Trench Rescue - Awareness Level

Student Manual

Technical Rescue
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THE NYS OFFICE OF FIRE PREVENTION AND CONTROL AND THE NYS OFFICE OF COUNTER TERRORISM

TRENCH RESCUE - AWARENESS LEVEL

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MEMORIUM

The Office of Fire Prevention and Control wishes to dedicate this program to the memory of Principle Development Group members Raymond Meisenheimer and Dennis Mojica. Both of these outstanding and courageous individuals perished in the line of duty at the World Trade Center on September 11, 2001. Their loyalty and dedication to the fire service in New York City and State will never be forgotten.

Unit 1: Introduction to Trench Rescue

Introduction

Course Overview

The Trench Rescue – Awareness Level course consists of two units totaling six hours. This course is designed to provide information to adequately prepare you to identify a trench incident and provide assistance to those trained and qualified to enter the trench to perform rescue services. The overall objective of the **Trench Rescue – Awareness Level** course is to impart rescuer awareness of the safety concerns at trench collapse situations. Topics include: regulations and standards, worker protection systems, safety, equipment, incident management and written testing.

Course Objectives

You will find specific learning objectives in each lesson of this course. The *overall course and terminal objectives* and are listed below.

1. The Overall Course Objective – To impart rescuer awareness of the safety concerns at trench collapse situations.

At the conclusion of this course, the student will be able to:

- Define trench construction and trench rescue terminology,
- List rules, laws, and regulations applicable to trench incident response,
- Identify PPE, rescue equipment, and resources necessary for trench rescue operations,
- Describe components of a trench rescue Incident Management System (IMS) and Incident Action Plan (IAP),
- Identify and describe safety concerns at trench collapse situations,
- Pass a written exam with a minimum of a 70% score

Course Overview

Unit 1 - Introduction to Trench Rescue
- Introduction
- Regulations and Standards
- Introduction to Trench Operations
- Worker Protection Systems

Unit 2 - Operations at Trench Rescue Incidents
- Trench Incident Safety
- Trench Rescue Equipment
- Trench Rescue Operations
- Student Exercises
- Final Exam.

Regulations and Standards

Lesson Objectives

- Describe the purpose of OSHA 1926.650-652 (and applicable appendices) and its application to rescue services;
- Identify the scope of PESH in NYS as it relates to trench safety;
- Describe the purpose of NFPA 2500 and 1006 and their application to rescue services.

This unit covers the work of four organizations:

- NIOSH (National Institute for Occupational Safety & Health)
- OSHA (Occupational Safety & Health Administration)
- NFPA (National Fire Protection Association)
- PESH (Public Employee Safety & Health)

NOTE: Additional material on this lesson is located in the Appendix at the rear of this student manual.

Worker Injury

Excavation is one of the most hazardous types of work done in the construction industry. The primary type of accident we will be addressing in this class are cave- in's

NIOSH

National Institute for Occupational Safety and Health (NIOSH) studies incidents and compiles statistics and makes recommendations to OSHA

NIOSH facts (1985):

- Deaths and injuries
  Average of 73 persons killed per year in cave-ins
  Average of 97 persons killed per year in excavation related accidents
  Average of 140 permanent disabilities

- Bureau of Labor Statistics (2010)
  From 2000–2009, 350 workers died in trenching or excavation cave-ins
  Average of 35 fatalities per year

Potential Response to Trench Incidents

- Collapse/Cave-in and Non-collapse
- Struck by Object

- Electrocution/Electric Shock
- Falls
- Hazardous Atmospheres
- Medical Situations

Facts You Should Know

- 1,000 to 4,000 injuries per year
- Cave-ins accounted for 76% of fatalities
- Struck by object accounted for 6.5% (35) of fatalities
- Most trench accidents happen in trenches 5ft to 15ft in depth
- 64% of fatalities in trenches occurred at depths of less than 10 feet

- Causes of Death:
  - *Suffocation* – unable to breathe
  - *Crushing Injury* – Damage to internal organs, acidosis
  - *Loss of Circulation* – Depriving vital organs the needed oxygen
  - *Being struck by fallen objects* – Becoming unconscious, blocked airway

OSHA

OSHA is a division of the U.S. Department of Labor and is charged with making the standards that apply to worker safety. While the following excavation standards do not technically apply to rescue services, we follow them just the same.

1926.650 – Scope, Application & Definitions

Includes definitions used throughout subpart P (excavations) and important Terms contained in 1926.650 such as:

- **Excavation** – any man-made cut, cavity, trench or depression in the earth's surface formed by the removal of that earth.

- **Trench** – a narrow excavation (in relation to its length) made below the surface of the ground. In general, the depth is greater than the width but the width of a trench (measured at the bottom) is not greater than 15 feet.

- **Competent Person** – one who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous or dangerous and who has authorization to take prompt corrective measures to eliminate them.

Every excavation site (including rescue operations) must have a competent person. Specific responsibilities include:

- Identify and Address:
  - Evidence of Possible Cave-ins
  - Failure of Protective Systems
  - Hazardous Atmosphere

- Conduct test for soil classification
- Understand the standards and data
- Recognize and classify soil after changing conditions
- Determine if damage to equipment renders it inadequate for employee safety
- Conduct air tests for hazardous atmosphere
- Design of structural ramps
- Locate underground utilities
- Monitor water removal
- Perform daily inspections
    - Prior to start;
    - As needed;
    - After any other hazard increasing occurrence

You should be familiar with these terms and any other terms contained within the standard. Refer to glossary in the appendix for other definitions.

- **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).
- **Cohesive Soil** – A type of soil with a high clay content that holds together firmly
- **Compact Soil** – Soil that is hard and stable in appearance, can be indented by the thumb, but penetrated with difficulty
- **Safing** – To make a portion of a trench safe, by using panels and shoring or by slopping.
- **Sloping** – Method of protecting employees from cave-ins by excavating the sides of a trench to form an angled wall, which will prevent the soil from sliding into the trench.
- **Spoil Pile-** A spoil tip is a pile built of accumulated spoil – waste material removed during mining.
- **Stable Rock-** a natural solid mineral matter that can be excavated with vertical sides and remain intact while exposed.
- **Loam** – A combination of sand and clay.
- **Saturated Soil** – Contains a high quantity of water, which fills the voids in that soil.
- **Running Soil** – Loose free flowing soil, fine sand is an example.
- **Benching** – Method of protecting personnel by excavating sides of a trench to form one or a series of horizontal levels or steps.
- **Tension Cracks** – Cracks in the ground adjacent to the trench indicating that the ground has shifted and should be considered a warning sign.
- **Virgin Soil** – Ground that has never been excavated.
- **Cave-in** – Collapse of unsupported trench walls in sufficient quantity to en-trap, bury, or other wise injure and immobilize a person.

1926.651 – Specific Excavation Requirements

- **> 4 ft** you must ladder
- **> 5 ft** you must shore
- 4 ft or more in depth you must have a stairway, ladder, or **ramp every 25' of lateral travel,**
- Ladder must be secured & **3' above** the lip of the trench.
- Protective systems for use in excavations more than 20 feet in depth must be designed by a registered professional engineer in accordance with 1926.652(b) and (c).

1926.652 – Requirements for Protective Systems

Includes requirements on:

- General protection of employees
- Design of sloping and benching systems
- Design of support systems, shield systems and other protective systems
- Materials and equipment
- Installation and removal of support
- Sloping and benching systems
- Shield systems

Subpart P – Appendix A-F

Appendix A – Soil Classification including:

- Scope & application- describes methods of classifying soil & rock deposits
- Definitions of soil types: described in detail in next lesson
- Requirements for:
  - Classification of soil & rock deposits
  - Basis of classification
  - Visual & manual analyses
  - Layered systems
  - Reclassification
- Acceptable visual & manual tests
  - Visual tests such as:
    - Observing soil samples
    - Observing soil as it is excavated
    - Observing sides of trench for spalling, cracks, layered systems and utilities
    - Observing adjacent area for surface water & water seeping
    - Observing for sources of vibration
  - Manual tests
    - Plasticity
    - Dry strength
    - Pocket Pentrometer or shearvane
    - Drying tests
    - Cracks as it dries – fissures
    - Dries without cracking – cohesion
    - Pulverize, granular

The above test shows why we (rescue services) classify soil as Type C soil. These tests require experience, expertise and time.

Appendix B – Sloping and Benching

- Scope & application
- Definitions
- Requirements
  - Soil classification
  - Maximum allowable slope
  - Actual slope
  - Configurations (based on soil type and depth)

Appendix C – Timber Shoring for Trenches

- Uses tables to determine timber shoring needs based on soil type and depth

Appendix D – Aluminum Hydraulic Shoring for Trenches

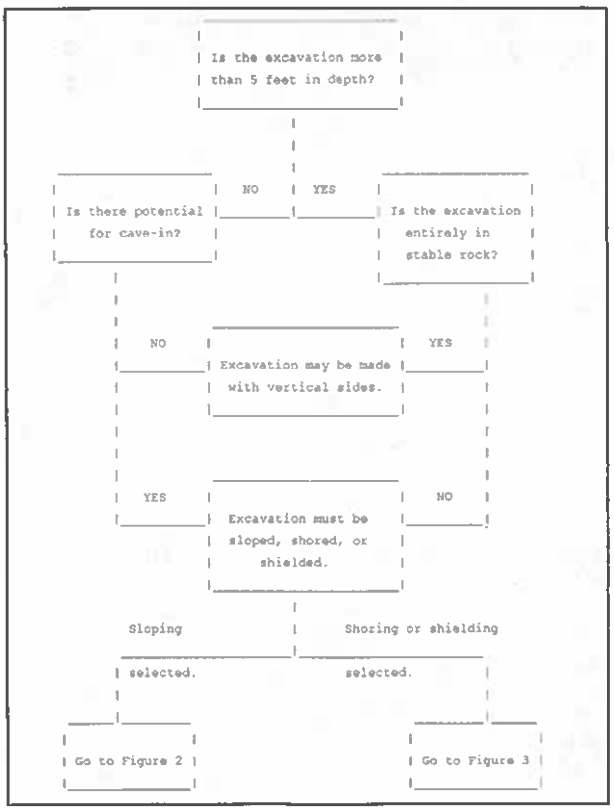
- Uses tables and diagrams to determine aluminum hydraulic needs based on soil type and depth

Appendix E – Alternatives to Timber Shoring

- Includes graphics of aluminum hydraulic shoring, pneumatic/hydraulic shoring, trench jacks and trench shields

Appendix F – Selection of Protective Systems

- Contains flow charts used in determining requirements for excavations 20 feet or less in depth. Excavations more than 20 feet in depth must have protective systems designed by a registered professional engineer.



