Confined Spaces

The Occupational Safety and Health Administration (OSHA) has not published regulations dealing specifically with confined spaces found in the construction industry. The OSHA confined-space standard, 29 CFR 1910.146, is written for general industry and states that it is not applicable to construction. However, the construction standard relating to safety training and education (29 CFR 1926.21) places an affirmative duty on the employer to train employees who enter confined or enclosed spaces during construction work on the hazards involved, precautions to take, and protective and emergency equipment needed. Therefore, the general industry standard on confined spaces still may be of use to roofing contractors as a means of assessing and dealing with hazards and selecting proper personal protective equipment (PPE) and emergency equipment. An OSHA training tool addressing confined-space hazards in construction that also may be helpful follows at the end of this chapter.

A roofing contractor's liability for construction-confined space hazards likely would be based on the general duty clause or the training and education rules of 1926.21. The general duty clause imposes an obligation on an employer to furnish a workplace free of recognized hazards likely to cause death or serious injury. The general duty clause assigns liability to an employer when a specific standard is not in place to govern the hazardous condition or conduct.

In roofing and waterproofing work, there are confined-space situations that pose significant health and safety issues. For example, tankers and trenches provide an enclosed atmosphere where hazards could exist for employees who enter. Tankers can contain material residue that could be harmful, and gases and vapors can settle in trenches and other low-lying areas, depleting oxygen or forming explosive mixtures. Employees who enter those areas must be protected even though the general industry confined-space rules do not apply to them. In addition, lockout/tagout rules must be put into effect to secure the tanker from movement while entry is made and work performed on the tanker's interior.

General Requirements

OSHA requires roofing contractors to evaluate their workplaces to determine if any spaces are to be classified as permit-required confined spaces. If permit-required confined spaces are present, contractors must mark each entry point with a sign reading "DANGER—PERMIT-REQUIRED CONFINED SPACE. DO NOT ENTER."

To understand the requirements of a permit-required confined space, the definition of a confined space must be understood. OSHA defines a confined space as any space that:

- *Is large enough and so configured that an employee can bodily enter and perform assigned work*
- *Has limited or restricted means for entry or exit (e.g., tanks, tankers, silos, storage bins, vaults and pits)*
- *Is not designed for continuous employee occupancy*

Permit-required Confined Spaces

When a roofing contractor determines that confined spaces exist, the next step is to determine whether the confined space is a permit-required confined space. OSHA defines a permit-required confined space as a confined space that meets one or more of the following characteristics:

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

If one or more of these conditions exist, a contractor must follow the procedures discussed under the paragraph in this chapter titled "Permit-required Confined Space Requirements."

Following this chapter, a sample permit-required confined-space (PRCS) written program, common in general industry, can be found that can be adapted for inclusion in a company's overall health and safety program.

Atmospheric Monitoring

It is impossible to detect a hazardous atmosphere without instruments designed for that purpose. It should never be assumed that a confined space is safe or that an employee will be fine if he or she doesn't linger in a confined space or perform dangerous work there. A person can be overcome in a hazardous atmosphere in a matter of moments. Even quick and simple work in an area not recognized as a confined space can result in injuries or death by asphyxiation or as a result of an explosion.

In order to enter any confined space without the use of special types of PPE, such as a self-contained breathing apparatus (SCBA), atmospheric conditions must have these characteristics:

- *Oxygen: 19.5 percent to 23.5 percent*

- *Flammability: below 10 percent of the lower flammable limit (LFL) for gases, vapors, mists or combustible dust*
- *Toxic gases: below the permissible exposure limit (PEL)/threshold limit value (TLV) or time-weighted average (TWA) of a substance*

When testing for atmospheric hazards, a contractor should first test for oxygen. Combustible gas meters are oxygen-dependent and will not work properly in an oxygen-deficient atmosphere. Second, a contractor should test for combustible gases and vapors because the threat of fire or explosion is usually more immediate and life-threatening. Third, a contractor must test for toxic gases and vapors.

All the operations that will be taking place within the space and any hazardous substances that may result, such as fumes from welding or vapors from solvents or other chemicals, must be considered. The proximity to traffic and automotive vehicles on site should also be noted because this may generate carbon monoxide.

Alternative Entry Procedures

A contractor may allow entry into a permit-required space using alternative entry procedures. Using these procedures, the contractor does not need to have a written program, written permit, attendant or rescue team, etc., providing that:

- *The only hazards in the permit space are atmospheric*
- *Hazards can be controlled by the use of continuous forced-air ventilation*
- *Atmosphere is tested periodically during entry*

It may be necessary, though, to conduct a full permit-required confined-space entry to test the atmosphere if it cannot be tested from outside. Once the atmosphere has been tested and it is determined that the only hazard is an atmospheric hazard that can be controlled through the use of forced-air ventilation, the rest of the requirements are relaxed—the only requirement being that the atmosphere must be tested periodically.

