

Fatality Investigation Report

OR 2003-22-1

Shipyard welder ignites hydraulic fluid and is fatally burned

Summary

A 48-year-old shipyard welder was injured and died 62 days later from burns she sustained when her wire fed welder ignited atomized hydraulic oil. She was using a self-propelled elevating work platform (high lift) to weld above her head on a barge undergoing renovation/repairs. Fire investigators theorize that a small pinhead leak developed in the lines while the victim was welding. This leak allowed the pressurized hydraulic oil to escape and atomize into the immediate work area. Sparks from the welding process were the ignition source. There were no eyewitnesses to the incident. However, it is estimated that the victim was exposed to the flames for between 2-4 minutes. Coworkers were successful in extinguishing the fire but the victim sustained burns to (80%) of her body and critical inhalation injuries to her airways and lungs. The victim was airlifted to a local hospital's burn unit where she remained in critical condition until her death.



Figure 1: Hydraulic lines in high lift work location.

Recommendations:

- ✓ Employers and employees should assure that equipment is appropriate for the task and maintained to manufacturer's specifications.
- ✓ Daily checks of all hydraulic equipment should include inspection of hydraulic hoses and connections.
- ✓ Hydraulic lines should be relocated and protected from physical damage.
- ✓ Check all safety equipment and ensure that it is operational, appropriate for the task and that employees know and understand how to use it.
- ✓ Employers should maintain a current list and copy of MSDS's for the chemicals in use in the work place, and employees should be appropriately equipped and trained for emergency response.

Introduction

On February 18, 2003, a 48-year old female was injured when sparks from her wire-fed welding gun ignited atomized hydraulic fluid. OR FACE investigators were initially notified of the incident on April 4, 2003. On August 20, 2003 the Oregon State Fire Marshall's office confirmed that the worker died as a result of her injuries on April 21, 2003. The OR FACE investigator went to the company site but was not permitted access to the incident scene. The employer has since ceased doing business. The death certificate, fire investigation report and Federal OSHA investigation reports were obtained during the course of the investigation.



Figure 2: High lift used in the incident.

Shipyards employers fall under Federal OSHA jurisdiction in Oregon. Federal OSHA investigated this incident but did not issue any citations. Federal OSHA reports that there have been three fatalities at this company, including this incident, in each of the years, 1999, 2002 and 2003. The Federal OSHA office supported the OR FACE investigation and findings.

Investigation

The incident occurred while the victim was welding on an ocean going barge that had been placed in dry dock for renovation. The mid portion of the barge had been removed and the company was in the final stages of welding two "skegs" (large rudder-like extensions) onto the barge's stern section. The company employed 40 employees. The victim was an experienced welder, according to her immediate supervisor. The OR FACE investigator was not provided with an opportunity to review the company's safety program to ascertain if the program addressed issues related to this fatality.

Documentation in the investigation conducted by Federal OSHA indicates that employee safety training was performed. Workers are unionized and segmented into specialized crafts, (e.g., boilermakers, pipe fitters, carpenters, etc.). Material Safety Data Sheets (MSDS's) were available to employees, however the MSDS for the hydraulic oil does not mention potential fire hazard if the oil



Figure 3: Barge in dry dock.

is atomized in the presence of an ignition source. It is not known if a risk assessment or job hazard analysis had been completed.

The victim was an experienced welder and had signed a document on January 29, 2003, indicating she had been trained to operate forklifts. The involved lift was used as a welding platform since it was purchased as a used unit in 1998. It had been used for three weeks by other welders on the same barge the victim was working on. Coworkers reported that the engine ran roughly and the victim had reportedly complained to a coworker that she had injured her back earlier while using this high lift when it suddenly and unexpectedly dropped approximately 8 feet while she was in the cage. The sudden drop incident was allegedly reported to the Job Foreman, but the unit was not taken out of service according to a coworker and it is not known if any repairs were made. Written responses to maintenance requests were “sketchy” according to Federal OSHA compliance officers on scene, and as a result the maintenance history on this high lift is incomplete. The high lift was equipped with a man-rated work platform and the victim was tied off on the day of the incident. Hydraulic lines were exposed beneath the floor grate of the work platform and inside the central console. A portable wire-fed welding unit was in the workers area on the platform and at elevation with the victim. During the conflagration, the worker fell to the floor of the platform. Co-workers on the scene reported that the fire re-ignited on its own at least once before the victim could be lowered to the ground and extricated from the cage. Lowering the platform was delayed due to confusion regarding the location and operation of the emergency valves on the high lift.

Cause of death: Sepsis, secondary to full thickness burns over 80% of her body.

Recommendations/Discussion

Recommendation #1. Employers and employees should assure that equipment is appropriate for the task and maintained to manufacturer's specifications.

Discussion:

The job foreman requested that welding be done from staging, not from a high lift. Staging is preferred according to the job foremen and supervisor of the victim. The job foreman cited the age of the high lift (built in 1977), increased stability provided by staging and generally a poor equipment maintenance history by this employer as reasons for why he requested staging. Staging is constructed by carpenters and would've added an additional cost (as much as \$6,000 on this job according to the supervisor). Both port and starboard sides aft would have required that staging be installed, removed and reinstalled with the installation of each skeg. The supervisor directed the use of the high lift because of its mobility and flexibility and previous use of the high lift without incident.

Equipment should be maintained in the original manufacturer's configuration. Employers should consult operational manuals to ensure all guards are installed and equipment is maintained to manufacturer specifications. Equipment manufacturers build equipment for anticipated uses but the actual work setting may be very different from that of equipment design. Employers should perform a job hazard analysis to ensure that equipment and its design are appropriate for the potential hazards likely to be encountered in the work area.

