Confined Space Rescue

Student Manual

Technical Rescue
36/1600 (1/01)

STATE OF NEW YORK DEPARTMENT OF STATE
OFFICE OF FIRE PREVENTION AND CONTROL

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Welcome to the New York State Fire Training Program

Confined Space Rescue

The Department of State recognizes that providing training for paid and volunteer firefighters and related officials is an important part of the services it makes available. Our Office of Fire Prevention and Control (OFPC) places a very high priority on training because we believe it is essential for the men and women of the fire and emergency services in New York State.

The Office of Fire Prevention and Control's programs include the most complete progression of training available today -- beginning with probationary firefighters and extending the full length of a firefighter's career with the fire service. While our training programs address specific fire and arson prevention and control issues, we also encourage expansion and improvement of local training facilities and programs in cooperation with fire companies, municipal corporations and districts.

Based on objectives from National Fire Protection Association (NFPA) 1006 - Rescue Technician, Chapter 7, this course provides training in confined-space hazards; air monitoring and ventilation; space isolation techniques; personal protective equipment including, supplied air self contained breathing apparatus (SCBA) and respirators; and retrieval systems and methods. Practical evolutions enable the student to evaluate a specific confined-space incident and perform the necessary procedures to safely and effectively rescue the victim.

Your comments and suggestions about this student manual, our training classes or any OFPC program are always welcome. Your input will help us build on our successes and make needed changes, when appropriate.

On behalf of the citizens you serve, we want you to know that your participation and commitment are greatly appreciated.

FIRE PREVENTION AND CONTROL
NEW YORK STATE

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Training Policy-Firefighter Safety Training Required by the Public Safety and Health Act

Date of Issue: 07/01/00

An evaluation of the Office of Fire Prevention and Control's Outreach Training Programs was conducted by the New York State Department of Labor to determine what course components meet the initial fifteen hour and annual eight hour safety training required for firefighters under the Public Employees Safety and Health Act. This listing provides the approved time for each subject area of the designated courses. Students completing the listed courses should receive credit as listed below:

Based on OSHA Safety Training Requirements
CFR 1910.156 & CFR 1910.134

COURSE #	COURSE TITLE	SUBJECT AREA	TIME
03	Fire Behavior and Arson Awareness	General Hazard Recognition	60 min.
06	Ladder Company Operations	General Hazard Recognition	30 min.
		Fire Scene Safety	30 min.
		Tool and Equipment Safety	30 min.
		Total	90 min.
23	Commanding the Initial Response	Fire Scene Safety	30 min.
24	Rescue Operations (until 10/21/00)	General Hazard Recognition	30 min.
		Fire Scene Safety	30 min.
		Protective Clothing	15 min.
		Tool and Equipment Safety	60 min.
		Total	135 min.
26	Apparatus Operator-Emergency Vehicle Operation	Response Safety	60 min.
		Scene Safety	30 min.
		Tools and Equipment	60 min.
		Total	150 min.
27	Mask Confidence	SCBA	120 min.
		Recent Developments in Fire Safety	60 min.
		Total	180 min.
29	Incident Command System	General Hazard Recognition	30 min.
		Response Safety	15 min.
		Fire Scene Safety	45 min.
		Total	90 min.

continued on reverse

35	Confined Space Awareness and Safety	General Hazard Recognition	15 min.
		Response Safety	15 min.
		Fire Scene Safety	45 min.
		Protective Clothing	30 min.
		SCBA	15 min.
		Total	120 min.
38	Water Supply Operations	General Hazard Recognition	15 min.
		Response Safety	30 min.
		Fire Scene Safety	45 min.
		Protective Clothing	15 min.
		Tool and Equipment Safety	30 min.
		Total	135 min.
45	Introduction to Fire Officer (effective 4/01/01)	General Hazard Recognition	30 min.
		Fire Station Safety	30 min.
		Response Safety	30 min.
		Scene Safety	60 min.
		Protective Clothing	30 min.
		Total	180 min.
47	Rescue Technician - Basic (effective 1/1/01)	General Hazard Recognition	30 min.
		Fire Scene Safety	30 min.
		Protective Clothing	15 min.
		Tool and Equipment Safety	60 min.
		Total	135 min.
78	Apparatus Operator - Pump (effective 1/1/01)	Response Safety	30 min.
		Fire Scene Safety	30 min.
		Tool and Equipment Safety	30 min.
		Total	90 min.
91	Basic Firefighter	Subject matter in Basic Firefighter exceeds both the fifteen-hour initial and the eight-hour annual refresher safety training requirements.	
92	Intermediate Firefighter	Subject matter in Intermediate Firefighter exceeds both the fifteen-hour initial and the eight-hour annual refresher safety training requirements.	
93	Advanced Firefighter	Subject matter in Advanced Firefighter meets the eight-hour annual refresher safety training requirement.	
80 81 82 83	Refresher Courses	To be determined at the local level after the content of the presentation has been evaluated.	

RESCUE OPERATIONS II: CONFINED SPACE

ACKNOWLEDGEMENTS

The preparation of this course was made possible through the assistance, cooperation and dedication of many people. The Department of State's Office of Fire Prevention and Control wishes to thank all of the following persons for their roles in the development of this course.

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Orleans-Niagara BOCES

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Office of Fire Prevention and Control

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Introduction to Confined Space Rescue

Lesson 1: Course Overview

Introduction to Confined Space Rescue

Overview

The responsibilities of emergency personnel during a rescue are to safely and efficiently use available equipment to complete their assigned task. With a good awareness and understanding of the personal safety hazards that may be present at any emergency scene, emergency personnel will be better equipped to prevent needless death and injuries once they arrive on the scene. Firefighters, thrust into a rescue mode at the scene, will therefore be better able to perform the necessary operations with a minimum of risks to themselves and those being rescued.

This course provides knowledge in the specialized nature of confined space emergency rescue situations and provides in-depth training in the principles and techniques that must be employed at the emergency scene. This training enables the student to: recognize a confined space incident; understand the concepts involved in proper planning for these types of incidents; and be able to perform entry level rescue activities.

Because this course is intended to be an advanced, rescue level program and is based upon the expectation of the student having received certain prior training, the following courses must be taken prior to attending this program:

Course 02 - Firefighting Essentials

Course 24 - Rescue Operations

Course 35 - Confined Space: Awareness and Safety

Some specific confined space rescue situations may require additional expertise so it is also recommended that the following courses be taken by students assigned to this type of rescue:

Course 15 - Accident Victim Extrication Training

Course 27 - Mask Confidence

Course 28 - Firefighter Safety & Survival

Course 29 - Incident Command System

Course 31 - Hazardous Materials: First Responder Operations

Course 32 - Hazardous Materials: Technician

The six hour **Confined Space: Awareness and Safety** course consists of two lessons with each lesson being three hours in length. The course consists of classroom instruction with student activities in both lessons one and two.

The actual course breakdown is as follows:

Unit 1 - Introduction to Confined Space Rescue

1.1 Introduction & Registration
1.2 Rescue Knots
1.3 Overview of the Problem
1.4 Regulations & Standards
1.5 FD Confined Space Response Plans
1.6 Rescue ICS
1.7 Personal Protective Equipment

Unit 2 - Confined Space Rescue Hazards

2.1 Review of Unit 1 and Knot Review
2.2 Confined Space Hazards
2.3 Air Quality
2.4 Space Isolation
2.5 Psychological Aspects of CS Rescue

Unit 3 - Confined Space Rescue Equipment

3.1 Review of Unit 2 & Knot Review
3.2 Communications
3.3 Rope, Hardware and Mechanical Advantage Systems
3.4 Tripods & Ladder Rescue Systems
3.5 Harnesses
3.6 Victim Packaging

Unit 4 - Confined Space Rescue Equipment (Practical)

4.1 Review of Unit 3 & Unit 4 Briefing
4.2 Tripods & Ladder Rescue Systems (Practical)
4.3 Rope Systems (Practical)

Unit 5 - Confined Space Horizontal Evolutions

5.1 Review of Unit 4 & Unit 5 Briefing
5.2 Horizontal Evolutions (Practical)

Unit 6 - Confined Space Vertical Evolutions

6.1 Review of Unit 5 & Unit 6 Briefing
6.2 Vertical Evolutions (Practical)

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7.1 Review of Unit 6 & Unit 7 Briefing
7.2 Vertical / Horizontal Evolutions (Practical)
7.3 Final Written Exam

Unit 1:
Introduction to Confined Space Rescue

Lesson 2: Rescue Knots

Introduction to Confined Space Rescue

Introduction

Knot tying is a skill. The knots learned in this lesson must be practiced by each individual team member to ensure that they can tie any of the needed knots without mistake or delay. All team members must be able to tie all knots used by the team.

A rescue team should rely on a small selection of knots that do their jobs well. By standardizing the knots used, there will be fewer knots for the team members to learn. During a rescue, checking the knot is much easier since a particular knot will be expected at a given position. This lesson utilizes the most common name for a given knot although the same knot may be known by several names.

The knots for rope rescue which are used throughout this course are;

Figure eight family of knots
- Simple Figure of 8
- Figure of 8 on Bight
- Figure of 8 Follow Through Loop
- Figure of 8 Bend - Join 2 Ropes
- Double Loop Figure of 8

Other rope knots
- Double Fisherman
- Prusik Hitch
- Overhand Knot
- Safety Knot
- Munter Hitch
- Square Knot
- Butterfly Knot
- Wristlet Knot

Webbing knots
- Overhand knot
- Water Knot
- Mariner's Knot

What Makes A Good Knot

Strength

The strength of a knot refers to how much the knot will weaken the rope. Bending weakens a rope and knots are tight bends. The following table of relative strengths (Figure 1.2-1) shows the strength of a rope with a particular knot in it and is given as a percentage of the strength of that rope without the knot.

Figure 1.2-1

Relative Strength Of Knots For Single Kernmantle Rope

	Strength in lbs.	Percent Lost
No Knot		100%
Clove Hitch		60% to 65%
Bowline		70% to 75%
Control Rope	10,705	-----
Control Web	4,800	-----
Bends		
Double Fisherman's Knot	8,440	21%
Figure 8 Bend (Flemish Bend)	8,640	19%
Loops		
Figure 8 Loop (with a bight)	8,560	20%
Figure 8 Loop (follow through)	8,640	19%
Double Figure 8 Loop	8,820	18%
Figure 9 Loop	9,760	9%
Inline Figure 8 Loop	8,000	25%
Butterfly Knot	8,000	25%
Bowline	7,180	33%
Overhand Loop (with a bight)	9,060	15%
Overhand Double Loop	7,900	26%
Rope With A Loop In It (*)		
Figure 8 Loop	6,960	35%
Inline Figure 8 Loop	6,280	41%
Butterfly Loop	7,360	31%
Knots In Web		
Water Knot	3,060	36%
Overhand Loop	3,120	35%
Figure 8 Loop (with a bight)	3,360	30%
Figure 8 Loop (follow through)	3,560	26%
Web Slings		
Water Knot-Single Loop	5,700	
Water Knot-Double Loop	12,920	
Water Knot-Triple Loop	22,860	

(*) *Rope pulled end to end*

Dressing a knot

Neatness counts when tying a knot. Making the rope run smoothly without any extra bends or twists is called "dressing" the knot. When you dress the knot, it is stronger and easier to check.

Securing a knot

Some knots, like the double fisherman and water knot, tend to be self-locking. Some knots, like the bowline, are not particularly secure and tend to loosen when loaded Because of this, the bowline has been eliminated from the knot selection for this course.

Rescue Knots

Knots are grouped according to what they do. The most common knot family is the Figure 8 family of knots. In webbing, knots based on overhand family look best. These knots have been chosen because of ease of use, as well as the minimal loss in strength the knot puts on the rope and webbing.

As part of this course, all students will tie the following;

Simple Figure of 8 (Figure 1.2-2)

This knot is the basis for the other figure 8 knots. It is also commonly used as a stopper knot.

Figure 1.2-2

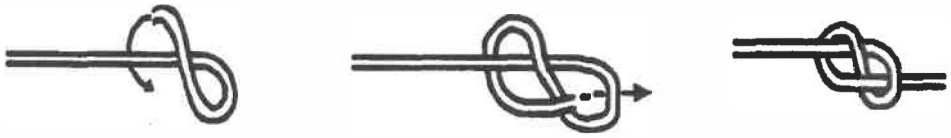


Figure of 8 on Bight (Figure 1.2-3)

This is a strong knot and is less bulky than double loop figure 8. It is used primarily for anchor systems and for attaching into the rope.

Figure 1.2-3

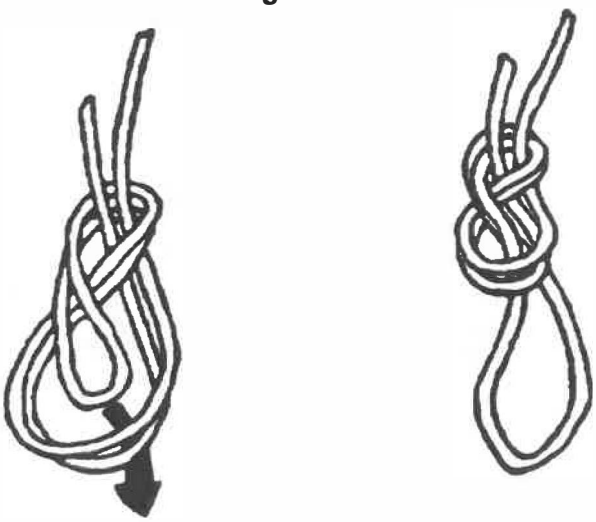


Figure of 8 Follow Through Loop (Figure 1.2-4)

This knot is used to tie around an anchor and tie into a harness when the loop in the rope cannot be put over or through the object (although we usually use a figure 8 on bight or double loop figure 8 with a carabiner).

Figure 1.2-4

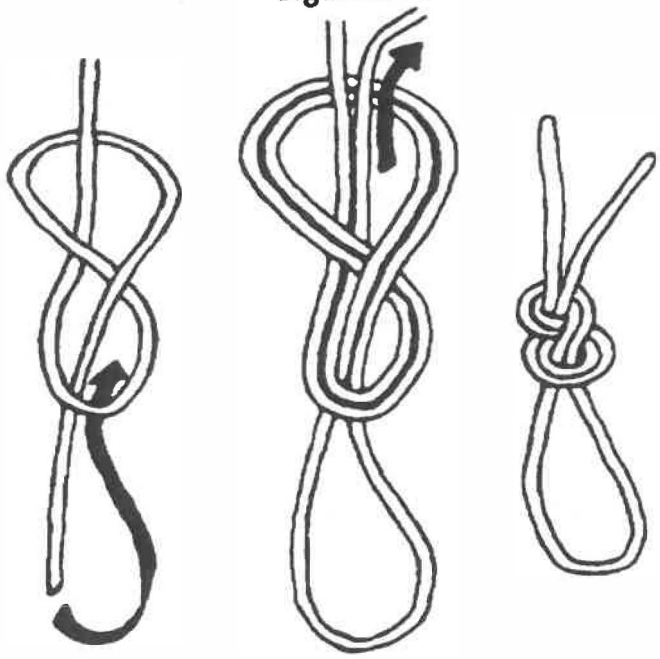
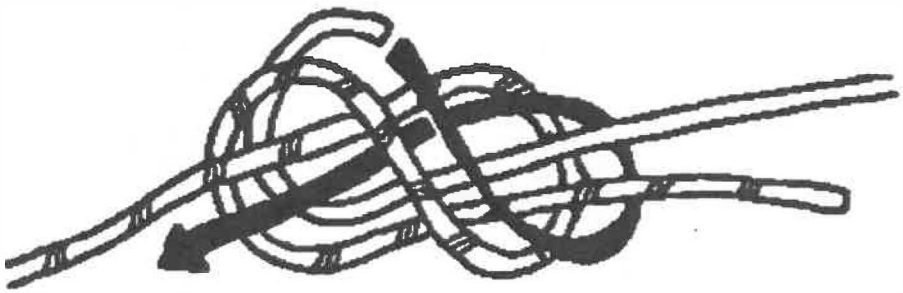


Figure of 8 Bend - Join 2 Ropes (Figure 1.2-5)

Used to join 2 ropes together.

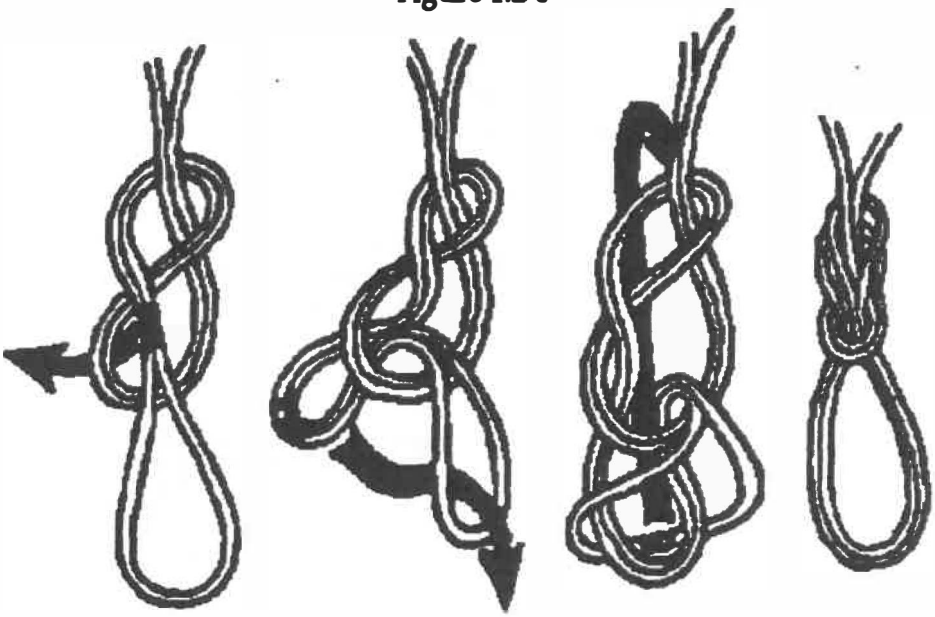
Figure 1.2-5



Double Loop Figure of 8 (Figure 1.2-6)

This is a strong knot and the double loop reduces wear and strength loss from the rope being bent around a carabiner. It adjusts easily and is a versatile knot for anchor systems. It works well for anchor systems having two, three, or more points and the self-equalizing and omni-directional efficiency of the knot is increased when it is tied in rope rather than web. This knot can be tied at the end of the main line, or you can use a separate anchor rope or webbing loop.

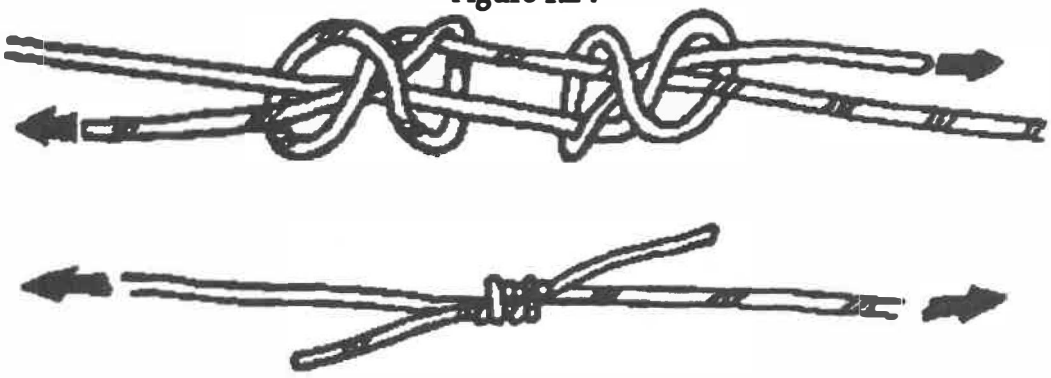
Figure 1.2-6



Double Fisherman Knot (Figure 1.2-7)

Used to connect two ropes or to make a rope into a loop. It is a strong, self-locking, very secure knot. This knot is primarily used with prusik cord in this course.

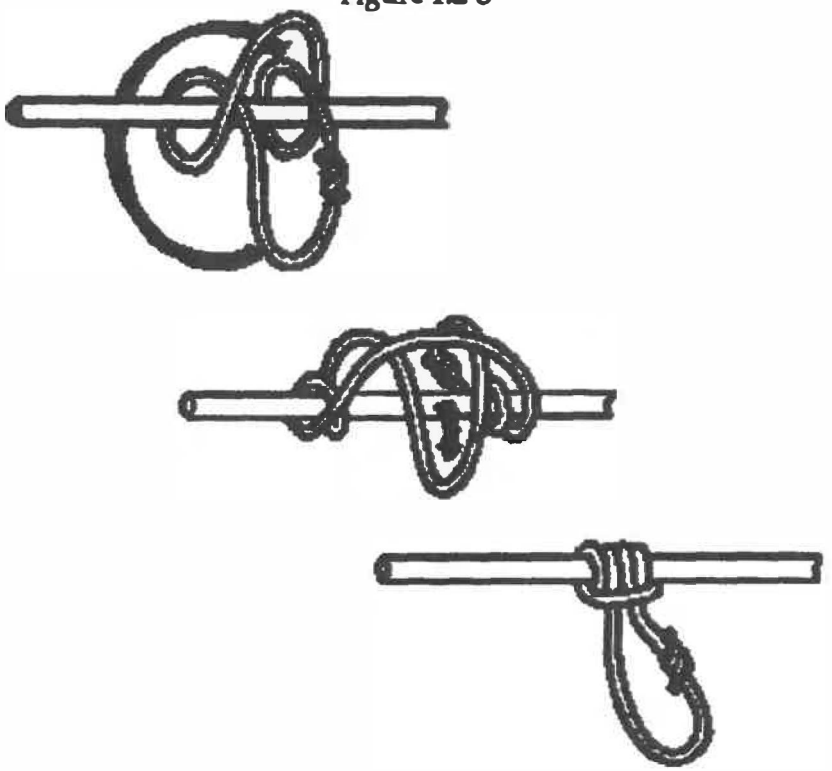
Figure 1.2-7



Prusik Hitch (Figure 1.2-8)

Used to secure a prusik cord to a rope. The knot holds when loaded but slides when loose.

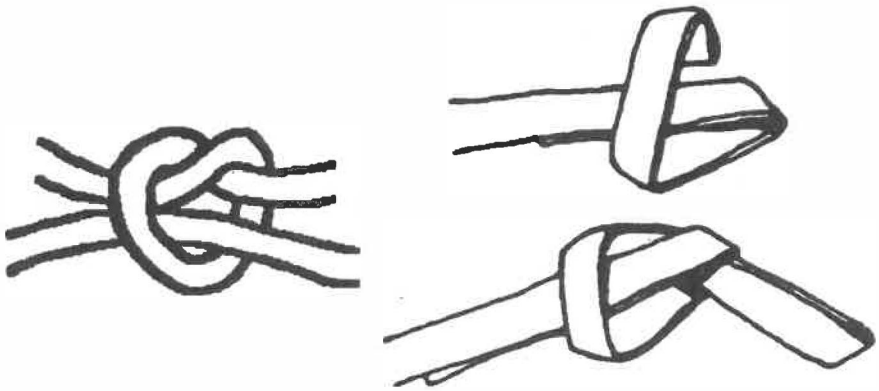
Figure 1.2-8



Overhand Knot (Figure 1.2-9)

Good choice for use with webbing. Is also used as a back-up or safety knot with rope.

Figure 1.2-9



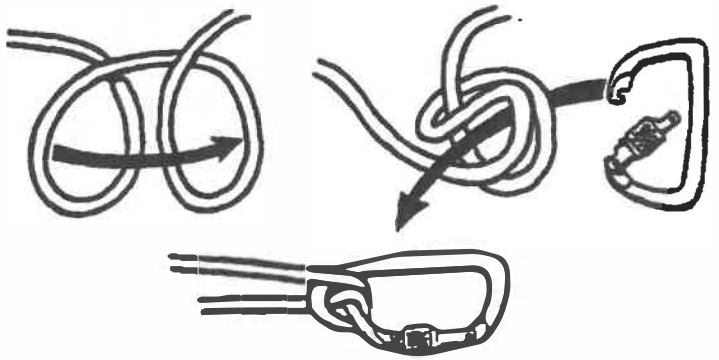
Safety Knot (Half Double Fisherman)

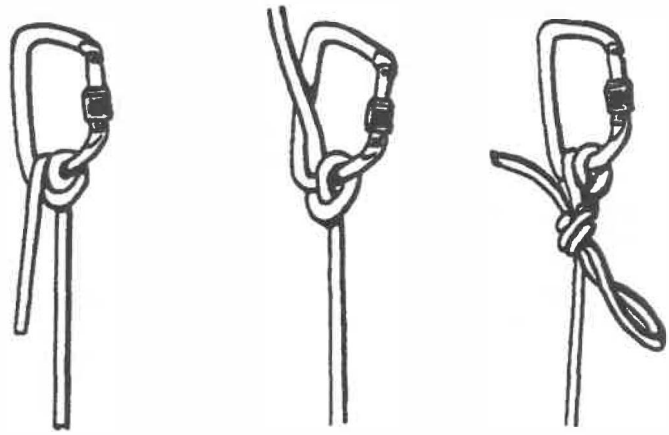
Used as a back-up/safety knot with rope.

Munter Hitch (Figure 1.2-11)

Used in place of the figure 8 plate as a belay device.

Figure 1.2-11



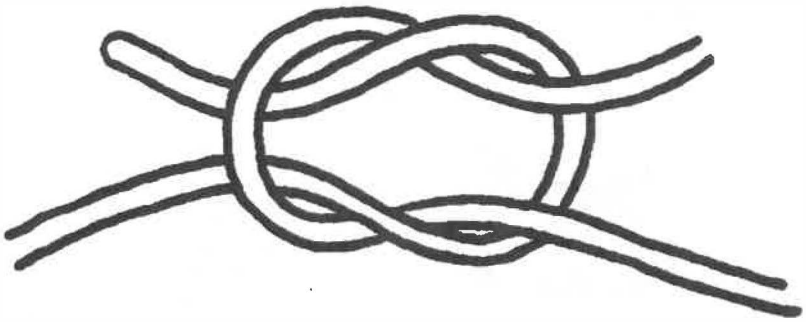


Most Closed Position (Maximum Friction) | Most Open Position (Least Friction) | Tied Off

Square Knot (Figure 1.2-12)

Used in some victim packaging systems.

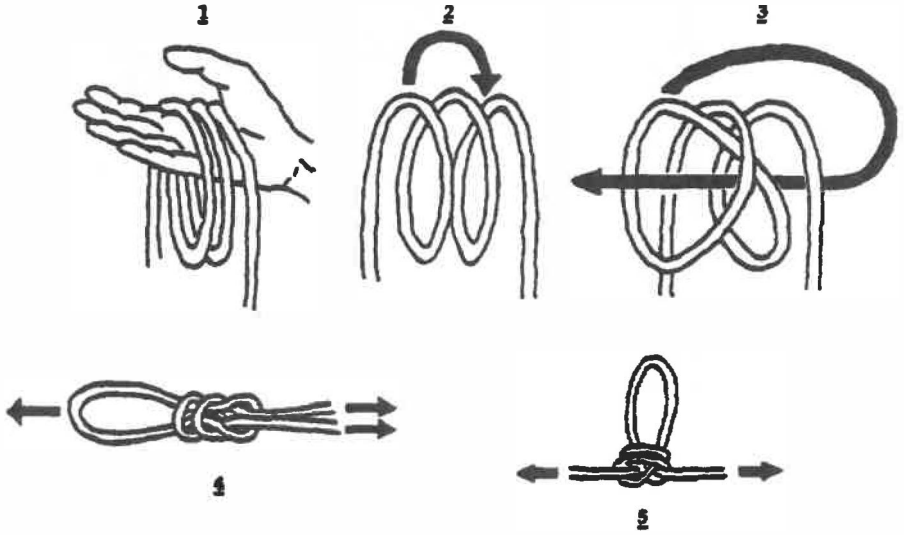
Figure 1.2-12



Butterfly Knot (Figure 1.2-13)

Used to create a loop in the middle of the rope. Often used for attachment of removal devices or victims to the rescue rope.

