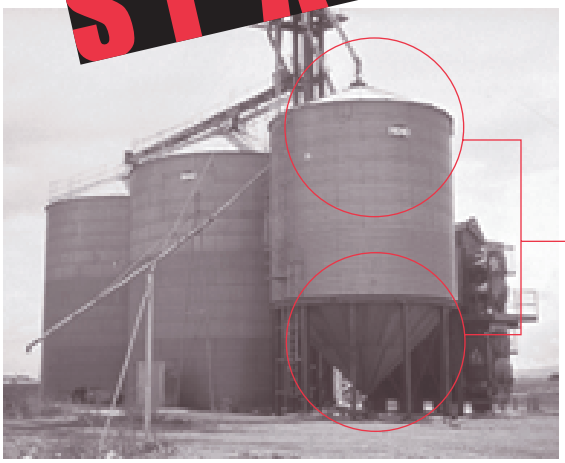
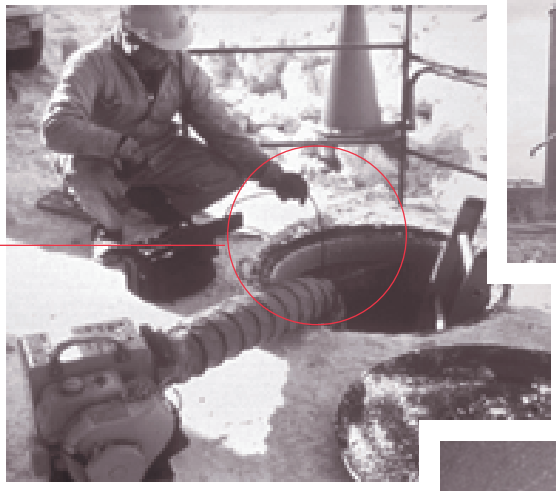
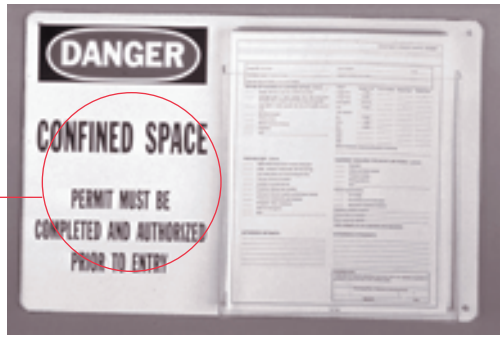
IS IT SAFE TO ENTER A CONFINED SPACE?











CONSULTATION CAL OSHA SERVICE

California State
Department of Industrial Relations
CAL/OSHA Consultation Service
Education and Training Unit



IS IT SAFE TO ENTER A CONFINED SPACE?

CONFINED SPACE GUIDE

California Department of Industrial Relations
Cal/OSHA Consultation Service
Education and Training Unit



Publishing Information

The *Confined Space Guide* was developed by the Education and Training Unit, Cal/OSHA Consultation Service, California Department of Industrial Relations. The document was published by the California Department of Education, 721 Capitol Mall, Sacramento, California (mailing address: P.O. Box 944272, Sacramento, CA 94244-2720). It was distributed under the provisions of the Library Distribution Act and *Government Code* Section 11096.

© 1998 by the California Department of Education

All rights reserved

TABLE OF CONTENTS

Acknowledgments ..... *v*

Regulatory Requirements *1*

Introduction *2*

Fatal Facts *4*

Rescue *5*

Emergency *6*

Self-Rescue, Non-Entry, and Entry Rescue *7*

Rescue Training and Plan *8*

On-Site Rescue Team vs. Off-Site Rescue Team *9*

Rescue Equipment *11*

Definitions and Basics *13*

General Terminology *14*

Confined Space; Immediately Dangerous to Life or Health (IDLH); Permissible Exposure Limits (PEL); Entry

Permit Evaluation *17*

Permit-Required vs. Non-Permit Confined Space; Space Reclassification; Alternate Procedures; Permit-Required Confined Space Program (Hot Work and Host Employer-Contractor)

Confined Space Hazards *24*

Atmospheric Hazards *25*

Oxygen Deficiency/Enrichment; Combustible/Flammable/Explosive Gases and Vapors; Combustible Dust; Toxics; Material Safety Data Sheets (MSDS); Monitoring-Air Sampling and Equipment

Physical Hazards *33*

Mechanical; Entrapment; Engulfment; Other Types of Hazards

Hazard Controls *35*

Controls for Atmospheric Hazards *36*

Ventilation; Respiratory Protection; Other Control Measures

Controls for Physical Hazards *38*

Isolation (Mechanical, Electrical, Pressurized Lines, Ducts, or Pipes); Other Control Measures

Personal Protective Equipment and Tools *40*

Communication System *41*

Training and Education *42*

Entry Team *44*
Supervisor; Entrant; Attendant

Frequently Asked Questions *47*

Attachments *53*

A – Hot Work Permit Sample *53*

B – Atmospheric Monitoring Equipment and General Testing Protocol *54*

C – Confined Space Entry Permit Sample *57*

D – Material Safety Data Sheet Sample *58*

E – Setting Up a Permit-Required Confined Space Program *60*

F – Permit-Required Confined Space (PRCS) Decision Flow Chart *62*

References *63*

Evaluation *65*

Cal/OSHA Consultation Service Offices ..... *Back cover*

ACKNOWLEDGMENTS

Writing and editing

Zin Cheung, Cal/OSHA Consultation Service, Education and Training (E & T) Unit, Sacramento, CA

Mary Grace Delizo, Cal/OSHA Consultation Service, San Diego, CA

The authors wish to thank the following persons for their review, comments, and support in the development of this document.

Editorial review

Michael Alvarez, Cal/OSHA Consultation Service, E & T Unit, Sacramento, CA

Bob Barish, Cal/OSHA Consultation Service, San Francisco, CA

Kent Freeman, Roseville Fire Department, Roseville, CA

Walter Graze, Asbestos Contractor Registration Unit, DOSH, San Francisco, CA

Dan Leiner, Cal/OSHA Consultation Service, Santa Fe Springs, CA

Peer review

Paul R. Burnett, Consultant/Trainer, Morgan Hill, CA

Mario Feletto, Cal/OSHA Consultation Service, E & T Unit, Sacramento, CA

Karen Fruin, JMD & Associates, San Diego, CA

Vicky Heza, Cal/OSHA Consultation Service, Anaheim, CA

Mary Jo Jensen, Cal/OSHA Consultation, Sacramento, CA

Debra Mital, Bioenvironmental Engineering Services, McClellan Air Force Base, Sacramento, CA

Robert C. Moats, Environmental and Occupational Risk Management, San Jose, CA

Steve Smith, Cal/OSHA Standards Board, Sacramento, CA

George Solano, City of Vista, Waste Water Division, San Diego, CA

Preliminary layout and design

Jack Oudiz, DOSH Professional Development and Training, Sacramento, CA

Draft document preparation

Bernadine Osburn, Cal/OSHA Consultation Service, E & T Unit, Sacramento, CA

REGULATORY REQUIREMENTS

UNDER the California Labor Code and the California Occupational Safety and Health Act of 1973, all employers in California have the legal obligation to provide and maintain a safe and healthful workplace for employees. The general requirements for employers to provide an effective Injury and Illness Prevention Program are in Title 8 of the California Code of Regulations (T8 CCR), Section 3203.

The specific confined space regulatory requirements are in T8 CCR, Article 108, sections 5156 through 5158. Because confined space work may involve many different hazards, other regulatory requirements may also apply.

Section 5156	Identifies operations and industries that are regulated under Section 5158.
Section 5157	Covers all other industries. It contains requirements for practices and procedures to protect employees from the hazards of entry into permit-required confined spaces.
Section 5158	Applies specifically to construction, agriculture, marine terminals, shipyard operations, grain handlings, telecommunication, natural gas, and electric utilities.

To obtain a free copy of the Injury and Illness Prevention Program or the confined space standard, or for more information on these requirements, please call the nearest Cal/OSHA Consultation Service Office listed on the last page of this publication. Employers needing on-site consultation may also call the Cal/OSHA Consultation Service Office for free professional assistance. Cal/OSHA consultants advise employers of any changes needed to eliminate potential and existing hazards. Consultants do not participate in enforcement activities. When hazards are identified during an on-site consultation visit, consultants do not issue citations or penalties.

INTRODUCTION

THIS *Confined Space Guide* has been developed to explain the hazards of confined space work and to assist employers in establishing and maintaining an effective confined space program. By implementing such a program, both employers and employees will be able to:

- Recognize, evaluate, and control confined space hazards.
- Save lives and protect employees from job-related injuries and illnesses.
- Promote safe and effective work practices.
- Reduce preventable workers' compensation losses.
- Comply with the law.

The *Confined Space Guide* contains information, definitions, and requirements for entry into permit-required confined spaces (Section 5157). To call the attention of employers whose operations and industries are regulated under Section 5158, the confined space definition and requirements are distinctively highlighted. To clarify and facilitate the understanding of confined space issues, the guide presents the information in the format of questions and answers and includes a list of the most frequently asked questions.

For easy reference, the guide is separated into six distinct main sections:

- ***Rescue,*** which addresses questions about various types of rescue operations, rescue training, and equipment, along with the importance of well-planned rescue activities.
- ***Definitions and Basics,*** which contains essential definitions of terms such as confined space, immediately dangerous to life and health (IDLH), and the permissible exposure limit (PEL). This section also addresses entry issues and issues relating to permit evaluation (including permit-required confined space reclassification, alternate procedures, and hot work permits).
- ***Confined Space Hazards,*** which addresses specific atmospheric and physical problems that can be encountered when working in confined spaces as well as questions relating to Material Safety Data Sheets and atmospheric testing.



- ***Hazard Controls,*** which addresses means of preventing accidents and controlling other problems by eliminating or controlling confined space hazards.
- ***Training and Education,*** which addresses the importance of gaining new understanding of critical confined space issues and acquiring practical skills for successful confined space work. This section applies to the supervisor, the entrant, and the attendant.
- ***Frequently Asked Questions,*** which contains a variety of other questions about miscellaneous confined space issues.

At the back of this guide, there are six attachments intended to further assist employers who are starting to learn about confined spaces or for those who wish to improve an existing program. Attachments A through D provide samples of hot work and permit-required confined space entry forms, Material Safety Data Sheets, atmospheric monitoring equipment information, and general testing protocols. Attachment E, "Setting Up a Permit-Required Confined Space Program," contains easy, step-by-step instructions for required and suggested actions in the implementation of a confined space program that meets regulatory requirements. Attachment F, "Permit-Required Confined Space (PRCS) Decision Flow Chart," helps employers to determine the required entry procedure as defined by the confined space standard.

This guide does not list every conceivable confined space hazard. It is not intended as a legal interpretation of federal or state standards and should not be used as a substitute for training.

Case: Oxygen deficiency and toxic vapors

Worker dies of asphyxia in toxic vapor-filled gasoline delivery manhole



In El Monte, California, the body of a worker was found in a gasoline delivery manhole measuring 36 inches in diameter by six feet deep. This was a permit-required confined space. The victim had been working in the manhole without any protection and asphyxiated after inhaling gasoline vapors. After an investigation, the employer was cited for failing to conduct or provide (1) a written permit-required confined space program; (2) a hazard evaluation; (3) adequate training; and (4) protective equipment or clothing.

Case: Asphyxiation

Ill-prepared worker suffocates in sawdust silo

A maintenance worker for a furniture manufacturing company died after falling headfirst into a sawdust silo. The silo was 17 feet in diameter, 36 feet high, and had a 24-inch diameter manhole. The victim was responsible for operating the silo. He would normally climb a staircase attached to the side of the silo, remove the manhole cover and rake the sawdust away from the inlet duct with a 10-foot-long aluminum-handled rake. Evidence indicates that the victim slipped and fell seven feet into the sawdust, submerging his torso in the material. He died of suffocation in an upside-down position.



The victim's employer had failed to develop or implement a confined space safety work program for employees who worked in or near confined spaces containing unstable material. Appropriate fall protection equipment was not provided to workers.

RESCUE

TWO-THIRDS of all confined space fatalities occur among would-be rescuers. For this reason, the rescue section has intentionally been placed near the beginning of this guide. To prevent deaths, it is critical to use good confined space entry practices so that there is no need for rescue operations. Remember, even a well-planned rescue can end up as a body retrieval.



Note for Section 5158 Employers

Though Section 5158 employers are not required to follow the rescue requirements of Section 5157(k), they are advised and encouraged to do so.

Case: Oxygen deficiency and cyanide gas

Workers killed by cyanide gas; employer charged with negligence

In Oakland, California, an employee from an electroplating company was overcome by cyanide gas while cleaning the interior of a wastewater treatment tank containing toxic acids and cyanide sludge. When a second employee entered the tank to rescue the co-worker, he was overcome by the fumes and died. Several other employees were hospitalized as a result of their involvement in the rescue and cleanup operations.

Criminal charges were filed through the District Attorney's Office and a $741,000 fine was assessed. The employer was cited for a number of safety violations, including failing to (1) prevent unauthorized entry into a confined space; (2) develop and implement a confined space program; (3) specify acceptable entry conditions; (4) label tanks to indicate their contents; and (5) test for oxygen deficiency.

1. Why have confined spaces killed so many people?

Confined spaces are deceiving. A confined space often appears to be harmless; no danger signs are apparent and the space may have been entered on prior occasions without incident. However, a worker cannot assume that conditions have not changed and that the space is safe for entry each time.

2. What is an emergency?

An emergency is any occurrence inside or outside the space, including failure of hazard control or monitoring equipment, that may endanger authorized confined space entrants.

3. Why do so many fatalities result from emergency rescues?

Fatalities can occur when the rescuers:

- Are overcome by their emotions.
- Take unnecessary chances.
- Do not know the hazards involved.
- Do not have a plan of action.
- Lack confined space rescue training.

