Industry code # 1781 Water Well Drilling
• Special trade contractors primarily engaged in water well drilling. (Establishments primarily engaged in drilling oil or gas field water intake wells on a contract or fee basis are classified in Mining, Industry 1381.)
• Drilling water wells-contractors
• Geothermal drilling-contractors
• Servicing water wells-contractors
• Well drilling, water, except oil or gas field water intake-contractors

Statistically the most dangerous type of work in the U.S.
Approximately 60 persons are killed and 600 hurt from cave-ins
Fatality rate for trenching work is 112% higher than construction work in general

This backhoe operator is having second thoughts about the day's events when resulted in the death of the company owner!

Osha definition of our trade

Not All of Our Work is Drilling

What osha standards apply?
29 CFR 1926 Construction
1926.651 Subpart P

EXCAVATION
Statistically the most dangerous type of work in the U.S.
Approximately 60 persons are killed and 600 hurt from cave-ins
Fatality rate for trenching work is 112% higher than construction work in general

Death and Injuries
Suffocating
Crushing
Loss of Circulation
Struck by falling object
Moves/Falls at 17 mph

This backhoe operator is having second thoughts about the day's events when resulted in the death of the company owner!
History
Since OSHA’s inception there has been a need for more comprehensive regulations which employers can comply with to protect their workers.

The new excavation regulations which became effective March 5, 1990 were designed to do just that.

Three Major Changes
1. The requirement that the employer assign a “Competent Person” to every excavation!
2. Every “Protective System” is required to have a certification.
3. The soil at every excavation must be analyzed.

The Competent Person
Knows the soil
Knows the Standards
Knows the Protective System
Has the Appropriate Authority

Competent person Should Make inspections
• Daily Prior to Work
• Of the Excavation
• Protective System
• Surrounding Area
• After a Rain
• Possible Cave-ins
• Hazardous Atmospheres are Possible
• After other Hazards Occur or Increase in Frequency

Soil Classifications
Sand, silt, and clay are the basic types of soil. Most soils are made up of a combination of the three. The texture of the soil, how it looks and feels, depends upon the amount of each one in that particular soil.

<table>
<thead>
<tr>
<th>Soil Type</th>
<th>Slope Ratio</th>
<th>Slope angle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stable Rock (The most stable material)</td>
<td>Vertical</td>
<td>90°</td>
</tr>
<tr>
<td>Type A (The most stable “soil”)</td>
<td>⅓:1</td>
<td>53°</td>
</tr>
<tr>
<td>Type B</td>
<td>1:1</td>
<td>45°</td>
</tr>
<tr>
<td>Type C</td>
<td>⅓:1</td>
<td>34°</td>
</tr>
<tr>
<td>Type A (ST)</td>
<td>½:1</td>
<td>63°</td>
</tr>
</tbody>
</table>

EXCAVATION Slopes
**Soil Analysis**

### What does it weigh?

Weights of Materials for 1 cu. ft:
- **Dry Sand**: 80-90 lbs.
- **Dry Clay**: 85-90 lbs.
- **Wet Clay**: 110-125 lbs.
- **Wet Mud**: 120-125 lbs.
- **Limestone**: 160 lbs.
- **Granite**: 165 lbs.

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**Soils Testing**

### Instruments

- **Thumb Penetrometer**
- **Shear Vane**
- **Instruments**

---

**Review soil testing**

- **Thumb Penetration Test**
- **Plasticity Test**
- **Shear Strength**
- **Unconfined Compressive Strength**

---

**Protective System**

### When needed?

- Less than 5 feet if a Competent person determines that a cave-in could occur
- When a trench is 5 feet or more in depth

---

**Excavation Depth**

- Is the excavation more than 5 feet deep?
  - **N** Is there potential for cave-in?
  - **Y** Is the excavation entirely in stable rock?
  - **N** Excavation may be made with vertical sides?
  - **Y** Excavation must be sloped, shored or shielded?

---

**Excavation options**

- **Sloping**
- **Benching**
- **Shoring**
- **Trench Box**
**Sloping Options**

When sloping a trench you must know

- Type of Soil
- Depth of Excavation
- Time Excavation will be open
- Changing conditions

**Factors of cave-ins**

- Soil Composition
- Water in soil
- Depth of Excavation
- Climatic Conditions
- Time Excavation will be open
- Locations of Utilities
- Traffic and near-by Structures

**Placement of spoils**

Spoil piles must be placed 2 feet away from the excavation

**Effects of Water**

**Previously Disturbed Areas**
After a cave-in

After the fact inspections are the most difficult for a contractor to defend against because:
“A highly predictable, preventable event has occurred.”

- **PREDICTABLE:** There are no permanently vertical soil or rock walls found in nature!
- **PREVENTABLE:** There are MEANS (equipment) or METHODS (work processes) available which will prevent worker exposure.

**CONCLUSION:** Cave-ins are not accidents!

Shield and shoring

Uprights
Wales
Cross Braces
Close Sheeting

Shoring is a structure such as a metal hydraulic, mechanical, or timber bracing system that supports the sides of an excavation.

