Confined Space Entry:

The University of Tennessee

Office of Environmental Health & Safety

This publication discusses those hazards, safe entry procedures and rescue associated with confined space entry. Its intent is educational, preventive and fulfills the requirements of the OSHA Confined Space Entry Written Control Plan, 29 CFR 1910.146. Click here to reference the document. A copy of this written program shall be available to any University employee upon request. With these procedures, persons working in confined spaces should always exit alive and unharmed. You may also view the the Confined Space Entry Written Program adopted by the University of Tennessee. Click here

The hazards that may be present in a confined space are not easily seen, smelled, heard or felt, but can represent deadly risks. The worker who enters confined spaces may be, or often is, exposed to multiple hazards due primarily to ignorance or negligence in the enforcement of safety regulations. This ignorance and neglect has led to countless deaths by asphyxiation, fire and/or explosion, and by fatal exposure to toxic materials.

A permit-required confined space is one in which dangerous air contaminants may be generated and may not be removed by ventilation. When an employee works in this type of environment, the chance exists that atmospheres present may be oxygen deficient, combustible or toxic. Prevention of injuries to the life and health of workers requires that they be properly trained and well equipped to recognize, understand and control the hazards they could encounter. In the process of identifying a confined space, the supervisor in charge should always assume that a hazard is present.

RESPONSIBILITIES

Central Administration:

1. Endorsement of the written plan.
2. Delegation of sufficient authority to the respective department heads involved to effectively implement the plan.
3. Appropriate the necessary resources required to effectively implement the plan.

Department Heads - Employees Who Enter Confined Spaces:

1. Appoint an individual(s) to serve as authorized individual(s) to perform the required monitoring and to issue entry permits.
2. Assure that the authorized individual(s) receive all the necessary training to effectively discharge their duties.
3. Assure that all individuals who enter confined spaces receive the required training.
4. Assure that all necessary equipment and supplies to effectively protect the health and safety of the workers are provided and maintained in a good state of repair.
5. Develop departmental policies that will assure that all confined space entries are performed in compliance with the campus written program and all applicable regulations.
6. Develop departmental policies that will assure that all required records are maintained.
7. Department heads, or designated agents, shall be responsible for ensuring that the confined spaces under their control have been posted.

Department of Environmental Health and Safety:

1. Develop a written control plan and perform an annual review to determine necessary revisions.
2. Monitor the compliance of the respective departments with the plan and regulations to include compliance with training, monitoring, permitting, record keeping, etc.
3. Provide guidance and technical assistance to departments in the design and selection of appropriate engineering and work practice controls.
4. Provide guidance and technical assistance to departments in the selection of the most appropriate types and quantities of personal protective equipment.
5. Provide consultation to the departments to assist them in fulfilling their training program.
6. Serve as the campus liaison to the Systems-Wide Safety Office.
7. Promote campus compliance with the OSHA Standard.
8. Provide a means in which employees can direct suggestions, complaints and concerns regarding the campus Confined Space Entry Program.
9. Identify, log, and classify confined spaces on campus. This information shall be communicated to the rescue personnel.

Employee:

1. Participate willingly in all training programs offered by the University and learn as much as possible about the confined space entry protection procedure.
2. Abide by all work rules and apply to the fullest extent possible the safety and health precautions specified by the University.
3. Report any problems that are observed, which could compromise health and safety, to the University administration through the immediate supervisor.

CONFINED SPACE HAZARDS

Types of Confined Spaces:

1. Those of such design that restrict the movement of air in such a manner that ventilation may be inadequate.
2. Enclosed areas with very limited openings for entry and exit. Examples of open-topped confined spaces are pits, degreasers, and certain storage tanks. Gases that are heavier than air (such as butane and propane) can remain in low sections of these type spaces where they are difficult to remove. Other hazards may also develop due to the nature of the work being involved or by a residue remaining in the space.
3. Confined spaces may contain an engulfment or entrapment hazard. See the definition section of this document for a more detailed explanation of these terms. Confined spaces, such as trenches, sewers, tanks or silos usually have limited access and are considered the most hazardous. Gases, such as carbon dioxide and propane, that are heavier than air, may lie in recessed areas for hours or even days. Because many of these gases are odorless, the hazard may be overlooked with fatal results. At the opposite end, gases that are lighter than air may be trapped at the top of a space where access is from the bottom.

