**Instructor Guide**

**Excavation**

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Overview and Goals

Excavating is serious business as there are many hazards associated with trenching and excavation work, which is why it is critical to take safety precautions seriously when performing excavation activities.

In this unit of work the instructor will:

* Highlight the concepts introduced in the online course.
* Demonstrate how to use the relevant tools and reference guides, applicable to the content and activities.
* Guide the participants through hands-on activities to work safely with natural gas, as a qualified operator would on the job to:
* Assess and take the necessary preventative measures and follow approved industry guidelines during an excavation to prevent hazards, potential problems, and to handle abnormal operation conditions.
* Follow inspection requirements and determine potential problems and abnormal operating conditions (AOCs) during and after third party excavation of encroachment to protect the operators’ facilities.
* Know how to manage excavation standards for backfill to provide pipe support, based on load, soil classifications, trench prep, trench safety, compaction, field tests and how to identify and handle potential problems and AOCs, based on guidelines for restoration based on state and local codes.

Upon completion of this unit of work, participants will be able to:

* Explain damage prevention programs, best practices, techniques, excavation standards, and inspection requirements used by qualified personnel.
* Apply One-Call notification procedures, OSHA requirements, and best practices as needed on the job.
* Identify:
  + Excavation hazards
  + Procedures for locating and properly marking buried facilities prior to excavation
  + Methods and means for exposing buried pipe before excavating
  + When to perform leakage surveys or system patrolling
* Explain how and why to monitor an area for settlement during and after excavation activities.
* Verify system integrity during and after excavation activities.
* Recognize and react to abnormal operating conditions.

***Note:*** *Specific step-by-step details and the outcomes of the demonstrations and participant activities will be determined by the materials and tools used at the training facility.*

Preparation – Facilitation Guidelines

Ensure the participants have completed:

* ASME-1321 Damage Prevention during Excavation Activities by or on behalf of the Operator, including the pre-test and 25 question course assessment.
* ASME-1331 Damage Prevention Inspection during Third Party Excavation or Encroachment Activities as Determined Necessary by Operator including pre-test and 15 question course assessment.
* ASME-0981 Backfilling OSHA Standard – Competent Person Excavation Standard including pre-test and 15 question course assessment.

Ensure the participants have a copy of the Common Ground Alliances (CGA) Best Practices guide: <http://www.commongroundalliance.com>

Conduct this training in a classroom setting, with a simulated lab and/or field site allowing the participants to work independently or in groups (dependent on the number of participants) and then present findings to the workshop for further discussion.

Use a flipchart to capture key lessons learned from the group discussions, or to identify questions that will be answered in upcoming units of work or that require further research and discussion.

Reinforce the importance of damage prevention programs and the best practices and guidelines of the Compressed Gas Association (CGA), the Occupational Safety and Health Administration (OSHA), and the Federal Government.

Review the following regulations as tasks are introduced, demonstrated, and practiced.

* §192.327 Cover.
* §192.361 Service lines: Installation.
* §195.248 Cover over buried pipeline.
* §192.614 Damage prevention program.
* §195.442 Damage prevention program.
* §195.452 Pipeline integrity management in high consequence areas.
* §1926.650 Scope, application, and definitions applicable to open excavations.
* §1926.651 Specific excavation requirements.
* §1926.652 Requirements for protective systems.
  + Reference Materials:
    - Appendix A to Subpart P of Part 1926 - Soil Classification.
    - Appendix B to Subpart P of Part 1926 - Sloping and Benching.
    - Appendix C to Subpart P of Part 1926 - Timber Shoring for Trenches.
    - Appendix D to Subpart P of Part 1926 - Aluminum Hydraulic Shoring for Trenches.
    - Appendix E to Subpart P of Part 1926 - Alternatives to Timber Shoring.
    - Appendix F to Subpart P of Part 1926 - Selection of Protective Systems.
* §192.703    General.
* §192.706    Transmission lines: Leakage surveys.
* §192.721    Distribution systems: Patrolling.
* §192.723    Distribution systems: Leakage surveys.
* §192.935    What additional preventive and mitigative measures must an operator take?

Proctor Test (adopted by the American Association of State Highway and Transportation Officials [AASHTO]).

Materials

Provide the following to each participant:

* A copy of the Activity Worksheets and Appendices 1-6.
* Access to the Internet, as needed, for OSHA, federal, and industry resources/references supporting course related discussions, demonstrations, and hands-on activities.
* Access to manufacturers’ instructions as needed.

