Excavation Safety

Environmental Health and Safety Services
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http://www.ehss.vt.edu
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</table>
# Table of Contents

- Introduction .................................................................................................................. 7
- Responsibilities ............................................................................................................. 7
- Training .......................................................................................................................... 8
- Excavation Assessment .................................................................................................. 9
  - Excavation Assessment Form Instructions ................................................................. 9
- Protective Systems ........................................................................................................ 13
- Inspections .................................................................................................................... 14
- Definitions .................................................................................................................... 16
- References ..................................................................................................................... 18
- Regulations ................................................................................................................... 18
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**Introduction**

**Purpose**
Environmental, Health and Safety Services (EHSS) developed this program to assure the safety of employees who work in or around excavations as part of their job duties. It is also designed to protect employees, students, and the general public who work or travel in the vicinity of excavations. This program complies with the requirements of the Occupational Safety and Health Administration (OSHA) regulations, 29 CFR 1926 (Construction), Subpart P.

**Application**
This program applies to excavation work on all Virginia Tech properties or being performed by Virginia Tech employees regardless of jobsite location.

**Scope**
This program applies to excavations formed by any man-made cut, cavity, trench, or depression in an earth surface formed by earth removal. There are minimal requirements for excavations less than four feet deep, whereas, excavations greater than four feet deep require oversight by a competent person and routine evaluation of hazards and selected controls.

**Responsibilities**

**Departmental Responsibilities**
Departments are expected to maintain safe and healthy living, learning, and working environments for faculty, staff, students, and visitors to our campus.
- Each department performing excavation work must appoint a “competent person(s)” to ensure compliance with this program.
- Departments must ensure that all persons designated as competent persons have attended EHSS competent person training.
- Departments must ensure that all persons entering excavations greater than four feet deep have attend EHSS awareness level training.

**Competent Person Responsibilities**
Competent persons designated by the department will perform the following tasks once they have received training from EHSS:
- Be familiar with soil analysis and determine the class of soil for each excavation.
- Determine the appropriate protective system for potential cave in. Be familiar with protective systems and how to use them.
- Determine appropriate elimination or control for all hazards, including protection from potential cave-in.
- Conduct site inspections in accordance with the requirements outlined in this program and maintain necessary documentation.
- Ensure employee training for all employees entering excavations greater than four feet deep.
- Ensure appropriate personal protective equipment is provided and worn.
Employees
Employees who work in or around excavations must:
- Follow the requirements of this program,
- Attend required training,
- Wear assigned personal protective equipment.

EHSS
EHSS will provide technical support, competent person and awareness level training, and oversight for this program. Involvement by EHSS does not relieve the departments, supervisors, or contractors of their individual responsibilities. EHSS responsibilities for this program include:
- Developing, implementing, and administering the program.
- Training on all aspects of the program requirements and maintaining centralized records.
- Serving as a technical resource.
- Providing guidance on the selection of protective systems.
- Evaluating the overall effectiveness of the program on a periodic basis and making appropriate changes as needed to assure the safety of personnel.

Contractors
Contractors must comply with all local, state, and federal safety requirements, and must assure that all employees performing work on Virginia Tech property have been suitably trained and are provided appropriate personal protective equipment per the “Safety Requirements for Contractors and Subcontractors” program. Contractors performing excavation work on university property must coordinate their work with Facilities and Miss Utilities to assure related activities, such as utility identification, location, and shutdown are addressed.

Training
Employees Entering Excavations
Each employee required to enter an excavation greater than four feet deep must attend, prior to entry, EHSS awareness level training regarding related hazards and methods of protection.

Competent Person(s)
Designated departmental competent persons who will be performing inspections and providing oversight must attend EHSS excavation competent person training. Topics include:
- Hazards related to excavation work,
- Work practices and selection of protective systems,
- Methods of evaluating the site and conducting inspections,
- Requirements of this program and any related programs,
- Emergency procedures.
General Requirements
Contact Miss Utility at least 72 hours prior to the anticipated start date to have all utilities identified and marked. Once the ticket has been cleared and all utilities located, digging may begin. Appropriate authorities must be notified if a gas or other hazardous substance leak occurs during excavation activities.

