Confined Space Rescue Technician

Date Approved: 11/2021

Confined Space Rescue Technician

NFPA 1006 Standard for Technical Rescue Personnel Professional Qualifications *2021 Version*

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Mission…

- Prepare Rescue Technicians to safely and effectively perform rescues from confined spaces in compliance with recognized standards and regulations

Our Goals

- Provide Rescue Technicians with the opportunity to apply the principles of confined space rescue through directed rescue scenarios
- Provide Rescue Technicians with the knowledge, skills, and abilities to perform confined space rescue as it also relates to incidents involving terrorism and/or weapons of mass destruction (WMD)

Course Description

Session 1 – PPT/Lecture/Tool Day

Session 2 – Horizontal Rescue

Session 3 – Vertical Rescue

Session 4 – Horizontal & Vertical with increase hazards - Scenario

NFPA 1006 Confined Space Rescue Awareness

- 7.1.1 Initiate isolation procedures for a specific confined space incident
- 7.1.2 Initiate a search in areas immediately adjacent to the confined space
- 7.1.3 Communicate with the victim
- 7.1.4 Perform non-entry rescue
- 7.1.5 Size up a confined space rescue incident
- 7.1.6 Recognize the need for technical rescue resources at an operations or technician level incident
- 7.1.7 Support an operations or technician level incident

NFPA 1006 Confined Space Rescue Operations

- 7.2.1 Initiate a search inside a confined space in those areas immediately visible from the confined space entry portal
- 7.2.2 Perform size up of a confined space rescue incident
- 7.2.3 Conduct Monitoring of the environment
- 7.2.4 Assess the incident
- 7.2.5 Control Hazards
- 7.2.6 Apply and use SCBA as a rescue entrant
- 7.2.7 Apply an atmosphere supplying respirator to a victim

NFPA 1006 Confined Space Rescue Operations

- 7.2.8 Perform full spinal immobilization of a victim inside a confined space
- 7.2.9 Prepare for entry into a horizontally oriented confined space
- 7.2.10 Enter a horizontally oriented confined space for rescue
- 7.2.11 Package the victim in litter for removal from a horizontally oriented confined space
- 7.2.12 Assemble a portable anchor system
- 7.2.13 Prepare for entry into a vertically oriented confined space

NFPA 1006 Confined Space Rescue Operations

- 7.2.14 Enter a vertically oriented confined space for rescue
- 7.2.15 Package the victim in a litter for removal from a vertically oriented confined space
- 7.2.16 Remove a victim from a vertically oriented confined space
- 7.2.17 Remove all entrant from a confined space
- 7.2.18 Terminate a technical rescue operation

