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Emergency Responder Health and Safety Manual

Chapter 10

Confined Space Safety Program
(Permit-Required and Non-Permit-Required Spaces)

Final

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LIST OF ACRONYMS

ACGIH	American Conference of Governmental Industrial Hygienists
ANSI	American National Standards Institute
CFM	Cubic feet per minute
CFR	Code of Federal Regulations
CPR	Cardiopulmonary resuscitation
EPA	U.S. Environmental Protection Agency
ERT	Environmental Response Team
FRM	Field Readiness Module
HASP	Health and safety plan
HQ	Headquarters
HSPC	Health and Safety Program Contact
IDLH	Immediately dangerous to life or health
LFL	Lower flammable limit (also may be referred to as lower explosive limit or LEL)
LEV	Local exhaust ventilation
LPG	Liquefied petroleum gas
NFPA	National Fire Protection Association
NIOSH	National Institute of Occupational Safety and Health
OLEM	Office of Land and Emergency Management (formerly called Office of Solid Waste and Emergency Response (OSWER))
OSC	On-Scene Coordinator
OSHA	Occupational Safety and Health Administration (U.S. Department of Labor)
PAPR	Powered air-purifying respirator
PEL	OSHA's permissible exposure limit
PRCS	Permit-required confined space
PPE	Personal protective equipment
REL	NIOSH's recommended exposure limit
SCBA	Self-contained breathing apparatus
SDS	Safety data sheet
SHEMP	Safety, Health, and Environmental Management Program
STEL	Short-term exposure limit (15-minute TWA)
TLV	ACGIH's threshold limit value
TWA	Time-weighted average
VOC	Volatile organic compound

1.0 INTRODUCTION

1.1 Background Information and Regulatory Basis

A confined space is any enclosed area that is large enough for a person to enter, has limited or restricted means of entry or exit, and is not designed for continuous human occupancy. Examples of confined spaces include, but are not limited to, tanks (all types), tunnels, ventilation ducts, crawl spaces, subcellars beneath buildings, manholes, utility vaults, and trenches (see Text Box 1).

Confined spaces can be hazardous in many ways. For example, confined spaces limit a worker's ability to avoid contact with electricity, moving mechanical parts or machinery, unstable substances that can accumulate, or hazardous atmospheres that can displace breathable air.

Text Box 1
Examples of Confined Spaces

- Barges
- Boilers
- Bunkers
- Casings
- Cisterns
- Ditches, diked areas, excavations, and trenches (especially those greater than 4 feet in depth)
- Enclosures with bottom access
- Furnaces
- Hoppers
- Machinery housings (e.g., air handling units)
- Manholes
- Open pits
- Open-topped water and degreaser tanks
- Pipelines
- Pumping or lift stations
- Reaction or process vessels
- Septic tanks, sewage digesters, and sewers
- Shafts
- Silos
- Stacks and chimneys
- Steam condensers
- Storage bins and tanks
- Ship holds or compartments
- Truck and railroad tank cars
- Tunnels and mines
- Underground utility vaults and storage areas
- Vats
- Ventilation and exhaust ducts
- Vessels (process/reaction)
- Wells

Confined space hazards can cause serious injury and death. Atmospheric hazards (such as oxygen deficiency and toxic air contaminants) are the leading cause of death in confined spaces and more than 60 percent of confined space fatalities occur among would-be rescuers. **The major reasons for confined space fatalities include failure to recognize and control confined space hazards and establish rescue procedures prior to entry. Because of the hazards inherent in confined spaces, emergency responders must not enter confined spaces unless they are properly trained and equipped.**

Confined spaces are classified as either non-permit or permit-required confined spaces (PRCSs). A non-permit confined space contains no hazards; however, a non-permit space can develop into a PRCS if conditions change (e.g., the type of work performed in or near[1] the space changes or atmospheric conditions change). A PRCS may contain hazardous atmospheres or other safety and health hazards (see Text Box 2). A PRCS requires a written self-issued entry permit and an attendant prior to entry into the space.

The Occupational Safety and Health Administration (OSHA) PRCS standard (29 CFR 1910.146), OSHA Directive, CPL 02-00-100 (Application of the Permit-Required Confined Spaces (PRCS) standard), and EPA SHEM Guideline 29: Permit Required Confined Space were used to develop this chapter. In some cases, the requirements in this chapter exceed the minimum program requirements of the OSHA PRCS standard. Other references used to develop this chapter include ANSI Z117.1-2003: American National Standard—Safety Requirements for Confined Spaces; NIOSH Criteria for a Recommended Standard—Working in Confined Spaces; and CAL OSHA's 1998 Confined Space Guide—Is it Safe to Enter a Confined Space?

[1] "Near" is interpreted to mean in the immediate vicinity of the confined space.

Depending on the size and complexity of the emergency response, technical assistance may be obtained from EPA's OLEM special teams, skilled contractors, and/or OSHA.

1.2 Instructions for Users

This chapter addresses both permit-required and non-permit confined spaces. The procedures described in this chapter represent the **minimum requirements** that EPA must meet to minimize the hazards of working in confined spaces.

This chapter constitutes EPA's confined space safety program. **The customized version of this chapter will become the organization's OSHA-compliant Confined Space Safety Plan.** In addition to the organization's plan, site-specific confined space safety procedures must be developed and incorporated into the response site health and safety plan (HASP). The site-specific procedures (Section 3.3) must include the use of a **self-issued** (and canceled) PRCS entry permit (when appropriate).

This chapter must be implemented across all EPA regions, OLEM special teams, and Headquarters (HQ). This means that each EPA organization must adopt the minimum Agency requirements and management practices listed in this chapter and produce a customized version of the chapter that is reviewed/updated on an annual basis. Other organizations within EPA are also encouraged to implement this chapter.

Text Box 2
Confined Space Classification

Confined Space—an enclosed area that:

- Is large enough and so configured that a person can enter and perform assigned work.
- Has limited or restricted means for entry and exit (e.g., may require use of the hands or contortion of the body to get into or out of).
- Is not designed for continuous human occupancy.

Non-Permit Confined Space—a confined space that does not contain hazards.

Permit-Required Confined Space—a confined space with one or more of the following hazards:

- Contains or potentially contains a hazardous atmosphere.
- Contains a solid or liquid material that could engulf an entrant.
- Has an internal configuration that could trap or asphyxiate an entrant through inwardly converging walls or by a floor which slopes downward and tapers to a small cross-section (e.g., a hopper bottom or silo).
- Contains any other serious safety or health hazard.

To customize this chapter, users must (1) complete Appendix A and (2) insert organization-specific information into the blank spaces (highlighted in yellow) that appear throughout the chapter. If organizations advocate additional policies and procedures, they must document them in Appendix B. Tools have been developed to support this chapter, including a glossary (Appendix C). An implementation checklist is included in the "Forms" section of the manual's website as a tool to assist each organization in ensuring that they have met the requirements of this chapter.

See the Introduction to this manual for details on customizing and posting an organization's PRCS plan to the manual's website. The website also includes tools and resources that will be helpful to users, including downloadable forms, reference documents, and training.

2.0 ROLES AND RESPONSIBILITIES

This section identifies the roles and responsibilities of individual organizations, OSHA PRCS standard-specified positions, contractors, and host and controlling employers.

2.1 EPA Organizations

EPA organizations are responsible for implementing the confined space safety program elements outlined in this chapter. Each organization will achieve compliance with OSHA's PRCS standard by participating in the Agency-sponsored confined space safety training and customizing this chapter so that it becomes the organization's confined space safety plan.

When an EPA organization encounters a PRCS at a work site and entry is planned, all confined space safety requirements must be addressed in the site-specific HASP. The Onsite Safety Officer must ensure that site-specific procedures (such as the completion, issuance, and cancellation of the PRCS entry permit) are incorporated into the HASP and that all onsite personnel adhere to the procedures.

Health and Safety Program Contacts (HSPCs), Removal Managers, Safety, Health, and Environmental Management Program (SHEMP) Managers, On-Scene Coordinators (OSCs), Equipment Managers, and individual emergency responders have specific roles and responsibilities in implementing EPA's confined space safety program. Appendix A details the tasks that these employees must perform. During a response, an OSC often serves as the Onsite Safety Officer.

2.2 PRCS Positions

OSHA's PRCS standard requires several specific position titles for PRCS operations, including entry supervisors, authorized entrants, authorized attendants, air monitoring personnel, and rescue personnel.

2.2.1 Entry Supervisors

Entry supervisors determine if acceptable entry conditions are present at a PRCS, authorize entry, oversee entry operations, and terminate entry. An entry supervisor may also serve as an authorized attendant or entrant provided that he/she is trained and equipped for each role. The duties of an entry supervisor may be passed from one individual to another during an entry operation. Entry supervisors are responsible for:

- Knowing the hazards that may be encountered during entry, including information on the mode, symptoms, behavioral effects, and consequences of exposure.
- Verifying (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 are in place before signing the permit and allowing entry to begin.
- Terminating the entry and canceling the permit when the operations covered by the entry permit have been completed or whenever a condition that is not allowed under the entry permit arises in or near the PRCS.
- Verifying that rescue services are available and that the means for summoning them are operable.
- Removing unauthorized individuals who enter or who attempt to enter a PRCS during entry operations.
- Determining that entry operations remain consistent with the terms of the entry permit and that acceptable entry conditions are maintained (whenever responsibility for a PRCS operation is transferred and at intervals dictated by the hazards and operations performed within the space).

2.2.2 Authorized Entrants

Authorized entrants are individuals that have been formally authorized by their employer to enter a PRCS. Authorized entrants are responsible for:

- Knowing the hazards that may be encountered during entry, including information on the mode, symptoms, behavioral effects, and consequences of exposure.
- Properly using the required equipment and supplies including personal protective equipment (PPE).
- Communicating with the authorized attendant as necessary so the attendant can monitor entrant status and alert entrants of any need to evacuate the PRCS.
- Evacuating the PRCS and alerting the attendant whenever they recognize any warning sign or symptom of exposure to a dangerous situation or they detect a prohibited condition, or whenever the authorized attendant or entry supervisor orders evacuation or an evacuation alarm is activated.

2.2.3 Authorized Attendants

Authorized attendants monitor the entrants in one or more PRCSs, perform all the attendant duties specified in the PRCS procedures (HASP), and perform non-entry and entry rescue, as specified by the HASP, if trained and equipped for rescue operations and relieved by another attendant before attempting an entry rescue. Authorized attendants are responsible for:

- Knowing the hazards that may be encountered during entry, including information on the mode, symptoms, behavioral effects, and consequences of exposures.
- Maintaining an accurate count of authorized entrants in the PRCS (monitor the count continuously and ensure that the means used to identify entrants is accurate).
- Remaining outside the PRCS during entry operations until relieved by another attendant.
- Communicating with authorized entrants as necessary to monitor entrant status and to alert entrants of the need to evacuate the PRCS.
- Monitoring activities inside and outside the PRCS to determine if it is safe for entrants to remain in the PRCS.
- Ordering an immediate evacuation of the PRCS if they detect a prohibited condition, behavioral effects in an entrant from exposure to a PRCS hazard, or a situation outside the PRCS that could endanger the entrants, or if they cannot safely and effectively perform all of their attendant duties.
- Summoning rescue and other emergency services as soon as it is determined that authorized entrants may need assistance to escape from PRCS hazards.
- Taking action when unauthorized persons approach or enter a PRCS while entry is underway (warn that they must stay away from the PRCS or exit if they have entered the PRCS and inform authorized entrants and the entry supervisor if unauthorized persons have entered the PRCS).
- Performing no duties that might interfere with their primary duty to monitor and protect the authorized entrants.

2.2.4 Air Monitoring Personnel

Air monitoring personnel identify and evaluate the atmospheric hazards in confined spaces and verify acceptable conditions for entry. These individuals are responsible for:

- Selecting appropriate direct-reading equipment to evaluate the air quality in confined spaces.
- Using, maintaining, and calibrating air monitoring equipment in accordance with the manufacturer's requirements.
- Knowing and understanding equipment limitations.
- Documenting air monitoring and equipment calibration results.
- Knowing and understanding contaminant exposure limits (e.g., OSHA permissible exposure limits [PELs], ACGIH[2] threshold limit values [TLVs], and others).
- Evaluating air monitoring results in regard to the potential hazard and relevant occupational exposure limits.
- Communicating air monitoring results to affected individuals (e.g., the entry supervisor and authorized entrants).
- Specifying the conditions or precautions required for entry and changes in conditions that would require a re-evaluation of confined spaces.

Text Box 3
Multi-employer PRCS Entry

All employers who have employees in the PRCS are responsible for developing and implementing procedures to coordinate entry operations. Any one of the employers having employees enter the PRCS may have operational control over the PRCS during multi-employer entry. All parties (host employer, contractors, and other agencies) retain responsibility for the protection of their own employees even though all the employers have agreed to a specific PRCS controlling employer. **There should be absolutely no doubt, by any PRCS entrant, attendant, and entry supervisor, about who the controlling employer is and whose policy and PRCS procedures are to be followed!**

2.2.5 Rescue Personnel

Rescue personnel physically retrieve entrants from PRCSs and are responsible for:

- Being equipped for and proficient in performing the needed rescue services.
- Requesting and obtaining information on the hazards they may confront when called on to perform rescues.
- Maintaining current certification in first aid and cardiopulmonary resuscitation (CPR).
- Developing appropriate rescue plans and practicing rescue operations in the PRCSs from which rescue may be necessary with dummies, manikins, or actual persons.

2.3 Host and Controlling Employers

A host employer is an employer that "arranges" to have employees of another employer perform work that involves a PRCS. Host employer responsibilities are specified in Section 29 CFR 1910.146(c)(8) of the OSHA PRCS standard. When a PRCS operation involves multiple employers (e.g., EPA, contractors, and other agencies), one employer must have operational control over the PRCS. This employer is the

[2] ACGIH: American Conference of Governmental Industrial Hygienists.

controlling employer. The host employer and the controlling employer must be clearly designated. In most incidents involving PRCS operations, EPA will function as the host employer, but not the controlling employer of the space.

2.3.1 Multiple Employers

When a PRCS operation involves multiple employers, the Onsite Safety Officer or Entry Supervisor (or another designated person) is responsible for:

- Coordinating entry operations and **establishing a controlling employer** (Text Box 3).
- Informing all employers that no entry will be allowed unless all provisions and requirements of the OSHA PRCS standard are met **through compliance with written site-specific PRCS procedures (in the HASP) that EPA has reviewed and deemed to be acceptable.**
- Instructing other employers on the actual or potential hazards and other factors that make the space a PRCS and conveying any previous experiences of entry into that space. There must be a "common" PRCS pre-entry briefing, also known as a "tailgate briefing" or "shift briefing" attended by all authorized personnel independent of their employer (i.e., attendants, entrants, supervisors, air monitoring personnel, other). The pre-entry briefing must apprise all active participants of the precautions and procedures related to entry into and working around the PRCS. The requirement for a common pre-entry briefing does not preclude other independent briefings and/or training by individual employers. The common pre-entry briefing must be conducted on every shift and/or PRCS entry operation.
- Providing all participants actively involved in the PRCS operation (independent of their employer) with the following information incorporated in the site-specific HASP:
  - Safety Data Sheets (SDSs) or other hazard information on the contents, coatings or liners of the space, if applicable (e.g., underground concrete pipelines can be coated with an asphalt or epoxy material to protect, preserve, or restore the pipeline).
  - Potential atmospheric hazards.
  - Air monitoring data.
  - Residue(s) found or anticipated in the PRCS.
- Holding exit safety briefings with personnel at the conclusion of entry operations to discuss any hazards encountered during occupancy of the PRCS.

2.3.2 Offsite Rescue Services

When offsite (external) rescue service personnel are used (Section 3.11.2), the Onsite Safety Officer or Entry Supervisor (or another designated person) must inform the rescue service of the hazards they may encounter and allow the rescue service access to the PRCS so that appropriate rescue plans and practice rescue drills can be completed before entry operations are conducted in the PRCS.

3.0 EPA's CONFINED SPACE SAFETY PROGRAM

EPA's confined space safety program elements are addressed in Sections 3.1 through 3.15. As previously discussed, each EPA organization must customize these sections with organization-specific information. The customized version of this chapter is the organization's confined space safety plan (or PRCS plan).

3.1 Organization Policy on Confined Space Entry

EPA organizations may elect to prohibit their employees from entering confined spaces including PRCSs. Employees of these organizations may not serve as PRCS entry supervisors, approved entrants or attendants, or participate in PRCS rescue teams. These organizations must employ confined space expertise from outside sources. Organizations electing to prohibit their employees from confined spaces must still ensure that their emergency responders receive at least Confined Space Awareness training (see Section 3.14). Moreover, employees of these organizations must not issue/approve entry permits for PRCSs, cancel permits, or modify or manage PRCS operations.

Region 4 allows their employees to enter PRCSs on an as needed basis provided acceptable written site-specific PRCS procedures are included in the HASP. Employees in this organization must complete the necessary confined space safety training and be equipped with the required equipment prior to entry. This organization must complete a customized version of this chapter.