If personnel will be entering the excavation, the designated competent person must determine the appropriate protective system for potential cave in. In most cases, soil at locations on VT campus is considered to be class C soil. Best practice is to assume the worst class of soil (class C) and implement appropriate protective systems for class C soil or use an appropriate trench box for the size and depth of the excavation. This practice should cover the majority of excavations performed by VT personnel. Where it does not, and class C protective system requirements cannot be met (ex. bell-bottom pier holes or excavations where manufactured trench boxes are not available), the competent person should contact EHSS for guidance.

Excavation Assessment
Prior to personnel entering the excavation, and as necessary throughout the shift, the designated competent person must perform an excavation assessment to identify hazardous conditions and determine protective measures. This evaluation must be documented.

All hazards identified must be eliminated or controlled prior to personnel entering the excavation. The site evaluation shall be documented on the Excavation Assessment Form provided in this program.

Excavation Assessment Form Instructions
Instructions and guidance for performing the site evaluation and completing the Excavation Assessment Form (see Exhibit 1) are provided below.

a. Location: (specify the location of the excavation)
b. Date/Time: (specify the date and time that the excavation is being evaluated)
c. Miss Utility Ticket Number: (specify the ticket number given by the Miss Utility system verifying that notification and approval to dig has been given)
   i. Miss Utility must be contacted (call 811 or 1-800-552-7001) prior to digging regardless of anticipated depth or location in order to identify sewer, telephone, fuel, electric, water lines, fiber optics, etc. Clearance to dig may take up to 72 hours. Excavators are required to keep the ticket number with them on the jobsite.
   ii. For more information, go to www.missutilityofvirginia.com.
d. Date/time Cleared: (specify the date and time that clearance was received)
e. Excavation Depth: (check one of the boxes for the anticipated depth of the excavation and follow the required action associated with the box checked)
   i. If “< 4 feet or personnel will not be entering “is checked, Miss Utility must be contacted only. The remainder of the form does not need to be completed provided there are no additional hazards.
ii. If “between 4 and 20 feet” is checked, all hazards must be identified and effectively controlled prior to personnel entering.
iii. If “> 20 feet” is checked, the competent person must contact EHSS at 231-2341 for additional review and compliance assurance.

f. Cave-in: any soil class: If a trench box will be used, check this box. Soil does not have to be analyzed and classified. The trench box must be appropriate for the excavation depth and used according to manufacturers recommendations.

g. Cave-in: assume Class C: If the excavation walls will be sloped or benched 1 ½ to 1 (34º), check this box. Note: This box cannot be checked if the excavation is a bell-bottom pier hole, protective systems for class C soil cannot be implemented, or timber or aluminum shoring will be installed.

h. Cave-in: all other (includes class A or B soil, bell-bottom pier holes, and the use of aluminum or timber shoring systems): If one of the two previous options cannot be selected and implemented, check this box. EHSS and/or departmental safety representatives must be contacted for additional oversight, analysis, and review.

i. Surface Encumbrances: All equipment, materials, supplies, permanent installations (e.g. buildings, roadways), trees, brush, boulders, and other objects at the surface of the excavation that could present a hazard to personnel working in the excavation must be removed or supported, as necessary, to protect personnel. (Check either N/A for not applicable or not present, or “removed or supported” for those items moved at least two feet from the edge of the excavation or shored/supported.)

   i. Materials piled, grouped, or stacked near the edge of an excavation must be stable and self-supporting.

j. Underground Installations: Arrangements must be made as necessary by the competent person with the appropriate utility agency for the protection, removal, shutdown, or relocation of underground installations identified by the Miss Utility system. (Check the appropriate control measure taken.)

   i. Work on such installations shall only be conducted by authorized personnel (i.e. the owner of the installation).

   ii. If it is not possible to establish the exact location of underground installations, the work may proceed with caution provided detection equipment or other safe and acceptable means (e.g. hand digging) are used to locate the utility as the excavation is opened and each underground installation is approached.

k. Access/Egress: Stairs, ladders, or ramps must be provided where personnel must enter excavations four feet or more in depth, and must comply with OSHA rules and regulations. The maximum distance of travel in an excavation to a means of egress shall not exceed 25 feet. (Check the appropriate box for the control measure selected.)