If a hazardous atmosphere is detected at any time during the entry, the following are required:

- *Each employee must leave the space immediately.*
- *The space must be evaluated to determine how the hazardous atmosphere developed.*
- *Steps must be taken to protect the employees from the hazardous atmosphere before a subsequent entry takes place.*

Once the contractor satisfies the requirements for entering using alternative entry procedures, certification must be completed before anyone enters the confined

space. The certification consists of the date, location of the space and signature of the person providing the certification.

Nonpermit-required Confined Spaces

Permit-required confined spaces may be reclassified as nonpermit-required confined spaces if certain criteria are met. If these criteria are met, rescue teams, special PPE, etc., are not required. The criteria include the following:

- *The space poses no actual or potential hazardous atmospheres.*
- *All hazards within the space can be eliminated without entry into the space, such as locking and tagging equipment so it cannot be operated while employees are working inside.*
- *Forced-air ventilation to control atmospheric hazards does not constitute elimination of hazards.*

A contractor must verify these conditions are met through certification, which is the same as the alternative entry procedure. Again, the date, location of the space and name of the person certifying the space must be on the certificate. This certificate must be made available to employees before entering the space.

If hazards arise in a confined space that has been declassified, each employee must exit the space. The contractor must determine if the space needs to be reclassified as a permit-required confined space. If the hazards are eliminated, the nonpermit entry can continue.

It is important to note that the difference between an alternative entry procedure and a nonpermit-required confined space is the use of forced-air ventilation. If forced-air ventilation is used during an entry, it cannot be classified as a nonpermit-required confined space. It must be classified as an alternative entry procedure.

It is in the best interest of the contractor to try to meet the requirements of alternative entry procedures or nonpermit-required confined spaces because the requirements for the two are much less stringent than for a permit-required confined space. However, it imposes the burden of making certain the conditions inside the space do not change.

If a contractor can neither declassify a permit-required confined space to a nonpermit-required confined space nor use alternative entry procedures, all aspects of permit-required confined spaces must be followed.

Permit-required Confined Space Requirements

If a contractor's employees are required to enter permit-required confined spaces, a written program must be developed addressing all potential hazards. The program must address the following topics:

- *Implementation of measures necessary to prevent unauthorized entry into the permit-required confined space. This can be done by informing those employees who have not been trained in the standard to keep away during the entry activities. Using appropriate signs and barricades to prevent entry would be sufficient.*
- *Identification and evaluation of hazards in the permit space before employees enter it*
- *Development of procedures and practices necessary to conduct safe permit space entries, including at least the following elements:*

    - *Specification of acceptable entry procedures. This includes having an oxygen content between 19.5 percent and 23.5 percent, LFL of substances below 10 percent and below established PELs, TWAs and TLVs.*
    - *Isolation of the permit space. This includes locking and tagging equipment to prohibit use while the entry is taking place. For example, a tanker must be prevented from being driven away.*
    - *Control or elimination of atmospheric hazards through purging, inerting, flushing or ventilating*
    - *Protection of pedestrian or vehicular traffic from hazards by using barriers*
    - *Verification that the conditions in the permit space remain at safe levels throughout the entry.*

- *Maintenance of equipment to ensure safe entry into a permit space, which involves:*

    - *Gas-detection equipment*
    - *Ventilating equipment*
    - *Communication equipment if necessary*
    - *PPE to be used when engineering controls such as ventilation equipment is not practical*
    - *Lighting*
    - *Barricades to prevent unauthorized entry*
    - *Equipment, such as ladders, to provide for safe access to and egress from the permit space*
    - *Rescue and emergency equipment, unless this service is provided*
    - *Any other equipment that would be used for safe permit space entry*
- *Evaluation of permit space conditions during entry operations by:*

    - *Testing conditions in the permit space before entry begins*
    - *Testing or monitoring the space to ensure the conditions are being maintained*

    - *Testing for oxygen first, flammable atmospheres second and toxic atmospheres last*

- *Provision of at least one attendant outside the permit space (an explanation of duties and training requirements of the attendant follows)*
- *Designation of employees who have active roles in entry operations and identification of the training requirements for those employees*
- *Development and implementation of procedures for summoning rescue and emergency services*
- *Development of a permit system to include preparation, issuance, use and cancellation of permits*
- *Coordination of entry operations when more than one employer is involved*
- *Cancellation of a permit after the work is complete*
- *Review of entry operations to correct problems that may have occurred during the entry operation*
- *Review of the written program annually, making revisions as needed*

Permit System

As stated before, OSHA requires employers to develop and implement a permit system. This system will ensure all steps have been taken to protect employees from hazards that may be in a confined space. Two sample permits are included at the end of this chapter.

Entry supervisors are required to sign the completed permit, authorizing the permit operations to begin. Authorized entrants must have the opportunity to review the permit before they enter the permit space. Also, a copy of the permit must be posted at the entry point of the space.