HAZARDOUS ATMOSPHERES

Flammable Atmosphere:

A flammable atmosphere generally arises from an enriched oxygen atmosphere, vaporization of a flammable liquid, chemical reaction, a by-product of work, heavy concentrations of combustible dust, and even desorption (release of entrapped substances) of chemicals from inner linings of confined spaces.

An atmosphere becomes flammable when the ratio of oxygen to combustible material in the air is neither too rich nor too lean for combustion to occur. Combustible gases or vapors will accumulate when there is inadequate ventilation in areas such as confined spaces. Flammable atmospheres may also be formed by chemical reactions. These occur when surfaces are initially exposed to the atmosphere or when chemicals combine to form flammable gases.

Combustible dust concentrations are usually found during loading, unloading, or conveying coal, grain, fertilizers or other combustible materials. The explosion from these concentrations occurs when high amounts of static electricity accumulates at low humidity readings and causes a spark which ignites the combustible mixtures present in the air. Also, desorption of chemicals from the inner linings of surfaces of a tank or vessel may produce a flammable mixture. An example of desorption can occur when propane is emptied from a tank. After the removal, the walls may de-sorb some remaining gas and create a flammable mixture in the tank.

Toxic Atmospheres:

Toxic atmospheres can be created from almost any gas, vapor, or airborne dust.

Examples of the source of these substances include:

1. The manufacturing process itself.
2. The product being stored.
3. The operation being performed in the confined space (e.g. welding or brazing certain metals).
4. Leakage of lines within the space.
5. Leakage of substances into the space from the outside.

Certain gases are prevalent in various vessels; one is carbon monoxide (CO). This odorless and colorless gas has approximately the same density as air and is formed from the incomplete combustion of such materials as wood, oil, gas, etc. It has poor warning signals as to its level of intoxification. Higher levels (more than 1,000 ppm) can occur without warning and are almost always fatal. Another prevalently released gas is hydrogen sulfide (H2S). Hydrogen sulfide may be formed several ways, but the most common way occurs when hydrochloric acid is combined with iron sulfide, as in the cleaning of vessel walls.

Another common source of hydrogen sulfide is microbial breakdown of organic material, such as sewage, manure, garbage, etc.

Irritant (Corrosive) Atmospheres:

Irritant or corrosive atmospheres can be divided into primary and secondary groups. Primary irritants exert no systemic toxic effects. The adverse effect exerted by them on the respiratory tract is direct irritation to the tissue. Examples of these are hydrochloric acid, sulfuric acid, and ammonia. A secondary irritant produces toxic effects plus surface irritation.

Examples of this type are benzene and carbon tetrachloride. Prolonged exposure at high levels of irritant atmospheres may produce a general weakening of the nerve endings in the upper respiratory tract. The danger is that the worker generally is not aware of the onset of distress.

Oxygen-Deficient or Oxygen-Enriched Atmosphere:

An oxygen-deficient atmosphere is caused when the oxygen (O2) level of an atmosphere depreciates below 19.5% by either consumption or displacement. The consumption of O2 takes place during combustion of flammable substances, such as in welding. Oxygen may also be consumed during chemical reactions, such as the formation of iron oxide (rust). A second factor in an asphyxiating atmosphere is displacement by another gas. One such example of displacement is by "inerting" a tank by placing nitrogen in it. The total displacement of O2 will cause immediate collapse and death. Since these gases are colorless and odorless, they pose an immediate hazard unless ventilation and oxygen measurements are carried out. A confined space should never be purged with nitrogen or other gas used in welding as this could lead to an oxygen-deficient atmosphere.