3.2 Assessing the Need for Site-Specific PRCS Procedures

All work sites must be evaluated to determine if they contain PRCSs. The Onsite Safety Officer (or another designated person) is responsible for conducting the site evaluation, explaining how it was conducted, and documenting the results. After the initial site evaluation, a list of all confined spaces (non-permit and PRCSs) must be included in the site-specific HASP. The HASP should be updated as new confined spaces are identified. A sample form to facilitate and document the confined space identification and hazard evaluation process is included in the "Forms" section of the manual's website. Completed forms must be retained in site files and it is recommended that EPA organizations also forward copies to the HSPC (or another designated person). For non-permit confined spaces, any conditions or precautions required for entry and changes in conditions that would require a re-evaluation of the confined space (and if necessary, reclassification as a PRCS) must be specified. Non-permit confined spaces must be periodically re-evaluated to ensure proper classification. Section 5 of *the Confined Space Identification and Hazard Evaluation Form* (see the "Forms" section of the manual's website) may be used to document any special requirements for non-permit confined space entry.

3.2.1 Prohibiting Entry

If entry is prohibited (i.e., no personnel will enter), the PRCS must be effectively barricaded and clearly identified with a sign(s). Effective control measures include permanently closing the space by bolting and locking the access, supplemented by training and posting danger signs to prevent entry. Examples of signs to control entry into PRCSs are included in Appendix D. One sign prohibits entry for all personnel and the second sign allows entry only for authorized personnel utilizing special hazard precautions. Both signs have spaces to insert the hazards and the name of the contact person. All PRCSs must be identified with a sign. Bilingual signs may be appropriate for some locations/responses.

When PRCS entry is prohibited, the Onsite Safety Officer (or another designated person) must cover this restriction in the safety briefing before each shift.

3.3 Written Site-Specific PRCS Procedures to Be Incorporated into the HASP

If emergency responders will enter PRCSs, they must adopt and follow the site-specific PRCS procedures in the HASP. These may be existing site-specific written procedures (developed by an EPA contractor or facility owner) reviewed and deemed acceptable by EPA prior to entry (and appended to EPA's HASP). For large scale responses where no existing procedures are available, EPA may enlist the services of the

ERT or OSHA (through the Incident Command System Liaison Officer) to develop written site-specific PRCS procedures for the HASP.

The HASP PRCS procedures must address the requirements of the OSHA PRCS standard, which are described in Appendix E. The Onsite Safety Officer (or another designated person) must ensure that the HASP includes:

- A list containing the location and identification of site-specific confined spaces (non-permit and PRCSs) and whether these spaces will be entered and by whom.
- Personnel in charge of the confined spaces (non-permit and permit).
- Measures for the prevention of unauthorized entry into site-specific PRCSs.
- Site-specific procedures necessary for safe PRCS operations.
- The duties and responsibilities of individuals involved in site-specific PRCS operations.
- Procedures for the identification and evaluation of site-specific hazards in confined spaces (including evaluation of the work to be performed) prior to entry.
- A site-specific system for the preparation, issuance, use, and cancellation of PRCS permits, including the closing off of the PRCSs.
- PPE and other specialized equipment (including proper use and maintenance) for safe entry into and rescue from the PRCSs.
- Atmospheric monitoring for acceptable conditions in PRCSs before and during operations.
- Training and onsite pre-entry briefings before each shift.
- Rescue options.
- At least one attendant outside the PRCS for the duration of PRCS operations.
- Site-specific emergency procedures for a single attendant monitoring multiple PRCSs (if applicable).
- Site-specific procedures for emergency summoning/rescue and the prevention of unauthorized personnel from attempting a PRCS rescue.
- Site-specific procedures and establishment of a controlling employer to coordinate PRCS operations when more than one employer (contractors or other agencies) is working simultaneously as an authorized entrant in a PRCS.
- Review of PRCS procedures (HASP) whenever circumstances indicate deficiencies, or at least annually, to identify weaknesses and make necessary revisions.

Pre-entry briefings (by shift) with all active participants (regardless of employer) are required prior to PRCS entry. The Onsite Safety Officer or Entry Supervisor (or another designated person) is responsible for providing and ensuring that emergency responders actively involved in PRCS operations attend pre-entry briefings. Discussion topics covered during the briefing and attendance must be documented. An attendance sheet or sign-in sheet may be used for this purpose (see the "Forms" section of the manual's website for a sample.) These forms must be completed by the Onsite Safety Officer or Entry Supervisor (or another designated person) and retained in site files.

Pre-entry briefings must address all of the information on the PRCS entry permit and any other site-specific information necessary for safe PRCS operations.

In all cases, employees must be told to immediately leave a confined space (PRCS or non-permit confined space) if hazards arise during entry. Confined spaces must always be reevaluated whenever there are changes in the use or configuration of the space or when hazards change or arise.

3.4 Confined Space Hazards

The following overview of confined space types and hazards was adapted from NIOSH's Criteria for a Recommended Standard: Working in Confined Spaces.

Confined spaces can be categorized generally as those with open tops and a depth that will restrict the natural movement of air, and enclosed spaces with very limited openings for entry. In either of these cases, the space may contain mechanical equipment with moving parts. Degreasers, pits, and certain types of storage tanks may be classified as open topped confined spaces that usually contain no moving parts. However, gases that are heavier than air (such as butane, propane, and other hydrocarbons) can remain in depressions in these vessels and be difficult to remove. Open topped water tanks that appear harmless can develop toxic atmospheres (e.g., hydrogen sulfide) from the vaporization of contaminated water. Other hazards can develop because of the work performed in the confined space or because corrosive residues can accelerate the decomposition of scaffolding supports and electrical components.

Confined spaces such as sewers, casings, tanks, silos, and vaults usually have limited access. The problems arising in these spaces are similar to those that occur in open topped confined spaces. However, the limited access increases the risk of injury. Gases that are heavier than air may lie in these types of spaces for hours or even days after the space has been opened. Gases that are lighter than air may also be trapped within an enclosed-type confined space, especially those with access from the bottom or side.

The most hazardous kind of confined space is the type that combines limited access and mechanical devices. All the hazards of open top and limited access confined spaces may be present together with the additional hazard of moving parts. Digesters and boilers usually contain power-driven equipment that, unless properly isolated, may be inadvertently activated after entry. Such equipment may also contain physical hazards that further complicate the work environment and the entry and exit process.

The hazards specific to a confined space are determined by (1) the material stored or used in the space (e.g., damp activated carbon in a filtration tank will absorb oxygen and create an oxygen deficient atmosphere); (2) the process or work taking place inside the space (e.g., the fermentation of molasses creates ethyl alcohol vapors and decreases the oxygen content of the atmosphere); and (3) the effects of the external environment (e.g., sewer systems that may be affected by high tides, heavier than air gases, or flash floods).

In general, confined space hazards can be separated into two main categories, physical hazards and hazardous atmospheres.

3.4.1 Physical Hazards

Physical hazards include engulfment, hazardous energy (e.g., activation of electrical or mechanical equipment, release of hazardous materials through lines connected with the confined space), falling objects, wet or slick surfaces, sharp and other abrasive surfaces, extremely hot or cold temperatures, excessive noise, vibration, radiation, and fatigue while working in the space.
Engulfment in loose material is a leading cause of death in confined spaces. Engulfment hazards are associated with loose materials that are stored, handled, or transferred in silos, hoppers, and storage bins such as ground grains, soybean meal or other meals, sand, gravel, cement, limestone, coal, and sawdust.

The behavior of these materials is unpredictable and burial and entrapment can occur in seconds. In some cases, material being drawn from the bottom of the storage container causes the surface to act like quicksand; the flow rate of materials becomes so great that escape is impossible.

An additional hazard can be created by a condition called "bridging." Bridging occurs when loose material clings to the sides of a container being emptied and creates a hollow space. The bridge of material over the space is unstable and can collapse without warning. Bridging is affected by the moisture content of the stored materials and the diameter of the storage container.

3.4.2 Hazardous Atmospheres

Among the most prevalent confined space hazards are hazardous atmospheres. Confined spaces may result in hazardous atmospheres that are immediately dangerous to life or health (IDLH). Atmospheric hazards include oxygen deficiency or enrichment, and flammable/explosive or toxic air contaminants. Hazardous and toxic confined space atmospheres are summarized in Table 1.

Table 1
Hazardous Atmospheres in Confined Spaces

Oxygen Deficient	Oxygen Enriched	Flammable/Explosive	Toxic
An atmosphere containing less than 19.5% oxygen by volume.	An atmosphere containing more than 23.5% oxygen by volume.	Flammable gas, vapor, or mist greater than 10% of its lower flammable limit (LFL). Airborne combustible dust at a concentration that meets or exceeds its LFL. [This concentration is approximated as a condition where the dust obscures vision at a distance of 5 feet or less.]	Atmospheric concentration of any substance in excess of its OSHA permissible exposure limit (PEL), ACGIH threshold limit value (TLV), or other occupational exposure limit.

Ionizing radiation (e.g., alpha and beta particles, gamma rays, X-rays, and other atomic particles) is a special case and may be a physical and/or atmospheric hazard. Ionizing radiation includes exposure to "penetrating" radiation (e.g., X-rays) as well as radioactive material dispersed in the air in the form of dusts, fumes, mists, other particulates, vapors, or gases.

3.5 Confined Space Air Monitoring

Air monitoring is required for evaluating the atmospheric hazards of a confined space and verifying acceptable conditions prior to and during entry. Representative air monitoring must be conducted to identify any IDLH condition, exposure over PELs or published exposure levels, exposure over a radioactive material's dose limits, and/or other dangerous atmospheric conditions. Air monitoring must be conducted with real-time direct-reading equipment of sufficient sensitivity and specificity to identify and evaluate any hazardous atmospheres that might exist or arise (see Text Box 4). Depending on the potential air contaminants that may be present, multiple types of equipment may be required. Air monitoring equipment must be used, calibrated, and maintained in accordance with the manufacturer's instructions. All individuals using air monitoring equipment must receive training on the equipment's use and limitations.

Air monitoring results (i.e., the actual values) must be documented on the *Confined Space Identification and Hazard Evaluation Form* and PRCS entry permit (see the "Forms" section of the manual's website).

Evaluation and interpretation of these data, and development of the entry procedures and acceptable entry conditions, must be done (or reviewed) by a technically qualified individual.

Text Box 4
Air Sampling Equipment for Confined Spaces

Portable real-time direct-reading equipment typically used to evaluate the atmosphere in confined spaces include: 1) single-gas or multigas continuous monitoring instruments and 2) colorimetric detector tubes. Other direct-reading portable instruments might include aerosol monitors, a portable gas chromatograph, radiation monitors, and a Drager chip measurement system.

1) Single-gas instruments are available for oxygen, flammable/combustible gases, and a variety of toxic air contaminants. Multigas instruments typically have sensors for both oxygen and flammable/combustible gases, and one or more toxic gases. Carbon monoxide and hydrogen sulfide are the most commonly used toxic gas sensors, but other toxic gas sensors available include ammonia, butane, carbon dioxide, chlorine, chlorine dioxide, ethylene, hydrogen, hydrogen chloride, hydrogen cyanide, methane, nitric oxide, nitrogen dioxide, phosphine, propane, sulfur dioxide, and volatile organic compounds.

Examples of single-gas and multigas manufacturers and equipment are:
- Drager PAC 3500, 5500, and 7000 single-gas monitors
- Drager X-am 7000 multigas detectors
- MSA Altair Pro single-gas detectors
- MSA Altair 5 multi-gas deluxe kits
- Industrial Scientific single-gas monitors
- Industrial Scientific MX6 iBrid multigas monitors
- Other single/multigas equipment manufacturers include: Sperian, RKI, BW Technologies, Honeywell, Scott

2) Colorimetric detector tubes are small glass filled tubes with chemically treated materials that undergo a color change when exposed to the contaminants they are designed to detect. They can be used for the analysis of several hundred specific contaminants and for broad range screening. Detector tubes are typically used in conjunction with a manually operated hand pump (piston or bellows).

Detector tube pump/tube manufacturers include:
- Drager Accuro and Accuro 2000 Gas Measurement Systems with Drager detector tubes (also Simultaneous Test Sets).
- MSA Deluxe Kwik-Draw Pump and MSA detector tubes.
- Gastec detector tube pump and tubes.
- Sensidyne Kitagawa detector tube pump (AP-20S) and tubes.

Acceptable entry conditions and the frequency of periodic monitoring of the space must be specified on the PRCS entry permit (Section 3.13 and the "Forms" section of the manual's website). The general results of air monitoring must be presented during the PRCS pre-entry briefings and before each shift.

3.5.1 Initial Evaluation Monitoring

The purpose of initial evaluation monitoring is to identify the atmospheric hazards present in a confined space. Initial evaluation monitoring should be conducted during the site evaluation to classify confined spaces identified during the evaluation as non-permit or PRCSs (Section 3.2). It might also be conducted immediately prior to a confined space entry. During the initial evaluation monitoring:

- Do not enter or lean over the space. Entry occurs as soon as any part of a person's body breaks the plane of an opening into the space.
- Monitor from outside the confined space using remote probes and sampling lines. If an initial entry into the space is required to evaluate the atmospheric hazards, the entry must be performed using a PRCS entry permit and attendant (Section 3.13).
- Attempt initial monitoring without disturbing the space, if possible. Monitor the air through a pick hole (e.g., pick holes in a manhole cover), vent hole, or some other opening. Where no openings exist, pry open the entrance cover (if applicable) on the downwind side of the space just enough to allow insertion of the probe. The purpose of this procedure is to determine if any lighter-than air gases have accumulated in the space. Monitoring prior to disturbing the space should approximate the "ambient" conditions.
- Turn off mechanical ventilation if it is being used. Testing with the ventilation off will closely represent the ambient atmosphere inside a confined space in the event of a ventilation system failure. Then turn the ventilation back on and retest the space to determine if the ventilation system is affecting the level of air contaminants.

3.5.2 Verification Monitoring

All potential hazardous air contaminants identified during the initial evaluation must be monitored using permit specified equipment (1) prior to entry, unless the initial evaluation monitoring is conducted immediately prior to entry, (2) prior to entry whenever confined space activities have stopped for a significant period of time including shift breaks, lunch, and overnight, and (3) during entry to ensure that contaminant concentrations are within the range of acceptable entry conditions specified on the PRCS entry permit. The requirement for verification monitoring prior to and during entry is critical because permit space atmospheres are dynamic and subject to change due to variables such as temperature, pressure, the physical characteristics of the atmospheric hazard(s), the variable efficiency of ventilation equipment and air delivery systems, and others.

3.5.3 Duration of Monitoring

Monitor continuously or periodically for as long as the space is occupied and as appropriate for the hazard involved to ensure that acceptable entry conditions are being maintained. Unless monitoring continuously, monitor for at least the minimum response time of the test equipment specified by the equipment manufacturer (i.e., you need to allow enough time for the air sample to reach the sensors in the equipment). Note that the configuration of the equipment may affect the response time and must be taken into consideration. For example, if a multigas detector is configured for remote air monitoring the response time will be slowed because it is connected to remote monitoring accessories (e.g., sampling pump, length of flexible tubing, probe). Consult the equipment operating manual or manufacturer for information regarding equipment response time.

3.5.4 Methods of Monitoring

Monitoring procedures may vary depending on the type of confined space being evaluated. Always monitor as much of the space's horizontal area as possible (i.e., within reach) and monitor several different vertical levels—top, middle, and bottom. Monitor where hazardous substances might leak or collect in the space (e.g., monitor adjacent to any pipes, ducts, conduits, or cables, below steel gratings or between rafters, and around all irregular interior surfaces).

3.5.4.1 Stratified Monitoring

Some gases are lighter (less dense) than air and some are heavier (Text Box 5). The lack of air movement in a confined space allows gases to collect at various levels (or stratify) depending on their densities relative to air. Therefore, periodically monitor all levels (top, middle, and bottom). **In confined spaces where long descents/ascents are required or where atmospheres may be stratified, monitoring must be conducted continuously or at intervals. If intervals are employed, monitoring at 4-foot vertical intervals in the direction of travel and to each side is recommended.**

Text Box 5
Monitor All Areas (Top, Middle, and Bottom) of a Confined Space Because Gases and Vapors Can Stratify

Methane (CH_4) is lighter (less dense) than air and will be found around the **top** of a confined space.

Methane's density = 0.554 (air = 1.00)

Carbon monoxide (CO) is similar in density to air and will be found near the **middle** of a confined space.

Carbon monoxide's density = 0.967 (air = 1.00)

Hydrogen sulfide (H_2S) is heavier (more dense) than air and will settle to the **bottom** of a confined space.

Hydrogen sulfide's density = 1.189 (air = 1.00)

3.5.4.2 Order of Monitoring

Oxygen must be monitored first, flammability second, and toxicity third, unless all are conducted simultaneously with a direct-reading multigas monitor. Oxygen is monitored first because most flammable gas sensors are oxygen dependent and may not provide reliable readings in oxygen deficient atmospheres. Flammable gases are monitored second because the potential severity of an adverse outcome (e.g., fire, explosion) is more immediate and life threatening, in most cases, than exposure to toxic gases or vapors. Monitoring for toxic gases and vapors (including ionizing radiation) is usually performed last. If several toxic gases or vapors are potentially present, more than one type of direct-reading instrument may be needed to evaluate the space.