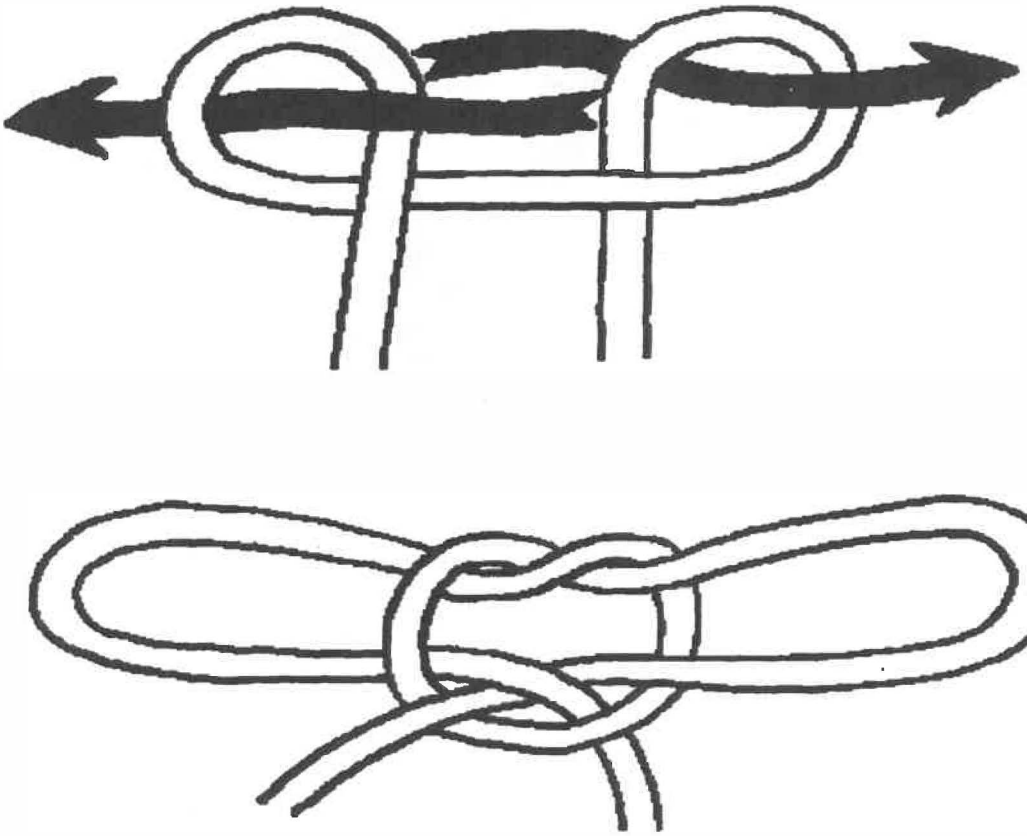
Figure 1.2-13



Wristlet Knot (Figure 1.2-14)

Used to attach the rope to the victim's wrists or ankles. This knot can be quickly made in the middle of the rope and unties by pulling on the ends.

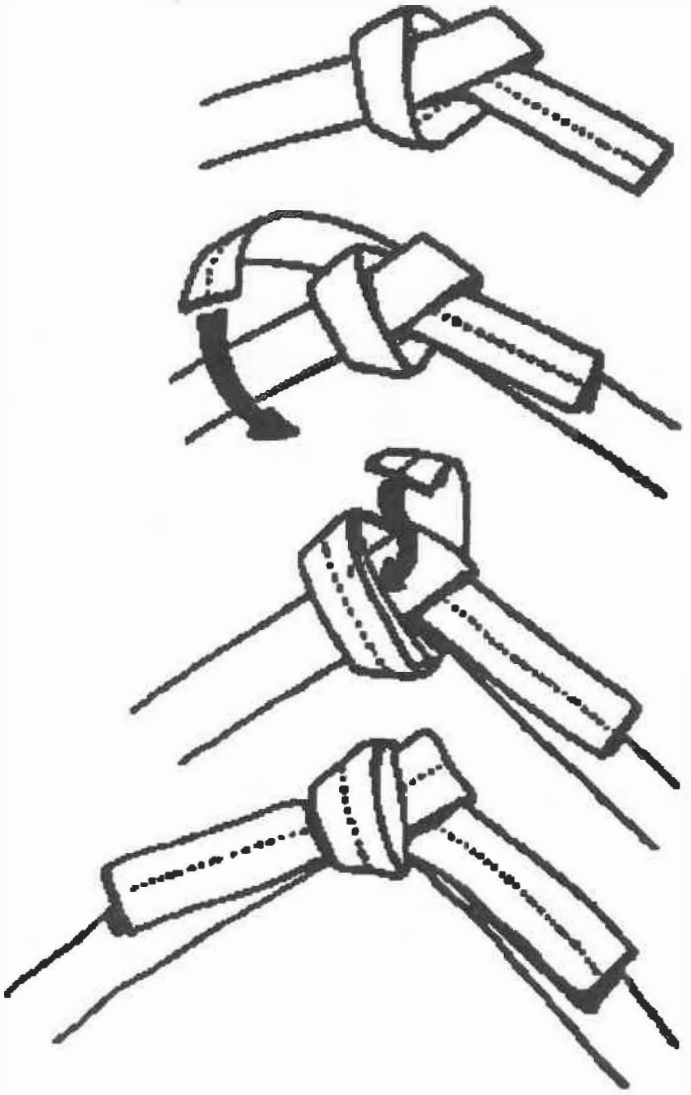
Figure 1.2-14



Water Knot (Figure 1.2-15)

Used with webbing. The knot is secured by tying an overhand safety knot on each side of water knot unless you set the knot very tightly before use.

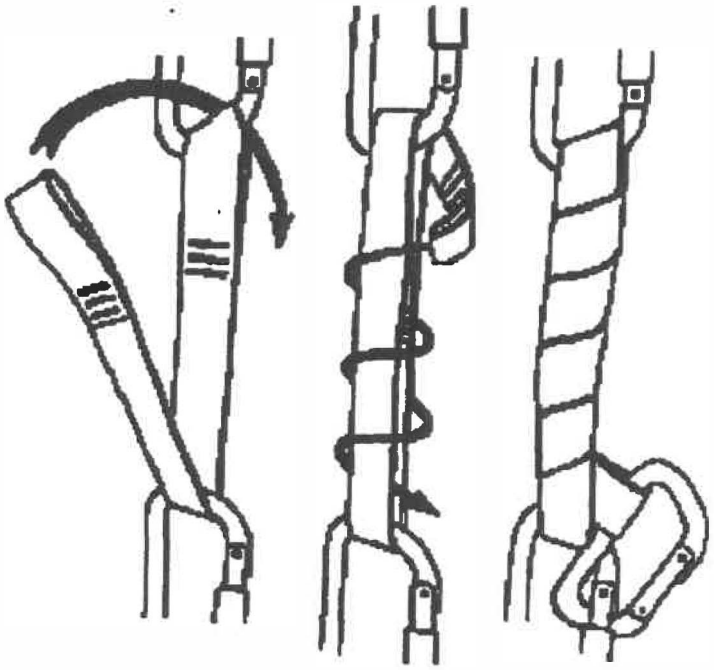
Figure 1.2-15



Mariner's Knot (Figure 1.2-16)

Actually a knot system that can be released under load. It is primarily used to connect brake Gibbs or prusiks to an anchor. If you need to release a Gibbs or prusik while it is still under load, such as when it is holding a system, the Mariners' knot will free the Gibbs or prusik. To untie the knot while it is under load, start by unclipping and removing the carabiner (the loose one) and push the loop back through the web, opposite of how you tied the knot. Start unwrapping the web carefully. As the web starts to slide, let the load transfer gently onto the Figure 8 plate.

Figure 1.2-16



Unit 1:
Introduction to Confined Space Rescue

Lesson 2: Rescue Knots
APPENDIX

Knot Practical Skills

Name:_____ Date: ____/____/____

Individual Knots:

Simple Figure of 8	Complete / Incomplete
Figure of 8 on Bight	Complete / Incomplete
Figure of 8 Follow Through Loop	Complete / Incomplete
Figure of 8 Bend - Join 2 Ropes	Complete / Incomplete
Double Loop Figure of 8	Complete / Incomplete
In Line Figure 8 Loop	Complete / Incomplete
Double Fisherman	Complete / Incomplete
Prusik Hitch	Complete / Incomplete
Overhand Knot	Complete / Incomplete
Safety Knot (Half Dbl. Fisherman)	Complete / Incomplete
Munter Hitch	Complete / Incomplete
Square Knot	Complete / Incomplete
Butterfly Knot	Complete / Incomplete
Wristlet Knot	Complete / Incomplete
Water Knot	Complete / Incomplete
Mariner's Knot	Complete / Incomplete

Unit 1
Introduction to Confined Space Rescue

Lesson 3: Overview of the Problem

Introduction to Confined Space Rescue

Introduction to confined space

Virginia Beach, Virginia..... One worker and one firefighter killed during a rescue attempt from a ship hold.

Binghamton, New York.....One worker killed, 14 firefighters injured during a rescue attempt from an underground sewer pipe.

Elkridge, Maryland.....Two workers killed, one firefighter injured during a rescue attempt from an acid tank.

Phoenix, Arizona.....One worker and 1 firefighter killed, 14 other firefighters injured during a rescue attempt from an above ground storage tank.

Anchorage, Alaska.....One worker killed, 9 firefighters injured during a rescue attempt from an aircraft fuel delivery truck.

Bristol, New Hampshire.....One worker and 3 firefighters killed during a rescue attempt from a 43 foot well.

Lancaster, Pennsylvania.....One firefighter and two paramedics killed during a rescue attempt from a septic tank.

Different cities, different fire departments and different rescues. All different but all sharing the same results – deaths and injuries occurred to would-be rescuers. If you look closely at these incidents you will see there is something in common. All of these deaths and injuries occurred while these departments were performing a rescue from a silent but deadly killer – a confined space.

The problem

The US Department of Labor's Occupational Safety and Health Administration (OSHA) statistics show there are almost 240,000 establishments with approximately 4.8 million permit required confined spaces. These spaces must be entered on occasion to perform maintenance work and other necessary tasks. It is estimated that there are about 1.6 million workers who enter these spaces.

Confined spaces can contain many different types of hazards and accidents can and do happen. OSHA accident statistics show there are an average of 67 deaths per year in permit required confined spaces. Of particular interest is that some studies show up to 60 percent of these deaths are to would-be rescuers. These would-be rescuers consist of co-workers as well as firefighters, police officers and the like. In addition to the fatalities, there are an estimated 5900 lost workday accidents and 7000 non-lost workday accidents.

Because of these statistics, OSHA 29 CFR 1910.146 - Permit Required Confined Spaces for General Industry was adopted and became effective on April 15, 1993. It is estimated that the enforcement of this standard will reduce fatalities, injuries and illnesses by 85 percent.

Unit 1
Introduction to Confined Space Rescue

Lesson 4: Regulations and Standards

Introduction to Confined Space Rescue

Regulations and standards

The regulations pertaining to confined space entry and rescue are contained in OSHA 29 CFR 1910.146 - Permit Required Confined Spaces for General Industry. While this regulation does not cover all industries, fire service response to confined space rescue is covered here. Some industries that are specifically excluded are agriculture, telecommunication, construction and shipyard employment.

Included in the standard are definitions, permit requirements, job descriptions and duties of the various functions including attendant, entrant and entry supervisor, rescue service requirements and training requirements. A copy of this standard, as well as 29 CFR 1910.147 - Control of Hazardous Energy Source (Lockout / Tagout), are included at the end of this lesson.

Definitions

A **confined space** is a space that:

- is large enough and so configured so someone can bodily enter and work,
- has limited or restricted means for entry or exit; and
- is not designed for continuous occupancy.

Examples of confined spaces may include tanks, vessels, silos, storage bins, hoppers, vaults, manholes and pits.

A **permit required confined space** means a confined space that has one or more of the following characteristics:

- contains or has the potential to contain a hazardous atmosphere;
- contains a material that has the potential to engulf an entrant;
- has an internal configuration such that an entrant could be entrapped or asphyxiated by inwardly converging walls or by a floor which slopes downward and tapers to a smaller cross-section; or
- contains any other recognized serious safety or health hazard.

An **attendant** means an individual stationed outside the space who monitors the entrants and conditions within and outside the space.

An **entrant** is the person who passes through an opening into a space. Entry is considered to have occurred when any part of the entrant's body breaks the plane of an opening into the space.

An **entry supervisor** is the person in charge of the operation where persons enter confined spaces. This may be the incident commander or the rescue officer.

In a confined space rescue situation, all three of the above mentioned positions will be filled by rescue personnel. They may be referred to by different names but the fact remains that each one of these functions are vital to the safe completion of a rescue operation.

Rescue and emergency services

Paragraph K of the standard details the requirements for rescue and emergency services. All employers (except for those mentioned earlier) who have permit required confined spaces where workers enter are required to provide for rescue services. This may be accomplished with the use of an in-house or on-site team or with an agreement with an outside or off-site team. This is in addition to the requirement for non-entry retrieval systems that must be in place unless it creates a greater hazard to the entrant or would not be effective.

If fire departments are going to provide confined space rescue services, OSHA 1910.146 requires fire departments to train their personnel in the following areas:

- personal protective equipment and rescue equipment necessary for making rescues from confined spaces;
- any areas where duties are assigned so that the employee will have the necessary understanding, knowledge and skills for the safe performance of the rescue; and
- simulated rescues from actual or representative confined spaces.

More specifically this would include (but is not limited to) training in :

- fire department confined space response plans;
- personal protective equipment including SCBA and airline systems;
- atmosphere monitoring equipment;
- retrieval systems including tripods and rope systems;
- ventilation of confined spaces;
- First aid and CPR;
- space isolation (lockout - tagout) procedures; and
- proper removal techniques in a variety of rescue scenarios - actual hands on removal of mannequins or persons.

If a fire department agrees to perform rescue services for a specific site, they must be informed of the hazards and provided with access to the space for planning and training purposes. In addition, it is recommended that an agreement be reached with those responsible for the site with regards to the specific conditions under which the services will be provided.

Other OSHA regulations pertaining to confined space rescue

The following OSHA standards can impact the ability of the fire department to provide rescue services depending on the level of response provided. Most of these have already affected the fire service so compliance should not, in most cases, be a major issue. Departments contemplating providing confined space rescue services will need to review these standards to ensure compliance.

OSHA 29 CFR 1910.133 - Eye and Face Protection

OSHA 29 CFR 1910.134 - Respiratory Protection (Includes requirements for physical examination and fit testing)

OSHA 29 CFR 1910.135 - Occupational Head Protection

OSHA 29 CFR 1910.136 - Occupational Foot Protection

OSHA 29 CFR 1910.120 - Hazardous Waste Operations and Emergency Response

OSHA 29 CFR 1910.1030 - Bloodborne Pathogens

OSHA 29 CFR 1910.147 - Control of Hazardous Energy (Lockout/Tagout)

Additional recommended standards

The following recommended standards provide information to assist in properly selecting equipment and developing SOP's and programs. Some of these standards are referenced in the OSHA standards so they (or portions thereof) may need to be complied with.

American National Standards Institute (ANSI)

ANSI Z88.2-1980 - Practices for Respirator Protection

ANSI Z88.2-1992 - Respiratory Protection

ANSI Z117.1-1989 - Safety Requirements for Confined Spaces

National Fire Protection Association (NFPA)

NFPA 1404 - Fire Department Self-Contained Breathing Apparatus Program

NFPA 1500 - Fire Department Occupational Safety and Health Program

NFPA 1521 - Fire Department Safety Officer

NFPA 1581 - Fire Department Infection Control Program

NFPA 1981 - Open-Circuit Self-Contained Breathing Apparatus for Fire Fighters

NFPA 1982 - Personal Alert Safety Systems (PASS) for Fire Fighters

NFPA 1983 - Fire Service Life Safety Rope

NFPA 328 - Control of Flammable and Combustible Liquids and Gasses in Manholes, Sewers and Similar Underground Structures

In addition, there may be other useful standards as indicated by the specific needs of the confined space site (i.e. NFPA standard for grain elevators etc.).

Unit 1
Introduction to Confined Space Rescue

Lesson 4: Regulations and Standards
APPENDIX

TECHNICAL BULLETIN

Confined Space Rescue

On April 15, 1993, the OSHA Final Rule for Permit Required Confined Spaces (29 CFR 1910.146) became effective and is being enforced by the New York State Department of Labor (DOL). In October 1993, DOL's Public Employee Safety and Health Bureau issued guidelines to insure compliance of local fire department programs.

This standard may have a substantial impact on the fire, rescue and emergency services depending on the adopted level of response. Before a fire department can determine the level of rescue service to be provided, they must understand the standard and its requirements; determine if the service can be provided in a timely manner; and maintain the necessary equipment and level of training.

Definition

A confined space is a space that:

- is large enough and configured so someone can bodily enter and work;
- has limited or restricted means for entry or exit; and
- is not designed for continuous occupancy.

Examples include: tanks, vessels, silos, storage bins, hoppers, vaults, manholes and pits.

A permit-required confined space has one or more of the following characteristics:

- contains or may potentially contain a hazardous atmosphere;
- contains a material with the potential to engulf an entrant;
- has an internal configuration such that an entrant could be entrapped or asphyxiated by inwardly converging walls or by a floor which slopes downward and tapers to a smaller cross-section; or
- contains any other recognized serious safety or health hazard.

Based on these definitions, many fire service response situations are considered confined space rescues. Most fire departments have confined spaces within their jurisdiction. Also, it does not matter whether a particular industry (such as agriculture) has been exempted from the regulation. Rescue services are required to follow the applicable sections of the standard any time entry is made into a space meeting the OSHA definition of a permit required confined space.

Training

If fire departments are providing confined space rescue services, under OSHA 1910.146 personnel must be trained in the following areas:

- personal protective equipment and rescue equipment necessary for making confined space rescues;
- areas where duties are assigned so the employee will have the necessary understanding, knowledge and skills to safely perform the rescue; and
- simulated rescues from actual or representative confined spaces.

(over)

This training must include but is not limited to:

- fire department confined space response plans;
- personal protective equipment including SCBA and airline systems;
- atmosphere monitoring equipment;
- retrieval systems including tripods;
- rope systems;
- A-frames and gin poles;
- confined space ventilation;
- first aid and CPR;
- lock out - tag out procedures; and
- proper removal techniques in a variety of rescue scenarios (actual hands on removal of dummies, manikins or persons).

If your fire department is contacted by private industry or a municipal government to be the rescue service for their confined space entry program, give careful consideration to the impact on your department. Ask these questions:

- Can we guarantee trained personnel will be available when needed?
- If we cannot commit personnel to the site, can we ensure response within a reasonable time?
- Do we have personnel who have the time to train at the specific sites or in representative spaces?
- Do we have the necessary equipment (monitoring equipment and retrieval systems) available?

If you answered no to any of these, avoid committing to be the primary rescue service. This does not mean, however, that you are not in the confined space rescue business. If you intend to perform rescues only when you are called because someone is "down" in a space or you are going to be a backup for an in-house team, then the requirements of the standard apply. You must still maintain the equipment and training as specified earlier.

Because many fire departments perform some level of confined space rescue, the Office of Fire Prevention and Control is developing a training program to assist local fire departments in meeting the requirements of 1910.146. This program, expected to be available statewide in the fall of 1994, will meet the standard's training requirements with the exception of site specific and medical training.

Direct questions regarding the training program to: Deputy Chief Thomas Wutz or Fire Protection Specialist Brian Rousseau, Office of Fire Prevention and Control, Fire Services Bureau, (518) 474-6746.

Questions about OSHA 1910.146 can be directed to OFPC or Mr. David Ruppert, New York State Department of Labor, Public Employee Safety and Health Bureau , (518) 457-1263.

Francis A. McGarry
State Fire Administrator
March 1994

- **Standard Number:** 1910.146
- **Standard Title:** Permit-required confined spaces
- **SubPart Number:** J
- **SubPart Title:** General Environmental Controls

(a) Scope and application. This section contains requirements for practices and procedures to protect employees in general industry from the hazards of entry into permit-required confined spaces. This section does not apply to agriculture, to construction, or to shipyard employment (Parts 1928, 1926, and 1915 of this chapter, respectively).

(b) Definitions.
"Acceptable entry conditions" means the conditions that must exist in a permit space to allow entry and to ensure that employees involved with a permit-required confined space entry can safely enter into and work within the space.

"Attendant" means an individual stationed outside one or more permit spaces who monitors the authorized entrants and who performs all attendant's duties assigned in the employer's permit space program.

"Authorized entrant" means an employee who is authorized by the employer to enter a permit space.

"Blanking or blinding" means the absolute closure of a pipe, line, or duct by the fastening of a solid plate (such as a spectacle blind or a skillet blind) that completely covers the bore and that is capable of withstanding the maximum pressure of the pipe, line, or duct with no leakage beyond the plate.

"Confined space" means a space that:
(1) Is large enough and so configured that an employee can bodily enter and perform assigned work; and
(2) Has limited or restricted means for entry or exit (for example, tanks, vessels, silos, storage bins, hoppers, vaults, and pits are spaces that may have limited means of entry.); and
(3) Is not designed for continuous employee occupancy.

"Double block and bleed" means the closure of a line, duct, or pipe by closing and locking or tagging two in-line valves and by opening and locking or tagging a drain or vent valve in the line between the two closed valves.

"Emergency" means any occurrence (including any failure of hazard control or monitoring equipment) or event internal or external to the permit space that could endanger entrants.

"Engulfment" means the surrounding and effective capture of a person by a liquid or finely divided (flowable) solid substance that can be aspirated to cause death by filling or plugging the respiratory system or that can exert enough force on the body to cause death by strangulation, constriction, or crushing.

"Entry" means the action by which a person passes through an opening into a permit-required confined space. Entry includes ensuing work activities in that space and is considered to have occurred as soon as any part of the entrant's body breaks the plane of an opening into the space.

"Entry permit (permit)" means the written or printed document that is provided by the employer to allow and control entry into a permit space and that contains the information specified in paragraph (f) of this section.

"Entry supervisor" means the person (such as the employer, foreman, or crew chief) responsible for determining if acceptable entry conditions are present at a permit space where entry is planned, for authorizing entry and overseeing entry operations, and for terminating entry as required by this section.
NOTE: An entry supervisor also may serve as an attendant or as an authorized entrant, as long as that person is trained and equipped as required by this section for each role he or she fills. Also, the duties of entry supervisor may be passed from one individual to another during the course of an entry operation.

"Hazardous atmosphere" means an atmosphere that may expose employees to the risk of death, incapacitation, impairment of ability to self-rescue (that is, escape unaided from a permit space), injury, or acute illness from one or more of the following causes:
(1) Flammable gas, vapor, or mist in excess of 10 percent of its lower flammable limit (LFL);
(2) Airborne combustible dust at a concentration that meets or exceeds its LFL;
NOTE: This concentration may be approximated as a condition in which the dust obscures vision at a distance of 5 feet (1.52 m) or less.
(3) Atmospheric oxygen concentration below 19.5 percent or above 23.5 percent;
(4) Atmospheric concentration of any substance for which a dose or a permissible exposure limit is published in Subpart G, Occupational Health and Environmental Control, or in Subpart Z, Toxic and Hazardous Substances, of this Part and which could result in employee exposure in excess of its dose or permissible exposure limit;
NOTE: An atmospheric concentration of any substance that is not capable of causing death, incapacitation, impairment of ability to self-rescue, injury, or acute illness due to its health effects is not covered by this provision.
(5) Any other atmospheric condition that is immediately dangerous to life or health.
NOTE: For air contaminants for which OSHA has not determined a dose or permissible exposure limit, other sources of information, such as Material Safety Data Sheets that comply with the Hazard Communication Standard, section 1910.1200 of this Part, published information, and internal documents can provide guidance in establishing acceptable atmospheric conditions.

"Hot work permit" means the employer's written authorization to perform operations (for example, riveting, welding, cutting, burning, and heating) capable of providing a source of ignition.

"Immediately dangerous to life or health (IDLH)" means any condition that poses an immediate or delayed threat to life or that would cause irreversible adverse health effects or that would interfere with an individual's ability to escape unaided from a permit space.
NOTE: Some materials -- hydrogen fluoride gas and cadmium vapor, for example -- may produce immediate transient effects that, even if severe, may pass without medical attention, but are followed by sudden, possibly fatal collapse 12-72 hours after exposure. The victim "feels normal" from recovery from transient effects until collapse. Such materials in hazardous quantities are considered to be "immediately" dangerous to life or health.

"Inerting" means the displacement of the atmosphere in a permit space by a noncombustible gas (such as nitrogen) to such an extent that the resulting atmosphere is noncombustible.
NOTE: This procedure produces an IDLH oxygen-deficient atmosphere.

"Isolation" means the process by which a permit space is removed from service and completely protected against the release of energy and material into the space by such means as: blanking or blinding; misaligning or removing sections of lines, pipes, or ducts; a double block and bleed system; lockout or tagout of all sources of energy; or blocking or disconnecting all mechanical linkages.

"Line breaking" means the intentional opening of a pipe, line, or duct that is or has been carrying flammable, corrosive, or toxic material, an inert gas, or any fluid at a volume, pressure, or temperature capable of causing injury.

"Non-permit confined space" means a confined space that does not contain or, with respect to atmospheric hazards, have the potential to contain any hazard capable of causing death or serious physical harm.

"Oxygen deficient atmosphere" means an atmosphere containing less than 19.5 percent oxygen by volume.

"Oxygen enriched atmosphere" means an atmosphere containing more than 23.5 percent oxygen by volume.

"Permit-required confined space (permit space)" means a confined space that has one or more of the following characteristics:

(1) Contains or has a potential to contain a hazardous atmosphere;
(2) Contains a material that has the potential for engulfing an entrant;
(3) 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; or
(4) Contains any other recognized serious safety or health hazard.

"Permit-required confined space program (permit space program)" means the employer's overall program for controlling, and, where appropriate, for protecting employees from, permit space hazards and for regulating employee entry into permit spaces.

"Permit system" means the employer's written procedure for preparing and issuing permits for entry and for returning the permit space to service following termination of entry.

"Prohibited condition" means any condition in a permit space that is not allowed by the permit during the period when entry is authorized.

"Rescue service" means the personnel designated to rescue employees from permit spaces.

"Retrieval system" means the equipment (including a retrieval line, chest or full-body harness, wristlets, if appropriate, and a lifting device or anchor) used for non-entry rescue of persons from permit spaces.

"Testing" means the process by which the hazards that may confront entrants of a permit space are identified and evaluated. Testing includes specifying the tests that are to be performed in the permit space.
NOTE: Testing enables employers both to devise and implement adequate control measures for the protection of authorized entrants and to determine if acceptable entry conditions are present immediately prior to, and during, entry.

(c) General requirements.

(c)(1) The employer shall evaluate the workplace to determine if any spaces are permit-required confined spaces.
NOTE: Proper application of the decision flow chart in Appendix A to section 1910.146 would facilitate compliance with this requirement.

(c)(2) If the workplace contains permit spaces, the employer shall inform exposed employees, by posting danger signs or by any other equally effective means, of the existence and location of and the danger posed by the permit spaces.
NOTE: A sign reading DANGER -- PERMIT-REQUIRED CONFINED SPACE, DO NOT ENTER or using other similar language would satisfy the requirement for a sign.

(c)(3) If the employer decides that its employees will not enter permit spaces, the employer shall take effective measures to prevent its employees from entering the permit spaces and shall comply with paragraphs (c)(1), (c)(2), (c)(6), and (c)(8) of this section.

(c)(4) If the employer decides that its employees will enter permit spaces, the employer shall develop and implement a written permit space program that complies with this section. The written program shall be available for inspection by employees and their authorized representatives.

(c)(5) An employer may use the alternate procedures specified in paragraph (c)(5)(ii) of this section for entering a permit space under the conditions set forth in paragraph (c)(5)(i) of this section.

(c)(5)(i) An employer whose employees enter a permit space need not comply with paragraphs (d) through (f) and (h) through (k) of this section, provided that:

(c)(5)(i)(A) The employer can demonstrate that the only hazard posed by the permit space is an actual or potential hazardous atmosphere;

(c)(5)(i)(B) The employer can demonstrate that continuous forced air ventilation alone is sufficient to maintain that permit space safe for entry;

(c)(5)(i)(C) The employer develops monitoring and inspection data that supports the demonstrations required by paragraphs (c)(5)(i)(A) and (c)(5)(i)(B) of this section;

(c)(5)(i)(D) If an initial entry of the permit space is necessary to obtain the data required by paragraph (c)(5)(i)(C) of this section, the entry is performed in compliance with paragraphs (d) through (k) of this section;

(c)(5)(i)(E) The determinations and supporting data required by paragraphs (c)(5)(i)(A), (c)(5)(i)(B), and (c)(5)(i)(C) of this section are documented by the employer and are made available to each employee who enters the permit space under the terms of paragraph (c)(5) of this section or to that employee's authorized representative; and

(c)(5)(i)(F) Entry into the permit space under the terms of paragraph (c)(5)(i) of this section is performed in accordance with the requirements of paragraph (c)(5)(ii) of this section.
NOTE: See paragraph (c)(7) of this section for reclassification of a permit space after all hazards within the space have been eliminated.

(c)(5)(ii) The following requirements apply to entry into permit spaces that meet the conditions set forth in paragraph (c)(5)(i) of this section.

(c)(5)(ii)(A) Any conditions making it unsafe to remove an entrance cover shall be eliminated before the cover is removed.

(c)(5)(ii)(B) When entrance covers are removed, the opening shall be promptly guarded by a railing, temporary cover, or other temporary barrier that will prevent an accidental fall through the opening and that will protect each employee working in the space from foreign objects entering the space.

(c)(5)(ii)(C) Before an employee enters the space, the internal atmosphere shall be tested, with a calibrated direct-reading instrument, for oxygen content, for flammable gases and vapors, and for potential toxic air contaminants, in that order. Any employee who enters the space, or that employee's authorized representative, shall be provided an opportunity to observe the pre-entry testing required by this paragraph.

