FOCUS ARTICLE

The Big Picture: The Role of Culture & Capability in High Reliability Organizations

Sarah Eck, PE, CCPSC and Mike Snyder, PE, CSP, CFPS
February 2020

Catastrophic Incidents Continue to Happen: Are We Doing Enough?

On October 21, 2016, the 11,000 residents of Atchison, Kansas, were ordered to shelter-in-place while a chlorine cloud vented from a bleach tank owned by MGPI. That morning, a truck operated by Harcros Chemicals inadvertently offloaded 4,000 gallons of sulfuric acid to the wrong tank. The two chemicals reacted to form a toxic gas cloud that resulted in a command to shelter-in-place within 10 miles of the release, ultimately resulting in over 120 people seeking medical attention.[i] Three years later, a federal grand jury indicted MGPI, stating that "MGPI did not design and maintain a safe facility consistent with current industry standards, generally accepted good engineering practices and recommendations cited in the chemical material safety data sheets that would have prevented or minimized the consequences of accidental releases of extremely hazardous substances."[ii] MGPI pled guilty to violating the EPA's Clean Air Act and agreed to pay a $1 million fine.[iii]

It's easy to assign blame and think "that can't happen here." However, each day, hundreds of decisions are made in industries that have the potential to harm workers and damage facilities. Catastrophic incidents continue to occur despite the best of intentions. How can we know we are doing enough to prevent catastrophic incidents from impacting our workers, our facilities, and our communities? By implementing the principles of High Reliability Organizations, you can move beyond compliance and transform your process safety outcomes.

From Standards and Compliance to Risk-Based Process Safety

Industry has established practices to manage catastrophic risk. Various government authorities and standards boards within North America have adopted versions of Process Safety Management (PSM) program strategies to prevent catastrophic events such as fires, explosions, and chemical releases. Three stand out: US-OSHA 1910.119 PSM of Highly Hazardous Chemicals, American Chemistry Council's Responsible Care Management System (including the Process Safety Code), and the US-EPA's Risk Management Plan (RMP) 40 CFR part 68.

Several organizations have established similar Process Safety strategies, including API RP 1173 Pipeline Safety Management Systems (SMS); NFPA 652 Standard on the Fundamentals of Combustible Dust (Chapter 8, Management Systems); and API RP 750, Management of Process Hazards. Even NFPA 45, the Standard on Fire Projection for Laboratories Using Chemicals, includes management system requirements that address Process Safety management elements including emergency planning, hazard analysis, and installation, and maintenance of mitigation.[iv]

Process Safety program strategies often provide a performance-based (rather than prescriptive) framework that includes several management systems working together to help reduce risks associated with rare but catastrophic events. Each strategy contains multiple elements that contain individual requirements.

Beyond meeting requirements for each element, effective Process Safety programs ensure the elements work together and adapt as there are changes within the organization's technology, design, workforce composition, and business procedures. Differences between Process Safety strategies are often noted within their scope of application (i.e., where facilities or industries need to comply) and the extent of how they are applied (i.e., what management system elements must be applied for a robust system).

Introduced in the 1990s and refreshed again in the 2000s, the Center for Chemical Process Safety (CCPS) took on that challenge by launching a project called "Risk-Based Process Safety." It is recognized globally as the gold standard for organizations to address risk. The current model describes 20 elements and is based on the idea that all organizations have limited resources.

All hazards are not equal; the amount of effort required to control hazards should be proportionate to the complexity of the situation and the magnitude of the risk. Since the strategy scales well, it can be applied to organizations that do not have large quantities of chemicals that are traditionally regulated by US-OSHA or the EPA (RMP). A facility's resources should be applied proportionately to the risk that exists in their organization amongst several management systems. When the management systems work together effectively, they are more efficient at helping to manage risk. Several companies have adopted tenets of CCPS Risk-Based Process Safety, as has the Canadian Society of Chemical Engineering (CSChE) via their PSM Guide.

