University of Tennessee Safety Guidelines

Policy Subject: **Trenching and Shoring Guidelines**	Effective Date: 9/1/12
Area Affected: Any departments who are involved in excavation work and trenching.	Reviewed/Revised: 2/1/2016 (Rev. 1)
Contact Information: Policy Owner: Environmental Health and Safety Subject Matter Expert: EHS Director; Sr. Safety Coordinator	

1.0 Purpose, Applicability, and Scope

1.1 Purpose - The purpose of this guideline is to reduce the risk of injury or death for those individuals who enter trenches or excavations.

1.2 Applicability – This shall apply to all staff and faculty from the Knoxville campus of the University of Tennessee. This does not apply to contractors and their employees who are conducting work onsite. UT students and minors who are not enrolled, but engaged in university sponsored activities on campus are prohibited from entering trenches exceeding four feet in depth.

1.3 Scope – This guideline applies to trenches and excavations onsite and offsite.

2.0 Abbreviations, Acronyms, and Definitions

2.1 Abbreviations/Acronyms

ACGIH – American Conference of Governmental Industrial Hygienists

EHS – campus Environmental Health and Safety

PEL – Permissible Exposure Limit

TLV – Threshold Limit Value

2.2. Definitions:

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

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

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

Competent person: one who is capable of identifying existing and predictable hazards in the surroundings, or working conditions that are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them. A competent person should have and be able to demonstrate the following:

1. Training, experience, and knowledge of:

    a. Soil analysis.

    b. Use of protective systems.

    c. Requirements of 29 CFR 1926 Subpart P.

2. Ability to detect:

    a. Conditions that could result in cave-ins.

    b. Failures in protective systems.

    c. Hazardous atmospheres.

    d. Other hazards including those associated with confined spaces.

3. Authority to take prompt corrective measures to eliminate existing and predictable hazards and to stop work when required.

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

Registered professional engineer: a person who is registered as a professional engineer.

Shield (shield system): a structure that is able to withstand the forces imposed on it by a cave-in and thereby protect employees within the structure. Shields can be a permanent structure or can be designed to be portable and moved along as work progresses. Also known as trench box or trench shield.

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

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

Soil Types

1. Type A – Most stable: clay, silty clay, and hardpan (resists penetration). No soil is Type A if it is fissured, is subject to vibration of any type, has been previously been disturbed, or has seeping water.

2. Type B – Medium stability: silt, sandy loam, medium clay and unstable dry rock; previously disturbed soils unless otherwise classified as Type C; soils that meet the requirements of Type A soil but are fissured or subject to vibration.

3. Type C – Least stable: gravel, loamy sand, soft clay, submerged soil or dense, heavy unstable rock, and soil from which water is freely seeping.

4. Layered geological strata (where soils are configured in layers) – The soil must be classified on the basis of the soil classification of the weakest soil layer. Each layer may be classified individually if a more stable layer lies below a less stable layer, i.e. where a Type C soil rests on the top of stable rock.

Trench (trench excavation): a narrow excavation (in relation to its length) made below the surface of the ground. In general, the depth is greater than the width, but the width of a trench is not greater than fifteen (15) feet. If forms or other structures are installed or constructed in an excavation as to reduce the dimension measured from the forms or structure to the side the excavation to one hundred fifty four (154) feet or less, the excavation is also considered to be a trench.

3.0 Roles and Responsibilities

Environmental Health and Safety shall:

- Assist supervisors with employee training upon request
- Review and revise this procedures
- Provide interpretations of this procedure where the intent is not clear
- Investigate complaints involving trenching and shoring activities under the control of UTK.
- Conduct safety assessment upon request of projects involving trenching and shoring
- Recommend controls and protective measures regarding trenches and excavations
- Investigate any accidents in trenches or excavations
- Conduct air monitoring for hazardous gases upon request in trenches and excavations

Departments who have staff, faculty or students who enter trenches or excavations shall:

- Ensure the individuals are properly trained and follow this procedure
- Provide any required safety equipment
- Assign a competent person to each excavation

Competent persons shall:

- Prohibit unauthorized individuals from entering trenches and excavations
- Evaluate soils conditions
- Conduct and document inspections of trenches and excavations
- Ensure no utilities are likely to be damaged prior to excavation

Staff or faculty who enter trenches and excavations shall:

- Prohibit students under their supervision from entering trenches that are more than four feet in depth.
- Participate in training
- Stop work in the event of imminent danger or when ordered by a competent person
- Follow the requirements established during training
- Report any problems, accidents, near misses or other hazards associated with trenching and excavation to their supervisor.