(c)(5)(ii)(C)(1) Oxygen content,

(c)(5)(ii)(C)(2) Flammable gases and vapors, and

(c)(5)(ii)(C)(3) Potential toxic air contaminants.

(c)(5)(ii)(D) There may be no hazardous atmosphere within the space whenever any employee is inside the space.

(c)(5)(ii)(E) Continuous forced air ventilation shall be used, as follows:

(c)(5)(ii)(E)(1) An employee may not enter the space until the forced air ventilation has eliminated any hazardous atmosphere;

(c)(5)(ii)(E)(2) The forced air ventilation shall be so directed as to ventilate the immediate areas where an employee is or will be present within the space and shall continue until all employees have left the space;

(c)(5)(ii)(E)(3) The air supply for the forced air ventilation shall be from a clean source and may not increase the hazards in the space.

(c)(5)(ii)(F) The atmosphere within the space shall be periodically tested as necessary to ensure that the continuous forced air ventilation is preventing the accumulation of a hazardous atmosphere. Any employee who enters the space, or that employee's authorized representative, shall be provided with an opportunity to observe the periodic testing required by this paragraph.

(c)(5)(ii)(G) If a hazardous atmosphere is detected during entry:

(c)(5)(ii)(G)(1) Each employee shall leave the space immediately;

(c)(5)(ii)(G)(2) The space shall be evaluated to determine how the hazardous atmosphere developed; and

(c)(5)(ii)(G)(3) Measures shall be implemented to protect employees from the hazardous atmosphere before any subsequent entry takes place.

(c)(5)(li)(H) The employer shall verify that the space is safe for entry and that the pre-entry measures required by paragraph (c)(5)(ii) of this section have been taken, through a written certification that contains the date, the location of the space, and the signature of the person providing the certification. The certification shall be made before entry and shall be made available to each employee entering the space or to that employee's authorized representative .

(c)(6) When there are changes in the use or configuration of a non-permit confined space that might increase the hazards to entrants, the employer shall reevaluate that space and, if necessary, reclassify it as a permit-required confined space.

(c)(7) A space classified by the employer as a permit-required confined space may be reclassified as a non-permit confined space under the following procedures:

(c)(7)(i) If the permit space poses no actual or potential atmospheric hazards and if all hazards within the space are eliminated without entry into the space, the permit space may be reclassified as a non-permit confined space for as long as the non-atmospheric hazards remain eliminated.

(c)(7)(ii) If it is necessary to enter the permit space to eliminate hazards, such entry shall be performed under paragraphs (d) through (k) of this section. If testing and inspection during that entry demonstrate that the hazards within the permit space have been eliminated, the permit space may be reclassified as a non-permit confined space for as long as the hazards remain eliminated.
NOTE: Control of atmospheric hazards through forced air ventilation does not constitute elimination of the hazards. Paragraph (c)(5) covers permit space entry where the employer can demonstrate that forced air ventilation alone will control all hazards in the space.

(c)(7)(iii) The employer shall document the basis for determining that all hazards in a permit space have been eliminated, through a certification that contains the date, the location of the space, and the signature of the person making the determination. The certification shall be made available to each employee entering the space or to that employee's authorized representative.

(c)(7)(iv) If hazards arise within a permit space that has been declassified to a non-permit space under paragraph (c)(7) of this section, each employee in the space shall exit the space. The employer shall then reevaluate the space and determine whether it must be reclassified as a permit space, in accordance with other applicable provisions of this section.

(c)(8) When an employer (host employer) arranges to have employees of another employer (contractor) perform work that involves permit space entry, the host employer shall:

(c)(8)(i) Inform the contractor that the workplace contains permit spaces and that permit space entry is allowed only through compliance with a permit space program meeting the requirements of this section;

(c)(8)(ii) Apprise the contractor of the elements, including the hazards identified and the host employer's experience with the space, that make the space in question a permit space;

(c)(8)(iii) Apprise the contractor of any precautions or procedures that the host employer has implemented for the protection of employees in or near permit spaces where contractor personnel will be working;

(c)(8)(iv) Coordinate entry operations with the contractor, when both host employer personnel and contractor personnel will be working in or near permit spaces, as required by paragraph (d)(11) of this section; and

(c)(8)(v) Debrief the contractor at the conclusion of the entry operations regarding the permit space program followed and regarding any hazards confronted or created in permit spaces during entry operations.

(c)(9) In addition to complying with the permit space requirements that apply to all employers, each contractor who is retained to perform permit space entry operations shall:

(c)(9)(i) Obtain any available information regarding permit space hazards and entry operations from the host employer;

(c)(9)(ii) Coordinate entry operations with the host employer, when both host employer personnel and contractor personnel will be working in or near permit spaces, as required by paragraph (d)(11) of this section; and

(c)(9)(iii) Inform the host employer of the permit space program that the contractor will follow and of any hazards confronted or created in permit spaces, either through a debriefing or during the entry operation.

(d) Permit-required confined space program (permit space program). Under the permit space program required by paragraph (c)(4) of this section, the employer shall:

(d)(1) Implement the measures necessary to prevent unauthorized entry;

(d)(2) Identify and evaluate the hazards of permit spaces before employees enter them;

(d)(3) Develop and implement the means, procedures, and practices necessary for safe permit space entry operations, including, but not limited to, the following:

(d)(3)(i) Specifying acceptable entry conditions;

(d)(3)(ii) Providing each authorized entrant or that employee's authorized representative with the opportunity to observe any monitoring or testing of permit spaces;

(d)(3)(iii) Isolating the permit space;

(d)(3)(iv) Purging, inerting, flushing, or ventilating the permit space as necessary to eliminate or control atmospheric hazards;

(d)(3)(v) Providing pedestrian, vehicle, or other barriers as necessary to protect entrants from external hazards; and

(d)(3)(vi) Verifying that conditions in the permit space are acceptable for entry throughout the duration of an authorized entry.

(d)(4) Provide the following equipment (specified in paragraphs (d)(4)(i) through (d)(4)(ix) of this section) at no cost to employees, maintain that equipment properly, and ensure that employees use that equipment properly:

(d)(4)(i) Testing and monitoring equipment needed to comply with paragraph (d)(5) of this section;

(d)(4)(ii) Ventilating equipment needed to obtain acceptable entry conditions;

(d)(4)(iii) Communications equipment necessary for compliance with paragraphs (h)(3) and (i)(5) of this section;

(d)(4)(iv) Personal protective equipment insofar as feasible engineering and work practice controls do not adequately protect employees;

(d)(4)(v) Lighting equipment needed to enable employees to see well enough to work safely and to exit the space quickly in an emergency;

(d)(4)(vi) Barriers and shields as required by paragraph (d)(3)(iv) of this section;

(d)(4)(vii) Equipment, such as ladders, needed for safe ingress and egress by authorized entrants;

(d)(4)(viii) Rescue and emergency equipment needed to comply with paragraph (d)(9) of this section, except to the extent that the equipment is provided by rescue services; and

(d)(4)(ix) Any other equipment necessary for safe entry into and rescue from permit spaces.

(d)(5) Evaluate permit space conditions as follows when entry operations are conducted:

(d)(5)(i) Test conditions in the permit space to determine if acceptable entry conditions exist before entry is authorized to begin, except that, if isolation of the space is infeasible because the space is large or is part of a continuous system (such as a sewer), pre-entry testing shall be performed to the extent feasible before entry is authorized and, if entry is authorized, entry conditions shall be continuously monitored in the areas where authorized entrants are working;

(d)(5)(ii) Test or monitor the permit space as necessary to determine if acceptable entry conditions are being maintained during the course of entry operations; and

(d)(5)(iii) When testing for atmospheric hazards, test first for oxygen, then for combustible gases and vapors, and then for toxic gases and vapors.

(d)(5)(iv) Provide each authorized entrant or that employee's authorized representative an opportunity to observe the pre-entry and any subsequent testing or monitoring of permit spaces;

(d)(5)(v) Reevaluate the permit space in the presence of any authorized entrant or that employee's authorized representative who requests that the employer conduct such reevaluation because the entrant or representative has reason to believe that the evaluation of that space may not have been adequate;

(d)(5)(vi) Immediately provide each authorized entrant or that employee's authorized representative with the results of any testing conducted in accord with paragraph (d) of this section.
NOTE: Atmospheric testing conducted in accordance with Appendix B to section 1910.146 would be considered as satisfying the requirements of this paragraph. For permit space operations in sewers, atmospheric testing conducted in accordance with Appendix B, as supplemented by Appendix E to section 1910.146, would be considered as satisfying the requirements of this paragraph.

(d)(6) Provide at least one attendant outside the permit space into which entry is authorized for the duration of entry operations;
NOTE: Attendants may be assigned to monitor more than one permit space provided the duties described in paragraph (i) of this section can be effectively performed for each permit space that is monitored. Likewise, attendants may be stationed at any location outside the permit space to be monitored as long as the duties

described in paragraph (i) of this section can be effectively performed for each permit space that is monitored.

(d)(7) If multiple spaces are to be monitored by a single attendant, include in the permit program the means and procedures to enable the attendant to respond to an emergency affecting one or more of the permit spaces being monitored without distraction from the attendant's responsibilities under paragraph (i) of this section;

(d)(8) Designate the persons who are to have active roles (as, for example, authorized entrants, attendants, entry supervisors, or persons who test or monitor the atmosphere in a permit space) in entry operations, identify the duties of each such employee, and provide each such employee with the training required by paragraph (g) of this section;

(d)(9) Develop and implement procedures for summoning rescue and emergency services, for rescuing entrants from permit spaces, for providing necessary emergency services to rescued employees, and for preventing unauthorized personnel from attempting a rescue;

(d)(10) Develop and implement a system for the preparation, issuance, use, and cancellation of entry permits as required by this section;

(d)(11) Develop and implement procedures to coordinate entry operations when employees of more than one employer are working simultaneously as authorized entrants in a permit space, so that employees of one employer do not endanger the employees of any other employer;

(d)(12) Develop and implement procedures (such as closing off a permit space and canceling the permit) necessary for concluding the entry after entry operations have been completed;

(d)(13) Review entry operations when the employer has reason to believe that the measures taken under the permit space program may not protect employees and revise the program to correct deficiencies found to exist before subsequent entries are authorized; and
NOTE: Examples of circumstances requiring the review of the permit space program are: any unauthorized entry of a permit space, the detection of a permit space hazard not covered by the permit, the detection of a condition prohibited by the permit, the occurrence of an injury or near-miss during entry, a change in the use or configuration of a permit space, and employee complaints about the effectiveness of the program.

(d)(14) Review the permit space program, using the canceled permits retained under paragraph (e)(6) of this section within 1 year after each entry and revise the program as necessary, to ensure that employees participating in entry operations are protected from permit space hazards.
NOTE: Employers may perform a single annual review covering all entries performed during a 12-month period. If no entry is performed during a 12-month period, no review is necessary.
Appendix C to section 1910.146 presents examples of permit space programs that are considered to comply with the requirements of paragraph (d) of this section.

(e) Permit system.

(e)(1) Before entry is authorized, the employer shall document the completion of measures required by paragraph (d)(3) of this section by preparing an entry permit.
NOTE: Appendix D to section 1910.146 presents examples of permits whose elements are considered to comply with the requirements of this section.

(e)(2) Before entry begins, the entry supervisor identified on the permit shall sign the entry permit to authorize entry.

(e)(3) The completed permit shall be made available at the time of entry to all authorized entrants or their authorized representatives, by posting it at the entry portal or by any other equally effective means, so that the entrants can confirm that pre-entry preparations have been completed.

(e)(4) The duration of the permit may not exceed the time required to complete the assigned task or job identified on the permit in accordance with paragraph (f)(2) of this section.

(e)(5) The entry supervisor shall terminate entry and cancel the entry permit when:

(e)(5)(i) The entry operations covered by the entry permit have been completed; or

(e)(5)(ii) A condition that is not allowed under the entry permit arises in or near the permit space.

(e)(6) The employer shall retain each canceled entry permit for at least 1 year to facilitate the review of the permit-required confined space program required by paragraph (d)(14) of this section. Any problems encountered during an entry operation shall be noted on the pertinent permit so that appropriate revisions to the permit space program can be made.

(f) Entry permit. The entry permit that documents compliance with this section and authorizes entry to a permit space shall identify:

(f)(1) The permit space to be entered;

(f)(2) The purpose of the entry;

(f)(3) The date and the authorized duration of the entry permit;

(f)(4) The authorized entrants within the permit space, by name or by such other means (for example, through the use of rosters or tracking systems) as will enable the attendant to determine quickly and accurately, for the duration of the permit, which authorized entrants are inside the permit space;
NOTE: This requirement may be met by inserting a reference on the entry permit as to the means used, such as a roster or tracking system, to keep track of the authorized entrants within the permit space.

(f)(5) The personnel, by name, currently serving as attendants;

(f)(6) The individual, by name, currently serving as entry supervisor, with a space for the signature or initials of the entry supervisor who originally authorized entry;

(f)(7) The hazards of the permit space to be entered;

(f)(8) The measures used to isolate the permit space and to eliminate or control permit space hazards before entry;
NOTE: Those measures can include the lockout or tagging of equipment and procedures for purging, inerting, ventilating, and flushing permit spaces.

(f)(9) The acceptable entry conditions;

(f)(10) The results of initial and periodic tests performed under paragraph (d)(5) of this section, accompanied by the names or initials of the testers and by an indication of when the tests were performed;

(f)(11) The rescue and emergency services that can be summoned and the means (such as the equipment to use and the numbers to call) for summoning those services;

(f)(12) The communication procedures used by authorized entrants and attendants to maintain contact during the entry;

(f)(13) Equipment, such as personal protective equipment, testing equipment, communications equipment, alarm systems, and rescue equipment, to be provided for compliance with this section;

(f)(14) Any other information whose inclusion is necessary, given the circumstances of the particular confined space, in order to ensure employee safety; and **(15)** Any additional permits, such as for hot work, that have been issued to authorize work in the permit space.

(g) Training.

(g)(1) The employer shall provide training so that all employees whose work is regulated by this section acquire the understanding, knowledge, and skills necessary for the safe performance of the duties assigned under this section.

(g)(2) Training shall be provided to each affected employee:

(g)(2)(i) Before the employee is first assigned duties under this section;

(g)(2)(ii) Before there is a change in assigned duties;

(g)(2)(iii) Whenever there is a change in permit space operations that presents a hazard about which an employee has not previously been trained;

(g)(2)(iv) Whenever the employer has reason to believe either that there are deviations from the permit space entry procedures required by paragraph (d)(3) of this section or that there are inadequacies in the employee's knowledge or use of these procedures.

(g)(3) The training shall establish employee proficiency in the duties required by this section and shall introduce new or revised procedures, as necessary, for compliance with this section.

(g)(4) The employer shall certify that the training required by paragraphs (g)(1) through (g)(3) of this section has been accomplished. The certification shall contain each employee's name, the signatures or initials of the trainers, and the dates of training. The certification shall be available for inspection by employees and their authorized representatives.

(h) Duties of authorized entrants. The employer shall ensure that all authorized entrants:

(h)(1) Know the hazards that may be faced during entry, including information on the mode, signs or symptoms, and consequences of the exposure;

(h)(2) Properly use equipment as required by paragraph (d)(4) of this section;

(h)(3) Communicate with the attendant as necessary to enable the attendant to monitor entrant status and to enable the attendant to alert entrants of the need to evacuate the space as required by paragraph (i)(6) of this section;

(h)(4) Alert the attendant whenever:

(h)(4)(i) The entrant recognizes any warning sign or symptom of exposure to a dangerous situation, or

(h)(4)(ii) The entrant detects a prohibited condition; and

(h)(5) Exit from the permit space as quickly as possible whenever:

(h)(5)(i) An order to evacuate is given by the attendant or the entry supervisor,

(h)(5)(ii) The entrant recognizes any warning sign or symptom of exposure to a dangerous situation,

(h)(5)(iii) The entrant detects a prohibited condition, or

(h)(5)(iv) An evacuation alarm is activated.

(i) Duties of attendants. The employer shall ensure that each attendant:

(i)(1) Knows the hazards that may be faced during entry, including information on the mode, signs or symptoms, and consequences of the exposure;

(i)(2) Is aware of possible behavioral effects of hazard exposure in authorized entrants;

(i)(3) Continuously maintains an accurate count of authorized entrants in the permit space and ensures that the means used to identify authorized entrants under paragraph (f)(4) of this section accurately identifies who is in the permit space;

(i)(4) Remains outside the permit space during entry operations until relieved by another attendant;
NOTE: When the employer's permit entry program allows attendant entry for rescue, attendants may enter a permit space to attempt a rescue if they have been trained and equipped for rescue operations as required by paragraph (k)(1) of this section and if they have been relieved as required by paragraph (i)(4) of this section.

(i)(5) Communicates with authorized entrants as necessary to monitor entrant status and to alert entrants of the need to evacuate the space under paragraph (i)(6) of this section;

(i)(6) Monitors activities inside and outside the space to determine if it is safe for entrants to remain in the space and orders the authorized entrants to evacuate the permit space immediately under any of the following conditions;

(i)(6)(i)
If the attendant detects a prohibited condition;

(i)(6)(ii)
If the attendant detects the behavioral effects of hazard exposure in an authorized entrant;

(i)(6)(iii)
If the attendant detects a situation outside the space that could endanger the authorized entrants; or

(i)(6)(iv)
If the attendant cannot effectively and safely perform all the duties required under paragraph (i) of this section;

(i)(7) Summon rescue and other emergency services as soon as the attendant determines that authorized entrants may need assistance to escape from permit space hazards;

(i)(8) Takes the following actions when unauthorized persons approach or enter a permit space while entry is underway:

(i)(8)(i) Warn the unauthorized persons that they must stay away from the permit space;

(i)(8)(ii) Advise the unauthorized persons that they must exit immediately if they have entered the permit space; and

(i)(8)(iii) Inform the authorized entrants and the entry supervisor if unauthorized persons have entered the permit space;

(i)(9) Performs non-entry rescues as specified by the employer's rescue procedure; and

(i)(10) Performs no duties that might interfere with the attendant's primary duty to monitor and protect the authorized entrants.

(j) Duties of entry supervisors. The employer shall ensure that each entry supervisor:

(j)(1) Knows the hazards that may be faced during entry, including information on the mode, signs or symptoms, and consequences of the exposure;

(j)(2) Verifies, by checking that the appropriate entries have been made on the permit, that all tests specified by the permit have been conducted and that all procedures and equipment specified by the permit are in place before endorsing the permit and allowing entry to begin;

(j)(3) Terminates the entry and cancels the permit as required by paragraph (e)(5) of this section;

(j)(4) Verifies that rescue services are available and that the means for summoning them are operable;

(j)(5) Removes unauthorized individuals who enter or who attempt to enter the permit space during entry operations; and

(j)(6) Determines, whenever responsibility for a permit space entry operation is transferred and at intervals dictated by the hazards and operations performed within the space, that entry operations remain consistent with terms of the entry permit and that acceptable entry conditions are maintained.

(k) Rescue and emergency services.

(k)(1) An employer who designates rescue and emergency services, pursuant to paragraph (d)(9) of this section, shall:

(k)(1)(i) Evaluate a prospective rescuer's ability to respond to a rescue summons in a timely manner, considering the hazard(s) identified;

Note to paragraph (k)(l)(i): What will be considered timely will vary according to the specific hazards involved in each entry. For example, §1910.134, Respiratory Protection, requires that employers provide a standby person or persons capable of immediate action to rescue employee(s) wearing respiratory protection while in work areas defined as IDLH atmospheres.

(k)(1)(ii) Evaluate a prospective rescue service's ability, in terms of proficiency with rescue-related tasks and equipment, to function appropriately while rescuing entrants from the particular permit space or types of permit spaces identified;

(k)(1)(iii) Select a rescue team or service from those evaluated that:

(k)(1)(iii)(A) Has the capability to reach the victim(s) within a time frame that is appropriate for the permit space hazard(s) identified;

(k)(1)(iii)(B) Is equipped for and proficient in performing the needed rescue services;

(k)(1)(iv) Inform each rescue team or service of the hazards they may confront when called on to perform rescue at the site; and

(k)(1)(v) Provide the rescue team or service selected with access to all permit spaces from which rescue may be necessary so that the rescue service can develop appropriate rescue plans and practice rescue operations.

Note to paragraph (k)(1): Non-mandatory Appendix F contains examples of criteria which employers can use in evaluating prospective rescuers as required by paragraph (k)(l) of this section.

(k)(2) An employer whose employees have been designated to provide permit space rescue and emergency services shall take the following measures:

(k)(2)(i) Provide affected employees with the personal protective equipment (PPE) needed to conduct permit space rescues safely and train affected employees so they are proficient in the use of that PPE, at no cost to those employees;

(k)(2)(ii) Train affected employees to perform assigned rescue duties. The employer must ensure that such employees successfully complete the training required to establish proficiency as an authorized entrant, as provided by paragraphs (g) and (h) of this section;

(k)(2)(iii) Train affected employees in basic first-aid and cardiopulmonary resuscitation (CPR). The employer shall ensure that at least one member of the rescue team or service holding a current certification in first aid and CPR is available; and

(k)(2)(iv) Ensure that affected employees practice making permit space rescues at least once every 12 months, by means of simulated rescue operations in which they remove dummies, manikins, or actual persons from the actual permit spaces or from representative permit spaces. Representative permit spaces shall, with respect to opening size, configuration, and accessibility, simulate the types of permit spaces from which rescue is to be performed.

(k)(3) To facilitate non-entry rescue, retrieval systems or methods shall be used whenever an authorized entrant enters a permit space, unless the retrieval equipment would increase the overall risk of entry or would not contribute to the rescue of the entrant. Retrieval systems shall meet the following requirements.

(k)(3)(i) Each authorized entrant shall use a chest or full body harness, with a retrieval line attached at the center of the entrant's back near shoulder level, above the entrant's head, or at another point which the employer can establish presents a profile small enough for the successful removal of the entrant. Wristlets may be used in lieu of the chest or full body harness if the employer can demonstrate that the use of a chest or full body harness is infeasible or creates a greater hazard and that the use of wristlets is the safest and most effective alternative.

(k)(3)(ii) The other end of the retrieval line shall be attached to a mecanical device or fixed point outside the permit space in such a manner that rescue can begin as soon as the rescuer becomes aware that rescue is necessary. A mechanical device shall be available to retrieve personnel from vertical type permit spaces more than 5 feet (1.52 m) deep

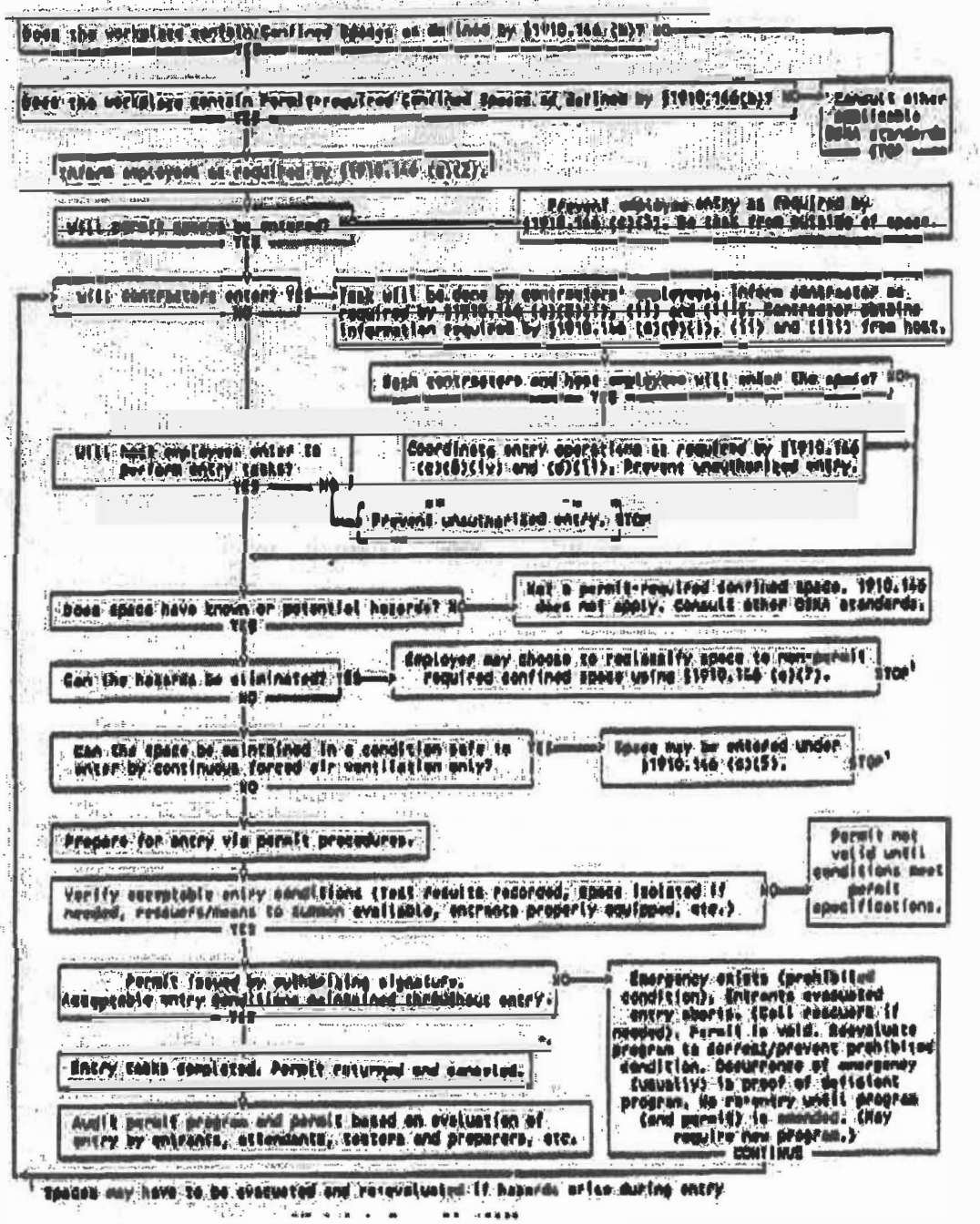
(k)(4) If an injured entrant is exposed to a substance for which a Material Safety Data Sheet (MSDS) or other similar written information is required to be kept at the worksite, that MSDS or written information shall be made available to the medical facility treating the exposed entrant.

(l) Employee participation.

(l)(1) Employers shall consult with affected employees and their authorized representatives on the development and implementation of all aspects of the permit space program required by paragraph (c) of this section.

(l)(2) Employers shall make available to affected employees and their authorized representatives all information required to be developed by this section.
[58 FR 4549, Jan. 14, 1993; 58 FR 34845, June 29, 1993; 59 FR 26115, May 19, 1994; 63 FR 66038, Dec. 1, 1998]

APPENDIX A TO §1910.146—PERMIT-REQUIRED CONFINED SPACE DECISION FLOW CHART



Standard Number: 1910.146 App B

- **Standard Title:** Procedures for Atmospheric Testing.
- **SubPart Number:** J
- **SubPart Title:** General Environmental Controls

Atmospheric testing is required for two distinct purposes: evaluation of the hazards of the permit space and verification that acceptable entry conditions for entry into that space exist.

(1) Evaluation testing. The atmosphere of a confined space should be analyzed using equipment of sufficient sensitivity and specificity to identify and evaluate any hazardous atmospheres that may exist or arise, so that appropriate permit entry procedures can be developed and acceptable entry conditions stipulated for that space. Evaluation and interpretation of these data, and development of the entry procedure, should be done by, or reviewed by, a technically qualified professional (e.g., OSHA consultation service, or certified industrial hygienist, registered safety engineer, certified safety professional, certified marine chemist, etc.) based on evaluation of all serious hazards.

(2) Verification testing. The atmosphere of a permit space which may contain a hazardous atmosphere should be tested for residues of all contaminants identified by evaluation testing using permit specified equipment to determine that residual concentrations at the time of testing and entry are within the range of acceptable entry conditions. Results of testing (i.e., actual concentration, etc.) should be recorded on the permit in the space provided adjacent to the stipulated acceptable entry condition.

(3) Duration of testing. Measurement of values for each atmospheric parameter should be made for at least the minimum response time of the test instrument specified by the manufacturer.

(4) Testing stratified atmospheres. When monitoring for entries involving a descent into atmospheres that may be stratified, the atmospheric envelope should be tested a distance of approximately 4 feet (1.22 m) in the direction of travel and to each side. If a sampling probe is used, the entrant's rate of progress should be slowed to accommodate the sampling speed and detector response.

(5) Order of testing. A test for oxygen is performed first because most combustible gas meters are oxygen dependent and will not provide reliable readings in an oxygen deficient atmosphere. Combustible gases are tested for next because the threat of fire or explosion is both more immediate and more life threatening, in most cases, than exposure to toxic gases and vapors. If tests for toxic gases and vapors are necessary, they are performed last.
[58 FR 4549, Jan. 14, 1993; 58 FR 34846, June 29, 1993]

- **Standard Number:** 1910.146 App C
- **Standard Title:** Examples of Permit-required Confined Space Programs
- **SubPart Number:** J
- **SubPart Title:** General Environmental Controls

Example 1.

