OBJECTIVE PAGE

LESSON THREE
RT: Confined Space – Rescue Equipment

DOMAIN: COGNITIVE / PSYCHOMOTOR

LEVEL OF LEARNING: COMPREHENSION / APPLICATION

MATERIALS

IFSTA 6th edition Fire Service Rescue manual; WILEY Confined Space Entry and Emergency Response manual; MOSBY Confined Space and Structural Rope Rescue manual; DELMAR Confined Space Rescue; CMC Confined Space Rescue and Entry; International Manual of Basic Rescue Methods by Dawson Nethercutt, NFPA 1006, Standard for Rescue Technician Professional Qualifications; NFPA 1670, Standard on Operations and Training for Technical Rescue Incidents; OSHA standards CFR 1910.146 (Confined Space) and 1910.147 (Lock-out-Tag Out); multimedia projector and laptop computer, access to white board or flipchart; assorted marker pens, Class I harness, Class II harness, Class III harness, ventilation equipment, SAR, atmospheric monitoring equipment, tripod, quad pod (if available), retrieval system, fall protection, 24' fire service extension ladders, rope rigging equipment (hardware and software) for creating lifting platforms and rigging mechanical advantage systems, 2 12' long 4" x 4" timbers for A-Frame assembly, (9) 1 inch diameter steel pickets 5 feet long, and (6) 1 inch diameter steel spinners.

NFPA 1006, 2003 edition JPRs

9.1.3 Conduct monitoring of the incident
9.1.4 Control hazards
9.1.5 Prepare for entry into a confined space

OBJECTIVE PAGE

TERMINAL OBJECTIVE

The Rescue Technician shall correctly identify, describe the function of, and demonstrate the operation of equipment used during confined space rescue incidents.

ENABLING OBJECTIVES

1. The Rescue Technician shall correctly identify in writing the components of an effective equipment assessment for confined space rescue incidents.

2. The Rescue Technician shall correctly identify in writing the different types of loads and how they interact with the equipment used to lift rescuers, victims, and other equipment.

3. The Rescue Technician shall correctly identify in writing describe the function and demonstrate the operation of various tools and equipment that may be necessary during confined space rescue incidents.

LESSON THREE
RT: Confined Space - Rescue Equipment

MOTIVATION

In order to provide a safe and effective rescue operation at a confined space rescue incident, personnel must be proficient with the operational characteristics of many types of specialized rescue equipment used for controlling hazards of the confined spaces and for safely gaining access to the victim. Tool proficiency should include identifying the efficiency and limitation of the tools, hazards of operation, and field maintenance.

PRESENTATION

ENABLING OBJECTIVE #1

The Rescue Technician shall correctly identify in writing the components of an effective equipment assessment for confined space rescue incidents.

1. Discuss the gear that is used for protection of the rescue team, as opposed to the PPE worn by each team member.
   a) Air-supply equipment.
   b) Ventilation equipment.
   c) Atmospheric-monitoring equipment.
   d) Lighting equipment.
   e) Retrieval systems.

2. Define and discuss the need for air-supply equipment.
   a) All the equipment needed to provide a safe and dependable source of breathing air to individual team members who must enter contaminated atmospheres to affect rescues.
   b) The equipment may consist of a cache of SCBA cylinders, an air supply unit with a cascade system for refilling cylinders, or an air supply unit with both large air tanks and an air compressor for supplying airline respirators.

3. Define and discuss the need for ventilation equipment.
   a) The interior of the space must be adequately and continuously ventilated by mechanical means.
   b) Ventilation is used to enhance the level of safety for rescues working in confined spaces in which the atmosphere is contaminated.
   c) Ventilation will increase chances of survival for trapped victims.
   d) It is loosely defined in 29 CFR 1910.146.
   e) It is essentially a mechanical means of ventilation located outside of the contaminated area with some means of channeling fresh air into the space.
   f) An intrinsically safe blower can be used to exhaust contaminated air from the space.

4. Define and discuss the need for atmospheric monitoring equipment.
   a) Monitoring equipment used to sample and analyze the atmosphere within a confined space must be accurately calibrated and capable of measuring the various contaminants that could be present in a confined space.
   b) Air monitors should read the oxygen content, flammable range, and toxicity levels of various hazardous gases.

