TRENCH CLASS
AWARENESS/OPERATIONS
& TECHNICIAN

“ABOVE ALL DO NO HARM”
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9-1.1 Organizations operating at rope rescue incidents shall meet all the requirements specified in Chapter 2 of this standard (1670).

9-1.2 The AHJ shall evaluate the effects of severe weather, extremely hazardous trench or excavation situations, and other difficult conditions to determine whether their present training program has prepared the organization to operate safely.

9-2 AWARENESS

9-2.1 Organizations operating at the awareness level shall meet all requirements specified in Section 5-2 within this standard, the requirements in Chapter 2 of NFPA 472, Standard for Professional Competence of Responders to Hazardous Materials Incidents, and the requirements of competent person as defined in Section 1-3 of this standard.

9-2.2 Awareness-level functions:

a. Size-up of existing and potential conditions

b. Identification of the resources necessary to conduct safe and effective trench and excavation emergency operations

c. Development and implementation of procedures for carrying out the emergency response system for trench and excavation emergency incident

d. Development and implementation of procedures for carrying out site control and scene management

e. Recognition of general hazards associated with trench and excavation emergency incidents and the procedures necessary to mitigate these hazards within the general rescue area.

f. Recognition of typical trench and excavation collapse patterns, the reasons trenches and excavations collapse, and the potential for secondary collapse

g. Development and implementation of procedures for making a rapid, non-entry extrication of non injuries or minimally injured victim(s)
h. Recognition of the unique hazards associated with the weight of soil and its associated entrapping characteristics

9-3 OPERATIONS

9-3.1 Organizations operating at the operations level shall meet all requirements specified in Section 9-2. In addition, members shall be capable of hazard recognition, equipment use, and techniques necessary to operate safely and effectively at trench and excavation emergencies, including the collapse or failure of individual, nonintersecting trenches with an initial depth of 8 ft (2.44 m) or less where no severe environmental conditions exist, digging operations do not involve supplemental sheeting and shoring, and only traditional sheeting and shoring are used.

9-3.2 Organizations operating at the operations level shall meet all requirements specified in Sections 4-3, 5-3, and 6-3.

9-3.3 Operations-level functions:

a. Development and implementation of procedures to make an entry into a trench or excavation rescue area

b. Recognition of unstable areas associated with trench and excavation emergencies and adjacent structures

c. Development and implementation of procedures to identify probable victim locations and survivability

d. Development and implementation of procedures for making the rescue area safe, including the identification, construction, application, limitations, and removal of traditional sheeting and shoring using tabulated data and approved engineering practices

e. Development and implementation of procedures for initiating a one-call utility location service

f. Identification of soil types using accepted visual or manual tests

g. Development and implementation of procedures to ventilate the trench or excavation space

h. Identification and recognition of a bell bottom excavation (pier-hole) and its associated unique hazards

i. Development and implementation of procedures for placing ground pads and protecting the "lip" of a trench or excavation
j. Development and implementation procedures to provide entry and egress paths for entry personnel

k. Development and implementation procedures for conducting a pre-entry briefing

l. Development and implementation procedures for record keeping and documentation during entry operations

m. Development and implementation of procedures for implementing and utilizing a rapid intervention team (RIT) as specified in Section 6-5 of NFPA 1500, Standard of Fire Department Occupational Safety and Health Program

n. Development and implementation of procedures for the selection, utilization, and application of shielding systems

o. Development and implementation of procedures for the selection, utilization, and application of sloping and benching systems

p. Identification of the duties of panel teams, entry teams, and shoring teams

q. Development and implementation of procedures for assessing the mechanism of entrapment and the method of victim removal

r. Development and implementation of procedures for performing extrication

9-4 TECHNICIAN

9-4.1 Organizations operating at the technician level shall meet all requirements specified in Sections 9-2 and 9-3. In addition, members shall be capable of hazard recognition, equipment use, and techniques necessary to operate safely and effectively at trench and excavation emergencies, including the collapse or failure of individual of intersecting trenches with an initial depth of more than 8ft (2.4 m) or where severe environmental conditions exist, digging operations involve supplemental sheeting and shoring, or manufactured trench boxes and/or isolation devices would be used

9-4.2 Organizations operating at the technician level shall meet all requirements specified in Sections 5-4 and 6-4

9-4.3 Technician-level functions:
a. Procedures for the identification, construction, application, limitations, and removal of manufactured protective systems using tabulated data and approved engineering practices

b. Procedures to continually, or at frequent intervals, monitor the atmosphere in all parts of the trench to be entered. This monitoring shall be done, in the following order, for oxygen content, flammability (LEL/LFL), and toxicity

c. Procedures for the identification, construction, application, limitations, and removal of supplemental sheeting and shoring systems designed to create approved protective systems

d. Procedures for the adjustment of protective systems based on digging operations and environmental conditions

e. Procedures for rigging and placement of isolation systems
SAFETY CONSIDERATIONS

According to last known statistics, almost 90% of all fatal trench accidents occurred in trenches less than 20 feet deep. The majority of these fatal accidents involved trenches less than 12 feet deep and 6 feet wide. We will be working in a trench that is 20’ long, 8’ deep and 3 ½’ wide. It is very important to practice all the safety tips that will be discussed.

The Washington State Labor and Industries will investigate all trench collapses, and the rescuers actions. We call them to the scene early. The key thing that is looked at is if all the persons involved have followed the basic requirements and rules. What we need to consider is that if we do not follow these rules, lives of the rescuers may be at stake. “ABOVE ALL DO NO HARM!”

Of 64 trench accidents reported to OSHA:

- Most occurred in good weather
- 40 of the workers were over the age of 30
- 18 of the workers were over the age of 50

Of 84 trench accidents studied:

- 32 were in clay or mud
- 21 in sand
- 10 in wet dirt
- 8 in sand, gravel and clay
- 7 in rock
- 4 in gravel
- 2 in sand and gravel

BASIC FACTS OF TRENCH ACCIDENTS:

- A cubic foot of soil weighs about 100 to 125 pounds
- 18 inches of soiled removed from on top of a mannequin weighs 2500 to 3000 pounds
- The soil concentrated around the chest and back area of the mannequin weighs about 700 to 1000 pounds
- Trenches that collapse usually collapse more than once and are 500 times more likely to continue to collapse
• The average time to remove two feet from around a worker can easily exceed 30 minutes
• The average time to complete a trench rescue is 3 to 4 hours
• The use of heavy equipment (backhoes, etc.) during emergency trench rescue operations is very hazardous and has caused severe injury and death to trapped victims
• If the worker has been buried above the waist, there is a good chance the worker will die of traumatic asphyxiation if the soil is not quickly cleared away from the chest area
• Trench accidents have a 112% higher fatality rate than other construction activities
• Trench accidents represent an average of 54 fatalities per year and approximately 1000 to 1500 injuries, of which approximately 150 are permanently disabling

F.A.I.L.U.R.E. ACRONYM

We’ve discussed this before during other technical rescue classes because these are the primary reason things go bad. So, let’s look at it AGAIN:

F: Failure to understand or underestimating the environment
A: Additional Medical implications not considered
I: Inadequate Rescue Skills
L: Lack of teamwork and/or experience
U: Underestimating the logistics needs of the operation
R: Rescue Vs Recovery not determined or communicated
E: Equipment Familiarity

T.E.A.M. ACRONYM

T: Together
E: Everyone
A: Accomplishes
M: More
MEDICAL PROBLEMS AND CONSIDERATIONS
CRUSH SYNDROME

Crush injury and crush syndrome are common in trapped victims of collapsed structures, collapsed trenches and confined space entrapments. Post-extrication medical deterioration and death occur from potentially treatable mechanisms and so this illness is a primary reason to provide the victim with prompt care within the area of entrapment.

