (S48-84) minus 180psf (surcharge load) = 770psf remaining capacity in the shield.
3. The psf rating balance of 770, when divided by the soil lateral earth pressure rating for a very moist sandy material of 55psf/vf = 14'

LIMITATIONS OF USE For all "S" Series Ultra Shore Shields

1. Shields cannot be used beyond the limits of the manufacturer's Tabulated Data and Limitations of Use without the written permission of the manufacturer.
2. Shield use is based upon the maximum LATERAL EARTH PRESSURE (psf) at the trench bottom.
3. The psf rating and shield model number are located on an identification tag on each side panel. No shield should be used with the identification tag missing or when the information on the tag is not legible.
4. All "S" series shields are intended for use in Dry, Moist or Moderately wet soils that are likely to collapse. The shield is not intended for use in conditions where adjacent soils are free flowing or submerged soils such as bogs or wetlands type conditions.
5. Any modifications or damage will void the trench shield certification. Use of the "S" Series shields is limited to skilled workmen trained in the application and understanding of the TABULATED DATA and LIMITATIONS OF USE.
6. All shields can be stacked in any combination to any depth certified in the TABULATED DATA. In excavations greater than 8' depth, the shields should be stacked with the shield with the highest psf value on the bottom and the lowest psf value on the top.
7. All shields can be used in either a horizontal or vertical position. Models S24-60 and S24-84, must be coupled with authorized stacking tubes and keepers to any model of equal length for use horizontally, or if used as an individual unit, must be operated by pressurized spreaders approved by the manufacturer.
8. Lifting the shield with heavy equipment from an excavation under significant collapse should be done with the use of nylon sling affixed around the spreader socket at all for uppermost points.
9. Each shield is given a psf rating that indicates the maximum lateral earth pressures the shield can be subjected to. Actual soil conditions will vary from the approximate bury depths given in the tabulated data examples. The user must verify that the existing solid conditions do not exceed the shield rating. In no case can the "S" series shields be used in excavations exceeding 12 feet in depth without conducting the proper earth pressure calculations. Ultra Shore recommends a soils engineer or qualified person be consulted to verify pressure rating of the soils being excavated.
10. Special care in determining the maximum depth of bury must be taken when the ground water conditions or SURCHARGE loads exist. Adjacent surcharge loads include but are not limited to such things as spoil material, adjacent structures and traffic. Adjacent is considered to be in the area parallel or perpendicular to the excavation depth. Dry to moist spoil material can be valued at 36 psf/vf of spoil height for that area adjacent to the trench. These loads must be taken into account in the determination of maximum bury depths. Ultra Shore recommends evaluation of surcharge loads by a professional engineer or a qualified person.

11. Shields must be protected from lateral movement to any extent that could endanger workmen inside the shield. Lateral movement can be kept to a minimum by keeping the excavation walls as close to the shield as possible. Significant voids may occur at the time of excavation that would allow significant movement of the shield in the event of a cave in. Control may be maintained by placing sufficient quantities of backfill material between the excavation sidewall and exterior of the shield to limit lateral movement.

12. Shield use must be consistent with all applicable laws and regulations pertaining to excavations.

V. Safety Planning

Protecting the health and safety of workers and passersby requires careful planning and communication. Excavation safety programs are written documents and checklists that ensure everyone understands the policies, procedures, and equipment that are essential for safety. It also helps ensure that the project will conform to OSHA requirements.

Liabilities

Anyone responsible for developing the excavation safety program needs to have an understanding of the following areas of liability:

Company and Organizational Liability

____

Personal and Competent Person Liability

____

Negligence

____

Responsibilities

Company Responsibilities

____

Employee Responsibilities

____

Competent Person Responsibilities

____

Subcontractor Responsibilities

____

TRENCHING AND EXCAVATION SAMPLE SAFETY PROGRAM

PURPOSE:

The purpose of this instruction is to ensure compliance with the OSHA Excavation Standard 29 CFR 1926 - Subpart "P" and the Safety Program and Training requirements of 29 CFR 1926 - Subpart "C". A competent person will never allow workers to be exposed to unsafe trench conditions, no matter how short the exposure.

