

Confined Space Program



CALIFORNIA STATE UNIVERSITY FRESNO
OFFICE OF
ENVIRONMENTAL HEALTH AND SAFETY

November 2015

Table of Contents

	<u>Page</u>
1.0 Scope.....	1
2.0 Policy	1
2.1 Purpose	1
2.2 Objectives.....	1
3.0 Applicable Code	1
4.0 Individuals Covered by This Program.....	2
4.1 Employees	2
4.2 Contractors	2
5.0 Defining Confined Spaces, Identifying Hazards & Acceptable Limits	2
5.1 Defining Confined Spaces	2 - 4
6.0 General Requirements	4
6.1 Notification of Entry	4
6.2 Employee Training.....	5
6.3 Entry Permits.....	5
6.4 Permit System	5
6.5 Prevention of Hazardous Conditions	6
6.6 Sources of Ignition	6
6.7 Ventilation.....	6
7.0 Identifying Confined Space Hazards	7
7.1 Confined Space Hazard Categories.....	7
7.2 Atmospheric Hazards	7 - 9
7.3 Acceptable Limits	9
8.0 Procedures.....	9
8.1 Confined Space Team	9
8.2 Planning the Entry.....	9 - 11
8.3 Pre-Entry	11 - 12
8.4 Pre-Entry Testing	12 - 13
8.5 Entry Operations	14 - 15
8.6 Entry.....	15 - 16

8.7	Removal of Hazardous Conditions	17
8.8	Entry Under Hazardous Conditions	17
8.9	Terminating the Confined Space Entry	18
9.0	Hazards & Safe Work Practices	18
9.1	Excess Pressure Hazards	18
9.2	Electrical Hazards	18 - 19
9.3	Engulfment Hazards	19
9.4	Accumulated Water Hazards	19
9.5	Entrant-Generated Hazards	19 - 20
10.0	Qualification and Training	20
10.1	Employees	20 - 21
10.2	Contractors	21
11.0	Emergency Rescue Procedures	21
11.1	Self-Rescue	21
11.2	Non-Entry Rescue	21 - 22
11.3	Entry Rescue	22
12.0	Recordkeeping	23
12.1	Office of Environmental, Health & Safety (OEHS)	23
12.2	Departments	23
13.0	Contractors and Visitors	23

Appendices:

Definitions	Appendix A
Confined Space Inventory	Appendix B
Confined Space Flowchart	Appendix C
Confined Space Permit	Appendix D
Hazardous Atmospheres & Categories	Appendix E
Duties & Responsibilities	Appendix F
Recommended Respirator Selection Guide	Appendix G
Confined Space Checklist	Appendix H
Confined Space Alternate Procedure/Reclassification Form	Appendix I
Signs & Symptoms	Appendix J

1.0 Scope

The following procedures describe safe operating practices in confined spaces. These may include silos, vats, bins, sewers, pipelines, tanks, boiler compartments, ducts, vaults, pits, etc. which may lack oxygen or have dangerous air contamination and be of such configuration that it would be difficult to remove a suddenly disabled person.

2.0 Policy

Entering and working in confined spaces is an integral part of workplace activity by California State University, Fresno maintenance personnel and contractors. This Confined Space Program has been developed to provide guidance to all maintenance and contract personnel to who must enter confined spaces, regardless if they are permit or non-permit spaces.

The hazards encountered and associated with entering and working in confined spaces is capable of causing bodily injury, illness, and death. Accidents occur because of failure to recognize that a confined space is a potential hazard. It should therefore be considered that the most unfavorable situation exists in every case and that the dangers will be present at the onset of entry.

2.1 Purpose

A. The purpose of this program is to identify and control the hazards encountered and associated with entering and working in confined spaces on the grounds of the University and preventing bodily injury, illness, and/or death.

2.2 Objectives

A. The objectives of this program are to achieve the purpose of this document by:

1. Identifying, appropriately labeling, and controlling hazards of confined spaces in the facility.
2. Outlining safe work practices, including the use of confined space permit for permit-required confined space entries, which are to be used when preparing to enter and entering confined spaces.
3. Training responsible personnel on their roles, responsibilities and duties to ensure safety when working within confined spaces.

3.0 Applicable Code

This document has been prepared in accordance with applicable Cal/OSHA regulations, Title 8, Article 108, Sections 5156-5158, and provides the basis and documentation of all activities, which have been completed as part of the development of California State University, Fresno's Confined Space Program.

While this program meets the above-mentioned codes, California State University, Fresno believes in conducting safe operations to maintain a safe workplace and for the safety of employees. As such, this program is designed to meet code requirements.

4.0 Individuals Covered by this Program

4.1 Employees

- A. Those individuals whose job duties involve one or more of the following activities are included:
 - 1. Perform actual entries into permit-required confined spaces (Authorized Entrants);
 - 2. Serve as attendants during permit-required confined space entry (Attendant); or
 - 3. Supervise others who enter or attend during entries (Entry Supervisor).

4.2 Contractors

- A. Contractors needing access into a recognizable confined space must adhere to the requirements of this program, at the minimum. University contractor liaisons must furnish as much available information to the contractor as possible.
- B. Contractors and University employees who direct contractor activities in confined spaces are also reminded to review the University's Contractor Environmental, Health & Safety Handbook.

NOTE: No one may serve in any of these capacities without first receiving Confined Space Entry training, either as provided or approved by the Office of Environmental Health & Safety (OEHS).

5.0 Defining Confined Spaces, Identifying Hazards & Acceptable Limits

5.1 Defining Confined Spaces

All employees should be aware of the definition of confined spaces and permit-required confined spaces. As stated in the definition:

- A. A Confined Space:
 - 1. Is large enough and so configured that an employee can bodily enter and perform assigned work.
 - 2. Has limited or restricted means for entry or exits.
 - 3. Is not designed for continuous employee occupancy.

B. Permit-required Confined Spaces are confined spaces that possess potential hazards that could result in serious injury or death and are therefore subject to all the provisions of this program before entry is allowed. A confined space that contains one or more of the following characteristics is considered a Permit-Required Confined Space:

1. Contains or has a potential to contain a hazardous atmosphere;
2. Contains a material that has the potential for engulfing an entrant;
3. Has an internal configuration such that an entrant could be trapped or asphyxiated by inwardly converging walls or by a floor which slopes downward and tapers to a smaller cross-section; or
4. Contains any other recognized serious safety or health hazard.

NOTE: These spaces require a written permit prior to entry. The process of generating the permit forces managers, supervisors, entrants, and attendants to work together and carefully consider the potential hazards associated with the space in advance, and prepare controls appropriate to the space and entry work activities.

C. Alternate entry procedures are confined space entry procedures that can be used in place of a full permit-required entry. These procedures may be adopted if:

1. The only hazard in the confined space is an actual or potential hazardous atmosphere.
2. Forced air ventilation alone can maintain a safe atmosphere during entry.

D. Underground electrical installations (vaults) are used for electrical transmission and switching gear. These locations shall ALWAYS be permit required confined spaces. Regardless if the entry work is exclusively for the purpose of inspection, housekeeping, taking readings, or similar routine low hazard work, employees working alone SHALL NEVER enter underground electrical vaults alone and without an attendant, even for brief periods.

NOTE: Only authorized personnel who have received the proper training shall enter a sub-terrain electrical vault. When maintenance is to be performed on live electrical units inside an electrical vault where protective covers must be removed, it is highly recommended that this be outsourced to a qualified contractor.

E. Sewer entry differs in three vital respects from other permit entries:

1. There rarely exists any way to completely isolate the space (a section of a continuous system) to be entered;
2. Because isolation is not complete, the atmosphere may suddenly and unpredictably become lethally hazardous (toxic, flammable or

- explosive) from causes beyond the control of the entrant or employer, and;
3. Experienced sewer workers are especially knowledgeable in entry and work in their permit spaces because of their frequent entries. Unlike other employments where permit space entry is a rare and exceptional event, sewer workers' usual work environment is a permit space.
 4. Only employees who are thoroughly trained in sewer entry procedures and who demonstrate that they follow sewer entry procedures should be authorized entry.
 5. Atmospheric monitoring equipment should be carried and used by the entrant in sewer line work to monitor the atmosphere in the entrant's environment, and in advance of the entrants' direction of movement, to warn the entrant of any deterioration in atmospheric conditions. Where several entrants are working together in the same immediate location, one instrument, used by the lead entrant, is acceptable.
 6. If sewer entries are not contracted out, sewer crews should develop and maintain liaison, to the extent possible, with the local weather bureau and fire and emergency services. This allows entrance into the sewer to be delayed or interrupted and entrants withdrawn whenever sewer lines might be suddenly flooded by rain or fire suppression activities, or whenever flammable or other hazardous materials are released into sewers during emergencies by industrial or transportation accidents.
 7. Entry into large bore sewers may require the use of special equipment. Such equipment might include such items as atmosphere monitoring devices with automatic audible alarms, Escape Self-Contained Breathing Apparatus (ESCBA) with at least 10-minute air supply (or other NIOSH approved self-rescuer device), and waterproof flashlights, and may also include boats and rafts, radios and rope stand-offs for pulling around bends and corners as needed.

NOTE: A list of recognized definitions may be viewed in Appendix A.

6.0 General Requirements

6.1 Notification of Entry

- A. Management must notify the Office of Environmental Health & Safety (OEHS) of the intended confined space entry 48 hours in advance for routine or planned maintenance. Upon review, if the space is designated a potential confined space; the operation must be monitored prior entering the space. In emergency situations, it is advised that adequate advance notice be given to ensure the space is safe for entry. Under no circumstances shall unauthorized personnel (unpermitted) attempt to enter into a confined space.

NOTE: The monitoring of some routine confined space operation may be designated a responsibility of the using department. In these cases, upon

initial notification, the OEHS will review the operation and establish specific written guidelines for monitoring and operating. If any aspect of the operation should change, the OEHS must be notified immediately and new guidelines will be established accordingly. Only persons trained and designated qualified by the OEHS may conduct this monitoring.

6.2 Training

- A. The Office of Environmental Health & Safety shall provide training so that all employees whose work is regulated by this section acquire the understanding, knowledge, and skills necessary for the safe performance of the duties assigned under this section.
- B. Training shall be provided to each affected employee:
 - 1. Before the employee is first assigned duties under this section;
 - 2. Before there is a change in assigned duties;
 - 3. Whenever there is a change in permit space operations that presents a hazard about which an employee has not previously been trained;
 - 4. Whenever the employer has reason to believe either that there are deviations from the permit space entry procedures or that there are inadequacies in the employee's knowledge or use of these procedures.
- C. The training shall establish employee proficiency in the duties required by this section and shall introduce new or revised procedures, as necessary, for compliance with this section.
- D. Managers shall certify that the above-required training has been accomplished. The certification shall contain each employee's name, the signatures or initials of the trainers, and the dates of training. The certification shall be available for inspection by employees and their authorized representatives.

