TR: Trench
Lesson One
Rescue Operations for the Trench Rescuer

DOMAIN: COGNITIVE

LEVEL OF LEARNING: COMPREHENSION

MATERIALS

IFSTA 7th Edition Fire Service Search and Rescue; Trench Rescue Training Levels: Awareness, Operations, and Technician 2nd Edition by C.V. Martinette Jr.; IFSTA 1st Edition Technical Rescue for Structural Collapse; NFPA 1006, Standard for Technical Rescuer Professional Qualifications; NFPA 1670, Standard on Operations and Training for Technical Rescue Incidents 2009 Edition; NFPA 1561 2008 Edition, Standard on Emergency Services Incident Management System; OSHA standards CFR 1926.650-652, (Excavation) 1910.146 (Confined Space) and 1910.147 (Lock-out-Tag Out), http://www.nclabor.com/pubs.htm, NIMS document, multimedia projector; laptop computer; access to white board or flipchart; assorted marker pens.

NFPA 1006, 2013 Edition JPRs

8.1.1 Conduct a size-up of a collapsed trench
8.1.2 Implement a trench emergency action plan
8.1.3 Implement support operations at trench emergencies
8.2.2 Install supplemental sheeting and shoring

Junior Member Statement:

Junior Member training activities should be supervised by qualified instructors to assure that the cognitive and psychomotor skills are completed in a safe and non-evasive manner. While it is critical that instructors be constantly

aware of the capabilities of all students both mentally and physically to complete certain tasks safely and successfully, the instructor should take every opportunity to discuss with departmental leaders and students the maturity and job awareness each participant has for the hazards associated with fire and rescue training.

TERMINAL OBJECTIVE

The Technical Rescuer shall correctly identify in writing the necessary elements of pre-incident planning, a scene size-up, incident action plan, hazard assessment procedures, and command responsibilities associated with trench rescue incidents.

ENABLING OBJECTIVES

1. The Technical Rescuer shall correctly describe in writing the necessary elements of successful pre-planning as they relate to trench collapse rescue incidents.

2. The Technical Rescuer shall correctly describe in writing the factors that rescuers must know to effectively perform a scene size-up involving trench rescue incidents.

3. The Technical Rescuer shall correctly describe in writing operational plan or incident action plan (IAP) associated with incidents involving trench rescue operations.

4. The Technical Rescuer shall correctly describe in writing the types of hazards and their consequences for rescuers that need to be included in a hazards assessment associated with incidents involving trench rescue operations.

5. The Technical Rescuer shall correctly describe in writing the responsibilities of Command and the primary functions of command associated with incidents involving trench rescue operations.

6. The Technical Rescuer shall correctly identify in writing the components of an effective equipment assessment for trench rescue operations.

7. The Technical Rescuer shall correctly identify in writing, describe the function, and demonstrate the operation of various tools and equipment that may be necessary during a trench rescue incident.

8. The Technical Rescuer shall correctly identify in writing, describe the function, and demonstrate the operation of various tools and equipment commonly used for lifting and moving operations during a trench rescue incident.

9. The Technical Rescuer shall correctly identify in writing the types, capabilities and applications of various pieces of heavy equipment that may be used during a trench rescue incident.

10. The Technical Rescuer shall correctly identify in writing personal protective garments and accessory gear recommended at trench collapse rescue incidents.

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MOTIVATION

Trenching and excavation operations in N.C. are regulated by the N.C. Department of Labor, Occupational Safety and Health (OSH). Fire and rescue agencies responding to trench related accidents are required to comply with the safety procedures that are mandated by OSHA. Fire and rescue agencies could be held accountable for inappropriate actions taken at a trench accident. A copy of the standards listed in the materials list and a guidebook are available by contacting N.C. OSHA, Bureau of Education, Training and Technical Assistance. The telephone number is (919) 733 2486. To access information regarding NC OSHA rules and regulation log on to www.NCLABOR.gov and go to compliance standards.

PRESENTATION

ENABLING OBJECTIVE #1

The Technical Rescuer shall correctly describe in writing the necessary elements of successful pre-planning as they relate to trench collapse rescue incidents.

1. Define and discuss the following excavation terminologies that are helpful for emergency responders working at a trench rescue incident to understand.
   a) Angle of repose - the angle trench walls should be cut back to reduce the chance of workers becoming buried in a collapse. The recommended angle is 34 degrees or for every foot of vertical depth the trench should be cut back horizontally 1½ times the vertical depth.

b) Cathead – A shore running between walers with a plank 6” longer nailed to the top.
c) Cave-in – separation of a mass of soil or rock from the side of an excavation, or the loosening of soil from beneath a trench shield in quantities that would entrap, bury, or otherwise injure a person.
d) Compact Soil – soil that is hard and appears stable can be indented by the thumb but difficult to penetrate.
e) Competent Person – certified by OSHA as the individual trained to identify existing and potential hazards of an excavation. He has the authority to take corrective measures to eliminate all hazards. Who assumes a similar role with emergency service responders?
f) Cross Brace – horizontal shoring installed perpendicular to the trench wall, pushed up against uprights or walers.
g) Distressed soil – soil that is in a condition where a cave-in is imminent. Signs include fissures around the lip of the trench or on the trench wall, bulging of the trench wall, or running water in the trench.
h) Excavation – any man-made cut, cavity, trench or depression into the earth’s surface created by earth removal.
i) Failure (kick out) – displacement or deformity of any structural member that may cause the protective system to be compromised.
j) Lip Slide – when the top edge of a trench breaks loose.
k) Protective System – a system designed to prevent the trench walls from caving in, protecting personnel working in the trench. Examples are close sheeting, cutting the trench back to a safe angle (angle of repose), or using trench shields.
l) Running soil – loose free flowing soil.
m) Safing a trench – making a trench safe by installing sheeting and shoring.
n) Sheeting – a member of a protective system designed to be erected and secured against the wall of the trench and in turn supported by other elements of the protective system. Fire department ladders are not suitable for makeshift sheeting material.

o) Shield or trench box – commercial protective system installed into the trench as a self-sufficient protective system. Quickest and safest to use and usually made of steel or aluminum.
p) Surcharge – additional weight in the trench area and lip.
q) Tag line – handheld length of rope used to steady an object.
r) Trench – narrow excavation made below the surface of the earth, the depth being greater than the width, with the width at the bottom not to exceed 15 feet.
s) Trench shores – device that provides opposing lateral support.
t) Uprights (strong backs) – vertical members of a protective system designed to absorb the horizontal generated by the cross braces; usually constructed using 2x10s, 2x12s or aluminum rails.
u) Wales – wooden or aluminum horizontal members of a protective system placed parallel to the trench wall and supported by cross braces. This configuration allows for larger working space inside the trench. Timbers may range form 4x4s to 10x12s depending on width and depth of the trench.

2. Identify and discuss the leading causes for cave-ins.
   a) Failure to follow safety rules.
   b) Working in disturbed soil.
   c) Inadequate protective system.
   d) Absence of any protective system.

3. Identify and discuss the contributing factors for a trench collapse.
   a) Effect of various types of weather.
   b) Surcharge weight – heavy weight sitting near the edge of the trench lip.
   c) Vibration, industrial traffic, heavy machinery.
   d) Water seepage.
   e) Mixed soil (soil stratification).
   f) Lack of sufficient moisture in the trench.

4. Discuss the OSHA statistics regarding worker injuries and fatalities at a trench operation.

a) From 2000 – 2009, 350 workers died in trenching or excavation cave-ins – an average of 35 fatalities per year.
b) An analysis of OSHA data from 1997 – 2001 showed that 64% of fatalities in trenches occurred at depths of less than 10 feet.

5. Discuss the dynamics of a collapsing trench wall.
   a) A collapsing trench wall moves at a rate of 55 – 66 feet per second. This is equivalent to approximately 45 miles per hour.

6. Point out that all NC Emergency Service responders likely to respond to a trench accident should be familiar with OSHA standards that pertain to trenching operations such as OSHA 29 CFR1926.650-652, Excavation 29 CFR 1910.146 – Confined Space and 29 CFR 1910.147- Lock Out Tag Out.

References:
http://www.nclabor.com/osha/etta/indguide/ig27.pdf
http://www.nclabor.com/osha/etta/indguide/ig14.pdf
http://www.nclabor.com/osha/etta/indguide/ig1.pdf

7. Discuss the definition of a needs assessment and identify the criteria for conducting a needs assessment specifically for a trench collapse incident.
   a) A needs assessment is typically part of the pre-planning process (preparatory).
   b) The purpose of a needs assessment is to evaluate the responding department's capacity to function safely at any given emergency incident.

8. Discuss questions that should be addressed during the needs assessment process.
   a) Are trench rescues performed regularly or infrequently?
   b) Do trench rescue incidents occur more frequently during a particular time of day or on a particular day of the week?
   c) How severe are the trench rescue incidents, do they involve simple, quick actions or are they long, tedious operations?
   d) Do the trench rescue problems involve natural hazards?
   e) Are parts of the response district more likely than others to generate a trench rescue incident?

f) What is the average response time to any location within the response district?

Reference: IFSTA, 7th Edition Fire Service Search and Rescue, pages 7 through 9.

9. Discuss issues that should be addressed when developing a pre-plan. This is also the Preparatory Phase.
   a) What are the technical capabilities of response agencies?
   b) Does the department have the necessary equipment to match the response level?
   c) How many personnel are trained to respond and work at a trench accident?
   d) Tour your district periodically to compile a list of active construction sites where trenching operations are being conducted.
   e) Identify construction site types; commercial, residential?
   f) For long - term operations, questions such as how will the personnel's hygiene needs be met?
   g) How will the personnel's need for food and water be met?
   h) What about a rehab station and medical monitoring of rescuers involved in the tactics of the operation?
   i) How will crowd control be handled?
   j) How will rescuers and victim(s) be protected from the environment: extreme heat, extreme cold, rain and thunderstorms?