Trench boxes

A trench shield or box is a heavy metal box designed to be placed in a trench; it prevents the sides of the trench from caving in.

- Installed Properly
- Provide end Protection
- No Employees Outside Of Trench Box
- Move Only When No One Is In The Trench
- Use Manufactures Tabulated Data Sheets
- Rated for The Depth Of The Trench

Trench box

- Rated for The Depth Of The Trench
- No Employees Outside Of Trench Box
- Move Only When No One Is In The Trench
- Use Manufactures Tabulated Data Sheets

Trench box

- installed properly
- Use Manufactures Tabulated Data Sheets

Trench box

- Assemble correctly
- Use Manufactures Tabulated Data Sheets
Personal Safety
Fall Protection – Physical protection shall be provided
Each employee at the edge of an excavation 6 feet (1.8m) or more in depth shall be protected from falling by guardrail systems, fences, or barricades when the excavations are not readily seen because of plant growth or other visual barrier

Hazardous Atmospheres – Low oxygen, flammable atmosphere, Toxic environment.

Hazardous Atmospheres

To prevent exposure to harmful atmospheres the following guidelines should be used:

Entry into excavations deeper than 4’ where it is reasonable to expect that hazardous atmospheres might exist shall be tested before entry is allowed.

Entry into areas where the O₂ (oxygen) level is less than 19.5% is prohibited.

Entry is prohibited when flammable gases are present in concentrations greater than 20% of the lower flammable limit of the gas.

Testing Requirement
It is reasonable to expect hazardous atmospheres in:

- Landfill areas (dump grounds, landfills, etc.)
- Next to fuel and chemical storage areas
- When doing removal of contaminated soils
- When digging in soils with high organic content

NOTE: Testing should always be performed in these areas.

Support Protect or Remove Utilities

An “I” beam and chains were used to support the concrete “duct-bank” crossing this excavation from left to right.

Contractor supported these communication lines by placing timbers across the trench then using strapping.

Common Effects of Gas

<table>
<thead>
<tr>
<th>Carbon Monoxide</th>
<th>Hydrogen Sulfide</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Headache</td>
<td>• Coughing</td>
</tr>
<tr>
<td>• Nausea</td>
<td>• Eye irritation</td>
</tr>
<tr>
<td>• Loss of Consciousness</td>
<td>• Loss of Consciousness</td>
</tr>
<tr>
<td>• Brain Damage</td>
<td>• PEL – 35 (No order)</td>
</tr>
<tr>
<td>• Death</td>
<td>• Hydrogen Sulfide</td>
</tr>
</tbody>
</table>

PEL – 35 (No order)
Any system not found within the guidelines set forth in the standard, or within the tabulated data tables in the standard requires use of a Professional Engineer.

*No where in the standard or tabulated data does it allow for excavations deeper than 20 feet.

Exposure to falling loads

Employees must be protected from falling loads or objects falling from lifting or digging equipment.

Employees are permitted to work under raised loads.

Employees are required to stand away from equipment that is being loaded or unloaded.

Surface crossing

Surface crossing of trenches should be discouraged. Vehicle crossing must be designed by and installed under the supervision of a registered professional engineer.

Each employee within six feet of the edge of an excavation six feet or more in depth must be protected from falling by guardrail systems, fences, personal fall arrest systems, or barricades.
Review questions

1. Protect workers from excavated materials that could pose a hazard by falling inside the excavation by placing and keeping such materials at least __________ feet from the edge of the excavation.

2. The depth of a trench is greater than its width, but the width of a trench is not greater than ___________ feet.

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

4. A stairway, ladder, ramp or other safe means of egress shall be located in trench excavations that are ___________ feet.

5. Trenches deeper than ___________ feet deep must be sloped, shored or shielded.

6. Hazardous atmospheres can occur in ___________ of an excavation.

7. Safe egress from a trench can require no more than ___________ feet of lateral travel for employees.

8. Ladders must be secured and extend at least ___________ feet above the landing.

9. Workers are prohibited from entering a trench with less than ___________ percent oxygen.

10. Inspection of the excavation and surrounding area has to be completed by a competent person at least ___________ times daily.

11. Entry is prohibited when flammable gases are present in concentrations greater than ___________ percent of the lower flammable limit of the gas.

12. Each employee within ___________ feet of the edge of an excavation six feet or more in depth must be protected from falling by guardrail systems, fences, personal fall arrest systems, or barricades.

13. An excavation deeper than ___________ feet has to be approved by a registered professional Engineer from that state.

14. An oxygen enriched atmosphere is any space with above ___________ percent oxygen.

15. A trench shield set below grade should extend ___________ inches above the bottom of the sloped part of the excavation.

16. A trench shield can be no more than ___________ feet above the bottom of the excavation.

17. Entry into excavations deeper than ___________ feet where it is reasonable to expect that hazardous atmospheres might exist shall be tested before entry is allowed.

18. Equipment must be kept at least ___________ feet away from an excavation.

19. Fatality rate for trenching work is ___________ percent higher than construction work in general.

20. Approximately ___________ persons are killed in cave ins each year.