4. Is it important to inform confined space workers and rescuers of the four-minute limitation?

Absolutely. It is important to know that the period of time for successful rescue is very limited. Otherwise, a rescue attempt will become body retrieval. *After only four minutes without oxygen, it is very likely that a worker will experience asphyxiation, which may result in brain damage or death.*



5. What can be done to prevent confined space rescuers from having fatal accidents?

Precautions must include:

- Planning.
- Designation of rescue team members and respective duties.
- Training of personnel in order to give them the understanding, knowledge, and skills necessary for safe rescue from confined spaces.

6. What shall confined space rescue training encompass?

At a minimum, training must include:

- Recognition of permit space hazards.
- Control of permit space hazards.
- Use of atmospheric monitoring equipment.
- Use and maintenance of personal protective equipment (PPE).
- Use and maintenance of rescue equipment.
- Annual practice of permit space rescues.
- Proficiency in first aid and cardiopulmonary resuscitation (CPR).
- Documentation of training.

Important rescue training considerations:

- Ensure that the rescuer does not travel a greater distance than allowed by the air supply, self-contained breathing apparatus (SCBA), and escape cylinders. Analyze distance, space configurations, physical obstacles, and total time needed to enter the space, perform rescue operations, and leave the space.
- Leave the space *immediately* whenever a problem arises with respiratory protection equipment or whenever the attendant orders evacuation.



Confined space rescue training

7. What does one need to assume in any rescue operation?

Everyone involved in a rescue should assume that *the space is deadly* and that *entry rescue may be required in the worst case*!

8. Who can be a rescuer?

Rescues can be performed by another employee or a professional rescuer so long as he or she has been fully trained and qualified to act as a rescuer. Qualifications include knowledge of and experience working with all hazards associated with rescue and confined space entry operations.

9. What are the different types of rescue operations?

Depending on the severity of the emergency, different rescue methods can be employed. When the emergency is minor, self-rescue is often the best approach; however, if the worker is disabled, it is likely that non-entry or entry rescue, the latter of which involves putting others at risk, will be necessary.

Attention

Employers need to assess *all* hazards associated with each confined space entry and then determine ahead of time the types of rescue operations that are most appropriate to cover all foreseeable emergencies that may arise during each confined space entry. Well-thought-out self-rescue and rescue plans increase the likelihood for a successful outcome in the event of an emergency.

Because of the speed at which confined space hazards can incapacitate and kill, ***self-rescue*** is the preferred plan. The self-rescue plan provides entrants with the best chance of escaping a permit space when hazards are present. Whenever authorized entrants recognize their own symptoms of exposure to a dangerous atmosphere, or when a prohibited condition is detected, entrants are still able to escape from the space unaided and as quickly as possible.

Non-entry rescue is the next-best approach when self-rescue is not possible because non-entry rescue can be started right away and prevents additional personnel from being exposed to unidentified and/or uncontrolled confined space hazards. Usually, equipment and other rescue aids are employed to assist in removing endangered entrants. In situations where configuration of the space or other elements prevent the removal of the worker, entry rescue may be the only solution.

Entry rescue involves rescuers entering the space to retrieve the entrant and/or provide the victim with emergency assistance such as CPR, first aid, and air via SCBA or a supplied air respirator (SAR), if needed. *An entry rescue plan needs to be developed ahead of time in the event of an emergency for which the non-entry rescue plan is not appropriate.*

10. Why is self-rescue so important?

Self-rescue is vital because the entrant is:

- Conscious and alert.
- Able to recognize his or her own signs and symptoms.
- Still physically able to evacuate space more rapidly than waiting for someone else to rescue him or her.
- Able to alert fellow workers of impending dangers.
- Not endangering anyone else.

11. What information needs to be immediately available to rescuers?

Rescuers will need to know:

- Number of victims and location of emergency.
- Length of time victims have been exposed to hazard.
- Suspected cause of accident.
- All information on entry permit, including:
  - Atmospheric testing results.
  - Isolation procedures.
  - Material Safety Data Sheet (MSDS) information.



12. What elements should be contained in a rescue plan?

A thorough rescue plan includes:

- A barricade area for crowd control.
- Additional ventilation options.
- Control of other hazards (cave-ins, traffic, etc.).
- Protective clothing and equipment.
- Appropriate lighting equipment (explosion-proof).
- Methods of communication.
- A standby rescue team.
- Victim removal procedures and devices.
- Available emergency vehicles.
- Medically trained personnel.

13. How often should rescue simulations be performed?

Rescue practices in simulated or actual spaces should be performed *at least* once every 12 months, or more frequently if deemed necessary.

14. When does a rescue plan need to be re-evaluated?

Re-evaluate the plan whenever:

- Conditions change within the space.
- Workers discover any new hazards.
- There are changes in the rescue personnel and/or personnel availability.
- New equipment is purchased.
- Routine proficiency training results are unsatisfactory.
- A rescue plan is found to be deficient (e.g., a failed simulated rescue).

15. How can the facility owner prepare for an emergency?

As an employer, you must have on-site rescue ability; however, you can also supplement your rescue operation with an off-site rescue team.

On-Site Rescue

At least one on-site employee shall be trained in first aid and CPR. Each member of the rescue team shall be trained to:

- Properly use and maintain PPE and rescue equipment.
- Act as a rescuer in annual simulated emergencies.
- Assume individual roles and take on any emergency.

Off-Site Rescue

If off-site rescue cannot be provided quickly enough, it is not a real option!

- Remember that while the window of opportunity for a rescue is very brief—only four minutes—the response time for an off-site rescue team may be considerably longer. After four minutes have lapsed, the victim could suffer brain damage or die. In some emergencies, rescuers may have even less than four minutes to act. Other situations may allow more time.
- Arrange for local rescue/fire departments to provide rescue services. Supply the number and description of each permit-required confined space in the facility ahead of time.
- Disclose all known hazards associated with the space(s) so that appropriate rescue plans can be developed.
- Provide access to the space so that off-site rescue personnel can familiarize themselves with the site, develop a rescue plan in advance, and practice rescue operations.



Off-site rescue team

16. Why does an employer have to verify the availability of the off-site rescue service each time a permit space entry is scheduled or attempted?

The employer has overall responsibility for employee safety. The verification task is usually assigned to the entry supervisor. If the off-site rescue service indicates for any reason that it would be unable to respond to a rescue summons, *entry must not be authorized unless and until an adequate back-up rescue service is arranged and confirmed.*

17. Will emergency rescue services always go into confined spaces to rescue entrants?

Not necessarily. If the worker is physically able to use rescue equipment (safety retrieval line, rope, wristlets, etc.), rescuers may choose not to enter the space. Instead, they can provide appropriate equipment and assistance necessary to bring the worker out of the space (a non-entry rescue). In situations in which the worker is unresponsive, atmospheric hazards are extremely high, or significant time has elapsed before rescuers arrive at the site, emergency rescue personnel may decide that the risks associated with entering outweigh the potential for a successful rescue. If this is the case, rescuers may elect not to go into the confined space until conditions warrant a safe entry.

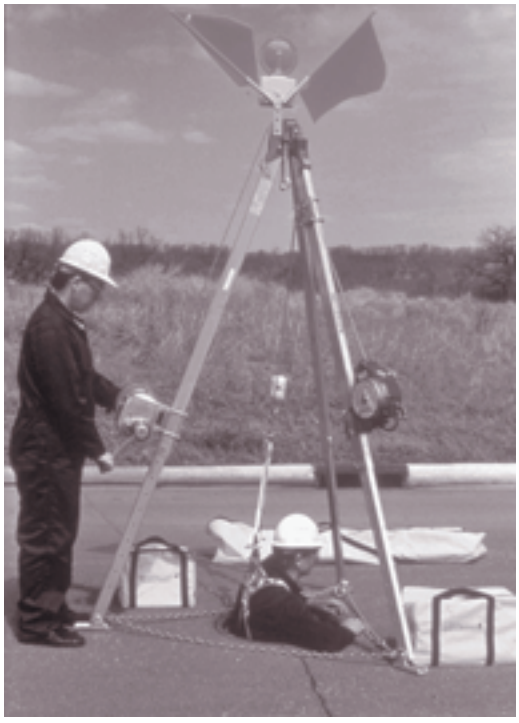
18. What are some types of rescue equipment?

Rescue equipment may include:

- Full body harness with retrieval line attached.
- Wristlets (may be used in rescue when it can be shown that they are the safest and most effective means of rescue).
- Hand-cranked mechanical winch and tripod (required when entrant is five feet or more below the entrance).
- Ladder.
- Explosion-proof lighting.
- SCBA/SAR.
- Stretcher.
- Approved head protection.

Attention

Although not required, a back-up system or secondary mechanical rescue device can be advantageous to the success of a rescue operation.



Tripod, winch, and full harness

19. Who is required to wear a full body harness and retrieval lines?

All authorized entrants and rescuers entering permit spaces are required to use full body harnesses and retrieval lines, unless it is determined that the retrieval equipment would increase the overall risk of entry or would not contribute to the rescue operation.

20. What kind of equipment should be used for lowering or lifting entrants?

Only devices designed by the manufacturer and approved for moving humans should be used. The equipment must enable a rescuer to remove the injured employee from the space quickly *without injuring the rescuer or further harming the victim.*

21. If, during a rescue operation, the readings for oxygen, Lower Explosive Limit (LEL), and carbon monoxide are all normal, should rescuers still wear respirators?

If there is even a remote possibility of other atmospheric contaminants, even though these readings appear to be within the normal ranges, rescuers should still use appropriate respiratory protection.

Play it safe:

- Wear SCBA or SAR.
- Do not use air purifying respirators for confined space rescue.



Rescuer with self-contained breathing apparatus

DEFINITIONS AND BASICS

In order to fully understand the information offered in this guide, the reader must first understand the terms used. Following are definitions for scientific and regulatory confined space terms used throughout this publication.

Case: Electrical hazard and flammable vapors

One painter dies, another suffers severe burns from flash fire explosion

A 41-year-old painter entered the top opening of a 1,300-gallon tank in order to paint the inside with flammable epoxy paint. To provide interior lighting, a co-worker placed a 500-watt, non-explosion-proof halogen lamp close to the opening. The co-worker sat on top of the tank to observe while the painter sprayed the bottom and sides of the tank. As he painted, the spray gun nozzle hit the lamp, broke the sealed beam, ignited the epoxy vapor, and caused a flash fire explosion. Over 40 percent of the painter's body was burned, and he died five days later. His co-worker suffered a broken arm and burns to his face and neck.

The company did not have a formal safety program and no job hazard analysis had ever been done.

22. What is a confined space?

General Terminology

A confined space is a space that has all three of the following characteristics:

- Is large enough and configured such that an employee can bodily enter and perform work; and
- Has limited openings for entry and exit; and
- Is not designed for continuous employee occupancy.

Note for Section 5158 Employers

Note

A confined space is defined as a space that meets both of the following conditions:

- Existing ventilation is insufficient to remove dangerous air contaminants and/or correct oxygen deficiency; and
- Access to or egress from the space is difficult.

Confined space examples



Silo

Some confined space openings are small in size, making passage difficult for workers, tools, and lifesaving equipment that would be necessary in the event of a rescue operation. In other cases, the size of the confined space is not a problem, but access to the opening requires the use of ladders, hoists, or other equipment. Consequently, entry and escape can be difficult.



Chemical storage tank



Railroad tank





Atmospheric Hazards in Shopping Malls and Swimming Pools

Confined spaces are found not only in industrial settings but also in public places such as shopping malls and large public swimming pools. Waterfalls and water fountain displays used in malls for beautification may have pump vaults or valve pits that are seldom entered. Some swimming pool pumps are placed in vaults below ground. There have been reports of maintenance employees entering these areas and losing consciousness.

Potential hazards include:

- No ventilation (pits and vaults seldom opened).
- Leaking chlorine gas (which is heavier than air) can accumulate in low-lying spaces.
- Oxygen depletion can be caused by:
  - Rotting vegetation and decaying dead animals.
  - Corroding or rusting machinery.

23. Why are confined spaces dangerous to entrants?

By nature, confined spaces can be hazardous due to:

- Space configurations such as small openings and inwardly converging walls, which can trap an entrant, restrict easy entry and exit, or impede rescue.
- Atmospheric hazards such as gasoline tank vapors, combined with limited ventilation. Such conditions can cause asphyxiation or explosion.
- Physical hazards, such as unstable grain contained in silos, which can engulf a worker.
- All other serious hazards associated with general industry, such as electrical equipment, moving machinery, falling objects, and wet or slippery surfaces.

24. What does immediately dangerous to life or health (IDLH) mean?

This refers to any condition in a permit space that would:

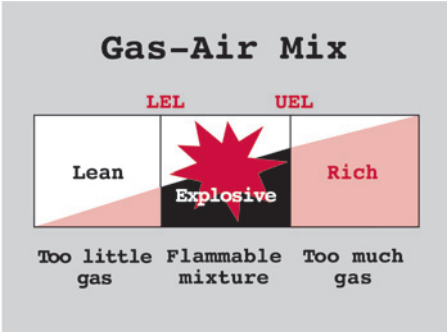
- Cause irreversible adverse health effects; or
- Interfere with self-rescue; or
- Cause immediate or delayed threat to life or health.

25. What are the PELs?

Permissible exposure limits, or PELs, are occupational exposure standards that refer to the maximum concentration of airborne chemicals to which nearly all healthy persons can be exposed day after day without adverse health effects. Workers' exposure to concentration of materials in excess of the PEL can result in detrimental health effects, including illness and/or death.

26. What are the LEL (LFL) and UEL (UFL)?

The lower explosive limit, or LEL, is the lowest atmospheric concentration of fuel in the fuel-air mixture at which a gas or vapor can explode (the lower flammable limit, or LFL, is the lowest concentration at which the gas or vapor will burn). Fuel concentrations below the LEL and LFL are too lean and will not explode or burn.