NOTE: Managing bystanders and spectators is a high priority due to the importance of preventing a possible secondary collapse.

10. Discuss self-sufficient response as an option for the AHJ.
    a) A department may choose to be self-sufficient which would require a commitment of many hours of specialized training and practice, the need for specialized equipment and transport vehicle.
    b) The above method of response is the most efficient method for ensuring rapid response and high-level skill capability but it is also the most expensive method.

11. Discuss the community dependent response as an option for the AHJ.
    a) A department may choose to be community dependent which would require meeting with local government agency officials such as the sewer department, water department and highway department to determine their resource capabilities, both personnel and equipment.
    b) Meet with owners of private construction companies, lumber companies, and heavy equipment rental companies to determine their resource capabilities. This includes cranes, aerial ladders and aerial platforms.
    c) Cranes and backhoes should not be used as manlifts.
    d) Establish a 24 hour resource list, including contact numbers and names of contacts.
    e) Meet with the department heads of other emergency service agencies to discuss their resource capabilities.

12. Discuss regional response as an option for the AHJ.
    a) A great advantage of this type of response is that it spreads the cost of implementation and operation over several jurisdictions.
    b) It reduces the financial burden on an individual organization.
    c) It requires a commitment of each agency involved to maintain training proficiency and maintenance of assigned equipment.
    d) This type of response system can be very hard to organize and maintain because personnel and equipment may be spread over a large area.
    e) Establish written mutual aid agreements and response guidelines with all agencies that have agreed to respond in the event of a trench rescue incident.

13. Discuss the elements of creating a trench rescue response team.
    a) Trench rescue activities are obviously very strenuous, requiring manipulation of heavy equipment under high stress conditions and various environmental situations.

b) It is critical that selected team members are physically fit to meet the demands of the rescue operation.
c) Select personnel that are emotionally adapt to the various stresses that may be present at a trench accident.
d) Select personnel that have some basic construction skills: using a hammer, cutting with a skill or chainsaw.
e) Be very selective in which roles you expect your team members to function.
f) Recognize that everyone does some things better than others.
g) Make sure that the medical personnel working with your team are well trained to deal with the special trauma associated a trench entrapment, such as compartment syndrome or crush syndrome.

Reference: Trench Rescue Training Levels: Awareness, Operations and Technician 2nd Edition, page 24.

NOTE: Point out that NFPA 1670, Chapter 4.1.1 requires the AHJ to establish levels of operational capability needed to conduct operations at technical search and rescue incidents safely and effectively, based on hazard identification, risk assessment, training level of personnel, and availability of internal and external resources.

14. Identify and discuss the departmental functions for the Awareness level response to trench collapse rescue incidents as established by NFPA 1670 Chapter 11.2.
    a) Recognizing the need for a trench and excavation rescue.
    b) Procedures should be established for the identification of the resources needed to conduct a safe and effective trench and excavation emergency operations.
    c) Procedures should be established for implementing the emergency response system.
    d) Procedures should be established for implementing site control and scene management.
    e) Recognizing general hazards associated with trench and excavation emergency incidents and

the procedures necessary to mitigate these hazards within the general rescue area.

f) Procedures should be established for identifying typical trench and excavation collapses, the reasons trenches and excavations collapse and potentials for secondary collapse.

g) Procedures should be for making a rapid non-entry extrication of a non-injured or minimally injured victim.

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

15. Identify and discuss the departmental functions for the Operations level response to trench collapse rescue incidents as established by NFPA 1670.

a) Develop and implement procedures for sizing up existing and potential conditions at trench and excavation emergencies

b) Develop and implement procedures for making an entry into a trench or excavation area.

c) Develop and implement procedures for recognizing unstable areas associated with trench and excavation emergencies and adjacent structures.

d) Develop and implement procedures to identify probable victim location and survivability.

e) Develop and implement procedures for making the rescue scene safe, including identification, construction, application, limitations, and removal of traditional sheeting and shoring using tabulated data and approved engineering practices.

f) Develop and implement procedures for initiating a one-call utility location service.

g) Develop and implement procedures to identify soil types using accepted visual or manual tests.

h) Develop and implement procedures for ventilation.

i) Develop and implement procedures for identifying and recognizing a bell-bottom pier hole excavation and its associated unique hazards.

j) Develop and implement procedures for placing ground pads and protecting the lip of the trench.

k) Develop and implement procedures providing entry and egress paths. Maximum lateral travel distance to egress should not exceed 25 feet.

l) Develop and implement procedures conducting a pre-entry briefing.
m) Develop and implement procedures for record-keeping and documentation during entry operations.
n) Develop and implement procedures for selection, utilization, and application of shield systems.
o) Develop and implement procedures for selection, utilization, and application of sloping and benching systems.
p) Identify the duties of panel team, entry team and shoring team.
q) Develop and implement procedures for assessing the mechanism of entrapment and the method of victim removal.
r) Develop and implement procedures for performing extrication.

16. Identify and discuss the departmental functions for the Technician level response to trench collapse rescue incidents as established by NFPA 1670.
a) Procedures for evaluating existing and potential conditions at trench and excavation emergencies.
b) Procedures for identifying, constructing, installing, and removing manufactured protective systems, consistent with the application and limitations of such systems using tabulated data and approved engineering practices. Procedures to continuously or at frequent intervals monitor the atmosphere in all parts of the trench to be entered. The monitoring shall be done in the following sequence; oxygen content, flammability (LEL/LFL) and toxicity in that order.
c) Procedures for identification, construction application, limitations and removal of supplemental sheeting and shoring systems designed to create approved protective systems.
d) Procedures for adjustment of protective systems based on digging operations and environmental conditions.
e) Procedures for rigging and placement of isolation systems

Reference: NFPA 1670 Standard on Operations and Training for Technical Rescue Incidents, 2009 Edition.

17. Emphasize that personnel responding to a trench accident require specialized training.
    a) Training should be tailored to address rules and regulations established by OSHA 1926.650-652 construction standard and response guidelines established by NFPA1670 and the professional qualification standard for trench rescue, NFPA 1006 Chapter 8.
    b) After initial training, periodic continuing education should be required to ensure that personnel retain their skill proficiency.

18. Discuss how training integrates into the pre-planning process.
    a) Periodic intensive training should be made available to all personnel who may be involved in the incident.
    b) Training exercises give those who would be involved in an incident an opportunity to see the plan in action and test their understanding of the plan.
    c) Any deficiencies can be identified and remedied.

Reference: IFSTA, 7th Edition Fire Service Search and Rescue, page 195.

19. Command Officers and especially scene Safety Officers should be very familiar with all regulations that might impact actions taken during a trench rescue operation.

20. Consider inviting an OSHA representative to your planning session to get input from them as to how the trench standard will affect your operation.
    a) Another suggestion would be to put your OSHA representative on your call resource list, he or she will probably show up anyway, especially if any of the following occur: a civilian or rescuer injury or fatality as result of a collapse, the death of anyone as the result of a construction incident, or when requested by the authority having jurisdiction.

21. From a rescue agency standpoint when does OSHA require compliance with the standard?
    a) When an employer/employee relationship exists.

b) When trench rescue operations are part of your job.
c) Would your department normally be dispatched to a trench collapse?
d) Does your department train for, acquire equipment for, and prepare to participate in a trench rescue operation?

22. Discuss the issue regarding paid versus volunteer departments.
    a) Most paid departments, especially those with a state run OSHA program must be compliant.
    b) Volunteers may be exempt from many OSHA regulations.
    c) Consider the following: do volunteers have to comply with NFPA?
    d) Do volunteers have to comply with OSHA?

Reference: Trench Rescue Training Levels: Awareness, Operations and Technician 2nd Edition, page 33.

23. Identify and discuss the components of Phase I – Assessment on arrival for a trench rescue operation.
    a) Primary Assessment – performed by the first arriving unit.
    b) Assessment actually begins with initial dispatch and continues during response and after arrival.
    c) The first-in officer must begin formulating a mental picture of the mission based on dispatch information.
    d) Time of day, weather, and traffic conditions during response to the scene.
    e) Upon arrival, the IC should initiate an information gathering process to include; all workers being accounted for, number of victims and location(s), is worker partially or totally buried, and how much time has elapsed since the cave-in. One problem incident commanders may have in gathering information is finding workers that speak English.
    f) Considerations for positioning apparatus at the scene should include, but not be limited to: proximity to the trench / hazard and accessibility for other specialty vehicles to enter the scene.
    g) Once data is gathered the IC can begin the decision-making process.

h) Can the on-scene or responding units handle the rescue?
i) Begin immediately requesting appropriate resources.
j) Formal command should be established by this point and location should be communicated to the communications center and responding units.
k) Scene control, to include setting up hazard control zones, should be initiated as soon as there are enough personnel on the scene to assign this task.
l) Secondary assessment involves a closer evaluation of the scene to gather specific information about the trench condition and surcharge load.
m) Identify and document type of soil.
n) Condition of the trench, type of cave-in, type of shoring needed, what are surrounding hazards.
o) Determining mode of operation as a rescue or recovery.
p) Identifying the mode of operation will affect the development of the IAP.

24. Identify and discuss the components of Phase II - Pre-Rescue Operations for a trench rescue operation.
    a) Begin developing and finalizing the IAP.
    b) Communicate the IAP to all participating personnel.
    c) Develop a back-up plan.
    d) Gather resources necessary to carry out the IAP, personnel and equipment.
    e) Monitor atmosphere.
    f) Ventilate the trench.
    g) Mitigate the hazards.
    h) Provide fire protection as needed.
    i) Initiate shoring operations.
    j) Laddering should be done before any other operations so that a rescuer can self-extricate themselves if they were to fall into the trench.

25. Identify and discuss the components of Phase III - Rescue Operations.
    a) Establish personnel accountability system.
    b) Once shoring is in place rescue operation can begin, which may consist of freeing a partially

buried victim and or physically removing soil to find a totally buried victim.