An estimated time for an entry operation must be provided on the permit. Once the time has expired, the permit is canceled and the operation must cease. In addition, the entry supervisor must cancel the entry when the operation is complete or when a condition arises in the space that was not allowed under the original permit conditions. Unpermitted conditions must be noted on the entry permit.

The permit must be retained for one year so it can be reviewed when the written program is reviewed.

Training

OSHA requires contractors to provide training for those who may be involved in the permit-required confined-space process. Training must be conducted before employees are first assigned duties relating to confined spaces or if there is a change in their assignments. Training must also be conducted when new hazards arise relating to permit-space operations where employees have not received prior

training. Also, training must be provided to each affected employee whenever the contractor believes there are deviations from the permit-space entry.

Contractors must train their employees so they are proficient in the duties of an authorized entrant, attendant or entry supervisor. All training must be certified, indicating employees' names, trainers' signatures or initials, and dates of training.

Authorized Entrants

Authorized entrants are employees who have been trained and approved to enter a confined space. These employees must have had training regarding the potential hazards of the confined space, as well as the signs and symptoms of overexposure to any of the hazards. They should be familiar with all equipment, know if the equipment is explosion-proof, and know how to tell when it is properly grounded. Authorized entrants must know how to communicate with the attendant, especially if a prohibited condition or a hazardous situation arises. Entrants must agree to exit immediately if an order is given to do so or an alarm goes off. Entrants must wear full-body harnesses with retrieval lines attached to the center of their backs or above their heads or wristlets if full-body harnesses are shown to be infeasible.

Authorized Attendants

Authorized attendants must be able to monitor situations inside and outside confined spaces so they can order entrants to evacuate a space if a dangerous situation arises in either place. Attendants must be well aware of the hazards of the confined space and also aware of the physical and behavioral effects of hazard exposure so that they would notice the effects in any of the entrants. If an emergency situation arises in the confined space, the attendant is the person responsible for summoning emergency services and performing whatever rescue operation he or she has been trained and equipped to perform. Another responsibility is keeping all unauthorized entrants out of the confined space. Under no circumstances is an attendant permitted to leave the space until replaced by another attendant or all entrants have come out of the space.

Entry Supervisors

Entry supervisors must know the hazards of confined spaces and the signs and symptoms of overexposure to those hazards. They must verify that permits are filled in, the appropriate testing and procedures have been completed, and all equipment is in place. The supervisor is the person responsible for knowing when and under what conditions to cancel a permit and terminate the work. Supervisors must also remove unauthorized persons. Finally, they are responsible for making sure rescue services are available and the means for calling them are operable.

Rescue and Emergency Services

Contractors who decide to have their employees enter a permit space must provide rescue and emergency services. There are three different types of emergency rescue that a contractor can rely on:

1. *In-house rescue services*
2. *Outside rescue services, such as local fire departments*
3. *Nonentry rescues*

Training for in-house rescue services requires employees to be trained in the rescue gear they would need to extract someone from a confined space. Because the rescuers need to enter the permit space, they must also receive the same level of training that authorized entrants receive. Once every 12 months, rescuers must simulate an actual rescue using real people or mannequins. At least one member of the in-house rescue team must be trained in first aid/CPR.

The second option, summoning an outside rescue team to perform the rescue, is a more difficult option with which to comply. A contractor must evaluate the prospective rescue team to determine how quickly it is capable of responding after members. OSHA requires the rescue team to respond in a timely manner, consistent with the specific hazard in the confined space.

As an example, if there is an immediately dangerous to life and health (IDLH) atmosphere in the permit space and entrants are required to wear self-contained breathing apparatus (SCBA), the contractor must have a standby person who is capable of entering the space in a short period.

The contractor must select a rescue team that has the capability to reach any victim within a time frame that is appropriate for the hazard in the permit space. The rescue team must be proficient in performing the needed rescue service. The contractor must also inform the rescue team of all types of permit-required confined spaces they have and give them time to practice and develop rescue plans.

The last option is to provide nonentry rescues. If this option is selected, the person entering the confined space must wear a full-body harness with a retrieval line attached to it. The retrieval line must be attached to a mechanical device, such as a tripod and winch or a fixed point outside the permit space. This will allow someone to pull an incapacitated victim out of the confined space.

Material safety data sheets (MSDSs) for chemicals to which an entrant was exposed in a confined space are required to be made available to the medical facility that provides aid.

Sample Written Program

Permit-required Confined Space (PRCS) Written Program

[Company name] recognizes that entry into confined spaces can kill or injure employees. The following work practices have been implemented to minimize the potential dangers associated with entry into permit-required confined spaces.

Introduction

This program identifies specific responsibilities of different parties and presents the criteria required for safe entry into permit-required confined spaces.