TIMBER TRENCH SHORING -- MINIMUM TIMBER REQUIREMENTS *

SOIL TYPE C P(a) = 80 X H + 72 psf (2 ft Surcharge)

DEPTH OF TRENCH (FEET)	SIZE (ACTUAL) AND SPACING OF MEMBERS **						
	CROSS BRACES						
	HORIZ. SPACING (FEET)	WIDTH OF TRENCH (FEET)					VERT. SPACING (FEET)
		UP TO 4	UP TO 6	UP TO 9	UP TO 12	UP TO 15	
5 TO 10	UP TO 6	6X8	6X8	6X8	8X8	8X8	5
	UP TO 8	8X8	8X8	8X8	8X8	8X10	5
	UP TO 10	8X10	8X10	8X10	8X10	10X10	5

Other OSHA Standards

1910.146 – Permit Required Confined Spaces
1910.133 – Eye & Face Protection
1910.134 – Respiratory Protection
1910.135 – Occupational Head Protection
1910.136 – Occupational Foot Protection
1910.120 – Hazardous Waste Operations and Emergency Response
1910.1030 – Bloodborne Pathogens
1926.500 – Fall Protection

OSHA in New York State

NYS Department of Labor

- PESH – Public Employee's Safety & Health
- Covers all state and local government workplaces

OSHA

- Covers all private sector workplaces and federal agencies

NFPA Standards

NFPA 2500 "*Standard for Operations and Training for Technical Search and Rescue Incidents and Life Safety Rope and Equipment for Emergency Services (2022)*" This is a combination of the existing 1858, 1670 and 1983. This standard identifies and establishes minimum standards for conducting operations at technical search and rescue incidents and applies to organizations.

Preparing the Response

Levels of Response in NFPA 2500:

Awareness - (First Responder)
Operations - (Limited Work Scope)
Technician - (Technical Rescue Team)

NFPA 2500 – Awareness Level

Organizations operating at the awareness level at trench and excavation emergencies shall implement procedures for the following:

- Initiating size-up to ascertain immediate response needs for a trench rescue
- Recognizing the need for technical resources
- Identifying the resources necessary to conduct safe and effective trench and excavation emergency operations

- Recognizing general hazards associated with trench and excavation emergency incidents and the procedures necessary to mitigate these hazards within the general rescue area

- Recognizing typical trench and excavation collapse patterns, the reasons trenches and excavations collapse and the potential for secondary collapse

- Initiating a rapid, non-entry extrication of non-injured or minimally injured victim(s)

- Recognizing the unique hazards associated with the weight of soil and its associated entrapping characteristics

- Implementing a hazard identification and isolation plan, including securing hazardous equipment, contacting utility location services, establishing control of affected utilities, and using methods for protecting bystanders and rescuers from accidentally falling into the excavation or increasing the likelihood of additional collapse

- Identifying and implementing methods for approaching and working around the excavation in a manner that minimizes the potential of collapse resulting from additional imposed loads on the lip of the trench

- Supporting an organization at the operations or technician level while functioning within an IMS

NFPA 2500- Operations Level

- Operate at trench and excavation emergencies that include the collapse or failure of individual, nonintersecting trenches with an initial depth of 8 ft.

NFPA 2500- Technician Level

- Operate at trench and excavation emergencies that include the collapse or failure of
  - individual, nonintersecting trenches with an initial depth of 8 ft.
  - where severe environmental conditions exist;
  - digging operations involve supplemental sheeting and shoring;
  - manufactured trench boxes or isolation devices would be used.

NFPA 1006

- NFPA 1006 - Standard for Technical Rescue Personnel Professional Qualifications 2021 Edition

- Establishes minimum job performance requirements (JPR's) for technical rescue personnel.

NFPA 1006 - Awareness Level - minimum capability of individuals who provide response to technical search and rescue incidents.

NFPA 1006 - Operations Level - the capability of individuals to respond to technical search and rescue incidents and to identify hazards, use equipment, and apply limited techniques specified in this standard to support and participate in technical search and rescue incidents.

NFPA 1006 Technician Level - the capability of individuals to respond to technical search and rescue incidents and to identify hazards, use equipment, and apply advanced techniques specified in this standard necessary to coordinate, perform, and supervise technical search and rescue incidents.

Trench rescue requirements include:

- Size-up
- Incident Management
- Non-entry Rescue
- Emergency Action Planning
- Scene Safety
- Equipment & Resources.

Introduction to Trench Operations

Lesson Objectives

Following the lesson, the student shall:

- Identify the potential for trench rescue incidents in their respective jurisdictions,
- Describe soil characteristics as they relate to trench construction and collapse,
- Describe the basic factors involved in excavation collapse, to include collapse patterns and associated hazardous conditions.

Trench Accidents

- Only 50% of incidents occur in trenches with some protection.
- Most fatalities occur when digging/repairing underground utilities or performing foundation work.

Potential for Trench Incidents

- Underground utilities
- Thousands of open trenches throughout the state
- Lack of contractor training
- Lack of enforcement
- More complex underground engineering
- Amount of construction on-going
- Home improvement projects
- Toxic atmospheres in trench.

Weight & Volume of Soil – these figures show why weight, volume and speed are important considerations in trench collapse

Approximate weights

- 1 cubic yard weighs 2,700 lbs.
- 1 gallon weighs approximately 13 lbs.
- One cubic ft. of dirt will fill 1.6 - 5 gal. buckets
- One cubic yd. of dirt will fill about 46 - 5 gal. buckets
- 13 lbs. x 46 (x 5 gal. buckets) = 2990 lbs.

Soil Physics

- The collapse forces of a trench are tremendous.
- Speed of soil collapsing + weight of the soil causes various injuries!
- Shear wall collapse speed = 45 mph
- 1 cubic foot of soil is = 100-120 lbs.
- Clay can weigh 140 lbs., dry sand as little as 65 lbs.
- 24 in. soil on chest = 750 lbs.-1,000 lbs.
- 18 in. soil covering the body = 1,000 lbs.-3,000 lbs.

Victim considerations

- Speed of soil collapsing + weight of the soil causes various injuries including:
- Crush injuries
- Suffocation and/or toxic atmospheres
- Mouth fills with soil
- Chest unable to expand
- Chest unable to continue expanding
- Take care pulling on the victim
- Weight can hold the victim
- Dislocation injuries
- Do not pull on victim unless completely unburied

Non-Entry / Victim Self Rescue

- Ladder
- Rope/Pt. Packaging
- Use of shovels from above
- Uncover head and chest first
- Creating a void for victim
- Cones and other marking systems to indicate position
- Don't try to pull the victim until they are completely unburied

Soil Types

Soils are classified by OSHA as one of three types:

- Type "A"
  - Most stable (other than stable rock)
  - Includes strong clay soils, cemented soils and hard pan
- Type "B"
  - Next most stable
  - Includes granular soils, weaker clay soil and disturbed soils
- Type "C"
  - Least stable
  - Includes gravel, sand and weakest clays

Stable Rock

- Natural solid material that can remain standing after excavation

Classifying Soil

- Grain Size
- Saturation- how much water is in the voids between the grains. When these voids fill with water, the soil becomes saturated
- Cohesiveness- Ability of soil to hold together firmly
- Compressive Strength- the resistance of a material to breaking under compression

Classifying Types of Soil

- Compact - soil that appears compact or even hard, and thus stable
- Running - loose, free flowing soil such as sugar sand

****All trench rescues should be considered type "C" soil. This will eliminate the problem of trying to classify the soil as Type "A", "B" or "C" soil.****

Soil Testing

The following is given for information purposes and to show how difficult and time consuming it is to accurately determine the type of soil you are dealing with. We can test soil to determine which "type" it is. OSHA requires at least one visual and one manual test performed by a competent person. A sample is taken from soil pile and tested quickly as possible to preserve natural moisture content. These tests take time and some level of expertise. Because of this we classify all soils as type "C"

Visual testing – Observe soil excavated as well as soil in and around excavation.

- With excavated soil look for:
  - Soil particle size
  - Clumping
- In excavation and adjacent areas look for:
  - Cracking
  - Utilities
  - Disturbed soil
  - Layered systems
  - Water
  - Vibration

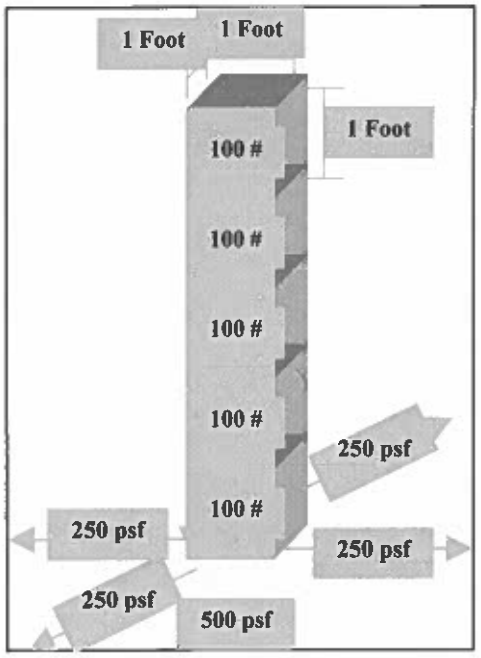
Manual soil testing

- Plasticity
  - Test to determine the cohesion of the soil.
  - Includes thread test and ribbon test.
- Dry strength
  - Used to help determine fissured or unfissured soil
- Thumb penetration
  - Used to estimate the unconfined compressive strength of cohesive soils
- Drying test
  - Used to differentiate between fissured cohesive material, unfissured cohesive materials and granular materials.
  - Requires that samples be taken & then dried completely – time consuming.
- Pocket penetrometer or shearvane
  - Used to estimate unconfined compressive strength of soil
- Sedimentation test
  - Determines how much silt & clay are in sandy soil
- Wet shake test
  - Another method to determine amount of sand vs. clay in the soil.