4.0 Procedure

All excavations shall be made in accordance with the rules, regulations, requirements, and guidelines set forth in 29 CFR 1926.650, 651, and .652; the Occupational Safety and Health Administration's standard on Excavations, except where otherwise noted below.

A. Procedures

1. A competent person shall be placed in charge of all excavations and shall be onsite at all times. Note that more than one person onsite may meet the qualifications for a competent person.

2. Underground utilities must be located and marked before excavation begins.

3. Employees are not allowed in the excavation or trench while heavy equipment is digging.

4. Provisions (e.g. fence, barricade) shall be made to prevent unauthorized individuals from accessing trenches or excavations more than four feet in depth.

B. Inspections

The competent person shall conduct inspections:

1. Daily and before the start of each shift.

2. As dictated by the work being done in the trench.

3. After every rainstorm.

4. After other events that could increase hazards, such as snowstorm, windstorm, thaw, earthquake, dramatic change in weather, etc.

5. When fissures, tension cracks, sloughing, undercutting, water seepage, bulging at the bottom of the trench or excavation or other similar conditions occur.

6. When there is a change in the size, location, or placement of the spoil pile.

7. When there is any indication of change or movement in adjacent structures.

For excavations and trenches four (4) feet or greater in depth, a trench inspection form shall be filled out for each inspection. See Appendix B (trench inspection form)

C. Testing Methods

The competent person in charge of the excavation shall be responsible for determining whether the soil is Type B or C. The competent person shall use a visual test coupled with one or more manual tests.

D. Visual test

1. In addition to checking the items on the trench inspection form, the competent person should perform a visual test to evaluate the conditions around the site. In a visual test, the entire excavation site is being observed, including the soil adjacent to the site and the soil being excavated. The competent person also checks for any signs of vibration.

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

3. This person should also look for signs of bulging, boiling, or sloughing, as well as for signs of surface water seeping from the sides of the excavation or from the water table.

4. In addition, the area adjacent to the excavation should be checked for signs of foundations or other intrusions into the failure zone, and the evaluator should check for surcharging and the spoil distance from the edge of the excavation.

E. Manual tests

1. Thumb penetration test. Attempt to press the thumb firmly into the soil in question. If the thumb penetrates no further than the length of the nail, it is probably type B soil. If

the thumb penetrates the full length of the thumb, it is Type C. It should be noted that the thumb penetration test is the least accurate testing method.

2. Dry strength test. Take a sample of dry soil. If it crumbles freely or with moderate pressure into individual grains, it is considered granular (Type C). Dry soil that falls into clumps that subsequently break into smaller clumps) and the smaller clumps can only be broke with difficulty) is probably clay in combination with gravel, sand, or silt (Type B).

3. Plasticity or Wet Thread Test. Take a moist sample of soil. Mold it into a ball and then attempt to roll it into a thin thread approximately 1/8 inch in diameter by two (2) inches in length. If the soil sample does not break when held by one end, it might be considered Type B.

A pocket penetrometer, shearvane, or torvane may also be used to determine the unconfined compression strength of soils.

F. Imminent Danger

Work in a trench with vertical walls and a depth exceeding seven feet is considered imminent danger. No employee shall enter a trench with vertical walls unless the trench is in solid rock or unless protection is provided.

G. Additional Program Requirements

The following subjects relative to trenching and excavations are covered in Appendix A

a. Spoil Piles
b. Crossing Trenches
c. Ingress and Egress
d. Exposure to Vehicles
e. Exposure to Falling Loads
f. Warning Systems for Mobile Equipment
g. Hazardous Atmospheres and Confined Spaces
h. Standing Water and Water Accumulation
i. Benching, Shoring, Sloping and Shielding Requirements

5.0 Recordkeeping

The following records shall be maintained in accordance with Records Retention for Safety, Health and Environmental Compliance (Procedure GS 43) in the Safety Manual.

a. Employee training

b. Trench Inspection Form (Appendix B)

6.0 Training

Personnel who perform work in excavations shall comply with the requirements of these guidelines and shall receive appropriate training that shall include at a minimum:

1. Safe work practices that must be followed during work in excavations;
2. The use of personal protective equipment (PPE) that will typically be required during work in excavations, including but not limited to safety shoes, hardhats, and fall protection devices;
3. Procedures to be followed if a hazardous atmosphere exists or could reasonably be expected to develop during work in an excavation; and
4. Emergency and non-entry rescue methods, and procedures for calling rescue services.