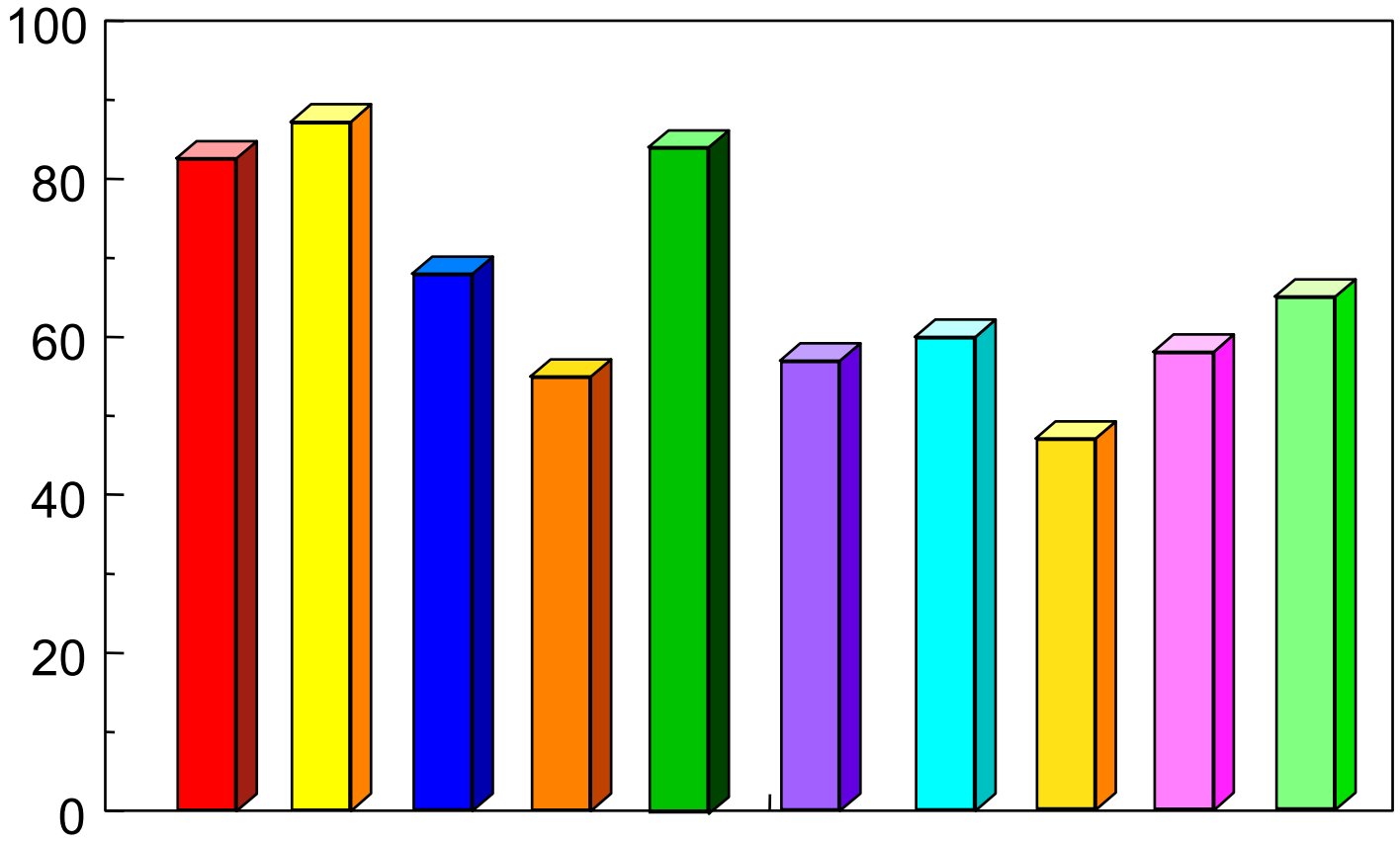
NFPA 1006 Confined Space Rescue Technician

- 7.3.1 Initiate a search inside a confined space in those areas not immediately visible from the confined space entry portal
- 7.3.2 Preplan a confined space incident
- 7.3.3 Apply and use SARS as a rescue entrant
- 7.3.4 Perform a short spinal immobilization of a victim inside a confined space
- 7.3.5 Prepare for entry into the confined space with a hazardous atmosphere
- 7.3.6 Enter a confined space with atmospheric hazards

Law, Standards & Codes

- OSHA 1910.146 Permit Required Confined Spaces for general industry
- OSHA 1926.650 Trench & Excavations
- NFPA 1561 Standard on Fire Dept Incident Management System
- NFPA 1670 Standard on on Operations and Training for Technical Search I Rescue Incidents
- NFPA 1006 Standard for Technical Rescue Personnel Professional Qualifications
- NFPA 1500 Fire Dept Occupational Safety & Health
- OSHA SARA Title III Superfund Amendments and Authorization Act
- OSHA 1910.134 Respiratory Protection
- NFPA 1983 Life Safety Rope, harness and Hardware
- NFPA 472 Standard for competence of Responders to hazardous materials/WMD Incidents

DEATHS IN CONFINED SPACE



Total deaths - 670

Causes of Fatalities

- 65% Hazardous Atmospheres
- 13% Engulfment
- 7% Struck by Falling Objects
- 6% Heat Stress / Exposure
- 4% All Others

- Most confined space injuries and deaths result from asphyxiation due to hazardous atmospheres

Confined Space

- Area large enough to enter to work
- Has limited or restricted means for entry and exit
- Is not designed for continuous employee occupancy

Permit Required Confined Space

Meets the definition of a confined space and contains one or more of the following:

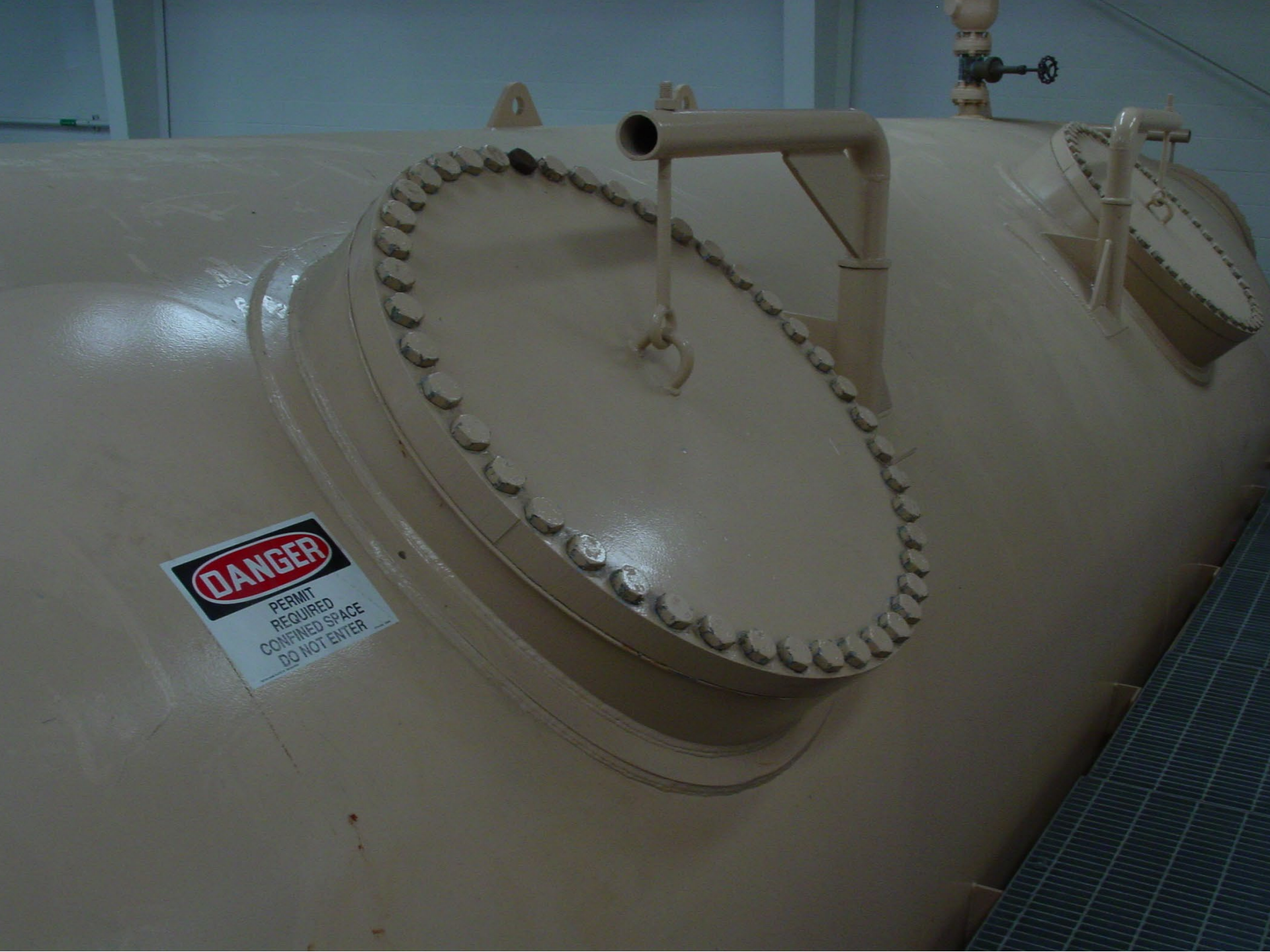
- Contains or has the potential to contain a hazardous atmosphere
- Contains a material that has the potential for engulfing an entrant

Permit Required Confined Space

Continued

- Has an internal configuration such that an entrant could be trapped or asphyxiated by inwardly converging walls or by a floor which slopes downward and tapers to a smaller cross-section

- Contains any other recognized serious safety or health hazard


DANGER
PERMIT
REQUIRED
CONFINED SPACE
DO NOT ENTER


STOP
Roseville Telephone


GATX

Warning Sign

Duties of Authorized Entrants

- Know the Hazards
- Communicate with the Attendant
- Alert the Attendant to problems
- Exit the permit space when necessary

Duties of Attendants

- Know the hazards
- Be aware of behavioral effects of hazards on entrants
- Remain outside permit space until relieved by another attendant
- Communicate with entrant to monitor status and alert entrants of need to evacuate
- Monitor activities inside and outside the permit space to determine if it is safe
- Perform no duties that might interfere with primary duty to monitor and protect entrants

Duties of Entry Supervisors

- Know the hazards
- Verify entry permit information
- Terminate entry and cancel permits as required
- Remove unauthorized individuals
- Assure consistent transfer of responsibility

Confined Space Hazards

- All confined space hazards fall into one of four basic categories:
  - Atmospheric Hazards
  - Physical/Mechanical Hazards
  - Environmental Hazards
  - Psychological Hazards

Note: All hazards must be identified and controlled (rendered non-hazardous) before entry.