6.3 Entry Permits

- A. Entry into a permit required space shall be by permit only (Appendix D). This permit is an authorization for entry under defined conditions for a stated purpose and specific time. The qualified person will fill out the permit and assure all portions are completed before any entry into the confined space. Permits are valid for up to one shift only (not to exceed eight hours). Permits must be posted at the site during the operation and when finished, returned to the Office of Environmental Health & Safety for revision and filing.

6.4 Permit System

- A. Before entry is authorized, supervisors shall document the completion of measures by preparing an entry permit.
- B. Before entry begins, the entry supervisor identified on the permit shall sign the

- entry permit to authorize entry.
- C. The completed permit shall be made available at the time of entry to all authorized entrants or their authorized representatives, by posting it at the entry portal or by any other equally effective means, so that the entrants can confirm that pre-entry preparations have been completed.
 - D. The duration of the permit may not exceed the time required to complete the assigned task of job identified on the permit and may not exceed an eight-hour period.
 - E. The entry supervisor shall terminate entry and cancel the entry permit when:
 - 1. The entry operations covered by the entry permit have been completed; or
 - 2. A condition that is not allowed under the entry permit arises in or near the permit space.
 - F. The Office of Environmental Health & Safety shall retain each canceled entry permit for at least 1 year to facilitate the review of the permit space program. Any problems encountered during an entry operation shall be noted on the pertinent permit so that appropriate revisions to the permit space program can be made.

6.5 Prevention of Hazardous Conditions

- A. When feasible, the confined space must be positively prevented from entry of any material or energy that may create a hazardous condition(s). In such cases, double blanking, double block and bleed, electrical lockout/tagout, and blocking or disconnecting mechanical linkages is authorized in such a manner as to prevent inadvertent reconnection.

6.6 Sources of Ignition

- A. Work involving the use of flame, arc, spark, or other source of ignition is prohibited within a confined space (or any adjacent space) which contains, or is likely to develop, dangerous air contamination due to flammable and/or explosive substances unless:
 - 1. An inert atmosphere, using gases such as nitrogen, is used to prevent the ignition and the oxygen concentration is maintained at less than 10% of the concentration, which supports combustion.
 - 2. Sufficiently frequent testing of the oxygen content is performed to ensure that the oxygen remains less than 10% of the concentration, which supports combustion.

6.7 Ventilation

- A. Adequate combustion air and exhaust gas venting must be provided whenever oxygen-consuming equipment (i.e. salamanders, plumber's torches, or other

heating devices) is to be used.

7.0 Identifying Confined Space Hazards

7.1 Confined Space Hazard Categories

A. Once a space has been identified as confined, the hazards that may be present within the confined space must be identified. Confined-space hazards can be grouped into the following categories:

1. Oxygen-deficient atmospheres,
2. Flammable atmospheres,
3. Toxic atmospheres, and
4. Mechanical and physical hazards.

7.2 Atmospheric Hazards

These hazards are difficult to identify since they are usually invisible. Every confined space must be evaluated for these four types of hazards.

A. Oxygen-Deficient Atmospheres

The normal atmosphere is composed of approximately 21% oxygen and 79% nitrogen. An atmosphere containing less than 19.5% oxygen is considered oxygen-deficient. An atmosphere containing more than 23.5% oxygen is considered oxygen-enriched.

The oxygen level inside a confined space may be decreased as the result of either consumption or displacement. There are a number of processes that consume oxygen in a confined space. Oxygen deficiency can result from:

1. Combustion of flammable materials, as in welding, cutting, or brazing.
2. Bacterial action, as in the fermentation process (subtle consumption).
3. Chemical reactions such as in the formation of rust on exposed surfaces.
4. Displacement of oxygen by other gases.
5. Consumption, dependent upon the number of people working in a confined space and the amount of physical activity.

B. Flammable Atmospheres

Flammable atmospheres are generally the result of flammable gases, vapors, dust mixed in certain concentrations with air, or an oxygen-enriched atmosphere.

1. Flammable gases or vapors can accumulate within a confined space when there is inadequate ventilation. Gases that are heavier than air will

accumulate in the lower levels of a confined space. Therefore, it is especially important that atmospheric tests be conducted near the bottom of all confined spaces.

2. The work being conducted in a confined space can generate a flammable atmosphere. Work such as spray-painting, coating or the use of flammable solvents for cleaning can result in the formation of an explosive atmosphere. Welding or cutting with oxyacetylene equipment can cause an explosion through small leaks in hoses, which could generate an explosive atmosphere and should be removed when not in use.
3. Oxygen-enriched atmospheres are those atmospheres that contain an oxygen concentration greater than 23.5%. An oxygen-enriched atmosphere will cause flammable and combustible materials such as clothing and hair to burn violently when ignited.

C. Toxic Atmospheres

Toxic atmospheres may be present within a confined space as the result of one or more of the following:

1. The Product Stored in the Confined Space

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

2. The Work Being Conducted in the Confined Space

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

3. Areas Adjacent to the Confined Space

Toxic gas, vapors or fumes produced by processes near the confined space may enter and accumulate in the confined space. For example, if the confined space is lower than the adjacent area and the toxic gas, vapor or fume is heavier than air, it may "settle" into the confined space.

D. Mechanical & Physical Hazards

Problems such as rotating or moving mechanical parts or energy sources can create hazards within a confined space. All rotating or moving equipment such

as pumps, process lines, electrical sources, etc., within a confined space must be identified and locked and tagged out.

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

NOTE: Additional information on Hazardous Atmosphere Categories may be found in Appendix E.

7.3 Acceptable Limits

The atmosphere of the confined spaces should be considered within acceptable limits whenever the following conditions are maintained:

- A. Oxygen – 19.5% to 23.5%,
- B. Flammability – less than 10% of the Lower Flammable Limit (LFL), and
- C. Toxicity – less than recognized ACGIH exposure limits or other published exposure levels (e.g. OSHA PELs, NIOSH RELs).

8.0 Procedures

These procedures will be used when any employee, permanent or temporary, and/or contractor must enter into a designated confined space area.

NOTE: For a list of Duties & Responsibilities when entering a permit or non-permit required space, refer to Appendix F.

8.1 Confined Space Team

A minimum number of Employees will make up the confined space team, as follows:

- A. Non-Permit Required: two (2) Employees (an entrant and an attendant).
- B. Permit-Required: three (3) Employees (two trained Employees will be within line of sight and/or verbal communication distance of one another outside of the confined space, and an entrant).

NOTE: A Confined Space Flowchart is available to assist in determining if the space to be entered is a permit or non-permit required space (Appendix C).

8.2 Planning the Entry

The first step towards conducting a safe confined-space entry is to plan the entry. This will allow for the identification of all hazards, and for the determination of all equipment necessary, to complete the project.

A. Preparation – once an entry into a confined space is determined to be made, the following will occur:

1. Discuss the type of work to be completed inside the confined space.

B. Hazard Identification:

1. Discuss the hazards involved for the confined space. These include:

- a. Type of work to be conducted and whether or not it adds any hazard to the confined space.
- b. Oxygen deficiency or enrichment atmosphere potential
- c. Flammable atmosphere potential
- d. Toxic atmosphere potential (i.e., CO, CO₂, H₂S, etc., product off-gassing or residue, other)
- e. Engulfment potential (i.e., fluid lines feeding into the confined space, solid material feeds, dust, etc.)
- f. Hazardous chemicals or chemical residues
- g. Physical hazards such as heat, cold, vibration, mechanical (i.e., rotating or crushing motions of equipment, etc.)
- h. Electrical, etc.

NOTE: For a list of recommended respirator equipment, see the Recommended Respirator Selection Guide, Appendix G.

C. Permit-Required:

If the confined space to be entered is labeled “permit-required” or determined to meet any of the criteria defined as “permit-required,” a confined space permit (Appendix D) shall be completed.

1. Permit-Required Confined Space Entry – The supervisor assigning work will complete Part 1 of the Confined Spaces Permit.

2. Equipment:

a. Based upon the hazard identification and work to be completed, the following appropriate equipment will be assembled and used in the confined space entry (note: this list is not all inclusive and if additional equipment is needed, then bring it)

- Air monitor
- Forced air device (blower)
- 2-way communication device (attendant / entrant(s) contact)
- Cell phones (attendant / rescue personnel contact)
- Tripod, winch (with rescue capability), and full body harness

(for vertical entry)

- Portable davit or horizontal rescue device/spreader, winch (with rescue capability) (for horizontal entry)
- Barriers and cones
- Appropriate eye, hand, foot and head protection
- Appropriate fire extinguisher (as needed)
- Chemical resistive protective clothing (as needed)

NOTE: A Confined Space Checklist is provided to assist with preparations prior to entry (Appendix H). This list is inconclusive and may be adjusted to suit the task at hand when warranted.

8.3 Pre-Entry – once preparation has been completed, personnel and equipment involved in the confined space work will proceed to the confined space with the equipment needed. The following will occur:

A. Isolation

1. All mechanical hazards such as rotating, cutting and crushing mechanisms and electrical lines shall be de-energized by locking and blocking.
2. Lines, which may introduce any substances or compressed air or gasses into the space, shall be disconnected, blinded, or blocked off by other positive means to prevent the development of dangerous air contamination and/or oxygen deficiency within the space. The disconnection or blind shall be so located or done in such a manner that inadvertent reconnection of the line or removal of the blind are effectively prevented.
3. Where interconnected spaces are blinded off as a unit, each space shall be tested and the results recorded. The most hazardous condition found shall govern procedures to be followed.
4. To the extent feasible, all exits and entries shall be readily accessible.
5. Permit Required. If the confined space to be entered is “permit-required,” then Part 2 of the confined space permit (Appendix D) will be completed as outlined in the permit.

B. Warning Signs & Barriers

1. Warning signs or barriers shall be used to prevent unauthorized entry or to protect employees or contract employees from external hazards. These will be placed at least 6 feet from the work area to prevent access and potential falls into a top-opening confined space entry.