Mechanics of Collapse

Understanding the mechanics of collapse requires an understanding of the material presented in this unit. Trenches collapse because of various factors including:

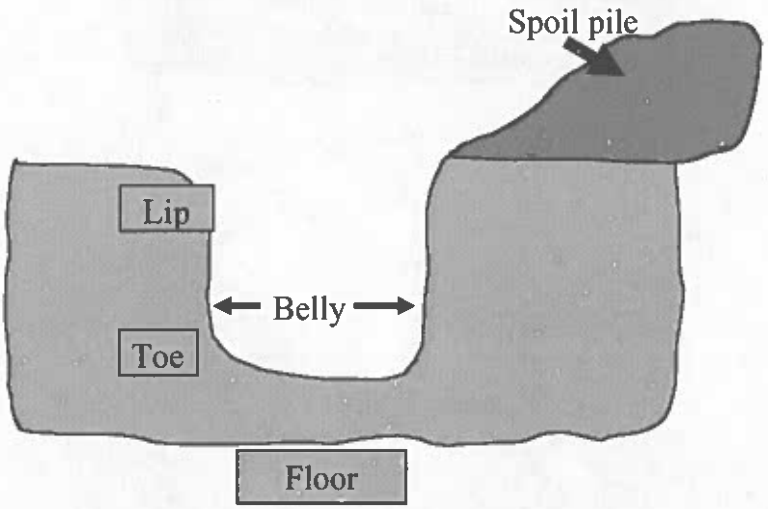
- Weight of soil
  - Remember soil weighs 100 lbs. or more per cubic foot. An example of the weight of soil: 1 cubic yard (3'x3'x3') contains 27 cubic feet of soil. At 100 lbs per cubic foot, this equals 2700 lbs. That is nearly 1 ½ tons (the equivalent weight of a car) in a space less than the size of the average office desk. Wet soil, rocky soil or rock is usually heavier
- Soil type
  - A trench may contain multiple soil types
- Tension cracks or fissures
  - Indicator of possible failure
- Hydraulic forces
  - Water flowing from the soil can indicate lack of soil cohesion as well as additional weight



Soil Weight and Pressure

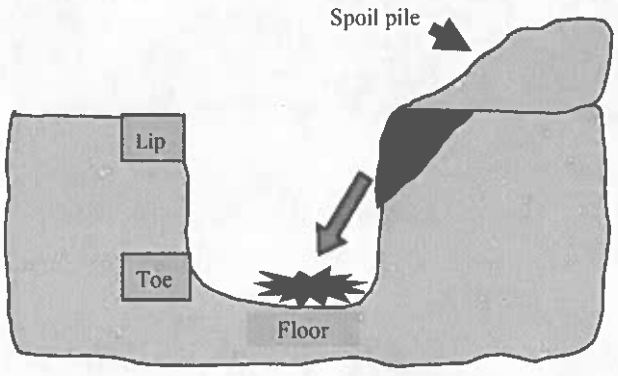
Anatomy of a trench

- *Lip* – 2 feet down from the ground surface
- *Toe* – 2 feet up from the floor of the trench
- *Belly* – Area between the lip and toe
- *Spoil Pile* – Soil that is removed from the trench
  - Should be located at least 2 feet back from the lip of the trench

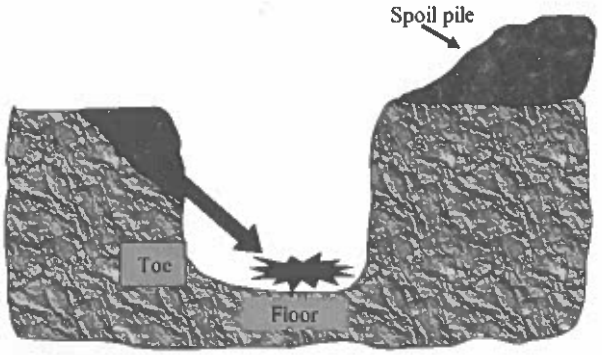


Trench Collapse Patterns

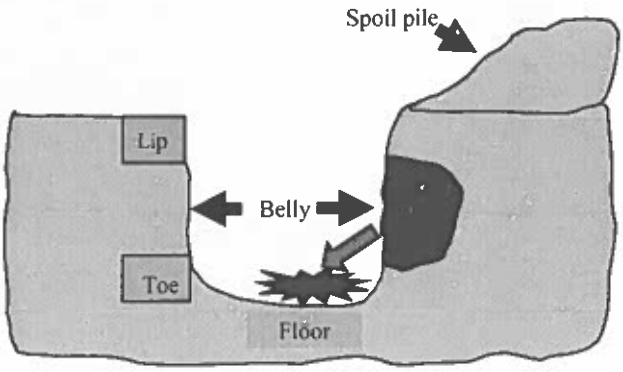
Spoil Pile Slide



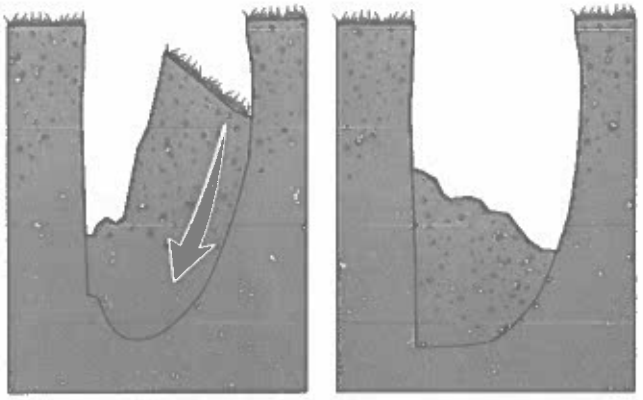
Lip Slide



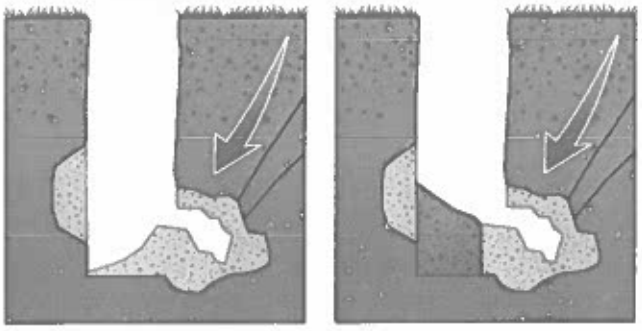
Belly/Slough In



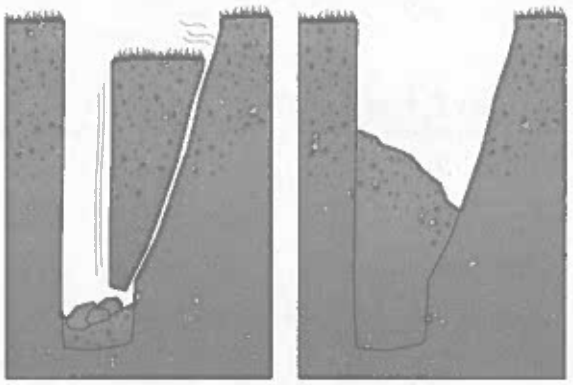
Rotational Failure



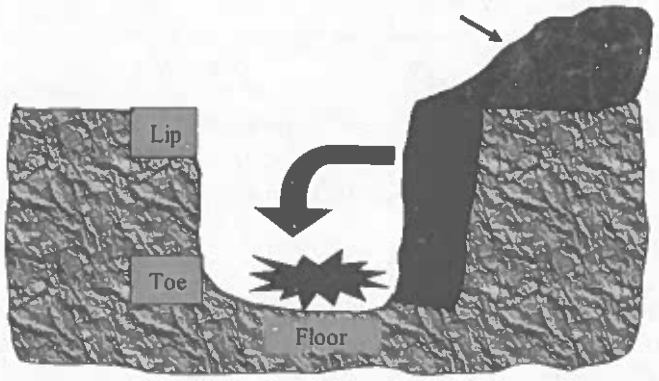
Toe Failure



Wedge Failure



Wall Shear



Conditions and Factors That Can Lead to Collapse:

- Water
- Water Table
- Environmental Conditions
- Multiple Soil Types/Layers
- Previously Disturbed Soil
- Intersecting Trenches
- Superimposed Loads
- Narrow Right of Way
- Vibrations

Signs of Potential Trench Collapse

- Cracks
- Bulging Floors &/or Walls
- Water
- Undercut or Blown-out Walls

Worker Protective Systems

Lesson Objectives

The student shall demonstrate an understanding of:

- The various protective systems used to stabilize an excavation;
- When these protective systems must be used and which types are the most appropriate for rescue services

Underlying Reasons for Non-Protection of Trenches

- Time
- Money
- Training

OSHA requires that an excavation be protected from cave-ins by an adequate protective system. The two exceptions to this rule is when the excavation is entirely in stable rock or when it is less than 5 feet in depth and the soil provides no indication of potential cave-in

Protective systems can be provided in one (or more) of 4 ways: sloping, benching, shielding or shoring. Rescue services, as a general rule, primarily use shoring systems but it is important for the rescuer to understand the various methods that they may encounter

One of the reasons why trenches are not protected is because time does not allow for it. Additionally, it takes money to allow for the added time to install systems as well as to train the worker properly

Sloping

Sloping requires a large open area so the sides of the trench can be sloped. This process takes more time and TIME = MONEY

The slope also referred to as "Maximum Allowable Slope". The OSHA maximum allowable slope (less than 20 feet) for soil types is:

Type A - ¾:1 (53 degrees)
Type B – 1:1 (45 degrees)
Type C – 1 ½:1 (34 degrees)

In stable rock – vertical is considered Type D soil. Because of its stability, we do not normally deal with this type. The OSHA maximum allowable slope (more than 20 feet) must be engineered

Benching

This process takes longer than sloping and requires a large open area to dig. Additional information on sloping and benching can be found in OSHA 1926 Subpart P Appendix B

Shielding

- Manufactured protective system
- Engineered system drawn from tabulated data
- Made of steel, aluminum or fiberglass
- Fixed shields are of one of the most common type of trench boxes / shields that you will see
- Lightweight, expanding boxes/shields are also available

Heavy equipment is the normal way most trench boxes are moved. Vibration and weak soil need to be considered when operating heavy equipment around a trench. Trench shields are put together in sections as the trench is expanded.

