CENTER FOR Hydrogen SAFETY
Connecting a Global Community

Safety Culture Spotlight

Poor Understanding of Hazards Leads to Fatalities—Training

- Failure to follow procedure leads to 5 fatalities and 3 seriously injured
- Flammable mixture drained to the floor ignites
- Lack of hazards recognition

BACKGROUND

An explosion and fire at a polyvinyl chloride (PVC) manufacturing facility killed five workers and severely injured 3 (Ref E.1). The explosion and fire destroyed most of the reactor facility and adjacent warehouse. Smoke from the fire drifted over the local community, and as a precaution, local authorities ordered community evacuation lasting two days. It was the third incident with a similar cause experienced by the company.

WHAT HAPPENED

The incident investigation found that while cleaning an out-of-service reactor, an operator forced open the bottom valve of the wrong reactor, bypassing a critical safety interlock by attaching an air hose adapted to fit an instrument air connection to the "open" port of the valve. A label on the hose described it as an "Emergency Air" hose. The contents of this reactor, hot reacting vinyl chloride monomer (VCM) and partially formed PVC, drained onto the floor. Shortly afterwards, the flammable mixture ignited. The resulting fire killed the operator, his supervisor, and 3 other operators.

The investigation found the "Emergency Air" line was provided to allow operators to drain the reactor in a runaway reaction scenario in case the normal vent and relief system alone were not sufficient to control the pressure during a runaway reaction. It seemed clear in hindsight the drained mixture would have ignited as occurred in this incident and therefore may not have provided much mitigation benefit. Instead, the "Emergency Air" line had become routinely used for what the operator thought he was doing – forcing open the bottom valve of a reactor being cleaned, rather than opening it according to procedure, from the panel board on a higher floor.

The incident was investigated by the US Chemical Safety Board (CSB). In their report, CSB pointed out the company's learning culture may not have been sufficiently strong. What other culture gaps might have contributed to this incident?

Did the Process Hazards Analysis team fully understand and act on the hazards and risks of the emergency procedure to drain hot, reacting VCM from the bottom valve using an "emergency air line"? Did operators feel any sense of vulnerability that they might open the wrong valve when using the emergency air line? Why was the emergency air hose frequently used to drain the reactor when cleaning? Did this represent deviance that became normalized, or was there a gap in the imperative for safety that encouraged operators to defeat interlocks?

SAFETY CULTURE FOCUS

- ✓ An open, questioning environment supports a more thorough hazards analysis process.
- ✓ Effective communications through training is essential to understanding and mitigating risk.
- ✓ Safety needs to be considered and integrated into all activities and process failure modes.

****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

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