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Confined Space in Construction

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Introduction

The words “confined space” should trigger a concern for added caution associated with a dangerous high-risk operation. In construction, there are many spaces that are identified as confined spaces. As a safety manager or person in charge, they should posses the knowledge required to evaluate each and every space for any potential risk or hazard. That being said, it is the responsibility of the safety manager or person in charge to determine whether or not the confined space requires a permit. In the following presentation we will review the permit-required confined space standard. In addition we will be providing three examples which are not considered your “run of the mill” confined spaces.

Exhibit 1. Permit-required confine space entry.

In construction, there are a number of areas which are considered confined spaces. The following list provides examples of what are considered confined spaces:

- Underpinning pit
- Sump pits

- Wood or steel forms
- Trenches
- Mix plants with hoppers or silos
- Caissons for auger drilling and pile placement, then inspected internally by a worker on a boatswains' chair seat
- Shafts
- Tunnels
- Sound barrier wall foundations
- Slurry walls
- Vats
- Vaults
- Bins
- Exhaust ducts
- Process vessels steam tunnels
- Utility vaults
- Electrical vaults
- Boilers
- Raw sewage sewers
- Storm water drains
- Any piping systems which would have to be accessed
- HVACs duct work
- Slurry tanks
- Railroad cars
- Any converging hopper
- Any tank which held a toxic substance (e.g. gasoline, benzene, an inert gas, nitrogen, argon, etc.)
- Water storage tanks
- Any temporary storage tanks for runoff water or hazardous waste
- Grain silos, coal silos or any thing which contains flow able material
- Barge inner bottom that rusts, eating up the oxygen and gives off carbon dioxide
- Bilge tanks on boats
- Any area that you have tented in by plastic or tarps and have placed space heaters in the enclosure to heat an area for concrete work. Those space heaters are throwing out carbon monoxide and create an oxygen-deficient atmosphere. Recognize the risk factors in all of your operations.
- Excavations that are deep
- Trenching or shoring operations that incorporate machinery that emits carbon dioxide on a major scale. Additionally, the open top of the excavation does not dissipate or move the carbon monoxide from the machinery away from the workforce. On one job I even had a container truck box which had filtration equipment in it with one of the two doors open considered as a confined space by two compliance officers; so my advice is when in doubt, treat it as a confined space.

I have provided some examples of confined spaces in construction which meet the requirements of a confine spaced. Who regulates confined space in construction and where could I go for guidance or help? In the CODE OF FEDERAL REGULATIONS 1926 .21(b)(6)(i)(ii) confined space amounts to two paragraphs. Since a new confined-space standard for construction has yet to be adopted we, are then directed to the existing CODE OF FEDERAL REGULATIONS 1910.146 *The General Industry Standard for Permit-required Confined Spaces*.

In the CFR 1910.146, the definition of a confined space is "any space that is large enough and configured that a employee can bodily enter and perform assigned work; has limited and restricted means for entry and exit; is not designed for continuous employee occupancy" (p. 37). This definition should assist you to determine if that space you have meets the definition of a confined space. The employer is obligated to evaluate the workplace and identify all the confined spaces on the construction site. Once you have identified the confined spaces, you need to determine if any of the confined spaces meet the criteria of being considered a "permit-required confined space."

A permit-required confined space contains one more of the following characteristics: "contains or has the potential to contain a hazardous atmosphere (e.g. lack of/overabundance of oxygen, flammable gas, airborne combustible dust, carbon dioxide, any toxic or hazardous vapors)" (CFR 1910.1946 (c), p. 37). A permit-required confined space also can be defined as "any confined space that contains moveable material (e.g. coal, grain, cement, etc) that has the potential of engulfing grain silos, coal silos, cement hoppers, other moveable material (e.g., sewage, storm water piping and vaults which may flood in a rain event have to be considered)" (CFR 1910.146 (c), p. 37).