Training shall be provided for individuals who are removing soil, enter the trench or excavation and the competent person. The training shall be documented and a record maintained.

Refresher training shall be conducted every three years or when any one of the following occurs:

a. The employee is not following correct excavation procedures

b. Equipment or processes change

c. Regulations changes

7.0 Standards

a. 29 CFR 1926.650, 651, and .652

8.0. Appendices

Additional Guidelines (Appendix A)

Trench Inspection Form (Appendix B)

9.0. Disclaimer

The information provided in this policy is designed for educational use only and is not a substitute for specific training or experience.

The University of Tennessee Knoxville and the authors of this policy assume no liability for any individual's use of or reliance upon any material contained or referenced herein. The material contained in this policy may not be the most current.

Appendix A

Additional Program Requirements

I. Spoil Piles

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

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

2. Permanent spoil should be placed some distance from the excavation.

II. Surface Crossing of Trenches. Surface crossing of trenches should not be made unless absolutely necessary. However, if necessary, they are only permitted under the following conditions.

1. Vehicle crossing must be designed by and installed under the supervision of a registered professional engineer.

2. Walkways or bridges must:

a. Have a minimum clear width of twenty (20) inches.

b. Be fitted with standard rails.

c. Extend a minimum of twenty-four (24) inches past the surface edge of the trench.

III. Ingress and Egress

1. Trenches four (4) feet or more in depth shall be provided with a fixed means of egress.

2. Spacing between ladders or other means of egress must be such that a worker will not have to travel more than twenty-five (25) feet laterally to the nearest means on egress,

3. Ladders must be secured and extend a minimum of thirty-six (36) inches above the grade level.

4. Metal ladders should be used with caution, particularly when electrical utilities are present.

IV. Exposure to Vehicles

1. Employees exposed to vehicular traffic shall be provided with and required to wear reflective vests or other suitable garments marked with or made of reflectorized or high-visibility materials.

2. Trained flag persons, signs, signals, and barricades shall be used when necessary.

V. Exposure to Falling Loads

1. All employees on an excavation site must wear hard hats.

2. Employees are not allowed to work under raised loads.

3. Employees are not allowed to work under loads being lifted or moved by heavy equipment used for digging or lifting.

4. Employees are required to stand away from equipment that is being loaded or unloaded to avoid being struck by falling materials or spillage.

5. Equipment operators or truck drivers may remain in their equipment during loading and unloading if the equipment is properly equipped with a cab shield or adequate canopy.

VI. Warning Systems for Mobile Equipment. The following steps should be taken to prevent vehicles from accidentally falling in the trench:

1. Barricades must be installed where necessary,

2. Hand or mechanical signals must be used as required,

3. Soil should be graded away from the excavation; this will assist in vehicle control and channeling of run-off water,

4. Trenches left open overnight shall be fenced and barricaded.

VII. Hazardous Atmospheres and Confined Spaces. Employees shall not be permitted to work in hazardous and/or toxic atmospheres. When there is any doubt or question about a hazardous atmosphere, calibrated meters shall be used. Such atmospheres include those with:

1. Less than 19.5% oxygen,

2. A combustible gas concentration greater than 20% of the lower flammable limit, and,

3. Concentration of hazardous substance that exceeds those specified in the Threshold Limit Values for airborne contaminants established by the ACGIH, or Permissible Exposure Limit by OSHA.

All operations involving such atmospheres must be conducted in accordance with OSHA requirements for occupational health and environmental controls for personal protective

equipment and for lifesaving equipment. Engineering controls (such as ventilation) and respiratory equipment may be required.