An oxygen-enriched atmosphere contains greater than 23.5% oxygen. The main hazard associated with an oxygen-enriched atmosphere is fire. Combustible materials burn much faster in the presence of an oxygen-enriched environment. Some materials which are generally not considered fire hazards will burn rapidly when the oxygen concentration is increased. A contaminated atmosphere must never be purged with oxygen as this would greatly increase the fire hazard in the space.

DEFINITIONS:

Acceptable Entry Condition - Means 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 and work within the space.

Atmosphere - Refers to the gases, vapors, mists, fumes, and dusts within a confined space.

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

Authorized Entrance - Means an employee who is authorized by the employer to enter a permit space.

Combustible Dust - A dust capable of undergoing combustion or burning when subjected to a source of ignition.

Confined Space - Refers to a space that (1) Is large enough and so configured that an employee can bodily enter and perform assigned work; (2) Has limited or restricted means of entry or exit; and (3) Is not designed for continuous employee occupancy.

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

Engulfment - Engulfment is the surrounding and effective capture of a person by a liquid or finely (flowing) solid substance that can be aspirated or 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.

Entrapment - A condition where an uninjured person is unable to remove himself or herself, or any body part, from a confined space. Entrapment occurs as a result of the configuration of a confined space and is often associated with converging or convoluted surfaces.

Entry - Entry is 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 - The entry permit is the written or printed document that is provided by the employer to allow and control entry into a permit space.
Entry Supervisor - The entry supervisor (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.
Flammable or Explosive Limits - When flammable vapors are mixed with air in the proper proportions; the mixture can be ignited. The Lower Explosive Limit (LEL) and the Upper Explosive Limit (UEL) designate the range of concentrations over which the flash will occur. Flammable limits (explosive limits) are expressed as percent volume of vapor in air.
Hazardous Atmosphere - A hazardous atmosphere may expose employees to the risk of death, incapacitation, impairment of ability to self-rescue, injury, or acute illness from one or more of the following causes:

1. Flammable gas, vapor, or mist in excess of 10% of the lower flammable limit.
2. Airborne combustible dust at a concentration that meets or exceeds the lower flammable limit.
3. Atmospheric oxygen concentration below 19.5% or above 23.5%
4. Atmospheric concentration of any substance for which a dose or a permissible exposure limit is published.

Note: An atmospheric concentration of any substance that is not capable of causing death, incapacitation, and impairment of ability or 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.

Hot Work - Any work involving burning, welding, riveting, or similar fire producing operations as well as work, which produce a source of ignition, such as drilling or abrasive, blasting.

Immediately Dangerous to Life or Health - Means 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 individuals' ability to escape unaided from a permit space.

Inerting - Displacement of an area's atmosphere by a non-reactive gas (such as nitrogen) to such an extent that the resulting atmosphere is non-combustible.

Isolation - The process whereby the confined space is removed from service and completely protected against an inadvertent release of material. Examples are blanking off lines, lockout of electrical systems, and disconnecting mechanical linkages.

Non-Permit Required Confined Space - A non-permit confined space means a confined space that does not contain a recognized acute hazard or does not have the potential to contain, any hazard causing death or serious physical harm.

Oxygen Deficiency - An atmosphere where the oxygen concentration is less than 19.5%.

Oxygen Enrichment - An atmosphere where the oxygen concentration is greater than 23.5%.

Permissible Exposure Limit (PEL) - The maximum 8 hours, time weighted average of an airborne contaminant to which an employee may be exposed. At no time shall the exposure level exceed the ceiling concentration for the contaminants as listed in 29 CFR 1910 Subpart Z.

Permit-Required Confined Space - A permit-required confined space 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 System - The permit system is the employer's written procedure for preparing and issuing permits for entry and for returning the permit space to service following termination of entry.

Purging - The method by which gases, vapors, or other airborne impurities are displaced from a confined space.

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

Threshold Limit Value (TLV) - An occupational exposure guide published by the American Conference of Government Industrial Hygienist (ACGIH), extensively used to judge acceptable exposure levels to hazardous substances.