The highest atmospheric concentration of a gas or vapor in the fuel-air mixture that can explode is called the upper explosive limit, or UEL. Above this concentration, the mixture will not explode because it is too rich (the mixture has too much fuel). The UFL is the maximum fuel concentration above which the mixture will not burn.

The composition of a fuel vapor and air mixture can change over time and may fluctuate within a space. Fluctuations occur because the fuel-air mixture moves around the space, particularly when people or other things create air currents that disturb the atmosphere. Consequently, the mixture is not uniformly distributed within the space.

27. What is "entry"?

An entry is considered to have occurred when *any* part of a person's body crosses the plane of an opening into the space.



A worker crosses the plane of entry into a confined space.



Note for Section 5158 Employers

Confined spaces with side and top openings shall be entered by the side openings when practical. Side openings are those located within three-and-a-half feet of the bottom.

28. Is confined space entry always necessary, or is it possible to complete the task from the outside?

Each employer should ask these questions at the onset of each project. If possible, ***avoid entering a confined space***. Every consideration should be given to completing the task from the outside.

Permit Evaluation

Permit-Required vs. Non-Permit Confined Spaces

29. Is a permit always needed in order to enter a confined space?

Not necessarily. There are two types of confined spaces. Those that require a permit for entry are classified as *permit-required confined spaces* (PRCS) and those that can be entered without a permit are called *non-permit confined spaces* (NPCS).



Note for Section 5158 Employers

No permit system is required to enter and work in confined spaces. Only written operating and rescue procedures are needed. Also, results of atmospheric testing of the space shall be written and maintained at the work site for all affected employees to review.

30. What is the difference between permit-required and non-permit confined spaces?

A *permit-required confined space* fits the definition of a confined space and has one or more of the following characteristics:

- Contains or has a potential to contain a hazardous atmosphere (e.g., paint thinner).
- Contains a material that has a potential for engulfing the entrant (e.g., liquid, soil).
- Contains inwardly converging walls or a floor that slopes downward and tapers to a smaller cross-section where an entrant could be trapped or asphyxiated.
- Contains any other recognized serious safety or health hazard (e.g., unsafe temperature, electrical shock, corrosive chemicals).

A *non-permit confined space* fits the definition of a confined space, but does not contain or have the potential to contain any atmospheric hazard capable of causing death or serious physical harm.

Attention

When initially classifying confined spaces, the best approach is to consider every space that has an atmospheric and/or non-atmospheric hazard, or even the potential to contain an atmospheric hazard such as a PRCS. Downgrading of a PRCS to a NPCS can be done only when all hazards have been thoroughly evaluated and eliminated.

31. What if the spaces in the facility are non-permit confined spaces and entry is necessary?

Entry into a NPCS must still be done in accordance with the employer's Injury and Illness Prevention Program and other applicable regulations in order to ensure that employees comply with safe and healthful work practices.

32. What shall employers do if the workplace contains permit-required confined spaces?

Inform employees of the existence, specific location, and dangers of PRCS by posting danger signs or by any other means that ensures *effective communication* with employees. Employers who have non-English-speaking employees may also have signs printed in other languages.



If the employer decides that employees *will not enter* permit spaces, the employer must implement effective measures to prevent entry, including the installation of physical barriers and permanently closing the space by bolting and locking. Reinforce the non-entry policy through employee training. The steps taken by the employer must *effectively prevent employees from entering permit spaces.*

If the employer decides that employees *will enter* permit spaces, the employer must develop and implement a written *permit-required confined space program* (see Attachment E, "Setting Up a Permit-Required Confined Space Program").

33. Once it has been determined that a workplace contains permit-required confined spaces and that entry is necessary, what procedures must be followed?

1. If you are unable to institute alternate procedures or reclassify to a non-permit space status, follow the requirements of a permit-required confined space entry (see Attachment F, "Permit-Required Confined Space Decision Flow Chart").
2. Use alternate procedures if you are able to effectively control atmospheric hazards solely by continuous forced-air ventilation.
3. Reclassify the PRCS as a NPCS if you are able to eliminate all hazards.

Reclassification

34. When can a permit-required confined space be reclassified as a non-permit confined space?

If the permit space poses no actual or potential atmospheric hazard and if all hazards within the space are eliminated without entry, the space may be reclassified as a NPCS for as long as the non-atmospheric hazards remain eliminated.

35. What happens if hazards arise in a space that has been declassified from permit-required to non-permit?

If hazards arise:

1. All employees must *immediately* leave the confined space; and
2. The space shall be evaluated to determine how the hazardous atmosphere developed; and
3. Measures shall be implemented to protect employees from the hazardous atmosphere before any subsequent entry takes place.

36. Will a non-permit confined space always be classified as such?

Not necessarily. Whenever there are changes in the use or configuration of an NPCS that might increase the hazards to entrants, the employer shall re-evaluate that space, and, if necessary, reclassify it as a PRCS. New work, such as painting inside a confined space, can create new hazards that may not have been accounted for in the initial space classification. Consequently, the space may no longer be safe for entry and must be reclassified.

Alternate Procedures

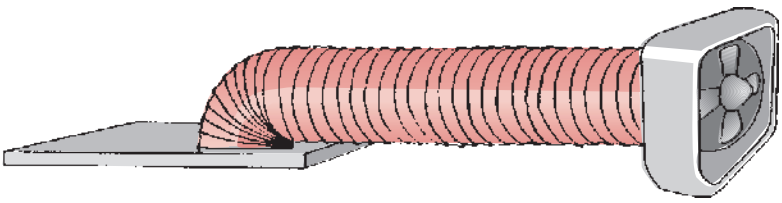
37. What if the only hazards or potential hazards of the space are atmospheric contaminants that can be eliminated by continuous forced air?

Alternate procedures can be used to enter the space when:

- No other hazards exist; and
- Atmospheric hazards can be effectively removed and controlled by forced ventilation; and
- Workers can safely enter and do work in the space; and
- All testing results and monitoring data are documented, retained, and made available to each employee who enters the space.

38. What is the "safe for entry" level as defined by the alternate procedures?

This is a general safety guideline of 50 percent of the permissible flammable level or permissible toxic substance level recommended during confined space entry under the alternate procedures.



Ventilation is essential when working under alternate procedures.

39. Why is it so important to observe the "safe for entry" level before entering a confined space under the alternate procedures?

The "safe for entry" level is a guideline that offers additional protection to the worker whose safety is totally dependent upon an effective ventilation system.

Remember that under the alternate procedures, permit space safety is maintained solely by continuous forced-air ventilation. It is important to prevent the atmosphere inside the confined space from reaching hazardous concentrations to ensure that, in the event of ventilation failure (such as a fan breakdown), the employees will still have enough time to recognize the hazards and leave the space.

40. How will an employer determine a "safe for entry" level for contaminants under the alternate procedures?

It is permissible to enter a PRCS when the atmosphere is at or below 10 percent of the LEL; however, in order to protect entrants from fluctuations in the concentration of gases, it is recommended that gaseous levels be reduced by an additional 50 percent. If toxic substances are present, the "safe for entry" guideline recommends that concentration of toxics be reduced to 50 percent of the PEL.

Permit-Required Confined Space Program

41. What are the elements of a written permit-required confined space program?



At a *minimum*, the written permit-required confined space program must address:

- Posting of warning signs.
- Preventing unauthorized entry.
- Hazard identification procedures.
- Workplace evaluation procedures.
- Procedures, practices, and means necessary for safe permit space entry and closure operations.
- An entry permit system.
- Employee training for entrants, attendants, and entry supervisors.
- Providing work equipment and PPE at no cost to employees.
- A system for ensuring that:
  - Pre-entry testings are performed.
  - Pre-entry preparations are completed.
  - Acceptable conditions are attained.
- Monitoring the space as needed.
- Developing and implementing rescue and emergency measures.

42. What is an entry permit?

An entry permit is a document prepared by the employer or employer representative. It is designed to be used as a checklist to document the completion of all steps necessary to prepare for safe entry and work in a confined space.

The entry supervisor shall sign the entry permit to ensure that acceptable conditions have been attained in the permit space and to authorize entry. Further, the permit shall be posted near the confined space entry for entrants to verify that pre-entry procedures have been completed.

43. What is included in the entry permit?

The entry permit should include:

- The location of the permit space to be entered.
- The purpose of the entry.
- The date and the authorized duration of the entry permit.
- The names of authorized entrants, attendants, and entry supervisors.
- The hazards of the permit space.
- The measures used to eliminate, isolate, or control permit space hazards before entry.
- The acceptable entry conditions.
- The results of initial and periodic tests performed, along with the names of the testers and when these tests were performed.
- The verified rescue and emergency services to be summoned.
- The communication system.
- The equipment to be used during entry.
- Any additional information necessary to ensure employee safety.
- Any additional permits issued to authorize special work in the space (such as hot work).



44. How does an employer get an entry permit?

Each employer needs to develop his or her own entry permit that addresses the specific hazards and controls for that particular confined space entry.

An entry permit is not a form issued by Cal/OSHA. Employers do not need to apply for or submit a completed permit to Cal/OSHA (see Attachment C, "Confined Space Entry Permit Sample" and appendices D-1 and D-2 of T8 CCR, "Confined Space Regulations").

45. When is an entry permit valid?

The entry permit is valid once it has been signed by the entry supervisor.

46. Is a permit valid for more than one shift?

An entry permit is valid for more than one shift if information documented in the entry permit contains provisions that cover the shifts:

- Names of all involved employees (entry team plus next shift).
- Clearly delineated transfer of responsibilities from one shift to another.
- Acceptable entry conditions are maintained.
- Entry operations remain consistent with terms of the entry permit.

Attention

The entry supervisor terminates entry and cancels entry permits. Cancellation prevents reuse; a new permit is required for subsequent entries.

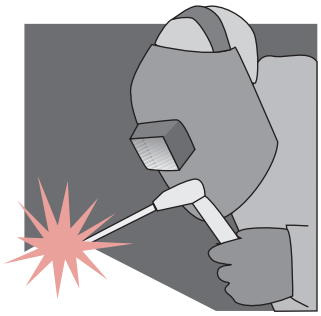
47. How long should a facility owner keep the entry permit?

The entry permit should be kept on file for one year.

48. Why are employers required to review canceled permits annually?

The annual review of canceled permits allows employers to assess and revise, if needed, their permit space program to ensure that confined space workers are protected from space hazards.

49. What is "hot work"?



"Hot work" includes any operation capable of providing a source of ignition. Examples include electrical tools with open brushes and commutators or any device that produces sparks or could become an ignition source. One of the dangers of hot work operations is the increased risk of fire and explosion because of the introduction of an ignition source into a space with an already-hazardous atmosphere (see Attachment A, "Hot Work Permit Sample").

50. Do hot work operations require special considerations?

Yes. Employers must evaluate existing hazards within the space *and* potential hazards created from hot work operations, and then:

- Take special precautions (such as improving ventilation, inspecting for frayed wires, implementing fire-suppression measures or using low-voltage, non-sparking tools) to reduce potential hazards; and
- Have a written hot work permit for every hot work operation.

51. What responsibility does the owner have when hiring a contractor to do work in a confined space within the facility?

The owner must inform the contractor:

- That the space is a confined space and that entry must be by permit only; and
- About all known hazards; and
- About any precautions that you, as the owner, are already instituting for the protection of employees.

52. Once the job is complete, is the contractor required to confer with the host employer?

Yes. The contractor is obligated to inform the host employer of his or her experience with the space and of any additional hazards that may have been created by the work.

53 . What if some of the site owner's employees are doing work in the confined space alongside the contractor's employees?

In this case, the site owner needs to coordinate entry operations with the contractor so that both understand the type of work and hazards involved. Such work can create new hazards, and everyone working inside the confined space must be alerted. If working together is unsafe, the two teams may have to plan a different strategy.

CONFINED SPACE HAZARDS

MANY confined space accidents occur because the workers did not realize the dangers or potential dangers within or nearby the space, or simply did not take into account the new hazards and other conditions created during work in confined spaces. Thus, it is crucial to carefully identify all confined space hazards before entering a space. This section addresses the two main categories of hazards: *atmospheric*, or those that involve problems with the air in the space (lack of oxygen, the presence of other gases in the space, etc.) and *physical*, or those that are caused either by equipment (rotors, sparks, etc.) or by other dangerous conditions (slippery surfaces, heat, etc.).

Case: Asphyxiation due to CO_2 and O_2 displacement

Lack of safety measures leads to death of employee

A 35-year-old employee of an alcohol and mash plant was lying down on the top of a fermentation tank while hosing it out. He dropped his hat, which fell through the 18-inch tank opening. In an attempt to retrieve the hat, he fell into the tank and struck his head. The foreman was unable to reach the victim, although he tried to pull him out with a rope. By the time the rescue squad was able to pull the worker out—two hours later—the man had already died of asphyxiation due to the high levels of carbon dioxide (a by-product of the fermentation process) in the tank.

The employer was cited for not having a comprehensive safety program and for failing to test or ventilate the space. The worker had only been on the job for three weeks.

54. What kinds of hazards are most likely to be encountered in confined spaces?

Usually, confined space incidents are caused by multiple factors. There are two primary categories of hazards: *atmospheric* and *physical*. It is critical to *identify all the hazards* in a space and determine how they can impact the health and safety of workers who enter this space.

Atmospheric Hazards

55. What does "hazardous atmosphere" mean?

A hazardous atmosphere is any atmosphere that may incapacitate, injure, or impair an employee's self-rescue or lead to acute illness or death to workers and rescuers who enter confined spaces.

The following are examples of hazardous atmospheres:

- Flammable or explosive gas, vapor, or mist in a concentration greater than 10 percent of its lower flammable limit (LFL) or lower explosive limit (LEL).
- Combustible dust suspended in air, which obscures vision at a distance of five feet or less.
- Atmospheric oxygen concentration levels below 19.5 percent or above 23.5 percent at sea level.
- Atmospheric concentration of any substance with an acutely toxic effect above its PEL, and any other atmospheric condition that is IDLH.