Care needs to be exercised when using trench boxes in conjunction with dewatering pumps. This will be dealt with in more detail in "Trench Incident Safety". Trench boxes can and are moved horizontally with workers inside. This should never, however, be done when moving the box vertically.

Shoring

Shoring is used for the temporary support of a trench for work or rescue. They may be site made or of commercial manufacture. Additional information on shoring can be found in OSHA 1926 Subpart P Appendix C - E (Appendix at the rear of this student manual).

Sheeting (panels) may be of plywood, dimensional lumber or aluminum. When working around the trench, ground pads should be used and consist of:

- 2" x 12" planks
- 3/4" plywood (4' x 8')
- Overlap all planks and plywood by 6"
- Trip hazards can be nailed and covered with dirt

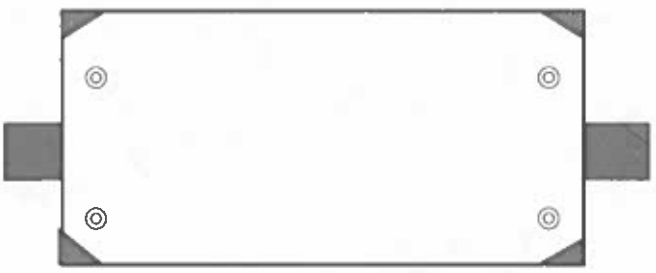


Diagram of a Panel Assembly

2 - 4'x8'x3/4" plywood screwed & glued together (1 1/4" min.) or
0.75 thick 14 ply Arctic White Birch (Finland form)

Unit 2: Operations at Trench Rescue Incidents

Trench Incident Safety

Lesson Objectives

- **Demonstrate an understanding of:**
  - The basic requirements required by regulation regarding shoring and methods of egress,
  - The general hazards encountered around trenches and trench incidents ,
  - The potential role utilities play in trench rescue and resources available to deal with utility issues.

Trench Requirements

- **> 4 ft** you must ladder
- **> 5 ft** you must shore
- **4** ft or more in depth you must have a stairway, ladder, or ramp every 25' of lateral travel,
- Ladder must be secured & 3' above the lip of the trench.
- Protective systems for use in excavations more than 20 feet in depth must be designed by a registered professional engineer in accordance with 1626.652(b) and (c).

Indicators of Trench Collapse

- Soil composition
- Passage of time
- Unprotected trench (lack of protection systems)
- Surface encumbrances
- Surcharge or superimposed loads
- Standing water or water seeping into trench (saturated)
- Intersecting trenches
- Previously disturbed soil
- Vibrations (vehicles, nearby roads, airports, etc.)
- Exterior cracking of trench walls or collapse zone (fissures/stress cracks)

Trench Hazards

- Physical Hazards
  - Spoil Pile
  - Heavy Equipment
  - Construction Materials
- Hazardous Atmosphere
- Falling Objects
- Utilities

Utility Overview

- Water
- Sewer
- Electrical
- Gas
- Communications

American Public Works Association

APWA Uniform Color Codes

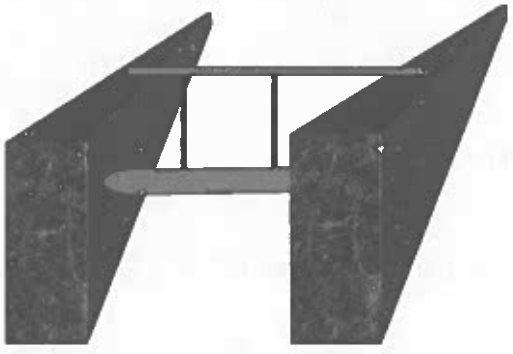
For Marking Underground Utility Lines

White	Proposed Excavation
Pink	Temporary Survey Markings
	Electric Power Lines, Cables, Conduit & Lighting Cables
Yellow	Gas, Oil, Steam, Petroleum & Gaseous Material
Orange	Communications, Alarm, Signal Lines, Cables or Conduit
Blue	Potable Water
	Reclaimed Water, Irrigation & Slurry Lines, Radioactive Material
Green	Sewers & Drain Lines

The service previously known as 811 is now UDIGNY.

Open Excavations

- Underground installations must be protected, supported, or removed.



Trench Rescue Equipment

Lesson Objective

- Demonstrate an understanding of:
  - The various equipment used in Trench Rescue
  - The uses of the various types of equipment

Trench Rescue PPE

- Gear
- Helmet
- Hand Protection
- Foot Protection
- Hearing Protection
- Eye Protection
- Respiratory Protection

Equipment Checklist

- Air Monitoring
- Ventilation
- Ladders
- Lighting
- Hazard Control
- Hand & Power Tools

Hand Tools

- Hammers & Nails (Duplex)
- Pry bars
- Shovels
- Saws
- Hand operated jacks
- Cribbing
- Tape Measure
- Strut Locking tools
- Hooks & Pike Poles
- Utility Wrenches
- Lock-out/tag-out equipment
- Specialized wrenches for water & gas shutoff

Power Tools

- Chainsaws and Other Saws
- Pneumatic or hydraulic jacks
- Pneumatic struts
- Air bags
- Pneumatic or hydraulic chisels or jackhammers
- Rescue Vac System
- Air Knife

Equipment Checklist

- Patient Packaging
- Heavy Equipment
  - Vac Truck
  - Rescue Vac System
- Lip Protection
- De-Watering
- Rehab
- Shoring

Lip Protection

- Ground Pads
  - Plywood (4'x8'x3/4")
  - Planks (2" x 10" or 12")
  - Placement of ground pads
  - Overlap and nail together
  - Beware of trip hazards
- Other Methods of Lip Protection
  - Girders
  - Platforms
  - Bases

Shoring Components

- Panels
- Crossmembers
  - Wood
  - Screw Jacks
  - Struts
    - Pneumatic
    - Hydraulic
  - Walers

Paratech® Struts: Types

- Lockstroke Thread (Gray)
- Acme Thred (Gray)
- LongShore Strut (Gold)

Paratech® Rescue Support Struts

- Lockstroke
  - Moveable grooved shaft
- Acme
  - Moveable acme threaded shaft

Lockstroke Thread

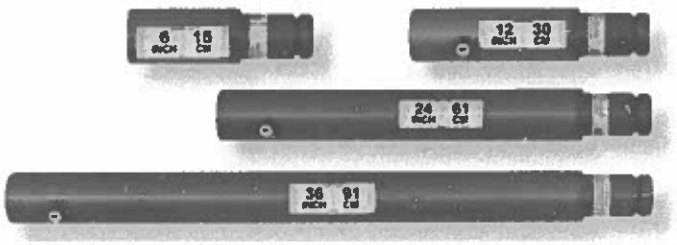
- Locks automatically increments of 0.400"
  - 19 - 25" / 6" stroke
  - 25 - 36" / 12" stroke
  - 36 - 57" / 24" stroke
  - 55 - 89" / 36" stroke

Acme Thread

- Permits "soft" placement with sensitive positioning
  - 12 - 15"
  - 19 - 25"
  - 25 - 36"
  - 37 - 58"
  - 56 – 88"

Paratech Strut Extensions

- 6 Inch
- 12 Inch
- 24 Inch
- 36 Inch



Paratech Bases

- 6 in. Rigid Base
- 6 in. Hinged Base
- 6 in. Swivel Base
- 6 in. Hinged Base with Anchor Ring
- Channel Base

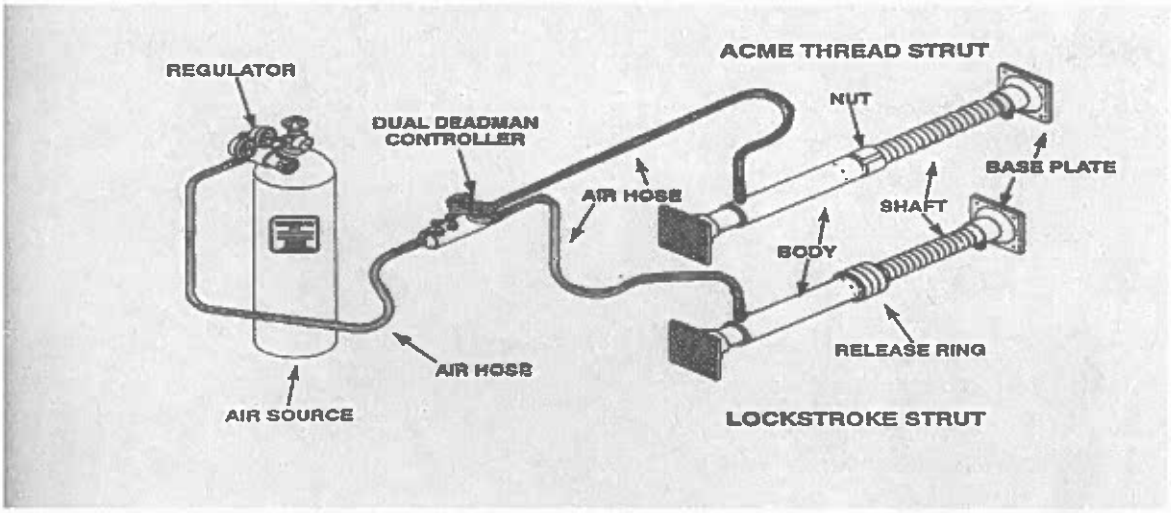
Longshore Struts

- Longshore Strut (Gold)
  - 203 (26 – 36")
  - 304 (36 – 50")
  - 406 (48 – 73")
  - 610 (72 – 116"
  - 812 (92 – 142")
  - 1016 (114 – 198")