GENERAL SAFETY HAZARDS

Mechanical - If the activation of any electrical or mechanical equipment could cause injury to persons in a confined space, each piece of equipment shall be manually isolated and inactivated (locked out) before workers are allowed to enter a confined space. Also, there may be other hazards associated with confined spaces, such as flammable vapors or gases, in which special precautions must be taken. Preventing vapor leaks, flashbacks, and other hazards by closing valves is not sufficient. All pipes should be physically disconnected or isolation blanks bolted in place. Some tanks or vessels must also be blanked off and a blanket of inert gas placed within the tank to prevent a build-up of flammable vapors.

Communications for Permit-Required Confined Spaces - Communication between the worker and personnel outside is of the utmost importance. If a worker becomes unconscious or suddenly feels distressed, an injury may quickly become a fatality without proper communication. Communications should include visual monitoring at a minimum. Frequently, there are situations where visual monitoring is impossible and communication by means of an electronic communication system will be necessary.

Entry and Exit - The extent of the time required to enter and exit is of major significance as a physical limitation and is directly related to the potential hazard of the confined space. The extent of precautions taken and the standby equipment needed to maintain a safe work area will be determined by the means of access and rescue. The following should be considered:

1) Type of confined space to be entered
2) Access to the entrance
3) Number and size of openings
4) Barriers within the space
5) Occupancy load
6) Time required to exit confined space
7) Physical Effects

A. T***hermal Effects*** - When working in confined spaces, certain considerations must be taken to prevent conditions such as frostbite, hypothermia (excessive body heat loss), and heat stress. The use of protective clothing for both hot and cold environments will add additional bulk to the worker and must be considered in allowing for movement in the confined space and also for exit time in emergencies. For work in hot confined spaces, the University's Heat Stress Policy and Guide should be followed.

B. ***Noise*** - Noise problems are usually intensified in a confined space because the interior tends to cause sound to reverberate and cause extremely high noise levels. This high noise level can sometimes cause hearing damage to workers and can create problems with communication between workers inside the confined space, and assisting workers outside the confined space. Hearing protection must be provided when the time-weighted sound level pressure exceeds 85 decibels.

C. ***General*** - Some physical hazards cannot be eliminated because of the nature of a confined space or the work to be performed. These hazards include such items as scaffolding, surface residues, and structural hazards. These hazards pose an almost unrecognizable threat when compared to threats posed by oxygen deficiency, combustible or lethal gas pockets, engulfment, entrapment, etc. These lesser problems, however, account for more injuries because of oversight. Samples of these problems are slips and falls, reaction of incompatible materials, improper scaffolding, electrical shock, etc. Because of these hazards, careful planning must be given to the relationship between the internal structure, the exit, and the worker.

D. ***Medical Requirements*** - Medical requirements of employees who enter a confined space must be taken into consideration due to the increased hazard potential. In this type setting, employees must rely more heavily upon their physical, mental, and sensory attributes, especially under emergency conditions. In areas where the hazard potential is high, a person certified in CPR and First Aid should be in attendance.

E. **Training** - Training of employees for entering and working in confined spaces is required because of the potential hazards and the use of life-saving equipment. To ensure worker safety, the training program must be especially designed for the type of problems encountered. Instructional areas to be covered in the training program are:

1. Potential dangers of confined space work
2. Emergency exit procedures
3. Use of respirators
4. First Aid and Cardio-Pulmonary Resuscitation
5. Lockout and Tagging procedures
6. Fire Protection
7. Communications
8. Air Quality Monitoring
9. Space Ventilation Procedure

10. Employee training for permit requirements must be performed by a qualified person or someone knowledgeable in all relevant aspects of confined space entry procedures. The qualified person must be proficient in the following areas:
    a. Types of confined spaces that employees will be entering
    b. Chemical and physical hazards
    c. Work practices and techniques
    d. Testing requirements, permissible exposure limits, etc.
    e. Safety equipment such as respirators, protective clothing, and other protection such as helmets and shields
    f. Rescue procedures
    g. Knowledge of applicable Federal, State, and Local regulations
    h. Evaluation and test methods

The effectiveness of the training program can be determined by the qualified person to see if safe work practices are being followed and testing the employee for knowledge of the operations and hazards. Training shall be provided by an approved source.