3.5.5 Equipment Calibration

Air monitoring with direct-reading equipment must be conducted only after the equipment has been calibrated in accordance with the manufacturers' requirements before each day's work. Depending on equipment usage, more frequent calibration may be necessary to ensure reliability. At a minimum, a functional check (or equipment self-test, if equipped) must be conducted prior to each day's use. Equipment must be zeroed in a clean environment (e.g., an office, outdoors, etc.).

For direct-reading colorimetric detector tube systems, pump volume capacity and leakage must be verified and tested according to the manufacturers' instructions. Detector tubes must not be used past their posted shelf-life date.

Equipment checks and calibration must be documented. The "Forms" section of the manual's website contains sample forms that can be used for this purpose.

3.5.6 Equipment Limitations

To evaluate the atmosphere, air monitoring personnel must know and understand the limitations of the equipment. For example, some equipment can give inaccurate test results if the temperature or humidity is too high or low, or if the air contains certain interfering chemicals. Consult the manufacturer's instructions for proper operating procedures and equipment limitations. Common limiting and/or error introducing factors associated with direct-reading air monitoring equipment include one or more of the following:

- Oxygen concentration
- Warm up time
- Lag time when using remote monitoring methods (probes, extension tubes, and lines)
- Catalyst poisons and/or interfering chemicals
- Conversion factors and response curves to convert readings for non-calibrant gases
- Temperature and/or humidity
- Electromagnetic/radiofrequency interferences (EMI/RFI)
- Battery power
- Out-of-date colorimetric detector tubes and/or pump leakage
- Lack of user knowledge, experience, and/or failure to calibrate properly

3.6 Minimizing Confined Space Hazards

Confined spaces can contain different types of physical and atmospheric hazards. Prior to entry, appropriate protective measures must be taken to ensure the safety of workers. Any conditions making it unsafe to remove confined space entrance covers must be eliminated before the covers are removed (if applicable) and authorized entrants must be protected from external hazards (e.g., from objects falling into the space) by guarding confined space openings with temporary barriers.

Text Box 6
Control versus Elimination

For the purposes of the OSHA PRCS standard, a hazard is controlled when the conditions which caused the hazard still exist in the PRCS but they are being continuously managed so the hazard cannot reoccur. Elimination means the conditions which caused the hazard no longer exist in the PRCS.

Confined space hazard control is achieved through the use of engineering controls, work practices, and/or the use of PPE. Engineering controls (such as mechanical ventilation) are the preferred method of hazard control and every effort must be made to implement effective engineering controls. The measures taken will depend on the nature of the hazards and whether the hazards will be eliminated from the space or controlled during entry (Text Box 6). When engineering and work practice controls are not feasible or insufficient, it may be necessary to protect workers with PPE (Section 3.6.4).

Assignment of hazard controls must be designated on the PRCS entry permit and discussed during the pre-entry briefings before each shift (Section 3.3, Section 3.13, and the "Forms" section of the manual's website). Hazard control measures are discussed below.

3.6.1 Ventilation

Ventilation includes mechanical ventilation (powered general dilution and local exhaust ventilation) and natural ventilation. Natural ventilation is the non-powered movement of outdoor air into a space through openings or by infiltration and is typically used for **non-permit** space entry.

General dilution ventilation flushes the atmosphere by supplying fresh air or exhausting large volumes of potentially contaminated air. Because this system does not reduce the amount (mass) of contaminants released, it is not recommended for highly toxic atmospheres. General ventilation is the best way to provide fresh air to a confined space or to control low concentrations of contaminants that are not highly

toxic. Use general ventilation when contaminants are widely dispersed or for confined spaces where local exhaust ventilation (LEV) may be difficult or impractical to install (such as a long underground pipeline or sewer). General ventilation may improve worker comfort in hot climates.

LEV captures and removes air contaminants at the source and is the best way to control flammable and toxic materials generated at a single location within a confined space. Use LEV for hot work (e.g., welding), cleaning with solvents, or other "localized" contaminant-producing activities, and position LEV ducts close to the source of the air contaminants. A general ventilation system can be used in conjunction with LEV in certain circumstances. LEV may not be appropriate for some spaces due to the location or shape of the space and/or if contaminants are widely dispersed. If LEV cannot be used, use a general ventilation system to supply or exhaust air out of the space.

Prior to entry, emergency responders must mechanically ventilate PRCSs until air monitoring results are within acceptable limits (Section 3.5 and Table 1) and provide continuous ventilation during entry until all personnel have left the space. **(Note that purging and ventilating does not preclude the requirement for air monitoring.)** The ventilating method and equipment chosen will depend on various factors such as the:

- Design of the confined space (e.g., size/volume/location of the space, number and size of the openings, distribution of air within the space).
- Output capacity of the ventilating device(s).
- Source(s) of supply/makeup/replacement air.
- Potential hazards (e.g., flammable or corrosive atmosphere; radioactive particles).
- Work to be performed (e.g., hot work, cleaning).
- Number of people (e.g., a minimum of 200 cubic feet of fresh air per minute per employee).
- Weather conditions (e.g., heater fan when supply air is below a productive working temperature).

Specifications for the ventilation equipment required to control atmospheric hazards are required and must be indicated on the PRCS entry permit.

Emergency responders must ensure that the ventilation air does not create an additional hazard from recirculation of contaminants, improper arrangement of the inlet duct, or the substitution of anything other than fresh air (Text Box_7). **The terms air and oxygen are not synonymous.** The use of oxygen in place of fresh air for ventilation will expand the limits of flammability of combustible materials and significantly increase the hazards of fire and explosion.

Text Box 7
What Is Fresh Air?

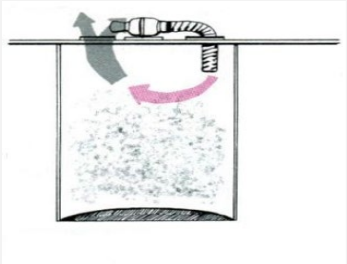
Fresh air is air that is free of contaminants and contains 20.9% oxygen, 78.1% nitrogen, and 1% argon with small amounts of various other gases.

Guidelines and additional tips for safely ventilating a confined space are listed below and in Appendix F:

- Exhaust toxic or flammable air contaminants and supply fresh air when the space is oxygen-deficient.
- Ventilate with clean, fresh air. Pure oxygen must **never** be used for ventilation purposes, comfort cooling, blowing dust or dirt from clothing, or for cleaning the work area.
- Monitor the air before entry to confirm that the ventilation has been successful and that the space is safe for entry.

- Continue the ventilation as long as the work in progress can make the air unsafe (e.g., hot work, painting, using solvents, abrasive blasting, etc.) or as long as the space is occupied.
- Monitor the air periodically (or continuously) to ensure that the ventilation is keeping the space safe.
- Keep ducts short and straight (to the extent possible) with no sharp bends. Secure ductwork if possible to prevent slip, trip, and fall hazards.
- Select a fan with the capacity to quickly replace the volume of air within the space.
- Locate the supply air fan intake in an area that will provide only clean, fresh air (e.g., upwind of the confined space entry with the inlet of the fan facing into the wind and out of the path of the purged air escaping from the space or any flammable or toxic materials that could be introduced into the space). See Text Box 8.

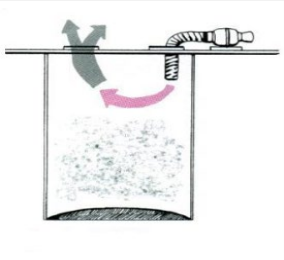
Text Box 8
Avoid Recirculation of Contaminated Exhaust Air Back into the Confined Space



Recirculation occurs when a supply air fan captures and reintroduces contaminated air that is exhausted or escaping from the space. Prevent recirculation by properly locating supply air fans and/or using additional ductwork to protect the supply air from the exhaust stream. *(Illustration obtained from the Confined Space Ventilation Handbook and used with permission from Coastal Training Technologies Corporation.)*

- Purge the supply air duct for a brief period of time before lowering it into the space.
- Ensure that supply air circulates throughout the space. Position the supply air duct at least 1 foot below the ceiling and at least 2 feet above the floor of the space. For side entry confined spaces, lay the duct on the floor of the space with the end at least 2 feet from the far wall.
- Arrange exhaust fans so that contaminated air discharged from the space does not present a hazard to personnel or equipment (exhaust air should be considered hazardous) and cannot be drawn back into the space. Locate the outlet where air currents will disperse the exhaust quickly. If the exhaust could be flammable, eliminate all sources of ignition from the area.
- Ground and bond equipment and use intrinsically safe fans when moving flammable atmospheres.
- **Avoid recirculation and short-circuiting air flow problems** by (1) using equipment with adequate power that is properly configured (e.g., to ventilate a large space or move air long distances a series of fans may be required); (2) safely locating fresh air inlets and exhaust outlets; and (3) using ductwork effectively (Text Box 8, Text Box 9, and Appendix F).

Text Box 9
Avoid Short-Circuiting the Air Flow



Short-circuiting occurs when fresh supply air moves directly from the confined space inlet to the exhaust outlet, without circulating through the other areas of the space. Prevent short-circuiting by using a fan that has enough power to blow air into the entire space and/or by using longer ductwork to direct the fresh air where it needs to go. *(Illustration obtained from the Confined Space Ventilation Handbook and used with permission from Coastal Training Technologies Corporation.)*

Ventilation alone cannot reduce some atmospheric hazards to safe levels and may be inappropriate under certain circumstances such as the presence of significant bird or rodent droppings; friable or loose asbestos; gas, vapor, or dust concentrations above the upper flammable limit; etc. When ventilation is not possible or cannot completely eliminate the

atmospheric hazards in a confined space, Air Monitoring Personnel, the Onsite Safety Officer, or Entry Supervisor (or another designated person) must specify other protective measures or methods (e.g., PPE, inerting) to control air contaminants and protect the entrants or determine if the PRCS should be entered under these conditions.

3.6.2 Lockout/Tagout

Specific procedures must be developed and implemented for each confined space where the unexpected energization, start-up, or release of stored energy could endanger the entrants (Text Box 10). Lockout/tagout procedures consist of securing, relieving, disconnecting, and/or restraining hazardous energy sources before entry. SHEM Guideline 30 (Electrical Safety and Energy Hazard Control) and applicable OSHA standards (29 CFR 1910.147 [The Control of Hazardous Energy—Lockout/Tagout]; 29 CFR 1910.333 [Electrical—Selection and Use of Work Practices]; and 29 CFR 1926.417 [Electrical—Lockout and Tagging of Circuits] must be used to develop lockout/tagout procedures for confined space entry operations. Specific information on lockout/tagout must be addressed in the PRCS pre-entry briefing before each shift.

Text Box 10
Types of Energy Sources

- Electrical
- Mechanical
- Hydraulic
- Pneumatic (air)
- Chemical
- Thermal (e.g., steam)
- Radioactive
- Gravity (falling objects)

3.6.2.1 Isolation

Isolation is an energy control technique used in lockout/tagout programs. Isolation is the process whereby a PRCS is removed from service and completely protected against the release of energy and material into the space. Standard isolation techniques include: blanking and blinding; misaligning or removing sections of lines, pipes, or ducts; a double block and bleed system; lockout or tagout of all sources of energy; and blocking or disconnecting all mechanical linkages (Text Box 11).

Text Box 11
Standard Isolation Methods for Confined Spaces Include One or More of the Following:

- **Blanking or blinding** is 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 is capable of withstanding the maximum pressure of the pipe, line, or duct with no leakage beyond the plate. It involves installing a blank between flanges with a leak-proof gasket at a point in the conducting line as close to the confined space as possible. The blank or blind must be marked identifying its purpose.

- **Line breaking or misalignment** is the intentional and physical disconnection of a pipe, line, or duct. Additional protection is obtained by misaligning or removing a section of the pipe, line, or duct. When hazardous residues could remain downstream from the disconnecting point, the line must be purged and atmospheric testing conducted.

- **Double block and bleed** is 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.

3.6.3 Work Practices

Work practice controls are procedures that reduce the likelihood of exposure to a hazard (or a hazardous situation) such as written safety policies and rules, supervision, and training and information. Before entering a confined space, emergency responders must review and adhere to the site-specific work procedures for safe entry and emergency exit. These procedures must be compiled by the Onsite Safety Officer or Entry Supervisor (or another designated person) and specified on the PRCS entry permit or other documentation for non-permit spaces.

3.6.4 Personal Protective Equipment

Appropriate PPE must be provided and worn when engineering and work practice controls do not adequately protect emergency responders. For example, if continuous ventilation reduces the atmospheric hazard to acceptable levels (i.e., controls the hazard during entry) but failure of the ventilation would create a life-threatening situation (e.g., IDLH conditions), then appropriate PPE (Level A or B) must be required for entry.

PPE must be selected, used, and maintained in accordance with the manufacturer's requirements and the requirements listed in the Respiratory Protection Program chapter and the Personal Protective Equipment chapter of this manual. PPE requirements must be specified on the PRCS entry permit and discussed in pre-entry briefings before each shift.

3.7 Specialized Equipment and Supplies

Specialized equipment, tools, and supplies required for safe PRCS operations must be provided to emergency responders, specified on the PRCS permit, and discussed in PRCS pre-entry briefings before each shift. This equipment may include direct-reading air monitoring equipment and calibration supplies, ventilating equipment (portable fans and ductwork), communications equipment (radios), portable lighting, barriers and shields, ladders, fall protection, rescue and emergency equipment, and any other equipment necessary for safe entry into and rescue from permit spaces.

When selecting equipment, tools, and supplies for PRCS operations, hazardous (classified) locations may be a factor. Classified locations include locations where ignitable concentrations of flammable gases and vapors, combustible dust, or other easily ignitable fibers or particles may occur. In these spaces, equipment and associated wiring that is approved as intrinsically safe (see Appendix C for a definition of the term intrinsically safe) for the classified location must be used. OSHA regulations pertaining to classified locations must be reviewed prior to equipment selection. These regulations include 29 CFR 1926.407 and 1926.449 for the construction industry and 29 CFR 1910.307 and 1910.399 for general industry.

The Onsite Safety Officer (or another designated person) must specify all of the appropriate equipment and supplies (including PPE) required for PRCS operations on the entry permit. To ensure that the required equipment and supplies are available and accessible to emergency responders, the following must be completed:

- The SHEMP Manager (or another designated person) and the HSPC (or another designated person) must determine the equipment and supplies (including PPE) that are needed to protect employees from confined space hazards and ensure the Equipment Manager (or another designated person) maintains a proper supply of equipment and issues all appropriate equipment for field bags and/or vehicles.
- The Removal Manager (or another designated person) must ensure that adequate resources are available.
- Emergency responders must report any equipment shortages, problems, malfunctions, etc. to the Onsite Safety Officer, HSPC, or Equipment Manager (or another designated person).

3.8 Communication

Communication methods and equipment to maintain contact between the attendant and entrants must be specified on the PRCS permit and discussed during PRCS pre-entry briefings before each shift. The OSHA PRCS standard requires employers to determine the type of communication system necessary for the PRCS being considered. Depending on the conditions existing in the PRCS, communication can be achieved in a number of ways including visual observation, voice communication (Text Box 12), hand signals, use of a signal line (rope tugging), telephones, and other portable electronic voice communication equipment.

Portable powered communication equipment for confined space operations typically includes two-way radios (wireless), cable connected intercom systems (wired or hard line), and hybrid systems. Radios are extremely effective outside confined spaces when used by attendants to maintain contact with entrants, or to call for help in the event of a problem. However, radios might not provide continuous communication in certain types of spaces because radio signals do not readily penetrate metal or concrete with rebar (resulting in messages that are garbled or not received). Radios may be best for short range or line of sight applications. For continuous reliable communication, hard line systems may be the best choice.

Text Box 12
Noise and PRCS Communications

In a confined space, noise is often intensified and may disrupt verbal communications between workers inside the space and the emergency standby person on the exterior of the space.

Continuous voice communication between the attendant and entrants allows for closer teamwork, the ability to monitor and assess the status of entrants on an ongoing basis, a reduced level of fear among entrants (more at ease, reduced stress and anxiety, less prone to feelings of claustrophobia and panic), and increased job efficiency (entrants work better and faster, and are less prone to mistakes and accidents).

Prior to selecting a communication system, a variety of issues must be considered including equipment durability; the use of communication equipment while wearing respirators (e.g., self-contained breathing apparatus or supplied air respirators), fall protection and other PPE (e.g., difficulties operating radio switches and dials with a gloved hand); working in a noisy or low light environment; battery maintenance; intrinsic safety; and others. For PRCS work, it is recommended that only intrinsically safe communication systems be used.

3.9 Illumination

Confined space illumination must be sufficient to support a safe and effective work place. Matched or open-flame devices must not be used as sources of illumination. In the absence of lighting, suitable portable (battery operated) lamps may be used that are appropriate for the suspect atmosphere. Portable lighting used in potentially hazardous (classified) locations must be intrinsically safe, approved or safe for the hazardous location, and not exceed 12 volts (open circuit). Slip, trip, and fall accidents may be indicators of insufficient lighting.