In entrapments that cause crush syndrome, patients can survive for days with this injury, dying shortly after rescue if not treated. Some patients may die days to weeks later. To increase survivability, treatment must be early and aggressive.

DEFINITIONS

Direct Mechanical Crush

- Mechanical disruption of tissue secondary to severe force
- Immediate cellular effect/injury

Crush Injury

- Muscle cell disruption due to compression
- Time/pressure relationship
- Cellular mechanism of injury controversial:
  - Stretch "membranopathy"
  - Cellular Ischemia
  - Re-oxygenation injury

Compartment Syndrome

- Crush injury caused by swelling of tissue inside confining fibrous sheath of muscle compartments
- Causes further destruction of intra-compartmental muscle and nerves

Crush syndrome

- The systemic manifestations caused by crushed muscle tissue
- Occurs when crushed muscle is released from compression
Pathophysiology of Crush Injury: (cell function & effects in crush situation)

- Local arterial blood flow interrupted
- Lack of oxygen causes cell to function “anaerobically”, creating lactic acid and other toxins
- Cellular membrane function is disrupted (mechanism is controversial), causing cell death and dissolution
- Intracellular contents, including myoglobin, potassium, purines (later converted to uric acid) and other toxic substances are released into the local tissue area
- Local capillaries are injured and become “leaky”, allowing an increased serum portion of the blood to extrude into the tissue
- The re-introduction of oxygen into the tissue later may cause additional “re-oxygenation” injury by creating other toxins such as free radicals, superoxides and thromboxane

Crush Injury

- All these effects are local only until the tissue is released and reperfused by blood
- That is why patients may remain entrapped for days with a severe crush injury and yet appear systemically stable when reached by rescuers
- Upon release of compression, blood flow is restored to the crushed area and multiple adverse processes begin
- Effects of releasing compressed tissue:
  - Capillary leak = Hypovolemia/hypotension/shock
  - Severe metabolic acidosis = V-Fib
  - High serum potassium level = Cardiac arrhythmia or standstill
  - Myoglobin/Uric acid/other toxins = kidney failure
  - Other toxins = lung, liver, renal injuries

Crush Syndrome: (major causes of death)

- Hypovolemia
- Dysrhythmia
- Renal Failure

Other Causes of Death

- Adult Respiratory Distress Syndrome: severe lung injury
- Sepsis
- Other electrolyte disturbances
- Ischemic organ injury (gangrene)
Crush Injury: Diagnosis
- High index of suspicion
- Identifying potential crush mechanism
- Looking for subtle signs and symptoms
- Urinary myoglobin post-release

Myoglobin
- “Spills” into urine at relatively low serum levels
- Causes reddish-brown urine color in high concentrations
- Lower concentrations detected by positive orthotolidene on urinalysis dip-strip
- May precipitate in kidney tubules, contributing to renal failure

Patient Management
- ABC’s
- Protect airway
- Psychological support
- Assess for crush injury potential
- If crush potential is identified:
  - Establish IV access
  - Fluid replacement prior to lifting compression
  - Consider prealkalinizing with bicarb
  - Cardiac monitor: run baseline strip

Be prepared during extrication to treat
- Hypovolemia
- Acidosis
- Hyperkalemia
- Re-evaluate frequently and also outside of the entrapped area prior to transport
THE LAW
&
WHAT IS A TRENCH?
The Washington State Law (WAC 296-305-05007) dictates:

1. Fire departments that engage in trench rescue operations shall adopt and maintain a written response program that addresses training and procedures to follow in emergency life threatening situations

2. Employees that directly engage in trench rescue operations shall be trained or shall be under the direct supervision of person(s) with adequate training in trench and excavation hazard recognition, equipment use and operational techniques.

REMEMBER: "Safety is an Attitude"

OSHA trench shoring regulations state:

- Trench 4’ deep must have ladders every 25’
- Spoil pile not less than 1’ from lip
- Trench greater than 5’ deep, spoil pile more than 2’ from lip
- Trench greater than 4’ must have protection for workers
WHAT IS A TRENCH?

WISHA = A trench is defined as an excavation in the ground deeper that it is wide, but not wider than 15’ at the base.

WHAT IS AN EXCAVATION?

Is wider than it is deep and more than 15’ wide.

WHEN ARE TRENCHES USED?

- To place utilities under ground
- To place or remove under ground tanks
- To build foundations and or basements

TYPES OF COLLAPSES:

- Spoil In or Spoil Pile Collapse:
  - This is when the spoil pile slides into the trench because it’s too close
- Lip In or Rotational Failure
  - Caused by the top edge of the trench breaking off
- Slough In or Slough Wall Collapse
  - Caused by the middle of the trench side collapsing, leaving an overhang
- Shear Wall Collapse
  - Caused by entire sections of trench wall separating
WHY DO COLLAPSES OCCUR?

Vibrations:

These are caused by vehicles; traffic close to the trench, vehicles working around the trench. This is why it is so important to immediately complete any lock out tag out when securing the scene. This will help avoid secondary collapses.

Disturbed soil:

The soil is disturbed by previous excavations, underground lines, and dump sites. Trenches usually collapse because the newer soil is squeezed by the older soil and the newer soil spills into the trench.

Layered soil:

These are similar to disturbed soil, but occur naturally.

Too much water:

Caused by surface water flowing into the trench from above or from a high water table flowing in from the sides or bottom. The trench collapses because the walls of the trench cannot hold the added weight of the water. The water lubricates the soil to the point where the trench walls will not hold together and support their own weight.

Too little water:

This usually occurs when the trench is left open for long periods of time. The trench collapses because the natural binding properties of soil are reduced to the point where the trench walls will not hold together and support their own weight. Basically, the moisture evaporates from the trench walls.

