

# ES&H manual

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## Environment, Safety, and Health

### Volume II

### Part 18: Pressure/ Noise/ Hazardous Atmospheres

## Document 18.7 Working in Confined Spaces

Recommended for approval by the ES&H Working Group

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New document or new requirements

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- New document  
 Major requirement change

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## 18.7

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## 18.7

### Working in Confined Spaces

#### 1.0 Introduction

##### 1.1 Purpose and Scope

This *Environment, Safety and Health (ES&H) Manual* document sets forth the requirements for working in confined spaces at LLNL main site and Site 300 and for preventing exposure of workers to dangerous air contamination, oxygen deficiency, and physical hazards associated with confined spaces. See Appendix A for definitions of the terms used in this document.

This document applies to all activities that may require LLNL workers and subcontractors to enter confined spaces. Laboratory workers who work offsite are governed by the rules and regulations of the offsite organizations involved, provided that those organizations have primary responsibility for health and safety. Subcontractors entering confined spaces owned by LLNL shall submit a written confined space program for review and approval by the Hazards Control Department (see Figure 1).

##### 1.2 General

Workers conducting utility inspections, cleaning activities, and maintenance operations periodically enter confined spaces. Because these spaces might be used to store and transport flammable, toxic, corrosive, or oxygen-consuming materials, and because these materials can leak into confined spaces, it is important to enter confined spaces using all necessary controls as defined in this document.

A confined space is defined in LLNL Work Smart Standards (WSSs) as an enclosed area that has all three of the following characteristics:

- Is large enough for a worker to enter into and work within.
- Has limited or restricted means of entry or exit.
- Is not designed for continuous human occupancy.

Below are examples of confined spaces that may exist:

- Storm drainpipes.
- Sewers.
- Valve vaults.
- Storage tanks.

- Utility pipeline trenches.
- Manholes.
- Large vacuum vessels.
- Transformer tanks.

### 1.3 Confined Spaces at LLNL

The two categories of confined spaces at LLNL are Non-Permit Confined Space and Permit-Required Confined Space. The different categories are based on the degree of hazard associated with the space.

- **Non-Permit Confined Space (NPCS):** a space that does not contain or (with respect to atmospheric hazards) have the potential to contain a hazard capable of causing death or serious physical harm. Examples of NPCSS include a pit or vault that does not have actual or potential hazards, a building crawl space with limited means for entry and exit, and a false-ceiling plenum.

Equipment failure, chemical usage, or other incidents in which new materials are brought into a confined space could introduce hazards into an NPCCS. For example, use of cleaners, paints, solvents, compressed gas bottles, and welding equipment could create a hazardous atmosphere. In these cases, the hazard classification of a space may be upgraded, and the RI shall request the area industrial hygienist to review entry and work activities prior to the start of work.

- **Permit-Required Confined Space (PRCS):** a confined space that meets any of the following:
  - Contains or has the potential to contain a hazardous atmosphere.
  - Contains a material with the potential to engulf an entrant.
  - Has an internal configuration (i.e., inwardly-converging walls or a floor that slopes downward and tapers to a smaller cross section) that could trap or asphyxiate an entrant.
  - Contains any other serious safety or health hazard.

Examples of PRCSs include mixing tanks, tank pits, manholes, sewers, waste retention tanks, and target chambers.

## 2.0 Hazards

Confined spaces often contain physical or atmospheric hazards that can be serious or even deadly. Oxygen-deficient atmospheres, or those that contain combustible or toxic gases and vapors, constitute serious hazards in confined spaces. Normal air contains approximately 20.9% oxygen. An atmosphere is defined as oxygen deficient if it contains less than 19.5% oxygen. If

an ignition source is present in, or is introduced into, an environment that contains flammable gases, solvents, or dust, the atmosphere may ignite or explode. Serious injury or death may result when the atmosphere contains even low concentrations of toxic gases (e.g., hydrogen sulfide, sulfur dioxide, or nitrogen dioxide). Everyday operations (e.g., welding, painting, and using solvents or inert gases) that are normally safe can quickly become hazardous when performed in a small, poorly ventilated area. The following criteria define a hazardous atmosphere:

- Flammable gas, vapor, or mist greater than 10% of the lower flammable limit (LFL).
- Airborne combustible dust (most dust is combustible) at a concentration that meets or exceeds its LFL and considering the dust particle size. This concentration may be approximated as a condition in which dust obscures vision at a distance of 5 ft (1.5 m) or less.
- Oxygen concentration less than 19.5% or greater than 23.5%.
- Any airborne contaminant present at a level capable of causing immediate and often serious health consequences.
- Any other condition recognized as immediately dangerous to life or health.

In addition to atmospheric hazards, confined spaces often contain physical or mechanical hazards, such as unguarded machinery, exposed electrical circuits, or materials which can engulf an entrant. The risk posed by a mechanical or physical hazard is amplified inside a confined space since an injured person may not be able to self-rescue.

## **3.0 Working in Confined Spaces**

### **3.1 Managing Confined Space Entries**

Safe entry into confined spaces at LLNL requires careful planning and coordination between management and the workers assigned to perform confined space work. The RI assigned the task for completing the work is responsible for determining the scope of work involved and the required confined space controls that need to be in place prior to entry. Figure 1 is a flowchart, which shall be followed by the RI to identify the proper classification of each space entered and the administrative controls required to complete the confined space work.