DUTIES OF THE COMPETENT PERSON:

1. Will maintain a copy of 29 CFR 1926 - Subpart "P" and have a comprehensive knowledge of OSHA's Excavation Standards. In addition, competent persons must have a general knowledge of all applicable construction standards.
2. Conduct pre-job site review to develop a job plan that ensures a safe, efficient job process. A competent person will evaluate difficult sloping and shoring problems (i.e. manholes, etc) prior to commencing the work.
3. Perform inspections of equipment and trench conditions at the start of each shift or as needed by changing conditions.
4. Competent person has the duty and responsibility to remove all employees from hazardous condition and effect all changes necessary to ensure safety.
5. Categorize soil conditions and conduct visual and manual tests to determine stability of soil and surrounding trench conditions. NOTE: If visual and manual tests are not performed, soils shall be classified as type "C".
6. Maintain on-site records of protection systems.
7. Determine the appropriate protection system to be used and oversee installation.
8. Verify that a competent person designs ramps and walkways for employee use in accordance with OSHA standards.
9. Competent person must verify proper design of structural equipment ramps, and walkways, or shall contact an RPE to design structural equipment ramps and walkways.
10. Hold safety meetings with all crew members prior to trenching and shoring operations. Subsequent meeting must be held as conditions warrant.
11. A competent person must be on-site at all times during excavation/trenching operations.
12. Assure that appropriate emergency rescue equipment is available to meet existing or potential conditions.
13. Monitor use of water removal equipment.
14. Test for oxygen presence and air quality in excavations as necessary. Competent persons must be qualified in identifying confine/hazardous spaces due to the presence of flammable/combustible gases, toxics, oxygen deficiency and oxygen enriched environments.
15. Competent person must consult with RPE for trenches over 20', specially designed shoring bracing or underpinning or when excavation endangers nearby structures.

NOTE: Competent persons must ensure that all trenches are properly classified, sloped, or shored in accordance with the appendices of 29 CFR 1926 - Subpart "P", or in accordance with manufacturer's tabulated data. Furthermore, competent persons must consult with a registered professional engineer (RPE) obtaining written guidance whenever the work exceeds 20 feet in depth, or the work will require control measures not specified in the standard.

DETERMINING SOIL CLASSIFICATION:

1. Visually inspect spoil pile and trench for indication of cohesive or granular soils. If soil appears to be cohesive conduct plasticity test. If soils are cohesive classify soils by either thumb penetration, shear vane, or pocket penetrometer. If soils do not pass plasticity test, classify granular soils by sedimentation test. NOTE: Other visual and manual test are authorized in appendix A to 29 CFR 1926 - Subpart "P".
2. To determine if soil is cohesive (plasticity test). The following provides a couple of examples for cohesive soil testing:
   a. Roll or Thread test: Mold a moist or wet sample of soil into a ball and attempt to roll it into threads as thin as 1/8" in diameter. Cohesive material can be successfully rolled into threads without crumbling. For example, if at least a two inch length of 1/8" in diameter thread can be held on one end without tearing the soil is cohesive. NOTE: Only use material passing a No. 40 sieve.
   b. Ribbon Test: Form a roll of moist soil about 1/2" to 3/4" in diameter. Cohesive material can be successfully rolled into 1/2" to 3/4" ribbon without crumbling. For example, if at least 3" to 5" in length can be held on one end without tearing the soil is cohesive. NOTE: Only use material passing a No. 40 sieve.
3. If plasticity test(s) proves that soils have cohesive qualities, determine the type of soil (A,B,C) by using the following test methods: NOTE: Soil testing equipment shall be used in accordance with manufactures specifications.
   a. Thumb penetration (cohesive soils only):

      Type "A": 1/4" or less

      Type "B": 1/4" to 1"

      Type "C": 1" or more
   b. Determining Shear Strength (cohesive soils only): By using the a hand held vane shear device the soil condition for cohesive soils can be determined.
   c. Determining unconfined compressive strength (cohesive soils only): By using a hand held pocket penetrometer the soil condition for cohesive soils can be determined.
4. If soil does not have cohesive qualities (granular soils), use the sedimentation test to determine if soils are a type "B" or "C" soil.