This does not include atmospheric concentrations of substances that are not capable of causing death, incapacitation, impairment of ability to self-rescue, injury, or acute illness.



Note for Section 5158 Employers

Dangerous air contaminant levels for flammable atmospheres are defined as greater than 20 percent of the LEL. Dangerous combustible particle levels are defined as greater than 20 percent of the minimum explosive concentration of the particulate.

56 . What are acceptable atmospheric conditions for air contaminants for which permissible exposure limits are not published?

For guidance, refer to sources of information such as MSDS that comply with Section 5194, published scientific and industry information, and National Consensus Standards from organizations such as the American Conference of Governmental Industrial Hygienists (ACGIH) and the National Institute for Occupational Safety and Health (NIOSH).

57. What is oxygen deficiency?

Air normally contains 21 percent oxygen. Oxygen deficiency is created when the oxygen level falls below 19.5 percent at sea level.

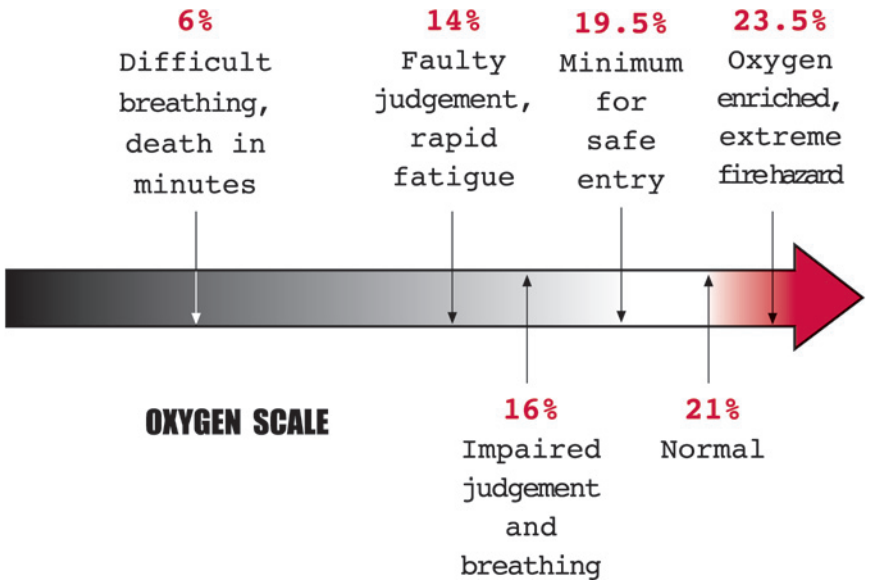
58. How do oxygen-deficient environments develop?

Oxygen deficiency can be caused by:

- Combustion (fire, welding, and operation of internal combustion engines all consume oxygen).
- Formation of rust (consumes oxygen).
- Decomposition of organic matter (consumes oxygen and produces flammable methane gas, which can also displace oxygen).
- Displacement by a heavy gas that has settled in a low-lying space or by another vapor (an inert gas such as argon, carbon dioxide, or nitrogen) used to purge the space.

59. How does oxygen deficiency affect a person who enters a confined space without protection?

Oxygen deficiency impairs judgment and breathing, often making self-rescue difficult or impossible. A severe oxygen deficiency can lead to loss of consciousness and eventual death.



Attention

Do not enter confined spaces containing less than 19.5 percent oxygen without approved SCBA or SAR.

60. What is oxygen enrichment?

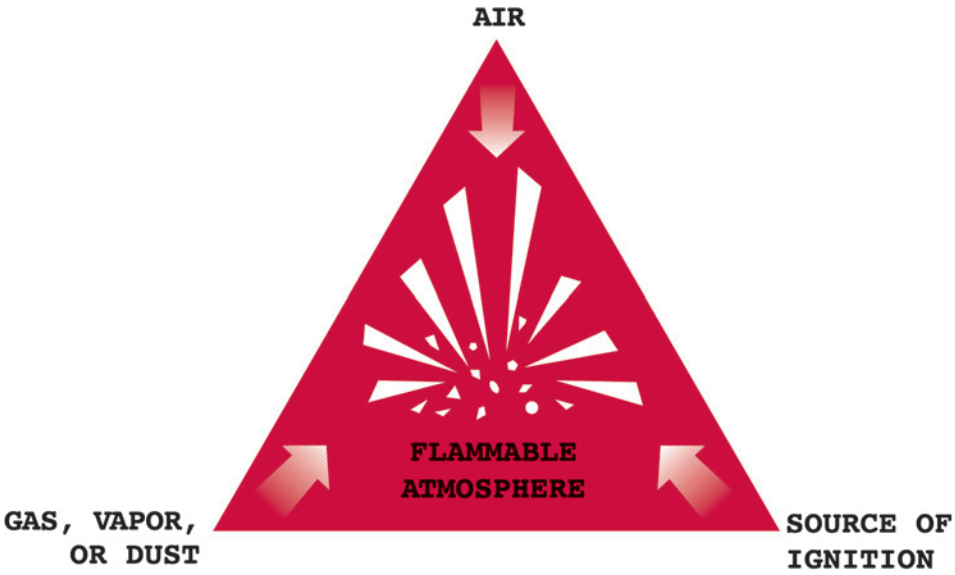
Oxygen enrichment refers to air containing more than 23.5 percent oxygen. This dangerous condition is an extreme fire hazard in which static electricity from materials such as hair or clothing can provide the ignition source needed to start a fire. This environment also allows any fire to burn more readily. Oxygen enrichment does not occur naturally and should be investigated.

61. What can cause oxygen enrichment?

Oxygen enrichment can be caused by leaking oxygen cylinders or hoses that have been brought into or near the space. Always ventilate confined spaces with normal, ambient air. *Never use pure oxygen*.

62. Why are combustible and flammable gases and vapors dangerous?

Atmospheres containing combustible or flammable gases or vapors can be dangerous because of the threat of fire and explosion. Three ingredients are necessary for an atmosphere to become flammable or explosive: an ignition source (heat or flame), fuel (combustible gas or vapor), and oxygen. However, the proportions of fuel and oxygen in a mixture must be within the flammable range for this mixture to be readily ignitable.



Remember, the atmosphere inside a confined space can change rapidly and unexpectedly. Also, any ignition source (such as sparks from grinding or welding equipment, static electricity, or unapproved electrical equipment that is not non-sparking or even smoking) can initiate an explosion.

63. When are vapors or gases combustible or explosive?

Gases or vapors can only be combustible or explosive between their LEL and UEL. This is called the ***flammable range.*** Substances with a wide flammable range are considered to be more hazardous since they are readily ignitable over a wider range. However, *any* concentration of combustible gas or vapor should be of serious concern in a confined space. Workers should be especially careful when ventilating a space containing a gas or vapor above its UEL. In order to reduce the concentration below the LEL, this procedure will first bring the gas or vapor within its flammable range.

64. How do combustible dust atmospheres develop?

Finely powdered dust from combustible materials such as wood, metal, or grain can be fuel for powerful explosions. Dust clouds can develop as result of handling dusty materials or when solid materials are reduced to smaller particles from processes such as grinding, drilling, or crushing.

65. How can airborne combustible/explosive dust concentrations be determined?

Airborne combustible dust at an explosive concentration would obscure vision at a distance of five feet (1.52 meters) or less. A direct reading instrument may be used to measure actual dust concentrations.

66. How do toxic atmospheres develop in confined spaces?

- The work performed within the confined space (such as welding, degreasing, painting, or sanding) may produce toxic atmospheres.
- Toxic gases and vapors from adjacent areas can migrate to and collect in the confined space.
- Vapors may be released from the sludges on the bottom or scales on walls of emptied confined spaces, such as storage tanks, that previously contained flammable or toxic chemicals. Vapor release may be accelerated by wall scraping and sludge removal from confined spaces.

Remember, atmospheric changes may occur due to the work procedure, the product stored, or a nearby gas line leak. The atmosphere may be safe upon entry, but can change very quickly.

67. Why do toxic substances become much more dangerous in confined spaces?

Confined spaces prevent toxic substances from escaping, diluting, or readily dissipating. Instead, substances can become trapped and a buildup occurs, whereby the concentrations of toxic substances reach dangerous levels.



68. What are the three most commonly found toxic gases in confined spaces?

Carbon monoxide (CO) results from incomplete combustion processes in equipment such as gasoline engines. CO is a colorless and odorless gas that displaces oxygen in the blood and can cause headaches, dizziness, unconsciousness, asphyxiation, and death.

Hydrogen sulfide (H_2S) is encountered in sewers, sewage treatment plants, and other locations where organic material (dead animals, leaves, etc.) decomposes. It has a distinct odor of rotten eggs at low concentrations but can cause olfactory fatigue (a deadened sense of smell) at high levels. H_2S can block respiration, causing rapid loss of consciousness, and possible death.

Methane (CH_4) is a natural gas produced from the decay of organic matter. It is a flammable, explosive, colorless, and odorless gas. It can displace oxygen to the point of oxygen deficiency in a confined space, causing dizziness, unconsciousness, and asphyxiation.

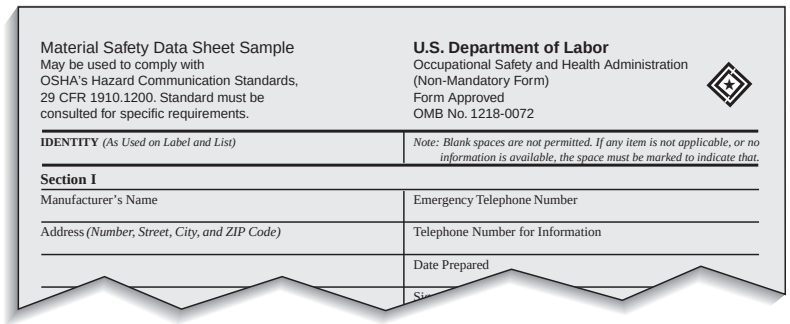


Be aware of any chemicals used in or generated by your specific industry, such as carbon dioxide in bakeries and breweries. Cleaning solvents and residues remaining in vessels can also be dangerous.

69. How can one learn about the hazards of chemical substances that are used within or introduced into confined spaces?

Read the product label and/or the MSDS. Labels provide general product information, and the MSDS gives useful information on proper use and handling, special precautions, and first aid treatment (see Attachment D, "Material Safety Data Sheet Sample"). When a chemical product is purchased, the manufacturer or supplier of the product provides an MSDS. The MSDS must be readily available to any employee who wishes to learn about a product that he or she comes into contact with.

If you have any questions, contact your company's safety and health professional, the manufacturer or supplier of the product, the *NIOSH Pocket Guide to Chemical Hazards,* or a Cal/OSHA consultant.



Material Safety Data Sheet sample

Material Safety Data Sheet Sample
May be used to comply with
OSHA's Hazard Communication Standards,
29 CFR 1910.1200. Standard must be
consulted for specific requirements.

U.S. Department of Labor
Occupational Safety and Health Administration
(Non-Mandatory Form)
Form Approved
OMB No. 1218-0072

IDENTITY *(As Used on Label and List)*

Note: Blank spaces are not permitted. If any item is not applicable, or no information is available, the space must be marked to indicate that.

Section I

Manufacturer's Name

Emergency Telephone Number

Address *(Number, Street, City, and ZIP Code)*

Telephone Number for Information

Date Prepared

70. Why can't a worker rely on sight and sense of smell to detect toxic atmospheres?

There are unseen and odorless contaminants (or oxygen-deficient atmospheres) that can kill or incapacitate workers. Of those contaminants that have odor, some can be detected by our senses only at low concentration. Hydrogen sulfide, for example, will deaden the sense of smell at high concentrations. Because of this, employees might assume that a confined space is safe when it is not. *There is no substitute for testing the air in a confined space prior to entry.* A worker can also be exposed to a contaminant through skin contact while working in a confined space.

71. When should continuous atmospheric monitoring be performed?

Atmospheric monitoring is necessary whenever:

- A safe atmosphere cannot be ensured.
- An existing hazardous atmosphere cannot be removed.
- The confined space cannot be physically isolated from the penetration of hazardous materials.
- There is reason to suspect the development of a hazardous atmosphere during work activity.

72. Why must atmospheric testing of confined spaces follow a certain order?

1. Oxygen is tested first because most combustible gas and toxic atmosphere meters are oxygen-dependent and will not provide reliable readings when used in oxygen-deficient atmospheres. In addition, both oxygen-deficient and oxygen-enriched atmospheres are *extremely hazardous to workers' health and safety.*
2. Combustible gases and vapors are tested next because the threat of fire and explosion is both more immediate and more life-threatening, in most cases, than exposure to toxic gases and vapors.
3. Toxic atmospheres are tested last.

Many modern direct-reading instruments provide simultaneous readings of multiple gases.

73. Can confined spaces be entered for air sampling?

Don't go inside the space to do the initial air sampling! To the extent feasible, pre-entry testing should be conducted with equipment that allows air to be tested remotely. If entry into the space is required to obtain further verification of acceptable entry conditions, entry is performed in accordance with a permit-required confined space program.

74. Why is it recommended that manhole atmospheric readings be taken through the "weep hole"?

This practice prevents employee exposure to:

- Potentially dangerous or deadly vapors or gases that may have built up under the manhole cover.
- Potential explosion due to the ignition of a flammable or explosive atmosphere by sparks generated while removing the cover.

More accurate samples are obtained when the cover is not removed (because fresh air has not been introduced into the atmosphere).

75. Why is it important to thoroughly test any confined space?

Testing must be done at *all depths* because some gases are heavier than others and gases are not uniformly mixed within a confined space. Air sampling should be done in four-foot increments vertically and horizontally, including *corners and low spots,* to ensure that all potential hazards are identified. Make sure that you allow time to accommodate sampling speed and detector response. See Attachment B, "Atmospheric Monitoring Equipment and General Testing Protocol," for guidelines on atmospheric testing.