For temporary lighting:[3]

- Ensure that guards are in place over exposed light bulbs.
- Use heavy-duty flexible electric cords with grounded connections.

[3] Source: SHEM Guideline 30 (Electrical Safety and Energy Hazard Control).

- Maintain electric cord insulation in a safe condition.
- Keep cords clear of walking and working surfaces to prevent cord damage and slip/trip/fall hazards.
- Ground non-current-carrying metal parts of lighting fixtures.
- Use ground-fault circuit interrupters (GFCI) for work in wet areas or on conductive surfaces and for portable lighting.
- Use explosion-proof fixtures if flammable gases, vapors, or liquids; combustible dusts; or ignitable fibers or other airborne particulate matter are present.

3.10 Hot Work Permits

Hot work is any work that produces arcs, sparks, flames, heat, or other sources of ignition such as brazing, burning, flame heating, riveting, torch cutting, and welding. Hot work must not be performed in or near a confined space until a hot work permit is issued by the Onsite Safety Officer or Entry Supervisor (or another designated person). The hot work permit may be a separate permit or incorporated into the requirements of the PRCS entry permit (see the "Forms" section of the manual's website). Hot work permits must be appended to the HASP. Any PRCS hot work must be an element of the pre-entry briefing before each shift.

General safety precautions for hot work in confined spaces include:

- Position fire extinguishing equipment, appropriate for the type of fire hazard present, in the immediate work area and ensure that it is ready for instant use.
- Brief workers on the use of fire extinguishing equipment.
- Provide a fire watch if the potential for fire is significant (Text Box 13).
- Remove or protect combustible materials within 35 feet of the hot work.
- Ventilate all welding and cutting operations, with LEV where possible, to prevent the accumulation of airborne contaminants. Other safety precautions associated with welding and cutting operations in confined spaces are summarized in Table 2.
- Leave gas cylinders and welding machines outside confined spaces.
- Strip all toxic/flammable surface coatings at a distance of at least 4 inches from the area of heat application.

Text Box 13
Fire Watches

Fire watches must be provided in locations where other than a minor fire can develop, and when:

- Combustible materials, in confined space construction or contents, are located closer than 35 feet to the hot work operation.
- Combustible materials are located more than 35 feet away from the hot work operation but could be easily ignited by sparks.
- Wall or floor openings within 35 feet expose combustible materials in adjacent areas.
- Combustible materials are located on the opposite side of a metal wall, partition, ceiling, or roof where hot work is being conducted.

If required, a fire watch must be (1) provided during the hot work operation **and 30 minutes following completion of the operation**; (2) supplied with an appropriate fire extinguisher(s); and (3) trained in the proper use of the extinguishing equipment, fire reporting procedures, and emergency rescue procedures. Fire watches remain outside of the confined space and are in communication with those working inside. Additional fire watches may be required to observe areas that are hidden from the view of a single fire watch (e.g., the other side of metal partitions, walls, or ceilings).

Table 2
Safety Precautions When Welding or Cutting in Confined Spaces Is Stopped for a Significant Period of Time (e.g., overnight, lunch, shift break)

If Arc Welding:	*If Gas Welding or Cutting:*
• Remove all electrodes from their holders. • Place the holders where accidental contact cannot occur. • Disconnect the welding machine from its power source.	• Close the torch valve. • Shut off the gas supply outside the space. • Place valve protection caps on compressed gas cylinders, if equipped. • Remove the torch and hose from the space; and • Immediately remove open-end fuel gas and oxygen hoses from the space after disconnecting them from the torch or other gas-consuming device.

Additional safety and health requirements for hot work in confined spaces may be found in the OSHA regulations for welding and cutting: 29 CFR 1910.252 (General Requirements for Welding, Cutting, and Brazing); 29 CFR 1926.352 (Fire Prevention for Welding and Cutting); 29 CFR 1926.353 (Ventilation and Protection in Welding, Cutting, and Heating); and 29 CFR 1926.354 (Welding, Cutting, and Heating in Way of Preservative Coatings).

3.11 Rescue

Inadequate or spontaneous reaction instead of well planned and executed rescue procedures has led to multiple fatalities in confined spaces. The details of rescue operations must be thoroughly planned and understood by PRCS participants and members of the rescue team in advance of PRCS entry. Rescue procedures must be specified on the PRCS permit and must always be discussed at the PRCS pre-entry briefing before each shift.

3.11.1 Rescue Options—Self-Rescue, Non-Entry Rescue, or Entry Rescue

Each PRCS must be reviewed to determine whether to employ self-rescue, non-entry rescue, or entry rescue methods (Text Box 14). This decision will depend on the size and configuration of the space; the hazards likely to be encountered, including the presence of entanglement and obstruction hazards; whether the space requires a vertical or horizontal rescue; anchor placement; and the body size of entering personnel. The rescue decisions must be documented on the *Confined Space Identification and Hazard Evaluation Form* and the PRCS entry permit, which are appended to the HASP (see the "Forms" section of the manual's website).

Text Box 14
Preferred Hierarchy of Rescue Options

1. Self-rescue
2. Non-entry (external) rescue
3. Entry rescue

Self-rescue (Text Box 15) is always the preferred approach when entrants are:

- Alert and conscious.
- Able to recognize their own symptoms of exposure to a hazardous atmosphere or when unacceptable entry conditions occur.
- Physically able to evacuate the space unaided and as quickly as possible.

Text Box 15
What Is Self-Rescue?

Self-rescue is to escape **unaided** from a confined space.

- Able to alert other workers of impending dangers.
- Not endangering other personnel.

When self-rescue is not possible, non-entry (external) rescue with retrieval systems or methods is the second preferred option and MUST be used whenever an authorized person enters a PRCS, unless the retrieval equipment increases the overall risk of entry or would not be effective in removing the entrant. Non-entry rescue employs a system of harnesses and lines (or other retrieval systems/aids) on the authorized entrant so the worker can be extracted by rescuers from outside the space (without exposing the rescuers to the PRCS hazards). Each authorized entrant must use a chest or full body harness, with a retrieval line attached at the center of the entrant's back near shoulder level or above the entrant's head. Wristlets may be used in lieu of a chest or full body harness if the use of a chest or full body harness is infeasible or creates a greater hazard and the wristlets are the safest and most effective alternative.

Retrieval lines must be attached to a mechanical lifting device or fixed anchor (Text Box 16) outside the PRCS. Mechanical lifting devices must be manually operated, have a mechanical advantage of at least four to one, and the capacity to lift entrants including any attached equipment and tools. Mechanical devices must be available to retrieve personnel from vertical type PRCSs more than 5 feet deep.

Text Box 16
What Is an Anchor?

An anchor is a single, structural component used either alone or in combination with other components to create an anchor system capable of sustaining the load on the rope system used for rescue.

Source: NFPA 1670 (Standard on Operations and Training for Technical Search and Rescue Incidents)

Life safety rope and system components used to support personnel during rescue operations or training exercises must meet the requirements of NFPA 1983 (Standard on Life Safety Rope and Equipment for Emergency Services).

If non-entry rescue is employed, the Onsite Safety Officer or Entry Supervisor (or another designated person) must ensure that appropriate equipment is available and that rescue personnel are proficient in the use of the equipment. Authorized attendants may perform non-entry and entry PRCS rescues (as specified by the employer's rescue procedures) provided they have been trained and equipped for rescue operations and relieved by another attendant if entry rescue is necessary.

In situations where the configuration of the space or other factors prevent the removal of workers with retrieval systems, entry rescue may be required. Entry rescue involves entering the confined space to retrieve the incapacitated entrants and/or provide emergency first aid, CPR, and breathing air, if needed. Entry rescue plans and arrangements must be developed ahead of time for PRCSs where non-entry rescue is inappropriate. **Under no circumstances must unauthorized individuals be allowed to enter a confined space during an emergency to attempt a rescue. Over 60 percent of PRCS fatalities are would-be rescue personnel.**

During non-entry and entry rescue, entrants must be carefully watched when being physically moved to avoid further injury.

3.11.2 Entry Rescue Services

If non-entry rescue is not possible, EPA must determine whether to equip, train, and employ an onsite entry rescue service using EPA employees and/or contractors, or use an offsite rescue service. If an onsite entry rescue service is used, the Onsite Safety Officer or Entry Supervisor (or another designated person) must ensure that the rescue service complies with OSHA's requirements in 29 CFR 1910.146(k)(2) for PPE, training, first aid/CPR, and annual simulated rescue drills.

If EPA determines that entry rescue will be performed by an offsite service, the Onsite Safety Officer or Entry Supervisor (or another designated person) must comply with the host employer requirements specified in Section 2.3.2 of this chapter and select a rescue service that is:

- Capable of responding within a time frame that is appropriate for the PRCS hazards identified.
- Equipped for and proficient in performing the needed rescue services.

Prospective rescue services must be contacted in advance of PRCS work to plan and coordinate the evaluations required by the OSHA standard [29 CFR 1910.146(k)(1)]. **Posting the service's telephone number or planning to rely on the 911 emergency telephone number to obtain these services at the time of a PRCS emergency is unacceptable, dangerous, and does not comply with the requirements of the OSHA standard.** The "Forms" section of the manual's website contains evaluation forms that can be used to evaluate prospective rescue services.

If a combination of onsite and offsite rescue services will be employed, the Onsite Safety Officer or Entry Supervisor (or another designated person) must ensure that:

- The combined rescue services will enable EPA to comply with OSHA's requirements for rescue services.
- The HASP PRCS procedures describe the roles of each party.
- The combined rescue services train together as a team.

Procedures for PRCS entry rescue may vary across EPA organizations. The procedures used in Region 4 for PRCS rescue services (as well as the people responsible for implementing those procedures) are:

Use local contract rescue services in all instances and document specific information in the HASP (e.g., description of emergency rescue procedures, identification of rescue service, method to be used to summon rescue or emergency services, planned rescue and emergency equipment including retrieval systems and methods). The Onsite Safety Officer (or another designated person) is responsible for selecting a rescue service and ensuring that all entry rescue requirements specified by the OSHA PRCS standard are met or exceeded.

3.12 Safety Data Sheets (SDSs) or Other Hazard Information

SDSs or hazard information on the contents, coatings or liners, residues, potential hazardous atmospheres or other contaminants found or anticipated in the PRCS must be available at the work site and provided to employees and contractors prior to entry. Placing SDSs in the HASP is recommended. Information from the SDSs must be discussed during the PRCS pre-entry briefing before each shift.

Air Monitoring Personnel, the Onsite Safety Officer, or Entry Supervisor (or other designated person) is responsible for ensuring that SDSs or hazard information is readily available at the work site. If an injured PRCS entrant is exposed to a chemical substance, Air Monitoring Personnel, the Onsite Safety Officer, or Entry Supervisor (or another designated person) must ensure that the SDS or hazard information is provided to the medical facility treating the injured employee.

3.13 Confined Space Entry Permit

A confined space entry permit is an authorization and approval in writing by the employer that allows and controls entry into a PRCS. It specifies the location and type of work to be done, and certifies that the

space has been evaluated and tested by a qualified person and that all necessary protective measures have been taken to ensure the safety of the entrants. **A confined space entry permit is self-issued and canceled.** It should identify the actual or potential hazards of the space and specify the means, procedures, and practices necessary for safe entry operations (see the "Forms" section of the manual's website). The permit must be tailored to meet the needs of the PRCS involved (i.e., site-specific) and include the following information:

- Identification and location of the PRCS.
- Specific description of the purpose for the entry or the work to be completed.
- The name of the person issuing the permit or serving as entry supervisor and the signature or initials of the entry supervisor who originally authorized entry.
- Identification of the hazards that may be encountered and specific actions to be taken to protect against the hazards.
- Date and authorized duration of the permit (the duration must not exceed the time required to complete the task or job identified on the permit).
- Identification of the active participants involved in the PRCS operations (e.g., authorized entrants, attendants, entry supervisors, air monitoring personnel, etc.), by name or other means (e.g., rosters or tracking systems).
- Emergency procedures for a single attendant monitoring multiple spaces (if applicable).
- Checklists for specifying: (1) isolation, cleaning, purging, inerting (Text Box 17), or ventilating to be completed prior to entry and certification that these procedures have been completed; (2) any special work procedures (e.g., hot work permit, etc.) to be followed due to additional hazards that may be generated by the activities of the entrants; and (3) required equipment (such as PPE, special tools, air monitoring equipment, communication equipment, alarm systems, rescue equipment, etc.).
- The frequency of air monitoring and the results of initial and periodic monitoring, with the initials of the individual monitoring the atmosphere in the space and the time the monitoring was performed.
- Documentation that acceptable entry conditions exist.
- The communication procedures to be used by authorized entrants and attendants to maintain contact during the entry.
- Rescue and emergency services and the means for summoning those services.
- Additional permits (e.g., hot work) that have been issued to authorize work in the PRCS.

Text Box 17
Inerting

Inerting means the displacement of the atmosphere in a confined space by the addition of an inert gas (a nonflammable, nonreactive, noncorrosive gas such as argon, helium, krypton, neon, nitrogen, or xenon). Inerting makes the atmosphere in a tank or container non-ignitable or nonreactive.

WARNING: INERTING CAN CAUSE OTHER HAZARDS SUCH AS OXYGEN DEFICIENCY

The completed permit must be made available at the time of entry to all authorized entrants, by posting it at the entry portal or by any other equally effective means, so that entrants can confirm the pre-entry preparations have been completed. (See the "Forms" section of the manual's website for a sample confined space entry permit.) The content of the PRCS permit must always be addressed in the pre-entry briefing before each shift.

The Onsite Safety Officer or Entry Supervisor (or another designated person) is responsible for authorizing entry for a PRCS by preparing or reviewing, verifying, and signing (approving) the entry

permit, identifying all active participants (including employees of other employers), and discussing the permit during the PRCS pre-entry briefings before each shift. Onsite workers must notify the Onsite Safety Officer or Entry Supervisor (or another designated person) before entering a PRCS.

3.13.1 Required PRCS Modifications

The Onsite Safety Officer or Entry Supervisor (or another designated person) must document on the permit **any** problems encountered during an entry operation, review those problems with affected employees, and make appropriate revisions to site-specific PRCS procedures in the HASP before subsequent entries are authorized. Circumstances requiring documentation on the permit include but are not limited to:

- Any unauthorized entry of a permit space
- Detection of a hazard not covered by the entry permit
- Detection of a condition prohibited by the permit.
- Occurrence of an injury or near-miss during entry
- A change in the use or configuration of a PRCS
- Employee complaints about the effectiveness of the procedures

Additionally, if emergency rescue or response was conducted for a PRCS operation, the site-specific PRCS procedures (HASP) must be reviewed because this action might be an indication of deficiencies in the procedures, equipment, training, or permit system.

3.13.2 PRCS Cancellation

At the conclusion of the entry operation, the Onsite Safety Officer or Entry Supervisor (or another designated person) must document the cancellation (or termination) of the entry operation and closure of the PRCS on the entry permit.

Canceled entry permits must be retained in site files and it is recommended that EPA organizations also forward copies to the SHEMP Manager (or another designated person). Within one year after each entry, or during a single annual review, the SHEMP Manager (or another designated person) must review the organization's confined space safety plan using the canceled permits (and other appropriate documentation) and revise the plan as necessary to ensure that emergency responders participating in entry operations are protected from PRCS hazards.

3.13.3 Alternate Entry Procedures

The OSHA confined space standard allows a PRCS to be entered without the need for a written permit or an attendant under two conditions:

1. The **only** hazard in the PRCS is an atmospheric hazard and the PRCS can be **maintained** in a condition safe for entry by using mechanical ventilation, or
2. All hazards within the PRCS have been **eliminated** (see Text Box 5) and the space has been reclassified as a non-permit confined space.

The two conditions require employers to demonstrate and document (certify) compliance with the respective procedures for alternate entries described in Sections 3.13.3.1 and 3.13.3.2. **Alternate entry**

procedures are used under limited conditions only. Alternate entry certifications are retained according to the requirements in Section 3.15.3.

3.13.3.1 PRCS with Atmospheric Hazard Only

If the **only** hazard of the PRCS is an actual or potential atmospheric hazard that can be safely controlled with continuous forced air ventilation, the PRCS may be entered without a written permit or an attendant present when all of the following conditions are met:

- The atmosphere has been monitored for oxygen, flammable gases/vapors, and potential toxic air contaminants and determined safe for entry (Text Box 18).
- The atmosphere within the space is periodically monitored to ensure the effectiveness of the forced air ventilation.
- Hazardous conditions are eliminated before the entrance cover is removed (if applicable).
- The entrance opening is guarded to prevent people and objects from falling into the space (if applicable).
- Continuous forced air ventilation is used until all employees have left the space.

If an initial entry of the PRCS is necessary to obtain the required air monitoring data, the entry must be performed utilizing a PRCS entry permit and attendant (Section 3.13).

Text Box 18
Safe Contaminant Levels for Alternate Entry with Atmospheric Hazard Only

The minimal "safe for entry" level for air contaminants under the alternate entry procedure is:

- Fifty (50) percent of the toxic substance's occupational exposure limit (e.g., PEL, TLV, other).
- Five (5) percent of a flammable substance's LFL.

