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CONNECTICUT DEPARTMENT OF LABOR DIVISION of OCCUPATIONAL SAFETY and HEALTH

Confined Space Entry: Case Studies Provide Valuable Lessons

The Occupational Safety and Health Administration (OSHA) defines and requires procedures to ensure safe entry into Permit-Required Confined Spaces. The following case studies, written by Timothy C. Healey and excerpted with permission from the May 2007 edition of Professional Safety: Journal of the American Society of Safety Engineers exhibit safe entry into confined spaces.

By following sound procedures at all times, confined space tragedies can be avoided. In 2005, inspectors from the Hartford Steam Boiler Inspection and Insurance Co. (HSB) performed nearly 9,000 confined space entries. To protect them against related hazards, all HSB inspectors must complete a rigorous 12-hour initial safety training course plus a 4-hour refresher course every 2 years. In addition, the company has a robust and mature safety and health manual that describes its safety standards and provides safe work practices and/or guidance. It is reviewed and revised annually and distributed electronically to all covered employees.

Even though more than half of HSB employees are exposed to significant industrial hazards, the corporate experience modification rate is 0.77 (a rate that is within the BLS statistical business group with the lowest injury, illness and fatality rates). Despite this enviable record, HSB continuously strives to be better. The case studies presented here highlight some lessons learned by the boiler inspection industry.

Industrial Boiler Steam Drum

Scenario: A small industrial facility had two water tube D-type boilers. One required an internal inspection while the other remained online. These boilers are approximately three stories tall with horizontally installed cylindrical steam drums approximately 15 ft long and 5 ft in diameter with domed/dished heads and manholes in each head.

The inspector had inspected this brand and type of boiler for several years, although not at this location. All site personnel were licensed and appeared to be running the plant well based on the inspector's initial impressions.

The boiler had been off-line for 2 days, lockout/tagout had been applied (per the chief engineer and confirmed by the inspector's spot check), and site personnel were observed working in the firebox under the permit issued the day before that described non-permit conditions.

Activity: The inspector and the chief agreed to start the internal inspection at the steam drum, which also was covered by the posted permit. Both entered the space and commenced the inspection.

After a few minutes of unremarkable findings, the inspector called for quiet as he proceeded to check his portable direct-reading atmosphere monitor. He then told the chief to follow him and exit the drum immediately.

When both were safely outside, the inspector continued to examine his monitor and determined it was not working properly. The chief procured another monitor, and a recheck of the atmosphere indicated oxygen readings near 19.5%. Forced ventilation was set up to vent the space and, after less than 10 minutes, it returned to normal levels.

Results: Neither entrant was injured. The inspector realized his monitor was not working properly after noticing erratic oxygen readings and no alarm. Subsequent servicing of the monitor found a suspect oxygen sensor. The inspection continued with a properly working monitor in a normalized atmosphere.

Conclusions: While not a regulatory requirement, constant monitoring is a good practice even during non-permit -required entries. Monitoring equipment must be maintained, calibrated and operating properly. In addition, instrument users must be trained to properly use and care for the equipment. In this case, a possible low oxygen exposure scenario was avoided because the entrants followed good procedures.

Boiler Furnace

Scenario: A large trash-burning steam generating facility that generated electricity was scheduled for an annual internal inspection, as required by state boiler inspection regulations. Following the site's established practices, the single boiler plant was shut down and cooled. In making the necessary arrangements to have the state boiler inspector or his representative conduct the internal exam, a question was

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raised about cleaning the ash and other combustion products off the tubes before the inspection.

Citing a short turn-around time allotted to placing the boiler back in service, plant management did not intend to do any cleaning except localized wire-brushing if something needed to be examined in greater detail. The inspector requested that the firesides be water-washed to remove the combustion products.

Activity: At the boiler house, the inspector and Point of Contact (POC) observed two employees inside the furnace. Both employees were wearing disposable hooded coveralls, filtering facemasks and atmosphere sampling gear.

The inspector questioned why the furnace tubes were covered with ash. He was told that the furnace had not been water-washed, but that two employees were standing by to perform wire-brush spot-removal of any ash as directed by the inspector.

The site's permit recognized the potential for the presence of arsenic, silica, lead, cadmium and mercury in the ash residue, as those are well known to exist as the result of burning trash or garbage. However, no documents indicated that personnel had checked for such substances.

The facility representative stated that the atmosphere was being sampled via the sampling pumps worn by the two employees. After the work was complete, the collected samples would be analyzed for the presence of those materials. The inspector declined to enter the furnace, deferring to a later time after the furnace had been water-washed.

Results: No entry was made, so there was no likelihood of exposure to any suspected or known hazards.

Conclusions: This case presented two matters of interest. First, merely testing the atmosphere at the time of entry to determine the level of known hazardous materials does not protect any entrants. Mechanical or abrasive removal of the combustion products will only release more of those materials into the atmosphere. Site representatives also stated that the entry personnel were already participating in medical monitoring programs because of the presence of these heavy metals and toxics.

Second, if the tubes are covered with the ash residue, the inspector would be unable to inspect the tubes themselves, which is what the applicable regulations, codes and standards require.