Likewise, when defining a permit-required confined space, it should possess 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" (CFR 1910.146 (c), p. 37). A few examples of "internal configuration" would be train hopper cars for grain, coal or any moveable material. Additionally, silos and temporary concrete batch plant silos would also incorporate some kind of a product release door at the bottom of the car or silo, which once activated by electric or hydraulic means, would open the doors and release the product.

The implementation of lockout/tagout system would have to be in place to render these systems inactive for a safe entry into the confined space as well as the use of a fall protection retrieval system to protect the entrants from engulfment. One must also determine whether or not the confined space contains any other recognized safety or health hazard. The confined space that has any or all of these conditions would be reclassified as a permit-required confined space. If your worksite has permit-required confined spaces, you must inform exposed employees by identifying these spaces. Identification of these spaces is accomplished by posting danger signs or any other equally effective means.

Exhibit 2. Identification of the permit-required confined space.

Now that the permit-required confined spaces have been identified, the question to ask is: does anyone have to access the space? If the answer is no, then identification of the confined

space and its location to potentially exposed workers has been done. If the employer decides that access will be made into a permit-required confined space either by his workers or a subcontractor's workers having to complete a task, the controlling contractor must have in place a written permit-required confined space program and implement the program. The initial questions to ask are; what is the task that has to be done in the confined space? Who is going to do it? What are the exposures that you can be reasonably be assured you will anticipate in the confined space? Have the workers been trained, and if not, what training needs to be provided to them to complete their work.

The CFR 1910.146 (d) states that a permit-required confined space program must contain the following measures:

(1) Implement measures to prevent unauthorized entry.

(2) Identify and evaluate the potential hazards.

(3) Develop and implement means, procedures and practices for safe entry operations. These should include but are not limited to:

What are acceptable conditions for entry?

Entrants shall observe testing of the confined space.

Isolating the permit space.

Purging, Inserting, flushing, or ventilating the permit-required space to eliminate or control the atmospheric hazards.

Providing external protection such as barriers to protect entrants from vehicles and pedestrians, and verifying that conditions in the permit-required space are acceptable throughout the duration of the authorized entry.

The CFR 1910.146 (d) (4) permit confined-space standard states the "equipment that shall be provided for permit-required confined space entry as follows: this equipment shall be provided at no cost to the employees and they shall be trained in its proper use" (p. 39). Furthermore "(i) the testing and monitoring equipment to evaluate the atmosphere in the confined space shall be a calibrated, direct reading instrument for oxygen content, flammable gases, and vapors and any other potentially toxic air contaminant" (CFR 1910.146, p. 39). Moreover, the testing shall be done in that order.

I recommend when you purchase this equipment that you consider a CGI four sensor gas detector indicating oxygen level, flammable gas, carbon dioxide and hydrogen sulfide. This should accommodate most confined-space entries in construction.

If you are aware of an additional gas or an atmosphere that you will encounter that is not one of the above gases, additional sensors or equipment may be needed. With the detector you should purchase the accessory battery charger with calibrating gas and bump kit. This will charge the instrument, bump it as needed, and calibrate it as needed. This is a purchase you won't regret and will make life easier for you and the confined-space entry crew in field.

In addition to the CGI you will need an entry permit form to log in the CGI readings and

the names of the entry supervisor, the attendant and entrants, as well as the duration of the entry permit and any other necessary information.

(ii) Once the testing is completed, you will need ventilation for the confined space. Ventilation options are as follows a blower (fan) with flex hose; you must decide the size of the blower and length of the hose dependent on your requirements. A blower is rated as to how much air it will push out or pull through the hose. This rating is a set amount of cubic feet of air per minute.

An example of this would be, you have welders in the confined space and you need two blowers and hoses pushing in fresh air and one pulling out the contaminates from the welding process. Be aware that every 90-degree turn in your hose reduces the cubic feet of air introduced into the confined space. If after giving a length of hose, the rating or cubic feet of air drops, inline blowers might have to be incorporated to bring the output back up.