Workplace. Sewer entry.
Potential hazards. The employees could be exposed to the following:
Engulfment.
Presence of toxic gases. Equal to or more than 10 ppm hydrogen sulfide measured as an 8-hour time-weighted average. If the presence of other toxic contaminants is suspected, specific monitoring programs will be developed.
Presence of explosive/flammable gases. Equal to or greater than 10% of the lower flammable limit (LFL).
Oxygen Deficiency. A concentration of oxygen in the atmosphere equal to or less than 19.5% by volume.

A. ENTRY WITHOUT PERMIT/ATTENDANT

Certification. Confined spaces may be entered without the need for a written permit or attendant provided that the space can be maintained in a safe condition for entry by mechanical ventilation alone, as provided in 1910.146(c)(5). All spaces shall be considered permit-required confined spaces until the pre-entry procedures demonstrate otherwise. Any employee required or permitted to pre-check or enter an enclosed/confined space shall have successfully completed, as a minimum, the training as required by the following sections of these procedures. A written copy of operating and rescue procedures as required by these procedures shall be at the work site for the duration of the job. The Confined Space Pre-Entry Check List must be completed by the LEAD WORKER before entry into a confined space. This list verifies completion of items listed below. This check list shall be kept at the job site for duration of the job. If circumstances dictate an interruption in the work, the permit space must be re-evaluated and a new check list must be completed.
Control of atmospheric and engulfment hazards.
Pumps and Lines. All pumps and lines which may reasonably cause contaminants to flow into the space shall be disconnected, blinded and locked out, or effectively isolated by other means to prevent development of dangerous air contamination or engulfment. Not all laterals to sewers or storm drains require blocking. However, where experience or knowledge of industrial use indicates there is a reasonable potential for contamination of air or engulfment into an occupied sewer, then all affected laterals shall be blocked. If blocking and/or isolation requires entry into the space the provisions for entry into a permit-required confined space must be implemented.
Surveillance. The surrounding area shall be surveyed to avoid hazards such as drifting vapors from the tanks, piping, or sewers.
Testing. The atmosphere within the space will be tested to determine whether dangerous air contamination and/or oxygen deficiency exists. Detector tubes, alarm only gas monitors and explosion meters are examples of monitoring equipment that may be used to test permit space atmospheres. Testing shall be performed by the LEAD WORKER who has successfully completed the Gas Detector training for the monitor he will use. The minimum parameters to be monitored are oxygen deficiency, LFL, and hydrogen sulfide concentration. A written record of the pre-entry test results shall be made and kept at the work site for the duration of the job. The supervisor will certify in writing, based upon the results of the pre-entry testing, that all hazards have been eliminated. Affected employees shall be able to review the testing results. The most hazardous conditions shall govern when work is being performed in two adjoining, connecting spaces.
Entry Procedures. If there are no non-atmospheric hazards present and if the pre-entry tests show there is no dangerous air contamination and/or oxygen deficiency within the space and there is no reason to believe that any is likely to develop, entry into and work within may proceed. Continuous testing of the atmosphere in the immediate vicinity of the workers within the space shall be accomplished. The workers will immediately leave the permit space when any of the gas monitor alarm set points are reached as defined.

Workers will not return to the area until a SUPERVISOR who has completed the gas detector training has used a direct reading gas detector to evaluate the situation and has determined that it is safe to enter.
Rescue. Arrangements for rescue services are not required where there is no attendant. See the rescue portion of section B., below, for instructions regarding rescue planning where an entry permit is required.

B. ENTRY PERMIT REQUIRED

Permits. Confined Space Entry Permit. All spaces shall be considered permit-required confined spaces until the pre-entry procedures demonstrate otherwise. Any employee required or permitted to pre-check or enter a permit-required confined space shall have successfully completed, as a minimum, the training as required by the following sections of these procedures. A written copy of operating and rescue procedures as required by these procedures shall be at the work site for the duration of the job. The Confined Space Entry Permit must be completed before approval can be given to enter a permit-required confined space. This permit verifies completion of items listed below. This permit shall be kept at the job site for the duration of the job. If circumstances cause an interruption in the work or a change in the alarm conditions for which entry was approved, a new Confined Space Entry Permit must be completed.
Control of atmospheric and engulfment hazards.
Surveillance. The surrounding area shall be surveyed to avoid hazards such as drifting vapors from tanks, piping or sewers.
Testing. The confined space atmosphere shall be tested to determine whether dangerous air contamination and/or oxygen deficiency exists. A direct reading gas monitor shall be used. Testing shall be performed by the SUPERVISOR who has successfully completed the gas detector training for the monitor he will use. The minimum parameters to be monitored are oxygen deficiency, LFL and hydrogen sulfide concentration. A written record of the pre-entry test results shall be made and kept at the work site for the duration of the job. Affected employees shall be able to review the testing results. The most hazardous conditions shall govern when work is being performed in two adjoining, connected spaces.
Space Ventilation. Mechanical ventilation systems, where applicable, shall be set at 100% outside air. Where possible, open additional manholes to increase air circulation. Use portable blowers to augment natural circulation if needed. After a suitable ventilating period, repeat the testing. Entry may not begin until testing has demonstrated that the hazardous atmosphere has been eliminated.
Entry Procedures. The following procedure shall be observed under any of the following conditions: 1.) Testing demonstrates the existence of dangerous or deficient conditions and additional ventilation cannot reduce concentrations to safe levels; 2.) The atmosphere tests as safe but unsafe conditions can reasonably be expected to develop; 3.) It is not feasible to provide for ready exit from spaces equipped with automatic fire suppression systems and it is not practical or safe to deactivate such systems; or 4.) An emergency exists and it is not feasible to wait for pre-entry procedures to take effect.
All personnel must be trained. A self contained breathing apparatus shall be worn by any person entering the space. At least one worker shall stand by the outside of the space ready to give assistance in case of emergency. The standby worker shall have a self contained breathing apparatus available for immediate use. There shall be at least one additional worker within sight or call of the standby worker. Continuous powered communications shall be maintained between the worker within the confined space and standby personnel.
If at any time there is any questionable action or non-movement by the worker inside, a verbal check will be made. If there is no response, the worker will be moved immediately. Exception: If the worker is disabled due to falling or impact, he/she shall not be removed from the confined space unless there is immediate danger to his/her life. Local fire department rescue personnel shall be notified immediately. The standby worker may only enter the confined space in case of an emergency (wearing the self contained breathing apparatus) and only after being relieved by another worker. Safety belt or harness with attached lifeline shall be used by all workers entering the space with the free end of the line secured outside the entry opening. The standby worker shall attempt to remove a disabled worker via his lifeline before entering the space.
When practical, these spaces shall be entered through side openings -- those within 3 1/2 feet (1.07 m) of the bottom. When entry must be through a top opening, the safety belt shall be of the harness type that suspends a person upright and a hoisting device or similar apparatus shall be available for lifting workers out of the space.

In any situation where their use may endanger the worker, use of a hoisting device or safety belt and attached lifeline may be discontinued.
When dangerous air contamination is attributable to flammable and/or explosive substances, lighting and electrical equipment shall be Class 1, Division 1 rated per National Electrical Code and no ignition sources shall be introduced into the area.
Continuous gas monitoring shall be performed during all confined space operations. If alarm conditions change adversely, entry personnel shall exit the confined space and a new confined space permit issued.
Rescue. Call the fire department services for rescue. Where immediate hazards to injured personnel are present, workers at the site shall implement emergency procedures to fit the situation.

Example 2.

Workplace. Meat and poultry rendering plants.
Cookers and dryers are either batch or continuous in their operation. Multiple batch cookers are operated in parallel. When one unit of a multiple set is shut down for repairs, means are available to isolate that unit from the others which remain in operation.
Cookers and dryers are horizontal, cylindrical vessels equipped with a center, rotating shaft and agitator paddles or discs. If the inner shell is jacketed, it is usually heated with steam at pressures up to 150 psig (1034.25 kPa). The rotating shaft assembly of the continuous cooker or dryer is also steam heated.
Potential Hazards. The recognized hazards associated with cookers and dryers are the risk that employees could be:
1. Struck or caught by rotating agitator;
2. Engulfed in raw material or hot, recycled fat;
3. Burned by steam from leaks into the cooker/dryer steam jacket or the condenser duct system if steam valves are not properly closed and locked out;
4. Burned by contact with hot metal surfaces, such as the agitator shaft assembly, or inner shell of the cooker/dryer;
5. Heat stress caused by warm atmosphere inside cooker/dryer;
6. Slipping and falling on grease in the cooker/dryer;
7. Electrically shocked by faulty equipment taken into the cooker/dryer;
8. Burned or overcome by fire or products of combustion; or
9. Overcome by fumes generated by welding or cutting done on grease covered surfaces.
Permits. The supervisor in this case is always present at the cooker/dryer or other permit entry confined space when entry is made. The supervisor must follow the pre-entry isolation procedures described in the entry permit in preparing for entry, and ensure that the protective clothing, ventilating equipment and any other equipment required by the permit are at the entry site.
Control of hazards. Mechanical. Lock out main power switch to agitator motor at main power panel. Affix tag to the lock to inform others that a permit entry confined space entry is in progress.
Engulfment. Close all valves in the raw material blow line. Secure each valve in its closed position using chain and lock. Attach a tag to the valve and chain warning that a permit entry confined space entry is in progress. The same procedure shall be used for securing the fat recycle valve.
Burns and heat stress. Close steam supply valves to jacket and secure with chains and tags. Insert solid blank at flange in cooker vent line to condenser manifold duct system. Vent cooker/dryer by opening access door at discharge end and top center door to allow natural ventilation throughout the entry. If faster cooling is needed, use an portable ventilation fan to increase ventilation. Cooling water may be circulated through the jacket to reduce both outer and inner surface temperatures of cooker/dryers faster. Check air and inner surface temperatures in cooker/dryer to assure they are within acceptable limits before entering, or use proper protective clothing.
Fire and fume hazards. Careful site preparation, such as cleaning the area within 4 inches (10.16 cm) of all welding or torch cutting operations, and proper ventilation are the preferred controls. All welding and cutting operations shall be done in accordance with the requirements of 29 CFR Part 1910, Subpart Q, OSHA's welding standard. Proper ventilation may be achieved by local exhaust ventilation, or the use of portable ventilation fans, or a combination of the two practices.
Electrical shock. Electrical equipment used in cooker/dryers shall be in serviceable condition.
Slips and falls. Remove residual grease before entering cooker/dryer.
Attendant. The supervisor shall be the attendant for employees entering cooker/dryers.

Permit. The permit shall specify how isolation shall be done and any other preparations needed before making entry. This is especially important in parallel arrangements of cooker/dryers so that the entire operation need not be shut down to allow safe entry into one unit.
Rescue. When necessary, the attendant shall call the fire department as previously arranged.

Example 3.

Workplace. Workplaces where tank cars, trucks, and trailers, dry bulk tanks and trailers, railroad tank cars, and similar portable tanks are fabricated or serviced.

A. During fabrication. These tanks and dry-bulk carriers are entered repeatedly throughout the fabrication process. These products are not configured identically, but the manufacturing processes by which they are made are very similar.

Sources of hazards. In addition to the mechanical hazards arising from the risks that an entrant would be injured due to contact with components of the tank or the tools being used, there is also the risk that a worker could be injured by breathing fumes from welding materials or mists or vapors from materials used to coat the tank interior. In addition, many of these vapors and mists are flammable, so the failure to properly ventilate a tank could lead to a fire or explosion.
Control of hazards.
Welding. Local exhaust ventilation shall be used to remove welding fumes once the tank or carrier is completed to the point that workers may enter and exit only through a manhole. (Follow the requirements of 29 CFR 1910, Subpart Q, OSHA's welding standard, at all times.) Welding gas tanks may never be brought into a tank or carrier that is a permit entry confined space.
Application of interior coatings/linings. Atmospheric hazards shall be controlled by forced air ventilation sufficient to keep the atmospheric concentration of flammable materials below 10% of the lower flammable limit (LFL) (or lower explosive limit (LEL), whichever term is used locally). The appropriate respirators are provided and shall be used in addition to providing forced ventilation if the forced ventilation does not maintain acceptable respiratory conditions.
Permits. Because of the repetitive nature of the entries in these operations, an "Area Entry Permit" will be issued for a 1 month period to cover those production areas where tanks are fabricated to the point that entry and exit are made using manholes.
Authorization. Only the area supervisor may authorize an employee to enter a tank within the permit area. The area supervisor must determine that conditions in the tank trailer, dry bulk trailer or truck, etc. meet permit requirements before authorizing entry.
Attendant. The area supervisor shall designate an employee to maintain communication by employer specified means with employees working in tanks to ensure their safety. The attendant may not enter any permit entry confined space to rescue an entrant or for any other reason, unless authorized by the rescue procedure and, even then, only after calling the rescue team and being relieved by an attendant or another worker.
Communications and observation. Communications between attendant and entrant(s) shall be maintained throughout entry. Methods of communication that may be specified by the permit include voice, voice powered radio, tapping or rapping codes on tank walls, signalling tugs on a rope, and the attendant's observation that work activities such as chipping, grinding, welding, spraying, etc., which require deliberate operator control continue normally. These activities often generate so much noise that the necessary hearing protection makes communication by voice difficult.
Rescue procedures. Acceptable rescue procedures include entry by a team of employee-rescuers, use of public emergency services, and procedures for breaching the tank. The area permit specifies which procedures are available, but the area supervisor makes the final decision based on circumstances. (Certain injuries may make it necessary to breach the tank to remove a person rather than risk additional injury by removal through an existing manhole. However, the supervisor must ensure that no breaching procedure used for rescue would violate terms of the entry permit. For instance, if the tank must be breached by cutting with a torch, the tank surfaces to be cut must be free of volatile or combustible coatings within 4 inches (10.16 cm) of the cutting line and the atmosphere within the tank must be below the LFL.
Retrieval line and harnesses. The retrieval lines and harnesses generally required under this standard are usually impractical for use in tanks because the internal configuration of the tanks and their interior baffles

and other structures would prevent rescuers from hauling out injured entrants. However, unless the rescue procedure calls for breaching the tank for rescue, the rescue team shall be trained in the use of retrieval lines and harnesses for removing injured employees through manholes.

B. Repair or service of "used" tanks and bulk trailers.

Sources of hazards. In addition to facing the potential hazards encountered in fabrication or manufacturing, tanks or trailers which have been in service may contain residues of dangerous materials, whether left over from the transportation of hazardous cargoes or generated by chemical or bacterial action on residues of non-hazardous cargoes.

Control of atmospheric hazards. A "used" tank shall be brought into areas where tank entry is authorized only after the tank has been emptied, cleansed (without employee entry) of any residues, and purged of any potential atmospheric hazards.

Welding. In addition to tank cleaning for control of atmospheric hazards, coating and surface materials shall be removed 4 inches (10.16 cm) or more from any surface area where welding or other torch work will be done and care taken that the atmosphere within the tank remains well below the LFL. (Follow the requirements of 29 CFR 1910, Subpart Q, OSHA's welding standard, at all times.)

Permits. An entry permit valid for up to 1 year shall be issued prior to authorization of entry into used tank trailers, dry bulk trailers or trucks. In addition to the pre-entry cleaning requirement, this permit shall require the employee safeguards specified for new tank fabrication or construction permit areas.

Authorization. Only the area supervisor may authorize an employee to enter a tank trailer, dry bulk trailer or truck within the permit area. The area supervisor must determine that the entry permit requirements have been met before authorizing entry.

[58 FR 4549, Jan. 14, 1993; 58 FR 34846, June 29, 1993]

- **Standard Number:** 1910.146 App D
- **Standard Title:** Confined Space Pre-Entry Check List
- **SubPart Number:** J
- **SubPart Title:** General Environmental Controls

Appendix D to §1910.146 -- Sample Permits

Appendix D-1

Confined Space Entry Permit
Date and Time Issued: _____ Date and Time Expires: _____
Job site/Space I.D.: _____ Job Supervisor: _____
Equipment to be worked on: _____ Work to be performed: _____

Stand-by personnel: _____ _____ _____

1. Atmospheric Checks: Time _____
   Oxygen _____%
   Explosive _____% L.F.L.
   Toxic _____PPM

2. Tester's signature: _____

3. Source isolation (No Entry):

	N/A	Yes	No
Pumps or lines blinded,	( )	( )	( )
disconnected, or blocked	( )	( )	( )

4. Ventilation Modification:

	N/A	Yes	No
Mechanical	( )	( )	( )
Natural Ventilation only	( )	( )	( )

5. Atmospheric check after isolation and Ventilation:

Oxygen _____%	>	19.5	%
Explosive _____% L.F.L	<	10	%
Toxic _____PPM	<	10	PPM H(2)S

   Time _____
   Testers signature: _____

6. Communication procedures: _____
_____

7. Rescue procedures: _____
_____
_____
_____

8. Entry, standby, and back up persons:	Yes	No
Successfully completed required training?		
Is it current?	( )	( )

9. Equipment:	N/A	Yes	No
Direct reading gas monitor - tested	( )	( )	( )
Safety harnesses and lifelines for entry and standby persons	( )	( )	( )

Hoisting equipment	( )	( )	( )
Powered communications	( )	( )	( )
SCBA's for entry and standby persons	( )	( )	( )
Protective Clothing	( )	( )	( )
All electric equipment listed Class I, Division I, Group D and Non-sparking tools	( )	( )	( )

10. Periodic atmospheric tests:

Oxygen	____%	Time	____	Oxygen	____%	Time	____
Oxygen	____%	Time	____	Oxygen	____%	Time	____
Explosive	____%	Time	____	Explosive	____%	Time	____
Explosive	____%	Time	____	Explosive	____%	Time	____
Toxic	____%	Time	____	Toxic	____%	Time	____
Toxic	____%	Time	____	Toxic	____%	Time	____

We have reviewed the work authorized by this permit and the information contained here-in. Written instructions and safety procedures have been received and are understood. Entry cannot be approved if any squares are marked in the "No" column. This permit is not valid unless all appropriate items are completed.

Permit Prepared By:
(Supervisor)_____
Approved By: (Unit
Supervisor)_____
Reviewed By (Cs Operations Personnel) :

_____

_____
(printed name) (signature)

This permit to be kept at job site. Return job site copy to Safety Office following job completion.

Copies: White Original (Safety Office)
Yellow (Unit Supervisor)
Hard(Job site)

Appendix D - 2

ENTRY PERMIT

PERMIT VALID FOR 8 HOURS ONLY. ALL COPIES OF PERMIT WILL REMAIN AT JOB SITE UNTIL JOB IS COMPLETED

DATE: - - SITE LOCATION and DESCRIPTION _____
PURPOSE OF ENTRY _____
SUPERVISOR(S) in charge of crews Type of Crew Phone #

_____

_____
COMMUNICATION PROCEDURES _____
RESCUE PROCEDURES (PHONE NUMBERS AT BOTTOM) _____

_____
* BOLD DENOTES MINIMUM REQUIREMENTS TO BE COMPLETED AND REVIEWED PRIOR TO ENTRY*

REQUIREMENTS COMPLETED	DATE	TIME
Lock Out/De-energize/Try-out		
Line(s) Broken-Capped-Blanked		
Purge-Flush and Vent		
Ventilation		
Secure Area (Post and Flag)		
Breathing Apparatus		
Resuscitator - Inhalator		
Standby Safety Personnel		
Full Body Harness w/"D" ring		
Emergency Escape Retrieval Equip		
Lifelines		
Fire Extinguishers		
Lighting (Explosive Proof)		
Protective Clothing		
Respirator(s) (Air Purifying)		
Burning and Welding Permit		

Note: Items that do not apply enter N/A in the blank.

**RECORD CONTINUOUS MONITORING RESULTS EVERY 2 HOURS

CONTINUOUS MONITORING** TEST(S) TO BE TAKEN	Permissible Entry Level	
PERCENT OF OXYGEN	19.5% to 23.5%	
LOWER FLAMMABLE LIMIT	Under 10%	
CARBON MONOXIDE	+35 PPM	
Aromatic Hydrocarbon	+ 1 PPM * 5PPM	
Hydrogen Cyanide	(Skin) * 4PPM	
Hydrogen Sulfide	+10 PPM *15PPM	
Sulfur Dioxide	+ 2 PPM * 5PPM	
Ammonia	*35PPM	

* Short-term exposure limit: Employee can work in the area up to 15 minutes.

+ 8 hr. Time Weighted Avg.: Employee can work in area 8 hrs (longer with appropriate respiratory protection).

REMARKS:_____

GAS TESTER NAME & CHECK #	INSTRUMENT(S) USED	MODEL &/OR TYPE	SERIAL &/OR UNIT #

SAFETY STANDBY PERSON IS REQUIRED FOR ALL CONFINED SPACE WORK

SAFETY STANDBY PERSON(S)	CHECK #	CONFINED SPACE ENTRANT(S)	CHECK #	CONFINED SPACE ENTRANT(S)	CHECK #

SUPERVISOR AUTHORIZING - ALL CONDITIONS SATISFIED_____

DEPARTMENT/PHONE _____

AMBULANCE 2800 FIRE 2900 Safety 4901 Gas Coordinator 4529/5387

[58 FR 4549, Jan. 14, 1993; 58 FR 34846, June 29, 1993]

- **Standard Number:** 1910.146 App E
- **Standard Title:** Sewer System Entry.
- **SubPart Number:** J
- **SubPart Title:** General Environmental Controls

Sewer entry differs in three vital respects from other permit entries; first, there rarely exists any way to completely isolate the space (a section of a continuous system) to be entered; second, because isolation is not complete, the atmosphere may suddenly and unpredictably become lethally hazardous (toxic, flammable or explosive) from causes beyond the control of the entrant or employer, and third, experienced sewer workers are especially knowledgeable in entry and work in their permit spaces because of their frequent entries. Unlike other employments where permit space entry is a rare and exceptional event, sewer workers' usual work environment is a permit space.

(1) Adherence to procedure. The employer should designate as entrants only employees who are thoroughly trained in the employer's sewer entry procedures and who demonstrate that they follow these entry procedures exactly as prescribed when performing sewer entries.

(2) Atmospheric monitoring. Entrants should be trained in the use of, and be equipped with, atmospheric monitoring equipment which sounds an audible alarm, in addition to its visual readout, whenever one of the following conditions are encountered: Oxygen concentration less than 19.5 percent; flammable gas or vapor at 10 percent or more of the lower flammable limit (LFL); or hydrogen sulfide or carbon monoxide at or above 10 ppm or 35 ppm, respectively, measured as an 8-hour time-weighted average. Atmospheric monitoring equipment needs to be calibrated according to the manufacturer's instructions. The oxygen sensor/broad range sensor is best suited for initial use in situations where the actual or potential contaminants have not been identified, because broad range sensors, unlike substance-specific sensors, enable employers to obtain an overall reading of the hydrocarbons (flammables) present in the space. However, such sensors only indicate that a hazardous threshold of a class of chemicals has been exceeded. They do not measure the levels of contamination of specific substances. Therefore, substance-specific devices, which measure the actual levels of specific substances, are best suited for use where actual and potential contaminants have been identified. The measurements obtained with substance-specific devices are of vital importance to the employer when decisions are made concerning the measures necessary to protect entrants (such as ventilation or personal protective equipment) and the setting and attainment of appropriate entry conditions. However, the sewer environment may suddenly and unpredictably change, and the substance-specific devices may not detect the potentially lethal atmospheric hazards which may enter the sewer environment.

Although OSHA considers the information and guidance provided above to be appropriate and useful in most sewer entry situations, the Agency emphasizes that each employer must consider the unique circumstances, including the predictability of the atmosphere, of the sewer permit spaces in the employer's workplace in preparing for entry. Only the employer can decide, based upon his or her knowledge of, and experience with permit spaces in sewer systems, what the best type of testing instrument may be for any specific entry operation.

The selected testing instrument should be carried and used by the entrant in sewer line work to monitor the atmosphere in the entrant's environment, and in advance of the entrant's direction of movement, to warn the entrant of any deterioration in atmospheric conditions. Where several entrants are working together in the same immediate location, one instrument, used by the lead entrant, is acceptable.

(3) Surge flow and flooding. Sewer crews should develop and maintain liaison, to the extent possible, with the local weather bureau and fire and emergency services in their area so that sewer work may be delayed or interrupted and entrants withdrawn whenever sewer lines might be suddenly flooded by rain or fire suppression activities, or whenever flammable or other hazardous materials are released into sewers during emergencies by industrial or transportation accidents.

(4) Special Equipment. Entry into large bore sewers may require the use of special equipment. Such equipment might include such items as atmosphere monitoring devices with automatic audible alarms, escape self-contained breathing apparatus (ESCBA) with at least 10 minute air supply (or other NIOSH approved self-rescuer), and waterproof flashlights, and may also include boats and rafts, radios and rope stand-offs for pulling around bends and corners as needed.

[58 FR 4549, Jan. 14, 1993; 58 FR 34845, June 29, 1993; 59 FR 26115, May 19, 1994]

SAMPLE LETTER FROM EMPLOYER TO OUTSIDE RESCUE SERVICE – NON-MANDATORY

Dear _____:
Name of Rescue Organizer

We are currently developing a permit-required confined space program as required under the Federal OSHA regulation, 29 CFR 1910.146, that will allow our employees to safely enter and work in permit-required confined spaces in our workplace. Although our existing program is intended to prevent employee exposure to health and safety hazards in the space, extraordinary circumstances could appear without warning that would cause an emergency situation where the employee(s) in the space may need rescue and/or emergency medical assistance. Therefore, a very important element of our program is to develop and implement procedures for summoning rescue and emergency services. We are requesting that Name of Rescue Organizer _____ be available to provide rescue and emergency services, in the event of an emergency.

Enclosed is a listing of the permit-required confined space(s) in my workplace(s), as well as a description of the hazard(s) associated with the space(s). I am providing this information to you so that you can adequately develop a rescue plan appropriate for the space(s). You may also have access to this space(s) as a part of your planning.

Name of Company _____ will be contacting you shortly to confirm your willingness to participate in our permit-required confined space program and to discuss adequate notification procedures (e.g., communication contact method(s) at the time of scheduling the entry operation) for a timely response. At that time we can also discuss the rescue plan provisions in more detail and offer you our assistance in working together to safeguard both your employees as well as ours.

Thank you for your cooperation, we look forward to meeting with you soon.

Sincerely,

_____
Employer Representative

CONFINED SPACE LOCATIONS

_____

_____

Name and Location of Facility

The following is a list of permit-required confined spaces located at our facility:

Space	Location	Hazards

Prepared By:

Date:

Phone Number:

SAMPLE LETTER FROM RESCUE AND EMERGENCY SERVICE PROVIDER TO HOST EMPLOYER - NON-MANDATORY

Dear Name of Employer _____ :

This is to confirm that the Rescue Organization _____ can provide the following rescue and emergency services in the event it is needed during confined space entries at your facility. Our organization can provide the following services:

_____

_____

_____

_____

In order for us to properly develop a rescue plan, we must be informed of the hazards associated with the space and we must have access to these spaces. Please provide for us a list of your permit-required confined spaces, their locations, and the hazards. I have enclosed a form you may use. In addition, we must conduct annual practice rescue entries in your confined space(s) or in some other similarly configured space(s). We would like to know if and when this could be arranged in your workplace.

Please contact Rescue Organization Representative _____ at Phone # _____ so that we can discuss this in more detail and make arrangements to visit your workplace before any confined space entry operations are scheduled. Thank you for your cooperation.

Sincerely,

_____

Rescue Organization's Representative

CONFINED SPACE LOCATIONS

_____

_____

Name and Location of Facility

The following is a list of permit-required confined spaces located at our facility:

Space	Location	Hazards

Prepared By:

Date:

Phone Number:

federal register

Friday
September 1, 1989

Part IV

Department of Labor

Occupational Safety and Health Administration

29 CFR Part 1910

Control of Hazardous Energy Source (Lockout/Tagout); Final Rule

§ 1910.147 The control of hazardous energy sources (lockout/tagout).

(a) *Scope, application and purpose—*

(1) *Scope.*

(i) This standard covers servicing and maintenance of machines and equipment in which the *unexpected* energization or start up of the machines or equipment, or release of stored energy could cause injury to employees. This standard establishes minimum performance requirements for the control of such hazardous energy.

(ii) This standard does not cover the following:

(A) Construction, agriculture and maritime employment;

(B) Installations under the exclusive control of electric utilities for the purpose of power generation, transmission and distribution, including related equipment for communication or metering; and

(C) Exposure to electrical hazards from work on, near, or with conductors or equipment in electric utilization installations, which is covered by Subpart S of this part; and

(D) Oil and gas well drilling and servicing.

(2) *Application.* (i) This standard applies to the control of energy during servicing and/or maintenance of machines and equipment.

(ii) Normal production operations are not covered by this standard (See Subpart O of this Part). Servicing and/or maintenance which takes place during normal production operations is covered by this standard only if;:

(A) An employee is required to remove or bypass a guard or other safety device; or

(B) An employee is required to place any part of his or her body into an area on a machine or piece of equipment where work is actually performed upon the material being processed (point of operation) or where an associated danger zone exists during a machine operating cycle.

