Confined Spaces

Module Purpose

This module focuses on the importance and severity of hazards in confined spaces. It covers the four major hazards involved in working in confined spaces, the responsibilities of on-site personnel, training requirements, and rescue requirements. While not a formal construction standard, the concepts and practices of the OSHA general industry standard 29 CFR 1910.146 apply to construction employers whose workers are performing construction work in a permit-required confined space at a general industry site.

Time

40 minutes (11:50 - 12:30 p.m.)
(A 50-minute lunch follows this module)

Objectives

Show slides 9.1 – 9.3.

Upon completion of this module, participants will be able to:

- Identify four categories of hazards that may be present when entering, working in and exiting confined spaces
- Describe examples of typical confined spaces found in road construction work sites
- Recognize the responsibilities and duties of personnel involved in confined space work areas
- Recognize the training and rescue requirements for personnel involved in supervising, monitoring, entering, and working in confined spaces
- Recognize the scope of OSHA General Industry Standard 1910.146 as it applies to the OSHA Construction Industry Standard 1926.21(b)(6)(i).

Materials and Resources	PowerPoint Slides: Module 9 Activities: Appendix 9-A

Module 9: Confined Spaces
Instructional Strategy and Course Content

Facilitator Notes	Lesson
Lecture  1. What a confined space? *Show Slides 9.4 – 9.5.* 	**1. What is a confined space?** A confined space is any enclosed or semi-enclosed space that has limited openings for entry and exit, and that does not have sufficient natural or mechanical ventilation. It is also a place that is not intended for continuous employee occupancy. Typical confined spaces in the roadway construction industry include: ▪ Manholes ▪ Sewers ▪ Vaults ▪ Pits ▪ Pumping Stations ▪ Tanks ▪ Tunnels ▪ Trenches
2. Why are confined spaces so dangerous? *Show slide 9.6.* 	**2. Why are confined spaces so dangerous?** Once a space has been identified as "confined," the hazards that may be present within the confined space must be identified. Confined space hazards can be grouped into the following four categories: ▪ Oxygen-deficient atmospheres ▪ Flammable atmospheres ▪ Toxic atmospheres ▪ Mechanical and physical hazards Every confined space must be evaluated for these four types of hazards. The three types of atmospheric hazards are often the most difficult to identify since they are normally invisible.
3. What makes the atmosphere become oxygen deficient? *Show Slides 9.7 – 9.9.* 	**3. What makes the atmosphere become *oxygen deficient*?** The normal atmosphere is composed of approximately 21% oxygen and 79% nitrogen. An atmosphere containing less than 19.5% oxygen is considered "oxygen-deficient". The oxygen level inside a confined space may be decreased as the result of either *consumption* or *displacement*. There are a number of processes which consume oxygen in a confined space: ▪ Oxygen is consumed during combustion of flammable materials, as in welding, cutting, or brazing. ▪ A more subtle consumption of oxygen occurs during bacterial action, as in the fermentation process.

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	▪ Oxygen can also be consumed during chemical reactions such as in the formation of rust on the exposed surfaces of a confined space. ▪ The number of people working in a confined space and the amount of physical activity can also influence oxygen consumption. ▪ Oxygen levels can also be reduced as the result of oxygen displacement by other gases. For example, if 100% nitrogen—a non-toxic, colorless, odorless gas—displaces oxygen in a confined space, it will cause immediate collapse and death to the worker if the confined space is not adequately ventilated before worker entry. Other examples of gases, which displace oxygen and have claimed lives in confined spaces, include carbon dioxide, argon, and helium.
4. Why do atmospheres become flammable? *Show Slides 9.10 – 9.12.* 	**4. Why do atmospheres become flammable?** Flammable atmospheres are generally the result of flammable gases, vapors, or dust mixed in certain concentrations with air. The hazard can also come from an oxygen-enriched atmosphere. ***Oxygen-enriched*** atmospheres are those atmospheres that contain an oxygen concentration greater than 22%. An oxygen-enriched atmosphere will cause flammable materials such as clothing and hair to burn violently when ignited. ***Combustible gases or vapors*** can accumulate within a confined space when there is inadequate ventilation. Gases that are heavier than air will accumulate in the lower levels of a confined space. Therefore, it is especially important that atmospheric tests be conducted near the bottom of all confined spaces. The work being conducted in a confined space can generate a flammable atmosphere. Work such as spray-painting, coating or the use of flammable solvents for cleaning can result in the formation of an explosive atmosphere. Welding or cutting with oxyacetylene equipment can also cause an explosion in a confined space and *should not be allowed* without a hot work permit. Oxygen and acetylene hoses may have small leaks that could generate an explosive atmosphere and, therefore, should be removed when not in use. The atmosphere must be tested continuously while any hot work is being conducted within the confined space.
5. How do atmospheres become toxic? *Show slide 9.13.* 	**5. How do atmospheres become toxic?** Atmospheres can become toxic from products that are stored in the space, work conducted in the space, or seepage from areas adjacent to the space.