CONFINED SPACE IDENTIFICATION AND WARNING

All permit-required confined spaces located inside buildings shall be identified and posted with appropriate signs to discourage the entry of unauthorized individuals. Where possible, they shall be secured to prevent unauthorized entry. The Department of Environmental Health and Safety shall identify, classify, and log the location of confined spaces on campus. A copy of the log shall be provided to the rescue service and to departments on campus that have employees who enter confined spaces. Contractors that enter confined spaces shall be provided with a list of the confined spaces in the building or areas in which they will be working. If a location is encountered on campus that appears to meet the definition of a confined space, and it is not posted as such nor does it appear on the log, contact Environmental Health and Safety.

PERMIT RETENTION AND RECORD KEEPING

Individual departments should maintain a copy of these forms. The records kept by Environmental Health and Safety shall be retained for the time period specified below. The following records shall be maintained:

1. Training. Information to include the date, location, instructor, content of course, name, and signature of trainee, etc. 3 years
2. Permits and pre-entry check lists. 3 years
3. Equipment calibration and maintenance log. 3 years
4. Confined space log. Indefinitely

EQUIPMENT:

The Department of Environmental Health and Safety will provide and maintain two multi-channel gas detectors for use by University personnel. These units shall be calibrated before each use. Departments may wish to purchase their own gas detectors or may borrow the detectors from Environmental Health and Safety. In addition, EH&S shall make available a single rescue tripod/winch, lifeline, and body harness for outside rescue.

CONTRACTORS:

Contractors who enter confined spaces on campus shall be appraised of this written program and the entry procedure. The University shall inform the contractor of hazards present in the space, the University's experience, any precautions or procedures. When employees of the University and the contractor enter a confined space together, the entry shall be coordinated to minimize hazards to the employees.

SPECIFIC PROCEDURES AND WORK PRACTICES:

The Confined Space Entry procedure does not cover all possible situations or conditions that could be encountered. Additional or different safety features or procedures may be necessary for specific operations.

WRITTEN PROCEDURE

APPLICATION:

This procedure must be followed when entering confined spaces such as manholes, vaults, boilers, ductwork, vessels, etc. Its intent is to protect entering personnel against such hazards as oxygen deficiency, combustible gas and vapors, toxic gases and vapors, mechanical hazards, entrapment, etc.

Confined spaces may be closed on all sides, top and bottom, with entry provided through restricted openings, or may be open completely on one side, top or bottom. Entry is defined as breaking the plane of the confined space with any part of the body.

Permit-required confined spaces are of greater hazard than non-permit required confined space. The entry points to permit-required confined spaces located within a building are marked with red stenciled signs stating: Danger - Permit-Required - Confined Space, Do Not Enter.

It is important to realize that a non-permit required confined space might require re-classification based on the type of work to be performed. For example, an underground vault may be classified as non-permit required; however, if an employee will be applying a solvent within this space, it could be upgraded to a permit-required confined space.

PROCEDURE:

WARNING: SMOKING IS NOT PERMITTED IN A CONFINED SPACE NOR NEAR THE ENTRANCE TO A CONFINED SPACE AT ANY TIME. THIS IS ESPECIALLY IMPORTANT WHEN THE SPACE IS BEING INITIALLY OPENED AND THE ATMOSPHERE TESTED.

WARNING: ALL ENERGY SOURCES MUST BE LOCKED OUT OR TAGGED OUT BEFORE ENTRY, UNLESS HOT WORK PERMITS HAVE BEEN AUTHORIZED BY THE SUPERVISOR.

QuizTime

To complete the Confined Space Entry Training Module, please click here for the quiz