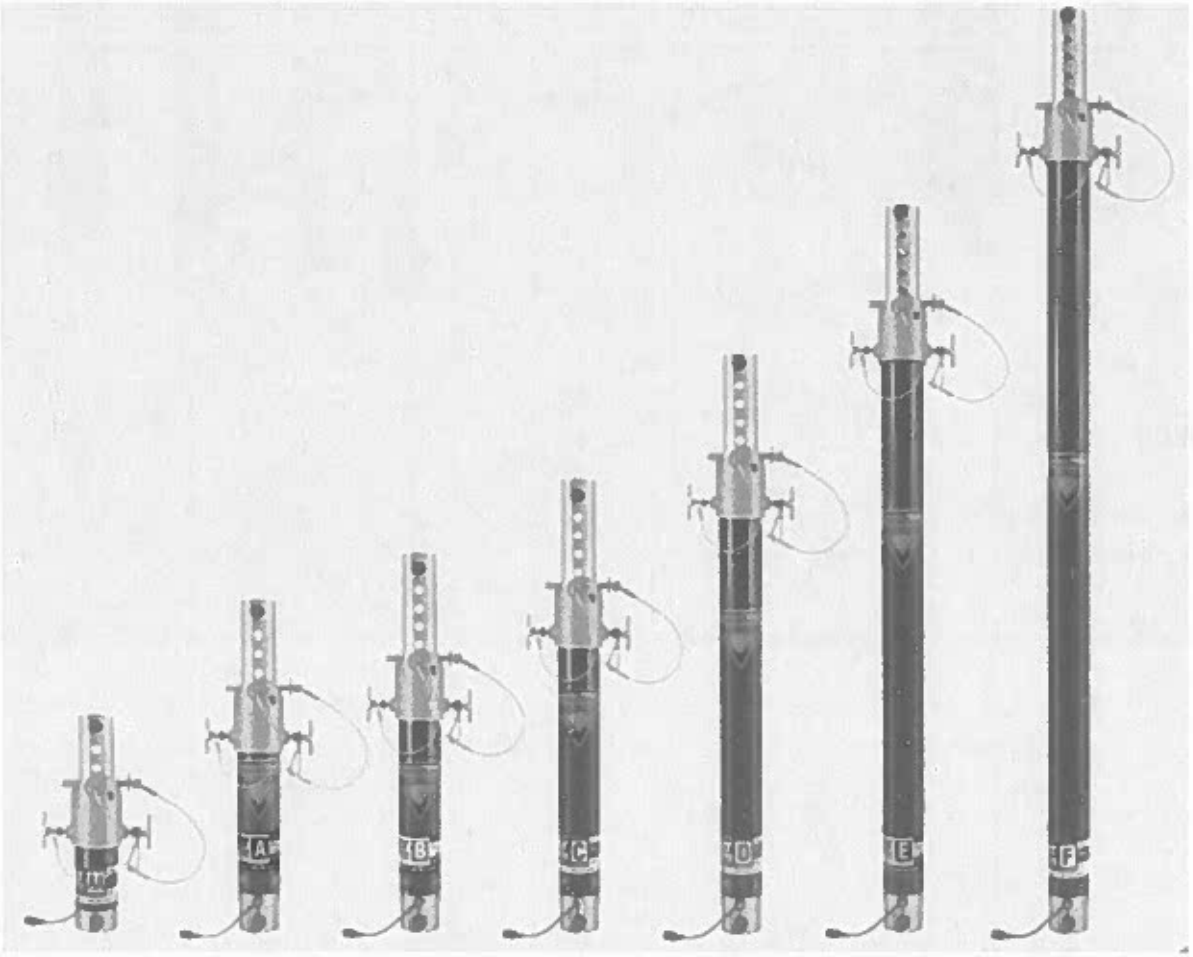
Longshore Strut Extensions

- 1 Foot
- 2 Feet
- 4 Feet
- 6 Feet

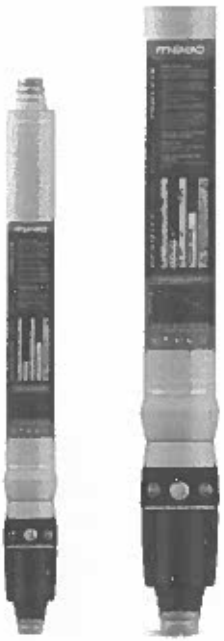
Paratech Longshore Waler

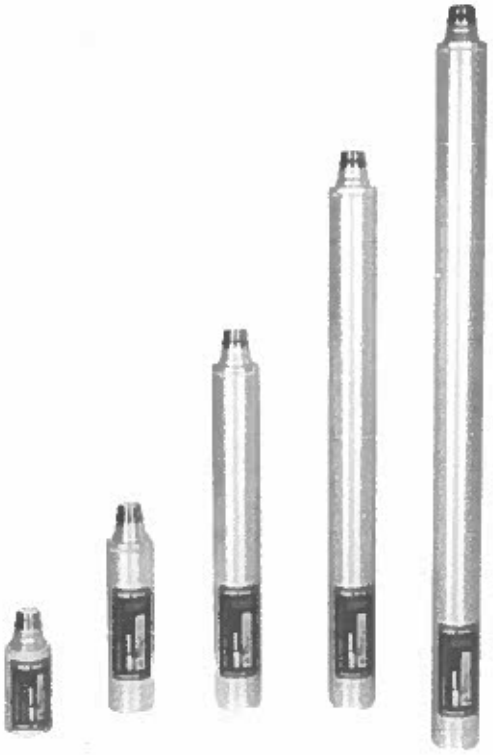


Airshore Struts



ResQtec Struts





Backfill

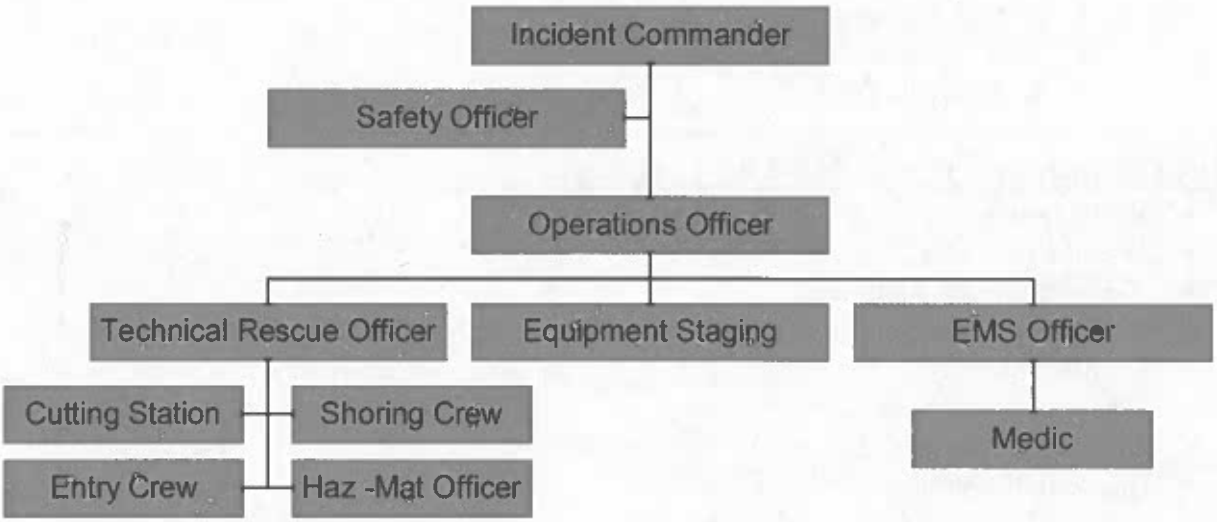
- Airbags
- Back Shores
- Buttressing
- Soil
- Wood

Trench Rescue Operations

Lesson Objectives

- Demonstrate an understanding of:
  - The incident management system (IMS) and its use in trench rescue operations.
  - Hazard assessment including preplanning, risk/benefit analysis and rescue vs. recovery.
  - Size-up and emergency action planning and its use in trench rescue operations.
  - The components and sequence of operations at trench rescue incidents.

Sample Trench Rescue Incident Management System



Hazard and Risk Assessment Components

- **Preplan Information**
  - Site Survey
    - Soil type and conditions
    - Accessibility
  - Analysis of Past Incidents
    - Where, How, Probability of Survivability
  - Assessment of available resources
    - In House
    - Mutual Aid

Rescue vs. Recovery

- Know Victim is Alive
  - Can see or hear victim
  - Report from reliable source
- High Probability Victim is Alive
  - No known toxic conditions
  - Air space available
- Low Probability Victim is Alive

  - Toxic or hazardous atmosphere
  - Minimal air space available
- Certain Victim is Dead
  - High concentration of hazardous gases
  - Trapped with no air voids
  - Body decapitated or dismembered

Hazard and Risk Assessment Components

- Determination of Hazards
  - Can dictate if incident is Rescue or Recovery
  - Size Up
  - Potential for secondary collapse
- Risk vs. Benefit
  - Danger to rescuers
  - Number of victims
  - Victims salvageable
  - Capabilities of the department
  - Anything overlooked

Operations at Trench Rescue Incidents

- **Preparation**
- **Initial Response**
- **Assessment and Planning**
- **Develop an Incident (Emergency) Action Plan**
- **Gaining Access**
- **Disentanglement**
- **Victim Packaging & Removal**
- **Incident Termination**

Preparation

- Training
- Equipment
- Personnel

Initial Response

- Pre-Arrival Size Up
  - Dispatcher can add valuable information while enroute.
    - Number of patients (victims)
    - Are they fully or partially buried
    - Any known hazards in the trench (water, electric, gas, etc.)
    - Name of the contractor in charge of the scene.
    - Weather conditions, present and future.
    - Location.