Figure 1: CCPS Risk-Based Process Safety, Evolution of Process Safety and Accident/Loss Prevention Strategies[v]

Figure 2: Organizational Process Safety Model © 2020 DEKRA SE or its subsidiaries. All rights reserved. All trademarks are owned by DEKRA SE or its subsidiaries, reg. U.S. Pat. & Tm. Off. and other countries as listed on our website. No modifications, reproduction or use without written permission from DEKRA SE or its subsidiaries.

Understanding Organizational Culture and Capability

Organizational Culture and Capability represent two critical components inherent to organizations that manage catastrophic risk effectively. Both are difficult to describe and enforce by government authorities. Culture is what people do in response to deeply held values of the organization. Capability is the combined skills, experience, and expertise that people have in the organization. Unlike other components within a risk-based program model, Organizational Culture and Capability are incapable of operating in an organizational silo. They exist and interact with each element, whether the facility recognizes them or not. Culture and Capability are the glue that holds a Process Safety program together.

A 2016 event at the University of Hawaii shows how Culture and Capability could have prevented an incident. An explosion caused extensive damage to a laboratory, and flying debris caused a doctoral student to lose her arm. On the surface, the cause of the event was simple: a flammable atmosphere within a 13-gallon portable tank ignited due to a spark from a digital pressure gauge. Yet upon closer look, there were indications that the laboratory staff lacked the capability (knowledge, skills, and expertise) to work with flammable hydrogen.

The researcher bought and assembled the equipment, including the digital gauge that was not electrically rated for the hazardous area. Despite widely available information on how to control ignition sources when handling flammable gas, the assembly was not grounded. The researcher previously experienced static shock incidents but did not stop work to make changes to the apparatus. There was also indication that the lab group had a poor Process Safety culture. The day before the incident, the researcher reported sound, smell, and visual indications of combustion within a 1-gallon set of equipment. The student escalated concerns to a more senior researcher, but they did not shut down operations or investigate. The researcher did not fully recognize the hazard.

If the research laboratory had a risk-based Process Safety program with stronger Culture and Capability elements, the catastrophic explosion might have been prevented.[vi,vii,viii]

Table 1: Organizational Process Safety Comparison to other PSM Models

Organizational Process Safety Components	CCPS Risk-Based Process Safety Elements
Capability	Compliance with Standards Process Knowledge Management Process Safety Competency Training and Performance Assurance
Incident Response	Stakeholder Outreach Emergency Management Incident Investigation
Risk Management	Hazard Identification and Risk Analysis
Asset Integrity	Asset Integrity and Reliability Management of Change
Accountability	Measurement and Metrics Auditing Management Review and Continuous Improvement
Operations	Operating Procedures Safe Work Practices Operational Readiness Contractor Management Conduct of Operations (Operational Discipline)
Culture and Organization	Process Safety Culture Workforce Involvement

Beyond Compliance: Process Safety Outside of the Traditional Chemical Processing Industries

In addition to ensuring that Organizational Culture and Capability are part of a robust Process Safety program, an increasing number of organizations are implementing Process Safety principles beyond the scope of traditional regulation. Rather than waiting for a chemical to be regulated and then applying a Process Safety program, companies are taking risk-based Process Safety principles and applying them outside the traditional chemical industry.

Impacted industries include pulp & paper, food & beverage, hazardous materials transportation, and mining. These industries recognize that rare but catastrophic events can occur within their facilities. They also understand that these hazards are not managed well using traditional occupational health and industrial hygiene principles. Large fires, dust explosions, chemical releases and unintended chemical reactions, including thermal decomposition, release of mechanical energy, and catastrophic electrical arc flash, pose significant risk. Risk-based strategies that apply Process Safety principles scaled to the complexity of the technology are effective.

As the world becomes more connected through the internet and global trade, the boundary where corporate responsibility begins and ends is becoming blurred. Cooperation among organizations to ensure sustainable and responsible behaviors that extend throughout the lifecycle of the products that go to market is now expected.

