

## **Selected Case Studies in Confined Space Entry**

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### **Introduction**

The Hartford Steam Boiler Inspection and Insurance Company was founded in 1866 and is one of the world's leading specialty insurers and reinsurers. We are a global provider of:

- equipment breakdown insurance products;
- other specialty insurance and reinsurance products;
- inspection services and engineering consulting.

Our staff includes authorities in electrical engineering, mechanical engineering, fire protection, nondestructive evaluation, transformer testing, welding, the ASME Code, refrigeration and other specialized disciplines.

In 2008, our Engineering Inspectors made over 9,000 documented confined space entries. All of these took place on customer facilities. In spite of the inherently hazardous work involved in conducting confined space entries, our Experience Modification Rate (EMR) is an enviable 0.58 within the insurance carrier industry group.

This was achieved in part due to our safety training, which is based on our *Safety & Health Manual*. Distributed via our intranet, our Manual is reviewed annually to include any regulatory revisions, incorporate new best practices, and other safety program elements that have been introduced during the preceding year.

Finally, our authorized inspectors go through a vigorous 12-hour initial safety training course, followed by periodic refresher training courses plus any specialized training when needed. Their training includes such topics as defensive driving, lockout/tagout, hazard communication, personal protective equipment, electrical safety and, of course, a focus on confined space entry.

### **About the Case Studies**

Sources for these cases include public records, industry reports, commissioned inspector

interviews or witnesses accounts. The identities of any companies or individuals have been removed. It should not be assumed that these scenarios stem from HSB activities.

### Disclaimer

The findings, conclusions, recommendations and comments offered in this presentation are those of the author and do not necessarily reflect those of HSB or MunichRe Americas.

## **Case Study Number 1**

### **Large Utility Boiler Steam Drum Entry; CO Gas alarm**

**Scenario:** A large, fully integrated mill in the Midwest has a large powerhouse with six water tube boilers. The boilers provide high-pressure steam to drive turbine-driven generators and turbine-driven blowers for the blast furnace. The boilers are a standard design approximately 8 stories tall with horizontally installed cylindrical steam and mud drums. Primary fuel is blast furnace gas, which has a high CO content, with fuel oil and natural gas as back-up. The Inspector had conducted inspections at this facility for several years. He was also familiar with the on-site safety procedures and followed the guidelines of the site's confined space entry program.

**Activity:** The Inspector met with the designated Point-of-contact and discussed the scope of work for the annual boiler outage. Due to the potential hazard of CO gas, all personnel entering the internal surfaces of the boiler were required to carry an emergency escape respirator which provided adequate oxygen supply to safely exit the power station in event of an excess CO gas level. The inspector had been trained in the site's blast furnace gas safety program and was very familiar with the emergency procedures.

The boiler had a valid confined space entry permit for the day shift since there were various ongoing tasks for the outage. This includes continuous CO monitoring throughout several levels areas of the boiler and power station.

The Inspector and his designated attendant entered the power station and proceeded to sign in at the control room. After completing the lockout tag out checks, the Inspector and his POC completed a secondary atmosphere check of the steam drum with a portable confined space monitor.

When the POC declared oxygen and CO gas to be in the proper range as well as no flammable gases detected, the Inspector entered the drum. About half way through the drum, an alarm on his portable gas monitor alarm went off indicating a high level of CO gas (54 ppm). Per the Plant's Written Procedure, the Inspector exited the drum and proceeded to exit the power station with his POC. The Inspector and his POC went back to his office adjacent to the power station to await the all clear signal to continue the inspection.

Approximately 15 minutes later, a rather irate Rescue Squad member entered the office and proceeded to scold the POC regarding the failure to follow emergency procedure. Since they had signed in to do the inspection, the Inspector and POC were required to go to a designated area when the alarm sound to ensure all personnel had exited the power station safely and no search and rescue would be required for unaccounted personnel.

**Results:** The POC was subject to a written disciplinary warning. The inspector was required to complete the blast furnace gas safety program before any future inspections could be completed.

**Observations:** A comprehensive written confined space entry and blast furnace gas safety program was in effect but not executed properly. The POC became complacent with his daily routine to the extent that too many assumptions were made, consciously and subconsciously, by the participants. The inspector similarly failed to follow the procedure even though he was informed and trained on it.

**Conclusions:** Familiarity breeds contempt. Failure to follow proven, written and safe work procedures. The inherent value of any good procedure is useless if it is not followed.