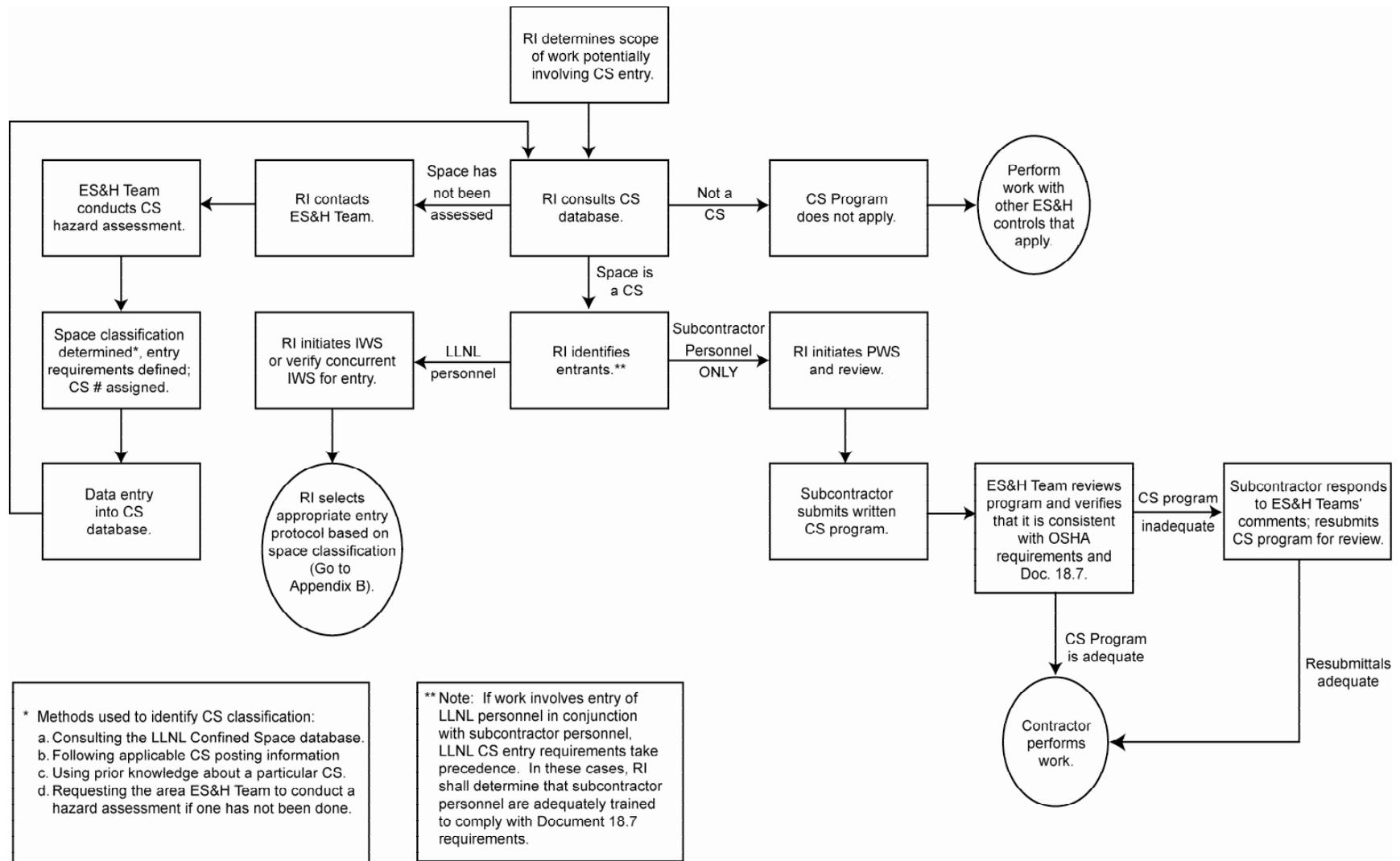


Figure 1. Management Flowchart for Confined Space Entry.

### **3.2 Confined Space Hazard Assessments**

Space classification is the most important factor when determining the proper controls needed for entering an NPCS or PRCS. Therefore, ES&H Teams shall complete hazard assessments for all confined spaces entered at LLNL. The confined space hazard assessment process consists of inspecting and classifying the space, and determining whether or non-entry rescue equipment (e.g., lifelines, harness, mechanical retrieval devices) is required for PRCSs.

### **3.3 Entering Confined Spaces**

Entry into a confined space is defined as occurring when any part of a worker's body passes through an opening into a confined space.

Once the proper confined space classification has been determined, entry controls shall be implemented as indicated in this section. Appendix B summarizes the entry requirements for all confined space classifications at LLNL. Note that when a confined space needs to be entered to make emergency repairs during off-normal working hours, and the space has not been assessed, the RI shall presume that the space is a PRCS and follow all controls for PRCS entry.

#### **3.3.1 Entering Non-Permit Confined Spaces**

The requirements for entering NPCSSs are as follows:

- Install barricades and isolation where appropriate.
- Use only UL/FM listed equipment with ground fault circuit interrupter (GFCI) connections.
- Ensure that adequate lighting is available (use portable if necessary).
- Proposed activities shall not introduce hazards into the space. Contact the responsible ES&H Team for guidance whenever required work could generate a hazardous atmosphere inside an NPCSS.

#### **3.3.2 Entering Permit-Required Confined Spaces**

In addition to the requirements for NPCSSs in Section 3.3.1, the following are required for PRCSs:

- An approved Integration Work Sheet (IWS).
- Notification of the area Health and Safety Technician prior to entry. Notification should be made 4 hours prior to entering the confined space. However, shorter notification times can be established with concurrence from the ES&H Team
- A completed written permit. (See Appendix C.) Attach the completed Confined Space Entry Permit to the approved IWS.

- Preparing the space for safe entry; e.g. isolating utility and pipe systems or locking and tagging un-insulated energy sources.
- Mechanical ventilation sufficient to eliminate actual or potential atmospheric hazards prior to entry and during all phases of the project.
- Testing of the atmosphere before and during entry by a Health and Safety Technician or other trained person (i.e., someone who has completed Course HS4152, "Confined Space Instruments," or equivalent).
- An attendant stationed at the entry point to the confined space.
- Two-way communication between entrants and attendant.
- Rescue communication capability with the LLNL Fire Department (see Appendix D for detailed requirements).
- Personal protective equipment (PPE) including respiratory protection as determined by the disciplines on the ES&H Team and documented on an IWS, a Hazard Assessment and Control (HAC) Form, and/or the entry permit.
- A retrieval line, full body harness, and mechanical retrieval device, unless these devices create additional hazards and will not contribute to rescue. Wristlets may be used in lieu of a full body harness if it can be demonstrated that the body harness is infeasible or creates a greater hazard. (Additional information regarding non-entry rescue provisions is provided in Appendix D.)
- Prenotification of entry to the LLNL Fire Department Dispatcher, extension 2-7595.
- One standby rescue person for every entrant in the confined space whenever supplied air respiratory protection is used to enter a space.

If unexpected hazards arise, all workers within a confined space shall immediately exit the space. The Hazards Control Health and Safety Technician shall then be notified so that he or she can make arrangements to reevaluate the space before re-entry.

**In an emergency, call the LLNL Fire Department [dial 911 if calling from a Laboratory phone or 1 (925) 447-6880 if calling from a cellular phone or from offsite].**

### **3.4 Control Methods for Permit-Required Confined Spaces**

The information in this section provides more detailed information and requirements for control methods typically used for PRCS entries.

### 3.4.1 Administrative Controls

Entry is not permitted into a PRCS until all precautions noted on the permit have been taken. The entry supervisor shall brief entrants on their responsibilities and shall review the hazards and controls that will be used for safe entry. This includes reviewing the proper use of non-entry emergency rescue equipment, and the emergency notification procedures with the Attendant.

### 3.4.2 Completing Entry Permits

A completed Confined Space Entry Permit (see Appendix C) is required before entering a PRCS. The entry supervisor shall initiate the permit. A representative of the ES&H Team or a person authorized and trained in confined space testing conducts the necessary tests for oxygen deficiency, flammability, and toxicity. If a confined space is vacated for more than one hour before the job is completed, the air shall be retested to ensure that conditions have not changed since the original entry. The results of all tests shall be noted on the permit. The completed permit shall be signed by the entry supervisor and posted in an easily visible location.