Examples:

The 8-hour TWA PEL for carbon monoxide is 50 parts per million (ppm). Fifty percent of the PEL is 25 ppm. Under the alternate entry procedure, the measured concentration of carbon monoxide in the PRCS cannot exceed 25 ppm with continuous forced air ventilation.

The LFL for methane is 5% (by volume) or 50,000 ppm. Five percent of the LFL is 0.25% or 2,500 ppm. Under the alternate entry procedure, the measured concentration of methane in the PRCS cannot exceed 0.25% (2,500 ppm) with continuous forced air ventilation.

Source: OSHA Instruction CPL 02-00-100 – Application of the Permit Required Confined Spaces (PRCS) Standards, 29 CFR 1910.146.

The alternate entry procedure would **not** be an acceptable alternative if atmospheric hazards in the space could quickly increase in the event the ventilation failed. For this procedure to be used, sufficient time must be available for an entrant to safely exit the space if the ventilation stops.

If the alternate entry procedure is used, the Onsite Safety Officer or Entry Supervisor (or another designated person) must document (certify) that there are no non-atmospheric hazards and that ventilation alone will keep the air inside the PRCS safe for entry. EPA can use the applicable sections of the PRCS entry permit (see the "Forms" section of the manual's website) or other documentation to certify that the PRCS meets the alternate entry requirements. The certification must include at a minimum:

- Date and time.
- Location and volume of the space.
- Capacity and configuration of the ventilation equipment.
- Identified atmospheric hazards (including atmospheric hazards created by work in the space).

- Air monitoring results from routine monitoring of the space from the time ventilation begins through final determination of acceptable entry conditions.
- Signature of the person providing the written certification.

The certification must be discussed during the pre-entry briefing before each shift and posted at the entrance to the PRCS so employees can review the measures taken for their protection.

3.13.3.2 PRCS Reclassified

If a PRCS poses no actual or potential atmospheric hazard and if all other (non-atmospheric) hazards are **eliminated** without entry into the space (e.g., through one of the isolation techniques specified in the OSHA PRCS standard), the PRCS may be reclassified as a non-permit confined space and may be entered without a written permit or attendant present. The Onsite Safety Officer or Entry Supervisor (or another designated person) must document the basis for determining that all hazards in the PRCS have been eliminated through a certification that includes at a minimum the date, time, location of the space, and the signature of the person making the determination. The certification must be discussed during the pre-entry briefing before each shift and posted at the entrance to the PRCS so employees can review the measures taken for their protection. Applicable sections of the PRCS entry permit (see the "Forms" section of the manual's website) may be used to document and certify this information.

If it is necessary to enter the PRCS to eliminate hazards, the entry must be performed using a PRCS entry permit and attendant (Section 3.13).

3.14 Confined Space Safety Training

Emergency responders must receive training that enables them to (1) recognize confined spaces, (2) evaluate the hazards of confined spaces, (3) understand the OSHA requirements for site-specific PRCS procedures, and (4) ensure that appropriate practices and procedures are adopted or developed and implemented prior to personnel entering confined spaces.

At a minimum, they must take a one-hour Confined Space Awareness course before being assigned to field activities. This requirement applies to all emergency responders, including those who work for organizations that hire skilled contractors to perform confined space entry rather than allowing EPA employees to do so. Biennial refresher training is also recommended. Depending on the specific job tasks assigned to them, some emergency responders may require more detailed confined space safety training. For example, emergency responders assigned to serve as authorized entrants, attendants, entry supervisors, air monitoring personnel, and rescue personnel will need to satisfy the training requirements identified in 29 CR 1910.146(g) and summarized below in Table 3. Immediate supervisors and SHEMP Managers (or other designated people) will determine what level of confined space safety training each emergency responder requires. The SHEMP Manager (or another designated person) must also ensure that all completed training requirements are documented (see Section 3.15.6 for details) and tracked in the Field Readiness Module (FRM) and that immediate supervisors and Removal Managers (or their equivalent) are alerted if employees have not completed their training requirements so they can be prevented from working in the field.

Site-specific training on confined space safety must also be addressed in the form of pre-entry briefings. These briefings must be provided:

- When a change in PRCS operations presents a hazard not previously addressed during training.
- Before a change in PRCS assigned duties.

- When there are deviations in the entry procedures for PRCS operations.

In instances where EPA (acting as the host employer) hires skilled contractors to perform confined space entry, EPA must oversee the contractor and ensure that the contractor's procedures are at least consistent with the requirements of the OSHA PRCS standard. When EPA is the host employer, the Agency must also check to ensure that its contractors have met their training requirements. If a contractor's employees have not been properly trained, EPA should either not use the contractor or require (and verify) that the contractor's employees receive the required training prior to entry.

Table 3
Confined Space Safety Training Elements

Training for Authorized Entrants	Training for Authorized Attendants	Training for Entry Supervisors	Training for Air Monitoring Personnel	Training for Rescue Personnel (onsite and offsite rescue service personnel)
• Organization's customized confined space safety plan. • Duties/responsibilities of authorized entrants. • Potential hazards of the space including symptoms and effects. • Recognition of dangerous situations. • General knowledge of the permit system and entry permit. • Proper use and maintenance of PPE. • Proper use and maintenance of specialized equipment required for entry (e.g., ventilation ducts and fans, radios, lighting, ladders, rescue harness and lifeline, other). • Communication procedures with attendants and the means attendants will use to notify entrants of emergencies. • Evacuation and emergency procedures including initiation of emergency response and rescue. • Self-rescue procedures.	• Organization's customized confined space safety plan. • Duties/responsibilities of authorized attendants (especially the responsibility to remain outside the PRCS during entry, unless relieved by another attendant). • Potential hazards of the space including symptoms and effects. • Methods for identification and accurate count of authorized entrants. • Communication procedures with entrants and proper use of communication equipment. • Procedures for monitoring hazards inside and outside the space that could endanger entrants and recognition of potentially hazardous conditions. • General knowledge of the permit system and entry permit. • Procedures for evacuating entrants and the conditions under which evacuation is required. • Procedures to prevent unauthorized entry. • Initiation of emergency response and rescue. • Non-entry rescue procedures. • Entry rescue procedures (if applicable).	• Organization's customized confined space safety plan. • Duties/responsibilities of entry supervisors. • Potential hazards of the space including symptoms and effects. • Entry permit system. • Procedures for verifying that all monitoring specified by the permit has been conducted. • Requirements for verifying that all procedures and equipment specified by the permit are in place. • Procedures for verifying the availability of rescue services. • Procedures for verifying the means for summoning rescue services are operable. • Procedures for removing unauthorized entrants. • Procedures for determining that acceptable entry conditions are maintained. • Authorization and termination of entry permits. • Supervision of entry operations. • Host employer and contractor (or other Agency) responsibilities.	• Organization's customized confined space safety plan. • All training elements for authorized entrants. • In depth training to establish proficiency on air monitoring (e.g., equipment and procedures, hazard identification and evaluation).	• Organization's customized confined space safety plan (EPA rescue personnel only, if applicable). • Duties/responsibilities of rescue personnel. • Hazards of the space(s). • Proper use of PPE, rescue, and other equipment necessary for PRCS rescues. • Basic first-aid and CPR. • Rescue plans. • Participation in simulated or actual rescues at least once every 12 months in the actual or similar type confined space(s).

3.15 Recordkeeping

Proper recordkeeping is an essential component of a confined space safety program. The goal is to ensure that nationally consistent, readily accessible records are maintained by each EPA organization. Table 4 and Sections 3.15.1 through 3.15.6 provide details about the specific recordkeeping procedures that must be followed, who is expected to complete specific forms, and who must retain copies of the records.

Table 4
Confined Space Safety Recordkeeping Requirements

Required Record	Details/Specified Forms	Completed/Compiled By[a]	Retained By[a]
Confined Space Identification and Evaluation (Section 3.2)	*Confined Space Identification and Evaluation Form* (see the "Forms" section of the manual's website)	Onsite Safety Officer (or another designated person)	• Site files • HSPC
Permits (entry permit, hot work permit, space certifications) (Sections 3.10 and 3.13) SDSs[b] (Section 3.12)	• *PRCS Entry Permit and Hot Work Permit Forms* (see the "Forms" section of the manual's website) • Space certifications for alternate entry procedures (see the "Forms" section of the manual's website). • SDSs or similar written hazard information for chemical substances to which entrants may be exposed	Onsite Safety Officer or Entry Supervisor (or another designated person) Air Monitoring Personnel, Onsite Safety Officer, or Entry Supervisor (or another designated person)	• Site files • SHEMP Manager
Equipment calibration (Section 3.5.5)	Calibration records (see the "Forms" section of the manual's website)	Air Monitoring Personnel, Onsite Safety Officer, or Entry Supervisor (or another designated person)	• Site Files • HSPC
Pre-entry briefings	Attendance sheet or sign-in sheet (see the "Forms" section of the manual's website for a sample)	Onsite Safety Officer or Entry Supervisor (or another designated person)	Site files
Training Records: • Confined Space Awareness training and other courses (if applicable) • Rescue drills if applicable (Section 3.14)	Training certificates or rosters (see the "Forms" section of the manual's website)	• SHEMP Manager (certificates) • Course instructors (rosters)	• Site files • Individual employees[c]

a The assignments in this table have been made with regional audiences in mind, and as a result, the positions listed might not be applicable to all organizations. Users can adjust the assignments when they go through the process of customizing this chapter.
b Applicable SDSs must be included and retained with the entry permit.
c Employees must provide documentation certifying the completion of their training requirements to the SHEMP Manager or HSPC (or another designated person), who in turn will document it in the FRM.

3.15.1 PRCS Records—Confined Space Identification and Evaluation Forms

The "Forms" section of the manual's website contains a sample *Confined Space Identification and Hazard Evaluation Form* that emergency responders can use to identify and evaluate confined spaces. This form must be completed by Air Monitoring Personnel, the Onsite Safety Officer, or Entry Supervisor (or another designated person). Completed forms must be retained in site files and it is recommended that EPA organizations also forward copies to the HSPC (or another designated person). If this form is used to support compliance with the alternate entry procedures specified in 29 CFR 1910.146(c)(5) through (c)(7) and Section 3.13.3 of this chapter, it must be preserved and retained for at least 30 years.

3.15.2 PRCS Records—Permits

The "Forms" section of the manual's website contains sample PRCS entry and hot work permits that may be used for PRCS operations. PRCS entry and hot work permits must be completed by the Onsite Safety Officer or Entry Supervisor (or another designated person). Canceled permits (at the conclusion of the entry operation) must be retained in site files and it is recommended that EPA organizations also forward copies to the SHEMP Manager (or another designated person). Entry permits that show the composition of an atmosphere to which an employee is exposed (even if the employee is using a respirator) are considered exposure records under 29 CFR 1910.1020(c)(5) (OSHA's standard for employee access to exposure and medical records) and must be retained for at least 30 years.

3.15.3 PRCS Records—Alternate Entry Procedures

The basis for determining that a PRCS is safe for entry through the alternate entry procedures must be documented as a written certification that is posted at the entry to the PRCS. The "Forms" section of the manual's website contains a sample PRCS entry permit that can be used to document and certify this information. Alternate entry certifications must be completed by the Onsite Safety Officer or Entry Supervisor (or another designated person). Canceled certifications (at the conclusion of the entry operation) must be retained in site files and it is recommended that EPA organizations also forward copies to the SHEMP Manager (or another designated person). Alternate entry certifications that show the composition of an atmosphere to which an employee is exposed (even if the employee is using a respirator) are considered exposure records under 29 CFR 1910.1020(c)(5) (OSHA's standard for employee access to exposure and medical records) and must be retained for at least 30 years.

3.15.4 PRCS Records—SDSs and Other Hazard Information

SDSs, air monitoring data, and other information on the contents, coatings or liners, potential hazardous atmospheres, and residues found or anticipated in a PRCS must be compiled by Air Monitoring Personnel, the Onsite Safety Officer, or Entry Supervisor (or other designated person) and included with the applicable entry permit. SDSs and other hazard information must be retained in site files and it is recommended that EPA organizations forward copies (with the applicable entry permit) to the SHEMP Manager (or another designated person). These documents are considered exposure records under 29 CFR 1910.1020(c)(5) (OSHA's standard for employee access to exposure and medical records) and must be retained for at least 30 years.

3.15.5 PRCS Records—Equipment Calibration

Air monitoring equipment calibration must be verified through appropriate documentation. To assist with this activity, the "Forms" section of the manual's website contains sample forms that may be used to document the calibration of various direct-reading equipment and detector tube systems. Calibration documentation must be completed by Air Monitoring Personnel, the Onsite Safety Officer, or Entry

Supervisor (or another designated person). Completed records must be retained in site files and it is recommended that EPA organizations forward copies to the HSPC (or another designated person). If the air monitoring equipment used at the site does not belong to EPA (e.g., contractor equipment), the EPA organization can request photocopies of the calibration records to retain in site files.

3.15.6 PRCS Records—Training Records

OSHA's PRCS standard (29 CFR 1910.146(g)(4)) requires a record of certification that the standard's training requirements have been met. The certification must contain the employee's name/job title, the names and signatures of the trainers, dates the training was conducted, and information on the content covered. Each EPA organization may determine their own format for documenting this information (e.g., a training certificate or a training roster [see the "Forms" section of the manual's website]). Emergency responders must obtain a training certificate (or an equivalent form of documentation) that certifies that they have completed the required training. They must present this documentation to the SHEMP Manager or HSPC (or another designated person), who in turn will ensure that the training is documented in the FRM. Upon completing that task, the SHEMP Manager or HSPC (or another designated person) is not required to retain a hardcopy of the training documentation. Emergency responders should, however, retain proof that they have completed the training.

APPENDIX A

Confined Space Safety Plan: Designation of Roles and Responsibilities

Instructions for Users

Appendix A provides a place for users to insert organization-specific information into the Confined Space Safety Program chapter. The appendix presents a list of tasks that must be performed to ensure the proper operation of a confined space safety plan. The tasks are listed in rows. EPA position or PRCS job titles are listed in columns. Each task has been assigned a default position. For some of the tasks, check marks have been placed in two or more columns to indicate that more than one person is responsible for that task. **Please note that users can re-delegate tasks.**

Users must take the following steps to customize Appendix A:

- Fill in the background information requested at the top of page A-3. For example, indicate when the table is being updated and who is doing the updating.
- Fill in actual names under the position titles.
- Add additional key players to the table (if necessary). *Note: The chapter authors have already provided a placeholder to add a new position, as the last column is labeled "Other." Users should customize this column to identify the position title (and name) of any additional key player assigned responsibility to implement this chapter. Users can insert more columns to include additional key players (if necessary).*
- Add rows to the table (if necessary) to provide information about activities that exceed the minimum requirements already included in Appendix A. (See Appendix B for a list of your organization's additional policies and procedures related to confined space safety.)
- Determine whether any of the recommended task assignments must be delegated to another person. (If so, move the check marks to re-assign the task.)
- Ensure that each task has been assigned.

ATTENTION OLEM Special Teams and HQ Users: The tasks and position titles that appear in Appendix A have been written with regional audiences in mind. OLEM special teams and HQ users should modify the language that appears in the rows and column headers to reflect the needs of their organization.