Storage—When a product is stored in a confined space, the product can be absorbed by the walls and give off toxic vapors when removed or when cleaning the residual material. The product can also produce toxic vapors that will remain in the atmosphere due to poor ventilation.

Work in Space—Toxic atmospheres can be generated as the result of work being conducted inside the confined space. Examples: welding or brazing with metals capable of producing toxic vapors, painting, scraping, sanding, etc. Many of the solvents used for cleaning and/or degreasing produce highly toxic vapors.

Adjacent Areas—Toxic fumes produced by processes near the confined space may enter and accumulate in the confined space. For example, if the confined space is lower than the adjacent area and the toxic fume is heavier than air, the toxic fume may "settle" into the confined space.

6. What are the mechanical and physical hazards of confined spaces? *Show slide 9.14.*

6. What are the mechanical and physical hazards of confined spaces?

Problems such as rotating or moving mechanical parts or energy sources can create hazards within a confined space. All rotating or moving equipment such as pumps, process lines, electrical sources, etc., within a confined space must be identified.

Physical factors such as heat, cold, noise, vibration, and fatigue can contribute to accidents. These factors must be evaluated for all confined spaces.

Excavations could present the possibility of engulfment. Employees must be protected from cave-ins by sloping, benching, or shoring systems when the depth of the excavation is more than four feet, in accordance with 29 CFR 1926.652, as discussed in Module 8.

7. What are some examples of typical confined spaces found in road construction work? Show slides 9.15 – 9.20.

7. What are some examples of typical confined spaces found in road construction work?

Vaults—A variety of vaults are found on the construction job site. On various occasions, workers must enter these vaults to perform a number of functions. The restricted nature of vaults and their frequently below-grade location can create an assortment of safety and health problems.

For example, while working in an electrical vault, workers may be exposed to the build-up of explosive gases such as those used for heating (propane). Welding and soldering produce toxic fumes that are confined in the limited atmosphere.

Electrical shock is often encountered from power tools, line cords, etc. In many instances, such electrical shock results from failure to use an approved grounding system or the protection afforded by ground-fault circuit interrupters or low-voltage systems.

In some instances, purging agents such as nitrogen and argon may enter the vault from areas adjacent to it. These agents may displace the oxygen in the vault to the extent that it will asphyxiate workers almost immediately.

A hazard normally considered a problem associated with confined spaces is material or equipment that may fall into the vault or onto workers as they enter and leave the vault. Vibration could cause the materials on top of the vault to roll off and strike workers. If the manhole covers were removed, or if they were not installed in the first place, materials could fall into the vault, causing injury to the workers inside.

Manholes—Throughout roadway construction sites, manholes are commonplace. As means of entry into and exit from vaults, tanks, pits, and so forth, manholes perform a necessary function. However, these confined spaces may present serious hazards that could cause injuries and fatalities.

A variety of hazards are associated with manholes. A manhole could be a dangerous trap into which the worker could fall. Often covers are removed and not replaced, or else they are not provided in the first place.

Pipe Assemblies—One of the most frequently unrecognized types of confined spaces encountered throughout the construction site is the pipe assembly. Piping of sixteen to thirty-six inches in diameter is commonly used for a variety of purposes. For any number of reasons, workers will enter the pipe. Once inside, they are faced with potential oxygen-deficient atmospheres, often caused by purging with argon or another inert gas. Welding fumes generated by the worker in the pipe, or by other workers operating outside the pipe at either end, subject the worker to toxic atmospheres.

The generally restricted dimensions of the pipe provide little room for the workers to move about and gain a degree of comfort while performing their tasks. Once inside the pipe, communication is extremely difficult. In situations where the pipe bends, communication and extrication become even more difficult. Electrical shock is another problem to which the worker is exposed. Ungrounded tools and equipment or inadequate line cords are some of the causes of injuries. Also, heat within the pipe run may expose the worker to heat stress.

