Driving Chemical Safety Change: The First 20 Years

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Vision:
A nation safe from chemical disasters.

Mission:
Drive chemical safety change through independent investigations to protect people and the environment.
CSB Quick Facts

• Independent, non-regulatory U.S. Federal agency
  – 40 professional staff; $11 million annual budget
  – Board members are appointed to 5-year terms by the President and confirmed by the Senate.

• Conducts root cause investigations of chemical accidents at fixed industrial facilities.

• Does not issue fines or citations.

• Primary policy levers are outreach and safety recommendations.
Significant Historical Process Safety Events

Union Carbide, Bhopal (1984)
Thousands dead; tens of thousands injured

Arco Chemical (1990)
17 Dead; 5 Injured; $36 MM in damage

23 Dead; 314 Injured; $716 MM in damage

AP Photo/Sondeep Shankar
www.healthandsafetyatwork.com
www.gendisasters.com
Clean Air Act Amendments (1990)

Created the Chemical Safety Board

Risk Management Plan rule (RMP)

Process Safety Management standard (PSM)
Types of Incidents That We Investigate

BP America Refinery
Texas City, TX
March 23, 2005

Deepwater Horizon
Gulf of Mexico
April 20, 2010

Freedom Industries
Charleston, WV
January 9, 2014

Jurisdiction: Release of hazardous substance into the ambient air from a fixed facility
Current Investigations & Deployments

- Refinery Explosion and Fire (4/26/18)
- Fatal Gas Well Explosion (1/22/18)
- Chemical Plant Fire (08/31/17)
- Vessel Explosion (05/24/17 and 06/20/17)
- Mill Explosion and Fire (05/31/17)
- Pressure Vessel Explosion (04/03/17)
- Flash Fire (08/12/16)
- Gas Plant Explosion and Fire (06/27/16)
- Toxic Chemical Release (11/15/14)
20 Years of Driving Chemical Safety Change

January
Overview of CSB’s First 20 Years

February
Process Safety Management

March
Safe Hot Work Practices

April
Combustible Dust Safety

May
Extreme Weather

June
Preventive Maintenance
20 Years of Driving Chemical Safety Change

July
Contractor Safety

August
Laboratory Safety

September
Human Fatigue

October
Emergency Planning & Response

November
Winterization

December
Reactive Hazards
The U.S. Chemical Safety and Hazard Investigation Board (CSB) is highlighting the important role of individual state governments in driving critical chemical safety change. A number of state governments have made significant safety improvements following a chemical disaster within their state. They make them to protect their residents and the environment with the common goal of preventing future similar incidents.

The CSB has issued 80 safety recommendations to 22 different state governments stemming from 27 CSB investigations. Currently, only six of these investigations still have open recommendations issued to state governments. These CSB recommendations range from identifying risks and increasing safety inspections to developing and adopting significant, state-level chemical safety legislation. Several states have taken significant steps to implement positive safety changes in light of chemical disasters. The following are a few notable examples:

Following a 2007 propane explosion that occurred at a general store in Ghent, West Virginia, killing four people, the CSB issued a recommendation to the Governor and Legislature of the State of West Virginia aimed at improving propane training requirements for propane technicians. West Virginia approved a bill in 2010 requiring the completion of a nationally recognized propane service training program for “persons who install or maintain liquefied petroleum gas systems.” This requirement was also implemented into the West Virginia State Fire Code.

On February 7, 2010, Kleen Energy, a natural gas-fueled power plant under construction in Middletown, Connecticut, experienced a catastrophic natural gas explosion that killed 23 people and injured at least 50. The incident occurred while workers were conducting a “gas blow,” where natural gas is forced through new piping and released into the atmosphere at high pressure and volume in order to remove debris. As part of its investigation, the CSB issued a recommendation to the Governor and Legislature of the State of Connecticut to enact legislation that prohibits gas blows. In September of 2010, the former Governor of Connecticut, M. Jodi Rell, ordered that gas blows be prohibited on new construction projects in the state.
Factual Investigative Update
Loy-Range Box Company Catastrophic Pressure Vessel Failure

Contents
- Incident Overview
- Process Description
- Steam Generator History
- Semi-Closed Systems History
- 2012 Leak Repair
- Seeking Answers, Right Before The Incident
- Immediate Cause of the Incident
- SCR Inspection and Repair Certification Requirements
- Conclusions to Date and Proposed Further Work

This is a Factual Investigative Update of a CSB investigation into a multi-fatality incident resulting from the catastrophic failure of a pressure vessel. It provides the facts and findings established by the investigation team and, which is subject to revision and updates as the investigation proceeds. This document identifies a path forward for number of potential investigation areas of inquiry that may yield lessons for safety improvements.

