Excavation Hazards

Excavation has always been dangerous work.

Workers in the underground industry have a 112% better chance of being killed than general construction trades.
2016 Statistics show another spike with fatalities double the previous two years....
Statistics show that excavation work has a fairly low occurrence rate but the ratio of fatality per occurrence at 33% is alarmingly high and remains steady.
TRENCH FATALITIES BY EVENT 1992-2001 (CDC)

- Cave-in: 400
- Struck by object: 20
- Struck by vehicle/equipment: 10
- Caught in or compressed by object: 5
- All other events: 10
Hazard and depth may be opposite of what you assumed...


- 0-5 feet: 37%
- 6-10 feet: 26%
- 11-15 feet: 26%
- 16-20 feet: 11%
Which excavation seems more dangerous?

#1

#2
Depth & Size are not the only factors...

Source: FACE Program
Safety Standards
29 CFR 1926 – Subpart P
Excavation & Trenching

FEDERAL SAFETY STANDARD
Michigan is one of several states to have their own OSHA Administration (MIOSHA)

Part 9 is unique to Michigan

All other states utilize OSHA Subpart P or a nearly identical state standard
OSHA 1926 Subpart P & MIOSHA Part 9 are unique standards organized as “Performance Based” Standards.

Standards identify common hazards associated with underground construction and provide minimum safety limits. The employer ensures that each excavation is free of identified or predictable hazards.
To ensure standards are met and each excavation is free of hazards – Part 9 requires that the employer designate a representative to design, construct and maintain the work area so it is free of all hazards.

This representative is defined as the QUALIFIED PERSON
Qualified Person

A person who, by possession of a recognized degree or certificate of professional standing, or who, by extensive knowledge, training, and experience, has successfully demonstrated the ability to solve or resolve problems relating to the subject matter and work.

*Rule 925 (6)*
Role of the Qualified Person

• Responsible for overall safety of excavation
• Knowledgeable in process of soil classification
• Responsible for selection and use of proper protective systems
• Represents employer in MIOSHA visits
• Has authority to implement protective measures
Qualified Person (cont’d)

• Identified in writing by employer
• Key piece of any good safety program
• Required on every site with excavation
• Has tools and publications necessary to conduct job
• Can be any trade or position with company
Duties Specific to Qualified Person

• An excavation as a work area does not exist until work begins.

• It is the duty of the Qualified Person to DESIGN, CONSTRUCT and MAINTAIN a safe work area.

• The work area is assumed to be as safe as this room – free of all known or predictable hazards.
• Excavation:
  – Any man-made cavity or depression in the earth’s surface, including its sides, walls, or faces, formed by earth removal. (Rule 925)
Definitions

• Trench:
  – An excavation having a depth greater than its width measured at the bottom (Rule 927)
Definitions

• Cave-in

Separation of a mass of soil from the bank of a trench or excavation

This hazard IS ALWAYS present in any excavation
Potential Hazards
Specific Excavation Considerations

- Inspections
- Surface Obstructions
- Underground Utility Lines
- Overhead Power Lines
- Access & Egress
- Exposure to Vehicular Traffic
- Exposure to Falling Loads
- Hazardous Atmospheres
- Water Accumulation
- Stability of Adjacent Structures
- Walkways, sidewalks, roadways
(4) An *ongoing* inspection of an excavation or trench shall be made by a qualified person. After every rainstorm or other hazard producing occurrence, an inspection shall be made by a qualified employee for evidence of possible slides or cave-ins. Where these conditions are found, all work shall cease until additional precautions, such as additional shoring or reducing the slope, have been accomplished.
The Qualified Person designs, constructs and **maintains** the safe work area. Maintenance is accomplished through **ongoing** inspections to ensure conditions comply with design.
Surface Obstructions

A tree, boulder, rock fragments or other obstructions whose movement could cause injury to an employee shall be removed or supported.
Underground Utilities
Rule 931

(1) An employer shall not excavate in a street, highway, public place, a private easement of a public utility, or near the location of a public utility facility owned, maintained, or installed on a customer’s premises, without having first ascertained the location of all underground facilities of a public utility in the proposed area of excavation.