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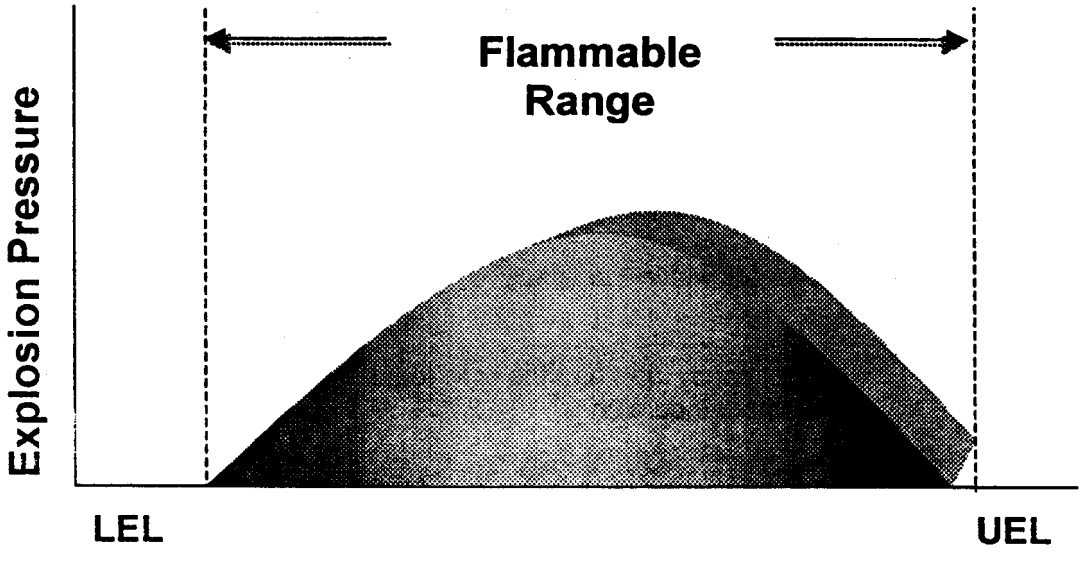
	Tanks—Tanks are another type of confined workspace commonly found in road construction. They are used for a variety of purposes, including the storage of water, chemicals, etc. Tanks require entry for cleaning and repairs. Ventilation is always a problem.
Show slide 9.21. 	Oxygen-deficient atmospheres, along with toxic and explosive atmospheres created by the substances stored in the tanks, present hazards to workers. Heat, another problem in tanks, may cause heat prostration, particularly on a hot day. Since electrical line cords are often taken into the tank, the hazard of electrical shock is always present. The nature of the tank's structure often dictates that workers must climb ladders to reach high places on the walls of the tank.

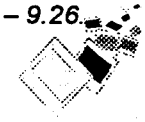
Figure 9-1

Upper and Lower Explosive Limits



Flammable (Explosive) Limits
When vapors of a flammable or combustible liquid are mixed with air in the proper proportions in the presence of a source of ignition, rapid combustion or an explosion can occur. The proper proportion is called the *flammable range* and is also often referred to as the *explosive range*. The flammable range includes all concentrations of flammable vapor or gas in air, in which a flash will occur or a flame will travel if the mixture is ignited. There is a minimum concentration of vapor or gas in air below which propagation of flame does not occur on contact with a source of ignition. There is also a maximum proportion of vapor in air above which propagation of flame does not occur. These boundary-line mixtures of vapor with air are known as the *lower* and *upper flammable* or *explosive limits* (LEL or UEL) respectively, and they are usually expressed in terms of percentage by volume of vapor in air. *See figure above.*

Facilitator Notes	Lesson
8. In addition to hazardous atmospheres, what should I always keep in mind when I face a confined space hazard? *Show slides 9.22 – 9.23.* 	**8. In addition to hazardous atmospheres, what should I always keep in mind when I face a confined space hazard?** ***Mechanical Problems***—If activation of equipment would cause injury, each piece of equipment should be manually isolated to prevent inadvertent activation before workers enter or while they work in a confined space. ***Communication Problems***—Communication between the worker inside the space and the standby person or foreman outside is of utmost importance. ***Entry and Exit***—Entry and exit access can be a good indicator of hazardous conditions as a physical limitation is directly related to the potential hazards of the confined space. The extent of precautions taken, and the standby equipment needed to maintain a safe work area, will be determined by the means of access and rescue. The following should be considered: ▪ Type of confined space to be entered ▪ Access to the entrance, including the number and size of openings ▪ Barriers within the space ▪ Occupancy load and the time requirement for exiting in event of fire or vapor incursion ▪ Time required to rescue injured workers. Everyone involved in a confined-space entry project has certain responsibilities and each requires a certain amount of training. It is very important that every individual is familiar with his/her responsibilities. The person(s) authorized to enter a confined space should receive training, at a minimum, in the following: ▪ Knowing the hazards that may be faced during entry, including the mode, signs or symptoms, and consequences of the exposure. ▪ Knowing who is the Competent Person (or whoever has responsibility at the job site for the company's Confined Space Program) to inspect the space, correct hazards, perform atmospheric testing, or effect rescue.
9. What rescue procedures are necessary? *Show slide 9.24.* 	**9. What rescue procedures are necessary?** Rescue procedures should be established before entry, and should be job site specific.