SEDIMENTATION TEST

1. The Sedimentation Test is the hydrometer analysis adapted for field use. Larger particles are the first to settle out of a soil-water suspension. It is used to determine the amount of sand in a sample taken in the field and is used only on soils that are obviously sands or very sandy. To run the sedimentation test a representative sample of the soil is taken from the spoil pile. Great care must be taken to insure that the sample represents the soil in the trench or excavation, otherwise the test will not be accurate.
2. The soil sample, after the gravel is removed, needs to be large enough to fill a glass jar to a depth of approximately 1-1/2". The soil is placed in a tall straight-sided glass jar so that there is at least 5" of water on top of the soil. The jar should have a flat bottom and must be at least 6-1/2" inches tall (olive jars work well).
3. The gravel may be removed by spreading a representative sample of the soil on a flat surface and hand picking the gravel, or by using a number 10 sieve or a piece of 1/8" hardware cloth. The 1/8" hardware cloth will pass some of the smaller gravel particles; they will need to be handpicked. All cohesive aggregations must be broken up so that all

particles fall as individuals in the soil water suspension. Use clean water for the test. Place the lid on the jar and thoroughly shake the mixture. After the particles have been completely dispersed and the suspension is uniform, set the jar down and give it slight twist. The larger particles will begin to settle out immediately. The twist levels out the largest particles so that a level surface is generated. All of the sand will have settled out 30 seconds after you set the jar down. Make a mark on the side of the jar. File folder labels work well for marking because they stick well to a damp jar.

4. The particles will continue to settle out of the suspension until nearly clear water remains above the layered soil. Most of the silt will have settled out in an hour. Make a second mark. Seldom is it necessary to wait over an hour. This test is good only for those soils which have a very high percentage of sands. The soil must be thoroughly dispersed because any small clods of silt and clay remaining unbroken up will act like sand.
5. All soil material below the first mark is sand. The material between the lines is silt and most of the clay. Allowing for the thickness of the glass jar bottom, determine the total height of the soil and the height of the sand. Divide the height of the sand by the total height of the soil and multiply by 100; the result will be the percentage of sand in the sample.
6. If the silt-clay mixture settles out rather quickly mostly silt is indicated. If the suspended solids above the sand settles out slowly, mostly clay is indicated.
7. Recall that if silt is the primary fine material present, the soil can be called a loamy sand even though it has only 70% sand by this test. If clay is the primary fine material there must be 85% sand to call the material a loamy sand.

Textural Classification - Percentages of sand, silt, and clay. The following chart will aid in soil classification:

TEXTURAL NAME (SOIL CLASS)	OSHA SOIL TYPE	RANGE IN PERCENT SAND	SILT	CLAY
SAND	C	85-100	0-15	0-10
LOAMY SAND	C	70-90	0-30	0-15
SANDY LOAM	B	43-80	0-50	0-20
LOAM	B	23-52	28-50	7-27
SILT LOAM	B	0-50	50-80	0-27
SILT	B	0-20	80-100	0-12
SAND CLAY LOAM	*	45-80	0-28	20-35
CLAY LOAM	*	20-45	15-53	27-40
SILTY CLAY LOAM	*	0-20	40-73	27-40
SANDY CLAY	*	45-65	0-20	35-55
SILTY CLAY	*	0-20	40-60	40-60
CLAY	*	0-45	0-40	40-100

* DENOTES: A, B, OR C DEPENDING UPON UNCONFINED COMPRESSION STRENGTH AND VISUAL INSPECTION OF TRENCH/EXCAVATION. NOTE: As a general rule of thumb, you can classify 80% sand or greater as a type "C" soil.

COMPETENT PERSON DOCUMENTATION:

Competent person must maintain the Daily Inspection Checklist for each trench/excavation. The documentation must include Job site Description; Trench/Excavation Inspection Comments; Employee & Public Safety Inspection; Protection System Selected; Soil Conditions; and Construction Design and Comments.

TRAINING:

Competent persons for trenching and excavation work must be trained in the following objectives:

1. DEFINE SELECTED TERMINOLOGY: Competent persons must be knowledgeable in the following terms:

   - Support system
   - Excavation
   - Trench shield/box
   - Sloping
   - Trench
   - Registered Professional Engineer (RPE)
   - Failure
   - Uprights