Note: *Exception to paragraph (a)(2)(ii):* Minor tool changes and adjustments, and other minor servicing activities, which take place during normal production operations, are not covered by this standard if they are routine, repetitive, and integral to the use of the equipment for production, provided that the work is performed using alternative measures which provide effective protection (See Subpart O of this Part).

(iii) This standard does not apply to the following.

(A) Work on cord and plug connected electrical equipment for which exposure to the hazards of unexpected energization or start up of the equipment is controlled by the unplugging of the equipment from the energy source and by the plug being under the exclusive control of the employee performing the servicing or maintenance.

(B) Hot Tap operations involving transmission and distribution systems for substances such as gas, steam, water or petroleum products when they are performed on pressurized pipelines, provided that the employer demonstrates that *(1)* continuity of service is essential; *(2)* shutdown of the system is impractical; and *(3)* documented procedures are followed, and special equipment is used which will provide proven effective protection for employees.

(3) *Purpose.* (i) This section requires employers to establish a program and utilize procedures for affixing appropriate lockout devices or tagout devices to energy isolating devices, and to otherwise disable machines or equipment to prevent unexpected energization, start-up or release of stored energy in order to prevent injury to employees.

(ii) When other standards in this part require the use of lockout or tagout, they shall be used and supplemented by the procedural and training requirements of this section.

(b) *Definitions applicable to this section.*

Affected employee. An employee whose job requires him/her to operate or use a machine or equipment on which servicing or maintenance is being performed under lockout or tagout, or whose job requires him/her to work in an area in which such servicing or maintenance is being performed.

Authorized employee. A person who locks or implements a tagout system procedure on machines or equipment to perform the servicing or maintenance of that machine or equipment. An authorized employee and an affected employee may be the same person when the affected employee's duties also include performing maintenance or service on a machine or equipment which must be locked or a tagout system implemented.

"Capable of being locked out." An energy isolating device will be considered to be capable of being locked out either if it is designed with a hasp or other attachment or integral part to which, or through which, a lock can be affixed, or if it has a locking mechanism built into it. Other energy isolating devises will also be considered to be capable of being locked out, if lockout can be achieved without the need to dismantle, rebuild, or replace the energy isolating device or permanently alter its energy control capability.

Energized. Connected to an energy source or containing residual or stored energy.

Energy isolating device. A mechanical device that physically prevents the transmission or release of energy, including but not limited to the following: A manually operated electrical circuit breaker; a disconnect switch; a manually operated switch by which the conductors of a circuit can be disconnected from all ungrounded supply conductors and, in addition, no pole can be operated independently; a slide gate; a slip blind; a line valve; a block; and any similar device used to block or isolate energy. The term does not include a push button, selector switch, and other control circuit type devices.

Energy source. Any source of electrical, mechanical, hydraulic, pneumatic, chemical, thermal, or other energy.

Hot tap. A procedure used in the repair, maintenance and services activities which involves welding on a piece of equipment (pipelines, vessels, or tanks) under pressure, in order to install connections or appurtenances. It is commonly used to replace or add sections of pipeline without the interruption of service for air, gas, water, steam, and petrochemical distribution systems.

Lockout. The placement of a lockout device on an energy isolating device, in accordance with an established procedure ensuring that the energy isolating device and the equipment being controlled cannot be operated until the lockout device is removed.

Lockout device. A device that utilizes a positive means such as a lock, either key or combination type, to hold an energy isolating device in the safe position and prevent the energizing of a machine or equipment.

Normal production operations. The utilization of a machine or equipment to perform its intended production function.

Servicing and/or maintenance. Workplace activities such as constructing, installing, setting up, adjusting, inspecting, modifying, and maintaining and /or servicing machines or equipment. These activities include lubrication, cleaning or unjamming of machines or equipment and making adjustments or tool changes, where the employee may be exposed to the unexpected energization or startup of the equipment or release of hazardous energy.

Setting up. Any work performed to prepare a machine or equipment to perform its normal production operation.

Tagout. The placement of a tagout device on an energy isolating device, in accordance with an established procedure to indicate that the energy isolating device and the equipment being controlled may not be operated until the tagout device is removed.

Tagout device. A prominent warning device, such as a tag and a means of attachment, which can be securely fastened to an energy isolating device in accordance with an established procedure, to indicate that the energy isolating device and the equipment being controlled may not be operated until the tagout device is removed.

(c) *General*—(1) *Energy control program.* The employer shall establish a program consisting of an energy control procedure and employee training to ensure that before any employee performs any servicing or maintenance on a machine or equipment where the unexpected energizing, start up or release of stored energy could occur and cause injury, the machine or equipment shall be isolated, and rendered inoperative, in accordance with paragraph (c)(4) of this section.

(2) *Lockout/tagout.* (i) If an energy isolating device is not capable of being locked out, the employer's energy control program under paragraph (c)(1) of this section shall utilize a tagout system.

(ii) If an energy isolating device is capable of being locked out, the employer's energy control program under paragraph (c)(1) of this section shall utilize lockout, unless the employer can demonstrate that the utilization of a tagout ystem will provide full employee protection as set forth in paragraph (c)(3) of this section.

(iii) After October 31, 1989, whenever major replacement, repair, renovation or modification of machines or equipment is performed, and whenever new machines or equipment are installed, energy isolating devices for such machines or equipment shall be designed to accept a lockout device.

(3) *Full employee protection.* (i) When a tagout device is used on an energy isolating device which is capable of being locked out, the tagout device shall be attached at the same location that the lockout device would have been attached, and the employer shall demonstrate that the tagout program will provide a level of safety equivalent to that obtained by using a lockout program.

(ii) In demonstrating that a level of safety is achieved in the tagout program which is equivalent to the level of safety obtained by using a lockout program, the employer shall demonstrate full compliance with all tagout-related provisions of this standard together with such additional elements as are necessary to provide the equivalent safety available from the use of a lockout device.

dditional means to be considered as part of the demonstration of full employee protection shall include the implementation of additional safety measures such as the removal of an isolating circuit element, blocking of a controlling switch, opening of an extra disconnecting device, or the removal of a valve handle to reduce the likelihood of inadvertent energization.

(4) *Energy control procedure.* (i) Procedures shall be developed, documented and utilized for the control of potentially hazardous energy when employees are engaged in the activities covered by this section.

Note: *Exception:* The employer need not document the required procedure for a particular machine or equipment when all of the following elements exist: (1) The machine or equipment has no potential for stored or residual energy or reaccumulation of stored energy after shut down which could endanger employees; (2) the machine or equipment has a single energy source which can be readily identified and isolated; (3) the isolation and locking out of that energy source will completely deenergize and deactivate the machine or equipment; (4) the machine or equipment is isolated from that energy source and locked out during servicing or maintenance; (5) a single lockout device will achieve a locked-out condition; (6) the lockout device is under the exclusive control of the authorized employee performing the servicing or maintenance; (7) the servicing or maintenance does not create hazards for other employees; and (8) the employer, in utilizing this exception, has had no accidents involving the unexpected activation or reenergization of the machine or equipment during servicing or maintenance.

(ii) The procedures shall clearly and specifically outline the scope, purpose, authorization, rules, and techniques to be utilized for the control of hazardous energy, and the means to enforce compliance including, but not limited to, the following:

(A) A specific statement of the intended use of the procedure;

(B) Specific procedural steps for shutting down, isolating, blocking and securing machines or equipment to control hazardous energy;

(C) Specific procedural steps for the placement, removal and transfer of lockout devices or tagout devices and the responsibility for them; and

(D) Specific requirements for testing a machine or equipment to determine and verify the effectiveness of lockout devices, tagout devices, and other energy control measures.

(5) *Protective materials and hardware.* (i) Locks, tags, chains, wedges, key blocks, adapter pins, self-locking fasteners, or other hardware shall be provided by the employer for isolating, securing or blocking of machines or equipment from energy sources.

(ii) Lockout devices and tagout devices shall be singularly identified; shall be the only device(s) used for controlling energy; shall not be used for other purposes; and shall meet the following requirements:

(A) *Durable.* (*1*) Lockout and tagout devices shall be capable of withstanding the environment to which they are exposed for the maximum period of time that exposure is expected.

(*2*) Tagout devices shall be constructed and printed so that exposure to weather conditions or wet and damp locations will not cause the tag to deteriorate or the message on the tag to become illegible.

(*3*) Tags shall not deteriorate when used in corrosive environments such as areas where acid and alkali chemicals are handled and stored.

(B) *Standardized.* Lockout and tagout devices shall be standardized within the facility in at least one of the following criteria: Color; shape; or size; and additionally, in the case of tagout devices, print and format shall be standardized.

(C) *Substantial*—(*1*) *Lockout devices.* Lockout devices shall be substantial enough to prevent removal without the use of excessive force or unusual techniques, such as with the use of bolt cutters or other metal cutting tools.

(*2*) *Tagout devices.* Tagout devices, including and their means of attachment, shall be substantial enough to prevent inadvertent or accidental removal. Tagout device attachment means shall be of a non-reusable type, attachable by hand, self-locking, and non-releasable with a minimum unlocking strength of no less than 50 pounds and having the general design and basic characteristics of being at least equivalent to a one-piece, all-environment-tolerant nylon cable tie.

(D) *Identifiable.* Lockout devices and tagout devices shall indicate the identity of the employee applying the device(s).

(iii) Tagout devices shall warn against hazardous conditions if the machine or equipment is energized, and shall include a legend such as the following: *Do Not Start, Do Not Open, Do Not Close, Do Not Energize, Do Not Operate.*

(6) *Periodic inspection.* (i) The employer shall conduct a periodic inspection of the energy control procedure at least annually to ensure that the procedure and the requirements of this standard are being followed.

(A) The periodic inspection shall be performed by an authorized employee other than the one(s) utilizing the energy control procedure being inspected.

(B) The periodic inspection shall be designed to correct any deviations or inadequacies observed.

(C) Where lockout is used for energy control, the periodic inspection shall include a review, between the inspector and each authorized employee, of that employee's responsibilities under the energy control procedure being inspected.

(D) Where tagout is used for energy control, the periodic inspection shall include a review, between the inspector and each authorized and affected employee, of that employee's responsibilities under the energy control procedure being inspected, and the elements set forth in paragraph (c)(7)(ii) of this section.

(ii) The employer shall certify that the periodic inspections have been performed. The certification shall identify the machine or equipment on which the energy control procedure was being utilized, the date of the inspection, the employees included in the inspection, and the person performing the inspection.

(7) *Training and communication.* (i) The employer shall provide training to ensure that the purpose and function of the energy control program are understood by employees and that the knowledge and skills required for the safe application, usage, and removal of energy controls are required by employees. The training shall include the following:

(A) Each authorized employee shall receive training in the recognition of applicable hazardous energy sources, the type and magnitude of the energy available in the workplace, and the methods and means necessary for energy isolation and control.

(B) Each affected employee shall be instructed in the purpose and use of the energy control procedure.

(C) All other employees whose work operations are or may be in an area where energy control procedures may be utilized, shall be instructed about the procedure, and about the prohibition relating to attempts to restart or reenergize machines or equipment which are locked out or tagged out.

(ii) When tagout systems are used, employees shall also be trained in the following limitations of tags:

(A) Tags are essentially warning devices affixed to energy isolating devices, and do not provide the physical restraint on those devices that is provided by a lock.

(B) When a tag is attached to an energy isolating means, it is not to be removed without authorization of the authorized person responsible for it, and it is never to be bypassed, ignored, or otherwise defeated.

(C) Tags must be legible and understandable by all authorized employees, affected employees, and all other employees whose work operations are or may be in the area, in order to be effective.

(D) Tags and their means of attachment must be made of materials which will withstand the environmental conditions encountered in the workplace.

(E) Tags may evoke a false sense of security, and their meaning needs to be understood as part of the overall energy control program.

(F) Tags must be securely attached to energy isolating devices so that they cannot be inadvertently or accidentally detached during use.

(iii) Employee retraining.

(A) Retraining shall be provided for all authorized and affected employees whenever there is a change in their job assignments, a change in machines, equipment or processes that present a new hazard, or when there is a change in the energy control procedures.

(B) Additional retraining shall also be conducted whenever a periodic inspection under paragraph (c)(6) of this section reveals, or whenever the employer has reason to believe, that there are deviations from or inadequacies in the employee's knowledge or use of energy control procedures.

(C) The retraining shall reestablish employee proficiency and introduce new or revised control methods and procedures, as necessary.

(iv) The employer shall certify that employee training has been accomplished and is being kept up to date. The certification shall contain each employee's name and dates of training.

(8) *Energy isolation.* Implementation of lockout or the tagout system shall be performed only by authorized employees.

(9) *Notification of employees.* Affected employees shall be notified by the employer or authorized employee of the application and removal of lockout devices or tagout devices. Notification shall be given before the controls are applied, and after they are removed from the machine or equipment.

(d) *Application of control.* The established procedure for the application of energy control (implementation of lockout or tagout system procedures) shall cover the following elements and actions and shall be done in the following sequence:

(1) *Preparation for shutdown.* Before an authorized or affected employee turns off a machine or equipment, the authorized employee shall have knowledge of the type and magnitude of the energy, the hazards of the energy to be controlled, and the method or means to control the energy.

(2) *Machine or equipment shutdown.* The machine or equipment shall be turned off or shut down using the procedures required by this standard. An orderly shutdown must be utilized to avoid any additional or increased hazard(s) to employees as a result of equipment deenergization.

(3) *Machine or equipment isolation.* All energy isolating devices that are needed to control the energy to the machine or equipment shall be physically located and operated in such a manner as to isolate the machine or equipment from the energy source(s).

(4) *Lockout or tagout device application.* (i) Lockout or tagout devices shall be affixed to each energy isolating device by authorized employees.

(ii) Lockout devices, where used, shall be affixed in a manner to that will hold the energy isolating devices in a "safe" or "off" position.

(iii) Tagout devices, where used, shall be affixed in such a manner as will clearly indicate that the operation or movement of energy isolating devices from the "safe" or "off" position is prohibited.

(A) Where tagout devices are used with energy isolating devices designed with the capability of being locked, the tag attachment shall be fastened at the same point at which the lock would have been attached.

(B) Where a tag cannot be affixed directly to the energy isolating device, the tag shall be located as close as safely possible to the device, in a position that will be immediately obvious to anyone attempting to operate the device.

(5) *Stored energy.* (i) Following the application of lockout or tagout devices to energy isolating devices, all potentially hazardous stored or residual energy shall be relieved, disconnected, restrained, and otherwise rendered safe.

(ii) If there is a possibility of reaccumulation of stored energy to a hazardous level, verification of isolation shall be continued until the servicing or maintenance is completed, or until the possibility of such accumulation no longer exists.

(6) *Verification of isolation.* Prior to starting work on machines or equipment that have been locked out or tagged out, the authorized employee shall verify that isolation and deenergization of the machine or equipment have been accomplished.

(e) *Release from lockout or tagout.* Before lockout or tagout devices are removed and energy is restored to the

machine or equipment, procedures shall be followed and actions taken by the authorized employee(s) to ensure the following:

(1) *The machine or equipment.* The work area shall be inspected to ensure that nonessential items have been removed and to ensure that machine or equipment components are operationally intact.

(2) *Employees.* (i) The work area shall be checked to ensure that all employees have been safely positioned or removed.

(ii) Before lockout or tagout devices are removed and before machines or equipment are energized, affected employees shall be notified that the lockout or tagout devices have been removed.

(3) *Lockout or tagout devices removal.* Each lockout or tagout device shall be removed from each energy isolating device by the employee who applied the device. *Exception to paragraph (e)(3):* When the authorized employee who applied the lockout or tagout device is not available to remove it, that device may be removed under the direction of the employer, provided that specific procedures and training for such removal have been developed, documented and incorporated into the employer's energy control program. The employer shall demonstrate that the specific procedure provides equivalent safety to the removal of the device by the authorized employee who applied it. The specific procedure shall include at least the following elements:

(i) Verification by the employer that the authorized employee who applied the device is not at the facility;

(ii) Making all reasonable efforts to contact the authorized employee to inform him/her that his/her lockout or tagout device has been removed; and

(iii) Ensuring that the authorized employee has this knowledge before he/she resumes work at that facility.

(f) *Additional requirements.* (1) *Testing or positioning of machines, equipment or components thereof.* In situations in which lockout or tagout devices must be temporarily removed from the energy isolating device and the machine or equipment energized to test or position the machine, equipment or component thereof, the following sequence of actions shall be followed:

(i) Clear the machine or equipment of tools and materials in accordance with paragraph (e)(1) of this section;

(ii) Remove employees from the machine or equipment area in accordance with paragraph (e)(2) of this section;

(iii) Remove the lockout or tagout devices as specified in paragraph (e)(3) of this section;

(iv) Energize and proceed with testing or positioning;

(v) Deenergize all systems and reapply energy control measures in accordance with paragraph (d) of this section to continue the servicing and/or maintenance.

(2) *Outside personnel (contractors, etc.).* (i) Whenever outside servicing personnel are to be engaged in activities covered by the scope and application of this standard, the on-site employer and the outside employer shall inform each other of their respective lockout or tagout procedures.

(ii) The on-side employer shall ensure that his/her personnel understand and comply with restrictions and prohibitions of the outside employer's energy control procedures.

(3) *Group lockout or tagout.* (i) When servicing and/or maintenance is performed by a crew, craft, department or other group, they shall utilize a procedure which affords the employees a level of protection equivalent to that provided by the implementation of a personal lockout or tagout device.

(ii) Group lockout or tagout devices shall be used in accordance with the procedures required by paragraph (c)(4) of this section including, but not necessarily limited to, the following specific requirements.

(A) Primary responsibility is vested in an authorized employee for a set number of employees working under the protection of a group lockout or tagout device (such as an operations lock);

(B) Provision for the authorized employee to ascertain the exposure status of individual group members with regard to the lockout or tagout of the machine or equipment and

(C) When more than one crew, craft, department, etc. is involved, assignment of overall job-associated lockout or tagout control responsibility to an authorized employee designated to coordinate affected work forces and ensure continuity of protection; and

(D) Each authorized employee shall affix a personal lockout or tagout device to the group lockout device, group lockbox, or comparable mechanism when he or she begins work, and shall remove those devices when he or she stops working on the machine or equipment being serviced or maintained.

(4) *Shift or personnel changes.* Specific procedures shall be utilized during shift or personnel changes to ensure the continuity of lockout or tagout protection, including provision for the orderly transfer of lockout or tagout devices between off-going and oncoming employees, to minimize exposure to hazards from the unexpected energization, start-up of the machine or equipment, or release of stored energy.

Note: The following Appendix to § 1910.147 services as a non-mandatory guideline to assist employers and employees in complying with the requirements of this section, as well as to provide other helpful information. Nothing in the Appendix adds to or detracts from any of the requirements of this section.

APPENDIX A — TYPICAL MINIMAL LOCKOUT OR TAGOUT SYSTEM PROCEDURES

General

Lockout is the preferred method of isolating machines or equipment from energy sources. To assist employers in developing a procedure which meets the requirements of the standard, however, the following simple procedure is provided for use in both lockout or tagout programs. This procedure may be used when there are limited number or types of machines or equipment or there is a single power source. For more complex systems, a more comprehensive procedure will need to be developed, documented, and utilized.

Lockout (or Tagout) Procedure for (Name of Company).

Purpose

This procedure establishes the minimum requirements for the lockout or tagout of energy isolating devices. It shall be used to ensure that the machine or equipment are isolated from all potentially hazardous energy, and locked out or tagged out before employees perform any servicing or maintenance activities where the unexpected energization, start-up or release of stored energy could cause injury (Type(s) and Magnitude(s) of Energy and Hazards).

Responsibility

Appropriate employees shall be instructed in the safety significance of the lockout (or tagout) procedure (Name(s)/Job Title(s) of employees authorized to lockout or tagout). Each new or transferred affected employee and other employees whose work operations are or may be in the area shall be instructed in the purpose and use of the lockout or tagout procedure (Name(s)/Job Title(s) of affected employees and how to notify).

Preparation for Lockout or Tagout

Make a survey to locate and identify all isolating devices to be certain which switch(s), valve(s) or other energy isolating devices apply to the equipment to be locked or tagged out. More than one energy source (electrical, mechanical, or others) may be involved. (Type(s) and location(s) of energy isolating means).

Sequence of Lockout or Tagout System Procedure

(1) Notify all affected employees that a lockout or tagout system is going to be utilized and the reason therefor. The authorized employee shall know the type and magnitude of energy that the machine or equipment utilizes and shall understand the hazards thereof.

(2) If the machine or equipment is operating, shut it down by the normal stopping procedure (depress stop button, open toggle switch, etc.)

(3) Operate the switch, valve, or other energy isolating device(s) so that the equipment is isolated from its energy source(s). Stored energy (such as that in springs, elevated machine members, rotating flywheels, hydraulic systems, and air, gas, steam, or water pressure, etc.) must be dissipated or restrained by methods such as repositioning, blocking, bleeding down, etc. (Type(s) of Stored Energy—methods to dissipate or restrain).

(4) Lockout and/or tagout the energy isolating devices with assigned individual lock(s) or tag(s) (Method(s) Selected: i.e., locks tags, additional safety measures, etc.)

(5) After ensuring that no personnel are exposed, and as a check on having disconnected the energy sources, operate the push button or other normal operating controls to make certain the equipment will not operate (Type(s) of Equipment checked to ensure disconnections).

CAUTION: Return operating control(s) to "neutral" or "off" position after the test.

(6) The equipment is now locked out or tagged out.

Restoring Machines or Equipment to Normal Production Operations

(1) After the servicing and/or maintenance is complete and equipment is ready for normal production operations, check the area around the machines or equipment to ensure that no one is exposed.

(2) After all tools have been removed from the machine or equipment, guards have been reinstalled and employees are in the clear, remove all lockout or tagout devices. Operate the energy isolating devices to restore energy to the machine or equipment.

Procedure Involving More Than One Person

In the preceding steps, if more than one individual is required to lockout or tagout equipment, each shall place his/her own personal lockout device or tagout device on the energy isolating device(s). When an energy isolating device cannot accept multiple locks or tags, a multiple lockout or tagout device (hasp) may be used. If lockout is used, a single lock may be used to lockout the machine or equipment with the key being placed in a lockout box or cabinet which allows the use of multiple locks to secure it. Each employee will then use his/her own lock to secure the box or cabinet. As each person no longer needs to maintain his/her lockout protection, that person will remove his/her lock from the box or cabinet (Name(s)/Job Title(s) of employees authorized for group lockout or tagout).

Basic Rules for Using Lockout or Tagout System Procedure

All equipment shall be locked out or tagged out to protect against accidental or inadvertent operation when such operation could cause injury to personnel. Do not attempt to operate any switch, valve, or other energy isolating device where it is locked or a tagged out.

LOCKOUT (OR TAGOUT) PROCEDURE

Entry No.	(Description)
1.	Name of Company
2.	Type(s) and Magnitude(s) of energy and hazards
3.	Name(s)/Job Title(s) of employees authorized to lockout or tagout
4.	Name(s)/Job Title(s) of affected employees and how to notify
5.	Type(s) and Location of energy isolating means
6.	Type(s) of Stored Energy-methods to dissipate or restrain
7.	Method(s) Selected, i.e., locks, tags, additional safety measures, etc.
8.	Type(s) of Equipment checked to ensure disconnections
9.	Name(s)/Job Title(s) of employees authorized for group lockout or tagout

Unit 1
Introduction to Confined Space Rescue

Lesson 5: Fire Department Confined Space Response Plans

Introduction to Confined Space Rescue

Fire department confined space response plans

If a fire department is going to respond to confined space incidents, it must have a plan in place that will provide the policies, procedures and guidance necessary for a safe and effective rescue. The plan should indicate the level of response the department will provide as well as basic guidance in areas, such as the duties of the various functions, training requirements, equipment, available resources and target sites and hazards.

Plan components

Identification of confined spaces

Before any consideration can be given to what level of response can be provided, it is necessary to determine the community's needs. The first step in this process is identifying the confined spaces on district property as well as within the departments' response area. As the responsible authority for department property, the governing body must comply with the provisions of 1910.146 if there are permit required confined spaces on department property.

Potential locations for confined spaces in a response area include:

- Industrial, commercial and institutional facilities
  Examples include: manufacturing facilities, power plants, hospitals, schools and utilities
- Agriculture
  Examples include silos, hoppers and pits
- Marine
  An example would be a ship hold
- Public Services
  Examples include: water systems, sewer systems including treatment facilities and storm sewer systems

Department response level(s)

After the confined spaces within the response area have been identified, the next step is deciding what is the appropriate level of response the department will provide. This is determined by evaluating the needs of the community, the ability of the department to provide the service and the available outside resources.

Aside from no response at all, there are four basic levels of response which a department may provide:

- Primary rescue team
  A fully trained and equipped team which will respond first to rescue incidents that occur.

- Backup response team
  A team that acts as a back-up to a primary response team, such as one provided by an industrial facility. This type of team may not carry all of the equipment necessary and instead rely on the facilities' equipment.
- First responder
  Where the organization utilizes mutual aid for rescue services but coordinates the response of other agencies. Medical and other non-rescue services may or may not be provided by the first responder organization.
- Support response
  No active role in rescue is provided and the only services provided are those that are as support to other agencies.

Personnel requirements

As mentioned earlier, it is important to determine the department's ability to provide the necessary level of response. The first of two major areas to be examined is the ability of department personnel in meeting the requirements of the expected level of response. The major areas of concern are:

- Personnel selection
  Physical requirements, mental attributes and enough people to volunteer for this duty. It is recommended, given the special stresses associated with this type of rescue, that this not be a forced assignment.
- Duty assignments
  Ample personnel must be available to fill the required positions for the chosen level of response.
- Training
  Depending on the level of response, the training requirements can be quite substantial. The assigned individuals must have the time and the desire to obtain and maintain the necessary training.
- Outside resources
  Identifying these resources will help determine what is available. An example would be an industrial team that can respond out to the community, thus eliminating the need for the department to have a primary level team.

Equipment requirements

The second major area to be examined when determining whether the department is able to provide the expected level of response is the equipment requirements. Evaluation of the spaces is required to determine such things as necessary monitoring and ventilation equipment, personal protective equipment and retrieval systems. When this has been accomplished, the ability of the department to purchase and maintain this equipment can play a major role in the decision making process.

Response checklist

The final major component of the response plan is an emergency response checklist. This checklist provides for a systematic approach of evaluating the hazards present and the appropriate procedure to deal with the hazard. This checklist can also be used as a planning tool before an incident to assist in determining the level of response a department will provide to a facility or type of space.

The sample checklist on the next page is an example of what may be used to assist in the decision making process. Listed along the left edge are a series of confined space hazards and across the top are control procedures and equipment. Where the corresponding rows and columns meet, "•" indicates a suggested control procedure and equipment. and "o" indicates that entry must not be made until the explosive atmosphere is removed.

Of final concern when determining the appropriate response to the rescue situation is the concept of rescue vs. recovery. Rescue is defined as the saving of a live victim from a dangerous situation. Recovery is the removal of a victim's body that has been either legally pronounced dead or is obviously dead by reason of massive trauma or has been exposed for an extended time to an unsurvivable condition. In the end, we do not trade rescuers lives for victims lives, nor do we risk rescuers lives to recover bodies.

Rescue Plan Checklist

General Information

Location of Rescue ____________

Entry Permit available Yes ___ No ___

No. of occupants in space ____________

Condition of occupants ____________

Approx. time incapacitated ____________

No. of rescuers in space ____________

Rescue on-site commander ____________

NOTE: The control procedures and equipment needed will depend on the specific confined space rescue situation. It is the responsibility of the rescue personnel to determine the appropriate action needed. Listed are the items which may need to be considered.

Control Procedures and Equipment

Permit Space Hazards	Test Atmosphere	Determine Cause	Ventilate Space	SCBA/SAR	Standby person with SCBA	Control/Eliminate Ignition Sources	Use non-sparking tools	Full Body Harness, Lifeline, Mechanical Winch, Tripod, Fall Arresting Device	Fire Suppression Equipment	Lockout energy sources and controls, dissipate stored energy	Rescue ropes, appropriate Stretcher for victim	Lockout valve / break line / misalignment of pipe etc.	Chemical Protective Clothing	Constant Communication	Explosion-proof lighting	Appropriate PPE
☐ Oxygen less than 19.5%	●	●	●	●	●			●			●			●		●
☐ Oxygen more than 23.5%	●	●	●	O	●	●	●	●	●	●	●			●		●
☐ Explosive gases/vapors	●	●	●	O	●	●	●	●	●	●	●	●	●	●	●	●
☐ Explosive dust	●	●	●	O	●	●	●	●	●	●	●	●	●	●	●	●
☐ Toxic gases/vapors	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
☐ Engulfment		●		●	●			●		●	●	●	●	●	●	●
☐ Entrapment		●			●			●			●			●		●
☐ Mechanical		●			●			●		●	●			●		●
☐ Electrical		●			●			●	●	●	●			●		●
☐ Chemicals	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●
☐ Heat Stress		●	●		●			●			●			●		●
☐ Noise		●			●			●			●			●		●
☐ Falls/Slippery Surfaces		●			●			●			●			●		●

Specific Entry Procedures | Note: Rescue services may use the following space to list the specific entry procedures for safe entry based on advanced preparation with the employer.