26. Identify and discuss the components of Phase IV - Termination Operations.
    a) The most obvious reasons include accounting for all personnel and equipment at the end of the operation.
    b) Wear all PPE throughout termination.
    c) If termination completion is during night time hours it is best to wait till morning to remove panels so they can be removed safely during daylight hours.
    d) If tools drop into the unprotected area rescuers should leave it and forget it.
    e) All used equipment should be inspected and serviced according to manufacturer's recommendations.
    f) A critique of effectiveness of the strategies, tactics, and debrief the team.

27. Discuss concerns regarding the dismantling of the shoring system.
    a) This can be a very dangerous process if not done correctly.
    b) Stress to personnel performing this function not to be complacent.
    c) The shoring system should be dismantled in reverse order of its construction.
    d) Personnel should always work within the safe zone, just as they did during the construction phase.
    e) Other issues to be addressed include; investigating the cause of the incident, releasing the scene back to those responsible for it, and providing psychological support for all requesting personnel by setting up a Critical Incident Stress Debriefing.

Reference: IFSTA, 7th Edition Fire Service Search and Rescue, pages 256 through 266.

PRESENTATION

ENABLING OBJECTIVE #2

The Technical Rescuer shall correctly describe in writing the factors that rescuers must know to effectively perform a scene size-up involving trench rescue incidents.

1. Initial size-up begins at the time of the alarm. Identify information that should be obtained while enroute to the scene.
   a) Initial information regarding the incident is typically sketchy.
   b) Prompt the dispatcher to try to maintain contact with the caller so that additional information may be gathered to assist with developing an initial plan of action while enroute to the scene.
   c) During the initial scene size-up initiate steps to take control of the scene.

2. Identify and discuss questions that should be addressed during the response phase.
   a) What has happened?
   b) Why was the excavation work being done?
   c) Is the victim completely buried?
   d) Is this a trench collapse or some other type of type of problem in or around the trench?
   e) Will access to the site be a problem for vehicles and personnel?
   f) What is the short term and long-term status of the weather?
   g) Where is the closest Level I staging area for all resources responding to the scene? This is also called the supply point.

3. Discuss points that should be addressed during the primary assessment of a scene size-up.
   a) Find out what has happened? Who is in charge?
   b) Assess what is currently happening.
   c) Determine what is likely to happen.
   d) Identify hazards that need to be mitigated.
   e) Determine what resources are immediately needed and evaluate for future resource needs.
   f) Have all workers been accounted for?
   g) How many victims are there?
   h) Is their location known?
   i) Is this a rescue or recovery?

4. Discuss the decision making process as it relates to the primary assessment.

a) Are on-scene resources sufficient to handle the operation?
b) Establish scene control.
c) Control the bystanders.
d) Set up the control zones.

5. Identify the components of a secondary assessment.
   a) Identify soil type.
   b) Identify condition of the trench: what type of cave-in occurred? Did one or both walls collapse? What type of shoring will be needed? What loads will have to be moved? Are there hazards in and around the trench?
   c) Determine the mode of operation - rescue or recovery?

Reference: IFSTA, 7th Edition Fire Service Search and Rescue, pages 258 and 259.

6. What significance does a risk/benefit analysis have on the success or failure of a trench rescue operation?
   a) It is always easier to surmise what should have been done, especially after we have evaluated the outcome of our actions.

7. Point out that a risk/benefit analysis is the internal process we use to decide how much risk we are willing to assume in the performance of our duty?
   a) The above analysis involves weighing all of the factors that deal with risk and compare them with all the factors that determine benefits.
   b) The operation can have a favorable outcome if the benefits heavily outweigh the risk
   c) If the risks appear to outweigh the benefits, there may be no advantage to continue the operation.

8. Discuss the purpose of conducting a risk/analysis as part of a size-up to prevent being put into a position that causes poor judgment calls that may have disastrous results.

9. Point out that the best two ways to reduce rescuer injuries and fatalities is through proper pre-planning and comprehensive training.
   a) By identifying potential trench operation sites, being aware of rules and regulations pertaining to

trench operations, and developing a comprehensive response plan, it will greatly help reduce problems that may arise during a trench rescue operation.

b) Strategy and tactics training is important and should be addressed continuously.

10. One way to reduce the risk is to identify early on in the operation whether you have rescue mission or a recovery mission.

11. What is the risk to the rescuer?
    a) After addressing all the safety issues and neutralizing hazards to the best of your ability, do the rescuers stand a fair chance of succeeding with the operation without getting injured or killed?
    b) Is the risk to the rescuer proportional to the potential benefit of the attempted action?
    c) If questions arise regarding your judgment at this point in the operation, chances are you are getting ready to make a big mistake.

12. What are the benefits to the situation?
    a) If the risk to the rescuer can be reduced and the benefit is a savable victim, you are close to giving the situation a green light.
    b) There is no benefit in saving a dead person or a dead person's property if the action taken unnecessarily jeopardizes the rescuer.

13. Remember the three major things that will greatly enhance the potential for a successful operation.
    a) Special people.
    b) Special equipment.
    c) Special training.

Reference: Trench Rescue Training Levels: Awareness, Operations and Technician 2nd Edition, pages 13 and 14.

PRESENTATION

ENABLING OBJECTIVE #3

The Technical Rescuer shall correctly describe in writing necessary elements for implementing an on-scene

operational plan or incident action plan (IAP) associated with incidents involving trench rescue operations.

1. Discuss points to consider when developing an incident action plan (IAP).
   a) Who is in charge of the construction site?
   b) Is there a language barrier?
   c) Is the collapse within your scope of operations?
   d) What are the injury problems?
   e) What is the victim's survivability profile?
   f) What type of protective system is/was in place?

2. Define and discuss definition of an incident action plan (IAP).
   a) An IAP is a battle plan designed to establish reasonable goals and objectives based on the situation and implemented to mitigate hazards, gain access to victims, stabilize them and remove them from harms way while minimizing the risk to all rescuers.
   b) An IAP is developed after a preliminary size-up has been competed.
   c) Hazards are identified and the risks and benefits to the victim and rescuers are addressed heavily.
   d) The IAP should be simple, concise and flexible.
   e) All on-scene personnel should be made aware of the IAP and instructed as to what each rescue component's role is.
   f) All personnel must be advised when changes are made to the IAP.
   g) Be sure to develop a back-up plan in the event something unforeseen occurs during the operations.
   h) Included in the IAP are plans for providing a rapid intervention crew (RIC) or other means for instituting rescue and care of injured rescuers.

Reference: IFSTA, 7th Edition Fire Service Search and Rescue, page 259.

PRESENTATION

ENABLING OBJECTIVE #4

The Technical Rescuer shall correctly describe in writing the types of hazards and their consequences for rescuers that

need to be included in a hazards assessment associated with incidents involving trench rescue operations.

1. Identify common types of trench accidents.
   a) Lip failure.
   b) Single wall/double wall slough-in.
   c) Single wall/double wall shear.
   d) Spoil pile collapse.
   e) Worker trapped by heavy equipment or pipe.
   f) Worker trapped by cave-in material.

Reference: Trench Rescue Training: Awareness, Operations, Technician, pages 35 and 72 through 77.

2. Identify and discuss the leading causes for cave-ins.
   a) Failure to follow safety rules.
   b) Working in disturbed soil.
   c) Inadequate protective system.
   d) Absence of a protective system.

3. Identify and discuss contributing factors that may lead to a collapse.
   a) Narrow right of ways (not enough room for spoil and other materials to be placed a safe distance from lip).
   b) Vibrations (traffic, railways, nearby construction equipment).
   c) Water seepage.
   d) Lack of sufficient moisture in trench walls
   e) Soil stratification (mixed soil layers).
   f) Rain, Melting Snow- excessive water.
   g) Changing Temperatures- affect stability of protective system.
   h) Heavy loads close to trench lips- increase pressure on trench walls.
   i) Establish a vibration zone when necessary (recommend 300-500’ radius).

Reference: IFSTA, 7th Edition Fire Service Search and Rescue, pages 242 and 243.

4. Discuss why water may contribute to a collapse.
   a) The addition of water can add tremendous weight to a total volume of soil.
   b) Water weighs 62.4 pounds per cubic foot.

c) The absorption rate determines the total weight for any given volume of soil.
d) The effect water has on the ability of the soil to maintain its strength when wet is critical.
e) Beware of soil that looks solid but is actually wet and unstable.
f) Soil that contains a high quantity of seeping water is considered saturated.

5. Discuss the dangers of a freestanding trench.
   a) Once a trench is cut, it is subjected to all of the climatic hazards; wind, dryness, and water.
   b) The freestanding time also creates a critical hazard as the compressive forces of the exposed wall want to push the wall into the open space
   c) The longer the trench stays open without the installation of a protective system, the greater risk for a collapse.

6. Discuss how varying soils (layered compositions) can contribute to the instability of the trench.
   a) Multiple layers of soil have different friction coefficients (stickabilty, cohesion).
   b) Multiple layers also make it difficult to establish a true soil classification.

7. Identify the hazards associated with the location of equipment on the site.
   a) Heavy equipment on scene should not be used for dirt removal within the trench.
   b) The equipment digging the trench causes pressure to be exerted on the trench lip and walls.
   c) The depth of the trench increases the lateral pressure and potential for collapse.
   d) If a running piece of equipment is the cause of a collapse it will probably be in the hole.
   e) The general rule of thumb is to turn off the piece of equipment, give the keys to the Command Officer or designee, and leave the equipment in place.
   f) Operating equipment also creates vibration which can contribute to making the trench unstable and ultimately leading to a collapse.
   g) A vibration zone should be established, most trench specialist recommend 300 feet in any direction from the trench.

h) Anything that is creating vibration within the vibration zone should be shut down or detoured.
i) Examples include: road traffic, industrial machinery, augers, and drilling equipment.