Monitoring equipment

76. Why is it necessary to conduct continuous or periodic monitoring during the occupation of a confined space?

Monitoring is the only way to detect whether a hazardous atmosphere has developed during entry. If this is the case, employees will be alerted to the change so they can leave the space immediately.

77. Why is atmosphere retesting necessary when re-entering a confined space after only an hour break?

The atmosphere within confined spaces can change rapidly. A worker should assume that every confined space may contain a hazardous atmosphere. Therefore, perform testing before each entry.

78. May employees see the results of the air sampling and exposure monitoring?

Yes. Test results that show the composition of an atmosphere to which employees are actually exposed (even if the employees are using respirators) are called "exposure records" under T8 CCR, Section 3204, "Access to employee exposure and medical records." These records must be accessible to the employee.

79. What are the two major types of direct-reading instruments used for atmospheric monitoring of confined spaces?

Electronic gas detectors and color-indicator gas detector tubes are the most common types of instruments used for determining oxygen content, lower explosive limit, and toxic atmospheres. See Attachment B, "Atmospheric Monitoring Equipment and General Testing Protocol."



Taking an accurate reading is a matter of life or death.

80. What features should be considered before purchasing monitoring equipment?

Before purchasing equipment, evaluate the instrument's:

- Accuracy.
- Environmental operating range:
  - Remote sampling capability.
  - Operating temperature.
  - Relative humidity.
- Intrinsic safety for explosive atmospheres.
- Specificity for contaminant of interest.
- Warm-up time.
- Response time.
- Ruggedness.
- Ease of use and maintenance.
- Vendor support.
- Sensor and battery life.
- Data-logging capabilities.

Physical Hazards

81. What are some types of mechanical hazards that may be encountered in confined spaces?

Moving equipment or parts and energized or pressurized systems can be dangerous. Examples include shafts, couplings, gears, belts, conveyors, mixers, rotors, and compressing devices.

82. What is an entrapment hazard?

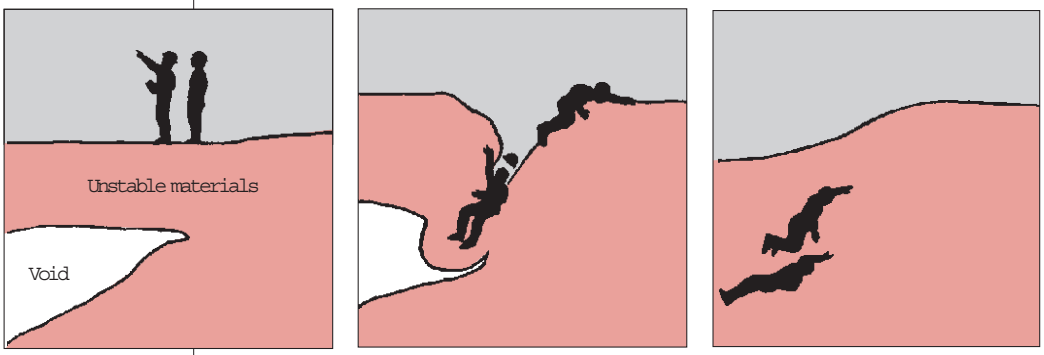
Examples of entrapment hazards in confined spaces include inwardly converging walls or floors that slope downward and taper to a smaller cross-section (such as air plenums).

83. What is engulfment?

This refers to the surrounding or burial of the worker in a liquid or loose, finely divided solid material, such as sand or grain. Such materials can suffocate a worker.

Examples include:

- Accidental dumping of a product on a worker.
- A worker walking on unstable material such as settled grain. Such materials could conceal a void underneath that gives way under the weight of the worker, resulting in engulfment.



84. What are thermal hazards?

A thermal hazard is a dangerous condition caused by excessive heat or cold or a hot surface.

Employees engaged in continuous heavy work while wearing PPE (e.g., body suit and respirator) in warm surroundings are particularly susceptible to thermal hazards. Heat stress may lead to heat exhaustion, heat cramps, heat stroke, loss of consciousness, or death.

Note

A confined space entry permit must address any hazards from heat or cold within confined spaces.

85. How does noise impact confined space workers?

Sounds generated by tools and heavy machinery can be magnified and reverberated within confined spaces. Noise may impede verbal communication between the entrants and attendants or rescue personnel. Over time, excessive noise may also impair a worker's hearing. If noise levels are high, a hearing conservation program may need to be implemented. For more information, refer to T8 CCR, sections 5096, 5097, 5098, and 5099, or see the Cal/OSHA *Noise Control* publication.

86. What other general safety hazards should confined space workers consider?

Snakes, rodents, spiders, poor lighting, obstructions, falling objects, wet surfaces, trip/slip and fall hazards, electrical shock, and acute chemical hazards may also need to be addressed.

HAZARD CONTROLS

ONCE hazards are identified, it is critical to institute appropriate control measures for the elimination (or, if not possible, the reduction) and control of hazards. Remember, acceptable entry conditions must be attained before entry *and* maintained throughout the duration of an entry. This section explains some of the procedures and precautions that should be in place to safeguard entrants while they are working in the space.

Case: Hazardous atmosphere

Lack of safety controls leads to tragedy for well cleaners

Three self-employed well cleaners arrived at a home to clean a 40-foot-deep well. They first used a portable gasoline pump, and then a sump pump, to remove the standing water from the well. One employee was lowered into the well with a cable and a homemade hoist. Soon after, the second worker called down to the first worker and received no response. The third man asked the homeowner to call for help, and tried to lower the second man into the well with a board. During the rescue attempt, the board began to crack, so the third man halted his efforts and decided to wait for the rescue team.

Unfortunately, by the time the rescue team arrived, the well had filled with water and the first worker had drowned. The second worker was taken to the hospital but later died of asphyxiation (oxygen in the space had been displaced by carbon monoxide) and cold water exposure.

The atmosphere had not been tested or ventilated prior to entry, and the workers had failed to use personal protective equipment (PPE). This is a prime example of why employers—as well as workers who are self-employed—must develop and implement a comprehensive confined space entry program.

Controls for Atmospheric Hazards

One primary control measure effective in preventing toxic hazardous atmospheres from developing in the first place is the use of less toxic products that vaporize less readily. Keep less of the product at the site and keep containers closed inside the confined space at all times.

87. Why is it important to ventilate confined spaces?

Ventilation helps to:

- Provide adequate oxygen to the air in the space.
- Control atmospheric contaminants.
- Prevent fire and explosion hazards.
- Control heat and humidity.

Attention

Workers should be allowed to enter only after acceptable atmospheric levels are secured within a confined space.

Once it has been determined that the confined space contains a harmful atmosphere, the next step is to clear it. Ventilation blows out oxygen-deficient or contaminated atmospheres and replaces harmful vapors with clean, fresh air. Make sure to ventilate the space thoroughly so that there are no contaminated pockets left, and then test the atmosphere again.

Welding, cutting, burning, and continuous brazing generate hazardous fumes and dusts that can be more effectively removed by local exhaust ventilation systems at or near the point of generation.



Continuous ventilation and testing are critical in any confined space with a harmful atmosphere.

88. What considerations should be made to ensure the space is properly ventilated?

Initially determine:

- Number and size of openings.
- Volume and configuration of the space to be entered.
- Capacity and positioning of the ventilation equipment to be used.
- Existing and potential atmospheric hazards.

After beginning ventilation:

- Routinely test the confined space until levels stabilize at acceptable entry conditions.

Once entry and work start:

- Continue ventilation and frequent atmospheric testing for the entire duration of entry.
- Consider atmospheric hazards created by work in the space.

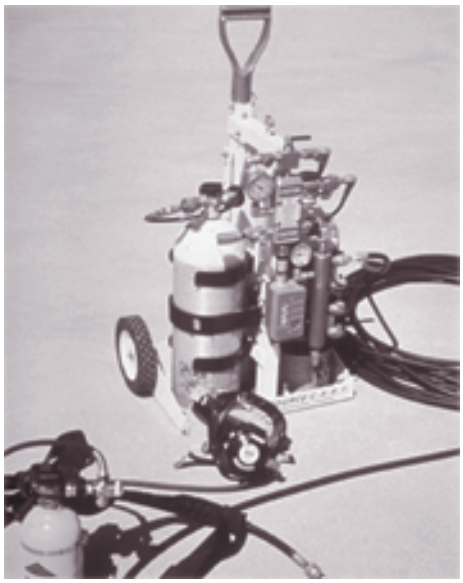
89. When should respiratory protection be used?

Respiratory protection is needed whenever:

- An emergency exists and entry cannot be delayed. Assume that an IDLH atmosphere exists.
- There is an inert atmosphere or testing shows that an IDLH exists and additional ventilation cannot reduce concentrations to safe levels.
- Current testing indicates atmosphere to be safe, but unsafe conditions could reasonably be expected to develop at any time.

Note

To help you determine which respiratory equipment is appropriate, refer to Section 5144 and request the Cal/OSHA *Guide to Respiratory Protection* publication.



Be familiar with your respiratory equipment.

90. What if flammable atmospheres cannot be controlled by ventilation?

Consider "inerting." Ventilation may not control all atmospheric hazards. In some cases, the introduction of air may bring the fuel-air mixture into the flammable range. Instead, it may be necessary to fill the confined space with an inert gas such as nitrogen to control vapor or gases that have the potential to ignite.

Remember that while inert gases eliminate the hazard of combustion or explosion, they also create an oxygen deficiency hazard.

Controls for Physical Hazards

91. What does isolation of equipment involve?

Isolation includes:

- Identifying potential mechanical hazards.
- Completing the de-energizing of all electrical, mechanical, pneumatic, and hydraulic systems and all other energy sources.
- Locking out and tagging out all electrical circuits and valves.
- Blocking or otherwise securing equipment that could have stored energy.
- Guarding or removing equipment from the area.
- Ensuring isolation procedures are fully implemented.



For more information, refer to Section 3314 and request the Cal/OSHA *Lockout/Blockout* publication.

92. How can workers be safeguarded against most mechanical hazards?

The best safeguards include:

- Physical guards that preclude contact with moving parts.
- Isolation and/or barricading of machinery or equipment that may be accidentally contacted or activated.

93. What do "lockout" and "tagout" mean?

Lockout of a machine refers to the installation of a lock that prevents another employee from turning on the machine. Tagout refers to the attaching of a sign or label to the isolated machine, which warns others not to operate it.

94. *How can workers be safeguarded against electrical hazards?*

In order to avoid electrical hazards:

- Inspect all electrical equipment and circuits for proper classification (wet locations or areas otherwise classified as being hazardous).
- Use ground fault circuit interrupters (GFCI) where required and ensure proper grounding for all circuits.
- De-energize circuits and implement lockout/tagout programs where required.
- Use only explosion-proof equipment and spark-proof tools where required.
- Ensure that all electrical parts are properly covered, protected, and maintained.

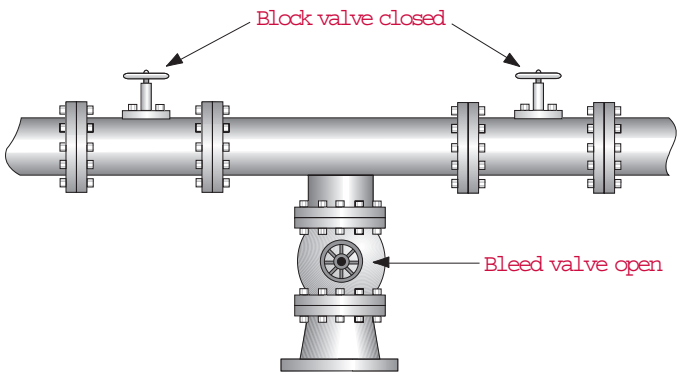


Lock out devices

95. *What safeguards can be used to protect from pressurized lines, ducts, or pipes?*

Blanking or blinding refers to the absolute closure of a pipe, line, or duct. This is done by completely covering the bore with a fastened solid plate that is capable of withstanding the maximum pressure of the pipe, line, or duct without leaking.

Double block and bleed refers to 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.



Double block and bleed

96. What steps are necessary in order to safeguard workers against engulfment hazards?

In order to avoid engulfment hazards:

- Remove material prior to entry.
- Institute isolation procedures to keep out any potential hazardous substances.
- Wear full body harnesses and retrieval lines.
- Allow entry only if entrant can be rapidly pulled out.

97. How can slips, trips, and falls be prevented?

In order to prevent slips, trips, and falls:

- Practice good housekeeping. Residues, unnecessary scraps, debris, and water should be removed from the floor and work areas.
- Keep ladders in good working order and ensure that proper ladder safety practices are followed.
- Ensure that guardrails protect all open sides of elevated work areas.
- Ensure that appropriate fall arrest equipment is provided and properly used where required.

98. What can be done to make the space safe from explosive hazards?

Aside from ventilating or taking other precautions to control hazardous atmospheres, *remove* all potential sources of ignition from the space. Institute a no-smoking rule and use only approved electrical equipment.



Personal Protective Equipment and Tools

99. Who is responsible for providing and using personal protective equipment (PPE)?

Employers are responsible for providing the proper PPE to their workers and for replacement and repairs as necessary. Employers are also responsible for providing adequate training on the proper use of the equipment, and for enforcing its use and wear.

100. Who can provide assistance in the selection of PPE and equipment?

Consult qualified persons, such as:

- Industrial hygienists.
- Safety engineers.
- Safety and health professionals.
- Other trained and experienced personnel.

Communication System

101. Why is communication important in confined space work?

Proper communication:

- Verifies that the work is proceeding well and the situation is normal.
- Alerts the entrant to any change, including those in surroundings or atmospheres, and allows the attendant to order immediate evacuation in the event of imminent danger.
- Reduces effects of claustrophobia.

102 . What communication system should be used?

Effective methods of communication include:

- Verbal.
- Hand signals.
- Two-way radios.
- Signaling through safety lines when oral communication is not possible.
- Intercom system.
- Light signals.
- Tapping or rapping codes.