- **First to Arrive**
  - Keep Apparatus 100'away
  - Establish a Command Post
  - Establish Victim Contact
  - Utilities
  - Set Up Zones

Assessment & Planning

- Scene Size – Up
- Who is in Charge?
- What Happened?
- How many Victims?
- *Victim Location:*
  - Where are they Buried?
  - Are there clues for location?
- What type of soil?
- Potential for non-entry or victim self-rescue
- Hazards
- Type of Injuries
- Rescue Vs Recovery
- Cave-in or Entrapment

Develop an Incident (Emergency) Action Plan (IAP/EAP)

- **Tactical Worksheet**

Initial Actions Checklists

Scene Management

Incident Command

- Establish a clearly identifiable Command Post
- Provide a radio report that includes:
  - Situation report
  - Command Post and Staging Area locations
  - Request for resources (activate the system)
- Establish Staging Area
  - Forward Staging for First Responders and selected resources (beyond 100' from the trench)
  - Primary Staging (> 300' from the trench)
- Assign Initial Action Duties
  - Site Control
  - Hazard Management
  - Nonentry Rescue

Size-Up (Conduct Assessments-Evaluate the Situation)

- Assessments- Gather information
  - Hazard Identification
    - Collapse
    - Utilities
    - Traffic
    - Atmospheric
    - Hazardous Materials
    - Physical Hazards
    - Biological
  - Victim Information
    - Mechanism of injury or entrapment (cave-in or noncave-in)
    - Number of victims
    - Condition of patient
  - Site Detail
    - Trench size (depth, width, and length)
    - Access to site
  - On-Site Resources
    - On-site equipment/materials that can be used for rescue
    - On-site construction personnel that can be used for rescue
- Evaluation- Determine the scope of the incident based on assessments
  - Rescue or Recovery
  - Level of Risk- Based on hazards and available mitigation efforts
  - Awareness Level- Nonentry rescue or Initial Actions for higher level response
  - Operations Level- Straight trench, < 8' deep, no supplemental shoring, no severe conditions
  - Technician Level- Straight or intersecting trench, up to 20' deep, supplemental shoring, severe
  - Specialist Level- Other trenches and excavations, extreme conditions

Summon Resources (Based on assessments and evaluation)

- Rescue or Recovery
- Awareness Level (First alarm and on-site resource)
- Operations Level (Tier 1 resources)
- Technician Level (Tier 1 and selected Tier 2 resources)
- Specialist Level (Tier 1 and selected Tier 2 resources)

Site Control

- Create a hot, warm, and cold zone
- Reroute all nonessential traffic at least 300 feet around the scene
- Remove all nonessential civilian personnel to at least 50 feet from the incident
- Shut down all heavy equipment operating within 300 feet of the collapse
- Prepare the site for incoming resources

Hazard Management (Defensive Actions)

- Assure proper PPE for all first responders
- Mitigate or isolate all hazards in the area, i.e., utilities, electric, gas, water, etc.
- Stabilize exposed utilities, pipes, or any other obstruction in the trench
- De-water the trench if necessary
- Monitor the atmosphere and ventilate the trench if necessary
- Place ingress and egress ladders in trench. There should be at least 2 ladders placed in the trench no more than 12 feet apart
- Install appropriate Lip Protection

Nonentry Rescue

- Determine if a nonentry rescue is possible
- If the possibility exists, assign an extrication team to implement the nonentry rescue
- Install lip protection in the area where rescuers will need to work on the trench lip
- For partially buried victims, tie a rope to a shovel and lower it to the victim
- Place a ladder near the victim and support the ladder (tied off or held) as the victim climbs out
- If the victim is unable to climb a ladder, set up a rope rescue system with an overhead anchor point (high directional), lower a simple harness (like a LSP Cinch Ring) attached to the rope, instruct the victim on how to don the harness, and raise the victim out of the trench
- Remove the victim from the trench

- **Rescue Zones**
  - Hot Zone
    - Rescue Personnel only
  - Warm Zone
    - Command Post
    - Equipment/ Supplies
  - Cold Zone
    - News Media
    - Support
    - Rehab

- **Incident Action Plan Components**
  - Establishment of "Rescue" Zone
  - Risk/Benefit Analysis
  - Safety
  - Strategy & Tactics

  - Tasks
  - RIT
  - Hazard Mitigation
  - Resources
  - Protective Systems

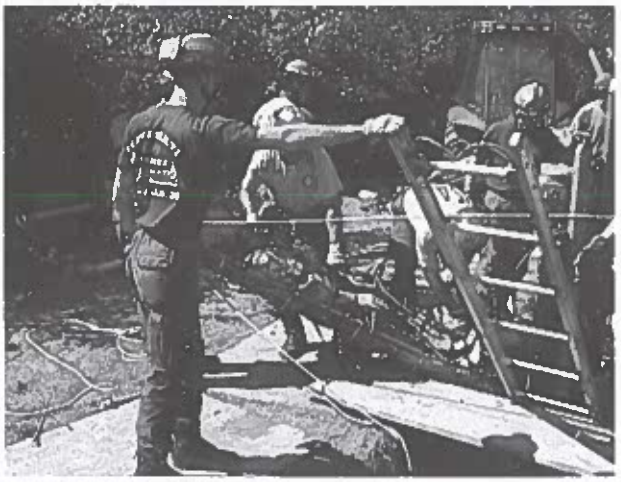
Gaining Access

- Lip Protection
  - Overlap & Nail
  - Beware of Trip Hazards
- Lip Bridges
  - Girders
  - Platforms
  - Bases
- Ladders
- Panel placement
- Voids behind the panels.

Disentanglement

- Hand Tools
  - Pry Bars
  - Power Chisels
  - Jacks
  - Hydraulic or Pneumatic
- Heavy Machinery
  - Crane
  - Bucket Loader
  - Backhoe
  - HydroVac (Vactor) Trucks
- May require additional digging to release victim
- May or may not be able to move or cut the item the victim is entangled in
- Use small trenching shovels and 5-gallon buckets

Victim Packaging & Removal



Incident Termination

- Once the victims have been rescued or recovered the incident is not over.
- The Trench must be inspected by the investigative agencies.
- Once a decision has been made to release the trench, shoring materials could be removed.
- The removal of shoring materials is labor intensive and additional personnel may be required to assist.
- Clean and replace equipment as necessary.
- Completion of documentation and reports
- Within a reasonable amount of time, a Critique of the entire incident shall be held that may include any of the agencies that responded to the call.
- Upon completion of the incident, efforts should be undertaken to provide a Critical Incident Stress Debriefing to any rescuers that took part in the rescue.

Awareness Level Actions

- Identify the need for, and call for, trench and excavation rescue resources.
- Conduct a size-up of a collapsed trench.
- Evaluate general hazards and existing and potential conditions.
- Identify the need for, and call for, trench and excavation rescue resources.
- Conduct a size-up of a collapsed trench.
- Evaluate general hazards and existing and potential conditions.
- Implement a trench emergency action plan,
- Implement support operations,
- Initiate the Incident Management System.
- ***Stay Safe!***

Student Exercises

Lesson Objectives

- Demonstrate an understanding of the various hazards and considerations contained in the presented examples.
- Identify scene hazards, perform a size-up, and provide a report to an incoming Trench Rescue Team.

Operations at Trench Rescue Incidents: Student Exercise 2

A. Students shall,

1. Elect a team spokesperson and scribe/recorder.
2. Perform and document an initial size-up,
3. Document what your initial size-up report to dispatch will be,
4. List 10 considerations you will take as a first-in, Awareness-level company,
5. Document what your size-up or status report to the incoming Technical Rescue Team (TRT) will be. Assume that you are now 10 minutes into the incident.

- Utility markings are provided.
- 30 minutes maximum will be provided for the completion of the above tasks.
- Each group will have 5 minutes for its spokesman to present the elements of the assignment (as directed by the instructor.)

Available Responding Resources – Anytown FD (AFD)

You are the officer of the first-in unit (E1) at a report of a "construction accident". The staffing of the unit is consistent with your normal response. All members on the unit are trained to the Trench Rescue – Awareness Level of NFPA 1006 and the AFD is able to operate at the Trench Rescue – Awareness Level of NFPA 2500.

Incident Utility Markings

Incident 1

Employees are working on a major drainage project in a trench 4 feet wide and approximately 9 feet deep. The backhoe operator calls 911 after she noticed a large chunk of dirt fall from the side wall behind the workers in the trench.

Your unit arrives to find a significant sidewall sheer collapse in an area of the trench that was not made safe through sloping, benching, shoring, or shielding. 2 workers are visible in the trench. Worker 1 is wearing an orange shirt and yellow hardhat who is buried to his neck in dirt and resting against the intact wall. The second worker (Worker 2); wearing grey pants, a light green t-shirt, and a white helmet, is not entrapped but is in the trench trying to dig out Worker 1 by hand.

There are no exit ladders.

Incident 2

Employees were laying sewer pipe in a trench 8 feet deep and 3 feet wide.

During the operation, a wedge-failure cave-in occurred completely covering Worker 1 (wearing black & red flannel shirt, bright green vest, and yellow helmet). Worker 1's helmet is visible at the top surface of the collapsed dirt. A supervisor outside of the trench called 911 to report the incident.

When your unit arrives, workers are directing the backhoe to dig in the area of the collapse.

