CENTER FOR Hydrogen SAFETY
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Safety Culture Spotlight

Shutdown yet Unsafe—Hazards Analysis

- Boiler restart results in an explosion
- Leaking by-pass valve identified as main contributor
- Operator failure to heed alarm notification

BACKGROUND

A distillation column in a unit producing an aromatic nitro compound exploded, shooting the top half of the column and other debris up to half a kilometer away. Three employees were cut by glass from a blown-in window, and some large fragments came close to storage tanks of flammable and toxic materials but fortunately caused no damage.

WHAT HAPPENED

The investigation team (Ref E.7) found the plant had been in an extended shut down, which included shut down of the plant boiler. However, when the boiler was restarted, steam flowed to the column reboiler at a slow rate through a leaking manual bypass valve. The liquid left in the bottom of the column heated slowly and eventually generated vapor. The vapor rose through the column, condensed on an upper tray, and caused a level alarm on the tray to sound. Operators, did not expect the column to be running, silenced the alarm and ignored it. The reboiler continued to heat, and eventually a runaway reaction occurred in the reboiler. The boiling rate increased significantly, overcoming the capacity of the narrower upper part of the column. The relief valve, designed for fire case, not for runaway reaction, was unable to relieve the pressure. A small breach formed first, then the top of the column burst from the lower section and flew off. The investigators found numerous errors in the Process Hazards Analysis (PHA), and operating procedures.

If investigators had investigated the plant's process safety culture, what might they have found? Operators dismissed the tray high-level alarm instead of questioning why it sounded when the column should have been shut down. Did they take the shutdown condition as "permission" to dismiss their sense of vulnerability? Did they not understand the nitro compounds left in column during the shutdown still represented a risk that needed to be managed? Bypass valves tend to be used only occasionally. Was maintenance of this valve dismissed because it was considered insignificant? Did the PHA team understand and act on the potential hazard caused by the failure of this valve? The reboiler temperature rised immediately after the boiler was brought on-line, but was not noticed because it was not being checked by operators during the shutdown. What was management's role in not continuing to monitor key process variables for equipment containing a hazardous material?

SAFETY CULTURE FOCUS

- ✓ Maintaining a robust maintenance program is essential to controlling risk.
- ✓ Fully understanding risk through the process safety analysis is critical to safe operations.
- ✓ Promoting a questioning environment is paramount so safety alarms are acted upon and not dismissed.

****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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