CSB Safety Spotlight: The Importance of Industry Safety Guidelines, Codes, and Standards

U.S. Chemical Safety and Hazard Investigation Board

Strong industry safety guidelines, codes, and standards play a key role in protecting the safety and health of workers, the public, and the environment. As part of its mission, the US Chemical safety Board (CSB) makes recommendations to standards developing organizations (SDOs), when industry-wide safety gaps or weaknesses are identified during an incident investigation.[1] SDOs can play a vital role in driving chemical safety change in the U.S. because of the variety of systems, equipment, and processes addressed by SDO guidance and standards, and the broad-reaching influence of such documents. For this reason, the CSB highly values the contribution of SDOs for accident prevention and safety advancement.

This Safety Spotlight focuses on a few of the critical industry safety codes and standards developed and issued by SDOs following incidents investigated by the CSB.

American Petroleum Institute (API): Human Fatigue as a Risk Factor

On March 23, 2005, the BP Texas City refinery experienced explosions and fire in an isomerization unit (ISOM) that resulted in 15 deaths, 180 injuries, and significant monetary losses. The accident was caused by the overfilling of a raffinate splitter tower during startup, which in turn opened pressure relief devices and dumped flammable liquid into a blowdown drum with a stack that was open to the atmosphere. The flammable liquid exceeded the capacity of the blowdown drum and erupted out of its stack into the surrounding area where it ignited, resulting in the explosions and fire.

View of the BP Texas City refinery following the March 23, 2005 explosions and fire.

The CSB investigation found that the incident was caused by multiple technical, system, and organizational deficiencies. Among the findings, the CSB concluded that the ISOM operators were likely fatigued from working long hours over consecutive days during the turnaround of the unit prior to startup. The CSB also concluded that there were no industry safety guidelines or voluntary standards addressing fatigue as a risk factor. The CSB recommended that the American Petroleum Institute (API),[2] a national trade association with more than 600 members representing the natural gas and oil industry, including large companies, exploration and production, refining, marketing, pipeline, and marine businesses, develop a fatigue standard and that the United Steel Workers[3] (USW), North America's largest union, work with API in its development:

1 CSB information on SDOs came from the following data sets: standard development organizations, traded associations, professional organizations, and other similar groups.

2 API's mission is to "promote safety across the industry globally and to influence public policy in support of a strong, viable U.S. oil and natural gas industry." For more information visit https://www.api.org.

3 USW is comprises 1.2 million members and retirees. For more information visit https://www.usw.org.

Work together [API and USW] to develop two new consensus American National Standards Institute (ANSI) standards. In the second standard, develop fatigue prevention guidelines for the refining and petrochemical industries that, at a minimum, limit hours and days of work and address shift work. In the development of each standard, ensure that the committees a) are accredited and conform to ANSI principles of openness, balance, due process, and consensus; and b) include representation of diverse sectors such as industry, labor, government, public interest and environmental organizations and experts from relevant scientific organizations and disciplines.

In April 2010, API issued Recommended Practice (RP) 755 – *Fatigue Risk Management Systems for Personnel in the Refining and Petrochemical Industries.* This was the first ever fatigue guidance developed for the petrochemical industry. Recognizing that additional improvements could be made, API invited CSB staff to attend and participate in the RP 755 Revision Committee meetings. The new revision improves several areas of the original standard, including:

- Revision of several 'should' statements to 'shall' statements;
- Simplification of 'hours of service limits' with increased flexibility and clarity;
- Modification of the 'exception approval process' to be more stringent for 'exceptions' with the greatest potential fatigue risk;
- Guidance on managing 'call-outs;'
- Additional 'work environment' information; and
- Reference to objective and validated tools for 'individual risk assessment and mitigation' efforts.

The 2nd Edition of API RP 755 is slated for release in early 2019.

Photo of "gas blow" method which was used at Kleen Energy to remove debris from the piping.

National Fire Protection Association (NFPA): Safe Conduct of Fuel Gas Piping Cleaning Operations

- On June 9, 2009, four workers were killed, three were critically burned, and 67 others were injured in a natural gas explosion at the ConAgra Foods Slim Jim™ meat processing facility in Garner, North Carolina. At the time of the explosion, natural gas was being purged indoors from piping connected to a newly installed water heater.
- On February 7, 2010, six workers were killed during a planned work activity to clean debris from natural gas pipes at Kleen Energy in Middletown, Connecticut. To remove the debris, workers forced natural gas through the piping at a high pressure and volume (known as a "gas blow"). At predetermined locations, the natural gas and debris were released directly to the atmosphere. During this process, the natural gas found an ignition source and exploded.