CALL MISS DIG

MICHIGAN’S UTILITY COLOR CODE
- RED: Electric
- YELLOW: Gas, Oil, Steam or Petroleum
- ORANGE: Communications
- BLUE: Potable Water
- PURPLE: Reclaimed Water Irrigation
- GREEN: Sewer & Drain Lines
- WHITE: Proposed Excavation
- PINK: Temporary Surveying
Underground Utilities
MISS DIG FACT SHEET

Miosha Fact Sheet
Construction Safety & Health Division
MISS DIG – New Public Act 174

The MISS DIG System:

New legislation in 2013 created the Miss Dig Underground Facility Damage Prevention and Safety Act 174 that went into effect on April 1, 2014. The act requires that a person or public agency must provide a dig notice to MISS DIG on intent to excavate, tunnel, discharge explosives or demolish at least three business days, but not more than 14 calendar days, before commencing the activity. Upon notification, MISS DIG will notify the owner of the utility (and or the depth of the utility. Damaging utilities include underground telephone and telegraph, gas, electric, water, sewer, and storm lines and drains.

A positive response system is housed at the MISS DIG notification system that will allow facility owners/operators or their authorized locating contractor to provide status of dig notice sent to them by MISS DIG. Once the facility owner/operator or the locating contractor determines the status of the dig notice (such as clear or marked) they can then post the response to the system.

The new Act 174 contains requirements when excavating with power equipment in proximity to utility marks and provides guidance for both exercising “reasonable care” and identifying “when working” in close proximity to underground utilities applies.

Hand exposing or soft excavation. “Approximate location” is defined as a strip of land at least 34 inches wide, but not wider than the width of the marked utility, plus 18 inches on either side of the utility mark. Excavation can request additional assistance if the location of marked utility within the approximate location cannot be determined when hand digging.

Hand Exposing

MISSHA Rules:

It is the employer’s responsibility to identify all underground utilities before beginning an excavation in accordance with Part 2: Excavation, Trenching, and Shoring Systems, Rule 903(1). Upon notice from the contractor, MISS DIG will notify the utility companies they have on their member list that an excavation site needs to be marked. Do not assume that all the utilities have been marked! The only way to know for sure is to access the MISS DIG positive response system.

Part 9, Rule 903(2) requires: Upon receiving the information from the public utility, an employer shall exercise reasonable care when working in close proximity to underground facilities of any public utility. If the facilities are to be exposed, or are likely to be exposed, only hand digging shall be employed in such circumstances and such support, as may be reasonably necessary for protection of the facilities, shall be provided in and near the construction area.

So what does all of this mean for a contractor engaged in construction activities that require excavating? Do I need to comply with both Act 174 and Part 9?

If an employer is excavating and is following the requirements established by Public Act 174, Miosha would consider them to be in compliance with the requirements of Part 9 rules 406-40631(1) and 406-40631(7) for addressing the location and working around underground utilities.

Miosha also encourages contractors to contact their local Damage Prevention Association (DPA). The website link below gives a listing of all the DPAs in Michigan. These associations are a resource for knowledge and the sharing of information to help contractors perform their job safely.

For additional assistance, please contact the Construction Safety and Health Division at 517-384-7230 or the Construction Education and Training Division at 517-384-7720. Construction Safety Standards can be viewed on the Miosha website at www.michigan.gov/miosharesponse.
OVERHEAD POWER LINES

Maintain 10-foot clearance from power lines up to 50,000 volts

<table>
<thead>
<tr>
<th>Voltage (nominal, kV, alternating current)</th>
<th>Minimum clearance distance (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>up to 50</td>
<td>10</td>
</tr>
<tr>
<td>over 50 to 200</td>
<td>15</td>
</tr>
<tr>
<td>over 200 to 350</td>
<td>20</td>
</tr>
<tr>
<td>over 350 to 500</td>
<td>25</td>
</tr>
<tr>
<td>over 500 to 750</td>
<td>35</td>
</tr>
<tr>
<td>over 750 to 1,000</td>
<td>45</td>
</tr>
<tr>
<td>over 1,000</td>
<td>(as established by the utility owner or operator or registered professional engineer who is a qualified person with respect to electrical power transmission and distribution).</td>
</tr>
</tbody>
</table>