Facilitator Notes	Lesson
	Rescue procedures may require withdrawal of an injured or unconscious person. Careful planning must be given to the relationship between the internal structure, the exit opening, and the worker. If the worker is above the opening, the system must include a rescue arrangement operated from outside the confined space, if possible, by which the employee can be lowered and removed without injury. The rescue procedures should be practiced frequently enough to provide a level of proficiency that eliminates life-threatening rescue attempts and ensures an efficient and calm response to any emergency. Preplanning must also consider the use of offsite rescue and proximity to rescue/medical services. *Do not assume that the local fire and emergency response services are trained and qualified in confined space rescue procedures*. The training, equipment, and response times vary greatly by municipality. *It is the employer's responsibility to assure that adequate rescue personnel are available*.
10. What does OSHA require of employers regarding confined spaces? *Show slides 9.25 – 9.26.* 	**10. What does OSHA require of employers regarding confined spaces?** OSHA's General Industry Regulation, §1910.146 Permit-required confined spaces, contains requirements for practices and procedures to protect employees in general industry from the hazards of entry into permit-required confined spaces. *This regulation does not apply to construction.* OSHA's Construction Safety and Health Regulations Part 1926 do not contain a specific permit-required confined space regulation. Subpart C, §1926.21 Safety training and education specifies training for personnel who are required to enter confined spaces and defines a "confined or enclosed space." These requirements are shown below. ***§1926.21 Safety Training and Education***—(b)(6)(i) All employees required to enter into confined or enclosed spaces shall be instructed as to the nature of the hazards involved, the necessary precautions to be taken, and in the use of protective and emergency equipment required. The employer shall comply with any specific regulations that apply to work in dangerous or potentially dangerous areas. ii) For purposes of paragraph (b)(6)(i) of this section, "confined or enclosed space" means any space having a limited means of egress, which is subject to the accumulation of toxic or flammable contaminants or has an oxygen deficient atmosphere. Confined or enclosed spaces

Facilitator Notes	Lesson
	include, but are not limited to, storage tanks, process vessels, bins, boilers, ventilation or exhaust ducts, sewers, underground utility vaults, tunnels pipelines, and open top spaces more than 4 feet in depth such as pits, tubs, vaults, and vessels. OSHA's Construction Regulations also contain requirements dealing with confined space hazards in underground construction (Subpart S), underground electric transmission and distribution work (§1926.956), excavations (Subpart P), and welding and cutting (Subpart J). Further guidance may be obtained from American National Standard *ANSI Z117.1-1989, Safety Requirements for Confined Spaces*. This standard provides minimum safety requirements to be followed while entering, exiting and working in confined spaces at normal atmospheric pressure. This standard does not pertain to underground mining, tunneling, caisson work or other similar tasks that have independent established national consensus standards.
Activity  11. Identify the hazards in the slide. *Show slides 9.27 – 9.28; see Appendix 9-A.*	**11. Activity — Identify the Hazards**
12. Elicit additional questions and summarize. *Slide 9.29.*	**12. Question and summary period.**
13. Transition to prepare participants for Module 10. 	**13. Transition to Module 10.**

Identify the Hazard - Confined Spaces

Objective: This short activity will allow participants to view a slide and list the specific confined space hazards and recommended abatement methods. It is designed to serve as a discussion tool for the instructor to emphasize the importance and severity of confined space hazards.

Materials:
- Slide 9.28; Pictorial slide of a highway construction site that contains a confined space scenario.

Time: 10 minutes

Activity: Instruct the students to observe the pictorial slide and list the hazards they recognize on a piece of paper. (You must also ask them to identify ways to abate the hazards.) After reviewing the slide, ask the students to share their observations with the class.

Important points to identify are:
- What can cause an atmosphere to be oxygen deficient
- What can cause an atmosphere to become flammable
- What can cause an atmosphere to become toxic
- The physical hazards of engulfment (excavation collapse)
- Never work alone