The entry supervisor's signature on the permit verifies that the space is safe to enter. Therefore, the entry supervisor shall ensure that:

- All appropriate entries are made on the permit.
- Entrants and the Attendant have been trained in confined space entry and have received any other training required for the work.
- Tests specified on the permit are conducted.
- All procedures and equipment specified on the permit are in place to permit safe entry into the confined space.
- Rescue services and the means for summoning them are available.

Each permit is valid for the duration of only one work shift or until the assigned task is completed, whichever is of shorter duration. Copies of the permit shall be provided to the industrial hygienist and the ES&H Team for review within five working days. Permits are retained in the ES&H Team's files for one year but may be destroyed thereafter.

### 3.4.3 Controlling Ignition Sources

All ignition sources, including lit cigarettes, are prohibited in or in close proximity to confined spaces. If sources such as welding or cutting equipment are required, a hot-work permit shall be obtained. When open flames must be used in confined spaces, take extra precautions to ensure adequate ventilation. To obtain a fire permit, call the Laboratory Fire Dispatch at 2-7595.

### 3.4.4 Isolating the Area from Hazards

Isolation is the process of protecting a PRCS from the release of energy and material by removing it from service, and controlling or eliminating the recognized hazard sources.

Open chemical or gas lines within the PRCS shall be isolated by one of the following procedures:

- Blanking or blinding (see Appendix A for definition).
- Misaligning or removing sections of lines, pipes, or ducts.
- Using a double-block-and-bleed system.

Before beginning work in these spaces, disconnect the lines that may allow hazardous materials to enter, or take other precautions to prevent such materials from entering into these areas. For example, take the lines apart, cap the ends, and insert a blank between the flanged connections. Be sure that the blank is strong enough to handle the pressure buildup if a pump is accidentally turned on.

Use Lockout/Tag out procedures: isolate, and lockout un-insulated or unguarded hazardous energy sources (e.g., electrical and mechanical hazards). These procedures are described in Document 12.6, "LLNL Lockout/Tagout Program," in the *ES&H Manual*.

### 3.4.5 Alternate Entry Procedures for Permit-Required Confined Spaces

A PRCS may be entered using alternate entry procedures, provided it exhibits the following characteristics:

- **The only actual or potential hazard in the space is an atmospheric hazard.**
- AND**
- **The actual or potential atmospheric hazard can be controlled by the provision of forced air ventilation alone.**

When a PRCS meets the two conditions set forth above, the following alternate entry procedures apply:

- All entrants shall meet the PRCS training requirements set forth in this document.
- Railings or barriers shall be installed around open covers leading to the confined space.
- Forced-air ventilation in quantities suitable to eliminate any hazardous atmosphere shall be installed prior to entry.

- Forced-air ventilation shall be maintained at all times until all entrants have left the space. Refer to Section 3.4.7 and the safety document (IWS/SP) for purging and ventilating procedures and information.
- Initial atmospheric monitoring shall be conducted prior to entry and after installation of forced-air ventilation to verify that the ventilation is preventing the accumulation of a hazardous atmosphere.
- Periodic or continuous atmospheric monitoring is required during entry to ensure atmospheric conditions remain safe.

Alternate entry procedures for a specific confined space or a group of identical confined spaces shall be documented in an approved IWS/SP.

**Note:** Alternate Entry Procedures shall not be documented in a generic/trade service IWS/SP.

In the field, the use of approved alternate entry procedures shall be documented using a Confined Space Entry Permit (Appendix C). The entry supervisor shall indicate the use of the alternate entry procedures on the permit and ensure that all controls listed above are implemented.

### **3.4.6 Downgrading a Permit-Required Confined Space to a Non-Permit Confined Space**

A PRCS may be downgraded to an NPCS if it exhibits the following characteristics:

- **The space poses no actual or potential atmospheric hazards.**

**AND**

- **Any nonatmospheric hazards can be eliminated without entering the space.**

In order to downgrade a confined space that meets the criteria above, all nonatmospheric hazards associated with the space shall be eliminated prior to entry. Some methods of hazard elimination include the following:

- Locking and tagging electrical equipment or mechanical equipment.
- Blanking or blinding utility lines, pipes, or ducts prior to working on such systems.
- Removing from the space a material that poses an engulfment threat.

The steps necessary to eliminate hazards and downgrade a PRCS to an NPCS shall be documented in an approved IWS/SP.

**Note:** The hazard elimination procedures shall not be documented in a generic/trade service IWS/SP.

In the field, the hazard elimination steps shall be documented on a Confined Space Entry Permit (see Appendix C). Once the hazard has been eliminated and the elimination procedure documented, entrants may enter the space using the NPCS entry requirements (see Section 3.3.1).

### **3.4.7 Purging and Ventilating Confined Spaces**

If a confined space contains sludge or other residue, tests positive for combustible or toxic gases, or indicates an oxygen deficiency or enrichment, purge the area with fresh air and provide positive ventilation both before and during entry into the space. Purging shall be of sufficient rate so that the air in the space is not hazardous [i.e.,  $O_2 > 19.5\%$ , combustibility  $< 10\%$  Lower Explosive Limit (LEL)] and toxicity less than the appropriate Occupational Exposure Limit (OEL). The OEL is the maximum concentration of an air contaminant to which workers can be exposed for a specified time interval, usually the maximum average exposure allowed throughout an entire eight-hour shift. The ES&H Team industrial hygienist can assist in determining the purging and ventilation rates.

Below are some precautions to observe when purging and ventilating a confined space:

- Provide a continuous supply of fresh air using a temporary ventilation system as close as possible to the work area before and while workers are working in the confined space. Take care to place the system inlet upwind and at least 5-10 ft away from the confined space and any other potential contaminant (e.g., vehicle exhaust).
- Retest the atmosphere for hazards upon completion of ventilating and purging.
- Continuously perform subsequent tests for oxygen deficiency, flammability, or toxicity during entry into the confined space or at intervals frequent enough to ensure a safe atmosphere. Despite purging, toxic substances may still remain in pores and deposits and may be released to recreate a hazardous atmosphere.

### **3.4.8 Testing and Monitoring the Work Environment**

Because work in confined spaces can create a hazardous atmosphere, atmospheric monitoring shall be performed before entry into a PRCS and continuously during entry into the space or at intervals frequent enough to ensure a safe atmosphere. A qualified member of the ES&H Team (or someone who has completed and is current with the two-year refresher requirements of HS4152) shall conduct tests for oxygen deficiency or enrichment, flammability, and toxicity.

Atmospheric tests shall be performed in the following order: oxygen deficiency, flammability, and (if necessary) toxicity. It is also important to ensure that sampling is representative of the total atmosphere in the space (e.g., sample at multiple depths in a deep space). If air testing indicates a hazardous situation, contact the area ES&H Team before proceeding.