Provide the following materials and tools used locally for the lab demonstrations and hands-on practice:

* Lab or field set up for pipe excavation
* Materials and tools to white line an area
* Color code chart/tools for marking
* Checklists, for inspection purposes
* Soil samples
* PPE
* Materials and tools with appropriate company guidelines and the manufacturer’s instructions for use in a simulated lab or field to prepare, excavate, and inspect trenches.
* Project guidelines specific to each lab site for Activities Worksheets #5-#11.

Schedule

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| **Time** | **Topics for Discussion, Demonstrations, and Activities** |
| **15 minutes** | **Introduction**   * Review the requirements of a damage prevention program.   ***Note****: The tools, PPE, and materials used in the demonstrations will be determined by the materials and tools used at the training facility.* |
| **30 minutes** | **Topic: Excavation Requirements**   * Review the requirements of a damage prevention program. * Review the best practices and required safety tasks identified by OSHA and the Common Ground Alliance (CGA). * Excavation Points * One-Call Center * Positive/verified locates   Instruct participants to complete **Activity Worksheet #1**. |
| **30 minutes** | **Topic: Excavation Hazards**  Review the following key points about excavation hazards and the industry references.   * Locating buried facilities is essential to preventing damage. * Shock hazards exist when buried power lines are damaged or when overhead power lines come in contact with excavation equipment. * Cave-ins and poorly placed soil can cause damage to facilities and pose the greatest risk of personnel fatalities. * Keep excavation site as water-free as possible.   + Water may be diverted using a dike or ditches.   + Use pumps to remove water that accumulates in the trench.   Instruct participants to complete **Activity Worksheet #2**. |
|  | **Demonstration: Locating and Marking Facilities**  Review the following key points about locating and marking facilities:   * Establishing, identifying, and pre-marking excavation points. * Notifying the One-Call center.   Demonstrate how to:   * White line an excavation. * Locate and mark buried utilities with color codes. * Review:   + The positive response rule   + Job site markings/documentation     - Callback, fax, and/or automated response   Instruct participants to complete **Activity Worksheets #3 and #4**.  *If there is an onsite lab field: Demonstrate, and then have participants, safely expose buried facilities by probing, hand-digging, or potholing, following company and safety guidelines.* |

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| **Time** | **Topics for Discussion, Demonstrations, and Activities** |
| **90 minutes** | **Topic: Damage Prevention**  Review the key points about how to prevent damage during excavation.  Discussion topics should include but are not limited to:   * Safety * Monitoring excavation activities * Documentation * Qualified Personnel * System Patrols * Inspections   + Damage Prevention   + Requirements   + Frequency   Present “real-world,” on-the-job experiences to highlight safety measures taken and encourage “what if” discussions if a problem was not recognized, reported, and/or documented.  Instruct participants to complete **Activity Worksheets #5, #6, and #7.** |
| **90 minutes** | **Lab: Soil\***   * Provide examples of the soil used to backfill. * Explain how the soils are tested.   + Unified Soil Classification * Review :   + Sources to define the classification systems, for example, tests.   + Pipeline safety requirements, for example classes of embedment and backfill materials. * Discuss the process to backfill an area using the appropriate tools and following the state guidelines to ensure the integrity of the property is restored.   Instruct participants to complete **Activity Worksheet #8**.  *If there is an onsite lab field: Demonstrate, and then have participants, backfill an area, using the appropriate tools following company and safety guidelines.* |
| **90 minutes** | **Lab: Trench Preparation (Field activity or lab simulated)\***  Explain that in the field participants will examine trenches to ensure:   * Trench depth and width meet requirements * Location of the buried main * Service line installation guidelines * How to cover a buried pipe * Trench padding * Cathodic protection system   Review the federal, state, local, and environmental (if applicable) guidelines to ensure the regulations are all in compliance.   * Discuss any problems   Instruct participants to complete **Activity Worksheet #9.** |