C. Purging of a confined space with an inert gas is not recommended and shall not be conducted by employees of California State University, Fresno. If for some reason this is the only way to perform the work in a confined space

safely, California State University, Fresno shall hire a qualified, competent contractor who will conduct the confined space entry as detailed in this program and describe the purging procedures in writing.

D. Pre-Entry Safety Meeting

1. All Employees involved in the entry will participate in a pre-entry meeting. The following information will be discussed at a minimum:
 - a. Identify the confined space and the reason(s) for entry.
 - b. Identify work detail
 - Who is assigned to the job(s) he/she is to perform in the entry project (entrant, attendant, etc.).
 - If an employee is required to use a piece of equipment, be sure that he/she is capable of using the equipment properly.
 - Inform all personnel that no one is to enter the confined space unless authorized and recorded by the attendant.
 - c. Hazards: Known or potential hazards for this confined space, and actions that have been taken to control them.
 - d. Permit Required: If the confined space to be entered is “permit-required,” then Part 2 of the confined space permit (Appendix D) will be completed as outlined in the permit.
 - e. Communication: Discuss the types of communication to be used during the entry. Inform entrants and attendants that they must maintain communication and contact with each other.
 - f. Rescue: Discuss the rescue procedures to be performed in the event an attendant or entrant declares a rescue.

NOTE: The attendant MUST NOT ENTER the confined space under any circumstances.

8.4 Pre-Entry Testing

Prior to entering the confined space, test the space immediately to determine whether dangerous air contamination and/or oxygen deficiency exists. Testing can occur through opening, or, if necessary, the confined space can be opened a crack and the testing equipment probe placed into the confined space.

A. Testing shall be conducted for the following:

1. Oxygen content
2. Flammable atmosphere
3. Toxic vapors and gases anticipated in the confined space (CO, CO₂,

H₂S, etc.)

- a. Permit Required. If the confined space to be entered is “permit-required,” then Part 2 of the confined space permit (Appendix D) will be completed as outlined in the permit.

B. Testing should be performed without disturbing the space, if possible.

1. The test equipment should be clear tested in a known atmosphere to insure its accuracy, as prescribed by the manufacturer.
2. The atmosphere must be tested at the bottom, top, and middle of all confined spaces.
3. Employees shall refrain from leaning over the area to be tested; instead, the air-testing device should be placed over or into the opening of the area.

C. Special Precautions

1. Work involving the use of flame, arc, or spark, or other source of ignition is prohibited within a confined space (or any adjacent space having common walls, floor, or ceiling with the confined space), which contains, or is likely to develop, dangerous air contamination due to flammable substances.
2. If the existence of dangerous air contamination and/or oxygen deficiency is determined by the tests performed, existing ventilation shall be supplemented by the appropriate means or the confined space entry is terminated.
3. Whenever oxygen-consuming equipment is used, ensure sufficient venting for all combustion air and exhaust gases.
4. Only approved lighting and electrical equipment, in accordance with low voltage electrical safety order, shall be used in confined spaces where dangerous air contamination due to flammable and/or explosive substances exists.
5. Where live electrical work will be performed, any retrieval unit (i.e., tripod, etc.) will be properly grounded (e.g. welding cable and clamp).
6. If chemical cleaners are to be used, name the type and describe the procedures. The Safety Data Sheet (SDS) for the chemical shall be consulted prior to use and shall be located at the confined space entrance. The compatibility of that chemical with the contents of the confined space must be checked. If in doubt, consult with head of the Office of Environmental Health & Safety.
7. If the chemical being used is flammable, ventilation must be used to dilute the atmosphere to within acceptable, measurable range and no spark-producing tools will be allowed for use.
8. If steam is used, the hose should be bonded to the confined space.

8.5 Entry Operations

Once the preparation and pre-entry procedures have been successfully completed, entry operations may proceed. If results of the monitoring show dangerous air contamination and oxygen deficiency does not exist, then entry may be allowed under the following provisions:

- A. The confined space must be cleaned/purged and continuous positive ventilation must be utilized during the operation. Care must be taken to direct ventilation exhaust air downwind of exterior personnel and away from intake(s) or point(s) of entry.
- B. Atmospheric testing will be conducted with sufficient frequency to ensure that the development of any dangerous air contamination and oxygen deficiency does not occur during the performance of any operation.
- C. Any change in the operation, such as the introduction of a different chemical or change in the quantity used, voids the permit. The Office of Environmental Health & Safety may issue a new permit upon reevaluation of the new operation.
- D. A standby employee, properly trained in confined space operations, must be located outside of the confined space site at all times. They must keep visual and/or audible contact with the entrants and summon emergency assistance if necessary.
- E. The confined area must be properly guarded against inadvertent entry of substances or other physical hazards (i.e. vehicles, pedestrians, cars, etc.).
- F. All necessary personal protective equipment needed to protect the employees(s) in the confined space must be utilized.
- G. Only approved explosion proof lighting, equipment and tools may be used when the environment may exceed 10% of the lower explosive level.
- H. The following outlines the entry operations:
 1. Opening a Confined Space
 - a. Any conditions making it unsafe to remove an entrance cover should be eliminated before the cover is removed.
 - b. If the confined space has two possible openings, both will be opened. As an example, a tank or silo may have an opening at the top and bottom. Opening both will ensure optimum airflow and prevent the accumulation of toxic gasses or vapors.
 - c. For a top opening, when entrance covers are removed, the opening should be promptly guarded by a railing, temporary cover, or other temporary barrier that will prevent anyone from falling through the opening. This barrier or cover should protect each entrant working in the space from foreign objects entering the space.

I. Ventilation

1. Ventilate the confined space as necessary by setting up the equipment (blower). Note that air being blown into the confined space must not be placed where hazardous air or toxics will be picked up and introduced into the confined space.
2. Ventilation ducts should be directed away and clear from the confined space entry point.

J. Atmospheric Testing

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

1. All of the manufacturer's operating instructions must be followed.
2. Ventilation equipment must be shut off before conducting any atmospheric tests.
3. The atmosphere must be continuously monitored while work is being conducted in the confined space.
4. If the confined space is left for any reason, the atmosphere must be re-tested before re-entering the space.
5. Permit Required. If the confined space to be entered is "permit-required," then Part 2 of the confined space permit will be completed as outlined in the permit.

8.6 Entry

A. Non-Permit Required Confined Space

1. A two-person notification policy shall apply, meaning two people, one inside and one outside, are required for each confined space entry. Continuous communication must be maintained.
2. Employees working in non-permit confined spaces shall wear appropriate personal protective equipment for the hazards expected in the space.
3. Air testing shall be conducted periodically to monitor the pre-existing atmospheric environment and to detect any atmospheric changes that might occur.

B. Permit-Required Confined Space

1. A three-person confined spaces entry team shall apply. Continuous communication must be maintained.
2. An approved safety harness with an attached line shall be used. The free end of the line will be secured outside the entry opening.

- a. Exception: Where an Entry Supervisor determines that a safety line would further endanger the life of the employee (i.e., rubbing contact, tangling with equipment inside the confined space, or around horizontal corners), the harness will remain on the employee to facilitate rescue in the event of an emergency.
 - b. Should this situation exist: The entrant shall be equipped with an ESCBA or equivalent and a rescue service shall be contacted for immediate deployment should a rescue be needed.
 - 3. Where air contaminants persist or begin to appear after ventilating a confined space, continuous air monitoring will be performed. The Entry Supervisor will enter data on permit.
 - 4. If air-sampling instruments indicate a developing adverse atmospheric change (e.g. steadily rising hydrogen sulfide or carbon monoxide levels, or steadily increasing or decreasing oxygen concentration), the Entry Supervisor will immediately pull all entrants from the confined space and reassess the area for its new hazard.
- C. When entry must be made through an opening in the top of the space, the following requirements also apply:
- 1. Any person entering the space shall wear a safety harness that suspends a person in an upright position.
 - 2. A hoisting device (tripod) or other effective means shall be erected for lifting Employees out of the space.
 - 3. Horizontal Opening – When entry must be made through a horizontal opening on the side of the confined space, the following requirements also apply:
 - a. Any person entering the space shall wear a safety harness.
 - b. A hoisting device (portable davit or horizontal rescue device such as a spreader bar) or other effective means shall be provided for pulling Employees out of the space.

NOTE: If there are multiple openings in the confined space (side and from the top), the opening located closest to the bottom of the confined space will be used.

NOTE: If a supervisor has determined that a space requires an alternate procedure for entry or may be reclassified, see Appendix I.

NOTE: For a list of Signs & Symptoms of hazards an employee may be exposed to, see Appendix J.

8.7 Removal of Hazardous Conditions

If the air monitoring results show dangerous air contamination or oxygen deficiency does exist, then the confined space will be ventilated and purged/cleaned/flushed to remove the hazard to the greatest extent feasible. This ventilation must be approved and may need to be statically bonded and explosion proof. When additional atmospheric monitoring has demonstrated no dangerous air contamination and no oxygen deficiency exists or may develop, only then may entry be allowed.

8.8 Entry Under Hazardous Conditions

However, if the additional monitoring demonstrates that an atmosphere free of dangerous air contamination or oxygen deficiency cannot be ensured or in emergency situations when the appropriate provisions cannot be implemented, entry may be allowed only under the following provisions:

- A. An approved safety harness with an attached line shall be used, with the free end of the line secured outside the entry point. Confined spaces with top and side openings should be entered from the side when possible. When entry must be made through a top opening, the safety belt shall be of a harness type and a hoisting device shall be utilized to lift employees out of the space.
- B. An approved airline respirator or self-contained breathing apparatus (SCBA) shall be worn by all person(s) entering the confined space. Air shall meet the requirements of the Compressed Gas Association of Group D breathing air.
- C. At least one standby employee in a constant, effective means of communication with the entrant shall be outside the confined space at all times, ready to give assistance. At least one additional stand-by employee, who may have other duties, must be within sight or call of the primary stand-by employee. This secondary standby must also be trained in confined space operations.
- D. The primary standby employee shall have an SCBA or approved airline respirator (independent source of breathing air) with an escape bottle. This standby may enter the confined space only in an emergency and only after:
 - 1. Attempting to pull the person out with the safety line.
 - 2. Alerting the secondary stand-by of the intended entry, the existence of an emergency, and issuing instructions to call the Police or Fire Departments.
- E. At least one person trained in CPR/Basic First Aid shall be on hand at the site.

8.9 Terminating the Confined Space Entry

A. A confined space entry may be terminated for any of the following reasons:

1. When the work is completed.
2. Anytime the entrant, attendant and/or entry supervisor declare it terminated based upon hazardous conditions, atmospheric measurements or entrant symptoms indicate there is a problem.
3. Emergency or rescue.

