

## THE ROLE OF THE CHEMICAL SAFETY BOARD IN PREVENTING CHEMICAL ACCIDENTS

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### Abstract

The U. S. Chemical Safety and Hazard Investigation Board (CSB) is an independent Federal agency with responsibility for investigating chemical releases, researching safety issues, and recommending improvements in the safety management of chemicals. This paper discusses the history of the Board and its institutional development. Recent investigations are highlighted in addition to safety issues such as process safety management, reactive chemicals, management of change, and the need for better data on chemical release incidents.

Keywords: Process accidents, hazard investigations, United States Chemical Safety Board

### Introduction

The U.S. Chemical Safety and Hazard Investigation Board (CSB) is an independent Federal agency whose mission is to investigate—and promote the prevention of—major chemical incidents at industrial facilities. CSB is a scientific investigatory organization; it is not an enforcement body. The U.S. Congress has directed the Board to:

- Conduct root cause investigations and report on findings.
- Conduct special studies on policy, guidelines, regulations, and laws governing chemical safety.
- Establish reporting requirements for chemical incidents within its jurisdiction.

The number and severity of chemical incidents in the United States supported the establishment of CSB. For example, among 14,500 chemical-handling facilities required to file risk management plans with the U.S. Environmental Protection Agency (EPA) in 1999, more than 1,100 reported approximately 1,900 accidents from 1994 through 1999. These incidents resulted in a total of 1,897 injuries, 33 deaths to workers/employees, and evacuation or sheltering in place of over 200,000 people in surrounding communities<sup>1</sup>.

The insurance industry recently estimated its direct losses from chemical releases at \$1 billion per year. Taking into account indirect losses and losses not covered by insurance companies, overall effects could be conservatively estimated at \$3 to 5 billion annually<sup>2</sup>.

### History and Structure

Following the catastrophic incident at the Union Carbide facility in Bhopal, India, in 1984 and a series of domestic incidents<sup>3</sup> in 1987-1989, the U.S. Congress authorized new chemical accident provisions through the Clean Air Act Amendments of 1990<sup>4</sup>. In addition to new regulatory approaches required of the U.S. Department of Labor's Occupational Safety and Health Administration (OSHA) and EPA, Congress mandated an independent Chemical Safety Board.

CSB began operations in January 1998. Modeled after the National Transportation Safety Board, CSB's authorizing statute provides for five Board Members, including a Chairperson, who are nominated by the President by and with the advice and consent of the

U.S. Senate. Members of the Board are appointed on the basis of technical qualification, professional standing, and demonstrated knowledge in the fields of accident reconstruction, safety engineering, human factors, toxicology, or air pollution regulation. Board members serve a 5-year term. The Board is governed by majority vote. Over the past year, CSB has grown to a staff of 35 with an operating budget of \$7.5 million.

### **Board Functions**

#### Stimulus to Regulatory Assessments and Recommendations

The U.S. Congress explicitly recognized the Board's unique statutory mission, particularly as a stimulus to future regulatory assessments and recommendations, noting:

The independence of the Board . . . is essential for several reasons. First, it is unlikely that an agency charged both with rule-making and investigating functions would be quick to acknowledge that existing requirements were insufficient to prevent an accident . . . . Second, the Board is intended as an organizational stimulus to an appropriate amount of regulatory activity by the Environmental Protection Agency [(EPA)] in this area . . . . A Board which did not operate independent from the [EPA] Administrator's direction would defeat the objective of stimulating regulatory action -- a stimulus created through the organizational tension built into the statutory relationship between the Board and the [Environmental Protection] Agency<sup>5</sup>

In particular, the Board is responsible for issuing periodic reports to Congress; Federal, state, and local agencies; and other interested persons concerned with the safe production, handling, and storage of chemicals. These reports may recommend:

- Measures to reduce the likelihood or consequences of accidental releases and corrective steps to make chemical production, processing, handling, and storage as safe and free from risk of injury as possible.
- Proposals for rules or orders that should be issued by the EPA Administrator or the Secretary of Labor under the Occupational Safety and Health Act to prevent or minimize the consequences of any accidental release causing death, injury, other serious adverse human health effects, or substantial property damage<sup>6</sup>.

### **Independent Investigations**

The Board's principal role is to investigate accidents at fixed facilities, determine the conditions and circumstances that led to the event, identify the causes, study chemical safety issues, evaluate the effectiveness of governmental policies and actions related to process chemical safety, and issue safety recommendations.