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| **Time** | **Topics for Discussion, Demonstrations, and Activities** |
|  | **Lab: Backfill process (Field activity or lab simulated)\***   * Explain that in the field participants will examine the trenches * External load of backfill * Pipe installation * Joint installation * Degree of compaction * Discuss how to reach compaction densities by backfilling in increments. * Review the compaction rules * Point out the types of backfill used at which layer. * Show the participants the results of an insufficient compaction. * Discuss how the corruption may have happened. * Point out a protected pipe. * Review the importance of following engineering specifications, for example the Proctor Test (adopted by the American Association of State Highway and Transportation Officials [AASHTO]). * Importance of site restoration   Instruct participants to complete **Activity Worksheet #10.** |
|  | **Lab: Compaction (Field activity or lab simulated)\***   * Explain, and offer examples regarding:   + - Compaction process and requirements.     - Affecting factors: soil type, moisture, compaction effort, method, and equipment     - Ground bed compaction     - Ground bed methods and the equipment used for each * Demonstrate how to compact around a pipe that is installed properly and within the trench guidelines. * Demonstrate (when possible) the types of field density tests:   + - Sand-cone     - Rubber balloon     - Nuclear gauge     - Soil compaction meter * Show the participants the results of an insufficient compaction. * Discuss how the corruption may have happened.   Instruct participants to complete **Activity Worksheet #11.** |

Boot Camp Activities

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| Working with a partner or partners, complete the following tasks, using the materials and equipment in your lab. Be sure to follow the industry guidelines and manufacturers’ instructions as needed for the project/activity assigned.   |  |  | | --- | --- | | Activity Worksheet #1 - Excavation Requirements - On the Job Scenario | | | Scenario: | Expansion and new construction is scheduled for a work site.   * Natural gas is used in this area for heat and cooling. * The site must be prepared before the area can be cleared.   Refer to the drawings and maps (See Appendix 1).  Based on these information sources, answer the following questions:   1. How do you identify the excavation reference points? 2. What was the purpose of contacting the One-Call center? 3. What would be addressed in a pre-excavation meeting? 4. When would digging start? Why?   Access the [Common Ground Alliance](http://www.commongroundalliance.com) website (<http://www.commongroundalliance.com>) and refer to the CGA Best Practices Quick Reference, 5. Excavation as an information source.   |  |  |  | | --- | --- | --- | | **Additional Notes and Information** | | | | **Information** | **Data Source** | **Link** | | Excavation activities accounted for more than 25% of fatalities because of pipeline failures between 2002-2011 according to statistics kept by the U.S. Department of Transportation’s Office of Pipeline Safety. | [U.S. Department of Transportation’s Office of Pipeline Safety](http://www.phmsa.dot.gov/staticfiles/PHMSA/DownloadableFiles/Press%20Releases/Excavation%20Rule%20Press%20Release%20033012.pdf) | -++<http://www.phmsa.dot.gov/staticfiles/PHMSA/DownloadableFiles/Press%20Releases/Excavation%20Rule%20Press%20Release%20033012.pdf> | | “The U.S. Department of Transportation classifies excavation damage as “damage by outside force,” “third party excavation damage,” and “operator excavation damage.” | [Common Ground Alliance](http://www.commongroundalliance.com) | <http://www.aga.org/Kc/aboutnaturalgas/consumerinfo/Pages/CausesofNGPipelineAccidents.aspx> | | | Answers |  | |  | |  | |  | |  | | References-  guidelines-tools used, including  CFR (If applicable)  Indicate, if applicable measures to respond report and document potential problems and AOCs. |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | |  | | Lessons learned |  | |  | |  | |  | |  | |  | |  | |  | | General discussion questions or notes |  | |  | |  | |  | |  |