l. Vehicular Traffic: Excavations affecting vehicular traffic must be barricaded and warnings provided to oncoming traffic. Additional precautions for personnel (i.e. high visibility warning vests, hard hats, etc.) may be required. (Check the appropriate box for the control measure selected.)
i. Personnel designated to flag traffic must comply with the Virginia Department of Transportation’s flagger certification program. Contact EHSS at 231-8759 for more information and training.

m. **Falling Loads:** Personnel shall not be permitted underneath loads handled by lifting or digging equipment. All personnel are required to stand away from any vehicle being loaded or unloaded. (Check the box to verify that personnel have been informed to stay clear of loading equipment.)
   
i. Vehicle operators may remain in the cabs of vehicles being loaded or unloaded by lifting/digging equipment provided the vehicle cab is reinforced or otherwise adequately protected from impact.

n. **Mobile Equipment:** When mobile equipment is operated adjacent to the edge of an excavation, a warning system must be used when the operator does not have a clear and direct view of the edge of the excavation. The warning system may consist of barricades, hand or mechanical signals, signs/flags, or stop logs. If possible, the surface grade will slope away from the excavation. (Check the type of warning system to be used.)

o. **Hazardous Atmospheres:** Atmospheric testing must be conducted in excavations over four feet deep where a hazardous atmosphere could reasonably be expected to exist (e.g. in or near landfill areas, near hazardous substance storage, near gas pipelines, when hazardous chemicals are used in the excavation, etc.). This determination is made by the competent person during excavation evaluation and/or inspection.
   
i. Atmospheric monitoring must be performed using a properly calibrated, direct reading instrument with audible and visual alarms. Monitoring must be continuous where controls are used to reduce the level of atmospheric contaminants. Monitors must be maintained and calibrated in accordance with manufacturer’s specifications. (Fill in the results of the atmospheric testing.)
   
ii. Acceptable entry conditions for atmospheric hazards include:
   - Oxygen content between 19.5 and 23.5 percent.
   - Carbon monoxide concentration is less than 35 ppm.
   - Hydrogen sulfide concentration is less than 10 ppm.
   - Lower explosive level is less than 10 percent.

iii. Precautions must be taken to prevent personnel exposure when the limits expressed above are not met. These precautions include providing forced ventilation (preferred) or appropriate respiratory protection in accordance with Virginia Tech’s Respiratory Protection Program. (Check the appropriate box if respiratory protection or forced air ventilation is required.)

iv. Emergency rescue equipment, such as breathing apparatus, a safety harness and line, or a basket stretcher, shall be readily available where hazardous atmospheric conditions exist or may reasonably be expected to develop during work in an excavation. This equipment shall be attended when in use.

p. **Water Accumulation:** Personnel are not permitted to work in excavations that contain, or are accumulating, water unless precautions have been taken to protect personnel from hazards posed by water accumulation. These precautions
may include special support or shield systems to protect from cave-in, water removal by mechanical pump to control the level of accumulating water, or the use of safety harnesses and lifelines. (Check the appropriate box for the control measure selected.)

i. If water is controlled or prevented from accumulating by the use of water removal equipment, the equipment and operation must be monitored by a person familiar with the equipment.

ii. If excavation work will interrupt the natural drainage of surface water, such as streams, diversion ditches, dikes, or other suitable means must be used to prevent surface water from entering the excavation. Precautions must also be taken to provide adequate drainage of the area adjacent to the excavation.

iii. Excavations subject to runoff from heavy rains must be re-inspected by the competent person to determine if additional precautions should be taken.

q. **Adjacent Structures:** Where the stability of adjoining buildings, walls, or other structures is endangered by excavation operations, support systems such as shoring, bracing, or underpinning shall be provided to ensure the stability of such structures for the protection of personnel.

i. Excavations below the level of a base or footing of any foundation or retaining wall that could reasonably be expected to pose a hazard to personnel is not permitted unless:

   - A support system, such as underpinning, is provided to ensure the safety of personnel and the stability of the structure; or
   - A registered professional engineer has approved the determination that the structure is sufficiently removed from the excavation so as to be unaffected by the excavation activity; or
   - A registered professional engineer has approved the determination that such excavation work will not pose a hazard to employees.