4. 1. If there is any possibility that the trench or excavation could contain a hazardous atmosphere, atmospheric testing must be conducted prior to entry. Conditions that might warrant atmospheric testing would be if the excavation was crossed by, was adjacent to, or contained pipelines containing a hazardous material (for example, natural gas lines). Contact EHS for air monitoring if their service in not provided by the contractor.

5. Testing should be conducted before employees enter the trench and should be done regularly to ensure that the trench remains safe. The frequency of testing should be increased if equipment is operating in the trench.

6. Testing frequency should also be increased if welding, cutting, or burning is done in the trench.

7. Employees required to wear respiratory protection must be trained. Fit-tested, and enrolled in a respiratory protection program.

8. Some trenches qualify as confined spaces. When this occurs consult the Confined Space Procedure (Procedure # GS 45) in the safety manual is also required.

VIII. Standing Water and Water Accumulation. Methods for controlling standing water and water accumulation must be provided and should consist of the following if employees must work in the excavation:

1. Use of special support or shield systems approved by a registered professional engineer.

2. Water removal equipment, such as well pointing, used and monitored by a competent person.

3. Safety harnesses and lifelines used in conformance with 29 CFR 1926.104.

4. Employees removed from the trench during rainstorms.

5. Trenches carefully inspected by a competent person after each rain and before employees are permitted to re-enter the trench.

IX. Benching, Sloping, Shoring and Shielding Requirements

1. All excavations or trenches four (4) feet or greater in depth shall be appropriately benched, shored, or sloped according to the procedures and requirements set forth in OHSA's Excavation standard, 29 CFR 1926.650, .651, and .652.

2. Excavations or trenches twenty (20) feet deep or greater must have a protective system designed by a registered professional engineer.

3. Excavations under the base of footing of a foundation or wall require a support system designed by a registered professional engineer.

4. Sidewalks and pavement shall not be undermined unless a support system or another method of protection is provided to protect employees from their possible collapse.

Sloping

Maximum allowable slopes for excavations less than twenty feet (20') in depth based on soil type and angle to the horizontal are as follows:

Soil Type	Height/Depth Ratio	Slope Angle
Type A	0.75 : 1	54 degrees
Type B	1:1	45 degrees
Type C	1.5: 1	34 degrees

A ten (10)-foot-deep trench in Type B soil would have to be sloped to a forty-five (45) degree angle, or sloped ten (10) feet back in both directions. Total distance across a ten (10)-foot-deep trench would be twenty (20) feet, plus the width of the bottom of the trench itself. In Type C soil, the trench would be sloped at a thirty-four (34)-degree angle, or fifteen (15) feet back in both directions for at least thirty (30) feet across, plus the width of the bottom of the trench itself.

Benching

1. There are two basic types of benching, single and multiple, which can be used in conjunction with sloping.

2. In Type B soil, the vertical height of the benches must not exceed four (4) feet. Benches must be below the maximum allowable slope for that soil type. In other words, a ten (10)-foot deep trench in Type B soil must be benched back ten (10) feet in each direction, with the maximum of a forty-five (45)-degree angle.

3. Benching is not allowed in Type C soil.

Shoring

1. Shoring or shielding is used when the location or depth of the cut makes sloping back to the maximum allowable slope impractical. There are two basic types of shoring, timber and aluminum hydraulic.

2. Hydraulic shoring provides a critical safety advantage over timber shoring because workers do not have to enter the trench to install them. They are also light enough to be installed by one worker; they are gauge-regulated to ensure even distribution of pressure

along the trench line; and they can be adapted easily to various trench depths and widths. However, if timber shoring is used, it must meet the requirements of 29 CFR 1926.650, .651. and .652.

3. All shoring shall be installed from the top down and removed from the bottom up. Hydraulic shoring shall be checked at least once per shift for leaking hoses and/or cylinders, broken connections, cracked nipples, bent bases, and any other damaged or defective parts.

4. The top cylinder of hydraulic shoring shall be no more than eighteen (18) inches below the top of the excavation.

5. The bottom of the cylinder shall be no higher than four (4) feet from the bottom of the excavation. (Two (2) feet of trench wall may be exposed beneath the bottom of the rail or plywood sheeting, if used.)