APPENDIX A
Task Table for Implementing the Confined Space Safety Plan

This table has been customized for Region 4**.**
Last updated on: March 3, 2017**.**
Updated by: Kevin Eichinger**.**

TASKS ▼ / ROLES ►	Who Is Responsible for Each Task or Action?									
	Removal Manager	**SHEMP Manager**	**HSPC**	**Onsite Safety Officer**	**Equipment Manager**	**Entry Supervisor**	**Authorized Entrants**	**Authorized Attendants**	**Air Monitoring Personnel**	**Other**
Name of person in role ►	See Appendix A-2 in the Introduction chapter for the names of personnel that fill these roles.									
General Tasks										
1. Ensure that the procedures outlined in the Confined Space Safety Program chapter are being followed. Support any confined space-related initiatives that the SHEMP Manager establishes.	✓									
2. Serve as the organization's technical expert (or establish a link to a technical expert) on the subject of confined space safety.		✓								
3. Facilitate and administer the organization's confined space safety plan and the emergency responders who are subject to the plan.			✓							
Tasks Associated with Developing a Customized Written Confined Space Safety Plan										
4. Develop a written confined space safety plan for your organization by customizing this chapter. Post the customized chapter to the manual's website and inform stakeholders of its availability.	✓	✓	✓							
5. Be familiar with your organization's confined space safety plan. Provide feedback on the plan and recommend improvements if necessary.				✓	✓	✓	✓	✓	✓	
6. Ensure that your organization's confined space safety plan is reviewed and updated **at least annually**.	✓	✓	✓							
7. Incorporate components of your organization's confined space safety plan into HASPs. Ensure that HASP PRCS procedures address all of the requirements in Section 3.3.				✓						
8. Provide technical support to emergency responders to ensure that the HASP adequately addresses site-specific concerns related to confined spaces.	✓	✓	✓							
9. Ensure that all PRCS-related components of the HASP are being implemented in the field.	✓	✓	✓	✓		✓				

TASKS ▼ / ROLES ▶	Who Is Responsible for Each Task or Action?									
	Removal Manager	SHEMP Manager	HSPC	Onsite Safety Officer	Equipment Manager	Entry Supervisor	Authorized Entrants	Authorized Attendants	Air Monitoring Personnel	Other
Name of person in role ▶	See Appendix A-2 in the Introduction chapter for the names of personnel that fill these roles.									
Tasks Associated with Pre-Entry Operations										
10. Survey the response site to determine if it contains confined spaces and take effective measures to prohibit or control entry. Document the survey results and maintain an up-to-date list of confined spaces (non-permit and PRCS) (Section 3.2). Forward copies of the survey results to the HSPC (or another designated person) for annual program review.				✓					✓	
11. Specify any conditions, precautions, and work practices required for non-permit confined spaces and changes in conditions that would require a re-evaluation of the confined space (Section 3.2 and Section 3.6.3).				✓		✓			✓	
12. Prohibit all entry into PRCS until the provisions and requirements of the OSHA PRCS standard are met.				✓		✓				
13. Know and understand the site-specific health and safety hazards that may be faced during entry, including routes of exposure, symptoms, behavioral effects, and consequences of exposure (Section 3.4).				✓		✓	✓	✓	✓	
14. Check that entrants and attendants are fully apprised of the hazards.				✓		✓				
15. Eliminate any conditions making it unsafe to remove an entrance cover before the cover is removed and guard the entrance opening to prevent the introduction of hazards, if applicable (Sections 3.6 and 3.13.3.1).				✓		✓				
16. Monitor atmospheric hazards to determine if acceptable entry conditions exist prior to and during entry. Document the results on evaluation forms and entry permits (Section 3.5).				✓		✓			✓	
17. Ventilate PRCSs properly to control atmospheric hazards (Section 3.6.1 and the "Forms" section of the manual's website).				✓		✓			✓	
18. Specify other protective measures or determine if the PRCS must be entered when ventilation alone is not possible or feasible to completely eliminate atmospheric hazards (Sections 3.6, 3.6.1, and 3.6.4).				✓		✓			✓	
19. Control hazardous energy sources with effective lockout/tagout procedures and/or isolation techniques before personnel are allowed to enter PRCSs (Section 3.6.2).				✓		✓				
20. Illuminate the work area effectively and safely with temporary and/or portable lighting (Section 3.9).				✓		✓				

TASKS ▼ / ROLES ▶	Who Is Responsible for Each Task or Action?									
	Removal Manager	SHEMP Manager	HSPC	Onsite Safety Officer	Equipment Manager	Entry Supervisor	Authorized Entrants	Authorized Attendants	Air Monitoring Personnel	Other
Name of person in role ▶	See Appendix A-2 in the Introduction chapter for the names of personnel that fill these roles.									
21. Issue hot work permits when hot work is performed in or near a confined space (Section 3.10 and the "Forms" section of the manual's website).				✓		✓				
22. Specify the equipment and supplies (including PPE) required for PRCS operations on the entry permit (Section 3.13).				✓		✓				
23. Specify communication methods and equipment to maintain communication between attendants and entrants (Sections 3.8 and 3.13).				✓		✓				
24. Station at least one trained attendant outside a PRCS. Specify the means and procedures to enable the attendant to respond to an emergency affecting one or more PRCSs, if multiple spaces are to be monitored by the attendant (Section 3.3 and Section 3.13).				✓		✓				
25. Establish rescue/emergency procedures prior to PRCS operations (Section 3.11).				✓		✓				
26. Comply with host employer responsibilities, coordinate entry operations, and establish a controlling employer when multiple employers are working in or near PRCSs (Sections 2.3 and 2.3.1).				✓		✓				
27. Prepare or review, verify, sign, and post entry permits and alternate entry certifications, as appropriate. Identify all active PRCS participants. Discuss permits and alternate entry certifications during pre-entry briefings (Section 3.13).				✓		✓				
28. Ensure that SDSs or other chemical hazard information on the contents, coatings or liners, potential hazardous atmospheres, and residues found or anticipated in PRCSs are readily available to entrants and medical personnel treating injured workers (Section 3.12), and are included and retained with the entry permit.				✓		✓			✓	
29. Attend pre-entry briefings at the beginning of each shift (Section 3.3).				✓		✓	✓	✓	✓	
Tasks Associated with Entry Operations (Section 2.0 and Appendix A)										
30. Determine that entry operations remain consistent with the terms of the entry permit and acceptable entry conditions are maintained throughout the entry period.				✓		✓			✓	
31. Maintain an accurate count of authorized entrants at all times.								✓		
32. Remain outside the PRCS at all times during entry operations until relieved by another attendant.								✓		

TASKS ▼ / ROLES ►	Who Is Responsible for Each Task or Action?									
	Removal Manager	SHEMP Manager	HSPC	Onsite Safety Officer	Equipment Manager	Entry Supervisor	Authorized Entrants	Authorized Attendants	Air Monitoring Personnel	Other
Name of person in role ►	See Appendix A-2 in the Introduction chapter for the names of personnel that fill these roles.									
33. Communicate with authorized entrants frequently to monitor entrant status and to alert entrants of the need to evacuate.								✓		
34. Communicate with the attendant frequently so the attendant can monitor entrant status. Immediately alert the attendant whenever any symptom of exposure occurs, a prohibited condition is detected, or any other emergency arises.							✓			
35. Monitor activities inside and outside the PRCS to determine if it is safe to remain in the space.						✓		✓		
36. Monitor contractors and other agencies to ensure that PRCS procedures (HASP) are followed.				✓		✓				
37. Take action/remove unauthorized persons who enter or attempt to enter the PRCS.						✓		✓		
38. Order authorized entrants to immediately evacuate the PRCS if: • A prohibited condition is detected inside or outside the space. • An authorized entrant(s) exhibits the behavioral effects of hazard exposure. • Any situation occurs outside the space that could endanger the authorized entrants. • The attendant cannot effectively and safely perform all of the required duties of an attendant.						✓		✓		
39. Exit the PRCS as quickly as possible when: • An order to evacuate is given by the attendant or entry supervisor. • Any symptom of exposure occurs. • A prohibited condition is detected. • An evacuation alarm is activated. • You believe you are in danger.							✓			
40. Summon rescue and other emergency services when needed.						✓		✓		
41. Perform non-entry and/or entry rescue as specified by the permit and HASP PRCS procedures.						✓		✓		

TASKS ▼ / ROLES ▶	Who Is Responsible for Each Task or Action?									
	Removal Manager	SHEMP Manager	HSPC	Onsite Safety Officer	Equipment Manager	Entry Supervisor	Authorized Entrants	Authorized Attendants	Air Monitoring Personnel	Other
Name of person in role ▶	See Appendix A-2 in the Introduction chapter for the names of personnel that fill these roles.									
Tasks Associated with Post-Entry Operations (Section 3.13)										
42. Document the cancellation (or termination) of the entry operation and closure of the PRCS on the entry permit (Section 3.13.2) and notify all participants actively involved in the PRCS operation.				✓		✓				
43. Investigate and document on the permit any problems encountered during entry operations and make appropriate revisions to the HASP PRCS procedures before subsequent entries to any PRCS are authorized (Section 3.13.1).				✓		✓				
44. Close the PRCS after entry operations are complete by removing any temporary barriers at the entrance, and restoring the space to pre-entry conditions.				✓		✓				
45. Ensure that canceled permits (entry and hot work) and alternate entry certifications are retained in site files (Sections 3.15.2 and 3.15.3). Forward copies to the SHEMP Manager for annual program review.		✓		✓		✓				
Tasks Associated with Equipment and Supplies (Section 3.7)										
46. Ensure that resources are available to procure the proper equipment.	✓									
47. Determine the equipment that is needed to support the organization's confined space safety plan.		✓	✓	✓		✓				
48. Maintain an adequate supply of the required equipment. Track equipment inventories and make purchases (or arrange to have them made) to replenish stocks (e.g., consumable items such as calibration gases, gas/vapor sensors, detector tubes, batteries, disposable PPE).		✓	✓		✓					
49. Issue equipment and ensure that emergency responders' are properly equipped.				✓	✓	✓				
50. Report equipment shortages, problems, malfunctions, etc. to the HSPC or Equipment Manager (or another designated person).				✓		✓	✓	✓	✓	
51. Learn how to properly inspect, use, and maintain the required equipment, supplies, and PPE. Use and calibrate air monitoring equipment in accordance with the manufacturer's instructions. Forward equipment calibration records to the HSPC (or another designated person) for annual program review. Wear the PPE specified for PRCS operations in the HASP (Sections 3.5 and 3.6.4).				✓		✓	✓	✓	✓	

TASKS ▼ / ROLES ▶	Who Is Responsible for Each Task or Action?									
	Removal Manager	SHEMP Manager	HSPC	Onsite Safety Officer	Equipment Manager	Entry Supervisor	Authorized Entrants	Authorized Attendants	Air Monitoring Personnel	Other
Name of person in role ▶	See Appendix A-2 in the Introduction chapter for the names of personnel that fill these roles.									
Tasks Associated with PRCS Training (Section 3.14)										
52. Determine which confined space safety training courses emergency responders require and ensure that they satisfy all training requirements.		✓	✓							
53. Participate in confined space safety training as required: • Confined Space Awareness • Other courses (if applicable) for entry supervisors, entrants, attendants, air monitoring personnel, and rescue teams • Pre-entry briefings (before each shift) • Annual rescue drills or exercises (if applicable)		✓	✓	✓		✓	✓	✓	✓	
54. Prevent employees from working in the field if they have not participated in required confined space training.	✓									
Tasks Associated with Recordkeeping Activities (Section 3.15)										
55. Retain copies of your confined space training certification.						✓	✓	✓	✓	
56. Ensure that training requirements are documented and tracked in the FRM and that the Removal Manager or supervisor is aware of employees that have (and have not) completed their training requirements.	✓	✓	✓							
57. Ensure that copies of confined space identification and evaluation forms, equipment calibration records, alternate entry certifications, and entry and hot work permits are retained in site files. Records that show the composition of atmospheres to which employees were exposed (even if respirators were worn) must be retained for at least 30 years (e.g., confined space identification and evaluation forms, alternate entry certifications, and PRCS entry permits).		✓	✓	✓		✓			✓	
58. Forward copies of confined space identification and evaluation forms and equipment calibration records to the HSPC (or another designated person).				✓		✓			✓	
59. Forward copies of canceled PRCS entry permits, hot work permits, and alternate entry certifications to the SHEMP Manager (or another designated person).				✓		✓			✓	
60. Ensure that copies of SDSs, air monitoring data, and other information on the contents, coatings or liners, potential hazardous atmospheres, and residues found or anticipated in PRCSs are included with entry permits and retained for at least 30 years.		✓	✓	✓		✓			✓	

TASKS ▼ / ROLES ►	Who Is Responsible for Each Task or Action?									
	Removal Manager	**SHEMP Manager**	**HSPC**	**Onsite Safety Officer**	**Equipment Manager**	**Entry Supervisor**	**Authorized Entrants**	**Authorized Attendants**	**Air Monitoring Personnel**	**Other**
Name of person in role ►	See Appendix A-2 in the Introduction chapter for the names of personnel that fill these roles.									
61. Forward copies of SDSs and other confined space hazard information to the SHEMP Manager (or another designated person).				✓		✓			✓	
Additional Tasks That Reflect Organization-Specific Practices (Appendix B)										
Attention users: Add rows if necessary.										

*Note: A list of the organization's emergency responders is provided in Appendix A-2 of the Introduction chapter.

APPENDIX B

Confined Space Safety Plan: Documentation of Additional Policies and Procedures

The procedures and tasks outlined in the Confined Space Safety Program chapter represent the **minimum requirements** that each EPA organization must meet. If organizations advocate the use of additional policies and procedures, they must document them in the table below. After doing so, they must also:

- Ensure that any of the additional policies and procedures that are added to the table below are addressed in the main text of the Confined Space Safety Program chapter. This can be accomplished by either (1) inserting the additional policies and procedures directly into the relevant portions of the main body of the chapter or (2) adding a sentence within the main text that directs readers to Appendix B for more information.
- Update Appendix A to capture any additional tasks that are listed in the table below and ensure that each task is assigned to a specific individual.

Topic	Please document the additional elected policies and procedures required for Region 4 here.
Section 2.0 Roles and Responsibilities	See R4 ERRB Standard Operating Guidelines at https://response.epa.gov/hsmanualregion4
Section 2.3.1 Multiple Employers	
Section 2.3.2 Offsite Rescue Services	
Section 3.1 Organization Policy on Confined Space Entry	
Section 3.2 Assessing the Need for Site-Specific PRCS Procedures	
Section 3.2.1 Prohibiting Entry	
Section 3.3 Written Site-Specific Procedures to Be Incorporated into the HASP	
Section 3.4 Confined Space Hazards	
Section 3.4.1 Physical Hazards	
Section 3.4.2 Hazardous Atmospheres	
Section 3.5 Confined Space Air Monitoring	
Section 3.5.1 Initial Evaluation Monitoring	
Section 3.5.2 Verification Monitoring	
Section 3.5.3 Duration of Monitoring	
Section 3.5.4 Methods of Monitoring	
Section 3.5.5 Equipment Calibration	
Section 3.5.6 Equipment Limitations	

Topic	Please document the additional elected policies and procedures required for Region 4 here.
Section 3.6 Minimizing Confined Space Hazards	
Section 3.6.1 Ventilation	
Section 3.6.2 Lockout/Tagout	
Section 3.6.3 Work Practices	
Section 3.6.4 Personal Protective Equipment	
Section 3.7 Specialized Equipment and Supplies	
Section 3.8 Communication	
Section 3.9 Illumination	
Section 3.10 Hot Work Permits	
Section 3.11 Rescue	
Section 3.11.1 Rescue Options—Self-Rescue, Non-Entry Rescue, Entry Rescue	
Section 3.11.2 Entry Rescue Services	
Section 3.12 SDSs or Other Hazard Information	
Section 3.13 Confined Space Entry Permit	
Section 3.13.1 Required PRCS Modifications	
Section 3.13.2 PRCS Cancellation	
Section 3.13.3 Alternate Entry Procedures	
Section 3.14 Confined Space Safety Training	
Section 3.15 Recordkeeping	
Other Topics _____ _____	

APPENDIX C

Glossary

GLOSSARY[1]

Acceptable entry conditions
Acceptable entry conditions 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.

Asphyxia
Asphyxia is suffocation from lack of oxygen. Simple asphyxia is produced by simple asphyxiants that become so concentrated that they can reduce (displace) the concentration of oxygen in air below levels necessary to support life. Simple asphyxiants include gases such as argon, butane, carbon dioxide, ethane, ethylene, helium, hydrogen, isobutane, LPG, methane, natural gas, nitrogen, propane, propylene, and others. Chemical asphyxia is produced by chemical asphyxiants (such as carbon monoxide, hydrogen cyanide, and hydrogen sulfide) that interfere with the body's utilization of oxygen.

Attendant
An attendant is 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 confined space permit program.

Authorized entrant
An authorized entrant is any employee who is trained and authorized by the employer to enter a permit space.

Blanking or blinding
Blanking or blinding is 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
A confined space is a space that (1) is large enough and so configured that a person can enter and perform assigned work, (2) has limited or restricted means for entry or exit, and (3) is not designed for continuous human occupancy.

Double block and bleed
Double block and bleed is 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
An emergency is defined as 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
Engulfment is 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.

[1] Most definitions were excerpted directly from OSHA's PRCS standard and modified to better meet the needs of EPA emergency responders, if necessary.

Entry
Entry is the action by which a person passes through an opening into a 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
An entry permit is the hard copy document that is provided by the employer to allow and control entry into a permit space and contains the information specified in paragraph (f) of the OSHA PRCS standard. Copies of all entry permits are to be appended to the HASP.

Entry supervisor
The entry supervisor is the person 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. An entry supervisor also may serve as an attendant or as an authorized entrant, as long as that person is trained and equipped for each role he or she fills. The duties of entry supervisor may be passed from one individual to another during the course of an entry operation.

Hazardous atmosphere
A hazardous atmosphere is an atmosphere that may expose workers 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 (approximated as a condition in which the dust obscures vision at a distance of 5 feet or less); (3) atmospheric oxygen concentration below 19.5 percent or above 23.5 percent; (4) atmospheric concentration of any substance in excess of its OSHA permissible exposure limit, ACGIH threshold limit value, or other recommended occupational exposure limit; or (5) any other atmospheric condition that is immediately dangerous to life or health.

Hot work permit
A hot work permit is the employer's written authorization to perform hot operations (e.g., riveting, welding, cutting, burning, and heating) capable of providing a source of ignition.

Immediately dangerous to life or health (IDLH)
IDLH is 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 (such as hydrogen fluoride gas and cadmium vapor) may produce immediate transient effects that, even if severe, may pass without medical attention, but are followed by sudden, possibly fatal collapse 12 to 72 hours after exposure. The victim "feels normal" after recovery from transient effects until collapse. Such materials in hazardous quantities are considered to be IDLH.