Monitoring equipment that has been (1) approved by the Hazards Control Department and (2) maintained and calibrated by the Industrial Hygiene Instrument Laboratory (IHIL) at least

annually or at a frequency recommended by the instrument manufacturer shall be affixed with a current sticker with the calibration and due dates for the next calibration.

Instruments used for confined space monitoring have been identified by the IHIL as critical Measuring and Testing Equipment (M&TE) under the SEP Quality Assurance Plan, Appendix A: Calibration Implementation Plan. Users of critical MT&E, and their supervisors, are assigned specific responsibilities, which include:

- Ensuring that equipment users are trained in the use of critical MT&E.
- Ensuring identified critical M&TE has been calibrated as required, including calibrating in the field, if appropriate.
- Ensuring that critical M&TE is calibrated on schedule.
- Upon discovery of a malfunction in critical M&TE, determine and record impacts on critical measurements or tests.

Consult the Safety and Environment Protection (SEP) Calibration Implementation Plan for the complete requirements and responsibilities.

Equipment out of calibration or functioning erratically shall not be used and shall be immediately tagged or labeled to indicate the problem. The equipment in question shall be returned to the IHIL within 24 hours for maintenance and calibration.

Directorates that own confined space monitoring equipment shall address this MT&E equipment concern within the Quality Assurance Program. The IHIL is the central LLNL point for instrument calibration and maintenance and should be identified as such in the directorate's program.

### **3.4.9 Attendants**

A trained attendant shall be present whenever worker(s) enter a PRCS. The attendant shall remain outside the entrance, be in communication with the person(s) entering the area, and be ready to summon help in case of emergency. An effective means of communication (e.g. two-way communication) between the attendant and the entrant(s) shall be provided whenever the entrant is out of the attendant's sight. (Detailed information regarding the duties of attendants is provided in Section 5.)

### **3.4.10 Emergency Rescue Workers**

The LLNL Fire Department is the LLNL-designated rescue team for all confined space emergencies. LLNL Fire Department personnel designated for confined space rescue shall practice making rescues in confined spaces at least every twelve months.

Mechanical retrieval devices shall be available to rescue workers for all vertical entries into a PRCS greater than 5 ft in depth. Each rescue worker shall wear a suitable harness attached to one end of a lifeline, provided the equipment does not increase the overall risk of entry or hinder

rescue. If rescue workers use supplied-air respiratory equipment to enter a confined space, one standby person for every person entering the space shall be immediately available outside the space. Standby rescue workers shall have an independent air supply and be fully suited with the required protective clothing.

### **3.4.11 Health and Safety Technician Notification**

The Health and Safety Technician shall be notified at least four hours before entry into a PRCS, unless specifically exempted by a safety plan (IWS/SP). Notification is not required for emergency situations involving workers and property. The Health and Safety Technician may audit the procedures for confined space entry.

## **3.5 Confined Space Posting and Identification Requirements**

Facility workers (or the space or equipment owner) shall post and maintain the appropriate signs in all spaces determined to be permit-required. Posting of NPCSS is optional; however, spaces that are commonly entered (e.g., crawl spaces under trailers) may not be posted. Training (Course HS4150) provides information so that entrants can identify these spaces in lieu of posting. Alternate methods for informing workers of these areas may be used with the approval of the ES&H Team.

The following wording shall be used on signs for PRCSs:

DANGER.

CONFINED SPACE.

ENTER BY PERMIT ONLY.

If the space or equipment owner decides to post a sign at an NPCSS, the following wording shall be used:

CAUTION—NON-PERMIT CONFINED SPACE

All confined spaces shall also be posted with a Confined Space ID Number associated with the space. This ID number is generated from the Hazards Control Confined Space Database (see Section 3.2).

Style and wording requirements for all confined space signs and postings are in Appendix E.

## **3.6 Telecommunication Spaces**

Because of the general absence of significant hazards in most telecommunication spaces (utility vaults), the potential of an accident occurring in such areas is less than that for other types of confined spaces. Entry into telecommunication confined spaces requires an approved IWS/SP that documents the specific entry procedures for telecommunication. Control required for entry include:

- Entrants are trained (HS4152)
- Barricades installed around vertical openings to telecommunication spaces
- Forced air ventilation into the space at all times during entry
- Initial atmospheric monitoring conducted by a trained Atmospheric Monitoring Provider

### **3.7 Construction Sites**

This section applies to construction sites that may have PRCs. Excavations (including trenches) at a construction site may be categorized as a confined space, depending on the depth, physical layout, and potential for air contamination in the trench. The ES&H Team shall conduct an evaluation of these areas on a case-by-case basis to determine if the area is a PRC. It is usually not necessary to post signs at confined spaces still under construction.

Excavations that are more than 4-ft deep usually qualify as confined spaces. Work within some deep excavations may qualify those excavations as PRCs. A deep excavation with a connected sewer line in the space is usually evaluated as a PRC because of the potential atmospheric hazard associated with the sewer system. An excavation more than 4 ft deep in which a gasoline-powered compactor is used is usually evaluated as a PRC, even if ventilation controls are in place, because of the expected buildup of an atmospheric hazard (i.e., carbon monoxide) from the compactor exhaust.

Not all excavations [e.g., very shallow excavations (less than 4 ft) or excavations with sloping sides] meet the definition of a confined space or a PRC. Entry into these spaces does not have to be in accordance with LLNL confined space requirements, although other health and safety requirements may apply.

## **4.0 Training**

All personnel (e.g., workers, attendants, or emergency services personnel) involved in confined space activities shall complete the required training in Table 1, including Course HS4150, "Confined Space Entry," before entering a confined space. Contractor personnel shall complete equivalent training and provide evidence of the training upon request. Retraining is required every 2 years and shall be documented in the Livermore Training Records and Information Network (LTRAIN).

Atmospheric monitoring workers shall complete Course HS4152.

All persons successfully completing Course HS4152 receive a badge card and training certification identification (ID) number indicating they are qualified to conduct air testing of confined spaces.

Depending on the nature of the entry into a confined space, other required training may include:

- Course HS1620, "Medic First Aid."
- Course HS4610-CBT, "Basic Air Purifying Respirator Training."
- Course HS4620-CBT, "Basic Air-Supplied Respirator Training."
- Course HS4630-S, "SCBA—Interspiro/Spiromatic-Specific."

The area ES&H Team identifies additional training needs.