Note: The value that follows “to” is up to and includes that value. For example, over 50 to 200 means up to and including 200kV.
(4) An excavation 48 or more inches in depth and occupied by an employee shall be provided with either a ladder extending not less than 3 feet above the top as a means of access or with a ramp meeting the requirements of subrule (5) of this rule. Lateral travel along the wall of the trench to a ladder or other means of egress shall not exceed 25 feet.
Access and Egress

Ladders shall be **SECURE** to prevent movement

Ladders must meet the standards of MIOSHA Part 11 – Rule 1124 (Portable Ladders)
Access and Egress
Rule 933

(5) An Earth Ramp May Be Used in Place of a Ladder if it Meets ALL of the Following Requirements

(A) The Ramp Material Shall Be Stable

(B) The Sides of the Excavation Above the Ramp Shall Be Maintained To the Angle of Repose or Shored Along Means of Egress

(C) The Degree of the Ramp Shall Not Exceed 45 Degrees

(D) Vertical Height Between the Floor of the Trench and the Toe of the Ramp Shall Not Exceed 30 Inches
Exposure to Vehicular Traffic

Employees exposed to vehicular traffic shall be provided with, and shall wear, warning vests or other suitable garments marked with or made of reflectorized or high-visibility material.
(1) Hoisting routes that minimize the exposure of employees to hoisted loads shall be used. An employee shall not be permitted under a suspended load.
To prevent exposure to harmful levels of atmospheric contaminants and to assure acceptable atmospheric conditions, all of the following requirements apply:

(a) Where an oxygen deficiency (an atmosphere that contains less than 19.5% oxygen) or a hazardous atmosphere exists, such as in excavations in areas where hazardous substances are stored nearby, the atmosphere in the excavation shall be tested before employees enter excavations that are more than 4 feet (1.22 m) deep.
(b) Precautions shall be taken to prevent employee exposure to atmospheres that contain less than 19.5% oxygen and any other hazardous atmosphere. These precautions include providing proper respiratory protection or ventilation in accordance with the requirements of this part.
(c) Precautions shall be taken, such as providing ventilation, to prevent employee exposure to an atmosphere that contains a concentration of a flammable gas in excess of 20% of the lower flammable limit of the gas (LFL/LEL)

Note: Most gas detectors come with 10% of LEL as default setting. Exercise caution if modifying this setting or altering detector limits.
(d) When controls are used that are intended to reduce the level of atmospheric contaminants to acceptable levels, testing shall be conducted as often as necessary to ensure that the atmosphere remains safe.
Exposure to Water Accumulation
Rule 932

(2) An employee shall not work in an excavation in which there is accumulated water or in which water is accumulating unless precautions have been taken to protect employees against the hazards posed by water accumulation. The precautions necessary to protect employees adequately vary with each situation, but may include special support or shield systems to protect from cave-ins, water removal to control the level of accumulating water, or the use of a safety harness and lifeline.
Exposure to Water Accumulation
Rule 932

(3) If water is controlled or prevented from accumulating by the use of water removal equipment, the water removal equipment and operation shall be monitored by a qualified person or a monitoring system to ensure that the equipment is properly operated.
STABILITY OF ADJACENT STRUCTURES

Rule 953

(1) A structure that is adjacent to an excavation or trench below the level of the base or footing of any foundation or retaining wall shall be protected against settlement, lateral movement, undermining, or washout.

(2) Before the excavation begins, the design of the protection used shall be set forth by a qualified person who is knowledgeable in the subject area.

(3) The shoring, bracing and underpinning shall be inspected daily or more often, as conditions warrant, by a qualified employee.
Walkways, sidewalks, roadways
Rule 951

(1) A sidewalk shall not be undermined unless it is shored to support a live load of not less than 125 pounds per square foot.
Walkways, Sidewalks, Roadways

Rule 951

(2) If an employee or equipment is required or permitted to cross a trench or ditch, a walkway, runway, ramp, or bridge shall be provided and shall have a designed capacity of not less than 3 times the imposed load. A guardrail prescribed by the provisions of Part 21. Guarding of Walking and Working Areas and Part 45. Fall Protection, R408.42101 and R 408.44501, shall be provided.
An active excavation shall be protected if obscured. When the excavation becomes a pit or shaft for other operations – it shall be provided with fall protection per CS Part 45.
SOIL CLASSIFICATION
SOIL CLASSIFICATION

• To properly construct a safe work area the Qualified Person must know what materials make up the excavation.