2. IDENTIFY DUTIES OF "COMPETENT PERSON" USING DAILY INSPECTION CHECKLIST: Competent persons must be knowledgeable in the elements of the Daily Inspection Checklist to identify duties.
3. DOCUMENT TRENCHES/EXCAVATIONS USING THE DAILY INSPECTION CHECKLIST: Competent persons must be trained to complete the checklist identifying the Job Site Description; Trench/Excavation Inspection Comments; Employee & Public Safety Inspection; Protection System Selected; Soil Conditions; and Construction Design and Comments.
4. DEFINE SELECTED SOIL TERMINOLOGY: Competent person shall be able to identify the following soil conditions:
   - Fissures
   - Granular
   - Saturated
   - Clay
   - Multiple soil types
   - Moist soil
   - Caliche
   - Cohesive
   - Plastic
5. HANDS-ON SOIL TESTING: Competent person training shall include hands on soil classification. Competent person training shall require competent person candidate to classify cohesive (clay) soil (commercial clay or play doe may be used as a substitute), and granular soils.
6. INTERPRET DESCRIPTIONS OF SOIL CONDITIONS AND IDENTIFY TYPES REQUIRING SHORING: Competent persons must be able to identify conditions that will effect soil classifications, such as: fissures, vibration, previous excavations, blasting, above water table, rock above soil layers, layers tilting in at 4:1 slope or steeper, water freely seeping from side of trench, etc.
7. IDENTIFY CAUSES OF TRENCH CAVE-INS: Competent person must be able to identify cause of trench cave-in such as: inadequate support systems, inadequate sloping,

surcharge loading, etc.

8. IDENTIFY HYDRAULIC SHORING REQUIREMENTS: Competent person must be knowledgeable in the manufactures tabulated data, as well as the application of Appendix D to Subpart P (29 CFR 1926). Competent persons must be able to identify proper installation techniques and limitation of hydraulic shoring depending upon the depth and soil type. Competent person must know:
   - Maximum horizontal distances between shores,
   - Distance from the top cylinder to soil's top edge,
   - Maximum trench width and depth allowed without consulting an RPE,
   - Thickness of Finn Form Sheeting for Type "B" soil,
   - Number of inches the Finn Form Sheeting should, extend above the vertical side of a compound trench and,
   - The amount the sheeting may be raised from the bottom of the trench, provided the first cylinder is not higher than 4' from the trench floor to the middle of the first cylinder.
9. IDENTIFY TECHNICAL CHANGES IN SLOPING AND BENCHING SPECIFICATION AND RECOGNIZE SLOPING REQUIREMENTS: Competent person must be able to identify the slope required for the following soil classifications:
   - A short term - less than 24 hours
   - A long term
   - B long term
   - C long term

   In addition, competent persons must be able to determine when benching is authorized for cohesive soils only.
10. IDENTIFY SAFETY REQUIREMENTS FOR USING A TRENCH SHIELD:

    Competent person must be able to identify when end plates are required, how to safely stack shield sections, access and egress requirements, shield construction requirements, material handling requirements (tag line, sling safety, etc.), and lateral support requirements.
11. IDENTIFY SAFETY REQUIREMENTS FOR A TRENCH WITH SURFACE ENCUMBRANCES:

    Competent person must be able to identify appropriate methods in bracing or removing surface encumbrances, including when such bracing should be designed by and RPE.

At the completion of the above training, competent person candidates will demonstrate their proficiency under the supervision of competent company officials prior to being designated as a "competent person" for trenching and excavation work.

Hazard Identification Checklist

Hazard	YES	NO
Surface Encumbrances		
☐ Removed and/or marked?	Y	N
Other Utilities Nearby		
☐ Local utility companies notified prior to dig?	Y	N
☐ Underground utility structures located?	Y	N
☐ Underground utility structures marked w/ paint or stakes?	Y	N
Access To Excavation		
☐ Ramps/runways of uniform thickness?	Y	N
☐ Are multiple ramp structures connected together?	Y	N
☐ Bottom of runways equipped w/ cleats to prevent slipping on the ground?	Y	N
☐ Surface of ramps/runways equipped w/ cleats to prevent employee shoes slipping?	Y	N
Egress From Excavation (if 4ft deep or more)		
☐ Ladder provided and placed within the protection system?	Y	N
☐ Does ladder extend at least 3 ft. above the lip of the trench?	Y	N
☐ Is bottom of the ladder less than 25 ft. away from employees?	Y	N
Overhead Loads		
☐ Is any employee standing underneath or near loads being handled by digging or lifting equipment?	Y	N
☐ Does the equipment operator remain in the cab at all times while loads are being lifted or moved?	Y	N
Vehicular Traffic		
☐ Employees wearing orange vests or high-visibility garments?	Y	N
☐ Traffic control measures adhere to the MUTCD?	Y	N
Mobile Equipment		
☐ Is the grade away from the excavation?	Y	N
☐ Equipped w/ audible warning device?	Y	N
☐ Warning systems in place at edge of excavation (i.e. barricades, stop logs, hand signalers, etc.)?	Y	N
Adjacent Structures, Sidewalks & Roads		
☐ Adequate support systems (i.e. shoring, bracing, underpinning, etc.) in place?	Y	N