5. Define and discuss the need for lighting equipment.
   a) Type and amount of lighting equipment can vary greatly.
   b) With the opening being small some form of artificial lighting is almost always needed.
   c) Individual flashlight or hand lanterns may be sufficient.
   d) Most of the time some higher level of lighting will be needed.
   e) All forms of lighting equipment used must be intrinsically safe.
   f) Portable generators must be placed downwind from the confined space access way to ensure the exhaust from the gasoline engine does not get carried into the confined space.

6. Define and discuss the need for a retrieval system.
    a) OSHA regulations require that anyone who enters a permit-required confined space must be fitted with some form of retrieval system.
    b) It also requires that there be an attendant outside the space monitoring those inside.
    c) Retrieval systems consist of a retrieval line attached to either a chest or full-body harness or to wristlets.
    d) These devices will allow the attendant to pull the entrant from the space without entering the space.
    e) Retrieval lines can be removed if the line actually increases the overall risk by becoming entangled, or if the line would not contribute to the rescue of the entrant.

Reference: IFSTA 6th edition Fire Service Rescue, page 247-250.

PRESENTATION

ENABLING OBJECTIVE #2

The Rescue Technician shall correctly identify in writing the different types of loads and how they interact with the equipment used to lift rescuers, victims, and other equipment.

1. Identify the different types of loads and how they interact with the equipment used to lift rescuers, victims, and other equipment.
    a) Static loads.
    b) Impact loads.
    c) Working loads.
    d) Axial loads.
    e) Eccentric loads.

2. Define and discuss static loads.
    a) A static load is a load applied when the load is at rest.
    b) They are applied and remain in the same position and location.
    c) Forces of a static load are applied in only one plane.

d) Examples of static loads are forces applied to a harness or life safety rope during testing, a building sitting on its foundation, or a tank sitting on its support.

3. Define and discuss impact loads.
   a) An impact load is a load applied in a very short duration so as to include the effects of acceleration in the load.
   b) They are more critical to rescues because they can greatly exaggerate the force being applied.
   c) Impact loads may be applied in all directions; up, down, left, right, front, and back.
   d) An example of an impact load is a person walking on a board. If the board is supported on each end and the person slowly lowers his weight onto the board, it might flex and bend but still support the weight.

4. Define and discuss working loads.
   a) A working load is the maximum weight that a rope is expected to support.
   b) Working loads are expected to be applied to equipment during its use.
   c) The maximum working load is the maximum weight that is expected to be supported by the equipment.

5. Define and discuss axial loads.
   a) An axial load is a load transmitted through the axis of its supporting device.
   b) An axial load refers to the direction that a load is carried.
   c) Axial simply means moving about the axis. The axis in this application is the centerline of a load bearing point. Example: Imagine that you are looking straight down on a tripod from above. As the victim is being raised, the direction of pull on the line supporting the victim is straight up and down. If the load was not transferred along the axis, but rather at an angle to the axis or off center of the axis, then the load could cause the tripod to fail.

6. Define and discuss eccentric loads.
   a) An eccentric load is a load applied so that the force is off center of the supports carrying the load.
   b) A load that is applied off center of the axis is an eccentric load which can cause collapse or twisting of a support.

7. As equipment is set up for a rescue situation, the Rescue Technician should consider the direction of pull that will be applied to any load and whether it will affect the stability of the point where its is being applied.

Reference: DELMAR Confined Space Rescue, page 161-165.

PRESENTATION

ENABLING OBJECTIVE #3

The Rescue Technician shall correctly identify in writing describe the function and demonstrate the operation of various tools and equipment that may be necessary during confined space rescue incidents.

1. Discuss the characteristics of the Class I rescue harness.
   a) It is designed for emergency escape use only.
   b) The harness is designed for one time use.
   c) NFPA 1983 requires a design load of 300 lbf.
   d) It looks like a Class II rescue harness in design but rated only for a one-person load.
   e) It fastens around the waist and thighs or under the buttocks.

2. Discuss the characteristics of the Class II rescue harness.
   a) It is designed for rescue operations
   b) It is not designed for fall protection.
   c) NFPA 1983 requires a design load of 600lbf.
   d) It is rated as a two-person load rescue harness.
   e) The harness fastens around the waist and thighs, or under the buttocks.

3. Discuss the characteristics of the Class III rescue harness.
    a) It is designed for fall protection and rescue operations where the potential for inversion may occur.
    b) NFPA 1983 requires a design load of 600lbf.
    c) The harness is rated as a two-person load rescue harness.
    d) It fastens around the waist and thighs or under the buttocks and over the shoulders.