Atmospheric Hazards

- Hazardous atmosphere means an atmosphere that may expose employees to the risk of death, incapacitation, impairment of ability to self rescue, injury, or acute illness from one or more of the following causes:

Atmospheric Hazards (continued)

- Oxygen concentration <19.5% or >23.5%
- Flammable gas, vapor, or mist >10% LEL
- Airborne combustible dust at a concentration that obscures visions at 5’ or less
- Radiation or radioactivity
- Any substance at or beyond its PEL
- Any other immediately dangerous to life or health atmosphere

Common Toxic Gases In Confined Spaces

- Methane
- Carbon Monoxide
- Carbon Dioxide
- Hydrogen Sulfide
- Sulfur Dioxide

Common Toxic Gases In Confined Spaces (cont)

The effects of carbon monoxide in parts per million:

- 100 ppm (0.01%) Slight headache in two to three hours
- 200 ppm (0.02%) Slight headache within two to three hours
- 400 ppm (0.04%) Frontal headache within one to two hours
- 800 ppm (0.08%) Dizziness, nausea, and convulsions within 45 minutes. Insensible within two hours.
- 1,600 ppm (0.16%) Headache, dizziness, and nausea within 20 minutes. Death in less than two hours.
- 3,200 ppm (0.32%) Headache, dizziness and nausea in five to ten minutes. Death within 30 minutes.
- 6,400 ppm (0.64%) Headache and dizziness in one to two minutes. Death in less than 20 minutes.
- 12,800 ppm (1.28%) Death in less than three minutes.

Physical/Mechanical Hazards

- Engulfment
- Mechanical
- Corrosive
- Radiation
- Falls
- Falling Debris

Environmental Hazards

- Heat or Cold
- Insects and Vermin
- Snakes & Reptiles
- Mold and Fungus

Psychological Hazards

- Claustrophobia
- Fatigue
- High Noise Levels

Atmospheric Monitor

Monitoring Strategies

- General Site Monitoring
- Perimeter Monitoring
- Confined Space Monitoring
- Personal Monitoring – PH paper on mask

Atmospheric Monitoring

- The following order
  - Oxygen, LEL, selected toxics
- Prior to entry
- Continuously throughout entry
- Periodically log results
- Monitor at all levels within space
  - 4 foot increments

Ventilation

- Replaces contaminated air
- Decreases possibility of explosion
- Reduces/Eliminates toxic atmosphere
- Increases survival profile of victim
- Reduces temperature inside space

Ventilation Devices

Ventilation Calculations

- Volume of Space
  - Width x Height x Depth = Total Cubic Feet
  - Cubic Feet ÷ CFM rating of blower = Minutes per air exchange
- Ventilation goal = 7 air exchanges
- Continuous ventilation

Vapor Density of Gases

Hydrogen	H2	0.0695
Methane	CH4	0.5540
Carbon Monoxide	CO	0.9660
Air		1.0000
Hydrogen Sulfide	H2S	1.1912
Carbon Dioxide	CO2	1.5291
Sulfur Dioxide	SO2	2.2638

Hazardous Energy

- Electrical
- Hydraulic
- Pneumatic
- Free flowing solids
- Mechanical
- Gravity

Lockout / Tagout / Blockout

- Some methods of isolation may also include blanking or blinding of pipes; misaligning or removing section lines, pipes or ducts; double block & bleed system
- LOTO of all energy
- Blocking or disconnecting all mechanical linages

Lockout / Tagout / Blockout

- Retain someone intimately familiar with the electrical and mechanical systems in the area, plant, or confined space where you are making entry
- Allow these personnel to brief, guide, or conduct the shutdown of these systems

Personal Protective Equipment

- Helmet
- Flash Protection
- Hood
- Boots
- Gloves
- Eye and Ear Protection

Personal Protective Equipment (continued)