Utility Boiler Steam Drum

Scenario: A large electricity-generating facility maintained a specific large capacity boiler to operate only during periods of high load. When not online, a nitrogen blanket was maintained to prevent corrosion.

This utility boiler was six to seven stories tall, with a horizontally installed cylindrical steam drum 30 ft long and 7 ft in diameter with domed/dished heads and manholes in each head. The inspector had previously conducted inspections at this facility, and on this boiler and steam drum. He was also familiar with the on-site personnel and the site's confined space entry program.

Activity: The inspector and POC proceeded to the steam drum. The boiler was coming off lay-up. A manhole was observed to be open, and the POC tested the atmosphere using a calibrated monitor with 6 ft of hose. He reported that oxygen was in the proper range and that no flammable gases were detected. The inspector entered the drum. Once inside, he passed out. The POC, acting as the attendant/entry supervisor, summoned the site's rescue squad. The squad arrived on scene in break-out gear and helped extricate the inspector in a timely manner.

The inspector was administered breathing air by the rescue squad, which helped him regain consciousness and, thereby, help in his own rescue. Monitors used by the rescue squad registered oxygen as low as 12% inside the drum.

Results: The inspector was taken by ambulance to a local hospital and released later that day. He had a small contusion on his forehead and no other detected injuries.

Conclusions: A comprehensive written confined space entry program was in effect but was not executed properly. Familiarity with the site and the boiler/drum to an extent caused the participants to make too many assumptions. These assumptions include the following:

- failure to recognize the significance of a (standard) nitrogen gas blanket or purge having been in place prior to opening the cold boiler;
- failure to open both ends of the steam drum and force fresh air ventilation prior to any entry activities;
- failure to properly test/assess the internal atmosphere of the steam drum.

Connecticut Tree Protective Association and OSHA Renew Alliance

On July 19, 2007, the Alliance between the Connecticut Department of Labor, Division of Occupational Safety and Health (CONN-OSHA), the U.S. Department of Labor Occupational Safety and Health Administration (OSHA), Bridgeport and Hartford Area Offices and the Connecticut Tree Protective Association, Inc (CTPA) was resigned. This Alliance forms a collaborative relationship that will help promote safe and healthful working conditions within CTPA. CTPA members and others will be provided with information, guidance and access to training resources that will help protect employees' health and safety. Special topics include: Procedures followed when working in proximity to electrical hazards, chainsaw safety, avoiding motor vehicle accidents, proper job site planning, and safe climbing techniques.

What is a Permit-Required Confined Space?

Confined space entry is not limited to any one specific industry. From 2003 to 2005, sixty-one workers in America lost their lives to confined space accidents. Seventeen of these deaths occurred in the construction industry.

So, what is a confined space? 29 CFR 1910.146 provides the technical answer to that question. A Confined Space is any space that has the following characteristics:

- It is large enough or so configured that an employee can bodily enter and perform assigned work.
- It has limited or restricted means for entry or exit.
- Is not designed for continuous employee occupancy.

Now the question becomes, is the space a Non-Permit Confined Space or a Permit-Required Confined Space?

A **Non-Permit Confined Space** is a confined space that does not contain, nor has the potential to contain, any hazard capable of causing death or serious physical harm (with respect to atmospheric hazards). Examples of non-permit required confined spaces might include the interiors of HVAC units, certain air plenums and pipe chases, attics, walk-in freezers or refrigerators, and some building crawl spaces.

A **Permit-Required Confined Space (permit space)** is a confined space that is potentially hazardous. It has one or more of the following characteristics:

- Contains or has a 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 by a floor that slopes downward and tapers to a smaller cross-section; or
- Contains any other recognized serious safety or health hazard. Examples of serious safety or health hazards might include: fall hazards, unguarded machinery, extreme heat or cold, steam pipes or chemical lines, hazardous noise levels, electrical hazards, presence of asbestos, potentially hazardous levels of dust (such as might occur at a Feed Mill)

Permit Spaces have very specific entry requirements which can be found on the OSHA web site at: http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9797

CONN-OSHA ~ Training Update...

Breakfast Roundtable This discussion group will next meet on September 18th from 8:15 am to 9:45 am. Pre-registration is required. To be placed on the e-mail distribution list, call John Able at (860) 263-6902 or email able.john@dol.gov

OSHA Requirements for Fall Protection and Scaffolding **August 15 from 8:30 – 11:30** This training class will discuss the OSHA requirements for fall protection and scaffolding on construction sites.

The Control of Hazardous Energy (Lockout/Tagout) ***August 23*** This workshop covers the requirements in 29 CFR1910.147 The Control of Hazardous Energy (Lockout/Tagout). This introductory class will take you through the various required sections of an effective written lockout/tagout program from beginning to end. If you are new to lockout/tagout this class will give you the basics you need to know to get your program running. **This class will be held at 38 Wolcott Hill Road, Wethersfield, CT, from 9-12. For directions contact Catherine Zinsser at 860-263-6942.**

Chemical Hazard Communication ***September 13*** Employees will be better able to take steps to protect themselves when they know what the hazards are and how to avoid exposure. This session will help attendees develop an effective Hazard Communication Program.