6. Three (3) vertical shores, evenly spaced, must be used to form a system.

7. Wales are installed no more than two (2) feet from the top, no more than four (4) feet from the bottom and no more than four (4) feet apart, vertically.

8. Here are some typical installations of aluminum hydraulic shoring:

a. Vertical aluminum hydraulic shoring (spot bracing)

b. Vertical aluminum hydraulic shoring (with plywood)

c. Vertical aluminum hydraulic shoring (stacked)

d. Aluminum hydraulic shoring water system (typical)

Shielding

1. Trench boxes are different from shoring because, instead of shoring up or otherwise supporting the trench face, they are intended primarily to protect workers from cave-ins and similar accidents

2. The excavated area between the outside of the trench box and the face of the trench should be as small as possible. The space between the trench box and the excavation side must be backfilled to prevent lateral movement of the box. Shields may not be subjected to loads exceeding those, which the system was designed to withstand.

3. Trench boxes are generally used in open areas, but they also may be used in combination with sloping and benching.

4. The box must extend at least eighteen (18) inches above the surrounding area if there is sloping toward the excavation. This can be accomplished by providing a benched area adjacent to the box.

5. The manufacturer must approve any modifications to the shields.

6. Shields may ride two (2) feet above the bottom of an excavation, provided they are calculated to support the full depth of the excavation and there is no caving under or behind the shield.

7. Workers must enter and leave the shield in a protected manner, such as by a ladder or ramp.

8. Workers may not remain in the shield while it is being moved.

Appendix B Trench Inspection Form

TRENCH INSPECTION AND ENTRY AUTHORIZATION FORM

LOCATION:	**DATE:**
TIME OF INSPECTION(S)	
WEATHER CONDITIONS:	**APPROX. TEMP.:**
CREW LEADER:	**SUPERVISOR:**

DIMENTIONS:			
	DEPTH =		
	TOP =	W	L
	BOTTOM =	W	L

SOIL TYPE:	**TESTED:**
❑ Solid rock (most stable)	❑ Yes
❑ Average soil	❑ No
❑ Fill material	
❑ Loose sand	

Yes No **HAZARDOUS CONDITIONS**
❑ ❑ ..... Saturated soil / standing or seeping water
❑ ❑ ..... Cracked or fissured wall(s)
❑ ❑ ..... Bulging wall(s)
❑ ❑ ..... Floor heaving
❑ ❑ ..... Frozen soil
❑ ❑ ..... Super-imposed loads
❑ ❑ ..... Vibration
❑ ❑ ..... Depth greater than 10’

PROTECTION METHODS:
(Walls MUST be vertical—NO voids)
SHORING
❑ Timber
❑ Pneumatic
❑ Hydraulic
❑ Screw Jacks
❑ Trench Shield
UNEVEN, IRREGULAR WALLS
❑ Trench Box
Sloping: **q 1:1 (45°)** **q 1 ½:1 (34°)**

PLACEMENT OF SPOILS & EQUIPMENT
❑ ❑ ..... Spoils at least 2 feet from edge of trench
❑ ❑ ..... Equipment at least 2 feet from edge
❑ ❑ ..... Backhoe at end of trench
❑ ❑ ..... Compressor, etc. at remote location
LADDER LOCATION
❑ ❑ ..... Located in protected area
❑ ❑ ..... Within 25 feet of safe travel
❑ ❑ ..... Secured
❑ ❑ ..... Extends 36 inches above the landing
❑ ❑ ..... Leads to safe landing

Yes No **ENVIRONMENTAL CONDITIONS:**
❑ ❑ Gas detector used?
❑ ❑ Confined space permit issued?

OTHER:
❑ ❑ Shoring equip. & matls inspected prior to use?
❑ ❑ Is trench SAFE to enter?

COMMENTS:

Work Order #

NOTE

All unsafe conditions must be corrected prior to trench entry. If any hazardous conditions are observed, the trench must be immediately evacuated and no one allowed to re-enter until corrective action has been taken.