- PASS Device
- Respiratory Protection
- Atmospheric Monitoring Instrument
- Lighting
- Communications System

Levels of Chemical Protective Clothing

- Level A
- Level B
- Level C
- Level D

Respiratory Protection

- Atmospheric hazards cause 65 percent of deaths in confined spaces
- Identify hazardous atmospheres and wear appropriate respiratory protection
- Comply with regulations

Self-Contained Breathing Apparatus (SCBA)

- 30-60 minute air supply
- Big and bulky
- Can be connected to a supplied air system
- Positive pressure

Air Purifying Respirators (APR)

- Inhale through filters or cartridges that filter airborne contaminants from the atmosphere
- Cartridges have service life
- Not for use in IDLH or less than 19.5% oxygen
- Not recommended for confined space rescue

Supplied Air Respirator (SAR) with Escape Cylinder

- Connected to remote air source
- NIOSH requirements limit airline length to 300 feet
- 5-10 minute air supply per cylinder
- Escape cylinders required with SAR when entering IDLH atmosphere

Supplied Air Respirator (SAR) with Escape Cylinder

The Face Mask

- The Face Mask is our own SCBA mask from the Firefighting side of the job.
- These masks should not need any special equipment to be used with the SAR system.

Supplied Air Respirator (SAR) with Escape Cylinder

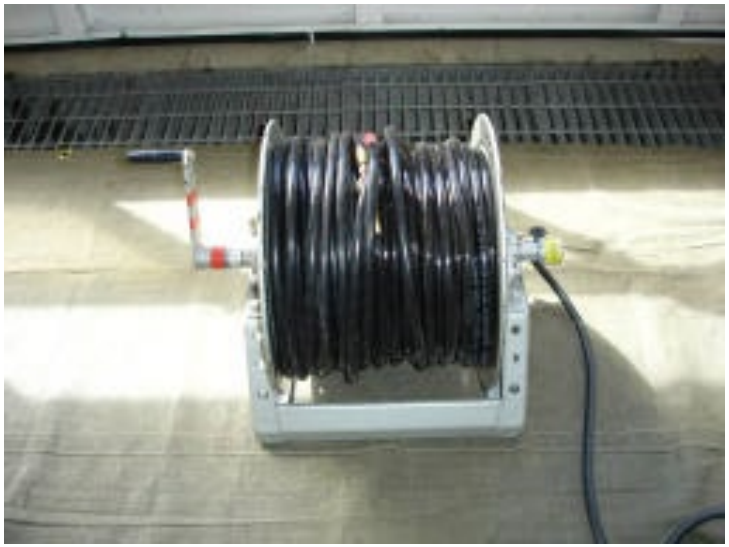
The Escape Bottle with Regulator

- The bottle is a 5, 10, or 15 minute escape bottle. The bottle is typically attached to a waist strap and also has a shoulder strap.
- The bottle will also have a regulator attached to attach to face mask. The regulator will also have a connection for the Air Supply Hose.

Supplied Air Respirator (SAR) with Escape Cylinder

The Air Supply Hose

- The Air Supply Hose is typically 300 feet in length. It may not be any longer than 300 feet. The hose can be on a reel or coiled in a bundle. In either case it will need an attendant to help pay out the line to avoid kinking and or knotting up. The 300-foot limit is due to the length of the tether rope line. These are limited by regulation to 300 feet.



Respirator Protection Factor

- Respirators rated by the protection they provide
- Factor = contamination concentration outside the face piece : inside the face piece
- ANSI recommends factor of 10,000
- Must be fit tested

NFPA 1006
Confined Space Rescue Action Plan

- Priority 1: Make the Scene Safe
- Priority 2: Victim contact by primary responder
- Priority 3: Size Up
- Priority 4: Preparation
- Priority 5: Access patient
- Priority 6: Stabilize and package pt
- Priority 7: Evacuate
- Priority 8: Response Termination

Priority 1: Make the Scene Safe

- Hazard Assessment: Approach to the space and entrance into the space
- Hazard mitigation: Control or remove the hazard
- De-energize and protect the sources of electricity, fluids, hydraulics and so forth

Priority 2: Victim contact by primary responder

- Establish victim location
- Primary medical survey (ABC's)
- Determine mode of injury
- Begin psychological first aid
- Determine feasibility of safe retrieval if possible