9.0 Hazards and Safe Work Practices

The following kinds of hazards may potentially exist in confined spaces. Each hazard is followed by a description of recommended safe work practice(s) for eliminating or appropriately controlling the hazard.

9.1 Excess Pressure Hazards

- A. The build-up of pressure inside a space can create a serious physical hazard during cover/hatch opening. Pressure build-up could occur as a result of internal reactions inside the space, or from a very tightly sealed space that have not off-gassed.
- B. Safe Work Practice: Prior to removing an entry manhole cover or hatch, visually inspect the area for any obvious discoloration, deterioration, or deformation. Prior to physically touching the cover, hold your hand above the cover to determine if it is excessively warm. The presence of vent or hook holes may prevent pressurization of the space. If no vent or hook holes are present, open the cover gradually to release any residual pressure that may be present. After removing the cover/hatch, install safety railings with an access chain to prevent an accidental fall into the space.

- | | |
|--|---------------|
| 1. Oxygen | 19.5 to 23.5% |
| 2. Flammability (% of Lower Explosive Limit) | <10% |
| 3. Carbon Monoxide | < 25 ppm |
| 4. Hydrogen Sulfide | < 10 ppm |

9.2 Electrical Hazards

- A. Confined spaces may also present serious electrical shock or electrocution hazards from potentially defective cables, the presence of water (flooded vault) in contact with electrical wiring, or by accidental physical contact with charged cables or wire leads.
- B. Safe Work Practice: The risks from electrical hazards depend upon the presence and condition of electrical sources and conduits inside the space, and the activity or work to be conducted inside the confined space. Employees are cautioned to NOT ENTER THE SPACE if an electrical shock potential is

identified.

NOTE: Underground Electrical Vaults may be entered without additional electrical hazard protections for “routine work” only. “Routine work” here refers to non-invasive, low hazard activities such as inspection, meter or dial reading, housekeeping, and other similar work. Entries into these kinds of locations are permit required.

NOTE: For routine work inside Underground Electrical Vaults, forced ventilation must be applied at all times even if initial monitoring indicates safe atmospheric conditions. Entrants must immediately exit the confined space if any gas monitor alarm set points are reached, and also if the forced ventilation system shuts down or fails.

9.3 Engulfment Hazards

- A. Engulfment hazards are either active or potential conditions that could crush, suffocate, drown, or otherwise engulf and incapacitate an entrant. The most common examples of confined space engulfment hazards on campus are the presence of high water levels or the potential for flooding while working inside a confined space. Other less common engulfment hazards are possible from the shifting or collapse of surrounding soil or sand, and the release or falling of supplies or other materials stored inside a confined space.
- B. Safe Work Practice: Before an entry is performed, confined spaces must be thoroughly visually inspected for potential engulfment hazards. Accumulated water must be pumped out of the space before entry is made. If there is a potential for flooding from an incoming feed pipe or valve, an appropriate lock-out/tag-out must be applied to prevent inadvertent filling.

9.4 Accumulated Water Hazards

- A. Small amounts of water often accumulate in the base of many confined spaces, especially those located outdoors. When water accumulates in excess of dampness or minor wetting, it can create or mask other hazards. These include slippery walking surfaces, the obscuring of trip or fall hazards, and increasing the potential for electrical hazards.
- B. Safe Work Practice: Prior to entry, accumulated water must be pumped down to ensure a clear and unobstructed view into the space, and visually confirmed as free from other recognizable hazards. Portable electrical lighting and other equipment for use inside a wet or damp confined space must be limited under most circumstances to self-contained battery operated devices, low voltage equipment, or protected by a functioning ground-fault circuit interrupter (GFCI).

9.5 Entrant-Generated Hazards

- A. Certain maintenance and repair operations performed in confined spaces have

the potential to generate their own hazards. Some examples include:

1. The use of volatile cleaning, stripping, or coating chemicals that can pose toxicity, flammability, or oxygen displacement hazards.
2. Introduction of flames and other ignition sources through welding or cutting work.
3. High potential exposures to silica and metal during sandblasting operations.

- B. **Safe Work Practice:** Prior to making any confined space entry, the authorized entrant(s) and their supervisors must review the anticipated purpose of the entry and any planned work activities. Special attention must be given to evaluating and controlling hazards from in-space work activities, (e.g., additional local exhaust or supply ventilation, changing chemical products to lower hazard materials, working remote, etc.). Hot work, occurring in a non-designated hot work area, requires the use of a hot work permit. Contact OEHS for additional information on controlling hazardous operations.

NOTE: Atmospheric monitoring must be made with a calibrated, OEHS-approved alarming multiple gas monitors. Employees may only enter a confined space after initial testing indicates that no atmospheric hazards exist; continuous monitoring is required while a confined space is occupied. Workers must immediately leave the space if any of the gas monitor alarm set points are reached. Workers may not return into the space until forced ventilation has been completed and the gas detector indicates that it is safe to re-enter. In addition to the multi-gas meter, individuals entering into atmospheric hazard confined spaces must also wear a personal, direct reading, alarming oxygen meter calibrated to the same set points as above.

10.0 Qualification, Training, and Certification

10.1 Employees

- A. Individuals involved in any aspect of work with confined spaces work must receive annual confined space safety training. This training must cover:
1. Confined space standard.
 2. Definition and identification of types of confined spaces.
 3. Confined space hazards (general and specific as defined in this program).
 4. Duties of entrants, attendants, and entry supervisors (as outlined in the Responsibilities section below).
 5. Permit entry procedure.
 6. Air monitoring and recording.
 7. Proper use of equipment.
 8. Rescue procedure.

9. Example of confined spaces.
10. Example entry and rescue procedures drill (hands on set-up).

NOTE: Confined space equipment is to be certified on an annual basis by a competent person.

10.2 Contractors

- A. Contractors, vendors, and other visitors are responsible for their own health and safety programs, including programs for any confined space entry work. Their programs must meet the requirements of this program, at the minimum.
- B. California State University, Fresno reserves the right to inspect training records of contractors and vendors at any time.

11.0 Emergency Rescue Procedures

Emergencies during a confined space entry can have catastrophic consequences if entrants, attendants, and potential rescuers have not developed a plan of action in advance.

Appropriate means for rescue must be established prior to entry, selected from the following gradations of rescue procedures:

11.1 Self-Rescue

- A. Entrant self-rescue generally provides the most effective means of escaping a recognized confined space hazard. Self-rescue must immediately be effected whenever an entrant, fellow entrant, or attendant recognizes the presence of a hazardous atmosphere, any signs or symptoms of over-exposure, or any other serious space hazards. Self-rescue must also be implemented in the event of forced ventilation system failure.
- B. Self-rescue requires entrants to safely stop whatever they are doing and exit the space in the most expedient and safe manner possible. Self-rescue is simple, fast, provides individuals with the ability to alert fellow workers, and does not require anyone else to enter the space, thereby avoiding the endangerment of more people. The obvious drawback is that it requires the entrant to be conscious and physically mobile, and therefore unsuited for entrants who have suffered serious exposure or injury.
- C. Should the confined space entry have the potential of becoming hazardous, the entrants may be provided with an Emergency Self-Contained Breathing Apparatus (ESCBA).

11.2 Non-Entry Rescue

- A. Non-entry rescue equipment typically consists of a body harness, non-conductive cable or rope, winch, and tripod (vertical entry) or spreader bar/

davit (horizontal entry) that can be operated from outside of the confined space by the attendant. When self-rescue is not possible due to unconsciousness or incapacitation of an entrant, non-entry rescue should be initiated. Under this method, mechanical equipment is used to physically extract, lift, pull, or otherwise remove entrants from the confined space without requiring any additional persons to enter into the space.

- B. Non-entry rescue reduces the risk of collateral injury to rescuers, but is only effective on simple vertical or clear horizontal spaces. Since mechanical retrieval of unconscious or incapacitated entrants from complex, convoluted spaces can cause serious injuries from entanglement, strangulation, and blunt force impacts, this method of retrieval must be carefully evaluated before implementation.

11.3 Entry Rescue

It is the policy of California State University, Fresno that Employees of the University shall not perform this type of rescue operation. In the event a non-entry rescue is required, the city fire department shall be contacted to perform all rescue operations involving entry rescue. In addition, campus police shall be called to render CPR assistance and crowd control, if either is needed.

NOTE: California State University, Fresno reserves the right to contract out the responsibility of entry rescues to an outside contractor. In this event, the emergency call shall be made to this entity.

- A. Entry rescues are the most dangerous form of confined space rescue since they require additional persons to enter into the very space that caused injury or over-exposure to the entrant(s).
- B. Rescues requiring entry into the area (entry rescue) may only be attempted by appropriately trained individuals who possess active certification in and knowledge of First Aid/CPR, self-contained breathing apparatus, rescue/retrieval equipment, and rescue training.
- C. An entry rescue plan must be developed prior to implementing this level of rescue responsibility, and includes the following elements:
 - 1. Barricades for crowd/traffic control,
 - 2. Additional ventilation options,
 - 3. Controls for other potential hazards (e.g., cave-ins, fire),
 - 4. Protective clothing and equipment,
 - 5. Explosion-proof lighting equipment,
 - 6. Redundant methods of communication,
 - 7. Standby rescue team,
 - 8. Victim removal procedures and devices,
 - 9. Available emergency vehicles,
 - 10. Medically trained personnel.

12.0 Recordkeeping

12.1 Office of Environmental Health & Safety

- A. Maintains copies of the inventory of recognized confined spaces, training records, safety audits, and incident/accident investigations.
- B. The original confined space permit (Appendix D) shall be kept on file in the Office of Environmental Safety & Health for a minimum of one year.

12.2 Departments

- A. Owner departments maintain copies of completed entry forms, and service and maintenance records for work in all locations, including confined spaces.

13.0 Contractors and Visitors

Contractors, vendors, and other visitors are responsible for their own health and safety programs, including programs for any confined space entry work. Their programs must meet the requirements of this program, at the minimum. University contacts and liaisons with these individuals are responsible for sharing information about known or suspected confined spaces in advance.

If the contractor or vendor does not have a confined space program that meets or exceeds this program, all contractors and vendors shall adhere to the program Confined Space Program established by California State University, Fresno.



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

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

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

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

Confined space: a space that:

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

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

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

Emergency Self-Contained Breathing Apparatus (ESCBA): a device with that personnel use to evacuate with safety, from a dangerous environment that lacks normal breathing conditions caused by a lack of oxygen, toxic gases, smoke, etc.