Remember, all electronic equipment must:

- Be intrinsically safe (there must be no chance of becoming an ignition source).
- Not interfere with atmospheric monitors.
- *Always* be backed up by a non-electronic communication system.

TRAINING AND EDUCATION

EMPLOYEE training is essential for successful confined space work and is an integral part of a confined space program. The goal is to work safely and effectively while preventing problems. Proper training is critical, as having prior knowledge of hazards and being prepared for potential problems can divert tragedy. This section should be reviewed not only by supervisors, but also by confined space entrants and attendants.

Case: Explosive atmosphere and "hot work"

Welding sparks ignite explosion, killing man

A repairman and an assistant entered an 8,500-gallon cargo tank to do pre-treatment work in preparation for spot-welding a leak on the tanker wall. The tanker had previously contained lacquer thinner but had been steam cleaned in order to remove trapped chemicals and vapors. Although the assistant commented on the strong fumes, the repairman decided to go ahead with the repairs rather than taking the time to clean the area again. When he began welding, the sparks ignited the vapors, causing an explosion. The repairman was killed.

The employer had a written safety program that required the use of an explosion meter; however, the victim did not follow the safety policy.



103. Why is employee training important for confined space work?

Employee training *prior* to confined space work is a key part of any successful confined space program. Lack of hazard awareness can result in death or serious physical harm. Untrained rescuers attempting to help victims may become victims themselves due to lack of awareness of confined space hazards and safe rescue procedures.

104. What must confined space training include?

The elements included are characteristics of the space as well as specific duties of the entrant, attendant, supervisor, and rescuer:

- Atmospheric monitoring and ventilation.
- Communication.
- Emergency, self-rescue, and rescue operations.
- Hazard communication—MSDS.
- Hazard recognition and control.
- Injury and Illness Prevention Program.
- Permit system.
- Personal protective equipment, first aid, and CPR.
- Signs, symptoms, and consequences of exposures.

105 . What other training topics should be included?

Depending upon the work activities and hazards associated with a particular industry, training may emphasize other areas such as:

- Respiratory protection.
- Electrical safety.
- Lockout/tagout.
- Equipment-specific issues.
- Fall protection.
- Noise.



Confined space training in the field

106. How does training help?

Proper training:

- Familiarizes employees with established entry procedures and the reasons why those procedures must be followed.
- Encourages employee teamwork and cohesiveness.
- Informs employees that only authorized personnel are allowed to enter confined spaces.

107. Who must be trained?

Entrants, attendants, entry supervisors, and rescuers must all receive proper and thorough training.



Note for Section 5158 Employers

All employees shall be trained, including standby person(s) and at least one additional employee who shall be within sight or call of the standby person(s).

108. When must confined space training be provided?

Training should be held:

- Before doing work within a confined space.
- Whenever there is change of work.
- Whenever the conditions and hazards within the space change.
- Whenever an employer has a reason to believe that an employee is not following established guidelines.
- Whenever there are new procedures or operational changes.
- Annually for rescue team members.

109. What should training documentation include?

Once training is completed, document the names of the trainer and trainees, as well as the date, hours, and subject of training. Keep all records in a secure location. Employees who participated in the training may also receive certificates of completion.

Entry Team

110. What is the "entry team"?

The entry team is the group of employees assigned to complete a task within a confined space. A typical entry team consists of an entrant, an attendant, and the entry supervisor. Depending on the employer's permit entry program, attendants may or may not perform entry rescue.



Note for Section 5158 Employers

In addition to the entrant and a standby employee (who must be fully prepared to take on the role of rescuer), a third employee shall be available and within sight or earshot of the standby employee.

111. What are the general responsibilities of the entry team?

Responsibilities include:

- Pre-entry work.
- Entry and egress.
- Work to be accomplished on site.
- Tools to be used.
- Potential hazards.
- Personal protective equipment.
- Recognition of symptoms following exposure and what to do when it does occur.
- Communication.
- Emergency procedures and equipment.

112. What is the role of the attendant?

The attendant:

- Does not enter the confined space.
- Is prepared to perform non-entry rescue or call for a rescue team.
- Performs entry rescue only when the employer's permit entry program authorizes attendant to do so.
- Knows the hazards or potential hazards of the space.
- Maintains accurate count of authorized entrants in the space.
- Stays alert to possible behavioral changes of entrants.
- Monitors activities inside and outside the space to ensure that it is safe for entrants to remain in the area.
- Remains outside the confined space until relieved by another attendant and prevents entry of unauthorized personnel.
- Communicates with entrants.
- Orders evacuation if prohibited or hazardous conditions arise.



Entrance into confined space with assistance of an attendant

113. What are the duties of the entry supervisor?

Attention

The employer and the entry supervisor are responsible for the overall confined space entry operation.

The entry supervisor:

- Knows confined space hazards.
- Ensures that atmospheric testing and proper confined space preparations have been done prior to entry.
- Verifies that safe conditions have been attained.
- Ensures that acceptable entry conditions are maintained.
- Ensures that proper equipment is on site and operational.
- Makes sure that site is clear of unauthorized personnel.
- Verifies emergency plan and confirms rescue team availability.
- Signs permit.
- Cancels permit once operation is completed.

114. What are the responsibilities of an authorized entrant?

An authorized entrant:

- Knows confined space hazards, exposure routes, signs, symptoms, and adverse health effects that could result from exposure.
- Uses adequate PPE.
- Uses proper entry equipment.
- Follows proper entry procedures.
- Performs assigned job.
- Is alert to any prohibited condition.
- Communicates with attendant.
- Evacuates immediately, if necessary.

115. Prior to entering a confined space, how can workers confirm that pre-entry preparations have been completed?

Entrants can check the permit and contact the entry supervisor in order to make sure that conditions within the confined space have been fully investigated and appropriate control measures have been taken.

116. Is physical survey of a confined space required in order to determine whether a permit is needed?

Not necessarily. The survey requirement may be met through existing records and knowledge of the space, provided this information is adequate to make the determination required by the standard. For example, a telecommunications company may have records showing that the hazards of all manholes in one section of the region can be addressed by Section 5158 procedures and that the manholes in another section of the region may contain toxins due to ground water contamination. Only manholes in the latter section would need to be surveyed. This approach can be used for any industry that has a number of identical spaces and records to support its determinations.

117. What is the difference between maintenance and construction activities?

Generally speaking, refurbishing of existing equipment and space is considered "maintenance." This includes painting and similar projects. Reconfiguration of space or installation of substantially new equipment (as for a process change) is usually considered "construction." Those spaces identified under Section 5157 as permit spaces that are undergoing maintenance and do ***not*** involve construction would be subject to the requirements of Section 5157.

118. Under what circumstances will stairs or ladders constitute a limited or restricted means of egress under the standard?

Ladders and temporary, movable, spiral, or articulated stairs will usually be considered a limited or restricted means of egress. Fixed industrial stairs that meet Cal/OSHA standards will be considered a limited or restricted means of egress when the conditions or physical characteristics of the space, in light of the hazards present in it, would interfere with an entrant's ability to exit or be rescued in a hazardous situation.

119. How would Cal/OSHA determine whether a surface such as a pit—which is entirely open on one plane—has limited or restricted means for entry or exit?

When determining whether a space has limited or restricted means for entry or exit, Cal/OSHA will evaluate the overall characteristics of the space to determine if an entrant's ability to escape in an emergency would be hindered. Thus, a pit, shaft, or tank that is entirely open on one plane can be considered a confined space if the means for entering the space (stairway, ladder, etc.) are narrow, twisted, or otherwise configured in such a way that would hinder an entrant's ability to quickly escape. Similarly, the pit, shaft, or tank itself may be confining because of the presence of pipes, ducts, baffles, equipment, or other factors that would hinder an entrant's ability to escape.

120. Does the fact that a space has a door mean that the space does not have limited or restricted means of entry or exit and therefore is not a "confined space"?

A space has limited or restricted means of entry or exit if an entrant's ability to escape in an emergency would be hindered. The dimensions of a door and its location are factors in determining whether an entrant can easily escape; however, the presence of a door does not in and of itself mean that the space is not a confined space. Examples of such spaces could include bag houses or crawl spaces that have doors leading into them, but also have pipes, conduits, ducts, equipment, or other materials that an employee would be required to crawl over or under or squeeze around in order to escape. This would qualify as limited or restricted means of exit.

121. If the presence of water alone is not considered a hazard characteristic that would trigger the classification of a permit-required confined space, what would?

The presence of water alone would not be a sufficient reason to apply the PRCS standard; there must be a quantity sufficient either to endanger the life of the entrant by engulfment or to interfere with escape from the space. For example, if the water conceals trip and fall hazards such as abandoned machine pads or floor holes and openings, the combination of conditions may very well cause the confined space to be classified as a permit space.

122. When workers enter a confined space only to retrieve a tool, is this considered confined space entry?

Yes. Regardless of the reason, once the plane of entry has been crossed, the confined space has been entered.

123. Does the characteristic "contains or has a potential to contain a hazardous atmosphere" in the definition of "permit-required confined space" refer only to those atmospheres that pose an acute hazard?

Yes, the PRCS standard is intended to protect entrants against acute hazards (not exposures at or below the PEL). However, the standard does not exempt employers from the responsibility to control harmful exposures to toxic substances at concentrations less than those immediately dangerous to life or health.

124. How can a worker determine if testing and monitoring instruments are working correctly?

Employees using instruments to test confined space atmospheres must follow manufacturers' directions to properly calibrate, operate, and maintain the instruments. The equipment can also be field-tested against a gas mixture containing the substance of interest at a known concentration. See Attachment B, "Atmospheric Monitoring Equipment and General Testing Protocol," for additional information regarding test equipment.

125. What does testing or monitoring "as necessary" mean as required by Section 5157(d)(5)(B)?

The employer must determine the degree and the frequency of testing or monitoring to ensure that acceptable entry conditions are being maintained throughout the entry operation. Some of the factors that affect frequency are:

- Pre-entry testing results.
- The regularity of entry (daily, weekly, or monthly).
- The uniformity of the permit space (the extent to which the configuration, use, and contents vary).
- The documented history of previous monitoring activities.
- Knowledge of the hazards that affect the permit space.

126. During rescue, how can a victim receive air when the confined space is very large, there is oxygen deficiency, and there is no time to ventilate the space?

Consider placing a fresh air hose (air cone) near the victim's face or above the head to introduce fresh air to the victim while continuing to set up the rescue operation. This approach may be used as a temporary measure of limited value when, in spite of good preparation, rescue is going to be significantly delayed.

127. Is it possible to have a toxic atmosphere at vapor concentrations that are considered "safe" from a fire and explosion perspective?

Yes. Carbon disulfide is an example of this. Its LEL is 1.3 percent. At 1 percent by volume, or 10, 000 parts per million (ppm), 1.3 percent equates to 13,000 ppm. Thus, 10 percent of the LEL (13,000 ppm) is 1,300 ppm. Cal/OSHA's PEL for carbon disulfide is 4 ppm. At 10 percent of the LEL, the levels of carbon disulfide in the air would exceed Cal/OSHA's PEL by 325 times!

128. A worker is six feet, two inches tall and the confined space is only five feet deep. Why should the worker be concerned with hazardous atmospheres in the confined space when he can breathe fresh air while he is standing in the confined space?

Any hazardous atmosphere should be of *serious* concern to confined space entrants and rescuers. Gases can distribute unevenly in confined spaces. If the assignment requires the worker to bend down, he may inhale toxic gases, be readily overcome, and possibly asphyxiated. Even when standing erect, his movements may cause upwelling of settled gases, causing him to inhale toxic fumes, become dizzy, and possibly drop or collapse to the bottom of the space.

129. Why is there a "one entrant—one padlock" rule for equipment lockout/tagout?

This rule is intended to protect employees not only from equipment malfunction but also from the unexpected or accidental energization of equipment or machinery within a confined space. If there are multiple entrants, each worker should have his or her own lock to prevent re-energization of machinery by other employees.

130. Does the implementation of an appropriate lockout procedure, which blocks out potentially hazardous atmospheres, remove the potential for an atmospheric hazard?

No. Even if a worker has implemented a lockout procedure to block flowable materials and subsequent evaluation of the space shows that there are no apparent atmospheric hazards, he should *always be alert to any hazard*, including physical symptoms that could be caused by a hazardous atmosphere. Continuous ventilation used to ensure that a hazardous atmosphere is not created is considered to be a control method rather than elimination of an atmospheric hazard. It is important to understand the distinction between elimination and control.

It is Cal/OSHA's aim to increase awareness of confined space hazards and contribute to greater confined space work safety. Although considerable material has been included in this guide, the unique nature of each job site mandates that this information be used only as a general guide and that a confined space permit program specific to each job location be established and followed. Because of the acute hazards associated with confined space work, and the fact that workers' lives are at stake, it must be remembered that regulatory requirements are only *minimum* standards and that employers and employees must strive to exceed them at all times.

CONSULTATION
CAL OSHA
SERVICE

Attachment A

Hot Work Permit Sample

(attach to Entry Permit)

XYZ Company

Date: _____ Issue time: _____ Expiration time: _____
Location of permit space: _____ Work tasks: _____
_____

Potential Hazards

O Toxic
O Corrosive
O Flammable
O Radioactive
O Energy release
O Stored energy
O Electrical
O Mechanical
O Fire/heat
O Spills
_____
_____

Authorized Workers

Entrants: _____
_____
Attendant(s): _____
Fire/safety watch: _____

Procedures/Precautions

O Procedures
O Communications
O Entry permit
O Ventilation
O Training
O CPR/first aid
O Rescue plan
O Sprinkler system in service
O Charged fire hose
O Surfaces wetted down
O Shower/eyewash located
O _____
O _____

Safety Equipment

O Hard hat
O Eye protection
O Hearing protection
O Foot/hand protection
O Protective clothing
O SCBA
O Respirator _____
O Tripod
O Barricade/cones
O Communication devices
O First aid kit
O Fire extinguisher
O _____

Vessel Prep/Isolation

O Cleaning/purging
O Ventilation
O Signs/barriers
O Lagging cloths/tarps
O Lockout/tagout
O Blanking/bleeding
O Disconnect mechanical linkages
O Secure moving parts
O _____
O _____
O _____
O _____

Special Tools

O Low voltage
O Non-sparking
O Tools inspected for frayed/broken wires
O Lighting—intrinsically safe
O _____
O _____
O _____

Special Work Procedures

O Never bring gas cylinders or other large equipment into space
O Never block entry/exit with equipment
O Shut down during breaks or overnight
O Fire watch to remain 30 minutes after completion of hot work
O _____

Entry authorizer (name, title, date): _____
Emergency contact: _____
_____

ATTACHMENT B

Atmospheric Monitoring Equipment and General Testing Protocol

DANGEROUS concentrations of gases and vapors may exist in a confined space; such hazards cannot be seen and may not be smelled. Therefore, air monitoring equipment is necessary to properly test the space prior to entry.