• Classification of soil is one of the skills that separates the Qualified Person from other safety personnel.

• MIOSHA Part 9 provides soil definitions and values but does not provide descriptions of tests to establish these values.

• For examples of testing methods and procedures – The Qualified Person can refer to OSHA Subpart P, Appendix A.
Michigan does not use the A,B,C Soils Classification used in Subpart P and in other states.

MIOSHA classifies soils using a modified and condensed version of standard geotechnical engineering system.
MIOSHA SOIL TYPES

RULE 926: SOIL MEANS ANY OF THE FOLLOWING:
CLAY

A very fine textured soil that derives its resistance to displacement from cohesion and may be:

(i) SOFT CLAY – A clay-type soil that has an unconfined strength of less than 1.0 TSF

(ii) MEDIUM CLAY – Sometimes called plastic – a clay-type soil that has a minimum unconfined strength of 1.0 TSF

(iii) FIRM SOIL – A clay-type soil that is resistant to forces causing rupture or displacement. A firm clay has a minimum unconfined strength of 1.5 TSF

(iv) STIFF CLAY – A clay-type soil that is very resistant to forces causing rupture or displacement. A stiff clay has a minimum unconfined strength of 2.5 TSF
FILL

A manmade soil condition that may be constructed of any type of soil or combination thereof.
GRANULAR SOIL

A coarse grained soil that does not possess cohesion but derives its strength from internal friction.
ORGANIC SOIL

A soil that contains significant amounts of peat, muck or marl.
RUNNING SOIL

Any type of soil that has insufficient strength to stand unsupported. Running soil tends to run or slough into the excavation as excavation is being dug.
• An excavation as a work area does not exist until work begins.
• It is the duty of the Qualified Person to DESIGN, CONSTRUCT and MAINTAIN a safe work area.
• The work area is assumed to be as safe as this room – free of all known or predictable hazards.
Every employee working in a trench or excavation over 5 feet deep must be protected from a cave-in by a protective system:

- Angle of Repose (Sloping)
- Shoring to support walls
- Shields to protect occupants inside when walls cave-in
Rule 925 (1)
“Angle of Repose” means the maximum permissible slope as determined by Table 1.
Angle of Repose (Benching)

Rule 925 (1)

“Angle of Repose” means the maximum permissible slope as determined by Table 1.
TABLE 1

MAXIMUM ALLOWABLE ANGLE OF REPOSE FOR THE SIDE OF AN EXCAVATION IN EXCESS OF 5' DEPTH

<table>
<thead>
<tr>
<th>Condition</th>
<th>Angle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solid Rock Formation (90°)</td>
<td>1/4:1 (75°)</td>
</tr>
<tr>
<td>Fractured Rock Formation</td>
<td>1/2:1 (63°)</td>
</tr>
<tr>
<td>Stiff Clay with Minimum 2.5 T.S.F.</td>
<td>2/3:1 (56°)</td>
</tr>
<tr>
<td>Firm Clay a Minimum of 1.5 T.S.F.</td>
<td>1:1 (45°)</td>
</tr>
<tr>
<td>Granular Soil (Dry)</td>
<td>Rubble or Trash Fill Firm or Medium Clays</td>
</tr>
<tr>
<td>Granular Soil or Clay Fill: Medium Clay with Minimum of 1.0 T.S.F.</td>
<td>1 1/2:1 (34°)</td>
</tr>
<tr>
<td>Granular Soil (Wet Clay or Silt Seams), Soft Clays with Less Than 1.0 T.S.F.</td>
<td>2:1 (26°)</td>
</tr>
<tr>
<td>Running Soil (Sand or Clay)</td>
<td>3:1 (18°)</td>
</tr>
</tbody>
</table>

NOTE: Job conditions may require the angle of response shown in this table to be reduced to prevent the side of the excavation from failure.

