

## **14. Fire/Explosion**

Three employees were killed in an explosion involving hydrogen gas which was used in the process of manufacturing powdered metal. Employees initially heard a sound which they determined to be caused by a leak coming from a sub-floor trough. In the trough were three pipes, one containing hydrogen, one containing nitrogen, and the other containing compressed air. The employees in the area could not determine exactly where the leak was located so they contacted maintenance to find and fix the leak. Maintenance workers responded and checked the gauges on the control panel and found that both the hydrogen and nitrogen gauges indicated normal pressure. They, therefore, assumed that the leak was in the compressed air pipe. They used chains and an overhead crane to remove the trough cover in one area but although they could still hear the leak, they could not find it. So they decided to move to another area of the trough, remove the cover, and check the pipes there. However, the overhead crane tracks did not extend to this location. They first attempted to remove the cover manually using a pry bar, but the cover could not be released. On their second attempt to remove the cover, they brought a forklift to the area, attached a chain to the trough cover and looped it over the forks of the forklift. The forklift then attempted to raise the cover by raising the forks. At first the cover would not move, so the forklift driver increased the engine's rpms. The cover suddenly popped off and immediately a fire and explosion occurred. Employees saw a fireball and a dense cloud of dust which made vision difficult. An employee in another building heard the explosion, came to the area, and saw the fireball and dust cloud. It was dark in the area because of the dust cloud and he could barely see. He made his way to the hydrogen control valve and shut it off; the fire in the trough immediately went out. Five employees were given first aid and transported to the hospital. Three subsequently died: one four days after the event, one 5 days after, and the final one 48 days after.

### **TOSHA Citation(s) as Originally Issued**

#### **Citation 1**

Item 1 1910.119(d)(3)(ii)	The employer did not document that the equipment in the process complied with recognized and generally accepted good engineering practices in the location of the hydrogen supply pipe where it was exposed to water contact.
Item 2a 1910.119(e)(1)	The employer did not perform an initial process hazard analysis (hazard evaluation) on processes.
Item 2c 1910.119(e)(3)(iii)	The process hazard analysis did not address facility siting by addressing the locating of hydrogen supply pipe.
Item 2d 1910.119(e)(3)(vi)	The process hazard analysis did not address human factors.
Item 3a 1910.119(f)(1)	The employer did not develop and implement written operating procedures that provided clear instructions for safely conducting activities in each covered process.
Item 3b 1910.119(f)(1)(i)(B)	The employer did not develop and implement written operating procedures that provided clear instructions for safely conducting activities in each covered process consistent with the process safety information and which covered the steps for each operating phase including normal operations.

Item 3c 1910.119(f)(1)(i)(E)	The employer did not develop and implement written operating procedures that provided clear instructions for safely conducting activities in each covered process consistent with the process safety information and which covered the steps for each operating phase including emergency operations.
Item 3d 1910.119(g)(3)	The employer did not prepare a record which contained the identity of the employee, and the date of training, and the means used to verify that the employee understood the training on the hydrogen process and operating procedures.
Item 4 1910.119(f)(1)(i)(D)	The employer's written operating procedures covering the steps for each operating phase did not address emergency shutdown including the conditions under which emergency shutdown is required, and the assignment of shutdown responsibility to qualified operators to ensure that emergency shutdown is conducted a safe and timely manner.
Item 5a 1910.119(j)(2)	The employer did not establish and implement written procedures to maintain the on-going mechanical integrity of process equipment.
Item 5b 1910.119(j)(4)(i)	Inspections and tests were not performed on process equipment to maintain its mechanical integrity.
Item 5c 1910.119(j)(4)(ii)	Inspections and testing procedures performed on process equipment to maintain its mechanical integrity did not follow recognized and generally accepted good engineering practices.
Item 5d 1910.119(j)(4)(iii)	The frequency of inspections and tests of process equipment to maintain its mechanical integrity was not consistent with applicable manufacturer's recommendations and good engineering practices or more frequently as determined to be necessary by prior operating experience.
Item 5e 1910.119(j)(4)(iv)	The employer did not document each inspection and test that had been performed on process equipment to maintain its mechanical integrity.
Item 6 1910.120(q)(2)	The employer did not develop an emergency response plan for emergencies which addressed, as a minimum, areas not addressed in any specific program.
Item 7 1910.120(q)(3)(i)	The senior emergency response official responding to an emergency did not become the individual in charge of a site-specific Incident Command System (ICS). All emergency responders and their communications were not coordinated and controlled through the individual in charge of the ICS assisted by the senior official present for each employer.
Item 8 1910.120(q)(3)(iii)	Based on hazardous substances and/or conditions present, the individual in charge of the ICS did not implement appropriate emergency operations, and assure that the personal protective equipment worn is appropriate for the hazards to be encountered.
Item 9 1910.120(q)(3)(iv)	Employees engaged in emergency response and exposed to hazardous substances presenting an inhalation hazard or potential inhalation hazard did not wear positive pressure self-contained breathing apparatus while engaged in emergency response, until such time that the individual in charge of the ICS determined through the use of air monitoring that a decreased level of respiratory protection would not

	result in hazardous exposures to employees.
Item 10 1910.120(q)(3)(v)	Operations in hazardous areas were not performed using the buddy system in groups of two or more.
Item 11 1910.120(q)(3)(vi)	Back-up personnel were not standing by with equipment ready to provide assistance or rescue. Qualified basic life support personnel, as a minimum, were not standing by with medical equipment and transportation capability.
Item 12 1910.120(q)(3)(vii)	The individual in charge of the ICS did not designate a safety officer who was knowledgeable in the operations being implemented at the emergency response site with specific responsibility to identify and evaluate hazards and to provide direction with respect to the safety of operations for the emergency at hand.
Item 13 1910.120(q)(3)(vii)	Training was not based on the duties and function to be performed by each responder of an emergency response organization.



Area where the explosion occurred. Red arrow indicates to the trough cover being removed, Green arrow indicated position of three employees who suffered fatal injuries.



Pipes in the trough