Another ventilation option may be a fan. If a fan is used in the ventilation process, be sure that the fan is enclosed in housing (shroud) so the pulling and pushing of the air is directed and not lost out the sides of the fan. Fans (commercial and with shrouds) do have rated capacity of air moved per minute. In the ANSI A10.16-2009 Safety Requirements for Tunnels, Shafts and Caissons, an exchange of two hundred cubic feet of air per worker per minute must be maintained.

(iii)What are my options for communication with the workers in the confined space and the attendant at the entrance? If the entrant and attendant are close enough, it could be voice communication, or it could be the use of a line (rope) and a series of tugs on the rope to notify the entrants there is a problem and they should vacate the confined space. Radio (hand-held) communication is another option. If it is used it should be tested to make sure it works.

Additionally, a hard-wired miner's phone will also work in the longest of tunnels or deepest of shafts. These phones provide excellent communication from the attendant to the entrants. They are easy to retrieve at the conclusion of the entry and are dependable. Communicating a need to the entry crew to evacuate the confined space immediately could be accomplished by the use of air horn blasts or flashing red light, depending on the type and location of the confined space.

(iv) Permit-required confined space entry will require the use of personal protective equipment. The PPE includes but is not limited to hardhats, safety glasses, fall protection equipment, harness, lanyard, a tripod with the ability to retract workers out of the confined space (manhole) for vertical rescue, or wristlets for horizontal rescue and rope. In permit-required confined spaces with additionally recognized hazards on the job, you will have to take additional steps to ensure the safety of the entrants.

An excellent example of a permit-required confine space with additional hazards is the storm sewer entry in this presentation; the job was the relining of a storm sewer pipe system that was damaged and collapsing. The job required additional training for all the workers involved. The workers had to be 40-hour hazardous-waste-trained because of the identified hazards they would encounter in the pipe. In addition to the additional training, the hazards would require additional PPE and training in its use.

The job hazards that required additional PPE included chromium leaking into the storm sewer pipe from the ground surrounding the pipe through its joints and damaged areas in the pipe

wall; standing water in the pipe had a PH of 13. Protection from these hazards included plastic Tyvec suits, rubber boots, two pairs of rubber gloves, and PAPR full-face respirators, taped in by yellow chemical tape.

The next concern involving the use of PPE is the heat stress. For example, you're suited up in the tunnel and now have to lift 90-pound liner plates over your head in the August 98-degree Baltimore heat. In this situation heat stress is a genuine concern. Additionally, there is the threat of potential engulfment by water in a rain event. When it rains the pipe would more than likely fill up in a matter of minutes; flooding the outfall and storm sewer drain pipes. The workers working up to a thousand feet into the pipe would have to make a fast evacuation once notified the rain was coming. The workers would have to retrieve all their equipment, lights, Miners phones, etc. with them on the way out. We not only followed weather forecasts, but at the first drop of rain the workers were evacuated from the pipe.

Another safety precaution we incorporated to warn of a potential flooding event was the use of an auto dialer. This is a device which has a float that is lowered into the pipe a considerable distance away from the work area, but in the same pipeline as the workers, as the water rises in a dammed area below the storm drain. Once a certain level of water has been reached in the dammed area, the float activates an electrical device which makes a pre-programmed telephone call to the top attendant warning of the rise of the water with in the pipe system. This would result in immediate evacuation.

v) The use of lighting in confined-space entry is also highlighted in the Construction Standard CFR1926.56. Illumination in shafts, tunnels and general construction area lighting required is 5 foot candles. In a confined space the lighting utilized could be stringer lighting with cages on the bulbs which should be intrinsically safe if a flammable atmosphere potential is possible.

Area lighting could also be used. This could be quartz lights or hand- held light sources. If any of this type of lighting is utilized, incorporate GFCI inline circuit protection. If doing tunnel work and the operation is of long duration, the use of both miners head lamps as well as stringer lighting can be used; the head lamps can be recharged between shifts. In the pipe operation I mentioned, stringer lights were utilized as well as small head lamps that were obtained from a local sporting goods store or Wal-mart. These head lamps were lightweight and worked exceptionally well, providing a focus beam of light for the bolting up of liner plates which were used to resleeve the deteriorating pipe.