Priority 3: Size Up

- Information gathering
- Resource identification
- Primary responder report
- Brainstorm Strategy: risk/reward
- Incident management system (IMS)
- Team member assignment

Priority 4: Preparation

- Rescuer personal protective equipment
- Anchoring and rigging rescue equipment
- Authorized entrant review

Priority 5: Access patient

- Designate access team leader; one team leader for each group of two or more
- Utilize rescuer retrieval (High point)
- Designate backup personal

Priority 6: Stabilize and package pt

- First Aid to life-threatening injuries
- Secure packaging for rescue transport

Priority 7: Evacuate

- Move victim to a safe location
- Provide medical report to EMS
- Remove rescuers
- Emergency retrievals

Priority 8: Response Termination

- Pick up and inventory gear
- Decontaminate
- Rebuild gear packages for the next call
- Field evaluate rescuer mental state

Response & Operation

The successful outcome of a confined space incident is dependent upon all personnel working within the Incident Management System (IMS) under direction of the Rescue Group Supervisor who in turn reports to the on-scene Incident Commander (IC). The Incident Management System provides safety, accountability of personnel communications, direction, an action plan and set roles, each with delegated responsibilities.

Non – Entry Rescue

Assess if the victim is on a retrieval system and the system can be used for rescue without making entry – A non technician may use a victim's retrieval system as long as no entry is made into the confined space at any time

At no time will a non rescue certified technician make entry into a confined space.

Rescue vs Recovery

Making a determination if operations will commence under Rescue or Recovery Mode shall be ascertained prior to initiating operations. This determination will affect the urgency and pace of the incident.

A Recovery operation is based on the recognition that the patient is not viable. A recovery operation is a more calculated event conducted at a slower pace when a sufficient number of trained personnel are available to safely mitigate the event.

**The safety of all rescuers is of paramount importance; therefore no undue exposure of risk to rescuers is acceptable at any time for the recovery of a body.

Rescue Rope and Related Equipment

- Standards and Regulations
  - State and federal laws
  - Additional requirements from standards
- Metric System
  - Standard measurement
  - Strength ratings

Rescue Rope and Related Equipment (continued)

- Equipment Description and Capabilities
  - Software
  - Hardware
- Rope
  - Uses and Construction
  - Specification and Care

Rescue Rope and Related Equipment (continued)

- Webbing
- Prusik Loop
- Anchor Straps
- Load Release Strap
- Harness
- Caribiners

Rescue Rope and Related Equipment (continued)

- Anchor Plate
- Mechanical Ascenders
- Figure Eight Plate
- Brake Bar Rack
- Edge Protection
- Pulleys

Rescue Rope and Related Equipment (continued)

- Static System Safety Factor (SSSF)
- Equipment Considerations
- What makes a good knot
- Knot efficiency
- Rules of knots

Rescue Rope and Related Equipment (continued)

- Knots
  - Overhand knot
  - Overhand bend
  - Half hitch
  - Double fisherman
  - Prusik

Rescue Rope and Related Equipment (continued)

- Knots (continued)
  - Figure eight stopper
  - Figure eight bend
  - Figure eight on a bight
  - Figure eight follow through loop
  - Tensionless hitch

Rescue Rope and Related Equipment (continued)

- Anchors
  - Types of anchors and how to select them
  - Single point anchors
  - Multiple point anchors
  - Critical angle

Rescue Rope and Related Equipment (continued)

- Rescue System
  - Belay system
  - Lowering system
  - Raising system
  - Pulley system

Rescue Rope and Related Equipment (continued)

- Summary
  - Capabilities and limitations of systems
  - Two basic systems
    - Lowering and Raising systems
  - Importance of anchor systems

4:1 Pre-Rigged Block & Tackle

- The main line is used to raise and lower the load. It must provide adequate mechanical advantage to easily control the movement of the load. Usually a MA factor of 4:1 will provide the necessary control.

4:1 Pre-Rigged

- The pre rigged 4:1 system may also be inverted to provide a MA of 5:1. A change of direction must be attached at the overhead pick point to facilitate hauling as in the 4:1 system.

Belay System

- The belay line is a separate system and provides fall protection in the event of a failure of either the main line or the tripod.
- The belay line must have its own anchor point. It must not be suspended from the tripod used for the main line. It is usually run along the ground, and into the access point using edge protection to protect the rope.