As in the case of the Atchison chlorine release, multiple companies can be involved in the simple act of loading or unloading a container of material. Both regulators and the public expect all organizations involved to accept the responsibility of managing hazards. When a train of crude oil derailed in Lac-Mégantic, Quebec, and killed 47 people in 2013, the Canada TSB concluded that the tragedy "was not caused by one single person, action or organization. Many factors played a role, and addressing the safety issues will take a concerted effort from regulators, railways, shippers, tank car manufacturers and refiners in Canada and the United States."[ix]

Organizations need to remember the "big picture" in managing their supply chain and how Process Safety risk can be incurred beyond traditional plant boundaries.

Similarly, industries not required to follow chemical processing regulations are taking a closer look at their operations in order to manage fire and explosion risks. For example, the agricultural industry is aware of the need to create a combustible dust program based on Process Safety principles. Data collected in partnership between the National Feed and Grain Association and Purdue University shows that operations located primarily in the Midwest continue to experience serious events (including fatalities) associated with combustible dust explosions.[x] NFPA 652 Standard on the Fundamentals of Combustible Dust includes a chapter on management systems that align with Process Safety principles and a requirement to conduct Dust Hazard Analysis (DHA, a form of Hazard Identification and Risk Assessment) by September 7, 2020. Similarly, NFPA 61 (2020 Ed), the Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Processing Facilities, was issued with a requirement for existing facilities to conduct Dust Hazard Analysis by January 1, 2022.[xi]

Grain handling operators frequently collaborate to discuss safety practices to identify and mitigate combustible dust explosion risk. The industry is not content to wait for regulators to tell them what to do. Instead, they are acting to protect their workers.
The mining industry has made sweeping changes to include aspects of Process Safety within their operations. These changes are made as a result of the April 2010 coal dust explosion at the Upper Big Branch Mine-South in West Virginia that became the worst mining disaster recorded in the United States in 40 years.

An initial explosion from an ignited accumulation of methane lofted coal dust located throughout the mine. The subsequent explosions from the coal dust resulted in 29 fatalities. A subsequent Mine Safety and Health Administration (MSHA) report stated the cause of the event included poor asset integrity practices, inadequate hazard mitigation practices (e.g., ventilation), and inadequate self-inspections to find and address hazards.[xii] There are symptoms throughout the report that show the operation had a poor safety culture.

Beyond Compliance: Assessing Organizational Maturity to Become a High Reliability Organization

Catastrophic toxic releases, fire, and explosions usually occur after a series of early warning signals are overlooked. Some organizations have been successful in avoiding catastrophic events, even in environments with high risk factors and complex operations. Known as High Reliability Organizations (HROs), these operations have developed cultures that embrace the disciplines of anticipation, questioning, diligence, resilience, and learning.

How can a facility know how well they are implementing their Process Safety program to move their organization toward becoming a HRO? Fundamentally, leaders drive their safety programs to the next level through a blended cultural and technical process. Leaders must establish the expectation that attention to Process Safety is an ongoing learning process that never stops. It applies beyond the boundaries of regulatory compliance. Process Safety principles can be applied to all technologies and processes within the organization. At the same time, they must also assure that organizational and technical systems support continuous learning.

Several practices can help an organization move to the next level of organizational Process Safety maturity:

1. **Conduct an unbiased, field-centric Process Safety Program Maturity Assessment.** Identify how the facility's Process Safety program is performing with current management systems and work practices. Rather than looking at incident rates (which are poor indicators of actual exposure) or Process Safety Compliance Audits (which often solely indicate compliance aspects), an unbiased cultural and technical assessment of each risk-based Process Safety element helps assess the state of the current program. Benchmark measures can fall into a maturity matrix or scale, like the one shown in the figure below.