Incident Overview
At approximately 7:20 a.m. on April 8, 2017, the bottom of a steam condensate (hot water) storage tank catastrophically failed at the Loy-Range Box Company (LRC), located at 100 Robin Drive in St. Louis, Missouri. The 1953-built, 350-gallon, 20-inch-diameter tank was 17.6 feet long and had a side wall thickness of 0.3 inches. The tank was designed for a working pressure of 150 pounds per square inch. The tank was connected to a 1,100-gallon, 150-gallon, 150-gallon, and 200-gallon tanks in a series. The tank was connected to a steam generator, which in turn was connected to a steam boiler.

As the pressure in the tank steadily dropped due to the failure of the tank bottom, a portion of the water in the SCR instantaneously expanded into steam, resulting in an increase in volume of about 75 times the volume of the SCR. A steam explosion of this type is extremely hazardous. The energy released was equivalent to

- about 350 pounds of TNT. Some of that energy dissipated when the escaping steam contacted water, where the water vaporized from a nearby custom work station. The water vaporized the powder on the building (Figure 1), as shown in the damage evidence after the event.

Figure 1. Before and after photos for the explosion - flame video

The force of the steam explosion hit the building, causing it to explode. The explosion destroyed a large portion of the LLRC facility, and launched the storage tank like a rocket through the roof (Figure 2 A). One LLRC employee was fatally injured, and a second was left in critical condition. Even after engulfing the building at the top of the building, the blast traveled at about 120 mph. It rose to about 25 feet above street level and traveled laterally across about 520 feet. It remained airborne for over 10 seconds.

As is often the case, the SCR exploded through the roof of a fast-food restaurant located at 2300 S. Broadway. This restaurant was two storeys high. The explosion killed four individuals and injured three individuals (Figure 2-3). The explosion killed four individuals and injured three individuals.

Various pieces of piping and debris from the explosion also crashed into the surrounding areas. A third building at 400 Robin Drive, owned by Pioneer Industrial Group, suffered significant mechanical and water damage. When a large piece of pipe from the Loy-Range site punctured the roof and trapped a portion of its water in the air (Figure 2-3). The fire was extinguished at the scene.

2. The investigation team nominated the weight of 350 pounds.
3. Overall length, including the stepped platform, is 20 feet. The investigation team nominated the height of 350 feet.
4. The SCR explosion is considered a steam explosion because steam and gas from the tank are excited into steam, rapidly expanding into steam, which is the reason for the sudden failure of the tank.
5. Pounds per square inch of pressure.
6. A steam generator is a device that takes steam from the boiler and transfers it to the steam lines. The steam lines are then connected to the SCR to provide steam for the process.
7. The SCR explosion is considered a steam explosion because steam and gas from the tank are excited into steam, rapidly expanding into steam, which is the reason for the sudden failure of the tank.
8. Investigation team calculations.
Overview of MGPI Toxic Release
Key Lessons from Incident

- Design
- Human Factors
- Pipe Markings
- Procedures
Fill line proximity

Pipe markings

Nonidentical connections and locks
• Alarms and interlocks on process control system
• Automated shutdown procedures
• Building design and ventilation system
• Practices aligned with procedures
• Access to respirators
• Defined responsibilities during an emergency
Post-Incident Changes

- Fill lines
- Chemical unloading procedures
- New couplings on sulfuric acid fill line
- Secure cages with card-reader access control
- Engineering system interlocks
- Monitoring and shutdown devices
- Design changes to control room
- Greater accessibility of respirators

New coupling on the sulfuric acid fill line (Source: MGPI)

Separation of unloading connections with secure cages around connection points (Source: MGPI)