Reference: Trench Rescue Training Levels: Awareness, Operations and Technician, 2nd Edition, pages 63 and 64.

8. Point out other hazards to look for. List and discuss the categories identified below.
   a) Chemical.
   b) Man-made.
   c) Electrical.
   d) Water.
   e) Sewage.
   f) Gas mains.

9. Discuss chemical and atmospheric hazards that may cause a problem for rescuers.
   a) Be aware of unearthed drums or canisters.
   b) Workers sometimes take chemicals into the trench including gas for saws, cleaning solvents for PVC pipe.
   c) Natural gases that may seep from the trench are methane and hydrogen sulfide.
   d) Always be on alert for these types of hazards.
   e) Provide continuous air monitoring during the course of the operation.

10. Discuss man-made hazards that may cause a problem for rescuers.
   a) Lack of appropriate protective system.
   b) Spoil pile location.
   c) Equipment location.
   d) Tripping hazards.

11. Discuss electrical hazards that may cause a problem for rescuers.
   a) Control of electricity is best left to the electrical expert.
   b) Examples of electrical hazards may include: electrical pole, cables, phone lines, and transmission boxes.

12. Discuss water hazards that may cause problems for rescuers.

a) Remember water is a rescuer's worst enemy.
b) Broken water main.
c) Seeping or running water in the trench.
d) Rain as result of inclement weather.
e) Water must be evacuated from the trench and controlled as soon as possible.
f) In the case of rain, run off drains may have to be dug and a canopy may have to be erected over the area of the trench where the rescue operation is taking place.

13. Discuss dewatering systems and well point systems.

Reference: Trench Rescue Training Levels: Awareness, Operations and Technician 2nd Edition, page 108.

14. Discuss the physical forces associated with a collapse.
    a) The weight of 1 cubic foot of soil is approximately 100 pounds, more or less depending on type of soil and moisture content.
    b) One cubic foot equates to a 1'x 1' x 1'box of dirt.
    c) Dry soil is one half soil and one half air.
    d) The specific gravity of rock is 2.65 times heavier than water.
    e) Water weighing 62.4 pounds x 2.65, rock would weigh 113.88 pounds per cubic foot based on adding one half cubic foot of water (31.2 pounds pcf) and one half cubic foot of rock (82.68 pounds pcf).
    f) Based on scientific calculation two feet of average soil resting on a victim's chest would weigh between 700 and 1000 pounds.
    g) With normal soil weighing about 100 pounds pcf, a column of dirt 1' x 1' x 6' tall would have a total force of 600 pounds per square foot at the bottom.
    h) The amount of lateral force exerted on an unshored wall is about 33% of the total forces as measured on the bottom of any cubic foot.
    i) The force at the four-foot level of a six-foot deep trench would be 400 pounds per square foot of vertical pressure; the lateral force would be about 132 pounds per square foot.
    j) Proper sheeting (panels) and shoring is designed to transmit the pressure of one side of the trench

to the earth on the other side of the trench thus stabilizing the trench walls.

Reference: Trench Rescue Training Levels: Awareness, Operations and Technician 2nd Edition, pages 59 through 61.

15. Discuss the OSHA rule regarding the position of a spoil pile.
    a) Spoil is dirt that has been excavated from the trench and placed somewhere at ground level.
    b) Most operators will place the spoil at the edge of the trench lip to expedite putting it back in the hole after the job is done.
    c) Soil placed to close to the trench edge (lip) creates excess surcharge (weight) on the lip of the trench that contributes to spoil pile failures.
    d) Spoil pile failure also results from the soil piled too high and the natural angle of the repose of the pile is too steep.
    e) Consider also that the height of the spoil pile located on the edge becomes part of the overall depth of the trench on the spoil pile side.
    f) OSHA requires that the spoil pile should be placed a minimum of 2 feet away from the lip of the trench and the angle be such that the spoil pile does not impose a threat of sliding into the trench.

16. Discuss how a slough failure may occur.
    a) It is the loss of part of the trench wall.
    b) The force associated with unconfined hydrostatic pressure becomes greater than the soil's ability to stand.
    c) Failure can also occur as the result of excess surcharge bearing downward against the wall.
    d) Cracks in and around the trench, and multiple layers of soil are key indicators for a potential slough failure.

17. Discuss how a shear wall failure may occur.
    a) This occurs when a section of soil loses its ability to stand and collapses into the trench along a vertical plane.
    b) It is caused most often by cracks in the earth's surface exposed to weather over an extended period.

c) As the cracks are exposed to the cycle of water and then drying out, the cracks get larger and deeper until the trench wall is no longer self-supporting.

18. Discuss how a toe failure may occur.
    a) This is a slough failure occurring at the bottom of the trench.
    b) As the soil falls into the trench it creates an opening on the wall at floor level.
    c) It can be caused by a sand pocket or water seeping in at the bottom of the trench.

19. Discuss how a rotational failure may occur.
    a) This type of collapse is referred to by some as a lip failure.
    b) It is a scooped shaped collapse starting back away from the lip and characteristically collapses in a half moon shape.
    c) This type of collapse creates difficult challenges when designing a protective system.

Reference: IFSTA, 7th Edition Fire Service Search and Rescue, pages 243 and 244.
Reference: Trench Rescue Training Levels: Awareness, Operations and Technician 2nd Edition, pages 72 through 77.

20. Discuss how a wedge failure may occur.
    a) This type of failure normally occurs with intersecting trenches.
    b) An angled section of earth will fall from the corner of an intersecting trench.
    c) This type of failure can be sudden and catastrophic.

21. Discuss tension cracks and what may cause them.

22. Discuss the definition of stable rock.
    a) Type of soil that is naturally solid and can remain standing after excavation.
    b) The danger associated with stable rock usually does not involve a collapse.

23. Discuss the definition for Type A soil.
    a) Type A soils are cohesive materials with an unconfined compressive strength of 1.5 tons per

square foot. Examples include: clay, silty clay, clay loam, and sandy clay loam.

b) No soil is Type A if it is: fissured, subject to vibration, previously disturbed soil, soil that is part of a sloped soil layer that is greater than 4 horizontal to 1 vertical.

24. Discuss the definition for Type B soil.
    a) Type B soils are cohesive materials with an unconfined compressive strength greater than 0.5, but less than 1.5 tons per square foot. Examples include: angular gravel, silt, silty loam, sandy loam, and sandy clay loam.

25. Discuss the definition for Type C soil.
    a) Type C soils are cohesive materials with an unconfined compressive strength of 0.5 tons per square foot or less. Examples include: granular soil, sand, sandy loam. Submerged soil, soil from which water is flowing or submerged unstable rock. Correct slope for this type of soil is 34 degrees.

26. Discuss the definition for Type C-60 soil.
    a) Type C-60 was created by the Speed Shore hydraulic shore company and adopted by OSHA for soils that are moist and cohesive or mist dense granular soils that do not fit into Type A or B classification and is not flowing or submerged.
    b) This type of soil can be cut near vertical walls and will stand unsupported long enough to allow shoring to be installed.

27. Discuss how a visual test is conducted for classifying various soil types.
    a) Begin looking at the spoil pile dirt, fine grain dirt that remains in clumps is said to be cohesive.
    b) Look at the trench walls for signs of layered soils, and indications of pre-disturbed soil such as the presence of underground utilities.
    c) Look for fissures on the trench wall and at ground level running away from the trench lip.
    d) Look for standing, seeping, or running water.
    e) Discuss the relationship of soil types and slope.

28. Discuss how a plasticity test is performed for classifying various soil types.
    a) This test is done by molding a moist wet sample into a ball, rolling it into a thread as thin as 1/8inch diameter, and holding onto one end without it tearing. If a 2 inch long thread rolled 1/8” diameter can withstand tearing it is said to be cohesive.

29. Discuss how a ribbon test is performed for classifying various soil types.
    a) This test determines how much clay or silt the soil contains.
    b) Roll fine soil and fine sand between the palms of the hand forming a cylinder 6 inches long, ¾ inch diameter.
    c) Lay the cylinder across one palm and using your thumb and forefinger press the cylinder to 1/8 inch flat.
    d) Hang the squeezed portion over the side of the hand.
    e) If the cylinder forms 6 or more ribbon sections in length the soil is said to be clay, less than 6 sections of ribbons the soil is said to contain silt.

30. Discuss how a thumb penetration test is performed for classifying various soil types.
    a) This test estimates the unconfined compressive strength of cohesive soils.
    b) Place your extended thumb horizontally against the exposed material and attempt to penetrate the material.
    c) Type A soil can be indented, but with great effort.
    d) Type C soil can be easily penetrated several inches.
    e) A penetrometer is a commercial device that performs a mechanical thumb test.

NOTE: Classifying the soil should be done regardless of whether the contractor will slope the excavation or not.

Reference:
http://www.nclabor.com/osha/etta/indguide/ig14.pdf.

31. Point out and discuss the various OSHA confined space rules that may very well apply to a trench operation.
    a) Large enough and configured for employee occupancy.
    b) Has limited means of egress.
    c) Not designed for continuous employee occupancy.
    d) Has an actual or potential hazardous atmosphere.
    e) May contain material that can engulf an entrant.
    f) Has an internal configuration that could trap or asphyxiate the entrant.
    g) Any other recognized serious safety hazard.

Reference:
http://www.nclabor.com/osha/etta/indguide/ig1.pdf.

PRESENTATION

ENABLING OBJECTIVE #5

The Technical Rescuer shall correctly describe in writing the responsibilities of command and the primary functions of command associated with incidents involving trench rescue operations.

1. Discuss the role of Command.
    a) The Command position fixes responsibility of command on a specific individual through a standard identification system.
    b) It ensures that a strong direct and visible command will be established from the onset of the incident.
    c) Command establishes an effective organization defining the activities and responsibilities assigned to the Incident Commander and to other individuals operating within the Incident Management System.
    d) It provides a system to process information to support incident management planning and decision-making.
    e) It provides a system for orderly transfer of command to subsequent arriving officers.
    f) According to NFPA 1561, Standard on Fire Department Incident Management System, an

IMS defines the roles, responsibilities and standard operating guidelines used to manage emergency operations.