Atmospheric Testing Record

Substance	Acceptable Level	Readings
Oxygen	19.5% - 23.5%	____ ____ ____ ____ ____ ____ ____ ____ ____ ____
Explosive(Gas/Vapor)	<10% LFL	____ ____ ____ ____ ____ ____ ____ ____ ____ ____
Explosive Dust	< LFL (5 ft. Visibility)	____ ____ ____ ____ ____ ____ ____ ____ ____ ____
Carbon Monoxide	50 PPM	____ ____ ____ ____ ____ ____ ____ ____ ____ ____
Hydrogen Sulfide	10 PPM	____ ____ ____ ____ ____ ____ ____ ____ ____ ____
____	____	____ ____ ____ ____ ____ ____ ____ ____ ____ ____
____	____	____ ____ ____ ____ ____ ____ ____ ____ ____ ____

Unit 1
Introduction to Confined Space Rescue

Lesson 6: Rescue Incident Command System

Radio traffic should be limited to only essential messages. Multi-channel radio capability enhances communications by allowing use of separate channels for different distinct functions or command responsibilities. The use of hard wire communication systems, face-to-face verbal communications, hand signals and tag line signals also have distinct advantages in some situations.

In the ICS, a communications unit may be established to handle responsibility for all communications planning and channel assignments at the incident, including:

- Two-way radio communication to/from personnel at the scene and to/from scene and communication center;
- Hard wired systems;
- Computer/modem/(fax); and
- Any other form of communications.

Resource management

Personnel and equipment resources are categorized and managed by three methods depending on the need of the incident. The most common mode of resource management used at an incident is referred to as a **single resource**. A single resource is defined as an individual company or crew. An example would be personnel arriving with a fire department pumper being considered a company if they function together with a designated leader to accomplish a specific task. A crew is a leader and five subordinates without apparatus. The number of personnel in a crew should not exceed the recommended span-of-control guidelines of five workers plus one crew leader.

A **task force** is any combination of single resources put together for a temporary assignment or special task. An example of a task force would be if two heavy rescue crews and their officers at a multi-story building collapse incident, previously designated as crews, are combined with the personnel from an advanced life support EMS unit and sent into the building to extricate a trapped victim on the second floor. These individual crews with combined resources now working under the direction of one officer, may be designated as a rescue task force.

A **strike team** is comprised of a set number of resources of the same kind and type. If, for example, for a mutual-aid fire in a rural area, the neighboring county is contacted and requested to dispatch five 1000 gpm pumpers to establish a water supply from a drafting site to the scene. These combined resources, with a certain number of personnel and one leader, all with common communication capabilities, could be designated as the mutual aid counties' water supply strike team.

Status conditions are assigned to each resource in order to maintain an accurate picture of the resources used. These status conditions are either classified as:

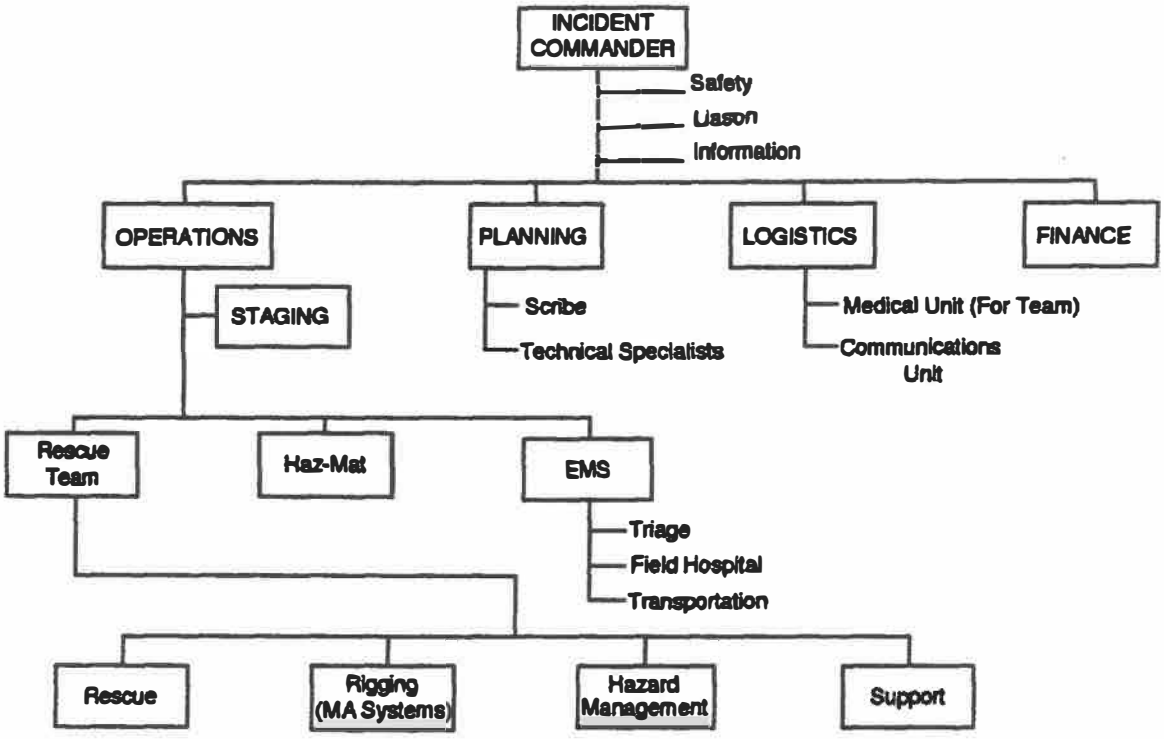
- assigned-in-service and working at the incident;
- staged and available for assignment;
- rehab - at rehabilitation/rest area and not available for work; or
- out-of-service

When rescue is just one portion of a larger overall incident, such as structure fire, the rescue of victims is included as part of the incident command system operations sector. In this instance, the rescue leader reports directly to "operations. The rescue officer supervises all tactical activities related to the rescue of victims. A rescue safety officer position may be established specially, in addition to the safety officer of the entire incident.

When rescue is the primary focus of an incident, such as a confined space rescue emergency, the rescue officer may also be assigned as operations officer. In either case, single personnel may function as a single resource and be designated as a crew or company or be lumped together with sufficient leadership to be designated as a task force or strike team. The incident commander supervises the overall incident regardless of the size or magnitude of the operation.

Figure 1.6-2

Sample Confined Space ICS Chart



The typical confined space incident command system does not normally require as elaborate a system as the NFA model system. The sample confined space ICS chart (Figure 1.6-2) shown above is one example of how a scene can be managed. Each branch covers a distinct area of concern, as does the NFA model, while maintaining an adequate span of control.

Unit 1
Introduction to Confined Space Rescue

Lesson 7: Personal Protective Equipment

Introduction to Confined Space Rescue

Personal protective equipment

When performing a rescue in a confined space, the most important consideration is the rescuer's safety. Just as in structural firefighting, using a total protective envelope is one of the most important aspects of providing for the safety of rescue personnel. This total protective envelope consists of body, respiratory, head, foot, hand and eye protection. Selecting the various components depends on the hazards present and the space configuration.

Body protection

Selecting body protection, as well as any other personal protective equipment, will be based on the known as well as potential hazards. The three major types of protective clothing used in confined space rescue are structural firefighter clothing (turnout gear), coveralls and chemical protective clothing.

Structural firefighter clothing: includes protective coat and possibly pants; protects against short duration temperature extremes as well as some protection against cuts, abrasions and certain chemicals, the bulky construction of this type of clothing may present mobility problems which could result in operational difficulties as well as significant physical stress.

Coveralls: should be flame resistant; some are insulated to protect against the cold; preferred in many situations because of the lack of bulk which provides for a great deal of comfort and mobility.

Chemical protective clothing: protects from direct chemical contact; used in situations where chemical exposure is an issue; the size and bulk of some types may not allow for entry into some spaces; chemical protective clothing is broken down into four levels depending on the extent of protection provided.

> **Level A:** used when the highest level of protection is necessary; includes totally encapsulated chemical protective suit, chemical resistant inner and outer gloves and chemical resistant boots.
>
> **Level B:** used when a reduced level of skin and eye protection is necessary; includes chemical resistant clothing (non-encapsulating design), coveralls, chemical resistant inner and outer gloves, chemical resistant boots (steel toe and shank) and chemical resistant over boots.
>
> **Level C:** used where airborne contaminate is known and criteria for air purifying respirator is met; skin and eye exposure problems are unlikely; includes chemical resistant clothing (non-encapsulating design), chemical resistant inner and outer gloves, chemical resistant boots (steel toe and shank) and chemical resistant over boots.

Level D: used where respiratory or skin hazards (due to chemical exposure) are not present; consists primarily of a work uniform (turnout gear and coveralls fall into this category). Most confined space rescues fall into this category.

Respiratory protection

Because atmospheric hazards pose one of the greatest risks to confined space entrants, selecting and using respiratory protection is of the utmost importance. The types of respiratory protection include:

Air purifying respirator: relies on filtration devices to remove particulates, gases and vapors from the atmosphere; filters may not handle all hazards present and they are no good for oxygen-deficient atmospheres; available in full and half mask varieties. Full mask provides eye and face protection; this type of respirator is **not normally used in confined space rescue** because of the possibility of oxygen-deficient or enriched atmospheres as well as multiple potential hazards.

Self-Contained Breathing Apparatus (SCBA): self-contained breathing air and full face piece provide a much greater level of protection than air purifying respirators; available in 30 to 60 minute versions; comes with a full face piece for eye and face protection; may have supplied air connection to allow for extended work time (commonly referred to as Supplied Air Breathing Apparatus (SABA); SCBA and SABA may be a disadvantage in confined spaces because of the bulk of the back frame and bottle as well as having a limited air supply (non-airline types).

Air Line Respirator/ Supplied Air Respirator (SAR): breathing air is supplied from either a compressor or stored air (bottle) system located outside the space; has the same advantages as SCBA as far as face piece and air supply; system components include the respirator (positive pressure), escape bottle (5-10 minute, 10 minute recommended), the air line (300 foot maximum depending on the flow required and manufacturer) and a compressor or stored air system. The harness assembly may be either a sling type or full body harness type. The full body harness type that is available is designed to eliminate the need for separate respirator and retrieval harnesses.

The advantages are that the air supply is not limited to what you take with you. Its small size allows access into smaller spaces and provides for more maneuverability. Disadvantages include the potential for air line entanglement or damage. The small escape bottle size may not allow much time in an emergency to evacuate the space.

Head protection

The types of head protection include:

Firefighter helmet: impact resistant shell provides a high level of protection; liner provides some thermal protection and may be combined with a Nomex hood; the wide brim at the rear of the helmet and the face shield may be a disadvantage because it may make it difficult to fit into and maneuver in tight places.

Hard hat-type helmet: impact resistant shell provides a level of head protection (depending on the style it may not provide as much as the firefighter helmet); liner (if provided) will provide some thermal protection and may be combined with a Nomex hood; has a small front brim and no rear brim; front brim provides some protection for the top of the respirator face piece; preferred by many rescue teams because of the impact resistance provided; its smaller, overall size allows for easier maneuverability as well as entry into tighter spaces.

Climbing helmet: impact resistant shell provides a level of head protection (depending on the style may not be as much as the firefighter helmet or hard hat); has no brims allowing for smallest possible size.

Eye protection and face protection

The types of eye protection include:

Respirator face piece: provides maximum protection because of full face coverage; eyes are totally insulated from outside atmosphere which protects them from dust, mist and chemicals.

Safety glasses or goggles: good for areas where respirators are not needed; should include retainer strap (chums) and side shields.

Helmet face shield: not normally used because it provides minimal protection in a confined space environment and because of its bulk.

Foot protection

The types of foot protection include:

Firefighter boots: primarily used in conjunction with turnout gear; provides a high level of protection but their bulk makes use difficult in some situations.

Safety work boots: steel toe and shank provide impact and puncture resistance; design provides some ankle protection; their light weight and flexibility make them good for confined space and rope work.

Safety work shoes: steel toe and shank provide impact and puncture resistance; lack of ankle support or protection makes them not the best suited for rescue work.

Hand protection

The types of gloves include:

Leather firefighting gloves: designed to be puncture and cut resistant; insulation provides thermal protection; bulkiness may reduce dexterity; lack of palm reinforcement makes them not as good as rescue gloves for rope work.

Leather rescue (rappel) gloves: provides some puncture and cut resistance; lack insulation for thermal protection; provide a good "feel" of the rope and tools; reinforced palm provides good protection for rope work.

Latex medical gloves: protect from contamination of hands from body fluids as well as some chemicals; should be worn when handling victims (refer to your fire department infection control plan).

Miscellaneous equipment

This category includes various items, such as hearing protection, PASS devices and personal lighting. With regards to choosing personal lighting, care should be taken as to its ease of use, duration and intensity. The most common types in use include hand held and helmet mounted flashlights as well as chemical lightsticks.

Unit 2
Confined Space Rescue Hazards

Lesson 1: Knot Review

Knot Practical Skills

Name:_____ Date: ____/____/____

Individual Knots:

Simple Figure of 8	Complete / Incomplete
Figure of 8 on Bight	Complete / Incomplete
Figure of 8 Follow Through Loop	Complete / Incomplete
Figure of 8 Bend - Join 2 Ropes	Complete / Incomplete
Double Loop Figure of 8	Complete / Incomplete
In Line Figure 8 Loop	Complete / Incomplete
Double Fisherman	Complete / Incomplete
Prusik Hitch	Complete / Incomplete
Overhand Knot	Complete / Incomplete
Safety Knot (Half Dbl. Fisherman)	Complete / Incomplete
Munter Hitch	Complete / Incomplete
Square Knot	Complete / Incomplete
Butterfly Knot	Complete / Incomplete
Wristlet Knot	Complete / Incomplete
Water Knot	Complete / Incomplete
Mariner's Knot	Complete / Incomplete

Unit 2
Confined Space Rescue Hazards

Lesson 2: Confined Space Hazards

Confined Space Rescue Hazards

Confined space hazards

The atmosphere in a confined space may be extremely hazardous because of the lack of natural air movement. This characteristic of confined spaces can result in oxygen-deficient atmospheres, flammable atmospheres and/or toxic atmospheres.

In addition to these atmospheric hazards, there are a number of physical hazards the rescuer may encounter that will be a threat to their safety and well-being. Identifying and eliminating these hazards is a major component of a successful operation.

The National Institute for Occupational Safety and Health has developed the following atmospheric hazard classification chart (Figure 2.2-1) to assist entrants in determining the level of hazard present in a space. This chart, when used in conjunction with generally accepted safety practices, should assist departments in reducing or eliminating the hazards associated with this type of rescue.

Oxygen-deficient atmospheres

An oxygen-deficient atmosphere has less than 19.5 percent available oxygen (O_2). Any atmosphere with less than 19.5 percent oxygen should **not** be entered without an approved self-contained breathing apparatus (SCBA) or supplied air respirator (SAR) with an escape bottle.

The oxygen level in a confined space can decrease because of work being done, such as welding, cutting or brazing; or it can be decreased by certain chemical reactions (rusting) or through bacterial action (fermentation).

The oxygen level is also decreased if oxygen is displaced by another gas, such as carbon dioxide or nitrogen. Total displacement of oxygen by another gas, such as carbon dioxide, will result in unconsciousness followed by death.

Flammable atmospheres

Two things make an atmosphere flammable: the oxygen in the air and a flammable gas, vapor or dust in the proper mixture. Different gases have different flammable ranges. If an ignition source (e.g., a sparking or electrical tool) is introduced into a space containing a flammable atmosphere, an explosion will result.

An oxygen-enriched atmosphere (above 23.5 percent) will cause flammable materials, such as clothing and hair, to burn violently when ignited. Therefore, **never use pure oxygen to ventilate a confined space.** Ventilate with normal air.

Figure 2.2-1

CHARACTERISTICS		
CLASS A	**CLASS B**	**CLASS C**
Immediately dangerous to life	Dangerous, but not immediately life threatening	Potential hazard
OXYGEN		
CLASS A	**CLASS B**	**CLASS C**
16% or less *(122 mm Hg) or greater than 25% (190 mm Hg)	16.1% to 19.4% *(122-147 mm Hg, or 21.5% to 25% (163-190 mm Hg)	19.5% - 21.4% *(148-163 mm Hg)
FLAMMABILITY CHARACTERISTICS		
CLASS A	**CLASS B**	**CLASS C**
20% or greater of lower flammable limit (LFL)	10 - 19% LFL	10% LFL or less
TOXICITY		
CLASS A	**CLASS B**	**CLASS C**
IDLH **	Greater than contamination level, referenced in 29 CFR Part 1910, Subpart Z (IDLH **)	Less than contamination level referenced in 29 CFR Part 1910 Subpart Z

*** Based upon a total atmospheric pressure of 760 mm Hg (sea level)**
**** Immediately Dangerous to Life or Health**

Toxic Atmospheres

Most substances (liquids, vapors, gases, mists, solid materials and dusts) should be considered hazardous in a confined space. Toxic substances can come from the product stored in the space or the product can be absorbed into the walls and give off toxic gases when removed. Toxic vapors can also be given off when cleaning out the residue of a stored product. For example, removing sludge from a tank of decomposed material can give off deadly hydrogen sulfide gas.

Work being performed in a confined space, such as welding, cutting, brazing, painting, scraping, sanding or degreasing, can also generate vapors. For example, cleaning solvents are used in many industries for cleaning/degreasing. The vapors from these solvents are very toxic in a confined space.

Atmospheric conditions in areas adjacent to the confined space can also enter and accumulate in a confined space, thereby contaminating the area.

Unit 2
Confined Space Rescue Hazards

Lesson 3: Air Quality

Confined Space Rescue Hazards

Air quality

The Occupational Safety and Health Administration, based on its review of accident data, has determined that asphyxiation is the leading cause of death in confined spaces. The asphyxiations that have occurred in permit spaces have generally resulted from oxygen deficiency or from exposure to toxic atmospheres.

Because of this, monitoring and controlling atmospheric hazards will play a major role in any response to a confined space incident. The results of atmospheric testing will influence almost every aspect of the operation including tactics, PPE selection and even whether the victim is most likely viable or not.

Atmospheric monitoring equipment

When choosing monitoring instruments for use in confined spaces, there are four characteristics that should be considered:

Portability: the chosen instrument should be small and lightweight, use battery power or have no power requirements, be resistant to shocks and moisture and have remote monitoring capability; (this last requirement is important because you will not need to enter space to test and you will be able test at various levels in the space).

Able to provide reliable, useful results: results should be easy to understand and relevant; field calibration is desirable and the degree of accuracy should be stated.

Sensitive and selective: sensitivity refers to the lowest detectable amount of a substance; selectivity refers to the device's ability to detect and measure only the target product.

Intrinsically safe: devices may be used in a hazardous environment so the device cannot act as an ignition source.

There are two basic types of portable monitoring equipment: direct reading instruments and colorimetric detector tubes. Direct reading instruments are further broken down into two types (as defined by how they operate): diffusion head assembly and electro-chemical sensor types.

Direct reading **diffusion head assembly** instruments burn combustible gases to determine presence and quantity. This type of assembly is used in combustible gas detectors.

Direct reading **electro-chemical sensor** instruments use a chemical reaction in the sensor(s) to determine the presence of certain gases. This type is used for oxygen, hydrogen sulfide, carbon monoxide, etc.

Colorimetric detector tubes are glass tubes containing a mixture of chemicals which change color when exposed to specific contaminates. An air sample is drawn through the tube by a pump. A major consideration with this type of detector is the need for different tubes for different contaminates.

Monitoring confined space atmospheres

It is important to understand that some gases or vapors are heavier than air and will settle to the bottom of a confined space. Also, some gases are **lighter** than air and will be found around the top of the confined space. **Therefore, it is necessary to test all areas (top, middle, bottom) of a confined space** with properly calibrated testing instruments to determine what gases are present.

Before testing the atmosphere, there are two checks with direct reading instruments that must be performed to insure the monitor will operate properly. First, the monitor must be calibrated as per manufacturer's instructions. This is usually accomplished using a calibration kit sold by the meter manufacturer. This calibration is normally performed on a routine basis at a place other than the emergency scene. The second is the field check immediately prior to testing. This is where the monitor is "zeroed" as per manufacturer's instructions.

Testing Sequence

To obtain accurate results, the atmosphere in the confined space **must** be sampled in the following order:

1) **Oxygen level**: diffusion head assembly meters will not show accurate readings if the oxygen level is too low or high.

2) **Flammability**: you must understand the type of meter and flammable material being tested. The meter may test for LEL, percent gas or PPM. LEL meters may require using a response curve or conversion factors for the specific gas or vapor being tested for.

3) **Toxics**: most common toxics found in confined spaces are carbon monoxide and hydrogen sulfide. Pre-planning or information obtained at the site may indicate a need to test for other chemicals.

If testing reveals oxygen-deficiency, greater than 10 percent LEL or the presence of toxic gases or vapors, the space must be ventilated and re-tested before workers enter. If ventilation is not possible and entry is necessary (for emergency rescue, for example), workers must have appropriate respiratory and body protection.

Never trust your senses to determine if the air in a confined space is safe! You can not see or smell many toxic gases and vapors nor can you determine the level of oxygen present.

Confined space ventilation

Unless you can be **absolutely** sure there is no atmospheric hazard within the confined space, there should **always** be a ventilation system in place. The type of system used and the ventilation method chosen will depend on the equipment available, space configuration and the hazards (or potential hazards) that are in the space.

When deciding what ventilation equipment to use, you may be able to choose between equipment already in place (fixed) or use equipment you bring with you (portable).

If the space already has a ventilation system installed, find out if it will ventilate to the degree and in the area that you need. Also, it may be locked out. If so, is it safe to turn it back on?

Examples of portable ventilation equipment include fire department exhaust fans, positive pressure ventilation fans and confined space ventilation fans. These fans can be electric or gas engine driven. Great care must be taken to ensure that exhaust fumes from ANY engine are not drawn into the intake of the ventilation fan.

When choosing a fan to use in confined space situations, the following selection criteria should be followed:

- The fan must be explosion proof. It is important that flammable vapors being drawn through the fan will not be ignited.
- The fan should be duct work compatible. Duct work may be important when eliminating "short circuiting" and when exhausting contaminated air to a safe place.
- The fan must be powerful enough to move the desired quantity of air and throw the air far enough into the space. Because this is not always possible, it may be necessary to use a series of fans.

Ventilation methods

There are two types of ventilation used in confined spaces; local exhaust and general (dilution) ventilation. Choosing the appropriate method requires evaluating the space for the type, characteristics and location of the contaminate, space configuration and available equipment.

Local exhaust ventilation is best for controlling highly toxic or flammable materials produced at a single point. The intake should be close to the point where vapors are being given off and the exhaust should be to a safe place away from the space. This type of ventilation does not work well when the toxic atmosphere is widely dispersed or the source of the vapors cannot be reached by the ventilation equipment and exhausted to a safe area.

General (dilution) ventilation is the most commonly used method of ventilation in confined space rescues. Because of the limited time some victims have to remain viable, it may not be possible to locate the source of a contaminate.

The two types of general ventilation are positive pressure (supply) (Figure 2.3-1) and exhaust ventilation (Figure 2.3-2). The advantage of general ventilation is that it is good for providing oxygen (fresh air) and controlling low levels of contaminates.

Figure 2.3-1

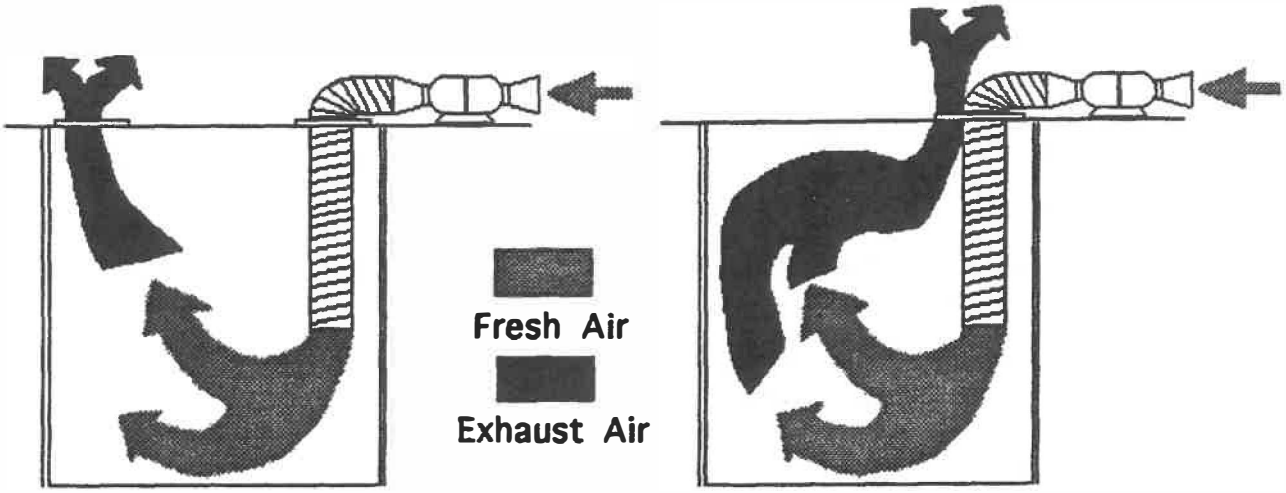
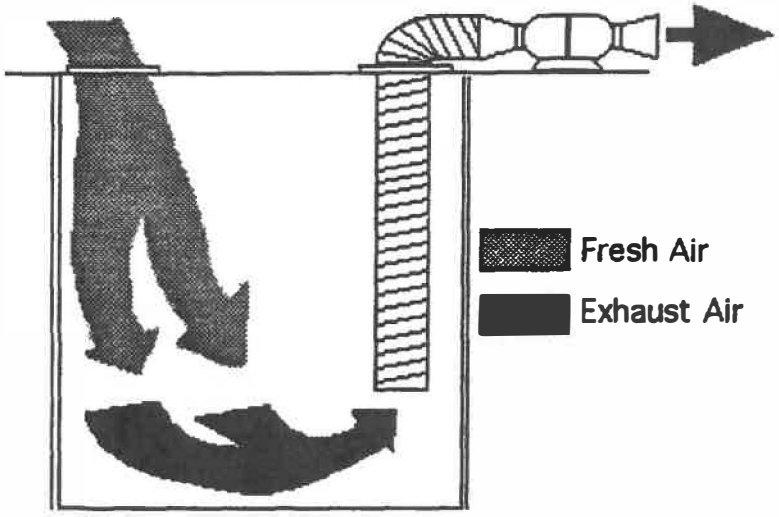


Figure 2.3-2



The disadvantages are: it does not work as well in highly toxic atmospheres where the source of the toxicity is close to the work area; and it must have an inlet and outlet in the space or adequate ductwork must be available to ventilate all portions of the space. Ductwork should be kept as short as possible, be kept as straight as possible avoiding sharp bends and be airtight (including connections). Also, it is prone to short circuiting (Figure 2.3-3) and care must be taken to avoid recirculating contaminated exhaust back into the space (Figure 2.3-4).

Figure 2.3-3

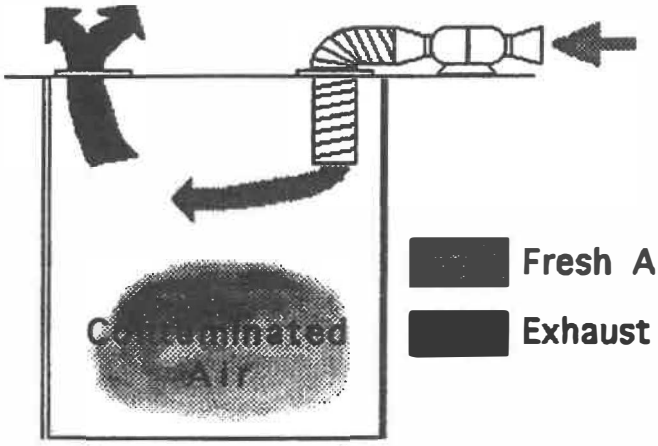
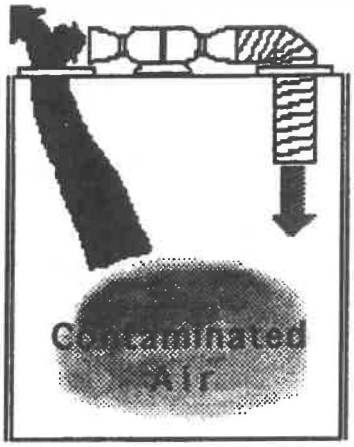


Figure 2.3-4



Determination of Ventilation Requirements

There are a number of factors which must be taken into consideration when determining the ventilation requirements of a space. The factors are:

The **size of area to be ventilated** must be determined by calculation of the cubic footage of the space.

The **number and location of openings** will determine the placement of fans and, if multiple fans are required, whether they need to be used individually or in series. Leakage to the ambient atmosphere is also a consideration and any unnecessary openings should be closed to prevent leakage. This includes covering any openings, closing doors or using plugs.

