Pipefitter Burned When Soldering Torch Fails

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On June 9, 2006, at the Los Alamos National Laboratory (LANL), a pipefitter working for the support services subcontractor (KSL) received first- and second-degree burns when his acetylene torch failed and flames engulfed his left hand. The pipefitter was soldering sections of copper pipe when the accident occurred, and was not wearing flame-retardant gloves. (ORPS Report NA--LASO-LANL-TA55-2006-0012; final report filed September 6, 2006)

An integrated work document (IWD) had been prepared for removing old piping and installing new piping underneath a glovebox. Two pipefitters attended a pre-job briefing and discussed the task. Their PPE included one pair of anti-C coveralls, two pairs of booties, and one pair of surgeon's gloves. The IWD included a spark and flame permit that required a fire watch. One of the pipefitters performed this function while the other one soldered the pipe connections. The pipefitter used an air-acetylene torch package that consisted of a TurboTorch®, a small bottle of acetylene with a regulator, and a section of gas hose (Figure 2-1). A closeup of the torch head is shown in Figure 2-2.

The pipefitter held the torch in his left hand and the solder in his right hand as he worked in the small, difficult-to-work-in space beneath the glovebox. As the work progressed, the fire watch heard a "pop." He then heard the pipefitter say that his hand was on fire and that flames coming from beneath the hose had ignited the base of the torch. The fire watch immediately kinked the hose to cut off the gas to the torch and turned off the regulator at the tank.

Figure 2-1. Acetylene bottle, regulator, hose, and torch head

Figure 2-2. Torch head and hose connection to the acetylene bottle

When the pipefitter pulled off his surgeon's gloves, he saw that the left glove was blackened, but had not failed (Figure 2-3), and the right glove was not significantly marked. Investigators believe the burns on the thumb, middle, and little finger of the pipefitter's left hand were caused by sweat in the glove that was turned to steam by the heat of the flames.

KSL management appointed a team to investigate the incident. They determined that the incident was caused by a loose hose connection on the torch head that allowed acetylene gas to escape and ignite (Figure 2-4). The hose connection did not have an engineered locking device to ensure the integrity of the connection.

The TurboTorch manufacturer's instructions required performing a leak test and tightening any loose connections, but those instructions were not included in the KSL work instructions.

Because the torch lacked an engineered locking device at the hose connection, the manufacturer-recommended controls were inadequate to prevent recurrence of this type of failure.

Figure 2-3. Pipefitter's blackened left glove

Figure 2-4. Closeup of hose connection at torch valve torch

The KSL general manager directed that all torches of this design (i.e., single-hose, air-acetylene) be removed from service. Two-hose oxyacetylene or disposable propane bottle torches will be used instead.

The KSL team also determined that the PPE used for the job was inadequate in that only surgeon's gloves were being worn for radiological protection, rather than leather or flame-retardant gloves, which would provide thermal protection. Although LANL's implementing requirement for PPE required the use of gloves to protect against potential tissue burns, KSL's procedure for gas welding and cutting did not include a requirement for leather or flame-retardant gloves during soldering. KSL will modify their procedure to include this requirement.

KSL will also modify their procedure for preparation and control of KSL work instructions to ensure that appropriate manufacturer's requirements, LANL and regulatory requirements, and specific equipment and tools are included in the development of work instruction procedures. In addition, KSL has decided to switch from copper piping to stainless steel piping, which is joined by orbital welding, thus eliminating the need for high-temperature brazing.

The following event is another example of failing to incorporate the manufacturer's recommendation for equipment use into facility operations.

On May 20, 1999, at the Hanford Site, a flashback occurred while D&D workers were using a cutting torch fueled by unleaded gas and oxygen rather than acetylene. The flash caused the oxygen hose to burst and burn in half, producing a "road flare"-size flame. Following the event, a field engineer reviewed the torch manufacturer's manual and found a recommendation that addressed installing a flashback arrester on the oxygen line at the torch. As a corrective action, a flashback arrester was installed before permitting the torch to be used again. (ORPS Report EM-RL--BHI-IFSM-1999-0004)

Acetylene (C_2H_2) is used almost universally as a gas for welding and cutting. Even though it is very common, acetylene is extremely dangerous. When mixed with pure oxygen in a torch, the flame can reach 5,700°F. Acetylene is chemically unstable, which makes it very sensitive to excess pressure, excess temperature, mechanical shock, or static electricity. It is very easy to ignite and burns at a very fast rate, so it is very important to ensure all fittings are tight and have been leak-tested.

The following events highlight the importance of taking these necessary precautions.

- On March 31, 2005, at the Savannah River Site, a small flame was observed on an acetylene bottle regulator as an operator was using the oxyacetylene torch to cut metal. A fire watch immediately extinguished the flame. The operator failed to perform a required leak test on the oxy-acetylene system before use. Investigators later determined that the regulator was defective. (ORPS Report EM-SR--WSRC-FDP-2005-0005)
- On April 6, 2004, at the Idaho National Laboratory, a worker felt heat through his glove and noticed a small flame as he attempted to close the isolation valve on an acetylene bottle following oxy-acetylene cutting. The flame originated between the valve stem and the packing nut (Figure 2-5). Investigators identified several other oxy-acetylene torch systems that leaked either at the valve-stem packing nut or at the regulator threads. The gas-bottle vendor stated that occasional packing-nut leaks on acetylene bottles can be expected. Investigators recommended testing the systems for leaks. (ORPS Report NE-ID--BBWI-SMC-2004-0003)

Figure 2-5. Fire originated between the isolation valve and packing nut

Performing an inspection of equipment before use is always a good practice, whether directed by a procedure or work instruction or not. The few minutes taken to verify safe equipment operability can prevent worker injuries and help to ensure smooth job performance.

These events underscore the need to check fittings and connections for leaks on acetylene and other compressed-gas cylinders. Acetylene leaks, no matter how small, can have serious consequences. When performing any type of hot work, it is essential that workers use properly rated PPE to protect them from thermal injuries. It is also very important to review manufacturers' recommendations and incorporate their instructions for equipment use into procedures, work packages, and worker training.

KEYWORDS: *Torch, burns, soldering, acetylene, personal protective equipment, gloves, procedures, manufacturer's information*

ISM CORE FUNCTIONS: *Analyze the Hazards, Develop and Implement Hazard Controls, Perform Work within Controls*