OSHA 300 Recordkeeping ***September 21*** At this workshop you will learn how to fill out the OSHA Log of Work-Related Injuries and Illnesses (Form 300) accurately and correctly.

Classes are free and held at 200 Folly Brook Boulevard, Wethersfield, CT in Conference Room A/B from 9 am - 12 noon, unless otherwise noted in the class description. To register, contact John Able at (860) 263-6902 or able.john@dol.gov. **Pre-registration is required**. For more training information, visit www.ctdol.state.ct.us/osha/osha.htm .

Connecticut Department of Labor - OSHA
38 Wolcott Hill Road
Wethersfield, CT 06109

To receive the *Quarterly* electronically, contact gregory.grayson@dol.gov. In the subject line type *"subscribe"* and provide your e-mail address. You may also reach us by phone at (860) 263-6900 or visit our website at http://www.ctdol.state.ct.us/osha/osha.htm

Hazard Corner…

According to the National Institute for Occupational Safety and Health (NIOSH), more than 60% of confined space fatalities occur among would-be rescuers. One such incident claimed four lives, three of which were rescuers.

The tragic incident began when two sewer workers entered a 50-foot deep underground pumping station via a fixed ladder. The pumping station measured 8' x 8' x 7' and the metal shaft was three feet in diameter. The ventilating fan was not functioning and neither worker was wearing personal protective clothing or equipment.

The two workers were unaware of procedures to isolate the work area and ensure that the pump had been bypassed. Therefore, the transfer line was still under pressure when they removed the bolts of an inspection plate. The force of the wastewater blew the plate off, allowing raw sewage to flood the chamber and overwhelm one of the workers. The second worker exited the pumping station and radioed the police department requesting assistance. He again entered the station and was also overcome.

Two police officers responded to the call and one officer entered the pumping station. The sewage systems field manager arrived on the scene and followed the officer into the pumping station. None of the rescuers returned to the top of the ladder. A construction worker, who was passing by the site, stopped and entered the station in a rescue attempt. After descending approximately 10 feet into the shaft, he called for help. The second police officer assisted the construction worker out of the shaft. None of the responding men wore respirators.

Eleven minutes after the incident began, fire department personnel arrived at the accident and attempted rescue with self-contained breathing apparatus (SCBA). However, the bulkiness of the equipment prevented them from accessing the workers. One of the firefighters became lodged in the shaft, but was unharmed.

No further rescue attempts were made until professional divers entered the station and removed the bodies. Autopsy results revealed that the two sewer workers drowned and the police officer and manager were asphyxiated by “sewer gas.

This tragedy occurred in 1985. It was investigated using the Permit-Required Confined Space (PRCS) entry practices in effect and the following recommendations were made. Current PRCS entry practices and procedures would have prevented those events.

Recommendations/Discussion:

Recommendation #1: Employers should develop proper work procedures and should adequately train employees to maintain and repair the sewage system. This training should include recognition of potential hazards associated with failures within those systems.

Discussion: The sewer workers did not have an understanding of the pumping station's design; therefore, mechanical failures and hazards associated with those failures were not adequately identified. Records were not kept of mechanical failures or repairs. The sewer workers "believed' that a malfunctioning valve had previously been repaired. This valve permitted the pumping station to flood. The lack of training resulted in the employee not being able to properly isolate the work area from fumes and sewage seepage.

Recommendation #2: Employers should develop comprehensive policies and procedures for confined space entry.

Discussion: Prior to confined space entry, all procedures should be documented. All types of emergencies and potential hazardous conditions should be addressed. These procedures should minimally include the following:

- Air quality testing to assure adequate oxygen supply, adequate ventilation, and the absence of all toxic air contaminants;
- Employee and supervisory training in the selection and usage of respiratory protection;
- Development of site-specific working procedures and emergency access and egress plans;
- Emergency rescue training;
- Availability, storage, and maintenance of emergency rescue equipment.

The air quality was not determined before the sewer workers entered the confined space and the ventilation system was not functioning properly. One respirator was available for use; however, it was not appropriate for the chemical contamination (sewer gas) present. Life lines were not available. Once confined space pre-entry procedures are developed, employees should be trained to follow them.

Recommendation #3: Firefighters, police officers, and others responsible for emergency rescue should be trained for confined space rescue.

Discussion: A police officer died in the rescue attempt of the sewer workers. The police officer was not trained in confined space rescue techniques and did not recognize the hazards associated with the confined space. The volunteer fireman, who attempted the rescue and wedged himself inside the shaft, should not have been allowed to enter. His size alone created a potential hazard for himself and the incident delayed possible rescue of the victims. Emergency rescue teams must be cognizant of all hazards associated with confined spaces, including rescue hindrances, and they should wear proper personal protection and devices for emergency egress.

Adapted from NIOSH’s FACE report #8531. The full article may be viewed at:
http://www.cdc.gov/niosh/face/in-house/full8531.html

Fatality & Casualty Reporting

State & Town: CONN-OSHA (860) 263-6946 (local) or 1-866-241-4060 (toll-free)
Private Employers: Report to Federal OSHA at 1-800-321-OSHA(6742)