Loose Rock & Soil		
☐ Has pit been scaled to remove loose material?	Y	N
☐ Has plywood or sheeting been installed to stop and contain falling material?	Y	N
☐ Are the protective measures *separate* from the load bearing protective system?	Y	N
☐ Is the spoil pile at least 2ft. from the edge of the excavation and/or sufficiently restrained?	Y	N
Open Pits & Shafts		
☐ Barricades placed at least 6 ft. from edge of excavation?	Y	N
☐ Barricades and guardrails at least 42" high (required for trenches that are 6 ft. deep or that are not visible)?	Y	N
☐ Are walkways and bridges *over* the pit equipped with 42" high guardrails?	Y	N
Hazardous Atmospheres		
☐ Excavations 4ft. or deeper have been atmospherically tested?	Y	N
☐ Excavations 4ft. or deeper are being continuously monitored?	Y	N
☐ Is atmosphere oxygen deficient (less than 19.5% oxygen)?	Y	N
☐ Is the excavation a confined space?	Y	N
☐ Have confined space entry permits been obtained?	Y	N
☐ Has adequate ventilation been provided?	Y	N
☐ Is test equipment in good working order?	Y	N
Water Accumulation		
☐ Are there visible signs of existing water accumulation?	Y	N
☐ Have groundwater tables been consulted?	Y	N
☐ Have weather reports and historical precipitation data been gathered?	Y	N
☐ Has soil been tested for moisture content?	Y	N
☐ Has nearby water been diverted?	Y	N
☐ Is dewatering equipment available on site?	Y	N
PPE		
☐ Hard hats?	Y	N
☐ Dust masks and/or respirators?	Y	N
☐ Hearing protection?	Y	N
☐ Safety glasses and/or face shields?	Y	N
☐ Safety shoes?	Y	N

Daily Excavation Inspection Checklist

Job/Location:	Date	Time: am / pm
Weather: Temp. ____° F Precip. (last 24 hrs): _______	Comp. Person:	
Locates: Date: ____________ Locates visible? ______ Conf. Number: ____________		

	Y	N	Conditions	Y	N	Conditions
Site Hazards	Y	N	Vehicles/vibration?	Y	N	Falling loads?
	Y	N	Heavy equipment/vibration?	Y	N	Nearby structures?
	Y	N	Surface encumbrances?	Y	N	Overhead hazards/obstructions?
	Y	N	Underground installations?	Y	N	Atmospheric hazards?
Haz. Control	Y	N	Traffic Control: ❑ Signs ❑ Cones ❑ Barricades ❑ Flagger			
	Y	N	Access and egress? If over 4 ft. deep.			
	Y	N	Ladders: ❑ Within 25 ft.? ❑ 3 ft. above lip?			
	Y	N	Dewatering: ❑ Pumps ❑ Accumulation?			
	Y	N	Atmospheric monitoring? Gas detector ID: Calibration Date:			
	Y	N	Rescue equipment available? Rescue pre-plan?			
	Y	N	After hours security?			
Visual	**Y**	**N**	**Conditions**	**Y**	**N**	**Conditions**
	Y	N	Excavated soil granular?	Y	N	Layered soils? Slope: ____ °
	Y	N	Excavated soil in clumps?	Y	N	Fissured soil?
	Y	N	Previously disturbed?	Y	N	Water table high?
	Y	N	Rock present?	Y	N	Seepage from sides?
	Y	N	Rock stable?	Y	N	Runoff accumulation?
	Y	N	Spalling, bulging, subsidence?	Y	N	Spoil location correct?
	Y	N	Particle size checked? ❑ Fine grained ❑ Coarse grained ❑ Gravel			