The product safety representative researched the history of this model and believes a shield was originally installed over the central console to protect the hydraulic lines present. No shield was in place over the central console on this high lift on the date of the incident. In addition, hydraulic lines were routed through the floor to valves in the console area and were exposed to potential physical damage presented by the work being performed on the workers platform. The cavity in the operators console should have a metal guard installed over it to prevent damage to the hydraulic lines contained within.

When making substantial modifications to equipment, first consult with the manufacturer to ensure that there is agreement with the proposed changes. If a potential problem with the equipment design is identified, the manufacturer may be able to issue a product safety bulletin to all registered owners.

Recommendation #2. Daily checks of all hydraulic equipment should include inspection of hydraulic hoses and connections.

Discussion:

Hydraulic lines should be checked daily for signs of wear, aging or damage. All fittings should be checked for leakage. A crack or small leak is an indication of a potential hose failure. Softened hoses, cracking or damaged lines need to be replaced. Product manuals do not state that hydraulic lines need to be changed on a periodic basis, only that they should be replaced when they show signs of aging or failure. Detailed maintenance records should be maintained on all equipment. In this case, mechanics written responses to work were often not documented, according to Federal OSHA compliance officers.

Fire investigators theorize that hot slag from the welding operation may have caused a pinhole size leak in the braided steel reinforced hose(s). It is also possible that other reasons exist for the failure of the hydraulic lines; e.g., defective hoses, overuse failure, age, and sudden catastrophic failure. The actual reason for hose failure is uncertain. It seems likely that a leak developed allowing oil to escape under pressure and in the presence of an ignition source cause a fire that resulted the victim's death.



Figure 4: Exposed hydraulic lines under grating of work platform.

Recommendation #3. Hydraulic lines should be relocated and protected from physical damage.

Discussion:

Hydraulic lines should be routed so that they are protected from hazards created by the work process and from physical damage. Hydraulic lines on the high lift were routed up through the floor of the cage into the worker area. The floor to the cage was an open grating (see Fig. 4). The proximity of the work area to the hydraulic lines demonstrates the concern to physically protect the lines. Open gratings cannot prevent hot slag from coming into contact with the hoses. Co-workers indicated that fire blanket material had been used in the past to act as a protective physical barrier between the hydraulic lines and the work being performed from inside the cage. Employees reported that they had routinely applied fire blanket materials over exposed hydraulic lines to protect them from the physical hazards present in the work environment, in the past.

Exposed hydraulic lines need to be protected from physical wear and tear of every day use by a means that is appropriate, based on the employer's assessment of risk. Fire blankets help to protect the lines from physical damage and may serve to deflect hydraulic oil spray in the event of a similar catastrophe. The victim had used fire blankets in the past, but not on the day of the incident. It is not known why fire blankets weren't used on the day of the incident. Management was apparently unaware of the use of fire blankets, or their need, to protect the equipment from welding operations.

Figure 1 on the first page shows the remnants of a hydraulic line connection inside the worker's platform. The hoses are gone and only the braided steel reinforcement remains. It is believed that an initial break caused the hydraulic fluid to "spray" out under line pressures (up to 1800 p.s.i.) and become the fuel that kept supplying and re-igniting the victims' clothes.

Recommendation #4. Check all safety equipment and ensure that it is operational, appropriate for the task, and that employees know and understand how to operate it.

Discussion.

When co-workers attempted to apply water on the worker at the working height of ~11 ft., above the deck of the dry dock, it is reported that the water hose to be used for this purpose was 15-20 feet too short and at first too little water pressure was applied and didn't reach the fire. Pressure was increased and the coworkers were able to extinguish the fire from below. At the same time, workers were also coming to the fire from the top of the barge with fire hoses. Working together they were able to put out the fireball, however, the fire re-ignited. A second attempt at extinguishing the fire was successful and this time the fire remained out.

The employer should test emergency response procedures regularly. Employees should practice how to use equipment needed in an emergency, before it is necessary to do so. Employees are reported to have bypassed a closer charged fire hose, only to return with an uncharged hose that was too short to reach the scene, according to the OSHA investigator. Employees should also be made aware of emergency systems placed on equipment, i.e., high lift, so that the man-rated platform can be lowered by anyone. Once the hydraulic oil was depleted, the platform did not lower to the deck of the dry dock but remained in position and it was several minutes before other workers were able to lower the worker cage so that the victim could receive first aid.

Recommendation #5. Employers should maintain a current list and copy of MSDS's for the chemicals in use in the work place, and employees should be appropriately equipped and trained for emergency response.

Discussion:

An MSDS for the hydraulic oil was obtained. It was dated 1/1/1994. There was no mention regarding the potential risk if hydraulic fluid is atomized and exposed to an ignition source. Generic precautionary statements are made regarding segregation of the oil from sources of heat. A number of chemical constituents listed are either flammable or combustible, however they are in low concentrations.

Employers should maintain a current copy of all MSDS's on site and make them available to all employees. Employees who work with any chemicals should be aware of the location of the product MSDS and how to read and understand an MSDS. Safety plans should address how to respond to emergency situations arising from hazardous substances used in the workplace, and emergency responders should be appropriately equipped and trained for these activities.



Figure 5: Photo of the manlift involved in this incident.

For More Information

The Center for Research on Occupational and Environmental Toxicology at Oregon Health & Science University performs Fatality Assessment and Control Evaluation (FACE) investigations through a cooperative agreement with the National Institute for Occupational Safety and Health (NIOSH), Division of Safety Research (DSR). The goal of these evaluations is to prevent fatal work injuries in the future by studying the working environment, the worker, the task the worker was performing, the tools the worker was using, the energy exchange resulting in fatal injury, and the role of management in controlling how these factors interact.

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