TO BE FILLED OUT BY EHS PERSONNEL

Excavation Entry Authorized By: _____

EHS Inspector

Appendix C

EXCAVATIONCHECKLIST

(To be completed by a Competent Person)

SITE LOCATION:			
DATE:	TIME:	COMPETENT PERSON:	
SOIL CLASSIFICATION:	EXCAVATION DEPTH:	EXCAVATION WIDTH:	
TYPE OF PROTECTIVE SYSTEM USED:			

Indicate for each item: YES - NO - or N/A for not applicable

1. **General Inspection of Jobsite:**	
A. Excavations, adjacent areas, and protective systems inspected by a competent person daily before the start of work.	
B. Competent person has the authority to remove employees from the excavation immediately.	
C. Surface encumbrances removed or supported.	
D. Employees protected from loose rock or soil that could pose a hazard by falling or rolling into the excavation.	
E. Hard hats worn by all employees.	
F. Spoils, materials, and equipment set back at least two feet from the edge of the excavation.	
G. Barriers provided at all remotely located excavations, wells, pits, shafts, etc.	
H. Walkways and bridges over excavations four feet or more in depth are equipped with standard guardrails and toeboards.	
I. Warning vests or other highly visible clothing provided and worn by all employees exposed to public vehicular traffic.	
J. Employees required to stand away from vehicles being loaded or unloaded.	
K. Warning system established and utilized when mobile equipment is operating near the edge of the excavation.	
L. Employees prohibited from going under suspended loads.	
M. Employees prohibited from working on the faces of slopes or benched excavations above other employees.	
2. **Utilities:**	
A. Utility companies contacted and/or utilities located.	
B. Exact location of utilities marked.	
C. Underground installations protected, supported, or removed when excavation is open.	
3. **Means of Access and Egress:**	
A. Lateral travel to means of egress no greater than 25 feet in excavations four feet or more in depth.	
B. Ladders used in excavations secured and extended three feet above the edge of the trench.	
C. Structural ramps used by employees designed by a competent person.	

D. Structural ramps used for equipment designed by a registered professional engineer (RPE)	
E. Ramps constructed of materials of uniform thickness, cleated together on the bottom, equipped with no-slip surface.	
F. Employees protected from cave-ins when entering or exiting the excavation.	
4. **Wet Conditions:**	
A. Precautions take to protect employees from the accumulation of water.	
B. Water removal equipment monitored by a competent person.	
C. Surface water or runoff diverted or controlled to prevent accumulation in the excavation.	
D. Inspections made after every rainstorm or other hazard-increasing occurrence.	
5. **Hazardous Atmosphere:**	
A. Atmosphere within the excavation tested where there is a reasonable possibility of an oxygen deficiency, combustible or other harmful contaminant exposing employees to a hazard.	
B. Adequate precautions taken to protect employees from exposure to an atmosphere containing less than 19.5% oxygen and/or to other hazardous atmospheres	
C. Ventilation provided to prevent employee exposure to an atmosphere containing flammable gas in excess of 10% of the lower explosive limit of the gas.	
D. Testing conducted often to ensure that the atmosphere remains safe.	
E. Emergency equipment, such as breathing apparatus, safety harness and lifeline, and/or basket stretcher readily available where hazardous atmospheres could or do exist.	
F. Employees trained to use personal protective and other rescue equipment.	
G. Safety harness and lifeline used and individually attended when entering bell bottom or other deep confined excavations.	
6. **Support Systems:**	
A. Materials and/or equipment for support systems selected based on soil analysis, trench depth, and expected loads.	
B. Materials and equipment used for protective systems inspected and in good condition.	
C. Materials and equipment not in good condition have been removed from service.	
D. Damaged materials and equipment used for protective systems inspected by a registered professional engineer (RPE) after repairs and before being placed back into service.	
E. Protective systems installed without exposing employees to the hazards of cave-ins, collapses, or threat of being struck by materials or equipment.	
F. Members of support system securely fastened to prevent failure.	
G. Support systems provided in ensure stability of adjacent structures, buildings, roadways, sidewalks, walls, etc.	
H. Excavations below the level of the base or footing supported, approved by an RPE.	
I. Removal of support systems progresses from the bottom and members are released lowly as to note any indication of possible failure.	
J. Backfilling progresses with removal of support system.	

K. Excavation of material to a level no greater than two feet below the bottom of the support system and only if the system is designed to support the loads calculated for the full depth.	
L. Shield system placed to prevent lateral movement.	
M. Employees are prohibited from remaining in shield system during vertical movement.	