Congress also recognized that Board investigations have the unique ability to identify serious chemical hazards that are not addressed by OSHA or EPA:

*[T]he investigations conducted by agencies with dual responsibilities tend to focus on violations of existing rules as the cause of the accident almost to the exclusion of other contributing factors for which no enforcement or compliance actions can be taken. The purpose of an accident investigation (as authorized here) is to determine the cause or causes of an accident whether or not those causes were in violation of any current and enforceable requirement. [Senate Report]*

The Clean Air Act prohibits the use of any conclusions, findings, or recommendations of the Board relating to any chemical incident from being admitted as evidence or used in any lawsuit arising out of any matter mentioned in an investigation report.

To date, the Board has completed six accident investigations, as summarized below:

- Sierra Chemical Company operated a facility in Mustang, Nevada, which produced explosive boosters used in the mining industry. As the plant began daily operations on January 7, 1998, two massive explosions occurred in sequence, killing four workers and injuring six. The jolts were felt 12 miles away in Reno (the larger was the equivalent of a magnitude 2.0 earthquake). The initial explosion occurred in a building that housed explosives-mixing equipment; it is likely that the restart of an interrupted mixing operation triggered the blast. Explosives used in making the boosters included trinitrotoluene (TNT) and Pentolite. Despite the severity of the explosions, there appears to have been little impact offsite because the plant was located in a remote, uninhabited area. The facility was never rebuilt. CSB issued an investigation report on September 28, 1998<sup>7</sup>
- At a Sonat Exploration Company production facility near Pitkin, Louisiana, four oil workers were killed in a vessel failure and fire on March 4, 1998. The incident occurred during startup of a normally unmanned facility. The blast occurred as a result of inadequate design and start-up systems, which led to connection of a high-pressure natural gas stream to an oil and gas separation vessel rated for service at atmospheric pressure. It is not known how much natural gas was contained in the 45-foot vessel at the time of the blast. Although the facility sustained significant damage, no offsite consequences were noted because it was located in a remote area. CSB issued a final investigation report on September 21, 2000.<sup>8</sup>
- On March 27, 1998, at a Union Carbide chemical plant in Taft, Louisiana, two workers were asphyxiated by nitrogen, an odorless and colorless gas. Nitrogen is commonly used in industry to protect materials that are sensitive to oxygen or moisture. The two workers erected a temporary enclosure over an open pipe containing nitrogen to facilitate a black light inspection, unaware that the enclosure also had the effect of trapping the nitrogen. One worker died, and the other sustained severe injuries. There was no significant environmental release. CSB issued a final investigation report on February 23, 1999.<sup>9</sup> Among the recommendations was assessment of the feasibility of adding a warning odorant to nitrogen supplies used in this type of application.
- At the Morton International chemical plant in Paterson, New Jersey, an explosion on April 8, 1998, injured nine workers. The explosion and subsequent fire were caused by a runaway chemical reaction in a 2,000-gallon reactor used to produce a yellow fuel dye (Automate Yellow 96). A vigorous exothermic reaction occurred shortly after the two chemicals used to make the dye were mixed. The temperature in the reactor began to rapidly increase, causing the further exothermic decomposition of the dye and eventually over-pressurizing and rupturing the kettle. The reactor contents were released to the air and distributed into the surrounding urban area. The chemicals released included toxic *ortho*-nitrochlorobenzene. Fallout occurred as far as 0.5 mile from the plant, and residents of a 10 square block area were required to shelter in place. Local authorities issued a health advisory to residents shortly after the incident, though the magnitude of human exposure is unknown. The plant was repaired, but the company discontinued the production of Automate Yellow 96. CSB issued a final investigation report on August 16, 2000.<sup>10</sup>
- On April 9, 1998, at the Herrig Brothers turkey farm in Albert City, Iowa, two volunteer firefighters were killed and seven persons were injured in a propane tank explosion. Two teenagers driving an all-terrain vehicle struck and ruptured the propane lines immediately below the 18,000-gallon storage tank that fed the farm's

heating system. The ensuing fire below the tank, which contained about 10,000 gallons of propane, led to a boiling liquid vapor explosion (BLEVE), which resulted in the deaths and injuries. The farm sustained significant damage, but there were no significant offsite consequences. CSB issued a final investigation report on June 23, 1999.<sup>11</sup>

- A catastrophic fire occurred at the Tosco Avon Refinery in Martinez, California, on February 23, 1999. Workers were attempting to replace piping attached to a 150-foot-tall fractionator tower while the process unit was in operation. The line to be removed contained naphtha. Although the job permit called for the line to be drained, steamed, and isolated, these requirements were not met and the work continued. The job was not re-evaluated, nor was the fractionator shut down. During removal of the piping, flammable naphtha was released onto the hot fractionator tower and ignited. The flames engulfed five workers located at different heights on the tower. Four workers were killed, and one sustained serious injuries. CSB issued a final investigation report on March 28, 2001.<sup>12</sup> Recommendations were developed to address deficiencies in maintenance, auditing, and management of change systems.