Any **restrictions in the space** can have adverse effects on the flow of air in the space. As such, any baffles, equipment and any other items which will restrict air flow or create "dead spots" must be identified and compensated for by the use of additional fans, ducting or other means as appropriate.

The **type of material to be vented** will determine fan placement and ventilation method. Whether the vapors are heavier, equal to or lighter than air and the concentration of the vapors need to be determined.

The **capacity and configuration of ventilating equipment** must be determined to calculate the minimum purge time for a space and also to determine if the equipment will be able to ventilate the space in a timely manner. The air flow in cubic feet per minute (CFM) must be known as well as other factors, such as whether the unit is hose adaptable.

Calculating ventilation requirements

Nomographs (Figures 2.3-5 and 2.3-6) are line charts used to determine the minimum purging time required for a space. It is important to remember that these values are only theoretical approximations with safety margins included. The blower capacities shown are based on one to two 90 degree bends and 15 feet of hose.

When using these charts, the following steps are followed;

1) Place a straight edge on the Confined Space Volume (left scale);
2) Place the other end of the straight edge on the Blower Capacity (right scale);
3) Read the minimum required purge time (in minutes) from the diagonal scale.

Figure 2.3-5

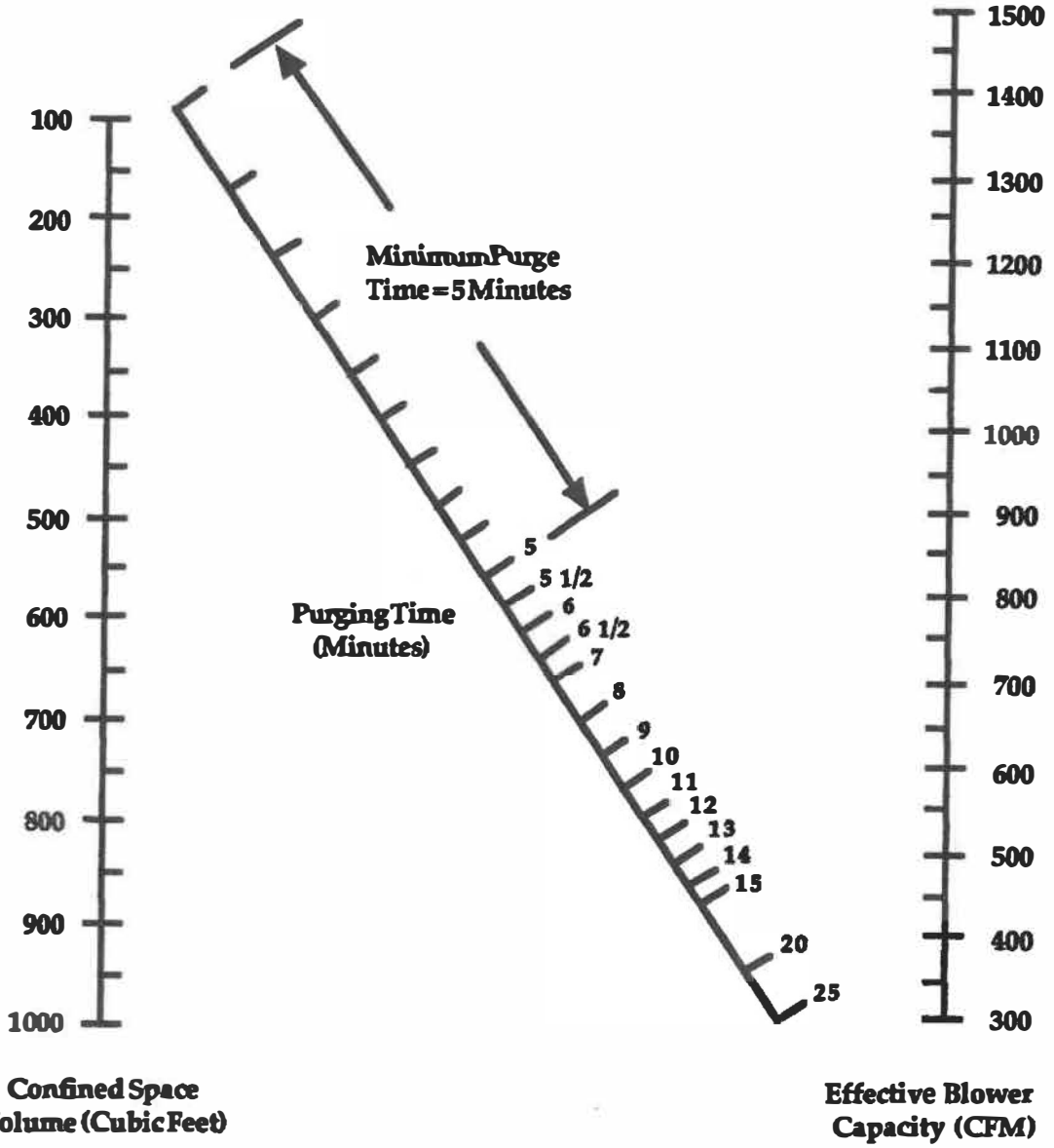
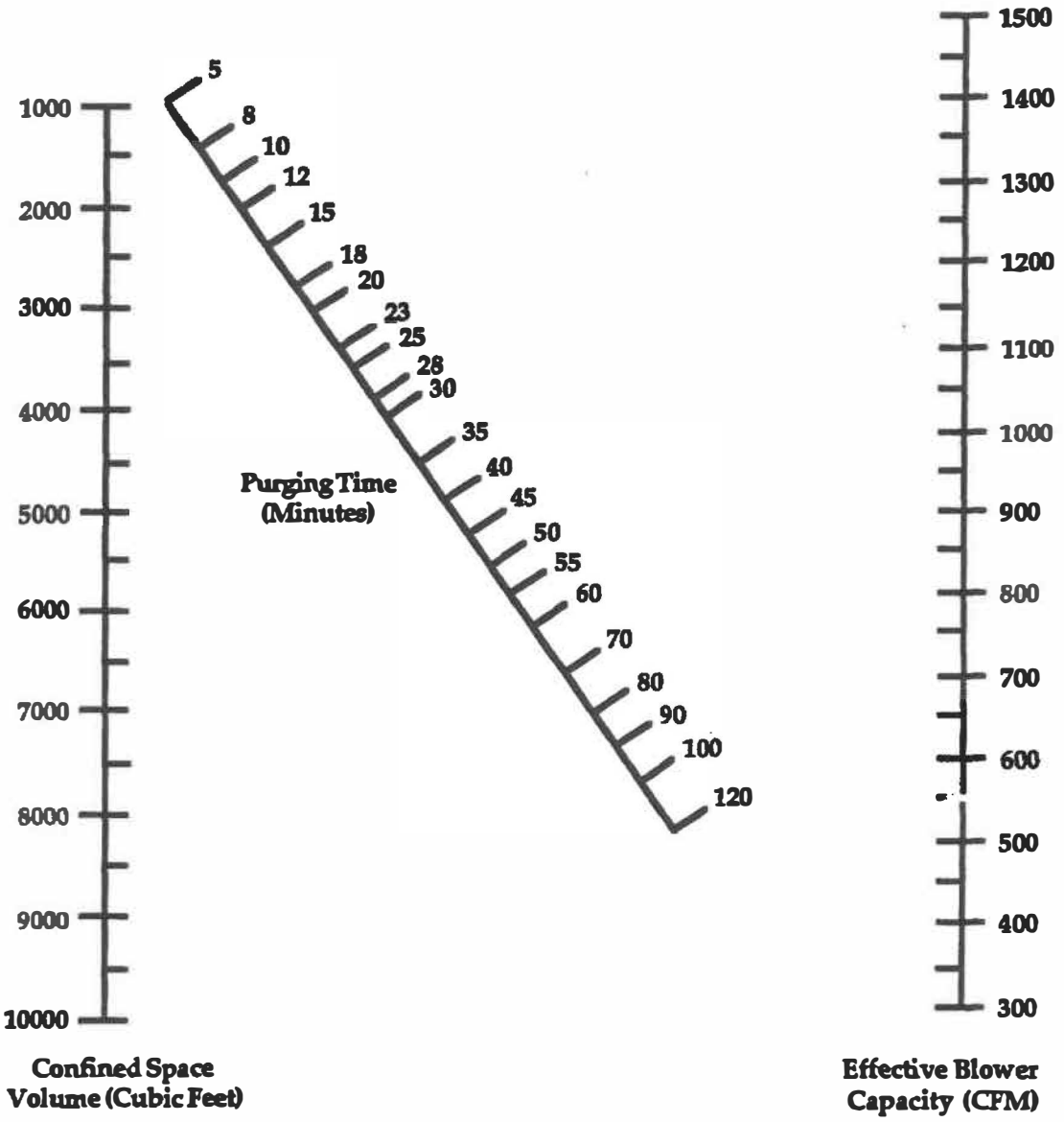


Figure 2.3-6



The **manual calculation method** may also be used to determine how long you need to ventilate the space in minutes (T) to accomplish 1 change of air. The formula to determine this is;

T=Cubic footage of space / CFM of blower unit

To determine the flow rate (Q) in cubic feet per minute required to achieve a desired number of air changes per hour (NACH) in a given space, the following formula should be used;

Q=(NACH x cubic footage of space) / 60 min. per hr.

Additional formulas and examples can be found in the appendix to this unit.

Unit 2
Confined Space Rescue Hazards

Lesson 3: Air Quality
APPENDIX

VENTILATION CALCULATIONS

1) Determine the flow rate (Q) required to achieve 20 air changes per hour (ACH) in an underground lift station 20 ft. high, 40 ft. long, and 20 ft. wide.

EQUATION $N = \frac{Q \times 60}{VOL}$

$20\ ACH = \frac{Q \times 60\ min/hr}{16{,}000\ ft^3}$

$Q = \frac{20\ AC/Hr \times 16{,}000\ ft^3}{60\ mins/hrs}$

$= 5.333\ ft^3/min$ ANS

N = Nos. of ACH
Q = Ventilation Flow Rate (CFM)
60 = Constant (mins/hrs)
Vol = Spoce Volume (ft^3)
N = 20
Q = ?
Vol = 20'x40'x20' = 16.000 $ft.^3$

2) A permit-required confined space 20'x30'x10' in size is found to have an initial concentration of 250 parts per million (ppm) of carbon monoxide. How long will it take to lower the concentration to 50 ppm using a portable ventilation unit with a flow rate of 1000 cfm?

EQUATION $t = -2.303 \left(\frac{Vol}{Q}\right) \times \log\left(\frac{C_2}{C_1}\right)$

$t = -2.303 \times \left(\frac{6{,}000\ ft^3}{1{,}000\ ft^3/min}\right) \times \log\left(\frac{50\ ppm}{250\ ppm}\right)$

$t = 9.6$ mins. ANS

t = time (minutes)
Vol = space volume (ft^3)
Q = ventilation flow rate (CFM)
C_1 = initial contaminant concentration (ppm)
C_2 = final contaminant concentration (ppm)
t = ?
Vol = 20'x30'x10' = 6.000 ft3
C_1 = 250 ppm
C_2 = 50 ppm
Q = 1.000 cfm
-2.303 = constant

3) What will be the concentration of hydrogen sulfide (H_2S) after 20 minutes of purging a cylindrical tank (40' high with a 10' diameter)? The initial concentration is 200 ppm and the ventilation rate is 800 cfm.

EQUATION $C_2 = C_1 \times e^{\left(\frac{-Q\,t}{Vol}\right)}$

C_1 = initial contaminant concentration
C_2 = final contaminant concentration
e = inverse natural log
Q = ventilation flow rate (CFM)
t = time (minutes)
Vol = space volume (ft^3)

C_1 = 200 ppm
C_2 = ?
e = inverse natural log
Q = 800 fpm
t = 20 mins.
Vol = space volume (ft^3) = $40' \times \frac{\pi \times D^2}{4} = 40' \times \frac{3.14 \times 100}{4} = 40 \times 78.5 = 3140\ ft^3$

$C_2 = 200\ ppm \times e^{\left(\frac{-800\ ft^3/min \times 20\ mins}{3.140\ ft^3}\right)}$

$= 200\ ppm \times e^{-5.1}$

$C_2 = 1.2$ ppm ANS

Unit 2
Confined Space Rescue Hazards

Lesson 4: Space Isolation

Confined Space Rescue Hazards

Space isolation

Space isolation prevents hazards from entering the space while people are inside. These hazards can take many forms and are introduced in a number of ways. There are a number of hazards that can present a problem in confined space situations. These include liquids, gases, solids, mechanical and electrical. Therefore, different methods need to be made available to prevent these hazards from entering the space.

In most cases, the space should be isolated before your arrival. These techniques are common practice in situations where permits are in effect. In any case, the space must be isolated. **Be sure of this** before committing personnel into the space.

In the extremely rare situations where it is not possible to isolate the space (such as sewer systems), take every precaution to monitor for the unexpected release of a hazard into the space. An example would be to station personnel at various points of the sewer system to monitor for a rise in liquid level or introduction of a hazardous material (such as an industrial discharge).

OSHA isolation procedure

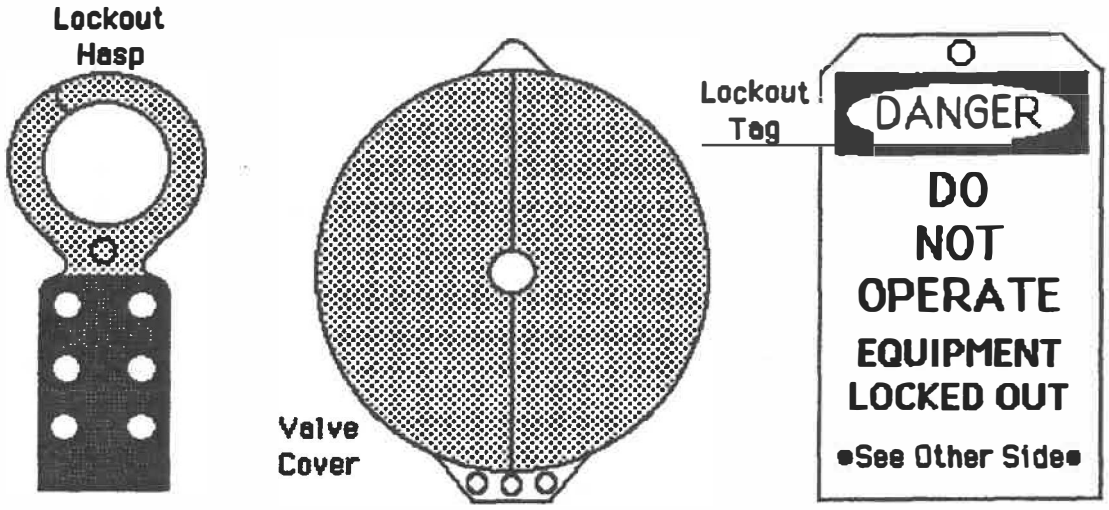
The Occupational Safety and Health Administration has developed a six step procedure for ensuring a space is properly isolated for safe entry.

- **Prepare for shutdown.** Determine energy type and control methods.
- **Shut down the equipment.** Use the normal stopping procedure if possible.
- **Isolate the equipment.** This includes ALL sources - both primary and secondary energy sources.
- **Apply lockout, tagout and/or bleed/block devices.**
- **Control stored energy.** This includes bleeding off pressure in lines etc.
- **Verify equipment isolation.**

Methods of space isolation

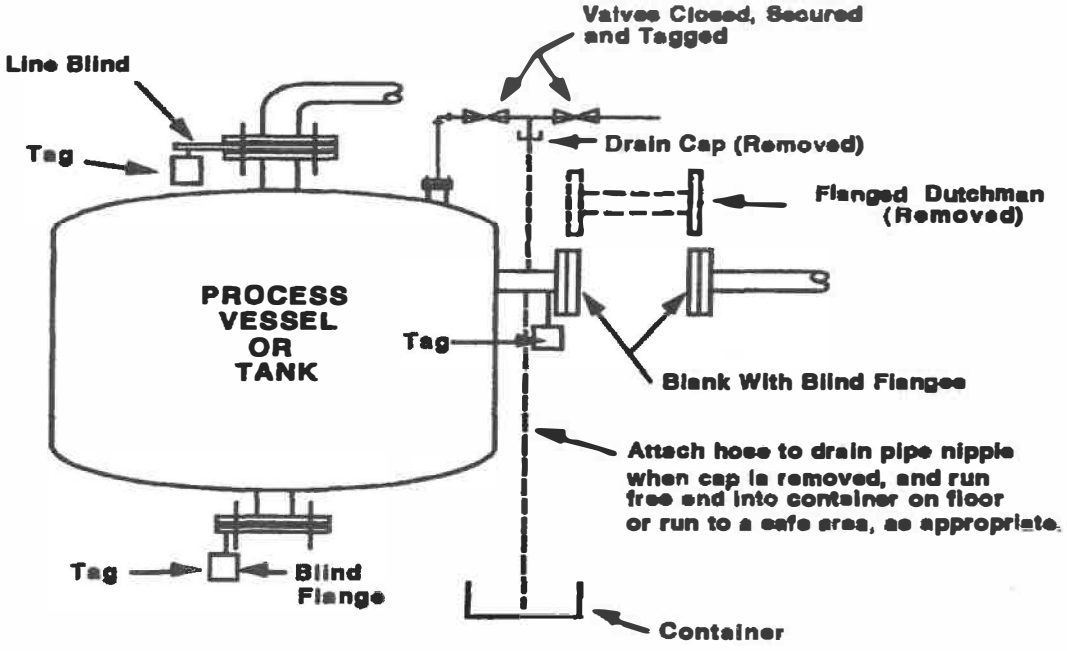
Lockout/tagout is used for all types of hazards. It prevents valves or switches from being opened; utilizes locks, chains, lockout hasps, circuit breaker lockouts, ball valve lockouts, valve covers, plug locks and warning tags (See Figure 2.4-1).

Figure 2.4-1



Bleed/block or blank/blind is used on piping that carries liquids, flowable solids and gases. It uses blind flanges, removal of sections of pipe and bleeding materials from the piping and is sometimes used in combination with lockout/tagout. (See Figure 2.4-2)

Figure 2.4-2



If it is not possible to lockout or bleed/block a line or device, a person should be stationed at the switches and/or valves to ensure they are not turned on. The best policy in this situation is to use fire department personnel with a clear policy set on who can order that a line or device be opened or turned on.

Unit 2
Confined Space Rescue Hazards

Lesson 5: Psychological Aspects of Confined Space Rescue

Confined Space Rescue Hazards

Psychological aspects of confined space rescue

Entering confined spaces in an emergency can be one of the most dangerous and stressful situations any firefighter can encounter. Physical constraints and the various hazards that may be encountered in many spaces can easily create stress in any firefighter. While this is normal, in fact helpful in some ways, an abnormal level of fear can be dangerous.

This lesson describes the major psychological reactions commonly faced in confined space situations and describes techniques that will alleviate and, in some cases, take advantage of these reactions.

Psychological terms

There are three basic psychological reactions that can come into play with both rescuers and victims in a confined space situation. An understanding of these reactions will help you comprehend what is happening, how severe the situation is and how these reactions can be controlled. These three reactions are anxiety, phobia and panic.

Anxiety is a distress or an uneasiness of the mind or a reaction when you feel danger from a person, object, situation or impulse. Normal anxiety is productive. It helps you survive. Excess anxiety can become crippling and create even greater hazards.

An example: you are at a fire scene and you observe a partial collapse of the structure. After the collapse, you observe a group of firefighters standing next to a wall that has become unstable and might fall at any moment. You yell to the firefighters to get out of the way before the wall falls. This fear and the resulting behavior probably saved their lives.

Another example is you have a disagreement with your company officer and have an impulse to tell him/her off. Your stomach gets a tight feeling and you realize the consequences of losing your temper. You back down and save yourself some embarrassment and possibly a reprimand.

Phobias are a persistent fear of a situation or an object in which the level of fear is not proportional to its actual seriousness. Specifically, claustrophobia is an **abnormal** fear of a closed or confined space.

Fear or anxiety of **real** hazards would not be considered abnormal. In a confined space, the fear of being stuck in a space that is too small for your body is normal. Fear of being stuck in a space that is more than large enough for your body size might not be considered normal.

Panic is a sudden terror or an unreasoning, infectious and uncontrollable fear. Panic may be the result of anxiety created by the particular phobia. Symptoms of panic include accelerating anxiety, difficulty breathing, stress associated physical symptoms and, on occasion, hallucinations.

An example of panic is: you are 100 feet into a 24 inch sewer pipe and you begin to feel your breath becoming labored. You feel like you are running out of air even though you are wearing a supplied air respirator and the flow is ample. The walls of the pipe feel as though they are closing in on you when in fact they are not. Your anxiety level dramatically increases and a sudden, intense fear overcomes you. Your urge to get out as fast as possible becomes overwhelming.

Causes of fear in confined spaces

There are both biological and psychological reasons why fear occurs. An understanding of these factors can help in its control. Current research indicates each person has a different physical and psychological makeup and, therefore, each rescuer should be aware of their individual limitations. Training, good physical conditioning and psychological control methods are the best preparations for confined space entry.

Biological causes of fear

Good physical condition reduces the production of sodium lactate, an anxiety producing chemical. This chemical can produce an anxiety attack which could lead to a dangerous state of panic. Some ingested chemicals, like caffeine, can also increase anxiety levels in some people. This could produce the same results as sodium lactate.

Psychological causes of fear

Subconscious forces - psychoanalysts believe phobias are carried over from memories and imaginations from childhood. A child being stuck in a small space may create a conscious or subconscious fear of confined spaces that could last a lifetime. A person may not even be aware that this fear exists. The person then avoids the threat (i.e. training evolution or rescue situation) by acting defensively. This defensive behavior relieves the anxiety and then tends to be repeated (learned).

Personality disorders / pathological or abnormal behaviors - indicates that pre and post employment psychological screening by a competent specialist could be advantageous.

Psychological control techniques

Experience has shown that combining training and psychological control techniques can either identify a problem or help the person overcome the problem. Behavioral training involves direct exposure to the phobic situation by progressively exposing the individual to more difficult situations. Expression of anxieties (recognizing your fears) by both the instructors and students assists in dealing with the fear. Benefits of this method are that it helps evaluate people involved, shows people their limitations and may help individuals overcome their limitations.

Some individuals may avoid this type of training. This may indicate confined space related-anxiety. If this is the case, this avoidance may reinforce the phobia and as such this person may not be suitable for confined space work. Individuals that develop avoidance patterns should be encouraged and helped by others to enter the phobic situation in a safe training environment and do it in manageable steps.

Contextual therapy is a six point program for phobia-related anxiety control. This technique is used when you are actually in the phobic situation and need to control the fear. The six points are:

- Expect, allow and accept that fear will arise.
- When fear comes wait, let it be. Take one step at a time. Create a goal.
- Focus your attention on the rescue.
- Label any fear responses 1-10. This helps analyze the anxiety by making you an outside observer.
- Learn to function with a level of fear and learn to appreciate it. This is self-preserving and keeps you alert.
- Allow and accept that the fear will reappear. Be prepared.

Confined space rescue is dangerous and stressful for emergency responders. Combining training in confined spaces with the proper equipment and techniques, as well as the accepted psychological responses and control methods are the best known methods of assuring a safe outcome to a rescue with a minimum of risk to all involved.

Unit 3
Confined Space Rescue Equipment

Lesson 1: Knot Review

Knot Practical Skills

Name:_____ Date: ____/____/____

Individual Knots:

Simple Figure of 8	Complete / Incomplete
Figure of 8 on Bight	Complete / Incomplete
Figure of 8 Follow Through Loop	Complete / Incomplete
Figure of 8 Bend - Join 2 Ropes	Complete / Incomplete
Double Loop Figure of 8	Complete / Incomplete
In Line Figure 8 Loop	Complete / Incomplete
Double Fisherman	Complete / Incomplete
Prusik Hitch	Complete / Incomplete
Overhand Knot	Complete / Incomplete
Safety Knot (Half Dbl. Fisherman)	Complete / Incomplete
Munter Hitch	Complete / Incomplete
Square Knot	Complete / Incomplete
Butterfly Knot	Complete / Incomplete
Wristlet Knot	Complete / Incomplete
Water Knot	Complete / Incomplete
Mariner's Knot	Complete / Incomplete

Unit 3
Confined Space Rescue Equipment

Lesson 2: Communications

Unit 3
Confined Space Rescue Equipment

Lesson 3: Rope, Hardware and Mechanical Advantage Systems

Edge protection and rollers

Used to protect rope and webbing when in contact with sharp or abrasive edge. Included are canvas pads, wrap around edge guards, short pieces of hose and rollers.

Mechanical advantage systems

Mechanical advantage systems are used to move objects in one or more of three different directions. A raising system is the most common use of mechanical advantage systems. Lowering systems are sometimes needed to lower rescuers or equipment in the space. Systems for horizontal movement are normally used to overcome friction or when long hauls are anticipated.

Mechanical advantage equipment

Site constructed systems: use standard rope rescue equipment, such as rope, pulleys, webbing, carabiners and the like; some parts may be pre-rigged to save setup time. These systems can be constructed to meet the needs of the situation at hand, such as the location of the pulley system, change of direction and anchor points. They can also be used in combination with other equipment (tripods, A frames etc.).

Manufactured systems:

Power winch: should NEVER be used for rescue because the power and speed may injure victim or rescuers.

Tripod winch: uses gear drive to gain mechanical advantage; simple to use - a hand crank allows for single person operation; its use is limited to those situations where a tripod can be used.

Tube winch: has the same gear drive system as the tripod winch but has an extension tube with a change of direction; this allows the winch operator to stand the length of the tube away from the lift point; can be used with a tripod or as an independent device.

Rope systems: available from various manufacturers; these systems include built in friction brake devices and some have a fall protection option; some are pre-rigged for faster setup and some designs require less rope than normal mechanical advantage systems; this makes them work well where long lifts are anticipated.

Calculating Mechanical Advantage

In order to determine the required mechanical advantage needed for a particular situation, there are two factors which must be considered; the weight to be lifted and the distance of lift.

Determine weight to be lifted

The amount of force needed to lift an object is theoretically proportional to the mechanical advantage system used. Because of other forces such as friction, there will be a slight (in most cases) difference between theoretical and actual.

Example: To lift a 200 pound object using a 1:1 mechanical advantage system, 200 pounds of force will be necessary. The use of a 4:1 system will require 50 pounds of force.

Because it is desirable to keep the amount of effort needed by the haul team at a reasonable level, many teams calculate their systems based on a force required of the haul team at 50 lbs. to 100 lbs.

Determine length of lift

The length of rope necessary is proportional to the mechanical advantage system used.

Example: A lift or run of 50 feet using a 1:1 system will require 50 feet of rope. The use of a 4:1 system will require 200 feet of rope. Remember, in order to lift the object 50 feet while using a 4:1 system, you will also have to pull 200 feet of rope through the system.

Because of the need for working slack and extra for stretch in vertical systems, the length of rope needed = (MA + 1) x length of lift. So, a lift of 50 feet with a 4:1 system requires 250 feet of rope (4:1 + 1 = 5 times 50 feet = 250 feet of rope). This calculation becomes critical because if your longest rope is 200 feet, it would not be possible to construct this system for this length of lift. Because of this, choose the minimum mechanical advantage system necessary. You can always add to it if necessary or, if you do not have enough rope to construct even a minimal workable system, use an alternate like the "piggyback system", which is described later.

Constructing mechanical advantage systems

Anchors

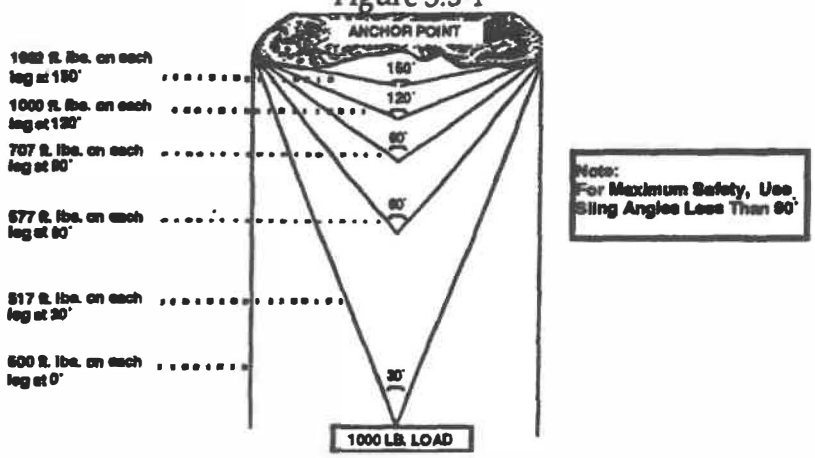
Anchors may be a single (backed up) point or a system (self equalizing and omni-directional). Anchor points should be "bomb proof" (a point that will not move when subjected to the expected and unexpected loads). Examples of commonly used anchor points include:

- Trees
- Fire trucks
- Boulders
- Picket holdfast
- Structural I beam
- Heavy, well anchored equipment
- Other heavy, well anchored objects

Load Relationships on Anchor Points

As the angle increases, the load on the anchor system multiplies (Figure 3.3-1). Because of this, it is very important in multiple anchor point systems and highlines.