Definitions

confined space: A space that has limited or restricted means of entry, is not designed for continuous occupancy, and is large enough and configured so that a person can enter the space and maneuver well enough to perform tasks.

permit-required confined space: A confined space that has the potential to expose personnel to hazards that require controls to prevent injury or death. These hazards may include any or all of the following:

- *Engulfment and/or entrapment*
- *Hazardous atmospheres*
- *Other serious safety or health hazards*

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

- *Atmospheric oxygen concentrations less than 19.5 percent or greater than 23.5 percent*
- *Flammable gas, vapor or mist at a concentration in excess of 10 percent of the lower flammable limit (LFL)*
- *Airborne combustible dust at a concentration that meets or exceeds its LFL*

- *Atmospheric concentration of a toxic substance that exceeds its dose or permissible exposure limit (PEL)*

- *Any other atmospheric concentration that is immediately dangerous to life and health*

nonpermit-required confined space: A confined space that does not have the potential for containing atmospheric conditions capable of causing injury or death.

General Procedures

- *Based on these definitions, management is responsible for determining which areas are considered confined spaces and which confined spaces are permit-required confined spaces.*

- *Immediately after identifying the permit-required confined spaces, signs reading "DANGER—PERMIT-REQUIRED CONFINED SPACE. DO NOT ENTER," or similar, must be placed at each entrance of the confined space.*

- *Before allowing entry into any permit-required confined space, the following steps must be followed:*

    - *An atmospheric test should be performed in the confined space to ensure the required ambient conditions—less than 10 percent LFL, greater than 19.5 percent and less than 23.5 percent oxygen, and less than the PEL of a contaminant—exist.*
    - *The space should be free of other hazards by locking and tagging out equipment as necessary.*
    - *External rescue services need to be identified or the company rescue group notified.*
    - *The permit has be completely filled out, reviewed by entrants and posted near the permit-required confined space's entrance.*
    - *Authorized employees, attendant(s) and entry supervisor(s) should be properly trained regarding all issues in the training section.*
    - *Ventilation systems must be used as required.*

Training and Responsibilities

General Training Requirements

Each employee at [company name] who is involved or has the potential to be involved in confined-space entries must be trained before entering any space, as well as:

- *Before first assigned duty in a confined space*
- *Whenever there is a change in the employee's duties or assignment*
- *Whenever there is a change in the permit space itself*
- *Whenever it is determined that there have been or must be changes in or deviations from procedures*

It is also important that employees fully understand the roles and training requirements of attendants, entrants and entry supervisors.

Upon completion of training, [company name] will issue certificates indicating each employee's name and identification number, such as social security number; dates of training; and name of the trainer.

Training Requirements and Responsibilities of Entry Supervisors

- *Know, understand and ensure the completion of the training requirements of the authorized entrants and attendants as outlined in their requirements and responsibilities.*
- *Ensure the entry permit is completely and properly filled out and verify that the air monitoring has been done correctly.*
- *Terminate the permit when conditions change either inside or outside the space or when the permit expires.*
- *Verify that either external or internal rescue services are available.*
- *Determine when responsibility for a permit space is transferred, and ensure operations remain consistent with the terms on the entry permit.*
- *Require all unauthorized entrants to leave the permit area.*
- *Know the signs and symptoms of exposure for the hazardous atmospheres encountered in each confined space.*

Training Requirements and Responsibilities of Authorized Entrants

- *Be properly trained on all anticipated hazards of permit-required confined spaces.*

- *Know how to use all equipment properly.*
- *Know the signs and symptoms of exposure to hazardous atmospheres and how to perform self-rescue.*
- *Know the evacuation signal, and understand that the attendant can initiate immediate evacuations requiring all entrants to exit.*
- *Remain in constant communication with the attendant.*
- *Alert the attendant when:*
    - *The entrant recognizes any warning signs or symptoms of exposure to a dangerous situation.*
    - *The entrant detects a condition that is not allowed on the permit.*

Training Requirements and Responsibilities of Attendants

- *Know the hazards that may be encountered during entry, including signs and symptoms of exposures and exposure consequences.*
- *Remain outside the space at all times, and be in constant communication with the entrants. Under no circumstances is an attendant allowed to leave the entrance area of the confined space or perform duties that will interfere with the primary responsibility of communicating with those inside the confined space.*
- *Continuously maintain a proper count and be able to identify all the entrants.*
- *Monitor activities inside and outside the confined space to ensure the safety of the entrants.*
- *Summon rescue or other emergency personnel when needed.*
- *Perform nonentry rescues when possible.*
- *Warn all unauthorized entrants of emergencies.*

Entering the Space

Permit System

- *Prior to confined space entry, the permit must be filled out completely. The entry supervisor must sign the permit before personnel enter the permit-required confined space.*

- *The completed permit must be posted at the entry point of the confined space so entrants can review it and confirm that the pre-entry steps have been taken.*

