Yale University
Environmental Health & Safety

Confined Space Program

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1. Introduction

This document establishes Yale University's Confined Space Program. It is designed to provide for the identification, evaluation, and control of confined space hazards, and ensure that employees and contractors who must enter such locations are trained and apprised of the Program. The Program provides criteria for identifying confined spaces, including permit-required confined spaces, and establishes the standard precautions and procedures that must be implemented to eliminate potential hazards during actual entries. The program addresses the requirements of the Occupational Safety and Health Administration (OSHA), Title 29 of the Code of Federal Regulations Part 1910.146 (permit-required confined spaces) and Part 1910.269 (e) (enclosed spaces).

2. Definitions

The following definitions are critical for evaluating the various kinds of confined spaces, their hazards, and control.

Confined Spaces are locations that meet all three of the following criteria:

1. Sufficiently sized and configured so that a person can physically enter the space, and
2. Possess a restricted means of entry or exit, and
3. Are not designed for continuous occupancy.

Common examples of confined spaces at Yale University include tanks, vaults, manholes, boilers, tunnels, sewer and sump pits, large HVAC equipment, pipe chases, and some crawlspaces and ductwork interiors.

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 <u>any</u> of the following characteristics is considered a Permit-Required Confined Space:

- Contains or has the potential to contain a hazardous atmosphere, or
- Contains a material that could engulf an entrant, or
- Possesses inwardly converging walls or floor sloping downward and tapering to a smaller cross-section that could trap or asphyxiate an entrant, or
- Contains any other recognized serious safety or health hazard.

These spaces require a written permit prior to entry. The process of generating the permit forces 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.

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:

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

3. Employees Covered by this Program

Employees whose job duties involve one or more of the following activities are included:

- Perform actual entries into permit-required confined spaces (Authorized Entrants);
- Serve as an attendant during permit-required confined space entry (Attendant); or
- Serve as entry rescuers during permit-required confined space entry (Entry Rescuer); or
- Supervise others who enter or attend during entries (Entry Supervisor).

No one may serve in any of these capacities without first receiving relevant Confined Space training, either as provided or approved by the Yale EHS.

4. Responsibilities

Various Yale University departments and employees have specific responsibilities under this program:

Yale University Environmental Health and Safety Department (EHS):

- Serves as primary resource and contact on confined space issues;
- Maintains and periodically reviews this Program;
- Assists in the evaluation and identification of confined spaces;
- Provides oversight for the campus inventory of multi-gas meters used by individual operating units for evaluating atmospheric hazards in confined spaces;
- Provide purchasing assistance with departments acquiring new multi-gas meters;
- Performs any additional specialty air monitoring or testing; and
- Develops and presents confined space training, and maintains applicable records.

Supervisors:

- Ensure overall employee compliance with this program, including training;
- Provide appropriate air monitoring instruments and all other safety equipment;
- Assist in the development and review of confined space entry permits before signing and authorizing a permit-required confined space entry, and collect and retain all permits after use for at least two years;
- Ensure appropriate maintenance and calibration of multi-gas meters.
- Communicate with contractors about confined space work and disclose known hazards;
- Periodically review the program with Yale EHS; and
- Serve as Entry Supervisor on permit space entries once so trained.

Attendants:

- Receive confined space training to safely observe and support entrants from outside of confined spaces;
- Prevent entry by unauthorized personnel;
- Understand the hazards or potential hazards of confined spaces;
- Maintain accurate count of authorized entrant(s) in the space;

- Continually observe and communicate with entrants to help ensure the safety of entrants, being on the alert for any signs or symptoms that might indicate hazardous conditions;
- Monitor activities inside and outside the space to ensure that it is safe for entrants to remain in the area;
- Remain at the entry of a confined space until relieved by another attendant;
- Order entrant(s) evacuation if any prohibited or hazardous conditions develop during the entry;
- Perform a non-entry rescue and/or summon rescue in the event of entrant incapacitation.

Authorized Entrants

Make actual entries into confined space, and have been trained and authorized to:

- Understand confined space hazards;
- Use personal protective equipment and entry tools and supplies;
- Follow proper entry procedures and perform assigned job;
- Communicate with attendant; and
- Evacuate space immediately, if necessary.

Entry Rescuers

Provide actual entry into a permit-required confined space to rescue entrants when self-rescue and non-entry rescue measures are infeasible. Due to the potentially severe hazards of entry rescue work, individuals performing this work must be:

- Appropriately trained in confined space entry procedures;
- Actively certified in and capable of delivering first aid/CPR;
- Trained and medically-cleared to use self-contained breathing apparatus;
- Trained to use rescue and retrieval equipment under confined space conditions;
- Capable of developing and executing a site- and project-specific entry rescue plan.

Section 10 of this Program provides additional details on entry rescue. Please note that Yale University obtains entry rescue services through qualified third-party contractors; contact Yale EHS for currently-approved entry rescue service vendors.

Control Centers

- Monitor confined space entries off hours for emergency notification purposes.

5. Identification of Confined Spaces

While Yale EHS maintains an inventory of recognized Permit Required Confined Spaces, personnel who enter confined spaces must NOT rely upon the inventory to identify whether a location qualifies as a confined space as conditions and hazards can change due to modifications, work performed, etc. Potential entrants are trained to always review the characteristics of a potential confined space using a decision flow chart. Recognized Permit Required Confined Spaces may include signage which reads “DANGER, PERMIT-REQUIRED CONFINED SPACE, DO NOT ENTER”. Recognized confined spaces which do not generally have the characteristics of a Permit Required Confined Space may be labeled “DANGER, CONFINED SPACE, AUTHORIZED PERSONNEL ONLY.”