Intersecting Trenches:

The trench usually collapses because the weight of the corner is being pulled in several directions at the same time. Another contributing factor to collapse is that the corners have two wall surfaces exposed, which increases any other contributing effects. This is in the “L”, “T”, or “cross” trenches.
TYPES OF SOIL

*Type A* – This type of soil include: clay, silty clay, clay loam, and sandy clay loam. Cemented soils are also considered Type A. It is also referred to as “Compact Soil”, that is hard, compact and adheres to itself.

*Type B* – Similar to Type A soil, but Type B soil is subject to vibration. Also this soil has been disturbed. Another term used is “Running Soil”, which is soft, loose and free flowing.

*Type C* – This type of soil deals with granular soils; sand, and sandy loam. They also include submerged soil, soils from which water is freely flowing, or submerged rock that is not stable. Also, this includes sloped or layered systems where the layers dip into the excavation at a slope of 4 horizontal to 1 vertical or steeper. Another term used is “Saturated Soil”, where water can be seen seeping or flowing from it.

**All Trench Rescue Incidents will be treated as soil Type C**

HOW TO TEST SOIL:

First, Terminology:

- **Cohesive soil** = Soil that is made up of fine grained material that remains in clumps is said to be cohesive.
- **Granular soil** = Soil that breaks up easily and is primarily composed of coarse grained sand or gravel is granular.
- **Fissures** = Tension cracks (could suggest a potential collapse).

**Visual test** – When performing a visual test, begin inspecting the excavated material then the soil that forms the trench wall and also the excavation site in general. This will help you determine the initial cohesiveness of the soil.

The trench particles will tell you a lot about the soil, but the most important area of the visual assessment would be the trench walls and the area surrounding the trench lip. On the trench walls, look for layered soil and any indication that the soil was previously disturbed. Disturbed soil can be indicated by the presence of utilities. A mixed soil will usually not be cohesive. In general, like particles of soil are the most likely to be attracted to each other and remain attracted.

A fair visual evaluation also considers if the trench contains fissures that could suggest a potential collapse. Openings, or spalling, in the exposed trench are indicators that the walls are under tension and subject to rapid release and subsequent collapse. The area around the trench should also be checked for
cracks in the soil, this would indicate soil movement. This would likely be caused by the trench walls falling into the trench, which creates voids in the earth surrounding the walls.

The hydrostatic forces can also be analyzed by looking for indications of standing, seeping, or running water. Water adds weight, and weight adds more tension to the trench walls. This is true for surface water that has pooled near the trench opening. As a clue to the anticipated hydrostatic forces look for indications that the contractor has "well pointed" the area surrounding the excavation. Well points are used to remove excess water from saturated soil before digging a trench.

**Manual test** - A manual test is necessary to determine the various characteristics of the soil, and to learn it relative strength when placed under a force. This indicates the ability of the soil to free-stand.

**Plasticity test** - The plasticity of the soil is the property that allows the soil to be deformed or molded, without appreciable change in total volume. Mold a moist or wet sample into a ball, and then attempting to roll it into threads as thin as 1/8-inch in diameter. A cohesive material can be rolled into threads without crumbling. As a rule, if a two-inch length of 1/8-inch thread can be held on one end without tearing, the soil is said to be cohesive.

**Dry strength test** - This is done to determine the propensity of the soil to fissure. If the soil is dry and crumbles on its own, or with moderate pressure, into individual grains or fine powder, it is granular. If the soil is dry and falls into clumps that break into smaller clumps, but the smaller clumps can be broken with difficulty, it may be clay in any combination with gravel, sand, or silt. If the dry soil breaks into clumps that do not break into smaller clumps and can only be broken with difficulty, and there is no visual indication the soil is fissured, the soil may be considered unfissured.

**Ribbon test** - The ribbon test is used to determine how much clay or silt the soil contains. The test is done with saturated fine soil and fine sands that are rolled together between the palms of the hands until a cylinder approximately ¾ inch thick by 6 inches long is formed. The cylinder is then placed across the palm of the hand and squeezed between the thumb and forefinger until it is approximately 1/8 inch thick. The squeezed portion is then allowed to hang over the side of the hand. If the cylinder forms 6 ribbons in length or longer it is said to be clay. If it forms shorter broken ribbons then the soil contains silt. A clay loam type of soil will barely form a ribbon.
PERSONAL AND RESCUE EQUIPMENT
PERSONAL PROTECTIVE EQUIPMENT

As always, we want to protect ourselves during any incident, whether it’s fires, aid calls or rescues. We are provided with bunkers or turnouts for fires, which may be used for aid calls, especially during the night.

Many may think we can use these turnouts in trench rescue. Unfortunately, many who think this have not had the opportunity to work in a trench during a rescue. Their thoughts come from trying to save money. Why buy our people another helmet, jump suits, gloves, etc, when they have these items already?

The key to doing an effective and safe job comes from working in comfort. The helmets, turnouts, and bunker boots we use for fighting fires are too large for trench work, which may cause rescuers to work without them.

To be in a trench the rescuer shall have; a helmet, safety boots, eye protection and gloves.

Specialty Items

Respiratory Protection - As a minimum, you may consider using a dust mask. In any case, if there is any indication that an atmospheric problem could exist you will want to have an SCBA or in-line respirator available.

Skull Caps - Welders wear skullcaps to keep their heads cool under their helmet while welding. Rescue personnel have started wearing them for the same reason.

Leather chaps - are good leg protection, and a great idea if you are going to be cutting with a chain saw.
TRENCH RESCUE EQUIPMENT

GROUND PADS

Ground pads are used to line the area around the trench, the lip. This is a very unstable area. The ground pads assist in distributing the rescuers weight over a large area. These are placed after soil from the spoil pile has been removed, if necessary.

The most common ground pad is 4’x8’ sheet of plywood ½” thick. The draw back to this type of ground pad is that it covers a significant portion of the ground around the trench, which makes it difficult to inspect for deteriorating conditions.

In some cases a 2’x12’ piece of lumber, usually 10’ to 12’ long, can be used as a ground pad. This works well next to spoil pile. This would minimize the amount of spoil pile to be moved.

SHEETING (panels)

Sheeting material can be made up from interconnected steel uprights, sheets of plywood/timber, or Finnform panels that are used to contact the walls of the trench. They function as a shield system with
uprights by holding back running soil and debris.

Most of what you’ll come in contact with is the Finnform, or homemade sheeting panel. The Finnform panel offers the rescuer a viable and safe sheeting panel for efficiently shoring trenches. It is a high strength, relatively lightweight, and non-conductive material that is made entirely of arctic white birch. The exterior of the Finnform panel is made durable by phenolic resins, which are impregnated into the hardwood surface to provide for maximum re-use and ease of cleaning.

The panels must be used with strongbacks. Strongbacks are a 2”x12”x10-12’ upright. The uprights are bolted to the panels using 3/4”x3 1/2” machine bolts and are the main component in the protective system. The strongback transmits the forces across a vertical plane into the trench wall. It is necessary to have the panel(s) tight against the walls of the trench to assure that the strongback can transfer the necessary force from the shore to the trench wall.