Figure 3.3-1



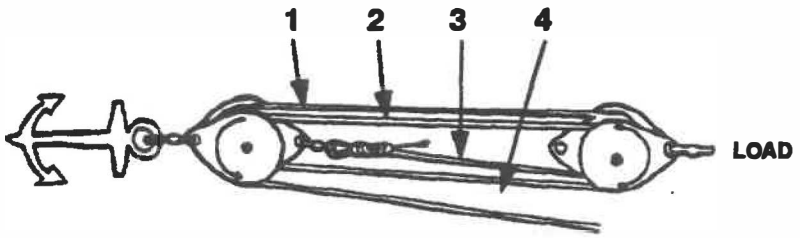
Pulley Systems

The pulley system selected will depend on the amount of weight to be moved, the available personnel, the equipment available and the system configuration necessary for the particular site. Some mechanical advantage systems will be given 2 examples: a "simple" system and a "compound" system (Figures 3.3-6 through 3.3-12).

A rule of thumb in constructing systems that may help is that the terminal (knot) end of the rope will be at the load end of the odd (3:1, 5:1 etc.) systems. Even (2:1, 4:1 etc.) systems will have the terminal (knot) end of the rope at the anchor end of the system.

The mechanical advantage of a simple system is determined by counting the number of ropes attached to the load (Figure 3.3-4).

Figure 3.3-4

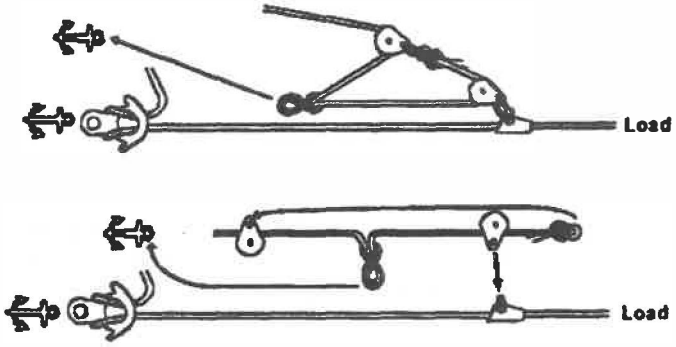


A compound system is made by using 2 or more systems together. When combining mechanical advantage systems, the numbers are multiplied. For example, if you pull a 3:1 system with a 2:1 system, the result would be 3 times 2, which is a 6:1 system.

One of the quickest ways to convert a lowering system to a raising system and back again is to use a **"piggyback"** system (Figure 3.3-5). This is a mechanical advantage system that is attached to the main line. It has its own anchor and can be pre-made for quick deployment when needed. A 4:1 piggyback requires 50 feet of rope, 2 pulleys, a gibbs or prusiks, 2 carabiners and anchor hardware and software.

Figure 3.3-5

4:1 Piggyback System

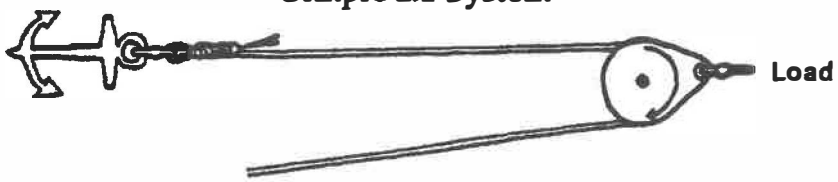


An **"inchworm"** is a short, simple 5:1 system that is used inside a space to pull a load (such as a victim). The inchworm is attached to the tag line in the same manner that the piggyback system is attached.

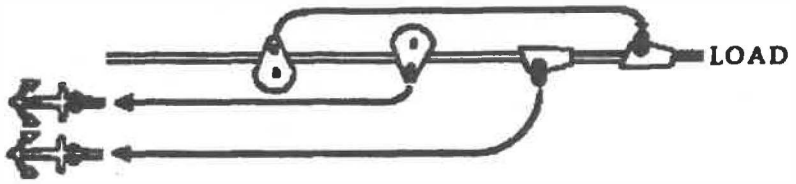
In any event, it must be remembered that, regardless of the hauling system selected, ALL victim and rescuer oriented lines require a belay or secondary line with safeties!

Figures 3.3-6 to 3.3-12

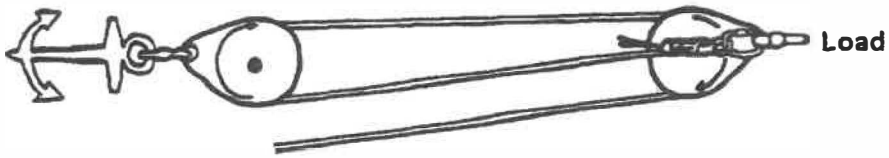
Simple 2:1 System



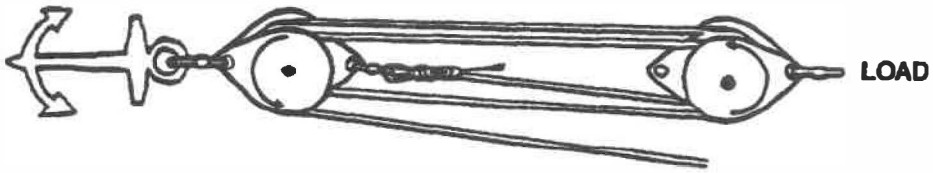
Simple 3:1 "Z" System



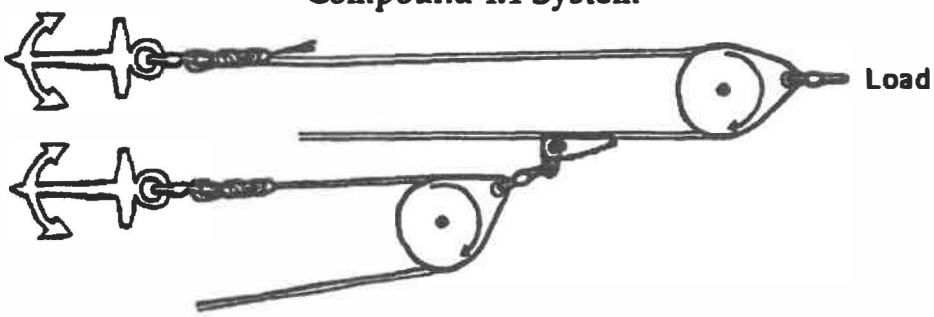
Simple 3:1 System



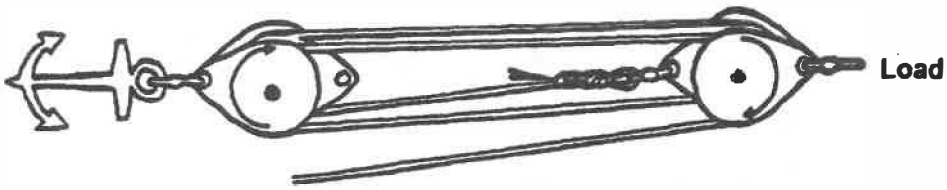
Simple 4:1 System



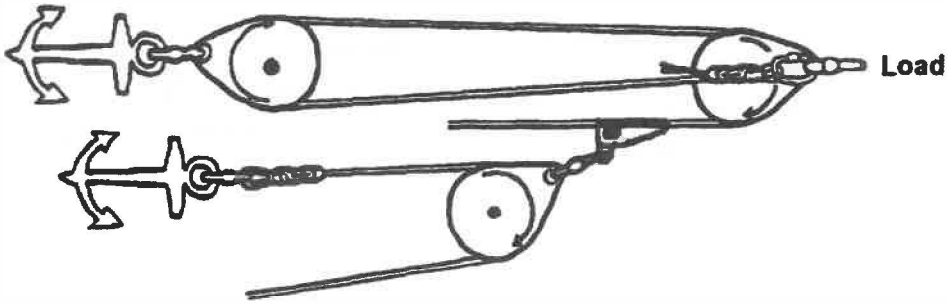
Compound 4:1 System



Simple 5:1 System



Compound 6:1 System



Unit 3
Confined Space Rescue Equipment

Lesson 4: Tripods and Ladder Rescue Systems

Confined Space Rescue Equipment

Introduction

In a confined space rescue situation, the mechanical advantage systems described in the last lesson will need to be attached to some object. Because many of these situations require a vertical removal, an anchor point above the opening will be necessary.

Confined spaces such as manholes, silos, pits and other outside type spaces have no anchor above the opening so it is necessary to provide one. The use of manufactured and improvised tripods, ladder A frames, gin poles and other ladder configurations can accomplish this goal. The configuration of the site, requirements of the rescue and available equipment will determine which of the methods shown in this lesson is the most appropriate.

Tripods

Tripods are devices with three legs that are used in vertical rescue situations to provide an anchor point directly over the opening to a confined space. This device can either be a manufactured type or one that is constructed using locally or site available materials. In either case, when setting up a tripod it is important to remember that the stability of the tripod is dependent on the appropriate leg span, which is 1/3 of the height of the tripod.

Manufactured tripods: typical sizes are up to 12 feet high with a span of up to 10 feet depending on the manufacturer; many are set up for mechanical winch or rope system use and fold up and collapse to a smaller size for storage and carrying; because they are engineered they are tested and rated for load capacity.

Improvised tripods: typically made from timbers and rope. Because they can, at times, be made of bulky and heavy materials, they must in some cases be made on site; tend to not be as convenient as manufactured tripods and are not tested for load capacity.

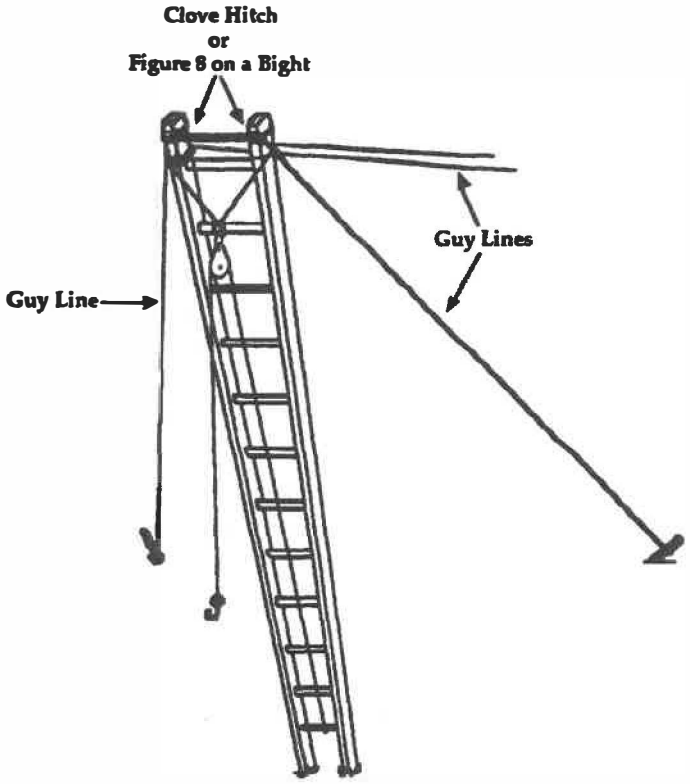
Ladder rescue systems

There are occasions where using a tripod is not practical (or one is not available) and overhead anchors are not available. In these cases, ladder rescue systems should allow you to create overhead anchors in a variety of situations and space configurations. Some common configurations include: A Frame, Ladder Gin (Open Field or Against a Vehicle (or other solid object), Leaning Ladder, Ladder Rig (Jib) and Cantilever Ladder. A ladder gin and A frame are shown in Figures 3.4-1 and 3.4-2.

The ladder gin (Figure 3.4-1) is one of the most useful ladder rescue systems. It requires minimal equipment and personnel, is quickly rigged, and has numerous rescue applications. A ladder gin is an upright spar which is supported at the top to keep it in a near vertical position and is equipped with a mechanical advantage rig for hoisting. The ladder gin is normally formed with a ground or aerial ladder.

Ladder gin

Figure 3.4-1



Ground ladders used for ladder gin rigging must satisfy NFPA standards for fire service ladders (Standard #1931 and #1932). A 12 to 16' straight ladder is best for light loads. The shorter extension ladders can also be used.

A mechanical advantage rigging system and a safety line are assembled and attached to the ladder gin before raising if possible.

Guy lines are rigged to hold the ladder vertical or near vertical. One rope serves as both the guy line and the sling point for the mechanical advantage system. Each clove hitch or figure eight on a bight is placed under the top rung from the back side of the ladder and then placed over the tips.

Guy lines should be formed with lifeline ropes and should be positioned at the best angle to support the vertical ladder. Guy lines can be adjusted to best support the ladder. Three anchor points are necessary, one for each guy line and one for the butt of the ladder.

The ladder gin can be used to lift or lower vertically, such as when lifting a load off a victim or when raising a victim out of a space. With proper equipment, the ladder gin could bring an injured patient out a window. The only restriction is your imagination coupled with common sense.

Generally, 12' to 16' straight ladders are rated at a maximum loading of 400 to 500 lbs. The ladder should be rigged at a proper climbing angle. The strength of the ladder gin is based upon the transfer of the load to the ground via the beams of the ladders. All loads must remain within the beams. The system will not accept side loading.

Guy lines support the ladder only and do not support the lifted load. Improper rigging, excessive loading, or poor ladder angles will transfer excessive load to the anchors or will cause excessive loading at right angles to the ladders' beams.

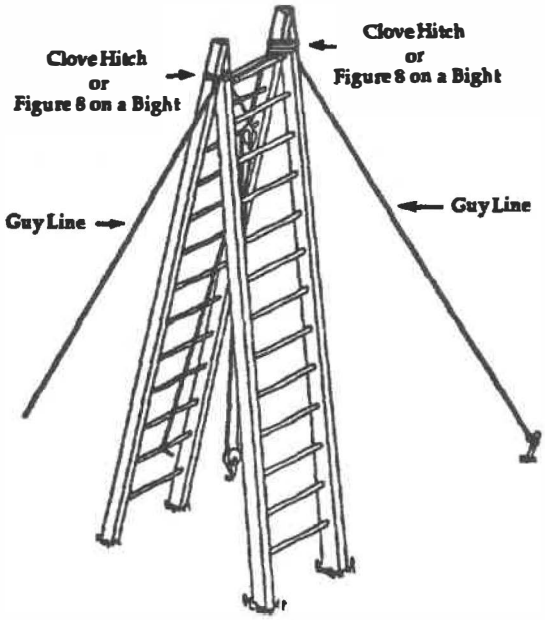
All loading must occur within the beams of the ladder. If this is a problem, the use of directional pulleys at the base of the ladder will allow the hauling crew to move to one side. The higher the load is raised, the more the load is increased on the system.

A ladder gin can also be rigged off a vehicle. The five basic components of a standard ladder gin (ladder, mechanical advantage rig, safety line, guy line, and anchors) are still present. Remember, the ladder gin has very little sideways stability. Keep the load and all pulling in front of the ladder near the tip.

Ladder A frame

An 'A frame' ladder rigging (Figure 3.4-2) can also be assembled for specialized rescue applications. Two ladders are positioned in a 'A' formation and lashed together. Guy lines and a raising line are assembled to work inside the center area of the ladders.

Figure 3.4-2



A mechanical advantage 3:1 or 4:1 ladder rig system is put in place along with a safety line. Anchor pickets secure the rigging in the upright position.

Another frequently used method involves the use of two ropes. The ladders are lashed together at the tips using 1 inch tubular webbing. Each rope is then attached to the top of the A frame using a figure eight follow through loop or a double loop figure eight. A sling of 1 inch tubular webbing is then constructed by creating a loop (as is made for anchors) around a beam on each side.

Unit 3
Confined Space Rescue Equipment

Lesson 5: Harnesses

Confined Space Rescue Equipment

Harnesses

In confined space rescue, harnesses are used by the rescuer to provide a body attachment for retrieval lines and other accessory items, such as air lines and communication lines. All harnesses used by the fire service should be in compliance with NFPA 1983 **Fire Service Life Safety Rope, Harness and Hardware**. There are three classes of life safety harnesses used by the fire service:

Class I: harness that fasten around waist and around the the thighs or under the buttocks: designed for emergency escape with a one person load.

Class II: harness that fasten around the waist and around the thighs or under buttocks: designed for rescue where two person loads may be encountered.

Class III: harness that fasten around the waist, around the thighs or under buttocks and over the shoulders; designed for rescue where two-person loads may be encountered and inverting may occur. Class III harnesses may consist of one or more parts. This is the primary harness used in confined space rescue.

Construction of manufactured harnesses

NFPA 1983 requires that harnesses for fire service use be manufactured to meet certain requirements. Specifically, these construction and testing requirements include testing of the harness assembly to meet the criteria specified in the standard. Both static and dynamic testing is required and the specific tests to be performed is based on the harness type.

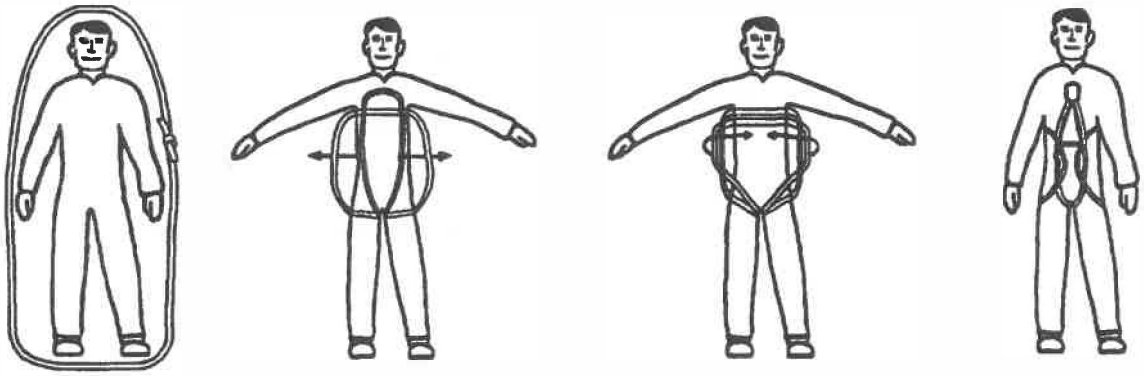
Site constructed full body harness

In confined space rescue, there may be occasions where it is either not possible or practical to remove a victim using a manufactured harness. Situations where this might occur would include where there is not enough time to have a harness sent into the space or where the physical constraints of the space will not allow a victim to be placed into a conventional manufactured harness.

In cases such as these, the use of a site prepared harness may be a viable alternative. While there are a number of ways to construct a site made harness, the one shown in this course (Figure 3.5-1) was chosen because of its simple construction and minimal equipment requirements.

Figure 3.5-1

Site Constructed Full Body Harness



1 2 3 4

This harness is constructed of 20 feet of 1 or 2 inch webbing and can easily be put on a victim in either a standing or lying down.

Unit 3
Confined Space Rescue Equipment

Lesson 6: Victim Packaging and Removal

Confined Space Rescue Equipment

Patient removal devices

When selecting a patient removal device in a confined space environment, great care must be taken to ensure the device meets the needs of the particular situation.

There are a number of factors to take into consideration when selecting a device; including victim condition and injuries, internal configuration of the space and configuration of the egress route. It is not unusual for sacrifices to be made against one factor because of the requirements of another factor. An example would be using a device with less spinal immobilization because tight internal configurations require a more **bendable** device.

There are two types of devices: harness and stretcher types. Harness devices tend to be quicker and easier to use, are easier to get through tight spaces and around bends and are easy to transport. Some provide partial spinal immobilization (such as the LSP half-back™) while others provide none (such as a standard full body harness or wristlets). Stretcher devices are more bulky and, therefore, more difficult (if not impossible) to use in some spaces but they provide a much greater level of victim protection. Examples of commonly used stretcher devices include the basket type stretcher, SKED™, Miller board™ and Res-Q-Mate™.

Choosing the proper device must be based on the requirements of the rescue, equipment availability and the knowledge of the rescuer.

Securing victims in stretcher type devices

Each device has its own requirements with regard to the specific packaging procedures to follow. It is very important that you be trained in the use of the devices that your department utilizes.

If you are using any stretcher type device, it is important that the victim be secured within the stretcher in a manner that the weight of the victim will be supported. The method used to accomplish this will depend on the stretcher used and the condition of the victim. The most common method of supporting a victim in a stretcher is by using foot supports (Figure 3.6-1 and 3.6-2). This method is acceptable if there are no leg injuries which would preclude their use.

The method shown in Figure 3.6-1 is used in low angle and head up type evacuations. The method shown in Figure 3.6-2 is used where the stretcher will need to be brought up in a vertical position feet first. While this is the least desirable way to vertically evacuate a victim there are situations where it will be unavoidable.

Figure 3.6-1

Horizontal or Head Up Evacuations

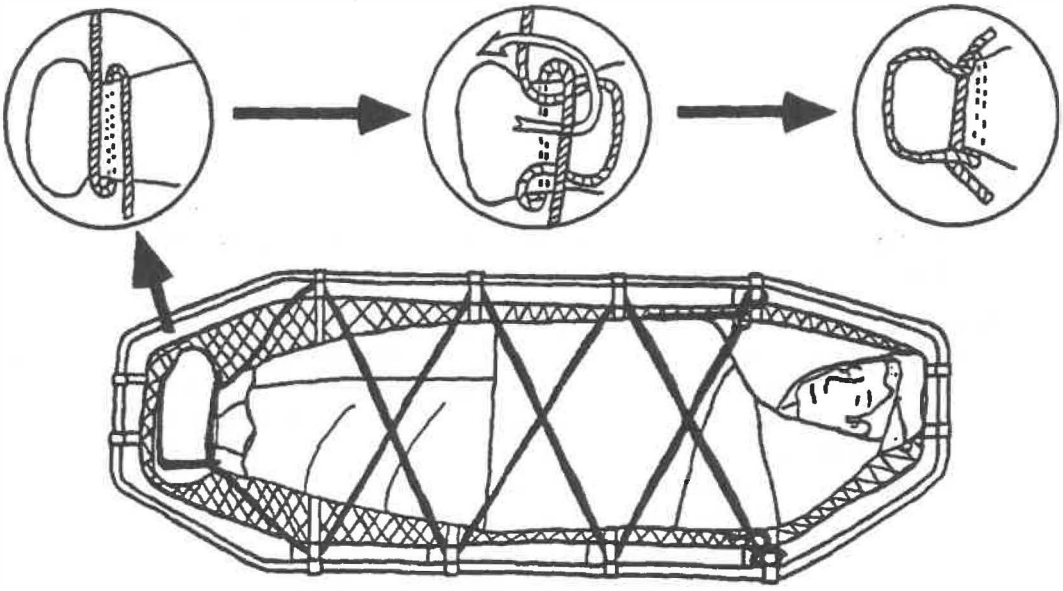
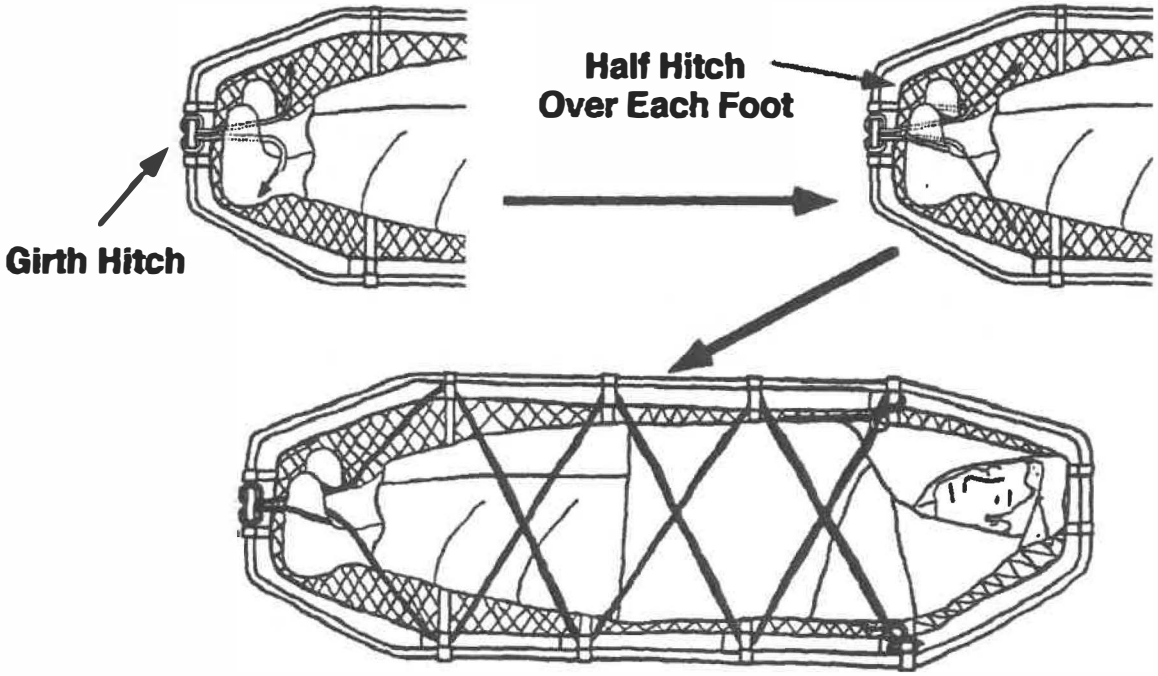


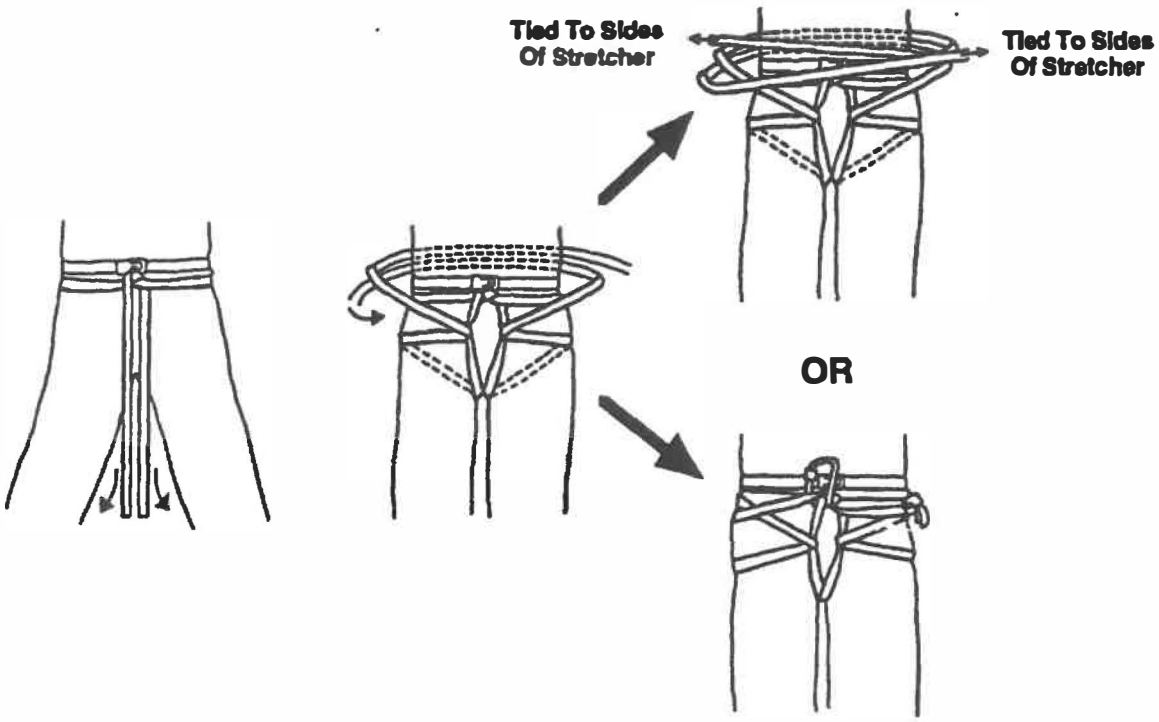
Figure 3.6-3

Horizontal, Head Up or Feet Up Evacuations



If the victim cannot be secured using foot supports (such as because of a leg injury), a harness support assembly (Figure 3.6-4) can be quickly fashioned from a 20 - 30 foot piece of webbing. This assembly will provide support in the hip area and reduce or eliminate pressure on the legs. As noted in the diagram, this harness can either be tied off to the sides of the stretcher or the ends can be tied together to form a seat harness. This method is also used as a secondary tie in to the stretcher and can be connected to the belay line for an additional safety.

Figure 3.6-4



When using a wire basket type stretcher for a head or feet first evacuation, attachment to the main and belay lines is accomplished in one of two possible ways: use of a manufactured stretcher spider or by weaving a rope (or webbing) around the stretcher rail. This is accomplished by tying a girth hitch on the rail at the foot (for a head first evacuation or at the head for a feet first evacuation) and weaving the rope around the rail. When the opposite end of the stretcher is reached the ends are tied togeather using a figure eight bend - join two ropes (or a water knot for webbing). This method is preferred to attachment to the rails because the stress is distributed around the entire stretcher instead of centered on one small area.

For any other type of packaging device, use the method and materials recommended by the manufacturer.