4. Identify the minimum guidelines for webbing to be used as improvised rescue harnesses for humans.
    a) The webbing should be a minimum of 1 3/4 inch wide.
    b) The breaking strength should be 6000 lbf with a design load of 600 lbf.

5. Discuss the characteristics and design of modified harnesses.
    a) Rescue knot.
    b) Seat harness.
    c) Seat harness with chest harness.

6. Identify and discuss the safety checks that should be conducted for rescue harnesses.
    a) Check Class I, II and III rescue harness straps and buckles.
    b) Check for frayed stitching and damaged metal.
    c) Follow the manufacturer's guidelines for use, inspection, and maintenance.

7. Discuss the Harness Induced Pathology (H.I.P).
    a) Serious problems can occur when rescuers suspend motionless for a long period of time. The compression created by the straps can reduce the venous flow from the legs.
    b) Venous pooling typically occurs in the legs due to the force of gravity and a lack of movement. Some venous pooling occurs naturally when a person is standing. In the veins, blood normally is moved back to the heart through one-way valves using the normal muscular action associated with limb movement. If the legs are immobile, then these "muscle pumps" do not operate effectively, and blood can accumulate. Since veins can

expand, a large volume of blood may accumulate in the veins.

c) An accumulation of blood in the legs reduces the amount of blood in circulation. The body reacts to this reduction by speeding up the heart rate and in an attempt to maintain sufficient blood flow to the brain. If the blood supply is significantly reduced, this reaction will not be effective. The body will abruptly slow the heart rate and blood pressure will diminish in the arteries. During severe venous pooling, the reduction in quantity and/or quality (oxygen content) of blood flowing to the brain causes fainting. This reduction also can have an effect on other vital organs, such as the kidneys. The kidneys are very sensitive to blood oxygen, and renal failure can occur with excessive venous pooling. If these conditions continue, they potentially may be fatal.

d) This pathology can be minimized greatly by using wide material for harnesses such 1 3/4 inch as recommended by NFPA 1983.

Reference: IFSTA 6th edition Fire Service Rescue, 97-100.
Reference: High Angle rescue Techniques, 3rd edition, pages 13-16.

8. Discuss the characteristics of wristlets.
   a) Wristlet straps are designed to be placed around the wrist of a person to allow him to be raised or lowered through a vertical opening while hanging from the straps.
   b) May be used in specific circumstances when it is not possible to use a harness.
   c) Wristlets may also be used around the ankles for a horizontal entry when the victim or rescuer could not use a harness.
   d) Webbing of a harness is required to have a minimum breaking strength of 6,000 pound; wristlets are more difficult to categorize.
   e) Wristlets carry the load through the joints within the body and do not support it, so the safety factor is 3:1. Example: you intend to lift a 300-pound load, then the wristlets must have a breaking strength of 900-pounds.
   f) Breaking strength of wristlets will vary and the rescuer must be aware of the strength.

g) Very few wristlets have a breaking strength of greater than 5,000 pounds.

Reference: DELMAR Confined Space Rescue, page 173-174.

9. Discuss the design specifications and characteristics of a tripod.
   a) When lifting with a tripod the rescuer must watch how the equipment will be loaded and make sure that all loads are axial loads to keep from tipping over or collapsing the equipment.
   b) It is the rescuers responsibility to know the limitations of the equipment. Not all hoists can carry the same loads.
   c) Attaching hoisting equipment incorrectly or at the wrong point can lead to a connection failure.
   d) Pay special attention to the usability of the tripod on some situations such as a sloped tank roof with a smooth surface.
   e) Most tripods come equipped with swiveling feet to provide traction on smooth surfaces.
   f) They will also have pointed feet on the reverse end to allow the foot to be pushed into soft ground for anchoring.
   g) Tripods that are placed on sloped surfaces should have two of the legs placed on the same plane downhill of the opening in order to provide the greatest stability.
   h) When lifting loads a change of direction pulley may be needed to keep the load axially to the tripod. If the change of direction pulley is placed outside the feet of the tripod, the load will not be axial, and the tripod could tip over.
   i) The head of the tripod and the earth must remain parallel and the load must be hoisted perpendicular to both the head of the tripod and the earth.
   j) The axis is imaginary line that runs perpendicular to the head of the tripod and the earth. It is also a path on which the load being hoisted out of a confined space must travel.

k) If this axis perpendicular to both the earth and head of the tripod is not maintained, the tripod is likely to tip over.
l) Some tripods have adjustable legs and extending the legs changes its load carrying ability. The longer the tripod legs, the less weight they can carry.
m) Most tripods are also equipped with chains between the tripod feet to keep them from spreading as a load is applied.