Direct reading instruments are portable units that can be carried by hand or worn on a belt. There are two major types of direct reading atmospheric testing equipment: electronic gas detectors and gas detector tubes. These devices may be subject to cross-sensitivity, which means that more than one chemical can produce the same or a similar reading. Interfering chemicals may give a positive or negative deflection from the true atmospheric concentrations. Other factors, which are discussed later in this section, may have a direct influence on the proper use and reliability of this equipment. Therefore, it is very important that the individual performing the tests be properly trained on the actual use, maintenance, limitations, and proper selection of the appropriate instrument.

Electronic Gas Detection Monitors

Electronic gas detection instruments are battery-powered, direct-reading devices capable of providing continuous monitoring of a permit space. Oxygen monitors measure atmospheric concentrations that range from 0 percent to 25 percent oxygen in air.

Most combustible gas monitors display concentrations as percent of the lower explosive limit (LEL), although some display concentration as percent by volume and some display both. Instruments that measure the percent of the LEL are generally easier to use. For example, the LEL of methane is 5 percent by volume; the upper explosive limit (UEL) is 15 percent by volume. When the concentration in a space reaches 2.5 percent by volume, it is 50 percent of the LEL. When the concentration reaches 5 percent by volume, it is 100 percent of the LEL.

Toxic gas monitors use special electrochemical cells to measure substances such as carbon monoxide, hydrogen sulfide, chlorine, and ammonia. The instruments are direct reading, available with either meters or digital read-outs and may also be equipped with alarms. Some instruments are equipped with a single sensor while others have multiple sensors to simultaneously measure a variety of gases. These devices are commonly referred to as 2-in-1, 3-in-1, or 4-in-1 monitors. It is very important to select an instrument that is appropriate for the specific applications to be encountered. Whenever contaminants have been identified at a site, substance-specific detectors should be used.

Special consideration must also be given to the use and interpretation of the results obtained from electrical gas meters under certain circumstances. The operator must be aware of situations that could interfere with the collection of accurate monitoring data. Instrument familiarization by the operator is needed for accurate atmospheric testing. A thorough understanding of the manufacturer's written operating instructions is crucial for the safe and effective use of the instrument. Employees who use this equipment also must receive hands-on training.

Operators should be aware of the following facts concerning electrical gas monitors:

1. The instrument must be certified as intrinsically safe for use in Class I, Division I, Groups A, B, C, and D hazardous locations.
2. Some combustible gas meter sensors are Wheatstone bridge-type sensors. This type of sensor can be easily contaminated by silicone vapors, leaded gasoline, sulfur compounds, and repeated exposure to halogenated hydrocarbons. This desensitization will cause erroneous low readings and reduce the life expectancy of the sensor.

3. The instrument selected must be specific to the substances likely to be found.
4. High relative humidity (90 percent to 100 percent) may cause reduced sensitivity and erratic behavior in the instrument. Humidity can also cause the instrument to fail to properly calibrate.
5. Sensors have a limited lifespan (for example, oxygen sensors typically have a one-year lifespan). Exposure to corrosive substances such as acid gases can significantly reduce sensors' life expectancy.
6. Erroneously low readings can result from the absorption of substances such as chlorine, hydrogen sulfide, sulfur dioxide, and ammonia, which condense in the sampling line or sensors. In drying ovens or unusually hot locations, solvent vapors with high boiling points also may condense in the sampling lines.
7. Battery maintenance is very important. There are three types of batteries currently used: nickel cadmium, alkaline, and sealed lead-acid. Each has advantages and disadvantages that should be researched through the manufacturer at the time of battery purchase.
8. Make sure the instrument has remote sampling capabilities.
9. Electronic gas detectors must be checked and calibrated prior to use each day. The inspection should include hoses, batteries, and any pumps the equipment might have. The unit must also be field-tested using test gas cylinders containing known amounts of the substance to be encountered.

Oxygen meters should be calibrated in fresh air to 21 percent. An operator can test a meter by holding his or her breath and then exhaling into the sensor; the sensor reading should drop to approximately 16 percent.

If the equipment does not calibrate properly, the unit must be removed from service. Replace the sensor or return the unit to the factory for repair and/or laboratory recalibration.

Operators should consult with the manufacturer's instructions or calibration curves when sampling for gases and vapors for which the instrument was not calibrated against.

Detector Tube Pump Method

Detector tube pumps are portable instruments that use different detector tubes to measure the concentration of a wide variety of substances. The operating principle consists of drawing a known volume of air through a detector tube designed to measure the concentration of the substance of interest.

Detector tubes are easy to use and provide a relatively good idea of the concentration of a substance within a space. The length of stain or degree of color change corresponds to the relative concentration of the substance tested. The tubes are generally specific to the toxic substance of concern. However, accuracy can be affected by cross-sensitivity. Therefore, the results must be interpreted in relation to *all* substances in the space.

Limitations of detector tubes include:

- Tubes cannot be interchanged with different brand pumps.
- Tubes may lack specificity and cross-sensitivity with other compounds is possible. Refer to the manufacturer's manual for information on the effects of interfering substances.
- Detector tubes give only instantaneous results.
- Tubes have a limited shelf-life (approximately one to two years). Refrigeration can extend the shelf-life. However, tubes should not be used beyond their expiration date.
- Accuracy ranges vary with each detector tube.
- Tube accuracy is significantly affected by cold temperatures. In cold temperatures, try to keep the tubes in a pocket close to the body to keep them warm.

Calibrations and Maintenance

Operators are reminded to consult the manufacturer's instructions for specific procedures for the calibration and maintenance of the instrument.

General recommendations regarding the conducting of atmospheric testing

1. Use only monitoring instruments that have been properly calibrated and maintained and are intrinsically safe.
2. Only trained operators who are skilled and knowledgeable about the use and limitations of the instrument should do the testing.
3. Check the area around the confined space opening for any hazardous gas or vapor concentrations.
4. Extreme care must be exercised when opening any confined space that may contain an explosive atmosphere.

   Some spaces may contain an atmosphere that is too rich to burn. But when the space is opened, entering air can quickly change the atmosphere, making it explosive. Sparks created by removing the hatch or cover could ignite the vapors in the space. Therefore, when possible, insert the test probe into a vent hole. If the manhole cover or hatch has no vent opening, open the cover just enough to insert the probe into the space. Spark-proof tools must be used. *All levels and remote areas of the space need to be tested*. An extension device should be used for this purpose. If a hazardous atmosphere is detected, purge and ventilate the space. Avoid having employees lean over the opening or breathe the air in the space.
5. Always test oxygen content first. Make sure sufficient oxygen (a minimum of 16 percent) is available to support the use of the combustible gas monitor. The sampling protocol requires that combustible gas levels in the confined space be checked next. Flammable gases or vapors must not exceed 10 percent of the lower flammability limit (LFL).
6. Toxic substances are measured next in parts per million (ppm). Again, the equipment used must be specific to the substance likely to be found in the space. Never use a standard flammable gas monitor sensor to test for a toxic substance. The results could be deadly, as the following example will show.

Hydrogen Sulfide

Percentage of LFL	*PPM*
100%	43,000
10%	4,300
5 %	2,150
0.7%	300 IDLH
0.02%	10 PEL

Hydrogen sulfide is a common toxic gas encountered in many permit space locations. Hydrogen sulfide has an LFL of 4.3 percent, or 43,000 ppm. The standard requires maintaining an environment of less than 10 percent of the LFL in order to avoid an explosion. Hydrogen sulfide also has a permissible exposure limit (PEL) of 10 ppm and an immediate danger to life and health (IDLH) concentration of 300 ppm. For example, if the LFL is found to be 5 percent, though the testing indicates no explosive hazard, it indicates a level of approximately 2,150 ppm, which exceeds both the PEL and IDLH.

7. Some toxic substances may not respond well to electrical gas sensors or detector tubes. If this is the case, more specialized test equipment or laboratory analysis may be necessary.
8. Depending on their densities, gases may be heavier, lighter, or nearly the same weight as air. As a result, gases and vapors will stratify within a given confined space. The only safe way to test the atmosphere of a confined space is to sample all levels (top, middle, and bottom) with properly calibrated equipment. When monitoring for entries involving a descent into atmospheres that may be stratified, the atmospheric envelope should be tested at a distance of approximately four feet (1.22 meters) in the direction of travel and to each side. If a sampling probe is used, the entrant's rate of progress should be slowed to accommodate the sampling speed and detector response.

Attachment C
Confined Space Entry Permit Sample
(Enhanced Title 8 Version)

Permit valid for 8 hours only. All copies of permit will remain at job site until job is completed.
Date: _____Time:_____
Site location and description: _____
Purpose of entry: _____

NATURE OF CONFINED SPACE HAZARD

___Oxygen deficiency (less than 19.5%)
___Flammable gases/vapors above 10% of lower explosive limit (LEL)
___Mechanical hazards
___Oxygen over 23.5%
___Toxic gases or vapors greater than permissible exposure limit (PEL)
___Electrical shock
___Materials harmful to skin
___Electrical lockout
___Engulfment
___Valve out/isolation
___Other(s)

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

PREPARATION COMPLETED	DATE	TIME
Lock out/de-energize/try-out	_____	_____
Line(s) broken/capped/blanked	_____	_____
Secure area (post and flag)	_____	_____
Breathing apparatus	_____	_____
Resuscitator/inhalator	_____	_____
Cleaned, drained, washed, & purged	_____	_____
Ventilation for fresh air	_____	_____
Emergency response team available	_____	_____
Employees informed of specific hazards	_____	_____
Procedures reviewed with each employee	_____	_____
Atmospheric test in compliance	_____	_____
Hot work permit attached (if required)	_____	_____
Continuous monitoring required	_____	_____
Other(s)	_____	_____

REQUIREMENTS COMPLETED	DATE	TIME
Full body harness w/ "D" ring	_____	
Emergency escape retrieval equip.	_____	
Lifelines	_____	
Lighting (explosion-proof)	_____	
Protective clothing (PPE)	_____	
Respiratory equipment Specify _____	_____	
Communication equipment Specify _____	_____	
Rescue equipment Specify _____	_____	
Rescue service Phone # _____	_____	

CONTINUOUS MONITORING TEST(S) TO BE TAKEN	PERMISSIBLE ENTRY LEVEL	RECORD MONITORING RESULTS/TIME			
Percent of Oxygen	19.5% to 23.5%	_____	_____	_____	_____
Lower flammable limit	Under 10%	_____	_____	_____	_____
Carbon Monoxide	25 ppm	_____	_____	_____	_____
Aromatic Hydrocarbon	1 ppm - 5 ppm	_____	_____	_____	_____
Hydrogen Cyanide	4.7 ppm (S)	_____	_____	_____	_____
Hydrogen Sulphide	10 ppm* 15 ppm**	_____	_____	_____	_____
Sulphur Dioxide	2 ppm* 5 ppm**	_____	_____	_____	_____
Ammonia	25 ppm* 35 ppm**	_____	_____	_____	_____
Other(s)	_____	_____	_____	_____	_____

* 8 hr. time-weighted avg.: Employee can work in area 8 hrs (longer with appropriate respiratory protection).
**Short-term exposure limit: Employee can work in the area up to 15 minutes.
REMARKS: _____

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

SAFETY STANDBY PERSON IS REQUIRED FOR ALL CONFINED SPACE WORK

Confined space entrants	Entry time	Exit time	Safety standby person(s)	Ambulance #	Fire #
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____

SUPERVISOR AUTHORIZATION:

I certify that all required precautions have been taken and necessary equipment is provided for safe entry and work in this confined space.

Name (print) _____ Time: _____ Date: _____ Signature: _____

Permit cancelled _____ Time: _____ Date: _____ Signature: _____

ATTACHMENT D

Material Safety Data Sheet Sample
May be used to comply with
OSHA's Hazard Communication Standards,
29 CFR 1910.1200. Standard must be
consulted for specific requirements.

U.S. Department of Labor
Occupational Safety and Health Administration
(Non-Mandatory Form)
Form Approved
OMB No. 1218-0072

IDENTITY *(As Used on Label and List)*	*Note: Blank spaces are not permitted. If any item is not applicable, or no information is available, the space must be marked to indicate that.*

Section I

Manufacturer's Name	Emergency Telephone Number
Address *(Number, Street, City, and ZIP Code)*	Telephone Number for Information
	Date Prepared
	Signature of Preparer *(optional)*

Section II—Hazardous Ingredients/Identity Information

Hazardous Components (Specific Chemical Identity; Common Name(s))	OSHA PEL	ACGIH TLV	Other Limits Recommended	% *(optional)*

Section III—Physical/Chemical Characteristics

Boiling Point		Specific Gravity (H_2O = 1)	
Vapor Pressure (mm Hg.)		Melting Point	
Vapor Density (AIR = 1)		Evaporation Rate (Butyl Acetate = 1)	

Solubility in Water

Appearance and Odor

Section IV—Fire and Explosion Hazard Data

Flash Point (Method Used)	Flammable Limits	LEL	UEL

Extinguishing Media

Special Fire Fighting Procedures

Unusual Fire and Explosion Hazards

Section V—Reactivity Data

Stability	Unstable		Conditions to Avoid
	Stable		

Incompatibility *(Materials to Avoid)*

Hazardous Decomposition or Byproducts

Hazardous Polymerization	May Occur		Conditions to Avoid
	Will Not Occur		

Section VI—Health Hazard Data

Route(s) of Entry: Inhalation? Skin? Ingestion?