**Table 1. Training requirements for permit-required confined workspace<sup>a</sup>.**

Responsible person	HS4150	HS4152	HS5245	HS1620	HS4610 HS4620 HS4630-S
Responsible Individuals (RI)	X	O	O		
Confined Space Owner	X				
Atmospheric Monitoring Providers	X	X			O
Entry Supervisors	X	O	X	O	O
Entrants	X	O	X	O	O
Attendants	X	O	O	O	O
Rescue/Recovery Workers	X	X	X	X	X

<sup>a</sup> See the current *LLNL Course Catalog* for complete course descriptions of the following:

- HS1620, "Medic First Aid"
- HS4150, "Confined Space Entry" (Biennial refresher training required)
- HS4152, "Confined Space Instruments" (Biennial refresher training required)
- HS4610-CBT, "Basic Air-Purifying Respirator Training"
- HS4620-CBT, "Basic Air-Supplied Respirator—Training"
- HS4630-S "SCBA – Interspiro/Spiromatic-Specific"
- HS5245-CBT, "Lockout and Tag" (Refresher required every 5 years)

O Recommended

X Required

In addition, workers who fail to follow or are unfamiliar with confined space entry procedures shall have their confined space authorization immediately suspended by the Responsible Individual or work supervisor. The Responsible Individual or work supervisor shall ensure that such workers have the required retraining before any entry into a confined space is allowed.

## 5.0 Responsibilities

This section describes the responsibilities of personnel who work in confined spaces or manage work involving confined space entry. General responsibilities for all workers are described in Document 2.1, "Laboratory and ES&H Policies, General Worker Responsibilities, and Integrated Safety Management," in the *ES&H Manual*.

### 5.1 Entrant(s)

Workers who enter confined spaces shall:

- Complete and maintain certification in the appropriate training (see Table 1).
- Be knowledgeable of the hazards associated with confined spaces; recognize the signs and symptoms of exposure, including behavioral effects; and understand the consequences of exposure to the hazards of these spaces.
- Initiate self-rescue if conditions become hazardous, or if directed to do so by the attendant (if applicable), entry supervisor, or other entrants.
- For Non-Permit Confined Spaces
  - Follow procedures in Section 3.3.1 of this document.
- For Permit-Required Confined Spaces:
  - Follow all procedures and controls listed on the Confined Space Entry Permit.
  - Perform confined space entry readiness procedures [e.g., Lockout/Tagout (LOTO), isolation of utilities] as assigned and directed by the Confined Space Entry Permit.
  - Maintain continuous communication capability with the attendant.

### 5.2 Attendant

The attendant, assigned by the RI to perform safety functions for PRCS entry work, shall:

- Complete the appropriate training (see Table 1), including specific training concerning the use of non-entry rescue equipment.
- Remain at the confined space entrance location at all times whenever entrants are inside the confined space. Note: Attendants may only perform attendant duties as defined in this document.
- Establish and maintain continuous communication capability with entrants.
- Be knowledgeable of the hazards associated with confined spaces; recognize the signs and symptoms of exposure, including behavioral effects; and understand the consequences of exposure to the hazards of these spaces.

- Initiate evacuation of the confined space whenever hazardous conditions arise.
- Summon the LLNL Fire Department if rescue of entrants becomes necessary.
- Initiate the use of non-entry rescue equipment to rescue entrants.

**Note:** The attendant is not permitted to enter the confined space to rescue entrants. Only trained LLNL Fire Department personnel may perform entry rescue.

- Provide information to emergency responders, including the number of entrants in the space, the space configuration, and any known hazards in the space.
- Monitors the status/effectiveness of engineering controls (e.g., forced air ventilation) required for entry as per the Confined Space Entry Permit.

### 5.3 Atmospheric Monitoring Providers

Atmospheric Monitoring Providers shall:

- Complete and maintain the appropriate training (see Table 1).
- Verify that air-monitoring equipment is calibrated prior to each use.
- Perform operational testing and equipment field checks in accordance with the equipment manufacturers' recommendations.
- Perform and record results of air tests as indicated on the Confined Space Entry Permit.
- Advise the entry supervisor and attendant as to the appropriate frequency of atmospheric monitoring.
- Advise the entry supervisor to not allow entry if atmospheric monitoring test results indicate atmospheric hazards are present.
- Serve as attendants, provided both functions can be performed as necessary.

### 5.4 Entry Supervisor

The RI assigns the entry supervisor to oversee all processes and controls for a PRCS entry. The entry supervisor shall:

- Complete and maintain certification in the appropriate training (see Table 1).
- Notify the Health and Safety Technician of all PRCS entries at least 4 hours in advance.
- Notify the LLNL Fire Dispatch of time and location of PRCS entry.
- Initiate the preparation and completion of a Confined Space Entry Permit.

- Ensure that the name of the designated attendant is printed on the Confined Space Entry Permit.
- Ensure that appropriate PPE and equipment is available as necessary to support the entry.
- Ensure that non-entry rescue equipment is used in accordance with the Confined Space Entry Permit.
- Ensure that entrants, attendants, and air-monitoring workers have completed necessary training.
- Confirm that pre-entry functions (e.g., LOTO, isolation of utilities) are completed as necessary and according to the Confined Space Entry Permit.
- Sign the Confined Space Entry Permit when all controls and entry procedures have been established and communicated to the entrants.
- Post completed and signed the Confined Space Entry Permit at or near the entrance to the confined space.
- Be knowledgeable of the hazards associated with confined spaces; recognize the signs and symptoms of exposure, including behavioral effects; and understand the consequences of exposure to the hazards of these spaces.
- Initiate the evacuation of a confined space if hazardous conditions arise.
- Forward the completed Confined Space Entry Permit to ES&H Team after the permit closeout.

## **5.5 Responsible Individual**

For any work involving entry into a confined space, the RI shall:

- Determine the scope of work to be performed in the confined space.
- Identify the proper confined space classification for each confined space involved in the work.
- Request the ES&H Team to conduct a confined space hazard assessment if none exists.
- Initiate or ensure that an IWS is in effect for the work involving confined space entry.
- Initiate or ensure that a PWS and a written confined space program is reviewed by the ES&H Team for all confined space work performed by a subcontractor.
- Determine which workers (e.g. program workers, Plant Engineering, Utel workers, or subcontractor workers) will enter the confined space.

- Designate the entry supervisor and the attendant for PRCS.
- Ensure a trained Atmospheric Monitoring Provider is available.
- Ensure that appropriate Personal Protective Equipment (PPE) and equipment is available as necessary to support the entry.
- Oversee subcontractor compliance with submitted and approved subcontractor confined space programs.
- Ensure that SPs are followed for specific types of confined space entries (e.g. telecommunications or electrical vaults).
- Ensure that all workers involved with the confined space work are appropriately trained.
- Ensure non-entry rescue equipment is available and properly maintained for entry into owned PRCS.
- Ensure that all workers involved with the confined space work are appropriately trained.
- Ensure non-entry rescue equipment is available and properly maintained for entry into owned PRCS.