## Hazard Investigations

Causation and recommendations from field investigations often reflect very specific aspects of manufacturing operations, which typically use specialized procedures, equipment, and technologies. However, occasionally in the course of conducting incident investigations, the Board is alerted to significant safety problems that could affect a large number of facilities and are beyond the scope of any one particular investigation. In these cases, CSB conducts a hazard investigation or safety study for industry-wide dissemination. Findings from such an investigation could lead to a variety of recommendations, including proposals for regulatory action.

In 1998, as requested by the U.S. Senate, CSB investigated hazards in the chemical sector from Year 2000 (Y2K) technology problems and issued an investigative report with recommendations.<sup>13</sup> In advocating its recommendations, the Board testified before the Senate, and worked with seven trade associations of the chemical handling industries and with EPA to produce and distribute both a guidance document<sup>14</sup> and a safety alert.<sup>15</sup> The report and the guidance were transmitted to the governors of states and territories, as well as to the major associations of emergency responders and firefighting organizations.

CSB helped to plan and convene a focused roundtable on chemical safety for the President's Council on Y2K. The Board also coordinated its efforts internationally, involving the Intergovernmental Forum on Chemical Safety, the World Health Organization's International Programme on Chemical Safety, and the Organization for Economic Cooperation and Development.

During the Morton International investigation, many stakeholders discussed systemic concerns regarding reactive chemical safety. In the course of this investigation, several other reactive hazards incidents were identified, including Napp Technologies (Lodi, New Jersey, April 21, 1995)<sup>16</sup> and Georgia Pacific Resins (Columbus, Ohio, September, 10, 1997).<sup>17</sup> Thus, in accordance with its congressional mandate, CSB initiated a hazard investigation of reactive chemical process safety.

The objectives of the study are to:

- Determine the scope and significance of reactive chemical incidents.
- Examine how industry, OSHA, and EPA address reactive chemical hazards.

- Determine the differences among companies with regard to reactive chemical policies, practices, testing, and process engineering.
- Analyze the effectiveness of industry and OSHA use of the National Fire Protection Association reactivity rating system<sup>18</sup> for process safety management.
- Develop recommendations for reducing the number and severity of reactive chemical incidents.

### **Other Safety Research**

The Clean Air Act authorizes CSB to conduct research and studies with respect to the potential for accidental releases, where evidence indicates the presence of a potential hazard or hazards. In implementing this objective, the Board has conducted studies in cooperation with Federal, state, and local governmental agencies and organizations in the commercial and nonprofit sectors.

CSB was vested with the responsibility for developing expertise on the content, use, and effectiveness of hazard assessments as a tool for preventing and minimizing the consequences of accidental releases of “extremely”<sup>19</sup> hazardous substances. The Board is also charged with recommending additions to the list of “extremely” hazardous substances (including threshold quantities for such substances) and categories of stationary sources for which hazard assessments apply. In this context, the Board also has explicit responsibility to assess the effectiveness of EPA-mandated risk management plans for accidental chemical releases.

### **Recommendations**

CSB’s mission in investigating chemical incidents is to determine the root and contributing causes, promote lessons learned, and advocate recommendations (which are keyed to root causes). The Board’s primary focus is to provide guidance in more effectively preventing or mitigating chemical accidents. Analyzing operational failures particular to an incident is a corollary objective.

For example, the Herrig Brothers investigation showed that better firefighter training might have prevented the two fatalities and seven injuries to emergency response personnel. In this incident, an 18,000-gallon cylindrical propane tank exploded following an earlier leak and propane fire. Volunteer firefighters arrived at the scene to find the tank intact, but engulfed in flames. They approached within 100 feet of the tank to set up firefighting equipment, thinking that they were safe as long as they avoided the two ends of the tank.