2. Identify the procedures for establishing command.
   a) The first unit or member on the scene must initiate whatever parts of the Incident Management System are needed to effectively manage the incident.
   b) Command is activated by the first radio report announcing arrival of the first in unit, and a brief report of existing conditions.
   c) Air horns and eye to eye contact are methods to establish communications.

3. Point out that a single company incident may only require that the company or unit acknowledge their arrival on the scene.

4. Emphasize that for an incident requiring the commitment of multiple companies or other resources, the first arriving unit or member must establish and announce command and develop an incident command structure appropriate for the incident.
   a) Multiple rescue sites requiring unified command will be more complex in developing the incident organization.

5. Identify the responsibilities of command.
   a) Remove endangered occupants and treat the injured.
   b) Provide for life safety and stabilize the incident.
   c) Conserve property and evidence.
   d) Provide for the safety, accountability, and welfare of personnel. Emphasize this priority is ongoing throughout the incident.
   e) Establish safe control zones in which the rescuers will work.

6. Identify and define the control zones that should be established
   a) **Hot Zone** – Area where the rescue takes place. Only rescuers directly responsible for freeing or treating the victim are allowed in this zone. This zone should have one way in and one way out and strict accountability should be maintained.

b) **Warm Zone** – located immediately outside the hot zone and designated for personnel assisting with support operations for rescuers in the hot zone.
c) **Cold Zone** – located outside the warm zone, this area is where the command staff, staging, media and family members will be staged.
d) **Vibration Zone** – extends from the hot zone out to a distance that may encompass ground vibrations that may effect the stability of the trench walls and thus may have to be eliminated through detour or stopping the operation causing the vibration. Examples may include road traffic, heavy equipment operations, active railroad line or nearby industrial operation. A minimum of 300 feet is recommended initially. Further extension is left to the AHJ discretion.
e) **Danger Zone** – The area surrounding an accident site that is proportional to the severity of the on-the-scene hazard.
f) **Rescue Area** – This should be an area directly around the rescue site, possibly 50 feet in all directions.
g) **Safe Zone** – Area within the trench that is protected by a shoring system.

Reference: IFSTA, 7th Edition Fire Service Search and Rescue, page 258.
Reference: Trench Rescue Training Levels: Awareness, Operations, and Technician 2nd Edition, page 48.

7. Identify the functions of command.
a) Responsible for all incident activities including the development of strategies and tactics, and the ordering and the release of resources
b) Assumes and announces command and establishes an effective operating position or command post.
c) Rapid size-up to evaluate the situation.
d) Initiate, maintain, and control the communication process.
e) Identifies the overall strategy, develops an incident action plan, and assigns companies and personnel consistent with plans and standard operating guidelines.

f) Develop an effective Incident Management Organization.
g) Provide clear tactical objectives.
h) Initiate and maintain a tactical worksheet for accountability and documentation.
i) Review, evaluate and revise the incident action plan.
j) Provide for the continuity, transfer, and termination of command.

Reference: IFSTA, 1st Edition Technical Rescue for Structural Collapse, pages 31 through 36.
Reference: NFPA 1561, Standard on Emergency Services Incident Management System, 2008 Edition.

8. Discuss the concept of Unified Command.
   a) An application of the Incident Command System (ICS) that allows all agencies with jurisdictional responsibility for an incident or planned event, either geographical or functional, to manage an incident or planned event by establishing a common set of incident objectives and strategies. This is accomplished without losing or abdicating (giving up) agency authority, responsibility or accountability.

Reference: NFPA 1561 Standard on Emergency Services Incident Management System 2008 Edition.

9. Identify the role of the Safety Officer.
   a) Answers directly to the IC.
   b) Is responsible for monitoring and assessing safety hazards and unsafe situations, and for developing measures for ensuring personnel safety.
   c) The Safety Officer must be familiar with the environment and any standards that may apply to the rescue incident.
   d) The Safety Officer is responsible for controlling the “big picture” regarding safety issues.
   e) The Safety Officer is the only officer, other than the IC, that has the authority to halt an operation.

Reference: NFPA 1561, Standard on Emergency Services Incident Management System, 2008 Edition.

10. Identify the role of the Liaison officer.
    a) Responsible for gathering critical inter-agency information from all responding agencies.
    b) The Liaison Officer is also responsible for coordinating with representatives from cooperating and assisting agencies.
    c) Agencies that might interact with the Liaison Officer are the police department, utility contractor, electric company, water department, Red Cross, and OSHA.

Reference: NFPA 1561, Standard on Emergency Services Incident Management System, 2008 Edition.

11. Identify the role of the Public Information Officer.
    a) The PIO is responsible for interfacing with the public and media or with other agencies with incident-related information requirements.
    b) The PIO educates the media on rescue methods and the difficulties of the task.
    c) The PIO keeps the media informed and gives command an important ally that may result in additional funding or donations for desperately needed equipment.

Reference: NFPA 1561, Standard on Emergency Services Incident Management System, 2008 Edition.

12. Identify the role of the Operations Section Chief.
    a) The Operation Section Chief is responsible for overall coordination of the rescue effort.
    b) The Operation Section Chief is responsible for implementing tactical decisions that will make the IC's strategy successful.
    c) Divisions and groups that would report directly to the Operation Section Chief include; Extrication Group, Medical Group, and Haz-Mat Group.

13. Identify the role of the Logistics Section Chief.
    a) The Logistics Section Chief, when appointed, is the person responsible for procuring the necessary equipment and personnel requested by the Operations Section Chief.
    b) Functions that fall under the Logistics Section Chief include rehab.

c) The Staging Manager is responsible for ordering and maintaining adequate resources at the scene to handle additional requests for equipment and manpower.
d) The Service Branch is responsible for medical monitoring of personnel and providing food and fluids.
e) Rescuers involved in tactics should be required to periodically rotate through this station during the operation.
f) The Logistics Section is responsible for maintaining an inventory of all equipment that is on standby for use, and is responsible for keeping track of what equipment is assigned to which section, as well as accounting for it after the operation is complete.

14. Discuss the functions of the Task Level of Command.
    a) The two groups that come under this level include the Extrication Group and the Medical Group.

15. Identify the role of the Extrication Group.
    a) This group is directly responsible for implementing the techniques necessary for gaining access to the victim, stabilizing the victim and extricating the victim.
    b) This group coordinates the various support functions and ensures the proper steps in the recovery effort are followed.
    c) The Extrication Supervisor reports directly to the Operations Section Chief.

16. Identify the resources that are attached to the Extrication Group.
    a) Air Supply Unit. This unit (1-2 rescuers) is directly responsible for securing and making sure that all pneumatic tools like air bags and shoring devices are in good working order. They should be able to operate the devices.
    b) Cutting Unit. This unit (minimum 2 rescuers) is directly responsible for cutting and manufacturing systems that use wood. Wood systems may include; wedges, strongbacks and wood shores or construction of plywood panels. Personnel selected for this team should be very comfortable

and knowledgabe in operating various types of saws.

c) Panel Unit. This unit (minimum of 4 rescuers) is directly responsible for assembling the panels needed for the trench, as well as carrying them to and placing them in the trench. They oversee the installation of any trench shields. Once all panels are installed, the panel unit can be reassigned to other tasks as needed. Example: this unit could be assigned to assist the shoring unit.

d) Shoring Unit. This unit (1-3 rescuers) works inside the trench to secure the panels or walers to the panels to ensure a safe interior work zone.

17. Identify the role of the Medical Group.
    a) This group is directly responsible for implementing the techniques necessary for gaining access to the victim, stabilizing the victim and extricating the victim.
    b) This group coordinates the various support functions and ensures the proper steps in the recovery effort are followed.
    c) The Medical Supervisor reports directly to the Operations Section Chief.
    d) Ambulances and rescue vehicles should remain in staging unless needed.

Reference: NIMS Document.

18. Display and discuss the modular development concept of an organizational chart for a multi-group / division response.

Reference: NIMS Document.

APPLICATION

1. Divide the candidates into an equal number of groups. Have each group develop a pre-plan on a flip chart for a trench rescue response. Post each plan and have each group present their plan. Compare the plans. After the plans are compared, have the class as a whole select the best components of each plan to come up with a workable and effective pre-plan.

2. Following the same procedure as listed in #1 have the candidates develop an effective Incident Action Plan.

PRESENTATION

ENABLING OBJECTIVE #6

The Technical Rescuer shall correctly identify in writing, the components of an effective equipment assessment for trench rescue operations.

1. Discuss issues that should be addressed when determining initial and long-term equipment needs.
   a) Conduct a visual inspection of the spoil pile and the trench walls to determine the cohesiveness of the soil, and identify the depth and width of the trench. OSHA requires that any trench with a depth of 5 feet or greater must have a protective system installed prior to workers entering the trench.
   b) Identify the type of collapse; spoil pile or shear wall.
   c) Did the collapse involve a single wall or both walls?
   d) Will the surcharge loads have to be moved?
   e) Verify the existence of water, and exposed utilities within the trench.

2. Point out the above information will help the IC to determine the type of shoring system best suited for the trench as well as other support equipment.