## **5.6 Confined Space Owner**

Confined owners, shall:

- Ensure that all owned confined spaces are posted in accordance with this document.
- Appoint a RI knowledgeable about confined space requirements to manage work-taking place in a confined space.
- Notify in writing the ES&H Team whenever a PRCS is demolished, filled or removed from the laboratory.
- Notify the ES&H Team whenever there has been new construction or equipment that may contain a confined space.
- Notify the ES&H Team whenever a subcontractor is performing confined space entries.

## **5.7 Environment, Safety and Health Teams**

The ES&H Team supporting the area in which particular confined spaces are located shall:

- Ensure that all program and facility areas have been comprehensively surveyed to identify all PRCS.
- Conduct and document a hazard assessment for all confined spaces.

- Notify the Confined Space Owner of all PRCS that need to be posted.
- Routinely check existing, identified confined spaces and inform the Confined Space Owner of any posting deficiencies.
- Survey all new construction and experimental apparatus for the existence of PRCS.
- Provide Confined Space Entry Permit forms to the entry supervisor.
- Review Confined Space Entry Permits with entry supervisors and countersign documents after verifying all controls are in place.
- Prepare Hazard Assessment and Control (HAC) documents for confined space entries where respiratory protection or other PPE is needed.
- Perform periodic quality checks on the closed out permits to ensure that the personnel doing the entry had appropriate training, the required controls were used, and that there are no inconsistencies.
- Report problems/deficiencies with confined space entry to the Confined Space-Entry Subject Matter Expert.
- Review and approve subcontractors' confined space programs.

### **5.8 Hazards Control Department**

The Hazards Control Department shall:

- Identify a Confined Space Subject Matter Expert (SME) who provides guidance to ES&H Teams and Programs concerning confined space issues.
- Maintain the LLNL Confined Space Database and corresponding confined space identification numbering system.
- Develop and provide confined space training to LLNL workers.
- Maintain an inventory of confined space survey instruments for the evaluation of confined spaces.
- Provide respiratory protective equipment as needed for certain confined space work.

### **5.9 LLNL Fire Department**

The LLNL Fire Department shall:

- Equip and train the LLNL Confined Space Rescue Team.
- Conduct confined space rescue drills annually.
- Approve or provide training in the use of non-entry rescue equipment.

### 5.10 Health Services Department

The Health Services Department shall:

- Provide medical care during emergencies as necessary.

### 5.11 Procurement Department

The Procurement Department shall:

- Ensure that prospective subcontractors are aware of confined space hazards associated with contracts.
- Ensure that PWS and subcontractor submittals are directed to ES&H Teams for review.

## 6.0 Work Smart Standards

29 CFR 1910.146, "Permit-required Confined Spaces for General Industry; Final Rule."

29 CFR 1910.268(o), "Telecommunications; Underground Lines."

29 CFR 1926.21(b), "Safety Training and Education, Employer Responsibility."

29 CFR 1926.21(b)(i), "Safety Training and Education, Confined or Enclosed Space Entry."

29 CFR 1926.651, "Specific Evacuation Requirements."

*ACGIH Industrial Ventilation Manual*, 23rd edition (1998).

ACGIH, TLVs and BEIs: Threshold Limit Values for Chemical Substances and Physical Agents, 2002 (excluding Biological Exposure Indices, TLVs for Physical Agents, and Biologically Derived Airborne Contaminants).

DOE Order 440.1A, "Worker Protection Management for DOE Federal and Contractor Employees," Attachment 2, "Contractor Requirement Document," Sections 1-11, 13-18 (delete item 18.a), 19 (delete item 19.d.3) and 22.

## 7.0 Resources for More Information

### 7.1 Contacts

For more information about working in confined spaces, contact your area ES&H Team or the Chemical/Biological Safety (CBS) section in the Hazards Control Department.

### 7.2 Lessons Learned

For lessons learned applicable to working in confined spaces, refer to the following intranet address:

[http://www-r.llnl.gov/es\\_and\\_h/lessons/lessons.shtml](http://www-r.llnl.gov/es_and_h/lessons/lessons.shtml)

### **7.3 Other Sources**

ANSI Z117.1-1989, "Safety Requirements for Confined Spaces," ANSI, New York.

8 CCR 5157, "Permit-required Confined Spaces."

Safety and Environmental Protection Directorate Quality Assurance Plan (Official Use Only),  
July 9, 2003.

## Appendix A

### Terms and Definitions

Acceptable entry conditions	The conditions that need to exist in a PRCS to allow entry and ensure that workers involved can safely enter into and work within the space.
Attendant	An individual stationed outside one or more PRCSs to monitor authorized entrants. He or she performs all attendant duties assigned in the employer's PRCS program.
Authorized entrant	A worker authorized by the employer to enter a PRCS.
Blanking or blinding	The absolute closure of a pipe, line, or duct by fastening a solid plate (e.g., a spectacle blind or skillet blind) that completely covers the bore and is capable of withstanding the maximum pressure of the pipe, line, or duct with no leakage beyond the plate.
Confined space	A space that (1) is large enough and so configured that a worker can bodily enter and perform assigned work; (2) has limited or restricted means for entry or exit (e.g., 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 worker occupancy.
Confined Space Owner	A manager of a program, facility, or service provider that includes operational responsibility for confined spaces.
Confined Space Program	The overall program for controlling and, where appropriate, protecting workers from PRCS hazards and for regulating worker entry into PRCSs.
Double block and bleed	The closure of a line, duct, or pipe by closing and locking or tagging two inline 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 of equipment) or internal or external event to the PRCS that could endanger entrants.

**Engulfment** The surrounding and effective capture of a person by a liquid or finely divided (i.e., flowable) solid substance that can be aspirated and 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 PRCS. 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** The written or printed document that is provided by the employer to allow and control entry into a PRCS.

**Entry supervisor** The person (e.g., the employer, foreman, or crew chief) responsible for:

- Determining if acceptable entry conditions are present in a PRCS where entry is planned.
- Authorizing entry and overseeing entry operations.
- Terminating entry.

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

Hazardous atmosphere      An atmosphere that may expose workers to the risk of death, incapacitation, impairment of the ability to self-rescue (i.e., escape unaided from a PRCS), injury, or acute illness from one or more of the following causes:

- Flammable gas, vapor, or mist exceeding 10% of its LFL.
- 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 ft (1.5 m) or less.

- Atmospheric oxygen concentration below 19.5% or above 23.5%.
- Atmospheric concentration of any substance for which a dose or a permissible exposure limit is published in a DOE-mandated health and safety standard.

**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.

- Any other atmospheric condition that is immediately dangerous to life or health. Other sources of information (e.g., material safety data sheets that comply with the Hazard Communication Standard, 29 CFR 1910.1200, published information, and internal documents) can provide guidance on establishing acceptable atmospheric conditions for air contaminants that OSHA has not yet determined a dose or the permissible exposure limit.