6. Entry Permits

Many confined spaces on campus carry very low hazard potential, do not meet the definition of a Permit Required Confined Space and generally may be entered safely following applicable safe work practices such as energy control (lockout/tagout) and fall protection. However, for the small subset of higher hazard locations, Entry Permits must be completed prior to entry. Entry Permits are standardized written documents that help ensure appropriate precautions are taken prior to entry into confined spaces which possess Permit Required Confined Space or Alternate Entry characteristics (see Definitions). They require supervisor authorization before entry and must be posted continuously at the entry site for the duration of work.

Two kinds of Entry Permits are available, depending upon the kind of space to be entered:

- Permit-Required Confined Space Entry Permit;
- Alternate Entry Permit, which is used when the only potential hazard is atmospheric and it can be safely managed via forced-air ventilation;

Regardless of type, Entry Permits must remain at the job site until entry work is completed. After use, permits must be returned to the applicable supervisor, and retained in department records for at least two years.

7. Entry Procedures

The following steps must be taken before entry is made into any known or suspected confined space:

1. Use the Confined Space Decision Flow Chart to determine if a space meets the definition of a Confined Space, and if so, what procedures are required for entry.
2. If the space is a Permit Required Confined Space, attempt to re-classify the space by removing all the characteristics which make it a Permit Required Confined Space. This process must be documented using the Temporary Declassification Form.
3. If the space is a Permit Required Confined Space that meets the criteria for Alternate Entry (see Definitions), follow the requirements of the Alternate Entry Procedures and Permit form.
4. If the space is a Permit Required Confined Space that does not meet the criteria for Alternate Entry and cannot be declassified, contact Yale EHS for entry procedures and required coordination with third-party rescue contractors.

In addition to the Confined Space Decision Flow Chart, other reference materials include Confined Space Reminders and Typical Confined Space Equipment.

8. 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.

Excess Pressure Hazards:

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.

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.

High Temperature Hazards:

Exposure to 140 F for only 5 seconds can result in 3rd degree burns. Such exposures may include contact with hot surfaces, water and steam. In addition, high temperature environments pose as a risk for workers to suffer a heat-related illness.

Safe Work Practice: Prior to performing work, consider waiting for systems to cool so that contact surfaces are below 140 F. Utilize insulating materials for exposed areas and appropriately rated personal protective equipment. Also, ventilate the space and attempt to obtain a condition where the heat index of the space is less than 97 F.

Atmospheric Hazards:

Atmospheric hazards are among the most common hazards posed by confined spaces. The atmosphere inside a confined space is considered hazardous if it contains dangerous concentrations of certain contaminants, is deficient in or overly enriched with oxygen, or contains sufficient flammable vapors or gas to be potentially explosive.

Safe Work Practice: Permit Required Confined Spaces must always be tested prior to entry to determine whether an oxygen deficient, flammable, or toxic atmosphere exists. Acceptable atmospheric levels are:

- Oxygen: 19.5 to 23.5%
- Flammability (% of Lower Flammability Limit): < 10%
- Carbon Monoxide : < 35 ppm
- Hydrogen Sulfide : < 10 ppm

Atmospheric monitoring must be made with a calibrated, Yale EHS-approved alarming multiple gas monitor. Employees may only enter a Permit Required Confined Space after initial testing indicates that no atmospheric hazards exist; continuous monitoring is required while the 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.

Electrical Hazards:

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.

Safe Work Practice: The risks from electrical hazards depend upon the presence and condition of electrical sources and conduits inside the space, the physical configuration of access, and the activity or work to be conducted inside the confined space. Any identified electrical shock potential must be mitigated through isolation, personnel protective equipment, etc.

Engulfment Hazards:

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.

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.

Accumulated Water Hazards:

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.

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 GFCI.

Entrant-Generated Hazards

Certain maintenance and repair operations performed in confined spaces have the potential to generate their own hazards. Some examples include:

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

Safe Work Practice: Prior to making any Permit Required 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. Contact Yale EHS for additional information on controlling hazardous operations; hot work also requires review by the Yale Fire Marshal in advance.

9. Employee Qualifications and Training

Individuals involved in any aspect of work with confined spaces work must receive confined space safety training. This training must cover: (1) classification and evaluation of confined spaces, (2) confined space hazards, (3) Yale's Confined Space Entry Program, (4) appropriate use and care of atmospheric monitoring equipment, (5) forced ventilation, and (5) emergency procedures. Employees must successfully complete this training before any confined space entry, attendant, or supervision work is performed.

10. 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:

Self-Rescue:

Entrant self-rescue generally provides the most effective means of escaping a recognized confined space hazard. Self-rescue must immediately be implemented 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 during entry when following Alternate Entry Procedures.

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.

Non-Entry Rescue:

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. Non-entry rescue equipment typically consists of a body harness, non-conductive cable or rope, winch, and tripod that can be operated from outside of the confined space by the attendant. 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.

Entry Rescue:

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). Entry rescue may only be attempted by appropriately trained individuals possessing active certification in and knowledge of first aid/CPR, self-contained breathing apparatus, rescue/retrieval equipment, and rescue training. Contact Yale EHS for currently-approved entry rescue service vendors.

11. Recordkeeping

Yale EHS maintains an inventory of recognized Permit Required Confined Spaces and relevant training records. Owner departments maintain copies of completed entry forms.

12. Contractors and Visitors

Contractors/vendors working in Yale or Yale-controlled facilities must meet the requirements outlined in Yale's "Contractor Health & Safety Advisory" and are responsible for ensuring that their personnel understand and comply with the requirements of OSHA standards. Whenever contract personnel are to be engaged in activities covered by this Program, the University contact/liaisons and the contract employer shall inform each other of their respective confined space entry procedures. The exchange of information must occur before service work begins. The University contact and the contract employer will ensure that their personnel understand and comply with one another's procedures.