## **Case Study Number 2**

### **Boiler Entry and the Absent Attendant; Near Miss**

**Scenario:** A large, well-managed chemical facility in the Northeast required an internal inspection of one of their Power plant boilers. This is a typical large, industrial water tube boiler: approximately 6 stories tall with a cylindrical steam drum approximately 30 feet long and 6 feet in diameter with domed/dished heads and manholes in each head. The mud drum was similar but slightly smaller in dimensions. The attending inspector was very experienced in the operations at the facility with extensive site specific safety training received on an annual basis. He had previously conducted inspections at this facility and was familiar with the on-site confined space entry program.

**Activity:** The inspector arrived on site at 10:30 a.m. and met with the designated Point-of-contact and proceeded to the steam drum for this annual inspection. The boiler was shut down and properly prepared for inspection. Both manholes were observed to be open, and the results of the site's atmosphere check using a calibrated monitor were posted. A designated attendant was stationed at the entrance manhole.

The scope of the inspection also included taking thickness readings on the internal surfaces of the steam drum walls. The Inspector made the entry into the steam drum and had a substantial amount of equipment, including flashlight, digital camera, portable confined space monitor and a UT digital thickness meter.

After completing the steam drum inspection, the inspector began to reach out the end of the steam drum to hand the attendant his hand tools. After noting the attendant wasn't outside the drum, he called for the attendant for assistance in removing the equipment from the drum so he could exit the space. . There was no reply to his repeated calls. At this point, the inspector carefully maneuvered out of the space. There was no one else present in the area.

**Results:** The inspector went directly to his point of contact's office and reported the above facts. He was also in violation of the site (as well as his own company) policy by being unescorted at this site.

**Observations:** Comprehensive written confined space entry and safety program in effect but not executed properly. A scheduled lunch break apparently took precedence over the attendant's confined space entry duties. Insufficient supervision was present.

**Conclusions:** Failure to follow proved, written and safe work procedures (attendant). Failure to consider hazards not specifically addressed in a written plan (Supervisor).

### **Case Study Number 3**

#### **Boiler Furnace Entry; Fall Injury**

**Scenario:** The location was a large primary metals mill. In their powerhouse was a large, three-drum water tube boiler providing steam to drive turbine-driven blowers and turbine generators. These blowers supply air to the mill's two blast furnaces, and the generators provide electric power for mill operations. The boiler was idle and all water side and fireside (furnace) access covers were opened for routine maintenance and inspection. The boiler had been fully prepared for inspection by draining all water from the boiler and applying the required lockout/tagout in accordance with mill procedures. Ventilation was provided for comfort purposes only.

**Activity:** The Inspector arrived on site to conduct the inspection of the boiler. After meeting with mill personnel to discuss upcoming maintenance to the boiler the Inspector began the inspection of the boiler.

The Inspector, an escort, and the representative from the water treatment firm conducted inspections of the boiler waterside areas. Following the waterside inspection the three began to enter the boiler furnace. The furnace access opening was located at floor level in the powerhouse. The opening, approximately sixteen inches square is approximately thirty-six inches from the furnace floor. The mill escort entered first followed by the water treatment firm representative then the Inspector. The Inspector entered feet first and felt with his feet for the top rung of the ladder that should have been present. Instead of a ladder, three plastic milk crates had been stacked to provide entry. When the Inspector's feet were placed on the milk crates they gave way and the Inspector fell to the furnace floor hitting his head on the furnace wall and floor.

**Results:** Temporarily stunned, the Inspector was assisted from the furnace by the water treatment firm representative. Following a brief examination by mill's in-house nurse he was advised to visit his personal physician. The next day the Inspector visited his physician who order x-rays and determined that the Inspector suffered a mild concussion.

**Observation:** Improper and inadequate preparations were made for furnace entry. The Inspector did not visually examine the means of entry to determine its' safety. Had the Inspector done so, he should have seen that it was unsafe and would have required that proper preparations be made for entry.

**Conclusions:** Inadequate preparation by mill personnel. Failure of the Inspector to fully evaluate hazards associated with ingress/egress. Consider the complications had this taken place at the (elevated) steam drum level while entering from a ladder.

### **Case Study Number 4**

#### **Multiple Employers; Equipment Issue**

**Scenario:** A large basic metals plant in the Midwest required an internal inspection of one of their Power plant boilers. This is a typical large, industrial water tube boiler: approximately 5 stories tall with a cylindrical steam drum approximately 25 feet long and 7 feet in diameter with domed/dished heads and manholes in each head. The furnace, or Firesides, was approximately 20 feet by 20 feet square, with the ceiling tubes starting about 18 feet overhead and angling upward to approximately 35 feet over the furnace floor. The attending Inspector was very experienced with this plant's operations, noting extensive inspection work and training there for over 20 years.