Soil Tests	
	Plasticity: 1/8" Thread length:_______ ❑ Granular (< 2") ❑ Cohesive (> 2")
	Dry strength. ❑ A (Breaks into clumps which are broken with difficulty) ❑ B (Crumbles on own or with slight pressure, angular grains and fissures seen) ❑ C (Falls in clumps, breaks into smaller clumps, forms rounded grains or fine powder)
	Thumb penetration: ❑ A (Great effort) ❑ B (Effort) ❑ C (Easy)
	Test instrument: ❑ Penetrometer ❑ Shear Vane Readings: ______________________________ Average tsf: _________ ❑ A (> 1.5) ❑ B (0.5 – 1.5) ❑ C (< 0.5)
	Drying test: ❑ Cracks (B or C, fissured) ❑ No cracks, breaks with force (A, unfissured, cohesive) ❑ Pulverize with difficulty (B, cohesive, fissured)
	Sedimentation: Granular height _____ in. Total height ____ in. Percent granular ____ %
	Shake: Jiggle soil: ❑ Shiny, wet surface (sand/silt) ❑ No change (clay) Shake/squeeze: ❑ Moisture quick appear, disappear (sand/silt) ❑ No moisture (clay)
	Dry Hand: ❑ Dusty, gritty, rubbing removes most (silt) ❑ Hard crust, tough to remove (clay)
	Hand Cleaning: ❑ Rinses easily (silt) ❑ Greasy, difficult to remove (clay)
	Results: Soil Type Based on Manual Tests: ❑ A ❑ B ❑ C

Protection Systems	
	Sloping: __ 1½:1 __1:1 __¾:1 ❑ Slope ratio appropriate, no signs of distress. Notes:
	Shields: ❑ No signs of damage or obvious signs of wear. ❑ Copy of shield certification available on-site. ❑ Shield suited to hazard and excavation specifications. Notes:
	Shoring: ❑ No signs of damage or obvious signs of wear. ❑ Copy of shoring components certifications available on-site. ❑ Shoring suited to hazard and excavation specifications. Notes:

Underground Installations

The estimated locations of underground utilities (water, sewer, steam, gas, fuel, electric, etc.) that may be encountered during excavation shall be determined before opening the excavation.

In most locations, 48 hour notice to the utilities is required.

Accuracy should be within 24 inches of outside dimensions of both sides of the underground facility.

Locates are often based on the AWPA model that lists acceptable methods of marking a locate.

Color Markings	
Red	Electric power lines, cables, conduit, and lighting.
Blue	Water, irrigation, slurry lines
Orange	Communication, cable TV, alarm/signal lines, cables or conduits.
Yellow	Gas, oil, steam, petroleum, hazardous liquid or gaseous materials.
Green	Sewer and drain lines
White	Proposed outlines of intended excavation (voluntary).

General Guidelines:

- Call before you dig. This should be at least 2 days but less than 10 days before you dig.
- Know the exact location where you will be digging. If there is no street address, know the driving directions, township, range, section and quarter section.
- Once the site is marked, or you have been told there is no conflict, you can start digging.
- Stay at least two feet away from the marks.
- If you must dig near (or on) the marks, use safe and acceptable means (hand dig, expose the lines carefully, support them as needed.)

Water Accumulation Hazards

The accumulation of water in and around an excavation site is one of the greatest hazards to the safety of employees in trenches.

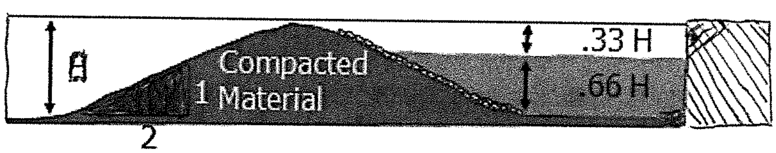
When soil is exposed to moisture its bearing capacity and shearing strength are weakened, significantly increasing the risk of a cave-in.

Water accumulation inside a trench also poses a drowning threat.

A competent person must know how to:

- Estimate the potential for water accumulation due to precipitation (taking into consideration past weather data, the slope of the ground, the size of the excavation, etc.) and calculate the time necessary to dewater the site.
- Use data collected from groundwater tables and soil classification tests to prevent water accumulation hazards.
- Prevent water from accumulating in the excavation due to natural surface drainage (i.e. runoff, streams, etc.) using effective diversion methods.
- Dewater the site using pumps, wellpoints, ditches, etc.

Water Diversion



Berms and Dikes:

____

____

Ditches:

____

____

Dewatering - Pumps

Before you select a pump you must know:

Groundwater Table:

MINIMUM 2 -5 ft. below excavation.

Fluid Type: Is the fluid being pumped clean, dirty, contain any solids or abrasives, or is it a hazardous material.

Flow Rate: How many GPM (gallons per minute) of pump flow are required.

Hose Lengths: Pumps usually have suction and discharge hoses required. Longer hoses increase line friction and reduce pump performance. Keep hose lengths as short as possible.