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

Immediately dangerous to life or health (IDLH)	<p>Any condition that poses an immediate or delayed threat to life, would cause irreversible adverse health effects, or would interfere with an individual's ability to escape unaided from a PRCS.</p> <p><b>Note:</b> Some materials (e.g., hydrogen fluoride gas and cadmium vapor) may produce immediate transient effects that, even if severe, may pass without medical attention but are followed by sudden, possibly fatal, collapse 12–72 hours after exposure. The victim "feels normal" after recovery from the transient effects until he or she collapses. Such materials in hazardous quantities are considered to be immediately dangerous to life or health.</p>
Inerting	<p>Displacement of the atmosphere in a PRCS by a noncombustible gas (e.g., nitrogen) to such an extent that the resulting atmosphere is noncombustible. This procedure produces an oxygen-deficient atmosphere that is immediately dangerous to life or health.</p>
Isolation	<p>The process by which a PRCS is removed from service and completely protected against the release of energy and material into that space by means such as:</p> <ul style="list-style-type: none"><li>• Blanking or blinding.</li><li>• Misaligning or removing sections of lines, pipes, or duct.</li><li>• Using a double-block-and-bleed system.</li><li>• Lockout or tagout of all sources of energy.</li><li>• Blocking or disconnecting all mechanical linkages.</li></ul>
Line breaking	<p>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.</p>
Non-permit confined space	<p>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.</p>
Oxygen-deficient atmosphere	<p>An atmosphere containing less than 19.5% oxygen by volume.</p>

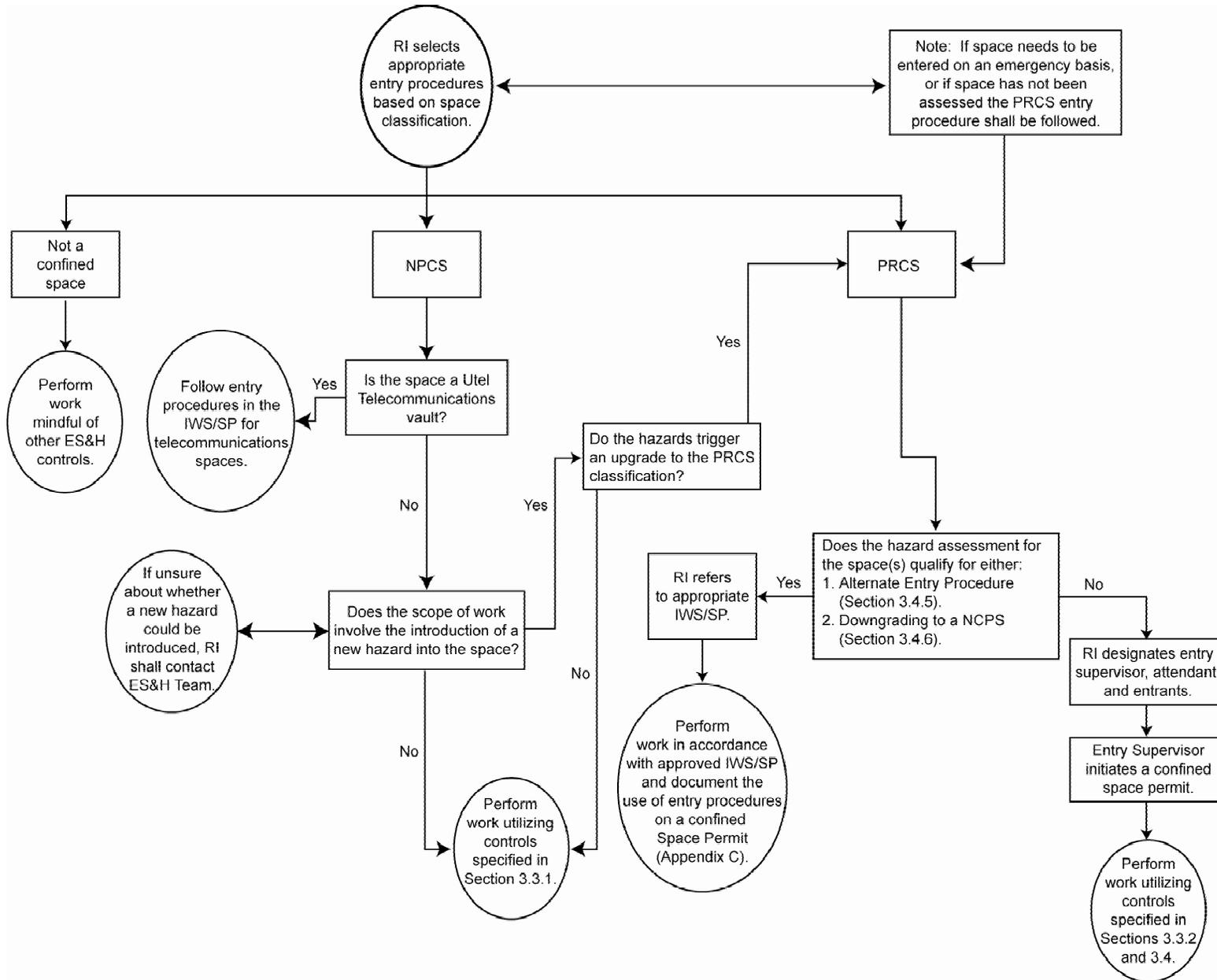
Oxygen-enriched atmosphere	An atmosphere containing more than 23.5% oxygen by volume.
Permit-required confined space (permit-required space)	<p>A confined space that has one or more of the following characteristics:</p> <ul style="list-style-type: none"> <li>• Contains or has a potential to contain a hazardous atmosphere.</li> <li>• Contains a material that has the potential to engulf an entrant.</li> <li>• Has an internal configuration, either inwardly converging walls or a floor that slopes downward and tapers to a smaller cross section, that could trap or asphyxiate an entrant.</li> <li>• Contains any other recognized serious safety or health hazard.</li> </ul>
Permit system	The written procedure for preparing and issuing permits for entry and for returning the PRCs to service following termination of entry.
Prohibited condition	Any condition in a PRCs not allowed by the permit during the period when entry is authorized.
Rescue service or team	Workers designated to enter confined spaces to rescue workers from PRCs. The LLNL Fire Department is the designated rescue team at the Laboratory.
Responsible Individual (RI)	The individual directly responsible for an operation, activity, or group of activities. The RI may be at any level within the organization and is formally identified by the activity's authorizing individual. In some organizations, the person is called the work supervisor. In most cases, the RI will be directing the work of others as part of the operation or activity.
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 PRCs.

Testing

The process of identifying and evaluating the hazards that entrants of a PRCS may encounter. Testing includes specifying the tests to be performed on the PRCS.

**Note:** Testing enables employers to devise and implement adequate control measures for protecting authorized entrants and for determining whether acceptable entry conditions are present immediately before and during entry.