*Strength values are given in unconfined compressive strength as measured by a penetrometer or laboratory tests.
Qualified Person classifies soil, finds best match on Table 1 and designs work area appropriately.

Example 1: Soil testing indicates a cohesive (or clay-type soil) with unconfined compressive strength of 1.0 TSF.

Proper angle of repose is 1:1 (45°)
Angle of Repose (Sloping)

Example of 6’ deep excavation in Medium Clay
Angle of Repose 45°

The 45º Angle of Repose is created by laying the bank back 1:1
Each bank of excavation will be constructed at the proper Angle of Repose

The banks DO NOT have to match but must be correct for soil present
Trench Shields
Trench Shield
General Description

• A trench shield is a movable box strong enough to protect the employee inside, but light enough to handle easily in the trench.

• Ideally, the width of a trench is wider than the width of the trench shield to reduce possible friction during movement. Thus, the trench shield cannot effectively prevent soil cave-ins outside the box.
(1) Portable trench boxes or sliding trench shields may be used for the protection of personnel in place of a shoring system or sloping. Where such trench boxes or shields are used, they shall be designed, constructed, and maintained in a manner that provides protection equal to or greater than the sheeting or shoring required for the trench.
All manufactured shielding and shoring equipment shall be supplied with tabulated data indicating the proper use and limitations of the equipment.

This data shall be used for the design of the protected area and should be available on site if requested by MIOSHA.

Manufactured systems shall be used within the limits of this tabulated data.
Manufacturer's Tabulated Data
Serialized Trench Shield

**Manufacturer**

**Model # of Shield**

**Option & Lifting Information**

**Limitations**

**Certified by Engineer**

**Serial # of Shield**

**Soil Types**

**Max. Depths**

**Soil Descriptions**

**Placement Diagram**

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**Manufacturer**

**Model #: HT6-B24**

**Serial Number:** 149985

**Date of Manufacture:** Sep 1

**Lift-Lug Rating:** 8,100 lbs

**Weight as Manufactured:** 12,185 lbs

**Shield Size:**

<table>
<thead>
<tr>
<th>Height (Feet)</th>
<th>Length (Feet)</th>
<th>PSF Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>24</td>
<td>114</td>
</tr>
</tbody>
</table>

**Limitations in Use of Table:**

1. Trench shield to be assembled and installed in accordance with manufacturer's instructions.
2. Excavation feet below bottom of shield is permitted when no use of soil, or programming, or below the bottom of shield is encountered. Do not exceed 8 feet below the bottom of shield.
3. The contractor is responsible for compliance with all federal, state, and local laws, rules, and regulations.
4. Spreader fins shall be used only as specified in the manufacturer's instructions.
5. Lift-lug rating is the maximum weight that can be lifted using the lift-lug system.

**Soil Types:**

- **Type B-45 (II):** Soft cohesive to very slightly cohesive clay, silt, silt loam or sandy loam
- **Type C-60 (III):** Soft cohesive, to slightly cohesive clay and sandy soil
- **Type C-80 (IV):** Soft cohesive to slightly cohesive clay, silt, silt loam, or sandy soil

**Placement Diagram**

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**Certified by Engineer:**

[Signature]

9/15/2014

**WARNING:** Any use of this product not specifically described on this certificate could cause erosion, collapse, or structural failure, and may result in injury or death.
Manufacturer’s Tabulated Data

Serialized Trench Shield

**Limitations Continued**

- accom. 1 soil, in 1 soil and 1 soil must be installed on each end of a trench shield used.
- **must not be used** for interal earth reinforcement.
- must not be used.
- This material is intended to provide basic assembly and installation information only.
- Always use trench shield in accordance with applicable local, state, and federal safety laws and regulations.
- Failure to do so could cause severe injury or death.