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| Activity Worksheet #2 - Excavation Hazards - On the Job Scenario | |
| Scenario: | At the work site (See Activity Worksheet #1 details and Appendix 1)   1. What shoring tools/equipment (and PPE) would be used to prevent cave-ins? 2. What are the safety guidelines:    1. To respond to cave-ins?    2. To divert water and avoid trench flooding?    3. To test the atmosphere for flammability and/or toxins? |
| Answers |  |
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| References-guidelines-tools used, including  CFR (If applicable)  Indicate, if applicable measures to respond report and document potential problems and AOCs. |  |
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| Activity Worksheet #3 - Locating and Marking Facilities - On the Job Scenario | |
| Scenario: | At the work site (See Activity Worksheet #1 details and Appendix 1)   1. What electronic/equipment (and PPE) would be used to identify the path of the metal pipe? Why? 2. Why must reference points be established? When? Why? How is the excavation area identified? 3. How will One-Call handle this excavation? (Be specific based on state.) 4. What is the facility owner’s responsibility for marking area? 5. What is the excavation timeline? Why?  * Be specific to the map you are using from Activity Worksheet #1 - the national, state, local guidelines, and the industry references. |
| Answers |  |
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| References-guidelines-tools used, including  CFR (If applicable)  Indicate, if applicable measures to respond report and document potential problems and AOCs. |  |
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| Activity Worksheet #4 - Locating and Marking Facilities | |
| Demonstration  Lab Activity | * Using the maps, white line the excavation area\*. * Use color codes to illustrate at the work site (See Activity Worksheet #1), buried utilities. * Explain how verification will be handled.   + Indicate the resources used for receiving and transmitting requests   *\*If onsite…*   * *White line the excavation area* * *Expose buried facilities by probing, hand-digging, or potholing*  |  |  |  | | --- | --- | --- | | **Additional Notes and Information** | | | | **Information** | **Data Source** | **Link** | | Reinforce uniformed color codes to prevent mistakes and injuries   * Red-electric• * Yellow-gas, oil, steam• * Orange-communication * Blue-potable water• * Green-sewer• * Pink-temporary survey markings• * White-proposed excavation• * Purple-reclaimed water | Louisiana One Call home page under Operations and Color Codes | <http://www.laonecall.com/apwa_color_codes.htm> | |
| Tools used |  |
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| Steps-actions |  |
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| Lessons learned |  |
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| Activity Worksheet #5 - Prevent Damage During Excavation-On the Job Scenario | |
| Scenario: | At the work site (See Activity Worksheet #1 details and Appendix 1) explain how to manage an excavation for:   1. Slope, Soil Type C 2. Bench, Soil Type A 3. With Shield, Soil Type B  * Indicate tools, resources used, references, and any other details taken into consideration to ensure the safety of property and personnel based on the map, details from Activity Worksheet #1, and the national, state and local guidelines, and industry references. * Explain how the site is monitored for safety after the excavation. * Document methods used. |
| Answers |  |
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| References-guidelines-tools used, including  CFR (If applicable)  Indicate, if applicable measures to respond report and document potential problems and AOCs. |  |
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| Activity Worksheet #6 - Damage Prevention Requirements-On the Job Scenario | |
| Scenario: | At the work site (See Activity Worksheet #1 details and Appendix 1)   * Explain the actions to take when an excavator contacts an underground facility. * What resources did you access? * Best practices * Industry guidelines * Federal, state, and local requirements/regulations   ***Note:*** *Be sure to consider, property* ***and*** *personnel.* |
| Answers |  |
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| References-guidelines-tools used, including  CFR (If applicable) |  |
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| Lessons learned |  |
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| Activity Worksheet #7 - Inspection Requirements-On the Job Scenario | |
| Scenario: | At the work site (See Activity Worksheet #1 details and Appendix 1):   * Identify the actions to take when encroachment/construction activity is discovered (visible change in plants/greens) during a system patrol. * Identify: * Code of Federal Regulations patrols must follow. * Actions taken with One-Call System * Factors that could affect future safety or operation of the facility   Complete a Damage Prevention Inspection checklist (See Appendix 2)   * Explain how to: * Set up an inspection schedule. * Conduct a leakage survey. Discuss its purpose.   + Indicate what must be documented and why. |
| Answers |  |
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| References-guidelines-tools used, including  CFR (If applicable)  Indicate, if applicable measures to respond report and document potential problems and AOCs. |  |
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| Activity Worksheet #8 - Soil Classification | |
| Lab Activity | **Part 1**   1. Examine soil taken from the work site (See Activity Worksheet #1 details) 2. Complete the Soil Checklist (see Appendix 3)  * Define and classify the soil samples * Test for:   + Soil stability   + Density   + Compaction   + *Note: Identify test(s) used* * Determine appropriate backfill material * Identify resources and classification systems used   **Part 2**  *\*If onsite…*   * *Backfill an area, using the appropriate tools.* * *Ensure the compacted area is properly managed during the fill and that the tools do not contact the pipe.* |
| General discussion questions or notes |  |
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| Activity Worksheet #9 - Trench Preparation | |
| Lab Activity | Examine the following in the field trench:   * Trench depth and width meet requirements. * Location of the buried main. * Service line installation guidelines. * How to cover a buried pipe. * Trench padding. * Cathodic protection system.   Complete the Trench Preparation Checklist (see Appendix 4) |
| General discussion questions or notes |  |
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| Activity Worksheet #10 - Backfill Process | |
| Lab Activity | Examine the following in the trench field:   * External load of backfill. * Pipe installation. * Joint installation. * Degree of compaction. * Corruption (if so, potential causes).   ***Note:*** *Be sure to reference engineering tests and or guidelines during the examination.*  Complete the Backfill Process Checklist (see Appendix 5) |
| General discussion questions or notes |  |
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| Activity Worksheet #11 - Compaction | |
| Lab Activity | 1. In the field demonstrate how to compact an area around a pipe. 2. Refer to the:    * Compaction requirements for soil compaction.    * Trench guidelines.    * Types of field density tests.   Complete the Compaction Checklist (see Appendix 6) |
| General discussion questions or notes |  |
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Appendix A – Activity Preparation