- *The permit is only valid for the duration of the work performed.*

- *The entry supervisor must terminate the permit when:*

    - *Work is complete*
    - *Conditions arise that were not accounted for on the original permit*

- *After the completion of the entry, the permit will be retained for a period of one year to facilitate review of the PRCS program. Any problems encountered during the entry must be noted on the permit and used for review.*

Atmospheric Monitoring

- *Before an employee enters any confined space, atmospheric testing will be conducted to assess the ambient conditions inside the space.*

- *The testing will be performed by a qualified person who is capable of operating the atmospheric testing equipment and interpreting the results.*

- *The equipment must be capable of detecting a minimum of three hazardous atmospheric variables: flammability, oxygen content and toxicity.*

- *The devices must be equipped with audio alarms, visual alarms or both.*

- *Before use or according to the manufacturer's scheduled specifications, the atmospheric equipment must be calibrated with the specified calibration gases in order to properly identify possible hazardous atmospheres.*

- *Acceptable atmospheric limits are:*

    - *Oxygen content: between 19.5 percent and 23.5 percent*
    - *Flammability: less than 10 percent of the lower flammable limit (LFL) for any substance*

    - *Toxicity: less than the permissible exposure limit (PEL) as established on the material safety data sheets (MSDSs)*

- *If the atmospheric monitoring equipment detects levels beyond these ranges, employees will not be permitted to enter the space.*

- *If levels rise above or fall below the required ranges while employees are in the confined space, the entry will be terminated and the attendant will instruct all employees to evacuate the space.*

- *The space will be ventilated and rechecked with the atmospheric equipment before subsequent entry is permitted. In most instances, [company name] will be required to operate the atmospheric equipment continuously.*

- *Ventilation equipment will be used when entering any space without respiratory protection. Examples of this type of space include but are not limited to tankers and waterproofing excavations.*

- *This program is not limited to roofing projects; it also applies to tasks or work performed in the shop area, including in vaults or enclosed areas where chemicals are stored. These areas will be determined by the shop foreman and properly marked with appropriate signs.*

Personal Protective Equipment

- *Work and/or rescue equipment will be immediately available at all times.*

- *Work and/or rescue equipment will be selected with the potential hazards and possible contingencies associated with the confined space in mind.*

- *As necessary, PPE will be worn to protect entrants from the hazards associated with the confined space. PPE may include eye protection, hearing protection, hand protection, hard hats, chemically treated protective garments, and respiratory protection, including self-contained breathing apparatus (SCBA) if necessary.*

- *If the confined space has a height of more than 5 feet with an entry point overhead, each entrant will be required to wear a body harness attached to a mechanical retrieval system, such as a tripod.*

- *If the confined space is less than 5 feet in height but has a potentially hazardous atmosphere, each entrant will wear a body harness attached to a lifeline that will be monitored by the attendant. This system will*

allow the attendant to perform a non-entry rescue, if necessary, by pulling the entrant out by the lifeline.

- *If the confined space entry requires more than one entrant using an airline system, the attendant will be responsible for ensuring the air hoses and lifelines do not become entangled.*

General Safety Issues:

- *Under no circumstances will compressed gas cylinders such as those containing oxygen or acetylene be allowed inside the confined space.*

- *The only pressurized cylinder that will be permitted is a SCBA for respiratory protection.*

- *If welding or cutting activities are conducted in the confined space, the following must be adhered to:*

    - *Hoses and torches will be inspected before use. If any piece of equipment is found to be defective, it will be tagged and removed from service immediately.*
    - *A fire watch will be posted during and after the confined space entry is complete.*
    - *All torches and hoses will be removed after work has ceased.*

- *Lockout/tagout procedures will be followed on all applicable equipment.*

- *When natural lighting is not sufficient, additional lighting will be provided. It must not exceed 12 volts in damp conditions and will be equipped with a ground fault circuit interrupter. In hazardous atmospheres, explosion-proof lighting will be required.*

- *Communications will be established and used throughout the entire confined space entry.*

- *Properly rated fire extinguishers will be present, fully charged and functional.*

Rescue and Emergency Services

Nonentry rescue services will be performed by the attendant. The local fire department will be notified before the procedure begins in case nonentry rescue cannot be performed. [Company name's] management allows its employees to conduct entry rescues provided the following conditions are met:

- *Each potential rescuer must be provided with proper PPE and be trained in its use for rescue.*

- *Each team member must be fully trained as an authorized entrant and confined-space rescue personnel.*

- *Training must take place initially before confined space entries occur and annually thereafter. Each rescue team member must practice removing humans or life-size mannequins.*

- *Each team member must be trained in first aid. At least one member must be trained in first aid and CPR.*

If an emergency occurs and these conditions are not satisfied, an attendant will call the fire department or the specified rescue service. If [company name] elects to use an outside organization to perform rescue duties, it will:

- *Inform the rescue service of the hazards of the confined space*

- *Allow access to previous permits so the rescue company can develop an action plan*

Confined Space Exceptions

Alternative Confined-space Entry Plan

Under certain circumstances, [company name] will reclassify a space to allow for a streamlined approach to entering the confined space. This alternative entry plan will be allowed to be implemented only when:

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

- *Continuous forced air ventilation alone is sufficient to maintain a safe atmosphere.*

- *Atmospheric monitoring is done to support the claims in items 1 and 2.*

- *All data from items 1 and 2 are recorded and made available for all entrants to review.*

If one of the these items cannot be achieved, permit-required confined-space entry procedures must be followed. The person(s) performing initial atmospheric monitoring tests must follow the standard permit-required confined space procedures.

If the items can be achieved and the space reclassified, the following procedures will be implemented:

- *Any condition making it unsafe to remove an entrance cover will be eliminated before the cover is removed.*

- *After entrance covers are removed, guardrails, barricade tape, etc., will be erected to prevent accidental falls through the opening.*

- *Atmospheric monitoring to determine oxygen levels, toxic air contaminants, and flammable gases or vapors will be completed before entry operations. Atmospheric monitoring will also be conducted periodically during the entry to ensure these levels have not become more hazardous.*

- *Continuous forced-air ventilation will be used as follows:*

    - *The system must be capable of eliminating the atmospheric hazard while entrants are inside the space.*
    - *The system must be directed to or away from (depending on the airflow direction) the immediate area of the entrants and remain operational during the entire entry procedure.*
    - *The air supply for the system must come from a clean source and not increase hazards.*

- *If a hazardous atmospheric condition is detected while entrants are in the confined space, the following steps will be taken:*

    - *Each entrant will leave the space immediately.*
    - *The space will be evaluated to determine how the hazardous atmosphere developed.*
    - *Measures will be taken to protect the entrants from the hazardous atmosphere.*

Nonpermit-required Confined Spaces

[Company name] may have the opportunity to reclassify a permit-required confined space as a nonpermit-required confined space provided the following conditions are met:

- *The permit space poses no actual or potential atmospheric hazards, and all hazards within the space can be eliminated from outside the space. If it is necessary to enter the space to eliminate the hazards, then permit-required confined space procedures must be followed.*

- *The space must remain free of atmospheric hazards at all times.*

- *All information must be documented, certifying the date, location of the space and signature of the person making the determination. This form must be made available to all employees entering the space.*

- *If hazards arise while employees are working in the space, employees must immediately evacuate and reclassify the space as a permit-required confined space.*

The use of forced-air ventilation systems does not constitute the elimination of atmospheric hazards during nonpermit-required confined space entries.

CONFINED SPACE ENTRY PERMIT

GENERAL INFORMATION

Space to be Entered: _____
_____

Location/Building: _____
_____

Permit No. _____

Purpose of Entry: _____
_____

Authorized Duration of Permit:
Date:_____ to _____
Time:_____ to _____

EQUIPMENT REQUIRED FOR ENTRY & WORK

(Specify as required)

Personal Protective Equipment: _____
_____
_____

Respiratory Protection: _____
_____

Atmospheric Testing/Monitoring: _____
_____

Communication: _____
_____

Rescue Equipment: _____
_____

Other: _____

COMMUNICATION PROCEDURES TO BE USED BY ATTENDANTS AND ENTRANTS:

AUTHORIZED ENTRANTS *(List by name or attach roster.)*

_____
_____
_____

AUTHORIZED ATTENDANTS *(List by name.)*

_____
_____
_____

PERMIT SPACE HAZARDS *(Indicate hazards with initials)*

_____ *Oxygen deficiency (less than 19.5 percent)*
_____ *Oxygen enrichment (greater than 23.5 percent)*
_____ *Flammable gases or vapors (greater than 10 percent of LFL)*
_____ *Airborne combustible dust (meets or exceeds LFL)*
_____ *Toxic gases or vapors (greater than PEL)*
_____ *Mechanical hazards*
_____ *Electrical shock*
_____ *Materials harmful to skin*
_____ *Engulfment*
_____ *Other:* _____

EMERGENCY SERVICE

Name of Service	*Phone Number*	*Method of Contact*
_____	_____	_____
_____	_____	_____

PREPARATION FOR ENTRY *(Check after steps have been taken.)*

☐ **Notification** *of affected departments of service interruption*

Isolation Methods:
☐ *Lockout/tagout* ☐ *Blank/blind*
☐ *Purge/clean* ☐ *Inert* ☐ *Ventilate*
☐ *Atmospheric test* ☐ *Barriers* ☐ *Other:*_____

Personal Awareness:
☐ *Pre-entry briefing on specific hazards and control methods*
☐ *Notify contractors about permit and hazard conditions*
☐ *Other:*_____

Additional permits *required and/or attached:*

☐ *Hot work* ☐ *Line breaking* ☐ *Other:*_____

TESTING RECORD

Time	*Oxygen-min.*	*Oxygen-max*	*Flammability*	*H2S*	*Toxic (specify)*	*CI2*	*CO*	*SO2*	*Heat*	*Other*	*Tester Initials*
Acceptable Conditions	*>19.5%*	*<23.5%*	*<10% LEL/LFL*	*<10ppm*		*<0.5ppm*	*<35ppm*	*<2ppm*	*°F/°C*		
Result a.m./p.m.											
Result a.m./p.m.											
Result a.m./p.m.											
Result a.m./p.m.											
Result a.m./p.m.											
Result a.m./p.m.											
Result a.m./p.m.											