10. Discuss the design specifications and characteristics of a quad pod.
    a) Quad pods are retrieval devices with four legs and a davit arm.
    b) The device must be loaded with the same care as a tripod.
    c) The davit arm, which extends between the feet of the device, relies on the device being loaded properly.
    d) If the device is tilted or not loaded axially, it may tip over or be pulled away from where it has been set-up.
    e) Knowledge of the equipment's limitation is essential.
    f) As with tripods, quad pods that are placed on sloped surfaces should have two of the legs placed on the same plane downhill of the opening in order to provide the greatest stability.

11. Discuss the design specifications and characteristics of a transformer retrieval support.
    a) One of the most difficult places to put a tripod is on the sloped roof of a tank or between several narrow and close confined spaces.
    b) These types of rescue situations need to be preplanned and may be better fitted with permanent equipment mounted in the area.
    c) A transformer retrieval support was designed for the situations described above.
    d) They are designed to be bolted directly to the flange of a man-way opening.
    e) It has a very specific use and is a very valuable device where the use of a tripod would be limited.

12. Discuss the design specifications and characteristics of retrieval winches.
    a) Retrieval winches are designed for hoisting people.
    b) They usually have stainless steel or galvanized steel cables and provide mechanical advantage for raising and lowering people.
    c) Some cannot be used for controlled lowers; but only as a raising mechanism.
    d) Built in advantaged include fall protection, handle breaks to prevent movement of loads when the handle is released, ability to adjust the mechanical advantage, and a clutch mechanism to prevent applying mechanical advantage to and entrapped person.
    e) Some winches can also provide a self-retracting safety line.
    f) A self-retracting safety line allows the line coming from the winch to be extended and retracted as fast as the wearer moves.
    g) If the wearer moves too quickly, such as during a fall, the line locks and stops the fall.
    h) These systems limit a free fall to 18 inches and will not have to be tended by a person.

13. Discuss the design specifications and characteristics of fall protection.
    a) Fall protection is used to terminate falls if they occur.
    b) A personal fall-arrest system is a harness connected by a fall-arrest lanyard and shock absorber to a suitable anchorage in the work area.
    c) These systems allow rescuer mobility but still provide fall protection.
    d) Various equipment and options for establishing fall-arrest systems are available.
    e) Rigging techniques can be applied in establishing personal fall-arrest systems.

Reference: DELMAR Confined Space Rescue, page 160-190.

14. Discuss and demonstrate atmospheric monitors and monitoring guidelines.
    a) Selection of an appropriate monitor.

b) Calibration and bump test.
c) Monitoring in order:
    I) Oxygen
    II) Flammability / combustibility
    III) Toxicity.

15. List and identify monitoring terms and related to the use of atmospheric monitoring.
    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 displays a percentage 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 percent 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) – the maximum concentration from which a person could escape without permanent or escape impairing effects within 30 minutes.
    i) Permissible exposure limits (PEL) – the average concentration that must not be exceeded during an 8 hour work shift or 40 hour work week.

16. Discuss the guidelines for using ventilation at a confined space operation.
    a) Anytime the confined space 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 rescue personnel near or in the confined space should consider wearing appropriate breathing apparatus until the atmosphere is deemed safe.
c) All fans used for ventilation purposes must be able to produce a continuous minimum airflow of 4000-5000 cubic feet per minute (CFM).
d) Flexible trunk tubes attached to a ventilation fan should stay relatively straight; a 90 degree bend in a trunk tube can reduce cfm air flow up to 50%.
e) Air monitoring should be periodically conducted even with constant ventilation.

17. 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 be operated with 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 29 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.

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

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

Reference: CMC Confined Space Entry and Rescue, page 9.1-9.40.

20. Discuss methods to reduce or avoid damage to all rescue equipment. Including Rescue Tool Kit.
21. Discuss Rescue Tool Kit: any tools that can be used for Specific rescue situations such as confined space rescue.
    a. Tools for pre-plans
    b. Tools for entry into the space.
    c. Tools for exiting the space.
    d. Tools for securing the space and making surrounding area safe.

SUMMARY

The importance of selecting the appropriate tool for the task and operating it in a safe manner cannot be stressed enough. Rigorous training and the constant revaluation of tool efficiency in conjunction with the rescuer's performance can only accomplish this goal.