3. Point out that for timber and hydraulic shoring, the dimension of the material and spacing requirements for each of the soil classifications are found on tabulated data sheets in the OSHA standard 1926 Subpart Appendix C and D.
   a) The OSHA Tabulated Data sheet rates timber and hydraulic shoring systems to a maximum depth of 20 feet.
   b) A Registered Professional Engineer (RPE) must design a protective shoring system for depths greater than 20 feet.
   c) When using commercial shoring equipment or trench boxes refer to the manufacturer's tabulated data sheet for proper installation.

d) Based on the dimensions of the shoring panels, rescue teams can safely shore a trench to a maximum depth of approximately 15 feet before supplemental shoring has to be considered and an RPE should be consulted.
e) If the incident is determined to be a recovery operation and the victim's location has been pinpointed, consideration should be given for the use of heavy equipment to cut the walls of the trench back to an acceptable depth and safe angle allowing the rescuers to enter the trench and recover the victim without undue risk to rescue personnel.
f) Guidelines for Sloping and Benching are found in 29 CFR OSHA 1926 Subpart B.

4. Identify support equipment that may be needed at a trench rescue operation and demonstrate the operational and maintenance characteristics of all listed power equipment. Follow manufacturer's recommendations.
   a) Ventilation fans with ductwork for air.
   b) Generators and lighting equipment. Consider hazards such as possible ignition sources. Is the equipment intrinsically safe?
   c) Power cords with junction boxes.
   d) Barricade tape and pickets.
   e) Shovels, both pointed tip and entrenching shovel.
   f) Dewatering pump. A diaphragm (mud hog) pump seems to work best for trenches.
   g) Intake and discharge hoses.
   h) Tool ropes, buckets, squares, duplex nails, nail pouches, and tape measures.
   i) Orange marking paint.
   j) Road cones.
   k) Air knife.
   l) Air compressor.
   m) Power saws.
   n) Shelters and thermal control options. Consider shelters for trapped victims as well as rehab for rescuers.

5. Lights at a trench collapse rescue operation are very important.
   a) Light stands can be outside the trench.
   b) They should be established prior to sunset.

c) It is important to light the entire scene for safety.

NOTE: The reference to depth requirement for installing a protective system is in conflict between the IFSTA Fire Service Search and Rescue manual that states 4 feet, and the Trench Rescue Training Levels: Awareness, Operations, and Technician manual that states 5 feet. OSHA 1926.652(a) requires 5 feet as the starting point for the installation of a protective system. OSHA states that if there is an existing or potential for a hazardous atmosphere in the trench protective shoring should be installed if the trench is 4 feet deep or greater.

Reference: IFSTA, 7th Edition Fire Service Search and Rescue, page 243.
Reference: Trench Rescue Training Levels: Awareness, Operation, Technician, 2nd Edition, page 33.
Reference: 29 CFR OSHA Construction Standard 1926, Subpart P Appendix B and C and D. 29 CFR OSHA Construction Standard 1926.652(a).

PRESENTATION

ENABLING OBJECTIVE #7

The Technical Rescuer shall correctly identify in writing, describe the function, and demonstrate the operation of various tools and equipment that may be necessary during a trench rescue incident.

1. Point out that the equipment cache located on scene should remain in close proximity to the rescue site. Rule of thumb is twice the distance from the lip as the trench is deep.

2. Discuss the design specifications for plywood panels used in the trench.
   a) When constructing panels using plywood the recommended grade is CDX and the required thickness is 1 and 1/8 inch as per OSHA guidelines.
   b) This can be accomplished by gluing and screwing 2 - 5/8” thick or 3/4” thick pieces of 4’ x 8’ sheets of plywood together giving a thickness of 1¼” or 1½”.

c) To enhance the durability of the plywood some rescue teams will water proof them and apply several coats of polyurethane.
d) Typically 2” x 12” x 12 foot long boards, referred to as strongbacks, are attached to the center line of the panels with 2 feet of the board extending from the top and bottom of the panel.
e) Some rescue teams will nail these strongbacks in place but most rescue teams prefer to bolt them on using 3½” to 3/4” carriage bolts and washers.
f) The strongbacks act as bearing plates for all cross braces.
g) Prefabricated sheeting assemblies should be stored vertically and on their edges.
h) Lumber used in trench rescue operations should be Kiln dried with a moisture content of 20% or less and can be stored indefinitely due to the low moisture content.

Reference: IFSTA, 7th Edition Fire Service Search and Rescue, pages 249 through 254.
Reference: Trench Rescue Training Levels: Awareness, Operations, Technician, 2nd Edition, page 102.

3. Discuss the design specifications for commercial panels such as Shor-Form and Finn Form panels used in the trench.
   a) These panels are made from artic birch; they are non-conductive and extremely strong.
   b) The exterior of these panels are impregnated with phenolic resins that provide for maximum reuse and ease of cleaning.
   c) The strongbacks act as bearing plates for all cross braces.
   d) These panels are available in 4’ x 8’ sheets with three available thicknesses, ¾ inch, 1 inch, and 1 ¼ inch, (14 ply, 17 ply, 21 ply).
   e) Rescue teams will use the 1 inch and 1 ¼ inch thickness for trench rescue operations.
   f) Attachment guidelines for the strongbacks are the same as for plywood.
   g) Rescue teams typically cut four ¾” holes in the panels, one on each corner and cut 45 degree angles on each corner of the panels and the strongbacks to eliminate sharp edges.

h) Utility ropes measuring a minimum of 7/16 inch diameter and at least twice the depth of the trench are secured to the panels, preferably at the bottom, one in each hole.

Reference: Trench Rescue Training Levels: Awareness, Operations, Technician 2nd Edition, page 102.

4. Discuss and demonstrate the operational characteristics of screw jacks.
   a) These jacks are constructed in two forms, one for use with timber and one for use with pipes.
   b) They consist of a boot end that is placed on one end of the timber or pipe and a threaded yoke assembly for tightening that is placed on the opposite end.
   c) The pipe, usually Schedule 80, 2" in diameter, or timber is cut on site to accommodate the span of the trench.
   d) They are not designed to span large distances, usually five to seven feet.
   e) Follow the manufacturer's tabulated data for usage.

Reference: IFSTA, 7th Edition Fire Service Search and Rescue, page 254.
Reference: Trench Rescue Training Levels: Awareness, Operations, Technician 2nd Edition, page 104.

5. Discuss and demonstrate the operational characteristics of Hydraulic Shores.
   a) These shoring devices offer a protective system that contains the shore (cross brace) and the upright as one unit.
   b) The system is lowered into the trench and then expanded using a 5-gallon reservoir of non-flammable and bio-degradable fluid.
   c) When the shores are expanded and tight the fluid is cut off using a stopcock valve built into the shore.
   d) They can be set quite quickly from above without having to enter the trench, but do not work well if the angle of the trench wall is not vertical or near vertical.

e) Display a sample tabulated data chart for hydraulic shores for each soil classification found in 1926 Subpart P Appendix D.
f) Discuss field maintenance procedures following manufacturer's guidelines.

Reference: IFSTA, 7th Edition Fire Service Search and Rescue, page 256.
Reference: Trench Rescue Training Levels: Awareness, Operations, Technician, 2nd Edition, page 104.

NOTE: Instructors should obtain the operating guideline for the hydraulic shore, and discuss the specific features, operational characteristics and safety concerns.

6. Discuss and demonstrate the operational characteristics of pneumatic shores.
   a) Air Shore and Paratech manufacture these gas-operated devices.
   b) These can be operated using air, nitrogen or carbon dioxide.
   c) They are constructed of lightweight tubular aluminum.
   d) They vary in length from 3 feet to 12 feet with a variety of extensions and base plate attachments.
   e) The shore is extended by using compressed air at pressures recommended by the manufacturer.
   f) These shores can be installed from the top. After the shore is extended, they should be locked.
   g) The operating pressures range from 100 psi to 350 psi. The lateral force exerted by the pneumatic shores will vary from 400 pounds to 700 pounds.

7. Discuss the usage of specific manufacture's tabulated data sheets for correct installation.

8. Discuss field maintenance procedures for pneumatic shores following manufacture's guidelines.

9. Demonstrate assembly of the shores to include attachment to air supply and operating procedures.
   a) The disadvantage of the pneumatic shore is the number of shores needed for the cache and the cost can be prohibitive for many departments.

NOTE: Instructors should obtain the operating guideline for each brand of pneumatic shore, and discuss the specific features, operational characteristics and safety concerns of the brand(s) being used by the AHJ.

Reference: IFSTA, 7th Edition Fire Service Search and Rescue, pages 255 and 256.
Reference: Trench Rescue Training Levels: Awareness, Operations, and Technician, 2nd Edition, pages 104 through 106.

10. Discuss the operating and maintenance requirements of various gasoline-powered chainsaws available to the AHJ.
    a) Chainsaws seem best suited for cutting heavy timber for trench shoring.
    b) Starting procedures should include setting the chain brake and stabilizing the saw.
    c) Before using saw check fuel mix, bar oil, chain tightness, and the status of the chain brake.
    d) Operators should wear OSHA approved chaps, hearing protection, and eye protection when operating the chainsaw.
    e) Discuss field maintenance procedures for chains, spark plugs, and filters.

Reference: IFSTA, 7th Edition Fire Service Search and Rescue, pages 83 and 84.
Reference: Trench Rescue Training Levels: Awareness, Operations, Technician 2nd Edition, pages 106 and 107.
Reference: IFSTA, 1st Edition Technical Rescue for Structural Collapse, pages 219 through 220, 223, 237 through 238 and 240.

11. Discuss and demonstrate atmospheric monitors and monitoring guidelines.
    a) Selection of an appropriate monitor.
    b) Calibration and bump test.
    c) Monitoring in order; oxygen, flammability / combustibility, toxicity.

12. List and identify monitoring terms.
    a) Alarm settings – the preset level within a monitor at which the monitor will display a visual and audible alert signal.

b) Detection – The act of discovering the presence of a contaminant.
c) Detection range – expresses the unit of measure a monitor uses to detect the vapor for which it is programmed; Combustible Gas Indicators (CGI) usually display a % reading for the LEL and a PPM reading for toxicity.
d) Explosive Limits – a display indicating the percentage of air to gas mixture known as LEL and UEL.
e) Flammable range – the % of vapor in the air that must be present to sustain combustion should an ignition source be present.
f) Flash point – the minimum temperature at which a combustible substance generates enough vapor to form an ignitable mixture with air in the vapor space above itself.
g) Ignition temperature – the minimum temperature to which a liquid must be raised in order for combustion to be initiated and sustained.
h) Immediately dangerous to life and health (IDLH)- an atmosphere that poses an immediate threat to life, would cause irreversible health effects, or would impair an individual's ability to escape from a dangerous atmosphere.
i) Permissible exposure limits – the average concentration that must not be exceeded during an 8 hour work shift or 40 hour work week.