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

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

Entry permit (permit): the written or printed document that is provided by the employer to allow and control entry into a permit space and that contains the information specified in subsection (f).

Entry supervisor: the person (such as the employer, foreman, or crew chief) responsible for determining if acceptable entry conditions are present at a permit space where entry is planned, for authorizing entry and overseeing entry operations, and for terminating entry as required by this section.

Note: An entry supervisor also may serve as an attendant or as an authorized entrant, as long as that person is trained and equipped as required by this section for each role



he or she fills. Also, the duties of entry supervisor may be passed from one individual to another during the course of an entry operation.

Fresh air set-up: Equipment utilized for the planned and systematic removal of potential gases and the replacement of these potential gases through systematic fresh air changes within the confined space.

Hazardous atmosphere: an atmosphere that may expose employees to the risk of death, incapacitation, impairment of ability to self-rescue (that is, escape unaided from a permit space), injury, or acute illness from one or more of the following causes:

- (1) Flammable gas, vapor, or mist in excess of 10 percent of its lower flammable limit (LFL);
- (2) Airborne combustible dust at a concentration that meets or exceeds its LFL;

Note: This concentration may be approximated as a condition in which the dust obscures vision at a distance of 5 feet (1.52 M) or less.

- (3) Atmospheric oxygen concentration below 19.5 percent or above 23.5 percent;
- (4) Atmospheric concentration of any substance for which a dose is published in Group 14 for Radiation and Radioactivity or a permissible exposure limit is published in section 5155 for Airborne contaminants and which could result in employee exposure in excess of its dose or permissible exposure limit;

Note: An atmospheric concentration of any substance that is not capable of causing death, incapacitation, impairment of ability to self-rescue, injury, or acute illness due to its health effects is not covered by this provision.

- (5) Any other atmospheric condition that is immediately dangerous to life or health.

Note: For air contaminants for which a dose is not published in Group 14 for Radiation and Radioactivity or a permissible exposure limit is not published in section 5155 for Airborne contaminants, other sources of information such as: Safety Data Sheets that comply with section 5194, published information, and internal documents can provide guidance in establishing acceptable atmospheric conditions.

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

Immediately dangerous to life or health (IDLH): any condition that poses an immediate or delayed threat to life or that would cause irreversible adverse health effects or that would interfere with an individual's ability to escape unaided from a permit space.

Note: Some materials – hydrogen fluoride gas and cadmium vapor, for example – may produce immediate transient effects that, even if severe, may pass without medical attention, but are followed by sudden, possibly fatal collapse 12-72 hours after exposure. The victim “feels normal” from recovery from transient effects until



collapse. Such materials in hazardous quantities are considered to be “immediately” dangerous to life or health.

Inerting: the displacement of the atmosphere in a permit space by a noncombustible gas (such as nitrogen) to such an extent that the resulting atmosphere is noncombustible.

Note: This procedure produces an IDLH oxygen-deficient atmosphere.

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

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

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

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

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

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

- (1) Contains or has a potential to contain a hazardous atmosphere;
- (2) Contains a material that has the potential for engulfing an entrant;
- (3) Has an internal configuration such that an entrant could be trapped or asphyxiated by inwardly converging walls or by a floor which slopes downward and tapers to a smaller cross-section; or
- (4) Contains any other recognized serious safety or health hazard.

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

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

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

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

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

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



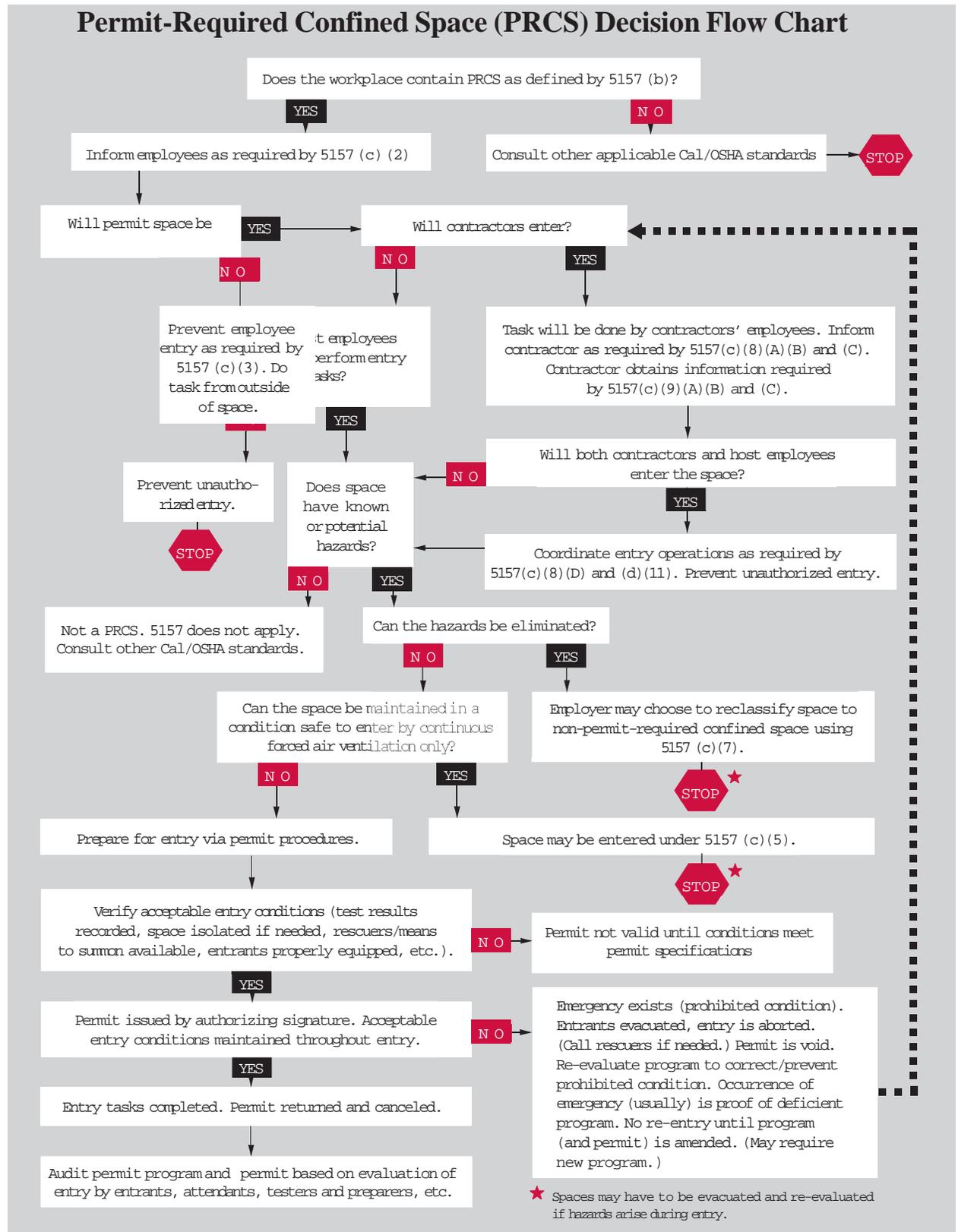
spaces.

Testing: the process by which the hazards that may confront entrants of a permit space are identified and evaluated. Testing includes specifying the tests that are to be performed in the permit space.

Note: Testing enables employers both to devise and implement adequate control measures for the protection of authorized entrants and to determine if acceptable entry conditions are present immediately prior to, and during, entry



CONFINED SPACE	LOCATION	PERMIT / NON PERMIT	POTENTIAL HAZARDOUS MATERIALS/CONDITIONS
Air Plenums	Campus Wide	Permit	Entrapment
Air Shafts	Campus Wide	Permit	Entrapment
Attic Spaces	Campus Wide	Non-Permit	Asbestos
Boiler Room Sump	Plant Operations	Non-Permit	Low Oxygen, Fall
Boiler Room Tank	Plant Operations	Permit	Low Oxygen
Boilers	Plant Operations	Permit	Low Oxygen, Carbon Monoxide, Carbon Dioxide, Heat Stress
Chiller Room Sump	Plant Operations Yard	Permit	Refrigerant, Oxygen Displacement
Cooling Tower	Plant Operations Yard	Permit	Low Oxygen, Fall
Cooling Tower Sump	Plant Operations Yard	Permit	
Cow Waste Pits (Incl. Pump Sta.)	Dairy	Permit	Low Oxygen, Methane, Hydrogen Sulfide
Crawl Spaces	Campus Wide	Non-Permit	Asbestos
Domestic Water Tower	Plant Operations Yard	Permit	Low Oxygen
Electrical Vaults	Campus Wide	Permit	Electrical, Low Oxygen, Asbestos
Grain Silos	Farm	Permit	Low Oxygen, Engulfment, Fall
Head Pressure Tank	Hydrology Lab	Permit	Low Oxygen
HVAC Ducts	Campus Wide	Permit	Entrapment
Basement Sump	Engineering West	Permit	Low Oxygen
Water & Energy Incubator	W.E.T.	Permit	Electrical, Drowning, Insect Bites
Lift Stations	Campus Wide	Permit	Low Oxygen, Engulfment, Hydrogen Sulfide
Mechanical Pit for Therapy Pools	Sport Medicine Building	Permit	Oxygen Displacement (CO2), Carbon Monoxide, Engulfment, LEL
Milk Tanks (Stationary & Portable)	Dairy	Permit	Low Oxygen
Molasses Tank	Dairy	Permit	Low Oxygen, Hydrogen Sulfide
Propylene Glycol Tanks	Enology	Permit	Low Oxygen
Sewage Vaults / Manholes	Campus Wide	Permit	Low Oxygen, Carbon Monoxide, Hydrogen Sulfide, Methane, Engulfment, Drain Disposed Chemicals
Storm Drain Vaults / Manholes	Campus Wide	Permit	Low Oxygen, Carbon Monoxide, Hydrogen Sulfide, Methane, Engulfment
Sump Pump Pits	Campus Wide	Permit	Low Oxygen, Methane, Hydrogen Sulfide
Swine Silos	Swine	Permit	Low Oxygen, Engulfment, Fall
Tele Communication Vaults	Campus Wide	Permit	Low Oxygen
Vacuum Vessel	West Engineering	Permit	Low Oxygen
Water Surge Tank	Plant Operations	Permit	Low Oxygen, Fall
Water Tower Sediment Tank	Plant Operations Yard	Permit	Low Oxygen, Fall,
Wine Vats	Enology	Permit	Low Oxygen
Zacky's Feed Silos	Agriculture Operations	Permit	Low Oxygen, Engulfment, Fall