Suction Lift: This is the vertical distance from the surface of the fluid being pumped to the pump impeller. Keep this distance to a minimum.

Discharge Head: This is the vertical distance from the pump impeller to the pump discharge.

Seepage: The rate at which the fluid being pumped accumulates at the point of suction. Slow seepage can result in air entering the pump suction. This can result in a loss of the pump's prime.

Types of Pumps

Two types of pumps are commonly used:

- Centrifugal, which includes self-priming, trash, and submersible pumps; and
- Positive displacement, which includes diaphragm pumps of various types.

Centrifugal Trash Pumps provide an efficient solution for applications where the suction lift is less than 25' and the discharge head is less than 100'. These pumps are capable of passing up to 25% (by volume) small solids (particles of mud, sand, leaves, rocks, etc.), up to half the diameter of the suction port. (A 2" trash pump can pass up to 1" diameter solids.) Trash pumps also provide easy access to the pump body for cleanout.

High-pressure (high-head) pumps are designed for applications requiring a greater than normal (two to three times greater) discharge head.

Positive Displacement Diaphragm Pumps are ideal for applications involving slow seepage at the point of suction, due to their great air handling capabilities. Although slower and less efficient than centrifugal pumps, diaphragm pumps can operate in conditions where centrifugal pumps would lose their prime. There are both gas and air-powered diaphragm pumps, including special-purpose models for handling hazardous materials such as corrosive chemicals.

Electric Submersible Pumps consist of a centrifugal pump closely coupled to a watertight electric motor with a waterproof power cord. These pumps operate submerged, thereby eliminating the suction lift limitations of other types of pumps.

Other features include quiet operation, no engine fumes, and continuous operation without refueling.

Other Dewatering Techniques

Wellpoints:

___

___

___

Gravity Drainage:

___

___

___

Deep Wells:

___

___

___

Hazardous Atmospheres

When is there the possibility of a hazardous atmosphere?

____

____

Do workers know the signs of exposure?

____

____

Oxygen Deficiency

Symptoms: ______________________________________

____

Toxic and Flammable Gases

____

____

Trenches and Confined Spaces

1926 Subpart AA Confined Spaces in Construction

Permit Space Definition:

- Large enough to enter
- Limited access and egress
- Not designed for continuous occupancy
- Contain a serious safety hazard (a hazard that prevents self-rescue).

General Rule: Follow the Excavation Standard unless the excavation is very narrow and deep or you are accessing a structure (e.g., sewer or vault) using an excavation.

____

____

Excavation Safety – Code Exercise

Using OSHA 29 CFR 1926.650-652 (or state regulations), answer the following questions and provide the exact code reference for your answers.

1. What (or who) determines whether you are a Competent Person on a trench or excavation project?

____

Are there any minimum hours of training specified? _____

Code Reference: ____

2. A shield must be assembled to the manufacturer's specifications or designed by a:

____

Code Reference: ____

3. What task needs to be completed before digging?

____

Code Reference: ____

4. Employees in trenches must be within how many feet of a ladder (or other means of egress)?

____

Code Reference: ____

5. How close can you store excavated material to the sides of the excavation or trench?

________ feet

Code Reference: ____

6. Employees must be protected by an adequate protective system whenever an excavation is more than ______ feet in depth?

Code Reference: ____

7. What steps and precautions do you have to take when removing shoring?

____

Code Reference: ____

8. When do you have to inspect an excavation?

____

Code Reference: ____

9. If a trench was classified as having Type B soil, what is the maximum allowable slope for excavation less than 20 feet in depth? ____________ Will this slope always be safe? ________

____

Code Reference: ____

10. If your trench is more than _____ feet in depth, the protection system must be designed by a

____________________________ .

Code Reference: ____

11. What is the maximum allowable distance between the bottom of the trench and the bottom of the trench box? ______ feet. What requirements apply to this?

____

Code Reference: ____

12. Type A soil that is fissured would be classified as what type of soil? _______

____

Code Reference: ____

VI. Emergency Planning

Accidents happen, and responding properly in the first few moments can mean the difference between a close call, an injury or a death.

Worker training can provide some level of protection, as can developing procedures for rescuing victims.

This chapter examines emergency preparedness issues that should be dealt with before any excavating is begun.

A Few Facts

The local fire department may not be trained or equipped to provide rescue services.

While most people think you can simply dial 911 in the event of any type of emergency, you should contact the local fire department and assess their capabilities. Determine the approximate response time.