   - Note: Where review or approval of a support system by a registered professional engineer is required, the competent person must secure this in writing before work begins. A copy of this approval must be provided to EHSS.

r. **Loose Rock or Soil:** Adequate protection must be provided to protect employees from loose rock, soil, or other materials that could pose a hazard by falling or rolling from an excavation face. Such protection may consist of:

   i. Scaling to remove loose material;
   ii. Installation of protective barricades, such as wire mesh or timber, at appropriate intervals on the face of the slope to stop and contain falling material; or
   iii. Benching sufficient to contain falling material.
   iv. Keeping materials/equipment at least two feet from the edge of the excavation.
   v. Use of restraining devices for materials/equipment that are sufficient to prevent materials/equipment from falling or rolling into the excavation.
s. **Fall Protection:** Standard guardrails, fences, or barricades must be provided for excavations adjacent to walkways, driveways, and other pedestrian or vehicle thoroughfares. Walkways or bridges for public and site personnel to cross over excavations must be provided when the excavation width is greater than 30 inches and depth is greater than four feet. Walkways or bridges must have standard guardrails and be at least 19 inches wide. If the walkway will serve the general public, it must be at least 36” wide, or the width of the building exit door(s), if serving as the exit for that building, whichever is greater. Where personnel will be working or passing under such walkways, a toe board must be installed on the walkway.

   i. Wells, holes, pits, shafts, and similar excavations must be effectively barricaded or covered and posted as necessary to prevent unauthorized access. All temporary excavations of this type must be backfilled as soon as possible.

t. **Security (overnight):** Barricades and/or fencing to restrict access, warning signs, and adequate lighting must be provided as necessary to protect the public from sunset to sunrise.

u. **Personal Protective Equipment:** (Indicate minimum required PPE for entry into excavation.)

v. **Entry Authorization:** Once the competent person has evaluated site conditions and necessary control measures have been implemented, the competent person shall sign the Excavation Assessment Form and post it at the excavation entrance or other central location.

   i. Personnel shall not enter the excavation until this assessment has been completed, control measures implemented, and competent person signature is on the form!

   ii. All entrants should review the information provided on the assessment form so that hazards are known and protective measures are understood.

   iii. If any of the protective systems identified on the form have been altered, removed, or damaged, entry should not occur until the competent person has re-evaluated the situation and corrective measures implemented.

w. **In Case of Emergency, Call 911 Immediately!** Personnel shall have a means for contacting emergency services in the event of an emergency. 911 can be dialed from campus phones to activate emergency services via Virginia Tech Police Department. When cell phones are primary means of contact, 231-6411 shall be dialed. When radio contact is the primary means of contact, personnel must be available at the base station with a phone system available.

### Protective Systems

Personnel entering excavations greater than four feet deep shall be protected from cave-in by using an adequate sloping/benching system or an adequate support/protection system. Excavations less than four feet deep where examination of the ground by the competent person indicates a potential cave-in may require a protective system. Protective systems shall be capable of resisting all loads that could reasonably be expected to be applied to the system.
Trench Boxes
Trench boxes are pre-built shield systems designed to manufacturer’s tabulated data. These boxes must be used in accordance with all specifications, recommendations, and limitations issued or made by the manufacturer.

- Trench boxes must be used at a depth not greater than that for which they are designed.
- The shield must be installed in a safe manner to restrict lateral or other hazardous movement of the shield in the event of the application of sudden lateral loads (i.e. cave-in). The closer a properly constructed trench shield is to the trench wall, the less chance that it could be dislodged by a lateral force.
- Personnel shall not be allowed in trench boxes when they are being installed, removed, or moved vertically or horizontally (where hazardous).

Sloping and Benching
Sloping or benching system requirements are specified below for excavations between 4 and 20 feet deep:

- The preferred option is for the competent person to assume the most unstable class of soil, Class C, and slope/bench the sides to $1 \frac{1}{2} \text{ H to 1 V (34°)}$.
- If the excavation site does not allow for sloping at a 34° angle and a trench box is not used, the competent person must test the soil to prove that it is actually class B soil (and not class C soil), and slope/bench the walls to $1 \text{ H to 1 V (45°)}$.
  - Class A soil is not an option at Virginia Tech due to soil being previously disturbed.
  - Solid rock classification is not recognized by Virginia Occupational Safety and Health (VOSH).