Health Hazards (Acute and Chronic)

Carcinogenicity: NTP? IARC Monographs? OSHA Regulated?

Signs and Symptoms of Exposure

Medical Conditions
Generally Aggravated by Exposure

Emergency and First Aid Procedures

Section VII—Precautions for Safe Handling and Use

Steps to Be Taken in Case Material is Released or Spilled

Waste Disposal Method

Precautions to Be Taken in Handling and Storing

Other Precautions

Section VIII—Control Measures

Respiratory Protection *(Specify Type)*

Ventilation	Local Exhaust	Special
	Mechanical *(General)*	Other
Protective Gloves		Eye Protection

Other Protection Clothing or Equipment

Work/Hygienic Practices

ATTACHMENT E

Setting Up a Permit-Required Confined Space Program

STEP 1. Review Confined Space Regulation. Employers can call Cal/OSHA Consultation for a free copy or may access the Internet at the DIR/Standard Board Web site: <www.dir.ca.gov/samples/search/query.htm>.

STEP 2. Employers are responsible for implementing and maintaining a written confined space program, but employers can designate qualified employees for developing, implementing and monitoring a permit-required confined space program.

STEP 3. Start by assuming that all spaces can be permit-required confined spaces (PRCS). Through a complete survey of your facility, determine *actual and potential* PRCS. Remember that an NPCS has the potential to become a PRCS because hazards can change or evolve due to processes being used *within* the space, or because of the migration of *external hazards* into the space (e.g., nearby spills/releases of liquids or gases).

STEP 4. Post danger signs on all PRCS.

STEP 5. Determine if entry is absolutely necessary. If task can be completed from the outside, do so.

STEP 6. If employer decides that employees are *not* to enter a permit space, employers must prevent unauthorized entry.

STEP 7. If employer determines that employees *must* enter a PRCS, employer must develop and implement ***a written permit space program*** that includes the means, procedures, and practices for safe permit space entry operation. For complete details see Title 8, CCR, Section 5157(d). The following are some of the highlights:

- Develop and implement procedures to ensure:
  a. In-house and off-site rescue service availability.
  b. Emergency services for rescued employees.
  c. Pre-entry preparations are completed, where applicable:
     - ➪ purge ➪ flush ➪ wash
     - ➪ inert ➪ drain ➪ ventilate
     - ➪ isolate (lock out, de-energize, line blank out, etc.)

d. Acceptable entry conditions are attained and maintained, e.g., monitoring throughout entry operation. If a hazardous condition develops, entrants will evacuate, entry will be terminated, permit will be voided, and program will be re-evaluated.

e. At least one attendant is posted outside the space to ensure entrants are protected from internal and external hazards.

f. Coordination between host and contractor's employees when working simultaneously.

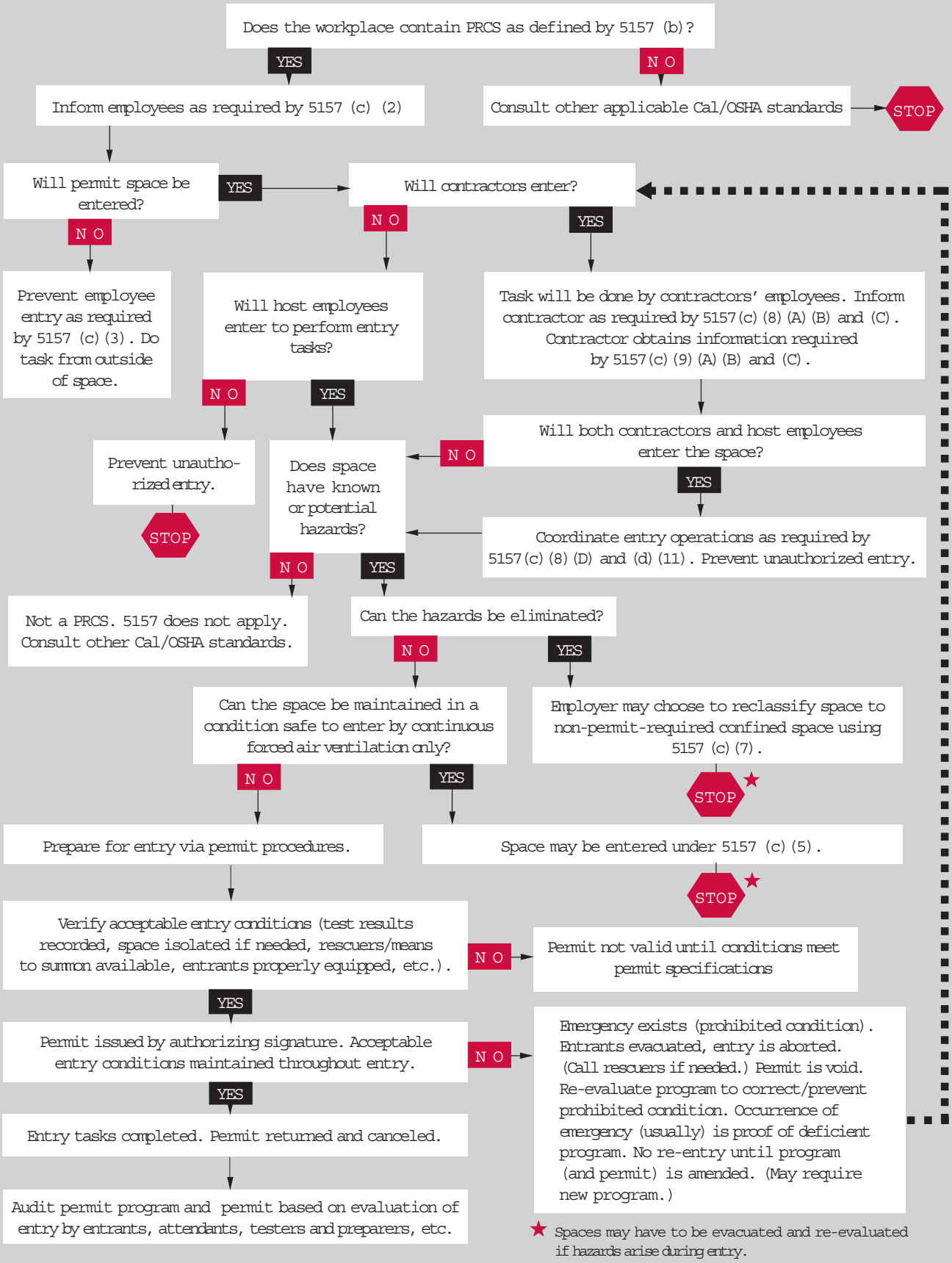
g. Employee training for safe entry and duty proficiency on hazard recognition and control, on-site rescue, etc. Train employees on the proper procedures for testing and monitoring, ventilation, communication, lighting, rescue and emergency, and use of any other equipment, including personal protective equipment necessary for safe entry into and rescue from permit spaces. Provide and maintain all necessary tools and equipment at no cost to employees. Be sure to keep training records.

h. Entry permits address all hazards and controls necessary for safe entry (see Attachment C of this guide for a sample permit). Entry permits must be signed prior to issuance, canceled once entry concludes, and filed for at least one year. These permits are used to review the confined space program.

i. Confined space entry/rescue programs are reviewed annually, and if necessary, *revised* to correct any deficiencies in order to ensure that employees entering permit spaces are protected from permit space hazards.

ATTACHMENT F

Permit-Required Confined Space (PRCS) Decision Flow Chart



★ Spaces may have to be evacuated and re-evaluated if hazards arise during entry.

REFERENCES

Application of the Permit-Required Confined Spaces (PRCS) Standard, 29 CFR 1910.146

Cal/OSHA Regulations and Guidelines:

- Confined Space Regulations Reprint, Title 8, Article 108, sections 5156, 5157, and 5158, November 1993
- Guide to Respiratory Protection at Work (S-630), August 1995
- Lockout/Blockout (English) (S-515), January 1997
- Lockout/Blockout (Spanish) (S-515S), October 1996
- Noise Control, Title 8, Article 105, April 1992

Federal Register, Vol. 58, No. 9, January 14, 1993, 29 CFR Parts 1910.146, Permit-Required Confined Spaces for General Industry; Final Rule

National Institute for Occupational Safety and Health (NIOSH)—Pocket Guide to Chemical Hazards (No. 94-116)

New York State Department of Labor, 1994, Employer Guide and Model Permit-Required Confined Space Entry Plan

NIOSH—Worker Deaths in Confined Spaces (No. 94-103)

Occupational Safety and Health Administration (OSHA) Instruction CPL 2.100, May 5, 1995

P. 64-blank

EVALUATION

Dear Reader,

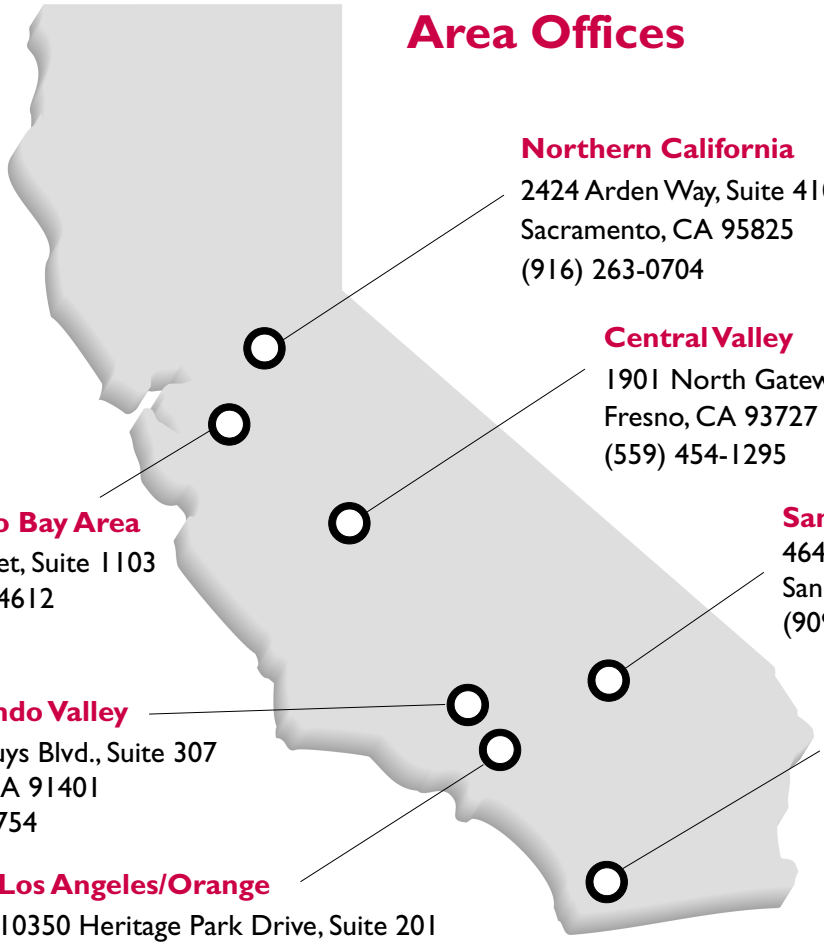
We value and welcome your comments on the *Confined Space Guide.* To better assist employers and employees, Cal/OSHA would like to invite you to participate in a brief evaluation. Please detach this page and fax to (916) 574-2532, or mail to: Cal/OSHA Education and Training Unit, 2211 Park Towne Circle Suite No. 4, Sacramento, CA 95825. **We thank you for your participation!**

Yes	No	Please ✓ and comment. Thank you.
☐	☐	1. Has the guide helped you to understand confined space hazards and requirements? Why or why not?_____
☐	☐	2. Did we miss any important confined space issues? If yes, what?_____
		3. Has the information contained in the guide encouraged you to: ❒ Develop a written confined space program in your facility ❒ Assess an existing confined space program ❒ Make improvements to your current confined space program
☐	☐	4. Overall, is the guide informative, useful, and easy to understand? Why or why not? _____
☐	☐	5. Do you have any specific comment(s) regarding the text or sections of this guide? If so, write your comment(s) and refer to specific page number(s), text, or section.
☐	☐	6. Do you have any success stories (avoided accidents, reduced number of injuries, etc.) that you would like to share with us? If so, please provide your company name and a brief description. _____

Cal/OSHA Consultation Programs

Toll-free number: 1-800-963-9424 • Internet: www.dir.ca.gov

On-site Assistance Program
Area Offices



Northern California
2424 Arden Way, Suite 410
Sacramento, CA 95825
(916) 263-0704

Central Valley
1901 North Gateway Blvd., Suite 102
Fresno, CA 93727
(559) 454-1295

San Francisco Bay Area
1515 Clay Street, Suite 1103
Oakland, CA 94612
(510) 622-2891

San Bernardino
464 West 4th Street, Suite 339
San Bernardino, CA 92401
(909) 383-4567

San Fernando Valley
6150 Van Nuys Blvd., Suite 307
Van Nuys, CA 91401
(818) 901-5754

San Diego/Imperial
7575 Metropolitan Dr., Ste. 204
San Diego, CA 92108
(619) 767-2060

Los Angeles/Orange
10350 Heritage Park Drive, Suite 201
Santa Fe Springs, CA 90670
(562) 944-9366

Your call will in no way trigger an inspection by Cal/OSHA Enforcement.

- **Voluntary Protection Program**
  San Francisco, CA 94142
  (415) 703-5272

- **Research and Education Unit**
  Sacramento, CA 95825
  (916) 574-2528

DIR
CALIFORNIA DEPARTMENT OF INDUSTRIAL RELATIONS

8 REU 11/00