**Appendix B**  
**Confined Space Entry Procedures Flowchart**



## **Appendix C**

### **LLNL Confined Space Entry Permit**

**A. Space Identification**  
 Describe location: \_\_\_\_\_ CS ID# \_\_\_\_\_ Date/Time: \_\_\_\_\_  
 Reason for Entry: \_\_\_\_\_  
 Names of Entrants: \_\_\_\_\_  
 Have all Entrants been trained? Yes  No  If No, entry is not permitted.

---

**B. Hazard Assessment** Answer both questions  
 1. Has a hazard assessment been conducted for this space?  
 Yes - Next question  No - Do not enter space, contact H&S Technician  
 2. Will work introduce a hazard into the space?  
 Yes - Contact H&S Technician  No - Proceed to Section C

---

**C. Type of Entry** Review hazard assessment information and check only one for this entry  
 Permit Required Confined Space entry procedures Complete Section D,E &F  
 Alternate Entry Procedures (29 CFR 1910.146 (c)(5)) Complete Section E &F  
 Downgrade to non-permit entry procedures ((c)(7)) Complete Section F  
 Alternate entry or downgrade procedure documentation (IWS/SP): \_\_\_\_\_

---

**D. Permit-Required Confined Space Entry**  
 Required Controls (Justify any "No" responses)  
 Attendant Name: \_\_\_\_\_  
 Has Attendant been trained? Yes  No   
 Has Pre-notification to LLNL Fire Dispatch (ext. 2-7595) been made? Yes  No  n/a   
 Are barricades installed? Yes  No   
 Describe two-way communication: \_\_\_\_\_  
 Has space been purged and ventilation installed? Yes  No   
 Will entrants use harnesses and retrieval lines? Yes  No  n/a   
 Will a mechanical retrieval system be used? Yes  No  n/a   
 If Yes, what type: \_\_\_\_\_  
 If applicable, check HAC for PPE requirements.

---

**Safe Entry Conditions**  
 Description of hazard to be eliminated prior to entry: \_\_\_\_\_  
 Method of elimination (i.e. LOTO, Double block and bleed, etc.) \_\_\_\_\_

---

**E. Atmospheric Monitoring**

	Initial	Periodic	Continuous	Readings/Time			
% Oxygen (>19.5%)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____	_____	_____	_____
Combustibility (<10% LEL)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____	_____	_____	_____
H <sub>2</sub> S (<10 ppm)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____	_____	_____	_____
CO (<35 ppm)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____	_____	_____	_____
Other:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	_____	_____	_____	_____

Instrument: \_\_\_\_\_ Cal date: \_\_\_\_\_  
 Person conducting monitoring: \_\_\_\_\_ Training Cert. No. \_\_\_\_\_  
 Is IDLH environment present? Yes  No  If yes, do not enter; contact ES&H Team.  
 For Alternate Entry Procedures only, describe how forced air ventilation will be used: \_\_\_\_\_

---

Have safe entry conditions been met? Yes  No  Additional Permits (e.g. Hot Work Permit)?  
 List: \_\_\_\_\_  
 Comments: \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

---

**F. Certification**  
 Entry Supervisor Signature: \_\_\_\_\_ Date: \_\_\_\_\_  
 H&S Technician or HCD  
 Designee Signature: \_\_\_\_\_

PERMIT TO BE POSTED AT THE JOB SITE UNTIL WORK IS COMPLETED OR REVOKED.  
 ROUTING: FORWARD SITE COPY TO INDUSTRIAL HYGIENIST

## Appendix D

### Non-Entry Rescue Provisions for Permit-Required Confined Spaces

Persons who have tried to rescue individuals from confined spaces have themselves become victims because of a failure to follow proper procedures. Thus, it is essential that all persons involved with the rescue of workers from confined spaces know exactly what to do in such situations. If possible, an attendant may rescue a victim from a confined space using a retrieval system and without additional help if the rescue does not require the attendant to enter the space.

#### **When are retrieval lines, harnesses, or mechanical retrieval devices required?**

The requirement is specified on the Confined Space Entry Permit.

In general, workers entering a PRCS shall wear a 5-point harness attached to a retrieval line (at a point in the middle of the back) during entry. Wristlets may be used in lieu of a 5-point harness if it can be demonstrated that the body harness is infeasible or creates a greater hazard. If a vertical entry exceeding 5 ft in depth into a PRCS is necessary, then the retrieval line shall be attached to a mechanical retrieval device, such as a tri-pod assembly with a winch (see picture).

Retrieval lines, harnesses, and mechanical retrieval devices are not required if their use would increase the overall risk of entry or would not contribute to the rescue of the entrant(s). Typical reasons to exclude the use of retrieval equipment are: 1) the confined space contains obstructions that would interfere with a safe rescue; 2) the confined space is configured such that a retrieval line could easily become tangled or caught up on corners; 3) the use of a mechanical retrieval device is not feasible because no suitable location on which to mount the device in a safe manner exists; and 4) if their use would increase the overall risk of entry.

The hazard assessment record for each confined space contains information about whether retrieval equipment is required. Attendants and entry supervisors shall consult with the hazard assessment to determine applicable requirements for each confined space entered.

Note that non-entry rescue equipment is not required for non-permit spaces, or spaces that are entered using the Alternate Entry Procedures or the permit downgrade process under 29 CFR 1910.146 (c)(5) and 20 CFR 1910.146 (c)(7), respectively.

#### **Rescue Communication Requirements**

Immediate rescue communication between the attendant and the LLNL Fire Department shall always be in place for all PRCS entries. If an LLNL phone is used for this requirement, it must be located no greater than 100 feet from the entrance of the confined space, otherwise a 2-way radio or cell phone shall be used. All means of rescue communication shall be function tested prior to entering a PRCS. In the event of a failure of rescue communication, the attendant shall

summon all PRCS entrants to leave the PRCS until rescue communication has been re-established.

### **Non-Entry Rescue Procedures**

A person who has collapsed or appears to be having difficulty while working in a confined space could be experiencing a heart attack or other illness. In such instances:

1. Dial 911 (from a laboratory phone) or 925-447-6880 (from a cellular phone onsite or offsite for both the Livermore site and Site 300). Do not attempt to enter the confined space during an emergency.
2. Attempt to retrieve the person from outside the confined space using a harness retrieval system or other equipment. Do not enter the confined space or attempt a rescue unless designated by the incident commander.
3. Using the retrieval system, remove the victim from the area immediately.
4. Render whatever first aid you are qualified to provide once the victim is outside the space until medical help arrives. Immediately check for injuries and treat life-threatening conditions.

**Note:** The attendant shall assist the Fire Department rescue team upon arrival.

Tri-pod and winch system



## Appendix E

### Confined Space Signs and Postings

The Danger sign is mandatory for PRCs. The Caution sign is optional for non-permit spaces.