Inerting
Inerting is the intentional 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. This procedure produces an IDLH oxygen-deficient atmosphere, but may be necessary for some types of work (e.g., hot work).

Intrinsically safe
As applied to equipment and wiring, equipment and wiring that are incapable of releasing sufficient electrical energy under normal or abnormal conditions to cause ignition of a specific hazardous atmospheric mixture.

Isolation
Isolation is 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
Line breaking is 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.

Monitoring
Monitoring is the real-time process by which the atmospheric hazards that may confront entrants of a permit space are identified and evaluated. Monitoring includes specifying the equipment and procedures that are to be used to evaluate the permit space. Monitoring enables employers 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.

Non-permit confined space
A non-permit confined space is 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 (Text Box 2).

Oxygen deficient atmosphere
An oxygen deficient atmosphere is an atmosphere containing less than 19.5 percent oxygen by volume.

Oxygen enriched atmosphere
An oxygen enriched atmosphere is an atmosphere containing more than 23.5 percent oxygen by volume.

Permit-required confined space (PRCS)
A PRCS is 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 procedures (PRCS procedures)
PRCS procedures are the employer's written site-specific procedures for controlling and, where appropriate, protecting employees from PRCS hazards and for regulating employee entry into PRCSs. Site-specific PRCS procedures must be incorporated into the HASP.

Permit system
A permit system is the employer's written procedure for self-preparing and self-issuing site-specific permits for entry and for returning the PRCS to normal or intended service following termination of entry.

Prohibited condition
A prohibited condition is any condition in a PRCS that is not allowed by the permit during the period when entry is authorized.

Rescue service
Rescue service is the personnel designated to retrieve employees from PRCSs.

Retrieval system
A retrieval system is 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 PRCSs.

APPENDIX D

Permit-Required Confined Space Danger Signs

D-1 **Entry Prohibited for All Personnel**
D-2 **Entry by Authorized Personnel Only**

APPENDIX D-1

Entry Prohibited for All Personnel

DANGER

PERMIT-REQUIRED

CONFINED SPACE

DO NOT ENTER.

ENTRY PROHIBITED FOR ALL PERSONNEL!

The hazards of this space include: _____

_____

Contact: _____

APPENDIX D-2

Entry by Authorized Personnel Only

DANGER

PERMIT-REQUIRED

CONFINED SPACE

SPECIAL PRECAUTIONS REQUIRED!

ENTRY BY AUTHORIZED PERSONNEL ONLY.

The hazards of this space include: _____

_____

Contact: _____

APPENDIX E

OSHA's Requirements for Site-Specific PRCS Procedures

Requirements for Site-specific PRCS Procedures (Pursuant to OSHA's PRCS standard [29 CFR 1910.146])		How EPA Meets This Requirement
1910.146(c)(4)	If an employer decides that its employees will enter PRCSs, the employer must develop and implement written site-specific PRCS procedures that comply with this section.	Covered by Section 3.1 and Section 3.3 in the Confined Space Safety Program chapter and the HASP.
1910.146 (c)(1) through (c)(3)	Each employer must determine whether the workplace contains PRCSs; post danger signs to inform employees of the existence, location, and danger posed by the spaces; and take effective measures to prevent employee entry if the employer decides that its employees will not enter PRCSs.	Covered by Sections 3.2 and 3.2.1, and Appendix D in the Confined Space Safety Program chapter and the HASP.
1910.146(c)(5) through (c)(7)	An employer may use alternate entry procedures if a PRCS can be maintained in a safe condition by continuous forced air ventilation only or if the space poses no actual or potential atmospheric hazard and all hazards within the space are eliminated.	Covered by Section 3.13.3 and in the Confined Space Safety Program chapter and the HASP.
1910.146(c)(8)	When a host employer arranges to have employees of other employers (e.g., contractors and other agencies) perform work that involves PRCS operations, the host employer must apprise the other employers of the need for written site-specific PRCS procedures; inform the employers of the hazards, precautions, procedures and experiences with the space; coordinate (combined) entry operations; and debrief the employers at the conclusion of the entry operations.	Covered by Sections 2.3 and 2.3.1 in the Confined Space Safety Program chapter and the HASP.
1910.146(d)	The written site-specific PRCS procedures must make provisions for: • Preventing unauthorized entry. • Identifying, evaluating, and controlling or eliminating all hazards in the space. • Specifying and maintaining acceptable conditions throughout the entry. • Specifying all equipment needed to safely perform all tasks in the space (including air monitoring and ventilation equipment, PPE, proper lighting, etc.). • Providing an attendant outside the space for the duration of the entry. • Assuring communications, rescue, and emergency capabilities. • Designating and training employees who have active roles. • Implementing a permit entry system. • Coordinating multi-employer entry operations. • Reviewing entry permits and operations and revising as necessary.	Covered by Sections 3.3 through 3.15 and Appendices A and B in the Confined Space Safety Program chapter and the HASP.
1910.146(e) and (f)	Before entry is authorized, the employer must document the means, procedures, and practices for safe PRCS operations by preparing an entry permit that meets the requirements of paragraph (f) of the OSHA PRCS standard.	Covered by Section 3.13 and in the Confined Space Safety Program chapter and the HASP.

Requirements for Site-specific PRCS Procedures (Pursuant to OSHA's PRCS standard [29 CFR 1910.146])		How EPA Meets This Requirement
1910.146(g) through (i)	The employer must provide and certify that all applicable training specified in paragraph (g) of the OSHA PRCS standard has been accomplished. If applicable, training must establish employee proficiency in the duties required by the standard for authorized entrants, attendants, and entry supervisors.	Covered by Sections 3.14 and 3.15.6 in the Confined Space Safety Program chapter and the HASP.
1910.146(k)	When practical, non-entry rescue is required. Non-entry retrieval systems must meet the requirements of paragraph (k)(3)(i) of the OSHA PRCS standard. *For onsite rescue services*: The employer must train affected employees (in rescue duties, PPE, first aid and CPR); provide PPE; and ensure that employees practice PRCS rescues at least annually. *For offsite rescue services*: The employer must (1) evaluate and select a rescue service that is capable of responding within an appropriate time frame and equipped for and proficient in performing the needed rescue services; (2) inform the rescue service of the hazards they may confront; and (3) provide the rescue service with access to all PRCSs so that rescue plans can be developed and rescue operations can be practiced. Medical facilities treating injured workers exposed to chemical substances must be provided with the applicable SDSs or other hazard information on the contents, coatings, liners, residues or other contaminants in the space.	Covered by Sections 2.3.2, 3.11, and 3.12 in the Confined Space Safety Program chapter and the HASP.
1910.146(l)	Employers must make the PRCS procedures available to employees and consult with them during development and implementation.	Covered by Sections 3.13 and Appendix A in the Confined Space Safety Program chapter and the HASP.

APPENDIX F

Ventilation Techniques for Confined Spaces

(***This appendix should be viewed or printed in color***)

VENTILATION TECHNIQUES FOR CONFINED SPACES

Ventilation does not eliminate air monitoring requirements (Section 3.5)

Confined Spaces with One Opening*

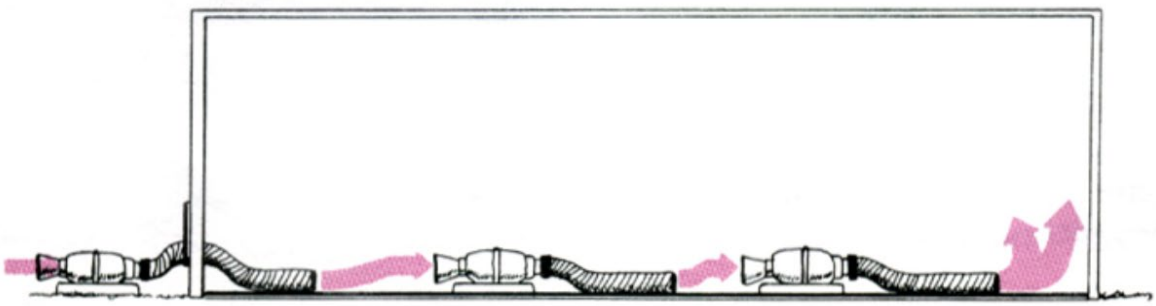


Figure 1. Moving Air Long Distances. To ventilate a large area or move air long distances use a series of fans.

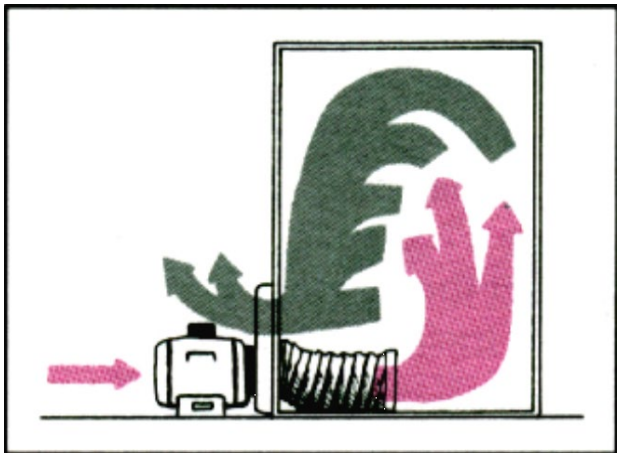


Figure 2. Prevent Short-Circuiting. To prevent short-circuiting when supplying clean air to a confined space with one opening, use a fan with enough power to blow the air throughout the entire space.

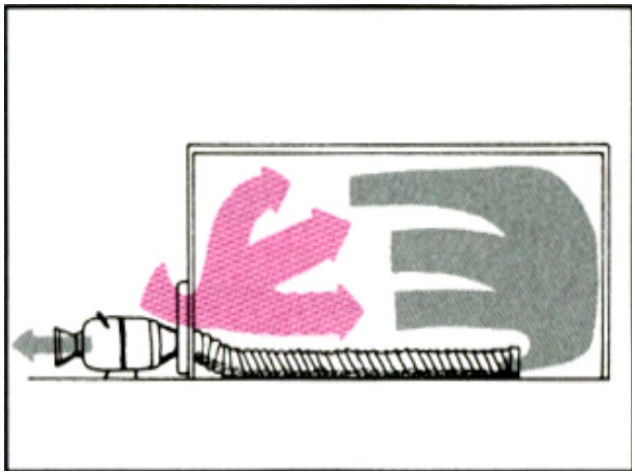


Figure 3. Air Circulation in a Long Space. To provide good air circulation in a long confined space with one opening, use (exhaust) ductwork to "direct" the makeup air flow to the far end of the space. "Long" means a space that is several times longer in length than width or height.

*Pink-colored air flow is clean supply air; grey-colored air flow is contaminated air exhausted from the space. (*Illustrations obtained from the Confined Space Ventilation employee handbook and used with permission from Coastal Training Technologies Corporation.*)

<u>Confined Spaces with One Opening</u> (continued)*

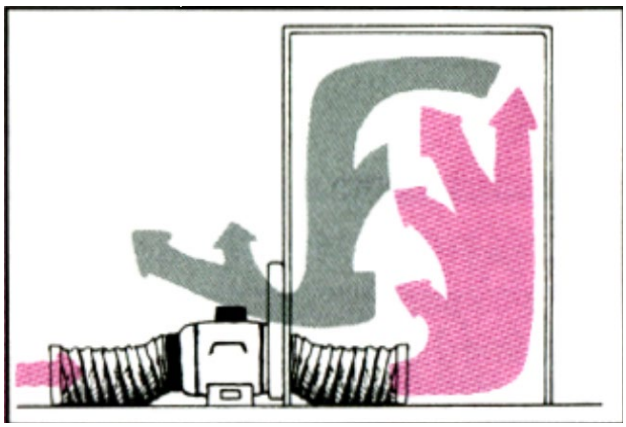


Figure 4. Avoid Recirculation. When supplying clean air to a confined space with one opening, avoid recirculation of the purged exhaust air by using additional ductwork on the fresh air intake to protect it from the exhaust air stream exiting the space.

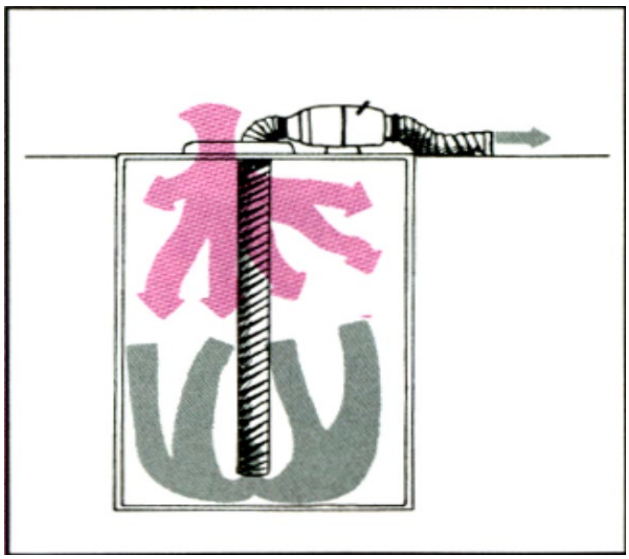


Figure 5. Prevent Short-circuiting. When using an exhaust fan in a confined space with one opening, prevent short-circuiting and recirculation by using (exhaust) ductwork to "direct" incoming fresh air to the bottom of the space. If exhaust air recirculates back into the space, use additional ductwork to direct the discharged air stream away from the opening to the space.

<u>Confined Spaces with Two Openings</u>*

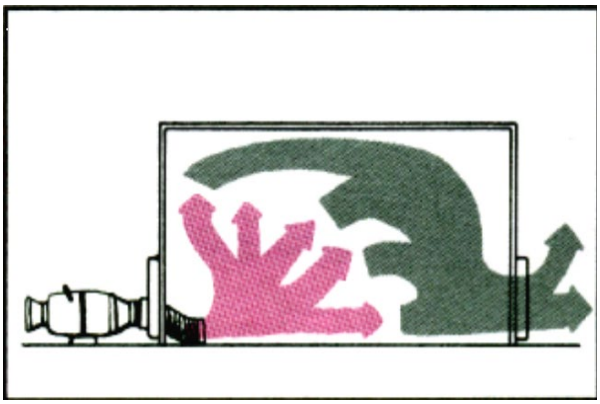


Figure 6. Supply Air in a Long Space. The best way to supply fresh air to a long confined space is to blow clean air in at one end of the space and exhaust contaminated air out at the other end. "Long" means a space that is several times longer in length than width or height.

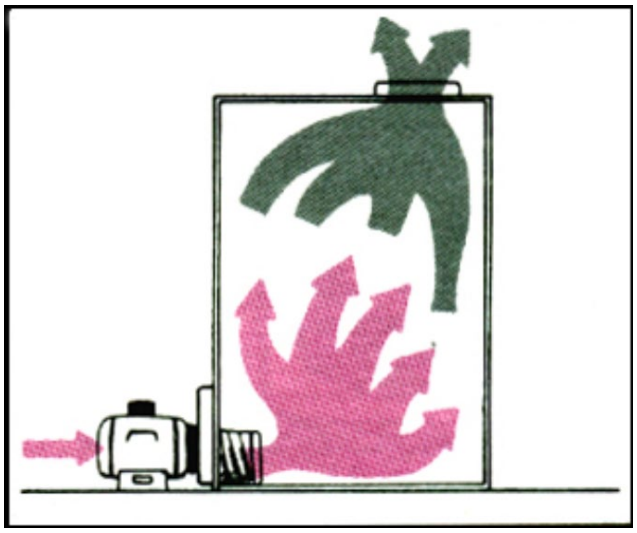


Figure 7. Supply Air in a Deep Space. The best way to supply fresh air to a deep (tall or vertical) confined space is to blow clean air in near the bottom, and exhaust contaminated air at the top.

*Pink-colored air flow is clean supply air; grey-colored air flow is contaminated air exhausted from the space.
(Illustrations obtained from the Confined Space Ventilation employee handbook and used with permission from Coastal Training Technologies Corporation.)

<u>Confined Spaces with Two Openings</u> (continued)*

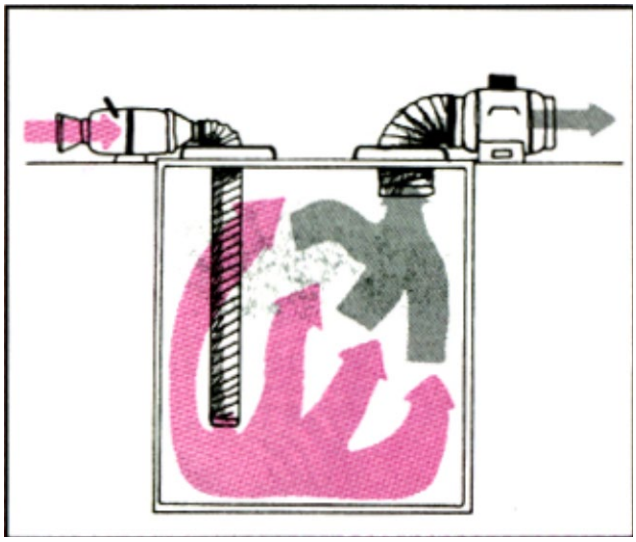


Figure 8. Contaminants Lighter Than Air. To remove air contaminants that are lighter than air from a confined space with two openings at the top, use long ductwork at one opening to supply fresh air to the bottom of the space and an exhaust fan at the second opening to remove contaminated air from the top of the space.