NOTE: THIS PERMIT IS GOOD ONLY FOR 8 HOURS FROM TIME OF ISSUE

Part 1: To be filled out by supervisor assigning work

Date Issued: _____ Time Issued: _____

Confined Space Location / I.D.: _____

Work to be performed: _____

Who is the Entry Supervisor / Employee in Charge of Entry: _____

Entry Personnel

Attendant Personnel

Signature of Assigning Supervisor: _____

Part 2: To be filled out by Entry Supervisor / Employee in Charge of Entry

• Source Isolation:	Date	Time
Lock-Out/Block-Out (All Sources of Energy)	_____	_____
Pumps or Lines Blinded, Disconnected, Blanked or Blocked	_____	_____
Secured Area (Barriers, Cones, etc.)	_____	_____
• Equipment:		
Air Monitor	_____	_____
Harness and Life Line	_____	_____
Tripod and Hand Crank Winch (Vertical Entry)	_____	_____
Davit (Spreader Bar) and Hand Crank Winch (Horizontal Entry)	_____	_____
Forced Air Device (Blower)	_____	_____
2-Way Communication Device (Attendant / Entrant(s) Contact)	_____	_____
Cell Phones (Attendant / Rescue Personnel Contact)	_____	_____
Barriers and Cones	_____	_____
Appropriate PPE (Eye, Hand, Foot, Head Protection, etc.)	_____	_____
Appropriate Fire Extinguisher (As Needed)	_____	_____
Chemical Resistive Protective Clothing (As Needed)	_____	_____

Types of Hazards

- | | |
|---|---|
| <input type="checkbox"/> Oxygen-Deficient Atmosphere | <input type="checkbox"/> Energized Electrical |
| <input type="checkbox"/> Oxygen-Enriched Atmosphere | <input type="checkbox"/> Engulfment |
| <input type="checkbox"/> Flammable Atmosphere | <input type="checkbox"/> Hazardous Chemical |
| <input type="checkbox"/> Toxic Atmosphere (CO, other) List if other: _____ | |
| <input type="checkbox"/> Physical Hazards (heat, cold, vibration, mechanical) List types: _____ | |
| <input type="checkbox"/> Other: _____ | |

NOTE: If welding/cutting operations are to be performed, attach completed Hot Work Permit form to this entry form.

- Communication Procedures: Review and document how you will maintain contact with each other
- _____



A. Hazardous atmospheres can be divided into four (4) categories:

1. Flammable;
2. Toxic;
3. Irritant/Corrosive;
4. Asphyxiating

B. Flammable Atmospheres

1. Enriched oxygen atmosphere above 25% oxygen.
2. Combustible gases such as acetylene, butane, propane, hydrogen, methane and natural or manufactured gases.
3. By-products of work such as spray paint vapors or cleaning solvents.
4. Chemical reactions that create flammable gases such as hydrogen for dilute sulfuric acid and iron acetylene for calcium carbide and water or percussion induced combustion of acetylene - metal compounds, peroxides and nitrates.
5. Combustible dust concentrations found in handling grain products, nitrated fertilizers and finely ground chemical products.
6. Desorption of chemicals from the inner surfaces of confined spaces as propane or natural gas.

C. Toxic Atmospheres

1. Hydrogen chloride and vinyl chloride monomer from PVC production.
2. Hydrogen sulfide from stored decomposed material.
3. Oxides of heavy metals from welding fumes.
4. Cadmium poisoning from torch cutting cadmium plated objects.
5. Hydrogen sulfide from using hydrochloric acid to clean iron sulfide off of heat exchanger walls.
6. Hydrogen sulfide from accidental combination of sodium sulfate and acid dichromate in the tanning process.
7. Toxic solvents such as trichloroethylene, methyl chloroform and dichloromethane.
8. Acrylonitrile, which is sometimes used as part of a protective coating for tank interiors.
9. Trichloroethane and dichloroethane, which are widely used cleaning solvents.
10. Arsine gas from the combination of aluminum, sodium hydroxide and sodium arsenite.
11. Carbon monoxide from incomplete combustion of wood, coal, gas, oil and gasoline, from microbial decomposition of organic matter in sewers, silos and fermentation tanks.

D. Corrosive Atmospheres

1. Primary irritants such as chlorine, ozone, hydrochloric acid, sulfuric acid, nitrogen dioxide, ammonia and sulfur dioxide.



2. Secondary irritants such as benzene, carbon tetrachloride, ethyl chloride, trichloroethylene and chloropropene. These irritants produce systemic toxic effects as well as surface irritation.

E. Asphyxiating Atmospheres

1. Consumption of oxygen due to welding, heating, cutting and brazing.
2. Consumption of oxygen due to bacterial action such as fermentation or during chemical reactions such as the formation of rust.
3. Consumption of oxygen by the number of people operating in a confined space.
4. Displacement of oxygen by inert gases such as helium, argon or nitrogen.
5. Displacement of oxygen by carbon dioxide as in sewers, storage bins, wells, tunnels, wine vats and grain elevators.
6. Absorption of oxygen by the vessel walls or substances contained like activated carbon.
7. Engulfment of an employee as a result of entrapment (i.e., grain silo), asphyxiates the person because the weight may not allow the individual to breathe.

F. Other Hazards

1. Electrical equipment, which would cause injury.
2. Mechanical equipment, which would cause injury.
3. Static charge due to mechanical cleaning such as abrasive blasting.
4. Communication problems between the worker inside and the standby person outside due to visual interference, failure of electronic equipment or lack of proper illumination.
5. Entry and exit problems due to space configuration, size and number of openings, barriers within, and the time requirements for exiting and rescue.
6. Physical problems such as heat, cold, humidity, air velocity, noise vibration, scaffolds, surface residues and structural hazards.



Everyone involved in a confined-space entry project has certain responsibilities and it is very important that every individual is familiar with his/her responsibilities. This section outlines the responsibilities of personnel involved in confined space entry.

Duties of Office of Environmental Health & Safety (OEHS):

1. Serves as primary resource and contact on confined space issues.
2. Maintains, revises, and distributes this program to appropriate campus departments.
3. Assists in the evaluation and identification of confined spaces.
4. Oversees field calibration of atmospheric monitoring equipment used for confined space entry work.
5. Performs any additional specialty air monitoring or testing.
6. Develops and presents confined space safety training, and maintains applicable records.

Duties of Managers:

1. Ensure that the Office of Environmental Health & Safety is notified of all confined space operations in their area.
2. Ensure only trained personnel participate in confined space operations.
3. Provide and maintain the equipment required to work, ventilate, rescue and if required, to monitor confined spaces.
4. Ensure that qualified personnel conduct required safety procedures, including inspections and testing of the confined space, throughout the confined space operation.
5. Ensure that all employees in the area are aware of confined space operations, and measures are taken to prevent inadvertent or unplanned entries.
6. Ensure that all employees are aware of emergency procedures.

Duties of Entry Supervisors:

1. Knows the hazards that may be faced during entry, including information on the mode, signs or symptoms, and consequences of the exposure;
2. Verifies, by checking that the appropriate entries have been made on the permit, that all tests specified by the permit have been conducted and that all procedures and equipment specified by the permit are in place before endorsing the permit and allowing entry to begin;
3. Terminates the entry and cancels the permit if either of the following conditions apply:
 - A. The entry operations covered by the entry permit have been completed; or
 - B. A condition that is not allowed under the entry permit arises in or near the permit space.
4. Verifies that rescue services are available and that the means for summoning additional services are operable;
5. Removes unauthorized individuals who enter or who attempt to enter the permit space during entry operations; and
6. Determines, whenever responsibility for a permit space entry operation is transferred and



at intervals dictated by the hazards and operations performed within the space that entry operations remain consistent with terms of the entry permit and that acceptable entry conditions are maintained.

Duties of Attendants:

1. Knows the hazards that may be faced during entry, including information on the mode, signs or symptoms, and consequences of the exposure;
2. Is aware of possible behavioral effects of hazard exposure in authorized entrants;
3. Continuously maintains an accurate count of authorized entrants in the permit space, by name or by such other means (e.g., rosters or tracking systems) and as will enable the attendant to determine quickly and accurately, for the duration of the permit, which authorized entrants are inside the permit space;
4. Remains outside the permit space during entry operations until relieved by another attendant;

Note: It is the policy of California State University, Fresno that attendants are not authorized to enter a permitted confined space for a rescue. Rescue is to be attempted by the attendant without entry by utilizing the emergency rescue equipment that has been set up at the entrance to the permitted confined space.

5. Communicates with authorized entrants as necessary to monitor entrant status and to alert entrants of the need to evacuate the permit space;
6. Monitors activities inside and outside the space to determine if it is safe for entrants to remain in the space and orders the authorized entrants to evacuate the permit space immediately under any of the following conditions;
 - A. If the attendant detects a prohibited condition;
 - B. If the attendant detects the behavioral effects of hazards exposure in an authorized entrant;
 - C. If the attendant detects a situation outside the space that could endanger the authorized entrants; or
 - D. If the attendant cannot effectively and safely perform all of his/her duties outlined in this program.
7. Initiate on-site rescue procedures and, if necessary, summon additional rescue and other emergency services as soon as the attendant determines that authorized entrants may need assistance to escape from permit space hazards;
8. Takes the following actions when unauthorized persons approach or enter a permit space while entry is underway:
 - A. Warn the unauthorized persons that they must stay away from the permit space;
 - B. Advise the unauthorized persons that they must exit immediately if they have entered the permit space; and
 - C. Inform the authorized entrants and the entry supervisor if unauthorized persons have



- entered the permit space;
9. Performs non-entry rescues or other rescue services as part of the employer's on-site rescue procedure; and
 10. Performs no duties that might interfere with the attendant's primary duty to monitor and protect the authorized entrants.