Twin Tension

- When using a twin tension system on a tripod, you can use the high directional anchor point, but both ropes must be on individual anchors!
- IMPORTANT – Watch resultant forces
- Use Tie Backs

Artificial High Directionals

- Tripod
- Man-Made (ex: Roof anchors)
- Davit Systems (Usually supplied by workers)
- Aerial Ladder

Tripod

- Current Tripod = Arizona Vortex
- The main line with appropriate mechanical advantage is attached to the top of the tripod, which is then set up directly over the access point. It is imperative that the tripod be secured in such a manor as to prevent toppling.

Tripod

- Tripods are generally considered to be the most efficient means of providing an overhead pick point. They are easily set up and rigged for mainline raising or lowering systems.
- Once the tripod is in position, and level, it must be secured to prevent accidental movement or toppling
- Free standing used for entry, retrieval, and rescue
- Legs adjust to varying heights and angles
- Loads are placed downward on the legs or within the footprint

Davit Arms

- Used for lowering or retrieval work
- Free standing or used with fixed mounting device
- Shorter than tripods
- Used in conjunction with commercial winches and fall protection devices

Communication Techniques and Equipment

- Portable Radio
- Hard-wire System
- Voice
- Hand Signals

Radio

- Radio's don't always provide reliable communication in the confined space arena.
- Concrete, steel, and other features of the space often render radios unreliable.
- Radio system must be intrinsically safe – current radio system is intrinsically safe

Tag Lines

- Rope tag lines may be used to convey signals between rescuers, and the outside of the space.
- The ‘’OATH”, or dive rescue rope signal system may be employed. It is important to note that familiarity with the chosen system must be mastered by all personnel involved.
- Rope signals often diminish over distance. That, coupled with the inherent friction encountered within the space tends to limit the usefulness of these systems.

Communication Techniques (continued)

- Rope Signals - OATH
  - O = OK = 1 pull
  - A = Advance Line = 2 pulls
  - T = Take Up = 3 pulls
  - H = Help = 4 pulls

Communication Techniques (continued)

- Tapping or rapping codes
- Personal Alert Safety System (PASS)
- Light Signals
- Back-up Plans

Communication Techniques (continued)

- RGS responsible for initiating, maintaining and controlling incident communications
- Entry Team Leader controls the verbal initiation, operation, resetting and conclusion of movement of the rope systems

- *The Rescue Group Supervisor may choose to retain the role of Entry Team Leader as far as controlling the movement of any rope system, if it is either a simplistic operation, or if a sufficient number of technician* l*evel personnel are not readily available to fill all required positions thus prompting multitasking by the RGS.*

Patient Packaging

- Removing a patient from a confined space can be very challenging especially when the patient is injured or unconscious.

Devices

- SKED
- Wristlets
- KED

Patient Packaging - SKED

- The Sked is not a spinal immobilization device; however, it will accommodate most long boards. Follow all spinal immobilization protocols prior to placing suspected spinal injury patients in the Sked.

Patient Packaging - SKED

- Horizontal Hoist Setup
- Vertical Hoist Setup

Patient Packaging - Wristlets

- Removing a patient vertically out of a hole with little clearance or quick removal of a patient in a hazardous setting are other reasons

Medical Considerations

- Claustrophobia
- Heat Stress / Fatigue
- Heat Exhaustion
- Heat Stroke
- Spinal Immobilization

Spinal Immobilization

While protocols allow clearance of the victim's spine in certain situations, due to potential for significant manipulation associated with movement of victims within confined spaces and the potential severity long term effects of spinal injuries.

It is Highly recommended that spinal precautions be instituted aggressively for those victims who have ANY indicator of the potential for spinal injury

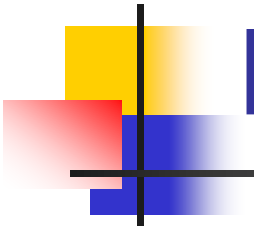
(Ex: Unwitnessed fall within a space or any other injury suspected to create enough force to produce spinal pain or injury.

Victim Support

- Water Removal
- Patient Protection
- Clean Air
- Patient Warmth

Skills you will Learn

- Non-Entry
- Horizontal Entry with SCBA
- Horizontal Entry with SAR
- Vertical Entry with SCBA
- Vertical Entry with SAR
- Combination type of entries with increased hazards present



References

See Lesson Plan