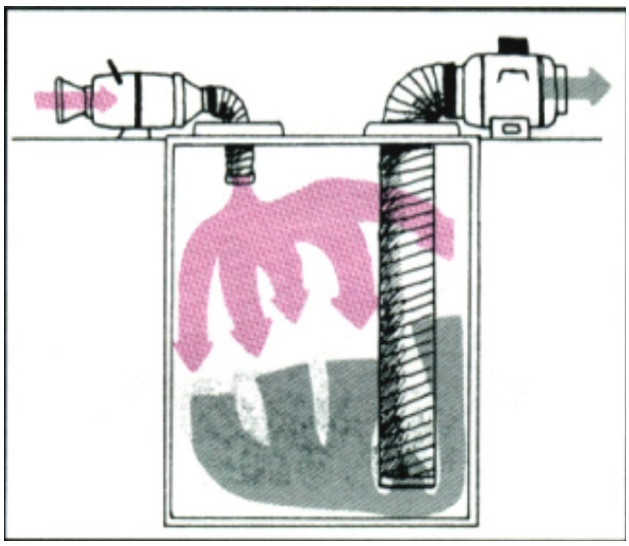


Figure 9. Contaminants Heavier Than Air. To remove air contaminants that are heavier than air from a confined space with two openings at the top, provide clean fresh air to the top of the space through one opening and use long exhaust ductwork at the second opening to capture and remove the low-lying contaminants at the bottom of the space.

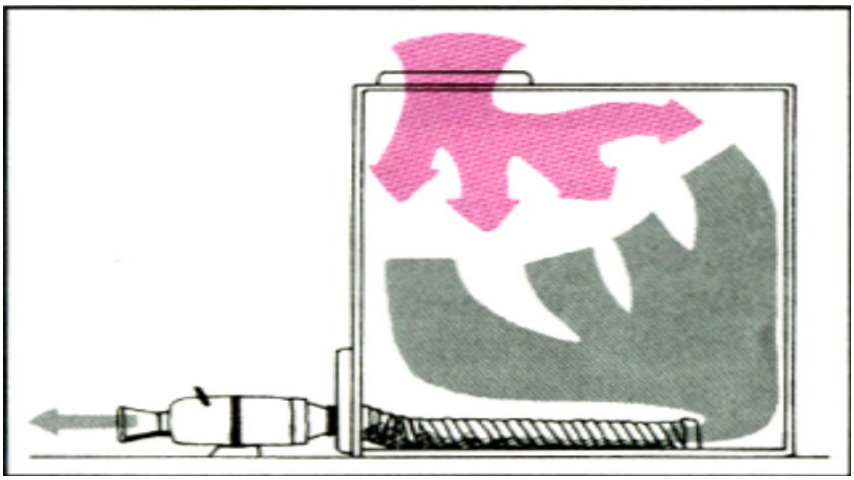
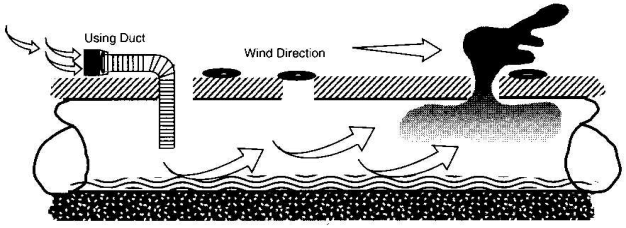


Figure 10. Prevent Short-Circuiting. To prevent short-circuiting in a confined space with two openings near each other, use (exhaust) ductwork to "direct" the incoming fresh air into places it would not otherwise reach.

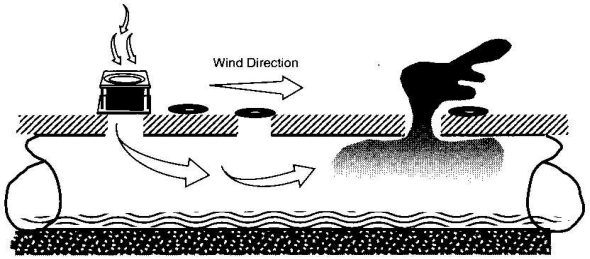
*Pink-colored air flow is clean supply air; grey-colored air flow is contaminated air exhausted from the space. *(Illustrations obtained from the Confined Space Ventilation employee handbook and used with permission from Coastal Training Technologies Corporation.)*

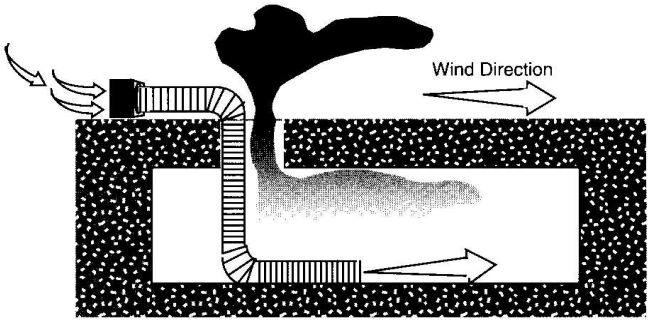
Pipelines and Underground Tanks or Vaults

11a

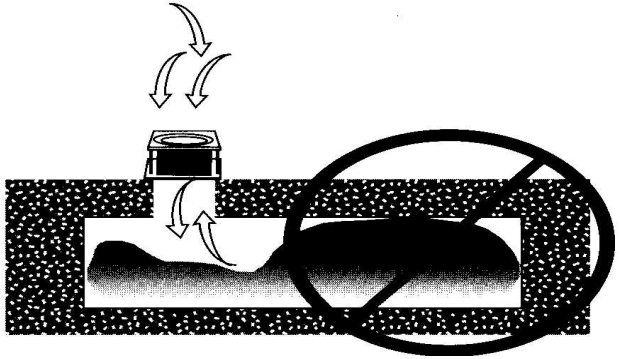


11b





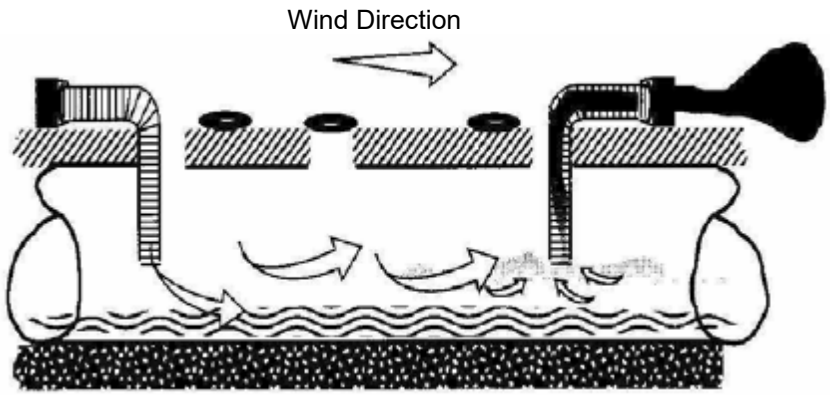
11c



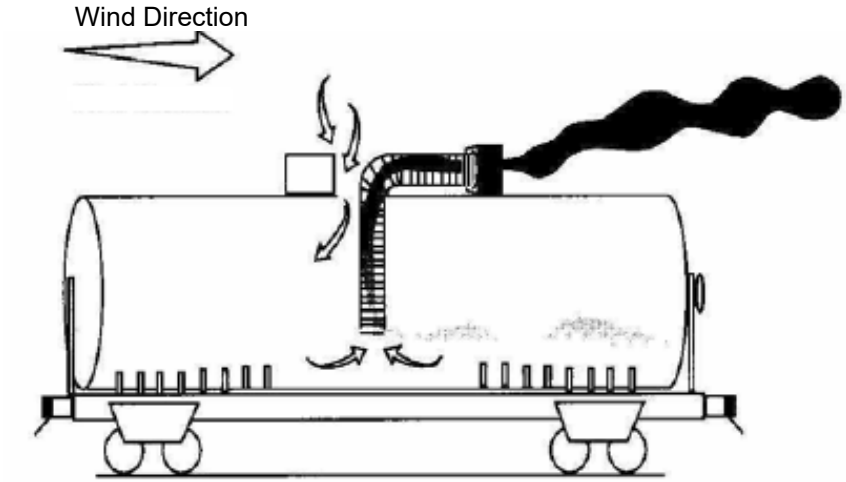
11d

Figure 11. Lighter Than Air Contaminants. Figures 11a through 11c show several confined space ventilation techniques for contaminants that are lighter than air. Note that wind direction is important to fan location to prevent short-circuiting. Figure 11d illustrates an ineffective ventilation technique for a space with one opening. (*Source of illustrations unknown.)*

Pipelines and Tank Cars



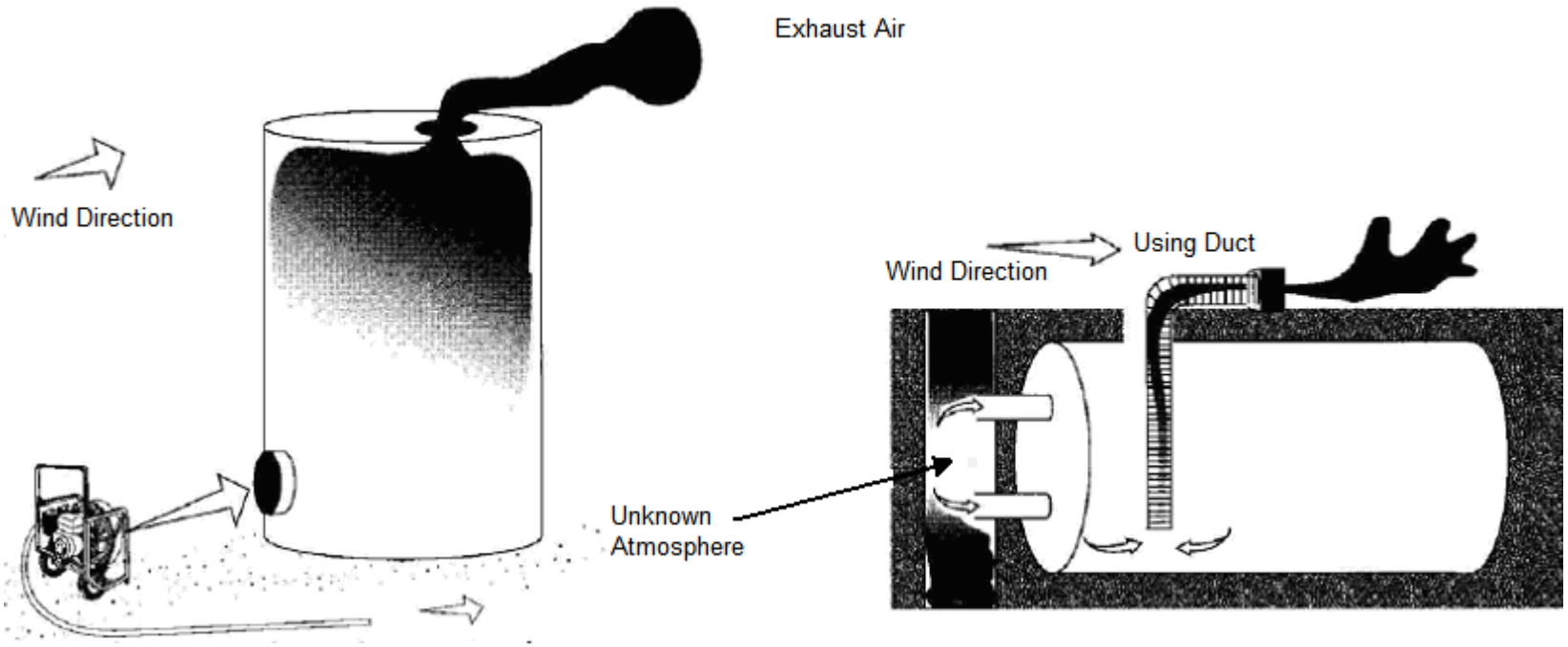
Heavier than air contaminants in a confined space with multiple openings.
An auxiliary fan is used to supply fresh air and create a positive bubble of air.



Heavier than air contaminants in a tank car with one opening.
Liquid contents should always be completely removed if possible.

Figure 12. Heavier than air contaminants. Confined space ventilation techniques for contaminants that are heavier than air. Note that wind direction is important to fan location to prevent short-circuiting. (*Source of illustrations unknown.)*

Above-Ground and Below-Ground Storage Tanks



Gas powered fan used for confined space ventilation showing remote engine exhaust extender. Use metal exhaust hose to extend exhaust air away from the space opening.

(13a)

Using only exhaust ventilation (negative pressure) may pull contaminants into the space from an unknown source.

(13b)

Figure 13. Confined space ventilation issues to be aware of in above-ground and below-ground storage tanks. Figure 13a illustrates an exhaust air hose extender to prevent recirculation of contaminated exhaust air back into the space. Figure 13b illustrates a situation where an unknown atmosphere could be drawn into a confined space under negative pressure from exhaust ventilation. (*Source of illustrations unknown.)*

Manholes and Basements

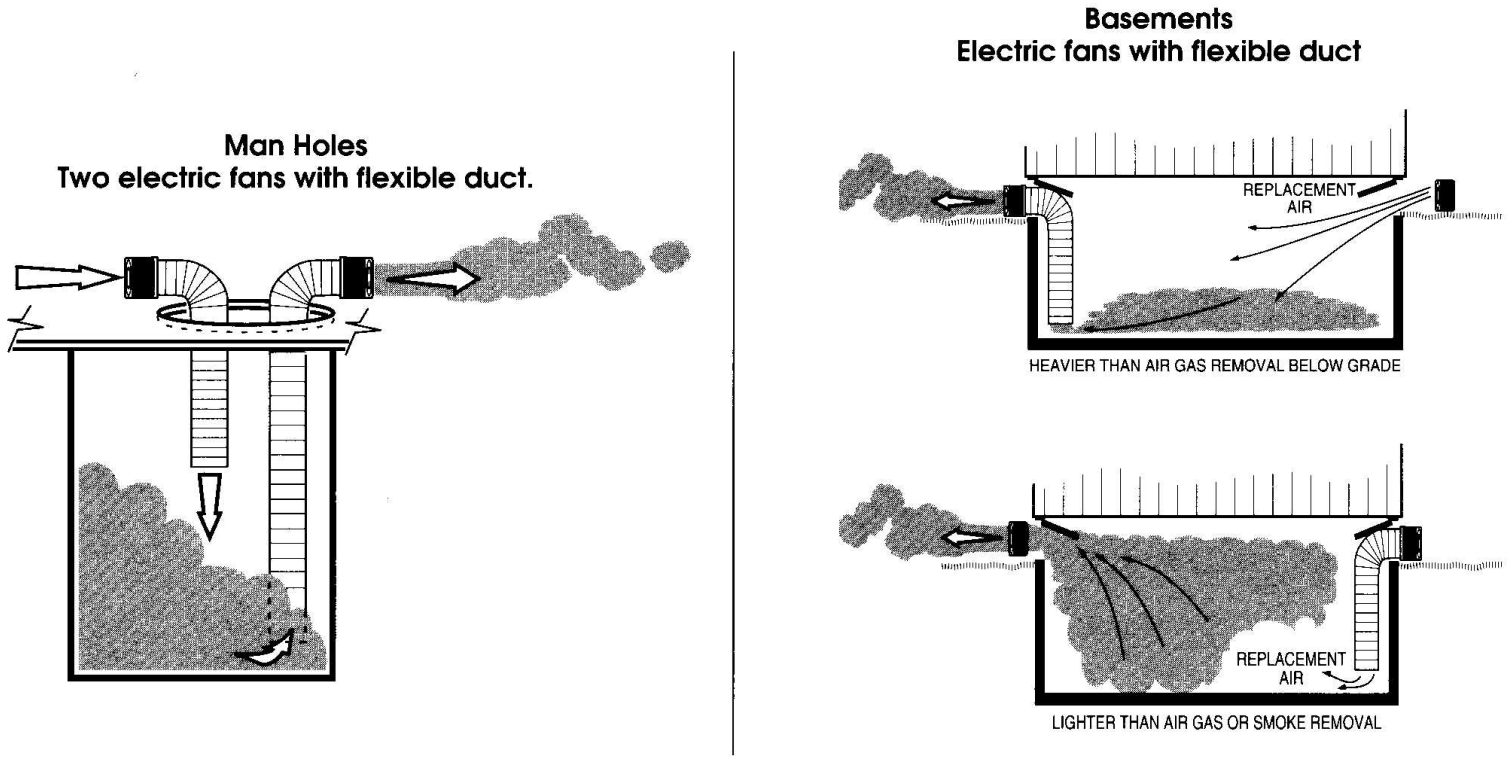


Figure 14. Effective confined space ventilation techniques for manholes and basements. (*Source of illustrations unknown.)*