When the propane tank exploded minutes later, it sent large fragments and shrapnel in all directions. The explosion was categorized as a boiling liquid expanding vapor explosion (BLEVE), which typically occurs when fire weakens the metal of a pressure vessel containing liquefied gas. In such cases, tank failure can be initiated at any point—particularly in the upper section of the tank where there is no stored liquid to provide cooling. Under these circumstances, the sides of the tank do not provide a safety shield, and all personnel should be withdrawn to a safe distance.

CSB determined that the training furnished to Albert City firefighters by the National Propane Gas Association (NPGA) and the Iowa State University Fire Service Institute did not adequately prepare them to respond to a potential BLEVE. The firefighters erroneously thought that the ends of the tank were the most significant hazard and that the sides could be approached in relative safety. The Board recommended to both NPGA and the Fire Service Institute that they modify their training materials and programs to adequately cover response to BLEVEs. Both organizations responded positively and made the requested changes.

The CSB report also noted a significant error in the U.S. Department of Transportation's (DOT) *North American Emergency Response Guidebook*. The *Guidebook* is widely used by personnel responding to hazardous material releases, though it was not directly consulted by firefighters during the Herrig incident. The 1996 edition stated that responders should “*always* stay away from the ends of tanks” when fighting flammable liquid tank fires. This advice might be thought to imply that the sides of tanks are safe. As a result of CSB inquiries and consultation, DOT revised the year 2000 guidebook to state that responders should “*always* stay away from tanks engulfed in fire.”<sup>20</sup>

## **Incident Reporting**

The Board recognizes the importance of systematically accumulating data on chemical accidents and their consequences. Such data are critical to measure the effectiveness of accident prevention programs and to target future investigation and research resources. In the United States, several Federal agencies have jurisdiction over various kinds of data records for accidental events; however, there is no single Federal source of comprehensive chemical accident data.

Congress authorized CSB to establish regulatory requirements for reporting incidents within the Board's investigatory jurisdiction. The Board has adopted the strategic goal of implementing a system for chemical accident data collection and analysis that can be used to measure prevention effectiveness. This multiyear effort to develop new high quality data is expected to help in predicting the frequency of accidental chemical releases and in identifying which substances and industry segments are most at risk. The Board believes that there is widespread support for data development among other agencies and interested stakeholders in the private sector.

## **Summary**

CSB is a new independent public agency whose mission is to investigate and promote the prevention of major chemical incidents at industrial facilities. As a scientific investigatory organization free of enforcement responsibilities, CSB conducts root cause investigations and safety studies. Through global information technology, the Board's investigation reports are an international resource for preventing chemical accidents.

## REFERENCES

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- <sup>2</sup> Estimating Chemical Accident Costs in the United States: A new Analytical Approach, Collins, L., D'Angelo, C, Mattheissen, C., and Perron, M., in Process Industry Accidents, Center for Chemical Process Safety, New York City, pp, 467 – 471, 2000
- <sup>3</sup> Among these incidents were: the Phillips Petroleum in Pasadena, TX, the Arco Refinery in Channelview, TX, Marathon Oil in Texas City, TX, Shell Petroleum in Norco, LA.
- <sup>4</sup> Clean Air Act, 42 USC 7412
- <sup>5</sup> 29 U.S.C. 651 et seq.
- <sup>7</sup> [http://www.csb.gov/reports/1998/sierra\\_chem/sierra\\_fr01.htm](http://www.csb.gov/reports/1998/sierra_chem/sierra_fr01.htm)
- <sup>8</sup> [http://www.csb.gov/reports/2000/sonat1\\_01.htm](http://www.csb.gov/reports/2000/sonat1_01.htm)
- <sup>8</sup> <sup>9</sup> [http://www.csb.gov/reports/1998/union\\_carbide/98005lafr.htm](http://www.csb.gov/reports/1998/union_carbide/98005lafr.htm)
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- <sup>15</sup> <http://www.epa.gov/ceppo/pubs/lodiintr.htm>
- <sup>16</sup> <http://www.epa.gov/ceppo/pubs/gpcasstd.pdf>
- <sup>17</sup> NFPA 704, Standard System for the Identification of Hazards of Materials for Emergency Response, 1996. In the 1996 standard, the terminology was changed from “reactivity” to “instability.”
- <sup>18</sup> “Extremely” hazardous substances are a class of materials regulated under Federal law— more specifically, Section 112( r), which deals with the prevention of accidental releases under the Clean Air Act Amendments of 1990.
- <sup>19</sup> U.S. Department of Transportation, *2000 Emergency Response Guidebook*, p. 195.