Personnel shall not be permitted to work above other personnel on the faces of sloped or benched systems except when personnel at lower levels are protected from the hazard of falling, rolling, or sliding material/equipment.

Support Systems
Where preassembled shield systems and sloping/benching is not available or feasible, the competent person must implement an appropriate system designed to OSHA criteria (i.e. timber or aluminum hydraulic shoring), designed to tabulated data (i.e. manufacturer data or the use of tables and charts), or designed by a registered professional engineer (i.e. written approval of designed system). For assistance with these situations, contact EHSS for guidance.

Inspections
Daily Inspections
The competent person must conduct daily inspections of excavations, adjacent areas, and protective systems for evidence of a situation that could result in possible cave-in, protective structure failure, hazardous atmospheres, and verification that control
measures remain in place are continue to be effective. Daily inspections must be conducted prior to personnel entering the excavation each day and as needed throughout the shift. Inspection is especially critical on Mondays, where rain or other changing conditions occurring over the weekend have deteriorated soil conditions and/or protective systems. If personnel will not be entering the excavation on a given day, inspection is not required.

Note: There is no regulatory requirement stating that the competent person must be on site at all times; however, the competent person must be present to make those inspections necessary to identify situations that could result in hazardous conditions (e.g. possible cave-ins, indications of failure of protective systems, hazardous atmospheres, or other hazardous conditions), and then to insure that corrective measures are taken. It is, therefore, subject to the conditions present at each individual worksite whether or not a competent person is required to be present at the jobsite at all times. The competent person must be available should situations arise that require attention.

Where the competent person or personnel entering the excavation find evidence of a situation that could result in a possible cave-in, protective system failure, hazardous atmosphere, or other hazardous conditions, exposed personnel shall evacuate the excavation until the situation has been corrected.

**Additional Inspections**
Inspections shall also be made after each hazard-changing event, such as a heavy rain storm. There is an “Inspection Log” provided on the back of the Excavation Assessment Form for documenting inspections.

**Emergencies**
A typical trench collapse involves three to five cubic yards of soil, or about 6,000 to 20,000 pounds! Hazardous effects include compression and asphyxiation. Typical extrication can take one to seven hours depending on the conditions of the cave in. Individuals should not place themselves at risk in order to save the life of another. Such situations too often lead to the death of the would-be-rescuer as well as the person originally in danger. It is the intent of this program to minimize the associated risks with excavation work and focus on accident prevention.

Blacksburg Volunteer Fire Department is the designated response agency for cave in emergencies. The first and most important action that can be taken in the event of a cave in is to activate the emergency response system by calling 911.

Personnel at Virginia Tech are not trained, nor expected, to perform trench rescue. However, there are several actions that can be taken to support the rescue team(s) and further protect on site personnel.
- If victim is not visible, try to identify the area where the victim most likely is located as closely as possible.
• Contact Facilities at 231-4300 to request the vacuum truck (located at Tech Electric Services) be brought to the site.
• Hand digging, if it is safe to approach the site, can begin immediately.
  o Mechanical excavating equipment should not be used to dig the person out due to potential for additional injury, crushing, or dismemberment.
• Have someone meet the fire department upon their arrival and brief them on the situation.
• Assemble materials and equipment that may be beneficial during rescue operations, such as shovels, plywood/lumber, ladders, buckets, etc.
• Clear the area so that rescue personnel have access to the site.

Definitions

**Accepted Engineering Practices:** the standards of practice required by a registered professional engineer.

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

**Benching:** a method of protecting employees from cave-in by excavating the sides of the excavation to form one or more horizontal steps, usually with vertical or near vertical surfaces between levels.

**Cave-in:** the movement of soil or rock into an excavation, or the loss of soil from under a trench shield or support system, in amounts large enough to trap, bury, or injure and immobilize a person.