Duties of Authorized Entrants:

1. Know the hazards that may be faced during entry, including information on the mode, signs or symptoms, and consequences of the exposure;
2. Properly use required equipment;
 - A. Testing and monitoring equipment
 - B. Ventilating equipment needed to obtain acceptable entry conditions;
 - C. Communications equipment;
 - D. Personal protective equipment;
 - E. Lighting equipment needed to enable employees to see well enough to work safely and to exit the space quickly in an emergency;
 - F. Barriers and shields;
 - G. Equipment, such as ladders, needed for safe ingress and egress by authorized entrants;
 - H. Rescue and emergency equipment, except to the extent that the equipment is provided by rescue services; and
 - I. Any other equipment necessary for safe entry into and rescue from permit spaces.
3. Communicate with the attendant as necessary to enable the attendant to monitor entrant status and to enable the attendant to alert entrants of the need to evacuate the space during the following conditions:
 - A. If the attendant detects a prohibited condition;
 - B. If the attendant detects the behavioral effects of hazards exposure in an authorized entrant;
 - C. If the attendant detects a situation outside the space that could endanger the authorized entrants; or
 - D. If the attendant cannot effectively and safely perform all his/her duties outlined in this program.
4. Alert the attendant whenever:
 - A. The entrant recognizes any warning sign or symptom of exposure to a dangerous situation, or
 - B. The entrant detects a prohibited condition; and
5. Exit from the permit space as quickly as possible whenever:
 - A. An order to evacuate is given by the attendant or the entry supervisor,



- B. The entrant recognizes any warning sign or symptom of exposure to a dangerous situation,
- C. The entrant detects a prohibited condition, or
- D. An evacuation alarm is activated.

Duties of Plant Operations:

- 1. Provide support in blanking off, locking out, and/or disconnecting potential contaminant lines in confined spaces where work is to be performed.
- 2. Coordinate with the Office of Environmental Health & Safety/Risk Management in approving lighting, equipment and tools that may be used in confined spaces subject to dangerous air contamination by flammable and/or explosive substances.
- 3. Oversight of the program to ensure Contractors use these practices when working within identified confined spaces.
- 4. Inform Contractors of this program, ensure they follow this program properly and be the point of contact once the Contractor has completed the permit-entry process.

Employee Participation:

- 1. California State University, Fresno shall consult with affected employees and their authorized representatives on the development and implementation of all aspects of the permit space program required under “General Requirements”.
- 2. California State University, Fresno shall make available to affected employees, their authorized representatives, contractors, and vendors, all information within this Confined Space Program.

Contractors:

- 1. All Contractor personnel assigned these tasks shall have received confined space training, either provided or approved by the Office of Environmental Health & Safety (OEHS).
- 2. All contractors shall review the University’s Contractor Environmental, Health & Safety Handbook.

Rescue and Emergency Services:

- 1. One standby person at the site shall be trained and immediately available to perform rescue and emergency services.
- 2. The following requirements apply when employees of California State University, Fresno enter permit spaces to perform rescue services:
 - A. Each member shall be provided with, and trained to use properly, the personal protective equipment and rescue equipment necessary for making rescues from permit spaces.
 - B. Each member of the rescue service shall be trained to perform the assigned rescue duties. Each member of the rescue service shall also receive the training required of authorized entrants under subsections (g) and (h).



- C. Each member of the rescue service shall practice making permit space rescues at least once every 12 months, by means of simulated rescue operations in which they remove dummies, manikins, or actual persons from the actual permit spaces or from representative permit spaces. Representative permit spaces shall, with respect to opening size, configuration, and accessibility, simulate the types of permit spaces from which rescue is to be performed.
 - D. Each member of the rescue service shall be trained in basic first-aid and in cardiopulmonary resuscitation (CPR). At least one member of the rescue service holding current certification in first aid and in CPR shall be available.
3. When an employer (host employer) arranges to have persons other than the host employer's employees perform permit space rescue, the host employer shall:
- A. Inform the rescue service of the hazards they may confront when called on to perform rescue at the host employer's facility, and
 - B. Provide the rescue service with access to all permit spaces from which rescue may be necessary so that the rescue service can develop appropriate rescue plans and practice rescue operations.
4. To facilitate non-entry rescue, retrieval systems or methods shall be used whenever an authorized entrant enters a permit space, unless the retrieval equipment would increase the overall risk of entry or would not contribute to the rescue of the entrant. Retrieval systems shall meet the following requirements.
- A. Each authorized entrant shall use a chest or full body harness, with a retrieval line attached at a suitable point so that when rescued, the entrant presents the smallest possible profile (for example at the center of the entrant's back near shoulder level, or above the entrant's head). Wristlets may be used in lieu of the chest or full body harness if the employer can demonstrate that the use of a chest or full body harness is infeasible or creates a greater hazard and that the use of wristlets is the safest and most effective alternative. The other end of the retrieval line shall be attached to a mechanical device or fixed point outside the permit space in such a manner that rescue can begin as soon as the rescuer becomes aware that rescue is necessary. A mechanical device shall be available to retrieve personnel from vertical type permit spaces more than 5 feet deep.
5. If an injured entrant is exposed to a substance for which a Safety Data Sheet (SDS) or other similar written information is required to be kept at the worksite, that SDS or written information shall be made available to the medical facility treating the exposed entrant.



Hazard	Concentration* Less Than or Equal To	Respirator**
Particulate	5 x PEL	Single use respirator***
Particulate	10 x PEL	Any dust respirator***
Particulate	50 x PEL	Full face piece respirator with high efficiency filter(s) or self-contained breathing apparatus with full-face piece operated in the demand mode.
Particulate	2000 x PEL	Supplied-air respirator with full-face piece operated in any positive pressure mode.
Particulate	Greater than 2000 x PEL	Self-contained breathing apparatus with full face piece operated in the pressure demand mode or a supplied-air respirator with full face piece operated in any positive pressure mode with an auxiliary self-contained breathing apparatus.
Known gas or vapor contaminant****	50 x PEL	Chemical cartridge respirator with full face piece and cartridges approved for the specific contaminant(s) or a full face piece self-contained breathing apparatus operated in the demand mode.

* If the concentration forms a flammable atmosphere only the self-contained breathing apparatus with full-face piece operated in the pressure demand mode may be used.

** Any respirator recommended for a higher concentration may be used at a lower concentration.

*** These respirators may not be used if the toxic material is carcinogenic.

**** If the concentration forms an atmosphere, which is immediately dangerous to life, then only the self-contained breathing apparatus operated in the pressure demand mode or the combination supplied air respirator with full-face piece operated in any positive pressure mode with an auxiliary self-contained breathing apparatus may be used.



Hazard	Concentration* Less Than or Equal To	Respirator**
Known gas or vapor positive pressure mode.	2000 x PEL	Supplied-air respirator with full-face piece operated in any contaminant***
Known gas or vapor contaminant***	Greater than 2000 x PEL	Self-contained breathing apparatus with full-face piece operated in the pressure demand mode or a combination supplied-air respirator with full-face piece operated in any positive pressure mode with an auxiliary self-contained breathing apparatus.
Combination of particulates and gases or vapors****	50 x PEL	A full-face piece combination respirator approved for dusts and mists and the specific contaminant(s) (gases or vapors).
	1000 x PEL	Powered air-purifying full-face piece combination respirator with high efficiency filter(s) and chemical cartridge approved for the specific gas or vapor.
	2000 x PEL	Supplied-air respirator with full-face piece operated in any positive pressure mode.
	Greater than 2000 x PEL	Self-contained breathing apparatus with a full face piece operated in the pressure demand mode or a combination supplied-air respirator with full face piece operated in any positive pressure mode with an auxiliary self-contained breathing apparatus.

* If the concentration forms a flammable atmosphere only the self-contained breathing apparatus with full-face piece operated in the pressure demand mode may be used.

** Any respirator recommended for a higher concentration may be used at a lower concentration.

*** These respirators may not be used if the toxic material is carcinogenic.

**** If the concentration forms an atmosphere, which is immediately dangerous to life, then only the self-contained breathing apparatus operated in the pressure demand mode or the combination supplied air respirator with full-face piece operated in any positive pressure mode with an auxiliary self-contained breathing apparatus may be used.



Hazard	Concentration* Less Than or Equal To	Respirator**
Unknown contaminant	Undetermined	Self-contained breathing apparatus with full-face piece operated in the positive pressure mode or a supplied-air respirator with full-face piece operated in any positive pressure mode with an auxiliary self-contained breathing apparatus.
Inert and other atmospheres where the oxygen level is below 17%		Self-contained breathing apparatus with full-face piece operated in the pressure demand mode or a combination supplied-air respirator with full-face piece operated in any positive pressure mode with an auxiliary self-contained breathing apparatus
Emergency	Unknown	Self-contained breathing apparatus with full-face piece operated in the pressure demand mode or a combination supplied-air respirator with full-face piece operated in any positive pressure mode with an auxiliary self-contained breathing apparatus.

* If the concentration forms a flammable atmosphere only the self-contained breathing apparatus with full-face piece operated in the pressure demand mode may be used.

** Any respirator recommended for a higher concentration may be used at a lower concentration.

*** These respirators may not be used if the toxic material is carcinogenic.

**** If the concentration forms an atmosphere, which is immediately dangerous to life, then only the self-contained breathing apparatus operated in the pressure demand mode or the combination supplied air respirator with full-face piece operated in any positive pressure mode with an auxiliary self-contained breathing apparatus may be used.



This checklist of consideration for entry, working in and exiting from permit and non-permit confined spaces is for reference only.

Items:

- Permit (for permit spaces only), Medical Surveillance, Labeling and Posting, Atmosphere Testing, Training of Personnel, Monitoring

Potential Hazards Expected:

- Oxygen Deficiency, Flammable Gases/Vapors, Engulfment, Toxic Gases/Vapors, Mechanical Hazards, Heat Stress, Electrical Shock, Materials Harmful to Skin, Other:

Preparation Required:

- Notify affected departments of service interruption, Isolate supply/return; blanked-double valve; lock & tag, Zero Energy State (Lock out/tag all energy sources), Cleaned, drained, washed and purged, Employees informed of specific confined space hazards, Ventilation to provide fresh air, Notified EH&S/RM Office, Procedures reviewed with each employee, Atmospheric Tests in compliance, Attach Hot Work Permit, Other:

Equipment Required for Entry:

- Respirator**, Type: _____, Supplied Air Breathing Apparatus, Communication Equipment, Barriers/Cones, Safety Equipment and Clothing: Head protection, Hearing protection, Body protection, Hand protection, Foot protection, Eye Protection, Life lines and harnesses, Personal Atmosphere Monitoring, Record keeping exposure, Intrinsic/Dielectric Equipment

Electric Equipment/Tools:

- Low Voltage Tools/Lights, Approved for Hazardous Environments, Ground-fault Interrupters

Rescue Equipment & Services:

- Fire Extinguisher, Harness/Lifeline, Qualified CPR on Site, Vertical Entry - Tripod, winch (with rescue capability), and full body harness, Horizontal Entry - Portable davit/horizontal rescue device/spreader, winch (with rescue capability), Other:

Emergency: 911

Fresno State Police Department: (559) 278-8400

†Depends on Job and Area *Must Have **Decision Rests With Qualified Person



Department Information

Department: _____

Department Manager / Supervisor: _____ Telephone: _____

Confined Space Description

Confined Space Name: _____ Space Location: _____

Space Description: _____

Alternate Procedure Determination

Complete this section for Permit-Required Confined Spaces to be entered following the alternate procedures specified in 8 CCR 5157(c)(5).