(vi) Equipment is crucial in providing extra protection for workers and others in the work zone area. The equipment they are using in the area around them can be utilized as barriers to keep vehicles and pedestrians from accessing the work area. A manhole cover may be several thousand feet away from the access to the outfall pipe. The manhole opening is covered by a fan which is used for ventilation, drawing air from the pipe opening ventilating the pipe tunnel. A generator is there to provide electricity to the fan.

This area is in the middle of a mile-square asphalt-paved lot. Barricades were placed enclosing all sides of the equipment to protect the ventilation gear and power source from truck traffic.

(vii) In addition the confined space may require ladders for access and egress into the confined space. The size of the manhole or access will dictate what you will have to use; evaluate each situation independently.

(viii)The use of rescue and emergency equipment also depends on your options for access. The pipe job previously mentioned had two independent access/egresses options: 1) manhole access, and 2) an outfall at the end of the pipe.

I was able to utilize ladders at the outfall pipe. which provided the entire entry crew fast exit from the permit-required confined space. The second access was through a restricted manhole using a tripod which was set up; this would only be used in an emergency, such as the outfall access option had been taken away.

The permit-required confined space standard mandates that the confined-space entry team address potential emergency response situations. The standard provides you with several options: external recue by the local fire department that is capable of confined space rescue and can provide it in a timely response; rescue by a rescue service provided on-site or they can respond in a timely manner, or rescue provided in-house by a trained, fully equipped and capable recue team.

The responders must be aware of how a worker will be rescued in your particular job site circumstances. They must be familiar with the equipment needed for the rescue and have practiced using the equipment in a mock rescue, such as practicing the use of a tripod and retrieval system.

The questions you will have to ask will be: a vertical rescue or horizontal rescue, and do I need wristlets and/or a harness? Is the worker going to be retrieved through a manhole by using a tripod and harness? Have they practiced using the tripod or can they walk out the outfall carrying an injured worker in a Stokes basket?

(ix)You must evaluate all your options and obtain the necessary equipment to be ready for any occurrence which might arise to your particular needs and exposure.

(5) While evaluating the conditions of the permit space, (i) it must have an acceptable entry condition prior to entry and continuously monitored though out the entry with your test monitoring equipment.(ii) You must also monitor as necessary; (iii) testing for oxygen, combustible gases, vapors and toxic gases in that order. (iv) Additionally, you must also provide each entrant the opportunity to observe the test monitoring. Reevaluating the permit space if requested by an entrant and providing the results of the testing must also be done.

(6) Place at least one attendant at the entrance of the permit-required confined space.

(7) If the attendant has multiple spaces to monitor, the means and methods for doing this must be identified.

(8) The persons with active roles in the permit space entry must be identified; entry supervisor, attendant, entrants, the person doing the testing etc.

(9) Develop procedures for summoning rescue and emergency services.

(10) Implement a system for preparation, issuance and cancellation of the entry permit.

(11) Develop procedures to coordinate entry operations.

(12) Develop and implement procedures for closing off the permit-required space and

cancellation of the entry permit.

(13) Review the entry operation when there is concern the entrants are not protected and revise as needed.

(14) Review the confined-space program and use retain the entry permits for 1 year.