**SHORES**

Shores carry the force from one side of the trench to the other. They can be made up of different materials and forms. As any tool, all shores have their limitations, or as referred to, “their good and bad points”. The only way to overcome any limitation is to know the limitation ahead of time and have alternate tools to overcome the limitation.

**Timber Shores** - are the most common and oldest type. Timber shores are cut mostly out of 4”x4”, 4”x6”, and 6”x6” Douglas Fir with a bending strength of not less than 1500 psi. In trenches that exceed 20’ in depth, all shores must be commercial, timber shores cannot be used. Remember when using wood shores, the shorter the shore or larger dimension, the stronger it is.

The advantages of wood shores are the low cost compared to other shores on the market and they can be cut to varying size. The size and length of the timber is based on the depth and width of the trench as
determined by the type of soil present. Although the benefits may sway one to use or consider using wood shores, keep this in mind: If your trench is greater than 10 feet in depth, and over 4 feet in width with any kind of soil, the minimum timber shore is 4 x 6.

**Screw Jacks** - are a common shore used in conjunction with timber shores. Also referred to as pipe jacks. This type tool has a boot end that fits over a piece of wood and then tightened by a thread and yoke assembly, or used with a section of pipe, hence, pipe shore. Screw jacks are inexpensive. The thing to remember is they are not very strong when compared to other types of shoring, and care has to be taken not to over extend the thread.

**Hydraulic Shores** “Speed Shores” (manufacturer) - offer a type of protective system that combines the shore and upright as one unit. This type of shore is operated via a 5 gallon non-flammable and biodegradable fluid. After lowering the shore into the trench and expanded, the fluid is cut off at the cylinder and the hose is taken off the shore. The benefit, the speed shore can be set from outside the trench. The downfall is, they do not work well if the walls of the trench are not vertical or near vertical.

**Pneumatic Shores** - manufactured by Paratech, Airshore, and ProSpan come in a wide variety of lengths. They are available from 18” to 12’ and come with a multitude of extensions and attachments. They are made from light weight tubular aluminum.

Most pneumatic shores operate under the same principle, they’re extended by using compressed air. After extension, the shore either locks by itself or is manually locked to prevent a collapse under load. These types of shores are quick, strong and dependable. The main disadvantage to pneumatic shores is the number of shores required to maintain an effective cache and the cost. Most shores are only rated for 400 pounds of lateral force when installed. “Don’t stand on them!”
Air Bags - a tool most firefighters are comfortable with. The air bag can perform many functions. Lifting is probably one of the most important tasks for us or for the patient. They have been used for lifting pipes, excavators, steel panels, and concrete distribution boxes. They can also be used for filling voids behind the panels. These voids are created by sloughs and other types collapses. As always, we need to be concerned with puncturing the bag and operator error.

When using air bags for lifting, always remember, crib as you lift. The bags are not made to support loads, only to lift them.

Cribbing - a couple of key items: First, look at the wood you’re using for the crib box, make sure there are no large cracks or splits in it. Splitting in the wood is an indicator of very dry wood. Secondly, always place the load directly over the point of contact, maintaining wood to wood contact from the load to the ground at all times. For various crib boxes, see FOG.

Wedges typically will be used with crib boxes. Wedges will help change the direction of force applied onto the box. They also help fill spaces that are too small for a regular or full piece of wood.
TOOLS OF CHOICE

**Entrenching Tool** - Is a small collapsible version of the large shovel, which is designed for situations where the working area is limited and a shovel is too big.

Digging operations to remove trapped victims should begin immediately after the protective system is in place. This means the digging team or person will be working in tight quarters. The entrenching tool is very effective during these times. Small gardening shovels are also very effective.

**Hammer** - You can never have enough hammers, especially framing hammers. Heavy hammers are the best, time is critical and you want to drive the nails in with two or three strikes. Obviously, the hammer is a very important tool when working with shores.

**Duplex Nails** - These nails are the best kind to use, they can be taken out easily. If not familiar with this nail, it has a shoulder or double head. The shoulder allows the claw of the hammer a place to get a bite for removing the nail.

**Chain Saw** - The saw of choice for rescues involving wood shores - a large emphasis should be placed on safety! Chain saws are used because they’re quick and for the most part firefighters have a good working knowledge of them.

**Ventilation Equipment** – Any electric blower can be used for ventilation. Ventilation is not always necessary. Use only when you have an atmosphere problem. It can be also used to keep our people cool, especially on hot days. When using ventilation, keep hypothermia in mind for rescuers and patients. Also consider the noise level, dust creation and additional soil impacts.

**Ladders** - Various types of ladders can be used. We use them for both the patient and rescuer. When you first arrive, a ladder into the trench may be all you need to rescue the patient (self rescue). We use them for entry and exiting. They can also be used as ground pads if nothing else exists or you have the need to span a spoil pile or weak area of the lip. If you use them as ground pad, they have to be assembled with 2 x 12’s or plywood to fill the space between the rungs.

**Sump Pumps/De-watering Devices** - These devices are very important in trench rescues. Water in the trench deteriorates the trench floor and it make for a very uncomfortable work environment. Always have a back up pump, just in case. Pumps with large diaphragms can be used for mud. Check with your Public Works to see what they have available.
Vacuum Truck – Most Public Works agencies have vacuum trucks and can be called to the scene. They have a great advantage in removing soil, but they create hazards as well. They create vibrations, noise and need to add water to trench to be most effective. It is best to request two trucks to be prepared for the potential failure of one.

CHECK LIST FOR TRENCH RESCUE TOOLS

SHOVELS
__Flat
__Pointed/Spade
__“D” Handle
__Post hole digger
__Entrenching tool

HAMMERS
__Nailing
__Large sledge
__Small sledge

SAWS
__Chain
__Circular
__Hand
__blades/chains
__Repair kits
__Saw horses

SAWS
__Large sledge
__Small sledge

MISCELLANEOUS
__Squares
__Pickets
__Spray paint
__2 x 4
__4 x 4
__Wedges
__4 x 6
__2 x 4
__Spray paint
__4 x 4
__Rope
__Ventilation fans
__6 x 6
__Tool belts
__Fan ducts
__8 x 8
__Nail pouches
__Power cords
__Nails (duplex)
__Generator(s)
__Measuring tapes
__Pike poles
__Road cones
__Air monitoring equipment
__Barricade tape
__Buckets
MANAGING
A
TRENCH RESCUE
INCIDENT
**TACTICAL CONSIDERATIONS**