The CSB investigated both incidents and concluded that relevant industry codes and standards did not address safe practices for cleaning fuel gas piping and did not require fuel gas piping to be vented safely outdoors. The CSB made an urgent recommendation[4] to the National Fire Protection Association (NFPA),[5] the world's leading authority on fire investigation, to revise the scope of its National Fuel Gas Code, NFPA 54/ANSI Z223.1, a consensus standard that provides requirements for fuel gas piping system safety. The recommendation provides:

Enact a Tentative Interim Amendment and permanent changes to the National Fuel Gas Code (NFPA 54/ANSI Z223.1) that address the safe conduct of fuel gas piping cleaning operations. At a minimum:

a. Remove the existing NFPA 54 fuel gas piping exemptions for power plants and systems with an operating pressure of 125 pounds per square inch gauge (psig) or more.
b. For cleaning methodology, require the use of inherently safer alternatives such as air blows or pigging with air in lieu of flammable gas.

In response, NFPA developed and issued a new gas process safety standard via an expedited rulemaking process. As a result, NFPA 56, *Standard for Fire and Explosion Prevention During Cleaning and Purging of Flammable Gas Piping Systems* was developed and approved in less than 24 weeks. The typical NFPA code development process lasts roughly 104 weeks. The 2014 edition of the standard was approved in July 2013. NFPA 56 prohibits the use of flammable gas to clean piping and provides guidance for the use of non-flammable alternatives. The standard also includes detailed safety requirements for purging fuel gas piping systems into and out of service, a common practice which inevitably involves some release of flammable gas. Notably, the standard requires that discharged gases be released to an outdoor location or captured for further processed before release.

American Chemical Society (ACS): The Need for Good Practice Hazard Evaluation Guidance in the Academic Community

On January 7, 2010, a graduate student within the Chemistry and Biochemistry Department at Texas Tech University (Texas

View of the damaged caused by the 2010 incident at Texas Tech

4 The Board procedures authorize the development of an urgent safety recommendation "if an issue is identified during the course of an investigation that is considered to be an imminent hazard and has the potential to cause serious harm unless it is rectified in a short timeframe, or a hazard is identified that is likely to exist in a large segment of industry such that the probability of an incident is significant."

5 The NFPA is a global, self-funded, nonprofit organization devoted to eliminating death, injury, property and economic loss due to fire, electrical and related hazards. It has developed more than 300 consensus codes and standards, with more than 50,000 members world-wide. For more information visit https://www.nfpa.org.

Tech) lost three fingers, sustained burns to his hands and face, and injured one of his eyes after the chemical he was working with detonated. The CSB investigated and found systemic deficiencies at Texas Tech that contributed to the incident: the physical hazard risks inherent in the research were not effectively assessed, planned for, or mitigated; the university lacked safety management accountability and oversight; and previous incidents with preventive lessons were not documented, traced, and formally communicated. The CSB concluded that there was a lack of hazard evaluation guidance for research laboratories and noted that the Occupational Safety and Health Administration (OSHA) identified the American Chemical Society (ACS) as instrumental in establishing that practices in laboratories are different enough from those in industry to warrant different guidelines.[6]

Based on its findings, the CSB made the following recommendation to the ACS:

Develop good practice guidance that identifies and describes methodologies to assess and control hazards that can be used successfully in a research laboratory.

In response to the recommendation, the ACS' Committee on Chemical Safety developed and published a document in 2015 entitled *Identifying and Evaluating Hazards in Research Laboratories: Guidelines developed by the Hazards Identification and Evaluation Task Force of the American Chemical Society's Committee on Chemical Safety.*[7]

The scope of the document indicates that it is intended for use by laboratory researchers "without deference to where they are in their careers" all with "varied approaches to learning and experimental design and who may require different kinds of assessment tools." The document identifies and describes in detail five different methodologies for "identification of hazards, analysis of the risks presented by each hazard [and] a selection of controls that will allow the work to be done safely": Chemical Safety Levels/Control Banding, Job Hazard Analysis, What-if Analysis, Checklists, and Structured Development of Standard Operating Procedures.

The document also addresses the variable nature of the work conducted within research laboratories and provides practical examples of changes that might require a hazard analysis, discusses factors that affect recognition of change, and provides organizational strategies for ensuring recognition of, and appropriate response to, significant changes in research environments. The document emphasizes the importance of both reporting and discussing incidents, near misses, and close calls. Finally, the publication emphasizes the importance of striving for continuous improvement by identifying lessons learned during work, and using lessons learned to inform future hazard evaluations. The thoroughness of the document accompanied by an additional publication on safety culture went well beyond what the CSB requested in its recommendation.

6 The ACS is a nonprofit organization, chartered by Congress, with more than 163,000 members, whose stated mission is "to advance the broader chemistry enterprise and its practitioners for the benefit of Earth and its people." It has published several widely-accessed publications associated with safety and health as it relates to chemistry. For more information visit https://www.acs.org.