**Assembly Instructions**

- **When using shields as protection during manhole assembly work, ensure that proper end plates are used, or lay soil at the ends back according to manufacturer’s tabulated data.**

**Special Uses**

- **Use in Stable Soils**
- **Use in Unstable Soils**

**Page Two**
Modular Systems will have charts showing depth ratings based on configuration of equipment.
Trench Shield Combined with Sloping

If shielding or support system cannot protect entire depth – sloping top portion is allowed with the following requirements:

1. Slope above system shall be correct Angle of Repose.
2. Slope shall meet the system 18” below top.
Placement Diagram
Tabulated Data

LAYBACK & SLOPE
B SOILS = 1-1 SLOPE MIN.
C SOILS = 1-1.5 SLOPE MIN.

DEPTH OF CUT

2' MAX.
SEE NOTE-2

1'-6" MIN
Using Stacked Trench Shields

Shields may be stacked for more vertical protection with no loss of depth rating. Shields must be stacked per manufacturer’s recommendations.

Shields must be rated for the depth where they will be used.
(2) The use of benching in conjunction with a portable trench box is permitted when the toe of the trench box is not more than 2 feet above the trench bottom, but only if the trench box is designed to resist the forces calculated for the full depth of the trench and if there are no indications, while the trench is open, of a possible cave-in below the bottom of the trench box.
Trenching Boxes and Shields
Rule 945

(3) An employee shall not be allowed in shields when shields are being installed, removed or moved.
Shoring & Support Systems
(2) A support system shall be designed by a qualified employee. The design of the supporting system shall be maintained at the jobsite. Changes from the design of the support system shall be approved by a qualified employee.
MIOSHA Part 9 allows for support systems designed by Qualified Person – exercise caution and be very sure you can meet all requirements of Rule 942 & Rule 943 before proceeding with this option.
Hydraulic Shores

Hydraulic shoring products are lightweight components that utilize hydraulic pressure to support banks of excavation.
Hydraulic Shores

Individual cylinders create pressure arcs that intersect to form pressure arches.
Hydraulic Shores

The pressure arches fan out into the banks – supporting the soil without the presence of sheeting
(If allowed per tabulated data)
## Shoring Selection Guide

### TABULATED DATA

<table>
<thead>
<tr>
<th>Depth of Trench (ft.)</th>
<th>Max. Horizontal Shoring Spacing (ft.)</th>
<th>Maximum Vertical Cylinder Spacing (ft.)</th>
<th>Max. Width of Trench (ft.)</th>
<th>Sheeting</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>See Note 5</td>
<td>See Note 6</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Type “A” Soil</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Up To 10’</td>
<td>8’</td>
<td>4’</td>
<td>12’ or 15’</td>
<td>3</td>
</tr>
<tr>
<td>11’ To 15’</td>
<td>8’</td>
<td>4’</td>
<td>12’ or 15’</td>
<td>3</td>
</tr>
<tr>
<td>16’ To 20’</td>
<td>8’</td>
<td>4’</td>
<td>12’ or 15’</td>
<td>3</td>
</tr>
<tr>
<td>21’ To 25’</td>
<td>8’</td>
<td>4’</td>
<td>12’ or 15’</td>
<td>3</td>
</tr>
<tr>
<td><strong>Type “B” Soil</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Up To 10’</td>
<td>8’</td>
<td>4’</td>
<td>12’ or 15’</td>
<td>3</td>
</tr>
<tr>
<td>11’ To 15’</td>
<td>7’</td>
<td>4’</td>
<td>12’ or 15’</td>
<td>3</td>
</tr>
<tr>
<td>16’ To 20’</td>
<td>6’</td>
<td>4’</td>
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<td>3</td>
</tr>
<tr>
<td>21’ To 25’</td>
<td>5’</td>
<td>4’</td>
<td>12’ or 15’</td>
<td>3</td>
</tr>
<tr>
<td><strong>Type “C-60” Soil</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Up To 10’</td>
<td>6’</td>
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<td>4</td>
</tr>
</tbody>
</table>
Slide rail systems utilize steel panels that slide in vertical posts.
Sheeting frames utilize a reverse-cantilever principal where steel sheeting is braced in an upper waler/frame combination.
Safe Working Area

Regardless the conditions – The Qualified Person must DESIGN, CONSTRUCT and MAINTAIN a work area as safe as this room.
WORK SAFE
QUESTIONS
Trench Safety & Qualified Person

Presented by:
Mike Ross – National Training Director