**PHASE I – ON SCENE. SIZE-UP. ESTABLISH COMMAND**

**ON SCENE**

- First arriving company officer should establish Command and initiate a size-up of the situation
- The first-in company should spot the apparatus at least 100’ from the location of the trench failure. Establish staging at least 300’ from the scene
- Complete a risk benefit analysis – **RESCUE** mode
- Call for resources – “Trench Rescue Response”
- Complete lock out/tag out, as applicable

**THE PRIMARY ASSESSMENT**

- Secure an RP (responsible party), job foreman, or witness to the accident.
- Place a ladder in the trench
- Determine exactly what has happened
  - Why were they digging
  - What time was the collapse
  - How many patients
  - Last known location
- Make patient contact
  - Initial evaluation of patient condition
  - Protect the patient
    - Uncover the patient to their waist
    - Provide them with head and eye protection
    - Provide them with a tool to dig
    - Consider oxygen
- Determine type of trench and soil
  - Survey for cracks and fissures
  - Consider possibility/probability of secondary collapse
  - Is water a factor?
- Determine Risk Analysis, assessing potential hazards
- Identify any language barriers that may be present between witness and rescuers. If there are barriers, call for bi-lingual individual to assist with communication with the witness.
ESTABLISH AN ACTION PLAN

- Assess on-scene capabilities
- Assess the need for additional resources
  - Consider vacuum truck
  - Public Works representative
- Contact Labor & Industries
- Assign a Technical Operations Safety Officer*
- Assign personnel
  - Rescue Group Supervisor*
    - Shore Team Leader*
    - Panel Team Leader*
    - Support Team Leader*
    - Entry Team Leader*
    - Rigging Team Leader*
  - Medical Group Supervisor
    - Consider Entry Medic
    - Patient Advocate
  - Staging Area Manager

(*)Denotes Technician Level Position

PHASE II – PRE-ENTRY OPERATIONS

MAKE GENERAL AREA SAFE

- Create a Hot, Warm, and Cold Zone
  - Hot Zone – Rescue Operations
  - Warm Zone – Tools/Personnel
  - Cold Zone – Non-Essential Personnel
- Control traffic movement
  - Shut down roadways within 300’
- Control the crowd
  - Remove all non-essential civilians from the Hot and Warm Zones
  - Remove all non-essential rescue personnel from the Hot Zone
- Shut down all heavy equipment operating within 300’ of the collapse
MAKE THE RESCUE AREA SAFE

- Protect the patient
  - Consider spot shore
  - Consider panel shelter
- Mark the location of the patient
- Clear trench perimeter and place ground pads – spoil pile minimum 2’ from lip
- Control all hazards in the area. (i.e. confirm lock out/tag out, utilities, gas, electric, water, on-site equipment)
- De-water trench, as necessary
- Monitor atmosphere in the trench
- Ventilate the trench, as necessary
- Assess ladder placement, maximum of 25’ between placement

DO NOT ENTER TRENCH UNTIL PROTECTION SYSTEMS ARE IN PLACE

PHASE III – ENTRY OPERATIONS

STABILIZE TRENCH (Making the trench safe)

- Approach the trench from the ends if possible
- Assess current soil conditions (i.e. fissures, unstable spoil pile)
- Assess spoil pile for improper angle of repose and general raveling
- Remove any trip hazards (i.e. shovels, shores, tree roots)
- Entry Team Leader will be responsible for entry operations
- Determine shoring system to be used (i.e. pneumatic, hydraulic, timber)
- Establish equipment cache
- Initiate installation of the protection/shoring system
- Initiate entry
- Make physical contact/assessment of patient
- Initiate treatment
  - ABC’s – primary survey
  - C-Spine precautions
  - Secondary survey
  - Consider removing patient from danger prior to providing definitive care
Follow local protocols
- Remove the dirt from the collapsed zone. The rescuer(s) shall remain in the “safe zone” while removing dirt from the collapsed zone.
- Secure all unsecured utilities, pipe, or any other obstruction in the trench
- Continue installation or protection systems until all work zones are considered “safe”
- Extricate patient

PATIENT REMOVAL

- Create a safe zone around the patient
- Remove objects trapping the patient (i.e. pipes, lumber, machinery)
- Continually assess the patient’s condition
- Begin dirt removal, operating from a safe zone (buckets, small shovels, by hand)
- Uncover the patient to below the diaphragm
- Completely uncover the patient
- Package the patient for extrication
- Remove the patient from the trench (vertical haul, horizontal haul)
- Transfer the patient to Medical Group

PHASE IV - TERMINATION

TERMINATION PROCEDURES

- Personnel accountability and welfare survey
- Announce the Termination Action Plan – remind all personnel to maintain situational awareness with a focus on safety
- Remove tools and equipment from the trench when approved by L & I
- Remove trench shoring system (last in/first out)
- Re-stock vehicles
- Conduct a debriefing
- Secure the scene. This may include covering the trench.
OTHER CONSIDERATIONS

- Rotation of crews.
- Environmental effects on the patient and rescuers.
- The affects of rain or snow on the hazard profile.
- Operational period and logistical needs
- Time of day. Is there sufficient lighting for operations extending into the night.
- The affect on family, friends, and co-workers; keep them informed.
TECHNICIAN LEVEL TRAINING
ATMOSPHERIC MONITORING FOR TRENCH RESCUE
The use of air monitoring and sampling equipment is one of the most important aspects of trench rescue operations. During your rescue effort someone on your support team will be providing periodic atmospheric monitoring in and around the trench and will continue to monitor until deemed unnecessary by the Technical Operations Safety Officer. Monitoring is used not only to detect the presence of IDLH atmospheres, but it is also used as a tactical guide to ventilation of the trench.

Here are some basic terms that apply to monitoring and sampling.

**Alarm settings:** A preset level within a monitor at which the monitor will display a visual alert and sound an audible alarm. Alarm settings are established by the manufacturer and based on OSHA and NIOSH levels for given product.

**Detection Range:** The term used to express the unit of measure that the monitor uses to detect the vapor for which it was intended. Combustible Gas Indicators usually have a display showing percentage(%) of the Lower Explosive Limit (LEL). Toxic sensors such as Carbon Monoxide or Hydrogen Sulfide display in parts per million (PPM).

**Explosive Limits:** A reading on the monitor given in percentage indicating a percentage of gas in air mixture. Can be known as Upper Explosive Limit (UEL) or Lower Explosive Limit (LEL).

**Flammable Range:** Is the percentage of vapor in air which must be present to sustain combustion should ignition occur.

**Flash Point:** The minimum temperature of a liquid that generates enough vapor to form an ignitable mixture in the vapor space above the liquid.

**Ignition Temperature:** The minimum temperature to which a liquid must be raised in order to initiate and sustain combustion.

**Immediately Dangerous to Life and Health:** (IDLH) Maximum concentration from which a person could escape (in the event of respirator failure) without permanent or escape-impairing effects within 30 minutes.