AUTHORIZATION BY ENTRY SUPERVISORS

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

Printed Name *Signature* *Date* *Time*

_____

_____

THIS PERMIT MUST BE POSTED ON JOB SITE * GOOD ONLY ON INDICATED DATE

CONFINED SPACE ENTRY PERMIT

Additional Authorized Entrants *Additional Authorized Attendants*

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Construction Safety and Health Outreach Program

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Anatomy of Confined Spaces in Construction

THE ISSUE

Fatalities and injuries constantly occur among construction workers who, during the course of their jobs, are required to enter confined spaces. In some circumstances, these workers are exposed to multiple hazards, any of which may cause bodily injury, illness, or death. Newspaper and magazine articles abound with stories of workers injured and killed from a variety of atmospheric factors and physical agents. Throughout the construction jobsite, contractors and workers encounter both inherent and induced hazards within confined workspaces.

INHERENT HAZARDS

Inherent hazards, such as electrical, thermal, chemical, mechanical, etc., are associated with specific types of equipment and the interactions among them. Examples include high voltage (shock or corona discharge and the resulting burns), radiation generated by equipment, defective design, omission of protective features (no provision for grounding non-current-carrying conductive parts), high or low temperatures, high noise levels, and high-pressure vessels and lines (rupturing with resultant release of fragments, fluids, gases, etc.). Inherent hazards usually cannot be eliminated without degrading the system or equipment, or without making them inoperative. Therefore, emphasis must be placed on hazard control methods.

INDUCED HAZARDS

Induced hazards arise and are induced from a multitude of incorrect decisions and actions that occur during the actual construction process. Some examples are: omission of protective features, physical arrangements that may cause unintentional worker contact with electrical energy sources, oxygen-deficient atmospheres created at the bottom of pits or shafts, lack of safety factors in structural strength, and flammable atmospheres.

EXAMINATION OF TYPICAL CONFINED SPACES

Following are typical examples of confined workspaces in construction which contain both inherent and induced hazards.

Vaults

A variety of vaults are found on the construction jobsite. On various occasions, workers must enter these vaults to perform a number of functions. The restricted nature of vaults and their frequently below-grade location can create an assortment of safety and health problems.

Oxygen-Deficient Atmosphere

One of the major problems confronting construction workers while working in vaults is the ever-present possibility of an oxygen-deficient atmosphere.

Explosive or Toxic Gases, Vapors, or Fumes

While working in an electrical vault, workers may be exposed to the build-up of explosive gases such as those used for heating (propane). Welding and soldering produce toxic fumes which are confined in the limited atmosphere.

Electrical Shock

Electrical shock is often encountered from power tools, line cords, etc. In many instances, such electrical shock results from the fact that the contractor has not provided an approved grounding system or the protection afforded by ground-fault circuit interrupters or low-voltage systems.

Purging

In some instances, purging agents such as nitrogen and argon may enter the vault from areas adjacent to it. These agents may displace the oxygen in the vault to the extent that it will asphyxiate workers almost immediately.

Materials Falling In and On

A hazard normally considered a problem associated with confined spaces is material or equipment which may fall into the vault or onto workers as they enter and leave the vault. Vibration could cause the materials on top of the vault to roll off and strike workers. If the manhole covers were removed, or if they were not installed in the first place, materials could fall into the vault, causing injury to the workers inside.

Condenser Pits

A common confined space found in the construction of nuclear power plants is the condenser pit. Because of their large size, they are often overlooked as potentially hazardous confined spaces. These below-grade areas create large containment areas for the accumulation of toxic fumes, gases, and so forth, or for the creation of oxygen-deficient atmospheres when purging with argon, freon, and other inert gases. Other hazards will be created by workers above dropping equipment, tools, and materials into the pit.

Manholes

Throughout the construction site, manholes are commonplace. As means of entry into and exit from vaults, tanks, pits, and so forth, manholes perform a necessary function. However, these confined spaces may present serious hazards which could cause injuries and fatalities. A variety of hazards are associated with manholes. To begin with, the manhole could be a dangerous trap into which the worker could fall. Often covers are removed and not replaced, or else they are not provided in the first place.