Based on company projects, labs, and local resources, provide details about a work site that the participants can work to gain experience for the field.

The tools, PPE, and materials used in the hands-on activities will be determined by the materials and tools used at the training facility.

**Example**:

An area that is being expanded for new construction.

For example: a mixed–use (restaurant and retail stores) retail center, a playground renovation, or a historic home renovation in the center of a populated city.

Provide the participants with the following information about the work site.

***Information about the project:***

* Natural gas is used in this area for heat and cooling.
* The site must be prepared before the area can be cleared.

***Project tools available:***

* General area map
* Site drawing
* One Call location
* Damage prevention inspection checklist
* Tools to:
  + White line
  + Collect soil
  + Measure
  + Additional materials, tools, and PPE as required by the assignment

**Note**: If a field training site/lab is not available, provide a case study on a completed project where the paperwork and findings on the following topics can be evaluated and discussed.

* Site Preparation
* Damage Control Checklist
* Soil Checklist
* Trench Preparation Checklist
* Backfill Process Checklist
* Soil Compaction Checklist

Appendix 1 – Work Site

Working with a partner or partners, complete the following task.

Using the information provided along with the materials and equipment in your lab, prepare a site for clearing in an area where natural gas is used for heating and cooling.

* Explain the actions you followed to identify the underground facility.
* What resources did you access?
* Best practices
* Industry guidelines
* Federal, state, and local requirements/regulations.

Appendix 2 – Damage Prevention Inspection Checklist

The checklist used meets industry and federal safety guidelines about natural gas in the geographic area.

*The checklist used in the hands-on activities will be determined by the tools used at the training facility.*

Appendix 3 – Soil Checklist

Working with the field samples, complete the following checklist and then use for discussion in the workshop.

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| **Soil Sample** | **Type** | **Tested** | **References** |
| A |  |  |  |
| B |  |  |  |
| C |  |  |  |
| D |  |  |  |
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| **Notes** | | | |
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Appendix 4 – Trench Preparation Checklist

Working in the lab/field, examine the trench and complete the following checklist.

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| **Item** | **Details and/or Yes, No** | **Problems/AOC** | **References** |
| Trench depth |  |  |  |
| Trench width |  |  |  |
| Location of the buried main |  |  |  |
| Padding |  |  |  |
| Cathodic protection system |  |  |  |

Refer to your answers during the workshop discussion.

Appendix 5 – Backfill Process Checklist

Working in the lab/field, examine the trench and complete the following checklist.

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| **Item** | **Details and/or Yes, No** | **Problems/AOC** | **References** |
| External load of backfill |  |  |  |
| Pipe installation |  |  |  |
| Joint installation |  |  |  |
| Degree of compaction |  |  |  |
| Corruption |  |  |  |
| *Indicate if you referenced engineering tests and or guidelines during the examination.* | | | |

Refer to your answers during the workshop discussion.

Appendix 6 – Compaction Checklist

1. Compact around a pipe that is installed properly and within the trench guidelines. Complete the checklist to indicate:
   * + Soil type, moisture
     + Compaction effort, method, and equipment
     + Compaction requirements (refer again to the Proctor Test) for moisture contact and dry density of the soil

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| --- | --- | --- | --- |
| **Item** | **Details** | **Problems/AOC** | **References** |
| Area Compacted |  |  |  |
| Soil Type |  |  |  |
| Moisture |  |  |  |
| Compaction Effort |  |  |  |
| Compaction Method |  |  |  |
| Compaction Equipment |  |  |  |