(e) The permit system. (1) Before the entry is authorized the employee shall document all requirements of this standard have been met. (2) The entry supervisor shall sign the entry permit. (3) The entry permit shall be posted at the entry portal for all to see that pre-entry requirements have been met. (4)The duration of the permit cannot exceed the time it takes to complete the assigned work task.(5)The entry supervisor shall cancel the permit at the completion of the task identified in the permit or a condition arises not allowed under the conditions of the entry permit (6) The cancelled permit shall be retained for 1 year. (f) In the entry permit the following items must be identified per the standard. (1) The space to be entered (2) Purpose of the entry (3) Date and duration of the entry (4) The authorized entrants (5) Attendant's name (6)Entry supervisors name (7) Hazards of the permit space (8)Measures used to isolate the permit space and to eliminate or control the permit space hazards prior to entry.(9)The acceptable entry conditions (10)The results of the initial and periodic tests performed and the name of the individual performing the tests (11) The rescue and emergency services identified with contact numbers.(12) Communication procedures to be used by the entrants (13) Equipment used (14)Any other necessary information (15) Any additional permits needed (hot work permit).

Exhibit 3. Training on the standard and hazards.

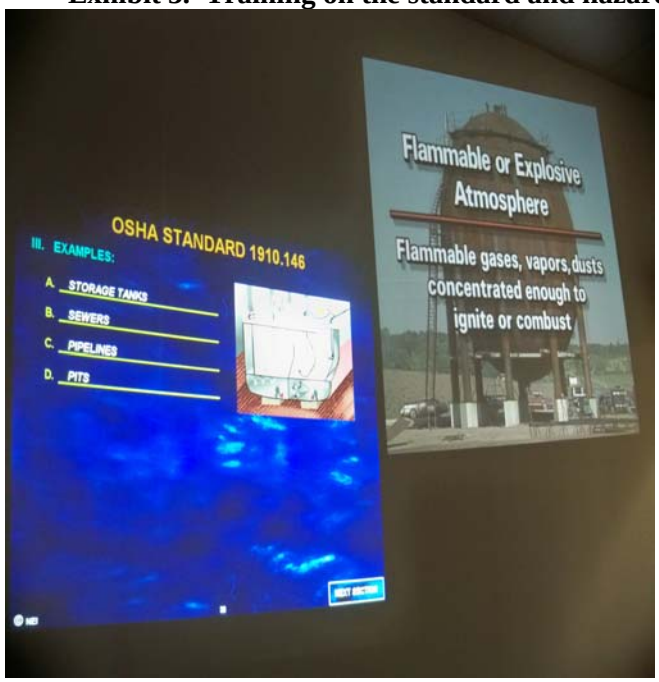

Exhibit 4. Equipment practice.

The employer will review the work of the employee to determine whether training is needed. If training is found to be needed, the employer will see to it that all employees are trained to the appropriate standards of confined space. In the training, the duties of each worker associated with the confined space entry are defined by the entry supervisor, the attendant and the

entrants. All aspects of working within a permit-required confined space are reviewed, hazards discussed, equipment gone over and practice using it, emergency procedures, rescue procedures reviewed etc. to name a few. The understanding of a permit-required confined space and the need to implement all the requirements of the standard will ensure a safe and successful confined-space entry.

Exhibit 5. Hard rock shaft and tunnel.

Exhibit 6. Ventilation and PPE.

Conclusion

Your knowledge of the requirements of the permit-required confined space standard will allow you make a more sound judgment call when it comes to evaluating a confine space entry. Remember if that permit-required confined space hazardous atmosphere can be controlled or eliminated; you may then reclassify it to a confined space and just monitor the space for any changes.

With regard to confined spaces in construction, the PowerPoint presentation will review three confined space entries.

Entry (1). This permit-required confined space entry was into a storm water drain. The confined space entry team not only had to be trained in permit-required confined space entry, but also were required to have the 40-hour hazardous waste training. The added training was required because of the hazards associated with working at this site.

Entry (2). The permit-required confined space entry was a vault located between the face of the Occoquan Dam, and the backside of the dam. The access to the permit-required confined space was through the feed pipe to the electric turbines

Entry (3). The confined space was the digging of a solid rock tunnel under a highway. To accomplish, this first a 20-foot shaft would have to be dug, then a liner plate tunnel dug in solid rock 100 feet long under a 4-lane highway.

Exhibit 7. Ventilation blower and hose.

Exhibit 8. 4-foot ventilation fan.