**Lower explosive Limit (LEL):** The minimum concentration of vapor in the air which propagation of flame occurs on contact with a source of ignition. Usually expressed as a percentage of gas vapor in air.
**Oxygen Sensor:** An electrochemical sealed unit measure the percentage of oxygen in the air. The sensor has two electrodes, an electrolyte solution and a membrane which separates the two. As oxygen passes through the membrane, a reaction with the solution and the electrodes produces and electrical current, which causes the sensor to display the percent of oxygen found.

**Permissible Exposure Limit (PEL):** Average concentration that must not be exceeded during an 8 hour work shift or a 40 hour workweek.

**Upper Explosive Limit (UEL):** Is the maximum concentration of vapor in air at which propagation of flame occurs when in contact with source of ignition.

Monitoring Considerations

Before monitoring a space, there are some things to consider regarding the atmosphere or potential hazards that exist at a trench rescue operation.

1. What is the nature of the hazard I am monitoring?
   a. What are the upper and lower explosive limits for the particular product?
   b. Is the atmosphere oxygen deficient which might create interference with instrument response?

2. What are the environmental site conditions you are operating in?
   a. Temperature
   b. Humidity
   c. Barometric pressure
   d. Overall weather conditions
**ACTION GUIDELINES**

In order to tactically use the monitor information, you must have action guidelines established.

<table>
<thead>
<tr>
<th>ATMOSPHERE</th>
<th>LEVEL</th>
<th>ACTION</th>
<th>MONITOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combustible/Flammable gas</td>
<td>10% of the LEL</td>
<td>If outside the space correct visually and audibly Atmosphere If Inside the space begin exit</td>
<td></td>
</tr>
<tr>
<td>Oxygen</td>
<td>Less than 19.5% Or greater than 23.5 %</td>
<td>If outside space determine problem and correct. If inside space Begin to exit</td>
<td>Alarms both visually and audibly</td>
</tr>
<tr>
<td>Toxicity</td>
<td>CO – 35 ppm H2s – 10ppm</td>
<td>If outside the space, determine cause of problem and correct, if inside the space begin to exit.</td>
<td>Alarms both visually and audibly</td>
</tr>
</tbody>
</table>
Atmospheric monitoring identifies the hazards and provides a baseline. The first step to handling any hazard is to know it’s there! There are two ways of dealing with a hazardous atmosphere:

- **Ventilation:** Ventilation may be necessary depending on the atmospheric readings and/or known conditions. It is very important to monitor during ventilation, this tells you whether your technique is working or not. If you’re still receiving high readings, reconsider the source and ventilation tactics.

Ventilation of a trench may also have negative impacts such as dust, noise, dehydration of the trench wall, hypothermia of the patient and the rescuers. Use of gas powered blowers should only be considered when electric blowers are not available. A good consideration for trench ventilation is a confined space blower.
TECHNIQUES FOR BUILDING PROTECTION SYSTEMS
Shoring Basics:

We will identify three types of shoring. We can expect to utilize all three types in one trench collapse incident.

Pneumatic Shoring:

Pneumatic shoring is available in a few different brands, Paratech, Air Shore, ProSpan. This manual will focus on the Paratech brand as it is considered the “standard” in King County Zone One.

Paratech has tabulated data for its application and this will serve as our guide to strut placement and working pressures.

The terms “soft” and/or “hard” are used to determine the air pressure delivered to the strut. By standard any pressure below 200 psi is considered “soft.” Soft shooting, typically between 75-100 psi, is used to hold a strut that is transitional or on a fragile area such as an outside corner.

Hard shot is a strut that is pressurized to between 200 & 250 psi. Per Paratech, a strut is not “installed” until its pressure is above 200 psi. All struts should be hard shot unless conditions exists that precludes the pressure at that time.

“Installed” means a strut is hard shot, collard locked and the base is nailed to the strong back or wood base using (2) 16d nails driven half way in and bent over.

Commands for pressurizing are: “Up on the (hose color) to desired pressure” or “down on the (hose color).”

Lumber/Wood Shoring:

This type of shoring utilizes dimensional lumber typically 4” X 4” or 6” X 6” hemlock or douglas fir. Lumber shores are used in the same fashion as pneumatic shoring except it is not pressurized per se. It is tightened using wood wedges. The dimension of lumber selected is conditional upon the span and the load being applied to the member – axial loading (column) vs. lateral (beam).

As general “rule of thumb” we consider 1’ of span will equal 1” of dimension in the lumber, i.e. a 4” X 4” will span up to 4’.

In addition to lumber being used as “columns and beams,” wood is used to make wedges, cleats, corner blocks, thrust blocks, and walers.
**Spot Shoring:**

The standard in Snohomish County for shoring is to use panels in the trench when we can and shooting the struts to the hardbacks (or walers if they are in play). However, there are times when it will be necessary to use a “spot shore” in lieu of that. Examples of spot shoring are:

- An initial spot shore over the patient to provide protection until a “system” can be put in place.
- To maintain our “two feet from the top and bottom and no more than four feet in between struts”. If you find you have removed material from the bottom of the trench to rescue/recover the patient and are now four feet lower than your lowest strut, a spot shore can be used to cover that gap.
- There may be other times when the configuration of the trench prohibits putting a panel in place.

A spot shore consists of a strut with an extra large “foot” attached. There are commercially made bases for this application. Paratech makes one. Another acceptable method is using 2X12 material or Finn Form, cutting it into a 12X12 size and nailing it to the base of the strut.
INSIDE WALERS

Inside walers are typically 6x6 material and are used in a trench to span a set of panels for the purpose of spanning and/or creating an open space. The open space may be required as the result of a piece of equipment in the trench that cannot be moved, to create space for digging and extrication operation, spanning an opening in a trench wall, and/or spanning an intersecting trench. Shoring a “T” or “L” trench would use this type of waler.

An example of how to install an inside waler:

- Place all walers in bottom of trench
- Place all panels
- Raise bottom waler on both sides and tie off to pickets or outside uprights.
- Place top waler and tie off to pickets or uprights
- Shoot shores between top waler
- Shoot shores between bottom waler
STRAIGHT WALL TRENCH

The straight wall trench will usually require the rescuer to set a minimum of three sets of panels. One set directly over the patient and one set on either side of the middle to provide a safe area for rescuers to work. Consideration for the first panel (not set) may be to protect the patient from further injury. Make sure you mark the location of the patient before beginning.

An example of how to set up the protection system:

- Consider placing the first set of panels directly over the patient
- When placing the shores:
  - Set the top shore
  - Next the middle shore
  - Any other shore required to maintain spacing standards
  - Last comes the bottom shore
    **unless mitigating circumstances prohibit this order. (ie: trench shape)
- For Hydraulic:
  - Set and expand shores between uprights
- Set the outside panels next using the previous procedures.
- The most important keys for setting panels are:
  - the uprights are in line with each other
  - the panels make full contact to trench wall
  - the panels are secure.
“T” TRENCH

The intersecting “T” trench is a very unstable trench due to the exposed wall and the other wall has been intersected, creating unstable corners. The key is to capture the corners as quickly as possible. Inside walers span the center panel because there is nothing to shore against where the “T” leg intersects with the long wall.