**Activity:** The Inspector met with the designated POC. He was also introduced to a Third Party Representative who had been hired by the facility to oversee and prepare all confined space's for entry throughout the plant. This was a new arrangement. For this requested inspection, the boiler had been shut down and was cooled ("Cold Iron"). All manholes and burner assemblies were observed to be open or removed so as to facilitate ventilation and access. The results of the Third Party's atmosphere check using a calibrated monitor were posted. Several personnel were observed to have entered and left the drum and the furnace during the Inspector's Briefing with the Third Party Entry Supervisor. An Attendant was stationed at the entrance manhole. The conditions found met the standard for a Non-Permit Required Confined Space Entry.

The Inspector's employer requires that he have on his person his company-issued, calibrated, direct-reading atmospheric monitor for every confined space entry. This procedure provides the Inspector the earliest possible warning of any changes in atmospheric conditions. When this was explained to the Third Party, they initially refused permission to even allow the presence of another monitor. The Third Party eventually relented, but required that the Inspector's monitor be 'bump tested' by them prior to breaking the plane. This was done, and the monitor was deemed to be unacceptable based on the Third Party Technician's say-so. The Inspector was afforded the use of an alternative instrument to conduct the inspection. He subsequently shipped his employer's monitor to their servicing facility for repair. The instrument was evaluated at their Lab and found to be fully functional.

**Results:** A serviceable instrument was unnecessarily removed from service after being exposed to non-standardized calibration gases. The useful lifetime of the instrument's sensors may have been compromised.

**Observations:** Improper surrender of an instrument to an outside party. The Bump Test was not conducted in accordance with the manufacturer's guidelines (different brand).

**Conclusions:** The Plant did not have effective controls in place over their Third Party Confined Space Contractor. The Contractor overstepped the bounds of good safety practices by demanding to service an instrument for which they were not trained. The Inspector should not have surrendered his employer's instrument to them for testing.

## **Case Study Number 5**

### **Boiler Steam Drum Entry/Exit; Incident**

**Scenario:** A West Coast facility had one boiler in a bank of two boilers open and prepared for the Inspector's internal examination while the other boiler continued on-line supplying the facility's steam. This is a D-Type water tube boiler; approximately 3 stories tall with a horizontal cylinder steam drum approximately 15 feet long and 5 feet in diameter with domed/dished heads

and manholes in each head. The attending Inspector had conducted inspections at this facility and on this boiler and steam drum several times over the preceding several years. The Inspector was also familiar with the on-site safety rules and the personnel with whom he worked under the guidelines of the site's confined space entry program previously, except for one new engineer. A routine internal inspection of the steam drum was scheduled.

**Activity:** The Inspector met with the designated POC and proceeded to the steam drum. The boiler was shut down and cool ("Cold Iron"). The manholes were observed to be open, and the POC had previously tested the atmosphere using a calibrated monitor. Site personnel had previously entered the drum and were observed exiting while the Inspector was on site. Full body harnesses with retrieving lines were employed per the facility's rules in spite of minor objections from the Inspector that the retrieval lines were always getting hung up and created an entanglement hazard. The new engineer and the Inspector entered the drum. Once fully inside, the Inspector satisfactorily completed the inspection. When preparing to exit back through the same manhole through which they had entered, the Engineer's retrieval line hung up on an internal fitting. The Engineer could not move and then panicked, his violent movements worsening the situation. The Inspector's retrieval line simultaneously became stuck, so he unbuckled his harness, removed it, and then proceeded to calm the Engineer and talk him through unbuckling and removing his harness. Both men then exited safely.

**Results:** No apparent injuries, no first aid or medical support was required.

**Observations:** A comprehensive written confined space entry program was in effect and executed, but the hazard assessment component and site program rigidity did not adequately address the entanglement hazard. Timely response by the Inspector overcame the new Engineer's panic.

**Conclusions:** Site's confined space program was perhaps too rigid with regard to the mandatory use of harnesses/retrieval lines. How is entrant extraction accomplished in a horizontally-configured confined space using the retrieval systems discussed in 29 CFR 1910.146(k) and the Appendices? Don't underestimate the power of claustrophobia: mental fitness is as important as physical fitness.