13. Discuss the guidelines for monitoring the trench.
a) Assign one person to collect and record monitoring readings through the entry and rescue / recovery operation.
b) All readings should be recorded on a trench rescue tactical worksheet.
c) All readings should be conveyed to the Extrication Supervisor or the Operations Chief on a regular basis.
d) Any changes in readings should be immediately reported.
e) Any alarm levels should be reported immediately and appropriate action initiated.
f) Never leave the monitor unattended.
g) If available, use your Haz-Mat team for the monitoring task, they usually are the best qualified.

14. Discuss the guidelines for using ventilation at a trench rescue operation.
    a) Anytime the trench is suspect of containing or has the potential for containing a hazardous atmosphere, ventilation should be implemented.
    b) If the hazardous atmosphere cannot be confirmed or denied by the on-scene competent person or contractor, rescue personnel near or in the trench should consider wearing appropriate breathing apparatus until the atmosphere is deemed safe.
    c) Gasoline or electrical fans are acceptable.
    d) Electrical fans tend to be quieter than the gasoline powered fan and do not produce off gassing from the exhaust. All fans used for ventilation purposes must be able to produce a continuous minimum airflow of 1000 cubic feet per minute (CFM).
    e) Flexible trunk tubes attached to a ventilation fan stay relatively straight; a 90 degree bend in a trunk tube can reduce cfm air flow up to 50%.
    f) Air monitoring should be periodically conducted even with constant ventilation.

15. Identify and discuss the features of a supplied air respirator (SAR), also called supplied air breathing apparatus (SABA).
    a) The SAR unit supplies air to the wearer for virtually unlimited amounts of time.
    b) It can operate off of an approved air compressor system, a cascade system, or SCBA bottles.
    c) It can be used in a toxic environment as well as an oxygen deficient atmosphere of less than 19.5 %.
    d) The air is supplied from the source through a supply line, passing through a regulator where the pressure is reduced, and on to the rescuer who wears an SCBA style facemask.
    e) OSHA CFR 1910.146 mandates that the wearer also carry an escape bottle system providing at least 10 minutes of air.
    f) Depending on breathing patterns and the amount of physical exertion, the escape bottle may only deliver 2-3 minutes of emergency air. Rescuers should be monitored closely to ensure that the distance and time traveled in a confined space

does not exceed the rescuer's ability to safely escape.

g) The SAR is not as bulky as an SCBA and is easier to use in a confined space.

h) Rescuers have the capability of traveling up to 300 feet using a SAR unit.

16. Discuss and demonstrate the proper operation and use of a SAR system.

17. Discuss and demonstrate the proper operation and use of an emergency escape bottle.

PRESENTATION

ENABLING OBJECTIVE #8

The Technical Rescuer shall correctly identify in writing, describe the function, and demonstrate the operation of various tools and equipment commonly used for lifting and moving operations during a trench rescue incident.

1. Point out how ladders and timbers are used for lifting and moving operations.
   a) Ladders are used for creating lifting, lowering and moving platforms such as, Ladder Jib, Ladder-as-a-Derrick, Ladder Hinge, Ladder Slide, and Ladder A-Frame.
   b) Timbers are used for creating lifting, lowering, and moving platforms such as, an A-frame, Tri-Pod, Timber Jib, and Gin Pole.

2. Discuss the design and operational characteristics of high-pressure air bags.
   a) The outer shell is constructed of neoprene / butyl rubber.
   b) The interior is reinforced steel / Kevlar™.
   c) The rated capacity is calculated at 1" of lift.
   d) At maximum height the usable capacity is typically reduced to 50% of the rated capacity.
   e) Check the bag's identification tag for the rated capacity of the bag.
   f) Consider lift height as well as load weight when using the bags.

3. Discuss the application of the low-pressure air bag in a trench rescue situation.
    a) They are used primarily in trench rescue operations for filling voids.
    b) They can be used for some lifting operations.
    c) They have a higher lifting range than high-pressure bags but cannot lift as much weight.
    d) The operating pressure ranges from 7-12 psi.
    e) A low-pressure bag rated for 16 tons can take as much as 250 cubic feet of air to start a lift.

Reference: IFSTA, 7th Edition Fire Service Search and Rescue, pages 87 through 90.
Reference: Trench Rescue Training Levels: Awareness, Operations, Technician 2nd Edition, pages 124 through 127.

4. Define the term rigging.
    a) A length of rope, chain, or webbing attached to a load, attached to an anchor for the purpose of stabilizing, lifting, pulling, or moving objects.

Reference: FEMA National US&R Response System Structural Collapse Technician Training Manual, Module 4, Shoring Basics, page 29.
Reference: IFSTA, 1st Edition Technical Rescue for Structural Collapse, page 259.

5. Describe and discuss wire rope slings and their application.
    a) The components of wire rope slings include a core, strand, wire and center.
    b) To determine the diameter of a wire rope, measure across the crown not across the flat section.
    c) Wire rope configuration consists of four types: Ordinary, Filler, Seale and Warrington.
    d) Strength depends on the size, grade and core.
    e) These slings are highly resistant to abrasion and crushing.
    f) When using these slings, it is important to prevent bending or kinking.
    g) The safety factor of a wire rope sling is 5:1.
    h) The safety factor of wire rope used in lifts with personnel is 10:1.
    i) The safety factor of wire rope used in elevators is 20:1.

j) The safety factor of wire rope used in mobile cranes is 3:1 due to the potential for rough usage and wear.

6. Emphasize that inspection of wire rope should be done on a regular basis.
   a) Inspect for broken wires, crushed strands, kinks, bends, protruding core, diameter reduction due to stretching, abrasion, corrosion and fatigue.

7. Identify and discuss wire rope fittings and terminations.
   a) The Flemish eye is the most reliable termination and does not reduce the load capacity.
   b) The Fold Back eye is unreliable. Do not use.
   c) The Wedge Socket, if manufactured correctly and properly installed, will only reduce the load capacity by 10%.
   d) Cable clips are very useful in the field for constructing cable terminations. They reduce the load capacity by 20%.

Reference: IFSTA, 1st Edition Technical Rescue for Structural Collapse, pages 261 through 263.

8. Describe and discuss chains and chain slings and their application.
   a) Their applications are limited due to weight.
   b) Links can break without warning.
   c) They should not be exposed to cold temperatures for an extended period.
   d) Avoid kinking and twisting while under load.
   e) Use padding around sharp corners on the load to prevent the links from being cut.
   f) They cannot be used for overhead lifting unless tagged by the manufacturer.

Reference: IFSTA, 1st Edition Technical Rescue for Structural Collapse, pages 260 through 261.

9. Describe and discuss synthetic slings and their application.
   a) These slings mold around the load providing additional holding power.
   b) They do not rust and are non-sparking.
   c) They are lightweight and easy to carry and rig.
   d) They are more elastic than chain or wire rope.

e) They are not effected by moisture and are resistant to many chemicals.
f) They are susceptible to abrasion and catastrophic failure.

10. Point out that synthetic sling material includes nylon, polyester, Aramid® fibers, Kevlar®, Dacron®, Nomex®, and high-density polyethylene.

11. Describe and discuss the various types of synthetic web slings such as the Triangle and Choker, the Double Eye, Reverse Eye, Endless Loop, and the Return Eye sling.

Reference: IFSTA, 1st Edition Technical Rescue for Structural Collapse, pages 263 through 264.

12. Describe and discuss sling arrangements for lifting loads.
    a) Single vertical / horizontal hitches. These are used to support a load using a single leg of rope, chain, or webbing. This hitch is not used when the load is hard to balance, it is difficult to find a center of gravity, the load is loose, or when the load extends past the point of attachment.
    b) Basket hitches are used when the sling is passed under a load and both loops are attached to hooks or a master link. It can be difficult to keep the load balanced or stabilized.
    c) Double basket hitches use two single slings wrapped in separate locations in the same manner as the basket hitch described above.
    d) Single choker hitches are sling configurations with one end of the sling passing under the load and through the other end of the sling. This puts a vise-like grip on the load.
    e) Double choker hitches are two single slings spread apart around the load. This hitch does not make full contact with the load.
    f) Bridle hitches consist of two or three legs attached to the load. The slings are secured to a single point usually positioned between the center of gravity and the sling anchor points.

Reference: FEMA National US&R Response System Structural Collapse Technician Training Manual, Module 4, Lifting and Moving, pages 32 and 33.
Reference: IFSTA, 1st Edition Technical Rescue for Structural Collapse, pages 265 - 266.

13. Identify and discuss the application of tighteners such as cable winches, load binders, chain hoists, and turnbuckles.
    a) Wire rope tighteners are used for light loads as well as tightening cable tiebacks and other rigging.
    b) Do not overload rope tighteners, and do not use cheater bars to gain extra leverage.

14. Point out that for cable winches, the length of the handle plus the strength of one person provides the overload limit.
    a) Take care in re-winding cable winches to prevent fouling.
    b) Point out that due to their size, cable winches have limited use within confined spaces.

15. Discuss load binders. Point out that they are most commonly used in conjunction with chain use.
    a) Use ratchet types for reliability and use wire ties on the handle for safety.
    b) Check manufacturer's specifications for maximum load limits.

16. Discuss chain hoists. Point out that some chain hoists can lift up to 6 tons with just 100 pounds of pull.
    a) They have up to 10 foot of take-up and only require 12 inches of clearance.