The trench was not protected from vibration caused by heavy vehicular traffic on the road nearby nor was made safe through sloping, benching, shoring, or shielding. There are no exit ladders.

1. **Initial Size-up Report to Dispatch:**

2. **10 Considerations:**
   -
   -
   -
   -
   -
   -
   -
   -
   -
   -

3. **Situation/Status Report to Incoming Technical Rescue Team (Trench Rescue Technicians):**

APPENDIX

OSHA Standard Overview

In the back of this manual all the standards are included.

Standard Number 1926.650 Scope, Application, and Definitions Applicable to this subpart:

Defines some of the following terms:

Benching, Cave-in, Competent person, Excavation, Failure, Hazardous Atmosphere, Protective System, Shield, Shoring, Sloping, Stable Rock, Trench, Wales

The above is a small sample of terms that are defined in this standard.

Standard Number 1926. 651 Specific Excavation Requirements:

Covers the following topics:

(a) Surface Encumbrances – shall be removed or supported as necessary

(b) Underground Installation –
- Estimated location of utility installations
- Utility companies/owners notified
- Approach of estimated underground installations
- While excavation is open

(c) Access and Egress
- Structural ramps
- Means of egress from trench
-

(d) Exposure to Vehicle Traffic

(e) Exposure to Falling Loads

(f) Warning System for Mobile Equipment

(g) Hazardous Atmosphere
- Testing and Controls
- Emergency Rescue equipment

(h) Protection from Hazards Associated with Water Accumulation

(i) Stability of Adjacent Structures
- Stability of Adjoining Buildings, Walls, or other Structures Endangered
- Excavation below the Level of the base or Footing of any Foundation
- Sidewalks, Pavements and Appurtenant Structures

(j) Protection of Employees from Loose Rock or Soil
- Adequate Protection Shall be provided to protect employees from Loose Rock or soil
- Employees shall be protected from Excavated or Other materials or equipment

(k) Inspections
- Daily Inspections of Excavations
- Competent Person Finds Evidence of a Situation that could Result in a Possible cave-in

(l) Fall Protection
- Walkways shall be Provided
- Adequate Barrier Physical protection

Standard Number 1926.652 Requirements for Protective Systems:

(a) Protection of Employees in Excavation
- Each Employee in an Excavation Shall be Protected from Cave-ins
- Protective Systems Shall Have the Capacity to Resist without Failure

(b) Design and Sloping and Benching Systems
(1) Option (1) Allowable Configurations and Slopes
(2) Option (2) Determination of Slopes and Configurations Using Appendices A & B
(3) Option (3) Designs using other Tabulated Data
(4) Option (4) Design by a Registered Professional Engineer

(c) Design of Support Systems, Shield Systems, and other protective Systems
(1) Option (1) Design Using Appendices A,C, & D
(2) Option (2) Designs Using Manufacturer's Tabulated Data
(3) Option (3) Designs Using Other Tabulated data
(4) Option (4) Design by a Registered Professional Engineer

(d) Materials and Equipment
- Materials and equipment Used for Protective Systems
- Manufactured Materials and equipment Used for protective Systems
- When Material or Equipment That is Used for protective Systems is Damaged

(e) Installation and Removal of Support
- General
- Additional Requirements for Support Systems for Trench Excavations

(f) Sloping and Benching Systems

(g) Shield Systems
- General
- Additional Requirements for Shield Systems Used in Trench Excavations

Standard Number 1926, Subpart P, App. A Soil Classification:

(a) Scope and Applications
(b) Definitions
(c) Requirements
- Classification of Soil and Rock Deposits
- Basis of Classification
- Visual and Manual Analyses
- Layered Systems
- Reclassifications

(d) Acceptable Visual and manual Tests
- Visual Tests
  - Observe samples of soil excavated
  - Observe soil as it is excavated
  - Observe the sides of the trench
  - Observe the area adjacent to the excavation
  - Observe the opened side of the trench to identify layered systems
  - Observe area adjacent for evidence of water, water seeping from sides of trench
  - Observe for sources of vibrations
- Manual Tests
  - Plasticity
  - Dry Strength
  - Thumb Penetration
  - Other Strength tests
  - Drying Test

Standard Number 1926, Subpart P, App. B Sloping and Benching:

(a) Scope and Application

(b) Definitions

(c) Requirements

- Soil Classification
- Maximum Allowable Slope
- Actual Slope
- Configuration

Standard Number 1926, Subpart P, App. c Timber Shoring for Trenches:

(a) Scope

(b) Soil Classifications

(c) Presentation of Information

(d) Basis and Limitations of Timber Members

- Dimensions of Timber Members
- Limitations of Application

(e) Use of tables

(f) Examples to Illustrate the Use of Tables C-1.1 through C-1.3

(g) Notes for Tables

Standard Number 1926 Subpart P, App. D Aluminum Hydraulic Shoring for Trenches:

(a) Scope
(b) Soil Classifications
(c) Presentation of Information
(d) Basis and Limitations of the Data
(e) Use of Tables D-1.1, D-1.2,D-1.3 and D-1.4
(f) Example to Illustrate the Use of the Tables
(g) Footnotes and General Notes for Tables D-1.1, D-1.2, D-1.3, and D-1.4

- For applications other than those listed in the tables
- 2 inch diameter cylinders
- Hydraulic cylinders capacities
- All spacing indicated is measured center to center
- Vertical shoring rails shall have a minimum section Modulus of 0.,40 inch
- When vertical shores are used
- Plywood shall be 1.25 inch thick softwood or 0.75 thick 14 ply, arctic white birch (Finland form)
- Timber Specifications
- Wales are calculated for simple span conditions
- Basis and limitations of the data

Glossary:

Accepted Engineering practices- Those requirements which are compatible with standards of practice required by a registered professional engineer.

Angle of Repose – The greatest angle above the horizontal plane at which loose material (soil) will lie without sliding.

Approach Assessment – The period of time from the moment when the incident site first becomes visible, to the time when the initial size-up is completed.

Atmospheric monitor – A device used to analyze the atmosphere, for Oxygen, LEL, CO and toxic gases.

Backfill – Refilling if a trench or the material used to refill a trench.

Backhoe – Excavating machine equipped with an articulating boom and a bucket. Can have either crawler tracks or tires.

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 bell shape.

Benching – Method of protecting personnel by excavating sides of a trench to form one or a series of horizontal levels or steps.

Bulldozer – Crawler equipped machine with a large horizontal blade designed for land clearing and earth moving.

Cathead – A shore running between wailers, it also has a 6" long plank nailed to the top of it.

Cave-in – Collapse of unsupported trench walls in sufficient quantity to en-trap, bury, or other wise injure and immobilize a person.

Cohesive - Holding together firmly.

Cohesive Soil – A type of soil with a high clay content that holds together firmly.

Command Post – Location where the IC (incident commander) can meet with other emergency services and community resources. Should also have the necessary communications needed for this emergency.

Compact Soil – Soil that is hard and stable in appearance, can be indented by the thumb, but penetrated with difficulty.

Competent Person- One who is capable of identifying existing and predictable hazards in the surroundings, or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them.

Cross Bracing – Horizontal members of a shoring system installed perpendicular to the sides of an excavation, the ends which bear against either shores, uprights or wailers.

Cut Sheet – A job foreman's daily worksheet shows depths and grades of pipes and work progress.

Danger Zone – Area surrounding the accident site, the size of this zone depends on the severity of the Emergency.

Dewatering – The process of removing water from the trench

Disturbed Soil – Ground that has been previously excavated.

Double Headed Nail – Nail that has two heads, designed not to be fully driven into the lumber.

Engulfment – The surrounding and effective capture of a person that can exert enough force on the body to cause death by strangulation, constriction, or crushing.

Excavation – An opening in the ground that results from digging effort.

Faces or Sides- The vertical or inclined earth surfaces formed as a result of excavation work.

Fissure – A narrow opening in the ground; a crack of some length and considerable depth.

Front-end Loader – Tire or crawler equipped machine with a movable bucket at one end.

Freestanding Time – The period of time during which the walls of a trench remain unsupported.

Frost Line – The depth to which frost penetrates the soil.

Grade Pole – A wood or fiberglass pole that is either cut or has markings, Used to set pipes on a grade.

Ground Cover – A tarp that is used to place equipment on it.

Ground Pads – Sheets of ¾" plywood or sections of lumber placed adjacent to the trench distributing the weight of rescue personnel.

Hauling Line – A length of rope used to hoist or lower equipment.

Hazard Analysis – The process of identifying situations or conditions that have the potential to cause injury to people, damage to property, or damage to the environment.

Hazardous Atmosphere- An atmosphere which by reason of being explosive, flammable, poisonous, corrosive, oxidizing, irritating, oxygen deficient, toxic, or otherwise harmful, may cause death, illness, or injury.

Imminent Hazard – An act or condition that is judged to present a danger to persons or property and is so immediate and severe that it requires immediate corrective or preventive action.

Incident Management System - the management system or command structure used during emergency operations to identify clearly who is in command of the incident and what roles and responsibilities are assigned to various members.

Incident Response Plan – Written procedures, including standard operating guidelines, for managing an emergency response and operation.

Landfill – A collection point for trash and garbage. .

Loam – A combination of sand and clay.

Mechanical Strut – An adjustable strut.

Mitigation – Activities taken, either prior to or following an incident, to eliminate or reduce the degree of risk to life and property from hazards.
OSHA – The Occupational Safety and Health Administration, a division of the U.S. Department of Labor.

Panels – Multi-layered sheets of plywood used to support then trench walls (usually 4'x8')

Pipe String - Lengths of pipe laid parallel to the trench in preparation for lowering into the trench and being joined together.

Parallel trench – A previously excavated and backfilled trench close to and paralleling the trench being dug.

Pneumatic Shoring – Shores or jacks with movable parts that are activated by the action of compressed air.

Primary Assessment – The initial determination of what has occurred in an accident situation.

Profile – A job blueprint that shows sectional elevation.

Rapid Intervention Team – At least two members available for rescue of a member or a team if the need arises. They shall be fully equipped with the necessary equipment needed.