An example of how to set up the protection system:

- First of all, limit any activity at the corners of the intersection
- Set pickets for tie backs
- Prepare panels and walers, number of walers depends on the depth of the trench
- Prepare shores
- Set two panels on wall of “T” leg
- Soft shoot (low pressure, about 50-75#) top, middle, bottom
- Place all walers on trench floor along long wall
- Set remaining 5 panels. Two panels on opposite “T” leg corners
  Three panels on long wall
- Place top waler and tie back to pickets
- Soft shoot top shore from outside panels to waler
- Raise middle waler and tie back
- Soft shoot middle shore on outside panels
- Raise bottom waler and tie back to pickets
- Soft shoot bottom shore from outside panels to waler
- Hard shoot shores on “T” leg shooting all shores on the same horizontal plane at the same time
The “L” trench presents a difficult scenario for rescuers because the inside and outside corners of the “L” are difficult to capture with the standard protective equipment.

An example of how to set up the protection system:

- Again, we want to limit activity at the corners of the intersection
- Measure depth and width of trench
- Set pickets for tie backs
- Prepare panels and walers
- Prepare shores
- Set opposing “inside L” panels, tie to pickets
- Place all walers on trench floor, both sides, tie to pickets
- Place “thrust blocks” (one per shore) using cleats on inside L panels
- Soft shoot center shores to capture corners
- Place two outside “L” panels, move them to form a clean corner and skip shore outside perimeter, as necessary
- Set walers. Walers should form a clean corner at the outside intersection of the corner panels. Anchor these in place by tying back to pickets
- Hard shoot all shores that are now placed.
- Place “corner blocks” on walers using cleats/hangers or toe nails
- Slowly pressurize corner/thrust shores from inside “L” panels to corner/thrust blocks simultaneously. Consider keeping these shores at the minimum “installed” pressure.
Deep trenches are those over 10 feet but not more than 20 feet. If over 20 feet, commercial shoring and techniques are required.

An example of how to set up the protection system:

- Measure depth and width of trench
- Set pickets for tie backs
- Prepare panels
- Prepare walers, if needed
- Prepare shores
- If needed - installing walers
  - Set deep wale on bottom floor of trench, picket back.
  - Prepare all other walers, as necessary (one set every four feet or per Paratech charts).

Note: You may find that may have to shoot panels to capture the wall before placing walers. You must make this decision based on stability of the soil and your comfort level. If you do this you will have to maneuver the walers into place between shores.

- Lower bottom sets of panels in place, in normal fashion, upright and tie back to pickets
- Place top panels at 90 degrees to bottom panels, laying them length wise across two panels.
- Depending on the trench, one might opt to place the bottom panels horizontally and the top panels vertically.
- Lower and place remaining sets of walers, not to exceed vertical spacing standards between walers. Tie back to pickets.
- Shoot top panels using shore system. (No wales) Must be at least two feet from lip.
- Strive to work from top to bottom.
- At this depth adding more shores, as necessary, to control the environment. All horizontal and vertical placement shall be per the Paratech chart.
- Check and adjust shores.

**SINGLE WALL SLOUGH – OUTSIDE WALERS**

This type of trench has a collapse of one wall. In this situation the protective system is designed with outside walers to span the opening and provide a backing for protective panels. Outside walers are positioned between the panels and the trench wall and usually consist of 6X6 material.

An example of how to set up the protection system:

- Place pickets to tie walers.
- Place and tie off bottom waler.
- Place middle waler, as needed.
- Place and tie off top waler.
- Place the first set of panels directly over the patient.
- Fill all spaces behind walers/panels with air bags, back shores* or other material (when expanding bag, do not push out panel).
  *This can also be accomplished with a spot shore from the slough trench wall to the outside waler.
- When shooting or placing the shores:
  - Set the top shore.
  - Next the middle shore, as needed.
  - Last comes the bottom shore.
  ** Unless mitigating circumstances dictate otherwise.
- Set the outside panels next using the previous procedures.
ASSIGNMENTS & RESPONSIBILITIES
RESCUE GROUP SUPERVISOR
This position is responsible for the tactical operations of the trench rescue. They determine the action plan and ensures the plan is implemented and adhered too.

TECHNICAL OPERATIONS SAFETY OFFICER
This person is responsible for overall safety. They must identify all scene hazards and potential problems. They shall insure that all personnel working at the site are wearing all necessary protective equipment and following established guidelines.

SUPPORT TEAM LEADER
They manage the support team. Initial tasks include placing ladders into the trench, one at the victim position, then, spaced no more than 25’ apart along the working area of the trench. Other responsibilities may include air monitoring, lock-out/tag-out, equipment cache, lighting, cut shop and/or water removal.

PANEL TEAM LEADER
They manage the panel team. Their first task is placing edge protection, ground pads. Once the edge is secured, the panel team is responsible for preparing and placing the panels.

SHORING TEAM LEADER
Manages the shoring team. The shoring team is responsible for assembling, placing and removing the shoring devices.

RIGGING TEAM LEADER
The rigging team is responsible for all the rope systems used during the rescue. They may need to build; “a” frames, ladder gins, stokes rigging, haul systems and or ladder slides.

ENTRY TEAM LEADER
The entry team enters the trench after all the shoring has been put in it’s place. They use hand shovels, buckets, and other means of debris removal to free the victim for extrication.
APPENDIX “A”
TERMINOLOGY
APPENDIX A

TERMINOLOGY

ACCEPTED ENGINEERING PRACTICES: Those requirements that are compatible with standards of practice required by a registered professional engineer.

ACTIVE SOIL: The ability of the soil to contain energy as it relates to movement.

ALUMINUM HYDRAULIC SHORING: A pre-engineered shoring system consisting of aluminum hydraulic shoring cylinders, used with vertical rails (uprights) or horizontal rails (wales or waler). Such a system is designed specifically to support the sidewalks of an excavation and prevent cave-ins.

ANGLE OF REPOSE: The natural angle at which loose particulate products will support its own weight, and which can be expected not to flow from a standing position.

AHJ: The acronym used to describe the Authority Having Jurisdiction.

BELL PIER: A type of shaft or footing excavation, the bottom of which is larger than the cross section above to form a bell shape.

BENCHING: Excavating the walls of an excavation in such a way to form horizontal steps with vertical faces, placed at predetermined angles and widths to prevent the soil from collapsing or sliding.