1. The only hazard posed by the permit space is an actual or potential hazardous atmosphere.

Yes No

Document that the only actual or potential hazard is atmospheric hazards (i.e., no other hazards).

2. Demonstrate that continuous forced air ventilation alone is sufficient to maintain the permit space safe for entry. Document monitoring dates:

▪ Date: _____ Conditions: _____

Atmospheric Test Results: _____

▪ Date: _____ Conditions: _____

Atmospheric Test Results: _____

▪ Date: _____ Conditions: _____

Atmospheric Test Results: _____

▪ Date: _____ Conditions: _____

Atmospheric Test Results: _____

▪ Date: _____ Conditions: _____

Atmospheric Test Results: _____

3. Document inspection data that supports that the only actual or potential hazard is atmospheric hazards, which can be controlled through continuous forced air ventilation alone.

▪ Date: _____ Findings _____



Reclassification Certification

****Complete this section for Permit-Required Confined Spaced reclassified to Non-Permit Required****

1. Describe how all hazards have been **eliminated** from the space: _____

2. Determination that all hazards have been eliminated from the space (e.g., inspection, testing, etc.)

This certifies that the space has been reclassified to a non-permit required confined space. This reclassification is temporary (Expires: _____) / permanent.

The Office of Environmental Health & Safety must be notified in writing. Forward this form with written notification.

Department Manager Name

Department Manager Signature

Date

**Asphyxiating Atmospheres:**

- Property - reduction of oxygen below 19.5%.
- Formation - result of either consumption or displacement.
- Symptoms - when oxygen levels fall to 17%, the first sign of hypoxia is deterioration of night vision, which is not noticeable until a normal oxygen concentration is restored. Physiologic effects are increased breathing volume and accelerated heartbeat. Between 14-16% physiologic effects are increased breathing volume, accelerated heartbeat, very poor muscular coordination, rapid fatigue, and intermittent respiration. Between 6-10% the effects are nausea, vomiting, inability to perform, and unconsciousness. Less than 6%, spasmodic breathing, convulsive movements, and death in minutes. The total displacement of oxygen by nitrogen will cause immediate collapse and death. Carbon dioxide, with a specific gravity greater than air, may lie in a confined space for hours or days after opening. Since these gases are colorless and odorless, they pose an immediate hazard to health unless appropriate oxygen measurements and ventilation are adequately carried out.
- Testing - specifically for O₂ with results between 19.5 and 23%.
- Details - the consumption of oxygen takes place during combustion of flammable substances, as in welding, heating, cutting, brazing, bacterial action, chemical reactions (iron oxide "rust"), and the number of people working in and amount of their physical activity. Displacement by another gas, such as nitrogen, carbon dioxide, or inerting agents to displace flammable substances can create asphyxiating atmospheres.

Carbon monoxide (CO):

- Property - odorless, colorless gas that has approximately the same density as air.
- Formation - from incomplete combustion of organic materials such as wood, coal, gas, oil, and gasoline; and it can be formed from microbial decomposition of organic matter in silos and fermentation tanks.
- Symptoms - early stages of CO intoxication are nausea and headache. Carbon monoxide may be fatal, and is considered dangerous because it forms carboxyhemoglobin in the blood, which prevents the distribution of oxygen in the body.
- Testing - carbon monoxide must be tested for specifically.
- Details - The formation of CO may result from chemical reactions or work activities. In welding operations, oxides of nitrogen and ozone are gases of major toxicological importance, and incomplete oxidation may occur with carbon monoxide forming as a byproduct. Another poor work practice, which has led to fatalities, is the recirculation of diesel exhaust emissions. Increased CO levels can be prevented by strict control of the ventilation.

**Combustible dust:**

- Property - dust suspended in air.
- Formation - concentrations are usually found during the process of loading, unloading, and conveying finely ground chemical products, and any other combustible material.
- Details - High charges of static electricity, which rapidly accumulates during periods of relatively low humidity (below 50%), can cause certain substances to accumulate electrostatic charges of sufficient energy to produce sparks and ignite a flammable atmosphere. These sparks may also cause explosions when the right air or oxygen to dust or gas mixture is present.

Flammable Atmospheres:

- Property - vapor or gas.
- Formation - generally arises from enriched oxygen atmospheres, vaporization of flammable liquids, byproducts of work, chemical reactions, concentrations of combustible dusts, and desorption of chemical from inner surfaces of the confined space.
- Testing - less than 10% of LFL / LEL. Test at top and bottom of confined space.
- Details - combustible gases or vapors will accumulate when there is inadequate ventilation in areas such as a confined space. Flammable gases such as acetylene, butane, propane, hydrogen, methane, natural or manufactured gases or vapors from liquid hydrocarbons can be trapped in confined spaces, and since many gases are heavier than air, they will seek lower levels as in various types of storage tanks and vessels. In a closed top tank, it should also be noted that lighter than air gases may rise and develop a flammable concentration if trapped above the opening. Specific kinds of work such as cleaning with solvents can result in the release of explosive gases or vapors. Welding in a confined space is a major cause of explosions in areas that contain combustible gas. Chemical reactions forming flammable atmospheres occur when surfaces are initially exposed to the atmosphere, or when chemicals combine to form flammable gases. This condition arises when dilute sulfuric acid reacts with iron to form hydrogen or when calcium carbide makes contact with water to form acetylene.

Hydrogen sulfide (H₂S):

- Property - colorless gas that is known by its characteristic rotten egg like odor.
- Formation - appears naturally as a byproduct of decomposition.
- Symptoms - low concentration exposure can burn the respiratory tract and cause swelling around the eyes. High concentration can shut off the lungs.
- Testing - specifically for H₂S.
- Details - one of the drawbacks of trusting the senses (olfactory) for protection against hydrogen sulfide is that prolonged exposure to the gas renders the sense of smell inoperative. It reacts with the enzymes in the blood stream, which inhibit cell respiration. In other words, high concentrations of hydrogen sulfide can shut off the lungs.

**Refrigerants:**

- Property - all of the fluorocarbon refrigerants are heavier than air and can displace it, thereby creating the possibility of suffocation with a major leak or spill.
- Formation - from leaks in refrigeration units.
- Symptoms - displaces oxygen, resulting in similar exposures found in asphyxiating atmospheres (see above).
- Testing - Many refrigerant vapors cannot be seen, tasted or smelled, so there is no natural warning. Leak alarms, "hissing" noise of leak, or use of oxygen deficiency measures in or under machine rooms.
- Details - Exposures to refrigerants, or other substances, at very low temperatures can cause frostbite. Likewise, prolonged contact, splashing into the eyes or release of pressurized gases or liquids pose occupational hazards. Several preventive measures are recommended, including use of appropriate eye protection and gloves when there is a possibility of occupational contact.

General/Physical Hazards:

Some physical hazards cannot be eliminated because of the nature of the confined space or the work to be performed. These hazards include such items as scaffolding, surface residues, and structural hazards.

- **Surface residues** in confined spaces can increase the already hazardous conditions of electrical shock, reaction of incompatible materials, liberation of toxic substances, and bodily injury due to slips and falls. Without protective clothing, additional hazards to health may arise due to surface residues.
- **Structural hazards** within a confined space such as baffles in horizontal tanks, trays in vertical towers, and bends in tunnels, overhead structural members, or scaffolding installed for maintenance constitute physical hazards, which are exacerbated by the physical surroundings. In dealing with structural hazards, workers must review and enforce safety precautions to assure safety.

Thermal Effects:

Four factors influence the interchange of heat between people and their environment. They are (1) air temperature, (2) air velocity, (3) moisture contained in the air, and (4) radiant heat. Because of the nature and design of most confined spaces, moisture content and radiant heat is difficult to control. As the body temperature rises progressively, workers will continue to function until the body temperature reaches approximately 102°F. When this body temperature is exceeded, the workers are less efficient, and are prone to heat exhaustion, heat cramps, or heat stroke.

- **Heatstroke** happens when sweating stops. A heatstroke victim usually has red or spotted skin and a high body temperature
- **Heat exhaustion** develops when the body loses more fluid through sweating than it is taking in. A victim of heat exhaustion sweats profusely but becomes extremely weak. The skin becomes clammy and the complexion is pale. Body temperature is fairly normal.
- **Heat cramps** often occur in your arms, legs or abdomen. A person with heat cramps will usually be sweating heavily. You can get heat cramps by drinking too many cold liquids or by drinking them too quickly.



Prevent these heat-related hazards by:

- **Drinking lots of water!** Sweating is one way your body cools itself. Since sweating results in water loss, the only way to replace the water is to drink more of it. Drink at least eight ounces of water every 20 - 30 minutes while working in a hot environment.
- **Avoiding alcohol and carbonated drinks**, which can cause cramps.
- **Wearing protective clothing:** Personal protective equipment for hot environments can range from ordinary work clothes made from fabrics that "breathe" to specially designed suits that are cooled by air or ice.

In a cold environment, certain physiologic mechanisms come into play, which tend to limit heat loss and increase heat production. The most severe strain in cold conditions is chilling of the extremities so that activity is restricted. Special precautions must be taken in cold environments to prevent frostbite, trench foot, and general hypothermia.

Noise:

Noise problems are usually intensified in confined spaces because the interior tends to cause sound to reverberate and thus expose the worker to higher sound levels than those found in an open environment. This intensified noise increases the risk of hearing damage to workers, which could result in temporary or permanent loss of hearing. Noise in a confined space, which may not be intense enough to cause hearing damage, may still disrupt verbal communication with the emergency standby person on the exterior of the confined space. If the workers inside are not able to hear commands or danger signals due to excessive noise, the probability of severe accidents can increase. A good guide to use is if you have to shout to be heard, and then reduce the noise level.

Vibration:

Whole body vibration may affect multiple body parts and organs depending upon the vibration characteristics. Segmental vibration, unlike whole body vibration, appears to be more localized in creating injury to the fingers and hands of workers using tools, such as pneumatic hammers, rotary grinders or other hand tools which cause vibration.