Pipe Assemblies

One of the most frequently unrecognized types of confined spaces encountered throughout the construction site is the pipe assembly. Piping of sixteen to thirty-six inches in diameter is commonly used for a variety of purposes. For any number of reasons, workers will enter the pipe. Once inside, they are faced with potential oxygen-deficient atmospheres, often caused by purging with argon or another inert gas. Welding fumes generated by the worker in the pipe, or by other workers operating outside the pipe at either end, subject the worker to toxic atmospheres. The generally restricted dimensions of the pipe provide little room for the workers to move about and gain any degree of comfort while performing their tasks. Once inside the pipe, communication is extremely difficult. In situations where the pipe bends, communication and extrication become even more difficult. Electrical shock is another problem to which the worker is exposed. Ungrounded tools and equipment or inadequate line cords are some of the causes. As well, heat within the pipe run may cause the worker to suffer heat prostration.

Ventilation Ducts

Ventilation ducts, like pipe runs, are very common at the construction site. These sheet metal enclosures create a complex network which moves heated and cooled air and exhaust fumes to desired locations in the plant. Ventilation ducts may require that workers enter them to cut out access holes, install essential parts of the duct, etc. Depending on where these ducts are located, oxygen deficiency could exist. They usually possess many bends, which create difficult entry and exit and which also make it difficult for workers inside the duct to communicate with those outside it. Electrical shock hazards and heat stress are other problems associated with work inside ventilation ducts.

Tanks

Tanks are another type of confined workspace commonly found in construction. They are used for a variety of purposes, including the storage of water, chemicals, etc.

Tanks require entry for cleaning and repairs. Ventilation is always a problem. Oxygen-deficient atmospheres, along with toxic and explosive atmospheres created by the substances stored in the tanks, present hazards to workers. Heat, another problem in tanks, may cause heat prostration, particularly on a hot day. Since electrical line cords are often taken into the tank, the hazard of electrical shock is always present. The nature of the tank's structure often dictates that workers must climb ladders to reach high places on the walls of the tank.

Sumps

Sumps are commonplace. They are used as collection places for water and other liquids. Workers entering sumps may encounter an oxygen-deficient atmosphere. Also, because of the wet nature of the sump, electrical shock hazards are present when power tools are used inside. Sumps are often poorly illuminated. Inadequate lighting may create an accident situation.

Containment Cavities

These large below-grade areas are characterized by little or no air movement. Ventilation is always a problem. In addition, the possibility of oxygen deficiency exists. As well, welding and other gases may easily collect in these areas, creating toxic atmospheres. As these structures near completion, more confined spaces will exist as rooms are built off the existing structure.

Electrical Transformers

Electrical transformers are located on the jobsite. They often contain a nitrogen purge or dry air. Before they are opened, they must be well vented by having air pumped in. Workers, particularly electricians and power plant operators, will enter these transformers through hatches on top for various work-related reasons. Testing for oxygen deficiency and for toxic atmospheres is mandatory.

Heat Sinks

These larger pit areas hold cooling water in the event that there is a problem with the pumps located at the water supply to the plant--normally a river or lake--which would prevent cooling water from reaching the reactor core. When in the pits, workers are exposed to welding fumes and electrical hazards, particularly because water accumulates in the bottom of the sink. Generally, it is difficult to communicate with workers in the heat sink, because the rebar in the walls of the structure deaden radio signals.

UNUSUAL CONDITIONS

Confined Space Within a Confined Space

By the very nature of construction, situations are created which illustrate one of the most hazardous confined spaces of all--a confined space within a confined space. This situation appears as tanks within pits, pipe assemblies or vessels within pits, etc. In this situation, not only do the potential hazards associated with the outer confined space require testing, monitoring, and control, but those of the inner space also require similar procedures. Often, only the outer space is evaluated. When workers enter the inner space, they are faced with potentially hazardous conditions. A good example of a confined space within a confined space is a vessel with a nitrogen purge inside a filtering water access pit. Workers entering the pit and/or the vessel should do so only after both spaces have been evaluated and proper control measures established.

Hazards In One Space Entering Another Space

During an examination of confined spaces in construction, one often encounters situations which are not always easy to evaluate or control. For instance, a room or area which classifies as a confined space may be relatively safe for work. However, access passages from other areas outside or adjacent to the room could, at some point, allow the transfer of hazardous agents into the "safe" one. One such instance would be a pipe coming through a wall into a containment room. Welding fumes and other toxic materials generated in one room may easily travel through the pipe into another area, causing it to change from a safe to an unsafe workplace. A serious problem with a situation such as this is that workers working in the "safe" area are not aware of the hazards leaking into their area. Thus, they are not prepared to take action to avoid or control it.

CONCLUSION

In this discussion, we have defined inherent and induced hazards in confined spaces. We have examined typical confined spaces on construction sites and we have described representative hazards within these confined spaces.