C-60 Soil: A class of soil that is a "moist, cohesive, or a moist dense granular soil which does not fit into type A or B classifications, and is not flowing or submerged. This material can be cut with near vertical sidewalls and will stand unsupported long enough to allow the shoring to be properly installed

CAVE-IN: The separation of a mass of solid or rock material from the side of an excavation, or loss of the soil from under a trench shield or support system, and it's sudden movement into the excavation, either by falling or sliding in sufficient quantity so that it could entrap, bury, or otherwise injure and immobilize a person.

CEMENTED SOIL: A soil in which a chemical agent similar to calcium carbonate holds together the particles, such as a hand size sample could not be crushed into powder or individual soil particles by finger pressure alone.
COHESIVE SOIL: Clay, or soil with high clay content, which has cohesive strength. Cohesive soil does not crumble, can be excavated with vertical side slopes, and is plastic when moist. Cohesive soil is hard to break up when dry, and exhibits significant cohesion when submerged. Cohesive soils include clay silt, sandy clay, silty clay and organic clay.

COMPETENT PERSON: The individual, usually the supervisor or director of rescue operations who meets the OSHA standard to determine soil profiles, safety concerns, protective mechanisms and other requirements.

CONSENSUS STANDARDS: Standards developed by a group of persons who represent a particular industry, or product that is applied to that industry. They are standards that are not legally binding, but can be used by Courts to determine negligence.

CROSS BRACES: The horizontal members of a shoring system installed perpendicular to the side of the excavation or trench, the ends of which apply pressure against the either uprights or walers.

DRY SOIL: Soil that does not exhibit visible signs of moisture content.

ENDS: The part of the trench where the walls meet the end.

EXCAVATION: An opening in the earth surfaces that is wider than it is deep.

FACES OR SIDES: The vertical or inclined earth surfaces formed because of excavation work.

FAILURE: The breakage, displacement, or permanent deformation of a structural member or connection that reduces its structural integrity and its supportive capabilities.

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

FLOOR: The bottom of the excavation.

GRANULAR SOIL: Gravel, sand, or silt with little clay content. Granular soil has no cohesive strength. Some moist granular soils exhibit apparent cohesion, but crumble when dry and cannot be molded.
GRAVITY: The function of nature that determines an objects attraction to another object. It is caused by, and is directly proportional to, the objects mass in relation to mass of another.

HAZARDOUS ATMOSPHERE: An atmosphere that because of being explosive, flammable, poisonous, corrosive, irritating, oxygen deficient, toxic, or otherwise harmful, may cause injury, illness or death.

HYDROSTATIC PRESSURE: The pressure that results from the effects of water contained in soil.

KICK OUT: The accidental release or failure of a cross brace.

LEL: An acronym for Lower Explosive Limit, which represents the minimum concentration of product in air that will support combustion in the presence of a source of ignition.

LAYERED SYSTEM: Two or more distinctly different soil or rock types arranged in layers.

LIP: The area 360 degrees around the opening of the trench or excavation.

LOAM: A soil consisting of a friable mixture of varying proportions of clay, silt, and sand.

MOIST SOIL: A condition in which the soil looks and feels damp.

OSHA: The Occupational Safety and Health Administration that is a federal office and also an agency in some states.

PCF: An acronym that describes the term pounds per cubic foot.

PPE: An acronym that describes the term personal protective equipment.

PASSIVE SOIL: A soil with no potential for movement.

PLASTICITY: The property that allows the soil to be deformed or molded, without appreciable change in total volume.

PROTECTIVE SYSTEMS: Pre-engineered systems designed to protect employees from cave-ins, collapse, falling material and other equipment.

RAMP: An inclined walking or working surface used to enter one point from another, and is constructed from each or other structural materials such as steel or wood.
SABA: The acronym used to describe the supplied air breathing apparatus.

SATURATED SOIL: A soil in which the voids are filled with water. Saturation does not require flow. Saturation or near saturation is necessary for the proper use of a pocket pentrometer or sheer vane soil testing devices.

SHEETING: Sheets of timber or Finn Form panels used in contact with the walls of the trench. They function as a shield system.

SHIELD (SHIELD SYSTEM): Permanent or portable structures designed to withstand the forces of a collapse or cave-in, such as trench boxes, rabbit boxes, coffins, etc.

SHORE: Horizontal members installed perpendicular to the wall of a trench, in which the ends press against the uprights, wales, or panels to create pressure zones and support.

SHORING: A system made of timber, metal, hydraulic, or mechanical members that support the walls and prevent cave-ins. Used to support sheeting in conventional rescue operations.

SILT: An earth matter made mostly of sand that is carried by water and deposited as sediment.

SLOPING: Excavating the walls so that they incline away from the trench or excavation at a pre-determined angle according to the soil profile to prevent cave in or soil movement.

SPOIL PILE: The dirt taken out of the trench and piled alongside of the trench. The spoil pile must have a two-foot setback from the trench lip if greater than 4’ deep, one -foot, (1’), setback for trenches less than 4’.

STRUCTURAL RAMP: A ramp built of steel or wood, used for vehicles access. Ramps made of soil or rock are not considered structural ramps.

TABULATED DATA: Tables and charts representing information approved by a registered engineer and used to design and construct a protective system. These are found in the shoring tables in the OSHA manual, and may be constructed by your own engineer but must show “pre-engineered data”.

TSF: The acronym for the term tons per square foot.
TOE:  The area where the walls and floor intersect. A 90-degree angle at the bottom of the trench and up the wall two feet.

TRENCH:  An opening in the ground that is deeper than it is wide.

TYPE A SOIL:  A soil with an unconfined compressive strength of 1.5 tons per square foot or greater.

TYPE B SOIL:  A soil with an unconfined compressive strength of greater than 0.5 tons per square foot, but less than 1.5 tsf.

TYPE C SOIL:  A soil with an unconfined compressive strength of less than 0.5 tons per square foot.

UNCONFINED COMPRESSIVE STRENGTH:  The force or load per unit area, as calculated with a pentrometer or other device and stated numerically in tons per square foot that determines the point at which a soil will fail in compression.

UPRIGHTS: Vertical members placed in contact with the walls, or panels. They may or may not contact each other, and more than one upright may be used on each panel system.

WALERS:  Horizontal members of a shoring system placed parallel to the walls whose sides bear against the uprights or the excavation shoring system of face. Walers can be 6x6, 8x8 or 10x10 wood timbers or various steel and aluminum components.

WET SOIL:  A soil that contains more moisture than moist soil, but is in such a range of values that the cohesive material will slump or begin to flow when vibrated.
APPENDIX B (Attachments)

AIRSHORE MANUAL
PARATECH MANUAL
SPEED SHORE MANUAL
WAC 296-155 (N)

For Further Information:

1. Refer to NFPA 1670 Operations and Training for Technical Search and Rescue Incidents.
2. Refer to NFPA 1006 Standard for Rescue Technician Professional Qualifications

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TRENCH RESCUE
“ABOVE ALL DO NO HARM”