Recovery Mode – Level of operational urgency where there is no chance of rescuing a victim alive.

Rescue Mode – Level of operational urgency where there is a chance that a victim will be rescued alive.

Right of Way – A strip of land temporarily granted to the contractor so that he can perform his work.

Risk / Benefit Analysis – A decision made by a responder based on a hazard and situation assessment that weighs the risks likely to be taken against the benefits to be gained for taking those risks. A live victim suggests a rescue and its high level of urgency. A deceased victim, however, is a body recovery that suggests a far less urgent response.

Running Soil – Loose free flowing soil, fine sand is an example.

Safing – To make a portion of a trench safe, by using panels and shoring or by slopping.

Saturated Soil – Contains a high quantity of water, which fills the voids in that soil.

Scab – A short piece of wood nailed to an upright to prevent shifting of a shore.

Screw Jack –A trench shore or jack with interchangeable threaded parts. The threaded parts allow for adjustments to the shore.

Secondary Assessment – Determination to see whether the on scene capabilities are sufficient to handle the emergency situation.

Secondary Cave-in – Collapse of another portion of the trench wall after initial incident.

Shall – Indicates a mandatory requirement.

Should – Indicates a recommendation or that which is advised but not required.

Shear Wall Collapse – A type of collapse where the ground cracks parallel to the trench and that section topples into the trench.

Sheeting – Generally, wood planks and wood panels.
Shorform – A laminated panel used for sheeting trench walls.

Shoring – A term used for lengths of timbers, screw jacks, pneumatic jacks.

Size-up – A mental process of evaluating the influencing factors at an incident prior to committing resources to a course of action.

Skip-shoring – Supporting trench walls with uprights that are spaced at specific intervals.

Slopping – Method of protecting employees from cave-ins by excavating the sides of a trench to form an angled wall, which will prevent the soil from sliding into the trench.

Slough-in Collapse – Collapse of a trench wall in such a fashion that an overhang remains, dangerous and difficult to shore.

Spoil Pile Slide – When the excavated material slides back into the trench.

Spot Bracing – See "skip shoring"

Staging Area – A gathering point for emergency services and support apparatus, equipment and personnel.

Standard Operating Guideline – An organizational directive that establishes a standard course of action or policy.

Standard Operating Procedure – An organizational directive that establishes a stand course of action

Strong back – See "Upright"

Story Pole – See "Grade pole"

Technical Rescue Incident – Complex rescue incidents requiring specially trained personnel and special equipment to complete the mission.

Tension Cracks – Cracks in the ground adjacent to the trench indicating that the ground has shifted and should be considered a warning sign.

Trench – A temporary excavation in which it is deeper then wider and no wider than 15 feet at the bottom.

Trench Box – Steel or aluminum structure that is placed in a trench to protect workman from a collapse of the side walls.

Trench Lip – The top edge of the trench.

Tripping Hazards - Debris, tools, ground pads, and anything that may cause a person to stumble at a construction site.

Uprights – Planks that are held in place against sections of panels or sheeting by the use of shores, adds strength to the shoring system by distributing the loads applied to the sheeting.

Virgin Soil – Ground that has never been excavated.

Whales – Braces that are placed horizontally against sheeting, transmitting the load from the sheeting to the shores also called whalers or stringers.

Well Point System – A series of pipes driven into the ground around the trench for the purpose of dewatering the area by the use of a pump.

Classifying Soil:

The soil type will influence the stability of a trench. OSHA requires a "Competent Person" to classify the soil prior to excavation. This allows the proper protective device to be chosen and used to protect the workers. Keeping this in mind the Technical Rescue Team should have a good understanding how soil is classified.

Soil Types as Classified by OSHA:

Type A	Most stable – includes heavy, strong, clay, hardpan soils (resists penetration).
Type B	Less Stable (medium stability), silt, sandy loam, medium clay, and unstable dry rock.
Type C	Least Stable, gravel, loamy sand, soft clay, submerged soil or dense, heavy unstable rock.

When soil is classified, several soil qualities are assessed in addition to the type. These would not be limited to grain size, saturation, cohesiveness and compressive strength. A simple way to review this is, if the grain of soil is larger then a piece of pencil lead, its considered gravel. If it were smaller, it would be sand.
There are four (4) different grain sizes:

- Gravel
- Sand
- Silt
- Clay

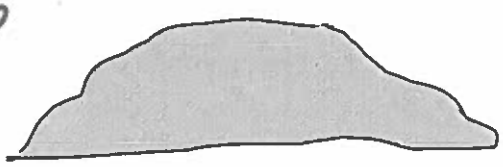
A general rule that the BIGGER the grain, the least stable the soil will be. You most proceed with caution!

What do we mean when we refer to *saturation*? Saturation refers to how much water is in the voids between the grains. When these voids fill with water the soil becomes saturated. As to when the voids fill with air, the soil is then considered Oven dry. Soil having a certain amount of moisture is considered stable. Having too much or too little water causes cave-ins.

Cohesion refers to how well the grains hold together. This well help you predict how well the trench walls will hold together.

A "Competent Person" will conduct both a visual and manual tests to help them make their determination of the soil classification. They would be looking for some of the following.

- Soil particle size & Type
- Does soil clump when its dug



- Cracks in the side walls
- Hazards surrounding the trench area: Buildings, roads, machinery
- Water

If you find water in trench weather is standing or moving the soil would be considered type C soil.

Some facts about soil you should consider:

- ✓ One cubic yard of dirt weighs about 2,990 lbs.
- ✓ One gallon of dirt weighs approximately 13 lbs.
- ✓ One cubic foot of dirt will fill 8 – 1 gal buckets
- ✓ One cubic yard of dirt would fill approximately 230 – 1 gal buckets
- ✓ 13 lbs. x 230 (1 gal buckets) = 2990lbs.

= 13 lbs. x 5gal bucket = 65lbs

Only fill the 5-gallon bucket ½ way. You have to be able to lift these buckets safely

Manual Soil Testing

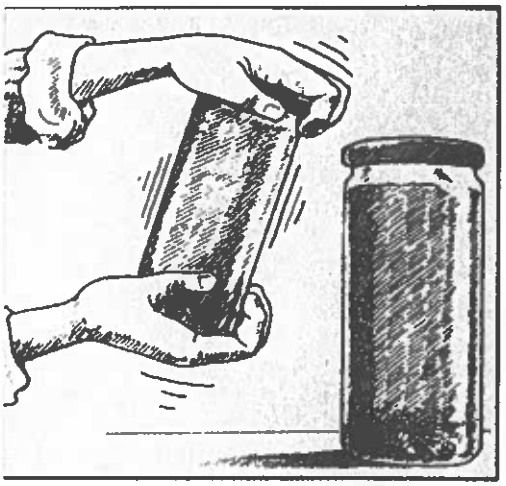
A sample of the soil is taken from the soil pile. Then it is test as soon as possible to preserve its natural moisture content. A "Competent Person" should do this manual test.

There are four (4) types of manual test that can be preformed.

1) Sedimentation Test
2) Wet Shaking test
3) Thread Test
4) Ribbon Test

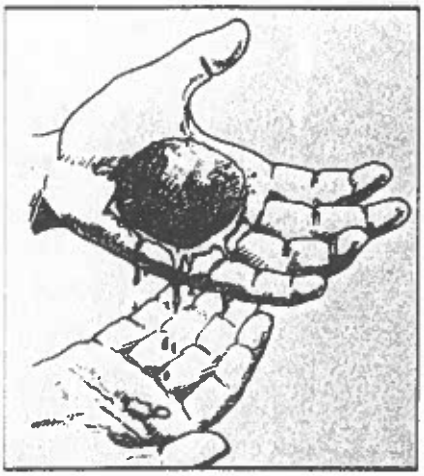
Sedimentation Test:

This test determines how much silt and clay are in sandy soil. Saturated sandy soil is put in to a straight-sided Jar that has approximately 5 inches of water in it. Thoroughly mix the sample in the jar by shaking the glass jar. Then allow the contents of the jar to settle. The percentage of sand is visible. Using this information the soil is classified: for example, a sample with 80 % sand will be classified Type C soil.



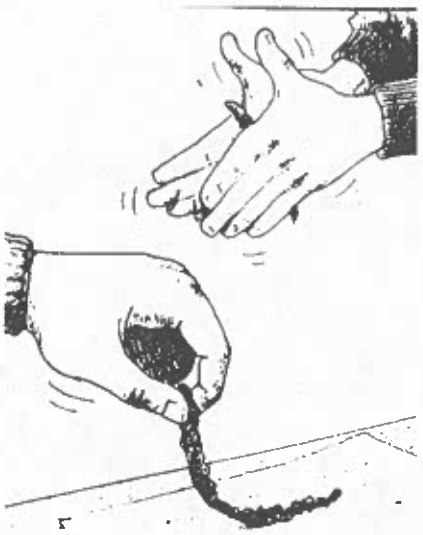
Wet Shaking Test:

This is another way to determine the amount of sand versus clay and silt in a soil sample. Take a sample of soil from the spoil pile; shake a saturated sample to gauge soil permeability. Shaken clay resists water movement through it. Water flows freely through sand and less freely through silt.



Thread Test:

This type of test will determine the cohesion of soil. Take a sample of soil from the spoil pile. Roll the sample between the palms of your hands to a diameter of 1/8" and several inches long. Place the rolled piece on a flat surface. Then pick up the piece you just laid down. If a sample holds together for two (2) inches, it's considered cohesive.



Ribbon Test:

This test also determines cohesion and is used as a backup for the Tread Test. Take a sample of soil from the spoil pile, and then roll it out using the palms of your hands to ¾" in diameter, and several inches long. Then squeeze the sample between your thumb and forefinger into a flat unbroken ribbon 1/8" to ¼" thick, at the same time let the sample fall freely over the fingers. If the ribbon does not break off before several inches are squeezed out, the soil is considered cohesive.