**Class A soil:** cohesive soils with an unconfined, compressive strength of 1.5 ton per square foot (tsf) (144 kPa) or greater. 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. However, no soil is Type A if:
  • The soil is fissured; or
  • The soil is subject to vibration from heavy traffic, pile driving, or similar effects; or
  • The soil has been previously disturbed; or
  • The soil is part of a sloped, layered system where the layers dip into the excavation on a slope of four horizontal to one vertical (4H:1V) or greater; or
  • The material is subject to other factors that would require it to be classified as a less stable material.

**Class B soil:** less cohesive soil (than class A) with an unconfined compressive strength greater than 0.5 tsf (48 kPa) but less than 1.5 tsf (144 kPa); or granular cohesionless soils including: angular gravel (similar to crushed rock), silt, silt loam, sandy loam and, in some cases, silty clay loam and sandy clay loam.
• Previously disturbed soils except those which would otherwise be classed as Type C soil.
• Soil that meets the unconfined compressive strength or cementation requirements for Type A, but is fissured or subject to vibration; or
• Dry rock that is not stable; or
• Material that is part of a sloped, layered system where the layers dip into the excavation on a slope less steep than four horizontal to one vertical (4H:1V), but only if the material would otherwise be classified as Type B.

Class C soil: non-cohesive soil with an unconfined compressive strength of 0.5 tsf (48 kPa) or less; or granular soils including gravel, sand, and loamy sand; or submerged soil or soil from which water is freely seeping; or submerged rock that is not stable, or material in a sloped, layered system where the layers dip into the excavation or a slope of four horizontal to one vertical (4H:1V) or steeper.

Competent person: one who has been trained to identify hazards in the workplace, or working conditions that are unsafe for employees, and who has the authority to have these hazards eliminated or controlled.

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

Face: the vertical or inclined earth surfaces formed as a result of earth removal.

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

Fissured: a soil material that has a tendency to break along definite planes of fracture with little resistance, or a material that exhibits open cracks, such as tension cracks, in an exposed surface.

Hazardous atmosphere: an atmosphere that is explosive, flammable, poisonous, corrosive, oxidizing, irritating, oxygen deficient, toxic, or otherwise harmful that may cause death, illness, or injury.

Kickout: the accidental movement or failure of a cross brace in a protective system.

Layered system: two or more distinctly different soil or rock types arranged in layers. Micaceous seams or weakened planes in rock or shale are considered layered.
**Maximum allowable slope:** the steepest incline of an excavation face that is acceptable for the most favorable site conditions as protection against cave-ins, and is expressed as the ratio of horizontal distance to vertical rise (H:V).

**Means of egress:** the safe means for personnel to enter or exit.

**Owner:** refers to the owner of the underground installation (i.e. utility).

**Protective system:** a method of protecting personnel from cave-in, material falling or rolling from an excavation face into an excavation, or from the collapse of adjacent structures. Protective systems include support systems, sloping and benching systems, shield systems, and other systems that provide the necessary protection.

**Registered professional engineer (RPE):** a person who is registered as a professional engineer in Virginia.

**Spoil:** soil removed from the excavation.

**Stable rock:** natural solid mineral matter that can be excavated with vertical sides and remain intact while exposed.

**Surcharge:** an excessive vertical load or weight caused by spoil, overburden, vehicles, equipment, or activities that may affect stability.

**Trench:** a narrow excavation (in relation to its length) made below the surface of the ground, typically long, deep, and not more than 15 feet wide (measured at the bottom of the excavation).

**Trench box:** a pre-built shielding system used to protect personnel in an excavation which is designed to withstand cave-in.

**Unconfined compressive strength:** the load per unit area at which a soil will fail in compression. It can be determined by laboratory testing, or estimated in the field using a pocket penetrometer, by thumb penetration tests, and other methods.

## References

### Published Sources
Occupational Safety and Health Administration (OSHA) regulations are available online at [www.osha.gov](http://www.osha.gov), 29 CFR 1926 Construction Standards, Subpart P

### On-line Information
OSHA at [http://www.osha.org](http://www.osha.org)
VOSHA at [http://www.dli.state.va.us/](http://www.dli.state.va.us/)
Miss Utility of Virginia at [http://www.missutilityofvirginia.com](http://www.missutilityofvirginia.com)