____

____

____

There's a 50-50 chance of secondary collapses.

After an initial cave-in, there is an even chance of a secondary and even tertiary collapse. This often results in additional victims who may be trying to extricate the first victim. Workers must be taught that they should never try to rescue someone unless they have been trained and equipped.

____

____

____

If a victim is completely buried, you only have a very short time to rescue them.

In most cases, people will not survive a complete burial for more than ten minutes. This means that off-site rescuers must have extremely quick response times and an ability to immediately deploy their rescue equipment if they hope to perform a rescue.

Victims may be able to increase their chance of survival if they respond quickly.

If workers have been trained to recognize the signs of an impending collapse (e.g., spalling, cracks, bulges) they may be able to evacuate before they become trapped.

Also, if they have been trained to recognize the signs and symptoms of hazardous atmospheres, they may be able to perform a self-rescue before becoming incapacitated.

Victims who are about to be buried can increase their chance of survival if they can assume a crouching position with their head down. The purpose is to create a small air pocket around their face and, more importantly, their chest. This may provide enough room to expand and contract their chest to breathe. Victims are often killed when the weight of the soil prevents them from moving their chest enough to breathe.

Pre-planning

Rescue pre-planning begins with a site inspection and then asking yourself, "what would happen if . . . ?" Specific items to consider include:

Traffic and access: Will you need to stop traffic (and its vibrations) to prevent secondary collapses? How will the emergency vehicles access the site?

____

____

Materials for emergency shoring: Are they available? Do the work crews know where they are and their intended purpose?

____

____

Tools and equipment for a rescue operation: What equipment (e.g., backhoes) will be available on-site to aid in a rescue? If hazardous atmospheres are anticipated, is the required emergency equipment present and ready to be used?

____

____

Crowd control: Who will provide crowd control? How will you designate and control access to the area(s) needed to perform the rescue?

____

____

Underground utilities: If there are nearby utilities, do the rescuers know their location? Utilities adjacent to the excavation may be impacted by digging outside the area of the original excavation.

____

____

Spoil location: Where will the spoil be placed when digging to extricate a victim?

____

____

Trench Rescue

The art of keeping everyone safe while excavating in unstable ground with someone's life in the balance.

____

____

Emergency Rescue Equipment – 1926.651(g)(2) ____________________

____

____

Rescue Equipment

- Hydraulic, pneumatic shores
- Sheeting – Finland form ¾ inch
- Atmospheric monitors
- Respirators
- Retrieval systems
- PPE
- Dewatering equipment

____

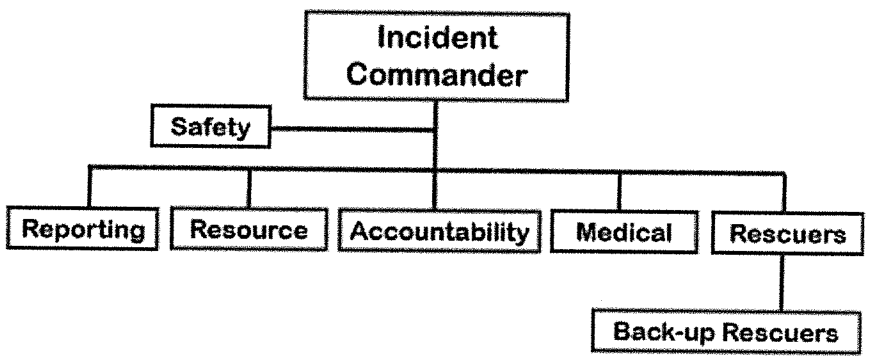
____

Rescue Process

Take Control

Incident Command System

- Limited span of control (5 – 6)
- Clear leadership and responsibilities
- Clear text: no codes or jargon
- Structure integrates with additional resources



Phase 1 – Size Up

Primary Assessment: ______________________________

Rescue or Recovery? ______________________________

What if the crew has established an ICS?

____

Secondary Assessment: ______________________________

- Match resources to the tasks
- Create an action plan
- Light, temperature, time needed, etc.

Phase 2 – Pre-rescue

____

Hot, Warm, and Cold Zones ______________________________

Surcharge Loads ______________________________

Phase 3 - Rescue

Manage surcharge loads ______________________________

Protect the patient ______________________________

Create safe zones ______________________________

Heavy Equipment? ______________________________

____

Patient Care and Removal ______________________________

____

Phase 4 - Termination

____

____

Notes

Notes