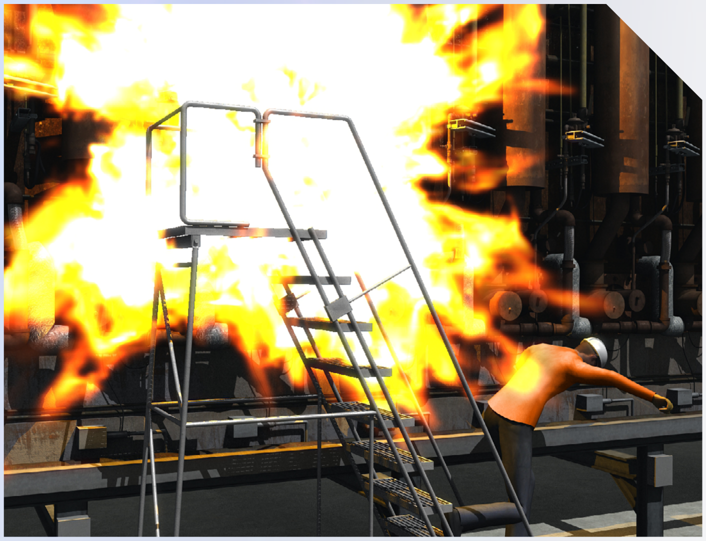
7 Available at: https://www.acs.org/content/dam/acsorg/about/governance/committees/chemicalsafety/publications/identifying-and-evaluating-hazards-in-research-laboratories.pdf.

International Code Council (ICC): Combustible Dust Hazards

Three combustible dust incidents occurred over a six-month period in 2011 at the Hoeganaes facility in Gallatin, Tennessee. The first iron dust flash fire incident occurred on January 31, 2011, and killed two workers. The second occurred on March 21, 2011, and injured one employee. The third incident, a hydrogen explosion and resulting iron dust flash fires, occurred on May 27, 2011, and killed three and injured two other workers.

The CSB reviewed pertinent safety codes and standards as a part of its investigation and found that both the State of Tennessee and the City of Gallatin had adopted the 2006 edition of International Fire Code (IFC), a product of the International Code Council (ICC), into law.[8] The CSB noted that Chapter 13 of the IFC (2006), entitled *Combustible Dust-Producing Operations,* briefly addresses precautions for ignition sources and housekeeping in areas where combustible dust is generated, stored, manufactured, or handled. The IFC also references several NFPA standards, such as NFPA 484, *Combustible Metals, Metal Powders, and Metal Dusts,* and specifies that "the fire code official is authorized to enforce applicable provisions of the codes and standards listed…to prevent and control dust explosions." This language did not specify, however, whether compliance with and enforcement of the referenced NFPA standards were mandatory or voluntary in the IFC.

The CSB concluded that had the Hoeganaes facility adhered to the requirements of this chapter, including the more detailed design and engineering requirements contained in NFPA 484,



Animation still from the CSB's Hoeaganaes Safety Video "Iron in the Fire"

the January and March incidents may have been prevented, and the effects of the May incident could have been reduced. The CSB, therefore, issued a recommendation to the ICC to revise the language in Chapter 22 of the most recently published IFC:

Revise IFC Chapter 22 Combustible Dust-Producing Operations; Section 2204.1 Standards, to require mandatory compliance and enforcement with the detailed requirements of the NFPA standards cited in the chapter, including NFPA 484.

In response to the recommendation, the ICC made the following changes to Chapter 22 of the 2018 edition of the IFC, entitled *Combustible Dust-Production Operations:*

- Section 2204.1 has been renamed with the title "Specific Hazards Standards" and the text has been revised to read as follows: "The industry- or commodity-specific codes

8 The ICC is a membership association established in 1994 with over 64,000 members, responsible for developing safety codes and standards used in residential and commercial buildings. For more information visit: https://www.iccsafe.org/.

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and standards listed in Table 2204.1 shall be complied with based on the identification and evaluation of the specific fire and deflagration hazards that exist at a facility."

- Table 2204.1 has been renamed "Specific Hazard Standards" and contains a listing of the following NFPA standards: 61, 69, 70, 85, 120, 484, 654, 655, and 664.
- Two new sections have been added to Section 2203 entitled "Precautions". Section 2203.1, entitled "Owner Responsibility" has been added which states: "The owner or operator of a facility with operations that manufacture, process, blend, convey, repackage, generate or handle potentially combustible dust or combustible particulate solids shall be responsible for compliance with the provisions of this code and NFPA 652." Section 2203.2 entitled "Dust Hazard Analysis" has also been added which states: "The requirements of NFPA 652 apply to all new and existing facilities and operations with combustible dust hazards. Existing facilities shall have a dust hazard analysis (DHA) completed in accordance with Section 7.1.2 of NFPA 652. The fire code official shall be authorized to order a dust hazard analysis to occur sooner if a combustible dust hazard has been identified in a facility that has not previously performed an analysis."

View of the massive damage caused by the combustible dust explosions and fires at Imperial Sugar.

Additional SDO Actions to Highlight

This CSB Safety Spotlight highlights just a few examples of revised and newly created industry codes and standards developed by SDOs following CSB investigations that clearly drive critical chemical safety change. The linked table lists all the positive changes that SDOs have made stemming from acceptably closed CSB recommendations. Additionally, some of these may be individually highlighted in more detail in future CSB Safety Spotlights or other CSB publications.

To those SDOs who have developed and implemented life-saving safety guidelines, codes, and standards, we at the CSB take this opportunity to acknowledge these broad reaching, technical advancements. For more information on any of these actions, visit the CSB's website at www.csb.gov.