17. Point out that turnbuckles can be used in place of a cable winch to do final tightening of tiebacks.
    a) Maximum take-up varies from 8 to 24 inches.
    b) They may be difficult to tighten under high loads.
    c) Hook ends are only 2/3 as strong as the eye or jaw ends.
    d) Use manufacturer's specifications for maximum load limits.

Reference: FEMA National US&R Response System Structural Collapse Technician Training Manual, Module 4, Lifting and Moving, page 34.
Reference: IFSTA, 1st Edition Technical Rescue for Structural Collapse, pages 266 through 268.

18. Identify and discuss the application of rigging fittings.
    a) The components of slings should be made from forged steel. They include the hook, shackle, pin, and eye.
    b) These fittings provide a means of lifting a load without directly tying to the load.
    c) They can be attached to wire or fiber rope, blocks, or chains.
    d) Hooks need to be latched or moused. Mousing is a process of closing the open section of a hook to prevent slings from slipping off the hook. Hooks can be moused using rope yarn, seizing wire, or shackle clips.
    e) Check the rating stamp and working load rating on shackles.
    f) Pins are not interchangeable with other shackles.
    g) Screw the pin in all the way then back off ¼ turn before loading.

Reference: FEMA National US&R Response System Structural Collapse Technician Training Manual, Module 4, Lifting and Moving, page 35.
Reference: IFSTA, 1st Edition Technical Rescue for Structural Collapse, page 268.

PRESENTATION

ENABLING OBJECTIVE #9

The Technical Rescuer shall correctly identify in writing the types, capabilities, and applications of various pieces of heavy equipment that may be used during a trench rescue incident.

1. As part of the pre-incident plan, point out the importance of developing and maintaining a listing of crane resources and heavy digging equipment.
    a) Develop a telephone call-up list.
    b) Develop an identification and vendor callback number for verification of incident needs.

c) Ascertain projected response times and confirm the on scene contact person and their location.

2. Discuss procedures for ordering a crane or digging equipment.

3. Discuss questions a rental company or heavy equipment company will ask before dispatching a piece of machinery to the trench incident.
   a) Point out that a good Incident Action Plan will address having these answers ready.
   b) Who you are and what you are doing.
   c) How quickly do you need the machines?
   d) What do you intend for the machine to do?
   e) Will multiple machines be needed?
   f) What are the capabilities of the onsite rescuers?
   g) Are they qualified to assist with set-up?
   h) What are the limits of room for operations?
   i) Are there obstacles along the route, overhead clearances, tail-swing clearance?
   j) Will work be performed on a 24 hour basis?
   k) What areas of operation are anticipated?
   l) Will radio communications be required? Whistles? Hand signals?
   m) Who is the contact person and who is the person in charge of the equipment?

4. Identify the various types of mobile cranes that can be used at a trench incident and discuss the operational characteristics of each.

5. Discuss hydraulic cranes.
   a) These cranes are mounted on a mobile chassis.
   b) Some have all wheel drive and all wheel steering.
   c) Outriggers need to be set on a firm surface.
   d) They are self-contained except for 120 tons and greater.
   e) They are rated by lifting capacity in tons at a distance of 10 feet from the center of the crane.
   f) Booms are variable length.

6. Discuss rough terrain cranes.
   a) These cranes have pick and carry capability.
   b) They are rated for “on rubber” or driving with a load.

c) They adapt to rough terrain but must be level to lift.

7. Discuss conventional cranes.
   a) They require more than one load to haul the boom components, counter weights, and rigging.
   b) They have a longer set-up time than a hydraulic crane.
   c) Lifting capacity guidelines are the same as for hydraulic cranes.

8. Note that the lifting capacity of all cranes is reduced the farther away the center of the crane is from the load.
   a) Point out that all cranes are considered a Class 1 lever.

Reference: FEMA National US&R Response System Structural Collapse Technician Training Manual, Module 4, Lifting and Moving, pages 36 through 39.
Reference: IFSTA, 1st Edition Technical Rescue for Structural Collapse, pages 252 through 259.

9. Discuss the various crane signals that may be used at a collapse rescue incident.
   a) Hoist.
   b) Lower.
   c) Use Main Hoist.
   d) Use Whip Line.
   e) Raise Boom.
   f) Lower Boom.
   g) Move Slowly.
   h) Raise the Boom and Lower the Load.
   i) Lower the Boom and raise the Load.
   j) Swing.
   k) Stop / Emergency Stop.
   l) Travel.
   m) Dog Everything.
   n) Extend Boom - use two hands.
   o) Retract Boom - use two hands.
   p) Extend Boom - use one hand.
   q) Retract Boom - use one hand.

10. Emphasize standing in clear view of the crane operator, while staying at a safe distance from the hook, block, or boom.

Reference: FEMA National US&R Response System Structural Collapse Technician Training Manual, Module 4, Lifting and Moving, page 39.

PRESENTATION

ENABLING OBJECTIVE #10

The Technical Rescuer shall correctly identify in writing personal protective garments and accessory gear recommended at trench collapse rescue incidents.

1. When establishing guidelines for personal protective equipment for specialty rescue responses, the AHJ may choose to review NFPA 1951(2013 Edition) Standard on Apparel for Urban Technical Rescue Incidents that would be appropriate for a trench rescue incident. The apparel list includes a helmet; wrap around eye protection, long pants and long sleeve shirt or jumpsuit, steel-toed boots, and leather work gloves.

2. Point out that additional PPE may include knee and elbow protection, SCBA, hearing protection, safety vest and dust masks.

Reference: IFSTA 7th Edition Fire Service Search and Rescue pages 54 through 60 and 248.
Reference: Trench Rescue Training Levels: Awareness, Operations and Technician 2nd Edition, pages 98 through 100.

3. Discuss with the students the criteria for selecting a helmet for rescue activity.
    a) Fire helmets, construction helmets, motorcycle helmets, and helmets used for sport activities are not suitable for most rescue activities.
    b) Rescue helmets should have a three-point suspension type chin strap. A single chinstrap is inadequate for rescue activities.
    c) The shell of the helmet should be constructed of material that will resist impacts and penetration of sharp objects. Examples of such materials include Kevlar or fiberglass composites.
    d) The design of the helmet should protect the head from falling objects and side impacts.

e) The helmet should have a narrow profile with a slight brim.
f) The inside suspension system of a helmet should hold the helmet away from the skull to reduce the shock of impact and provide comfort and adequate air circulation.

The helmet used should comply with NFPA 1951
Reference: IFSTA, 7th Edition Fire Service Search and Rescue, pages 54 and 55.
Reference: Trench Rescue Training Levels: Awareness, Operations and Technician, 2nd Edition, page 99.

4. Discuss with the students the criteria for selecting appropriate clothing protection for trench collapse rescue.
   a) Clothing that has potential for coming into contact with fire should be constructed of fire resistant material such as Nomex.
   b) Turnout gear tends to be bulky and too hot for most rescue activities. Jumpsuits or BDUs (battle dress uniforms) tend to be more functional.
   c) Clothing should give full body protection and have the ability for self-ventilation. Gor-tex™, polypropylenes, and Thinsulate™ are materials that provide good ventilation and protection from the elements.
   d) Clothing used for rescue should be sized so as not to bind when arms are extended above the head or when legs are raised. Avoid binding at the wrists and ankles.

5. Emphasize that cotton is the least desirable material for wet and cold environments. Discuss the most desirable materials for wet and cold environments.

6. Point out that layering clothing prepares the rescuer for various environmental conditions.
   a) The first layer is underwear.
   b) The second layer is for insulation.
   c) The third layer is the outer shell.

7. Point out footwear should provide adequate support to the ankle and protect the feet from impact loads, bruises, scrapes, and cuts.
   a) Boots usually fill this requirement well.

b) The soles of the boot should have a good adhesion surface, not slick like street shoes.
c) Select socks that provide good wicking capability that pulls moisture away from the feet to keep the feet dry and warm and decreases the formation of blisters.

8. Explain that gloves used for trench rescue should provide comfort, protection from abrasions, cuts, and ease of use for rope handling activities.
   a) Gloves should allow the hands to retain a sense of feeling so the fingers can manipulate equipment. Leather work gloves provide good hand protection and are flexible enough to pick up objects easily and are relatively inexpensive. Fire service gloves are often bulky and not the best choice.
   b) Many rescuers are purchasing military flight gloves that have the same features as a leather work glove with the added feature of being flame resistant, but unless you have a good contact source they are relatively expensive.

9. Point out that protective eyewear should prevent dust and flying debris from entering the eyes.
   a) The eyewear should be OSHA approved close-fitting goggles or safety glasses; faceshields alone on fire and rescue helmets do not give adequate protection from dust and flying debris.

10. Point out when working inside the trench, rescuers benefit from wearing elbow pads and kneepads to protect the rescuer's joints from abrasion and blunt trauma.

11. Point out that selection of respiratory protection devices will depend on the atmospheric conditions of the environment in which the rescuer is working.
   a) To filter dust and non-toxic particulates in an open clean atmosphere (19.5-23.5 % oxygen), a simple dust mask may be adequate but will not filter out toxins.

12. All PPE should be worn when working in or around the trench through termination.

Reference: Trench Rescue Training Levels: Awareness, Operations Technician, Unit 10, pages 89 through 92.
Reference: IFSTA, 7th Edition Fire Service Search and Rescue, pages 58 through 60.

SUMMARY

This lesson introduces the Technical Rescuer to the various components of preplanning, effective scene and structural size-up procedures, developing effective operational plans, instituting an effective incident management system, identifying building materials, structural systems, appropriate tool selection and usage, appropriate PPE selection and usage, and collapse patterns. It is designed to prepare the Technical Rescuer to identify the many hazards that will be present at a trench collapse incident and organize an effective and functional incident management system to combat those hazards while ensuring the safety of all rescue personnel, victims, and bystanders.