CENTER FOR Hydrogen SAFETY
Connecting a Global Community

Safety Culture Spotlight

Explosions: Business As Usual—Risk Planning

- Failure to mitigate risk leads to 5 fatalities and 3 seriously injured
- Ignition of iron powder leads to multiple explosions
- Failure to question and review safety of operations

BACKGROUND

In 2011, 3 explosions involving iron dust occurred over less than 4 months in a plant that manufactured finely divided iron powder (Ref E.2). In the previous 12 years, local firefighters responded to a total of 30 iron dust fire and explosion incidents at the site, although the 2011 explosions were more severe.

In the first explosion of 2011, iron dust was suspended in air by the jerky motion of a malfunctioning bucket conveyor. In the second, iron dust was suspended in air when a piece of equipment was struck with a mallet to drive a gas line into a fitting. In the third, a leak presumed to be from a nitrogen line turned out to be from a hydrogen line below the floor. In removing the access cover, a spark was created, causing a hydrogen explosion, which in turn created a pressure wave that suspended iron dust on nearby equipment. In all three cases, the iron powder flashed and exploded, the last one leveling the building. In all, 5 workers were killed, 3 were injured.

WHAT HAPPENED

In all three 2011 cases, ignition took place nearly immediately, indicating the abundance of ignition sources. In 2 of the 3 cases, dust was suspended by mechanical action that could have been avoided, and in the third case, the mechanical action that ignited the hydrogen could have suspended dust if it had been present. In the third case, the hydrogen explosion lifted dust that had settled on many surfaces, causing the secondary explosions. It is only luck that prevented secondary explosions in the first two incidents.

The Chemical Safety Board in their report highlighted poor understanding of the hazards and risks of iron powder on the part of the company, and questioned the understanding of local, state, federal, and insurance inspectors. What other culture gaps might have contributed to this incident? The explosiveness of iron dust is well-documented in the literature and was clearly stated in the plant's Safety Data Sheets. Yet, plant personnel tolerated a dusty workplace, did not take steps to prevent mechanical actions that could suspend dust, and tolerated 2-3 minor explosions per year. Did the tolerance of a dusty dirty environment represent the absence of an imperative for safety? Did a gap in performance occur because workers and management were not communicating openly about the hazards? What factors led the facility to normalize deviance to the extent that they would think that 30 incidents in 12 years (or even one in one year) could be accepted as business as usual? Why did workers tolerate being in such a hazardous workplace? Did they feel empowered to improve the safety of their workplace? Employees reliably wore flame resistant clothing in the plant. However, the clothing did not provide significant protection to workers when the fires and explosions occurred. Was the use of fire-resistant clothing part of a pattern of many factors used to dismiss workers' sense of vulnerability?

SAFETY CULTURE FOCUS

- ✓ Everyone is responsible for safety and understanding the risks related to their operations.
- ✓ Strong leadership recognizes and takes action to identify and mitigate risk.
- ✓ An open, questioning environment is essential to a healthy safety culture.

****Only 54% of those surveyed indicated risk planning was a strength in their organization.****

IMPROVING HYDROGEN SAFETY CULTURE

LEARNING OPPORTUNITIES FROM OTHER'S EXPERIENCES

"Safety culture is how the organization behaves…
…when no one is watching."

Safety Culture Framework

- Safety is everyone's responsibility
- Strong leadership support
- Integrated into all activities
- Open, timely, effective communications
- Questioning/learning environment
- Mutual trust
- Continuous improvement

What are the benefits?

- ✓ Eliminates common weaknesses identified as contributing factors to catastrophic events.
- ✓ Promotes trust in the hydrogen energy industry's ability to deliver safe, reliable, quality products and services.
- ✓ Supports a sustainable legacy for companies and the hydrogen industry.
- ✓ Fosters efficiency and productivity in the workplace.

Resources

- ✓ For further information and resources on safety culture, see: https://www.aiche.org/ccps/safety-culture-what-stake
- ✓ For further case studies on safety culture, see: https://h2tools.org

Keywords: weak, poor, minimum, regulations, flammable, chemical, checklists, compliance