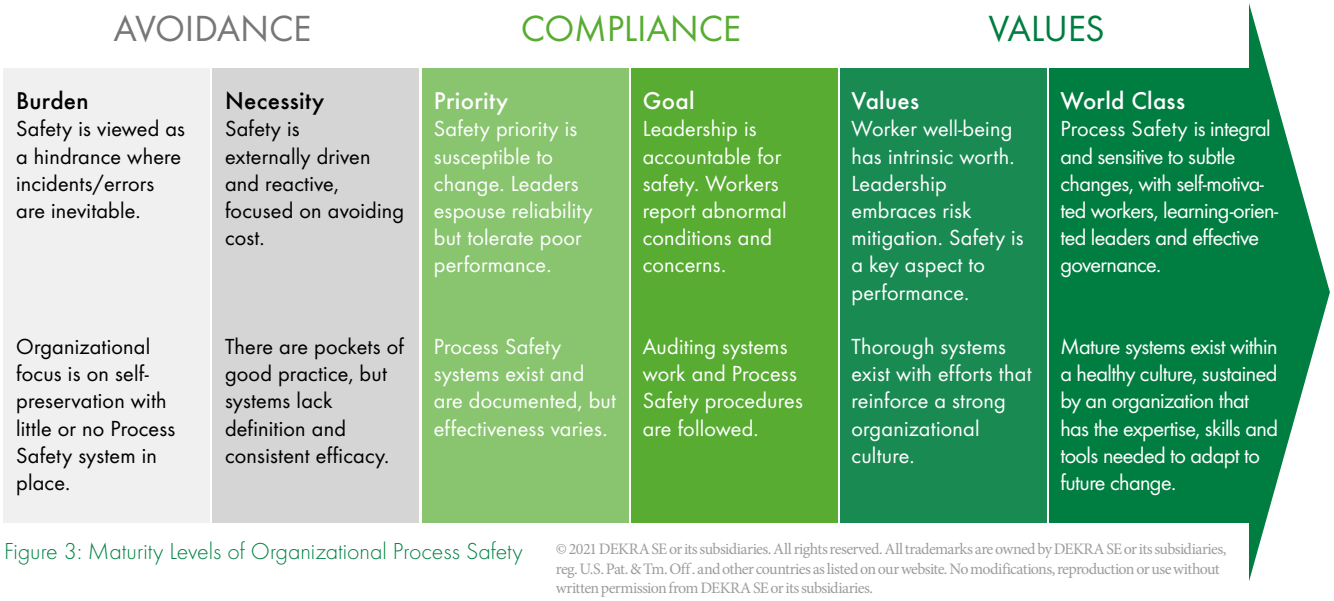

Figure 3: Maturity Levels of Organizational Process Safety

2. **Develop a Process Safety Improvement Roadmap.** Based on the findings from the Maturity Assessment, develop improvement plans paced to meet organizational risk resolution timelines and resource capacity. Too often, Process Safety improvement plans fail because the vision is too lofty without enough concrete details formed so workers can make it become reality. Leaders must instead be sensitive to offer a roadmap that is attainable and offer the resources needed to meet goals. Roles and Accountabilities must be assigned to assure engagement at each level of the organization, and that details are not being missed.

3. **Maintain an organizational sense of vulnerability and adopt a learning orientation.** Continuous learning organizations are vigilant about preserving organizational memory and assuring that hard lessons are not forgotten or repeated. Take measures to ensure that even the newest worker knows the story of where the organization came from and where it is going. Establish an oversight board that includes a thorough review of leading and lagging indicators, including oversight of progress that each facility is making with their improvement roadmap. Facilities should undergo another assessment after a significant organizational change or after 3-5 years of operation. Findings can be shared between facilities so common challenges and improvements can be leveraged and help fuel a continuously learning culture.

4. **Be diligent to identify and address organizational silos.** Care should be made to look for variants in work practices at a facility or within the organization. For example, a pilot plant located on site may have a different maturity level than the full-scale production unit located at the same site. Similarly, understand the difference between highly regulated facilities (e.g., those that are covered by US-OSHA PSM or EPA RMP) versus the less regulated facilities (e.g., less hazardous warehousing or blending operations).

Assessing Organizational Process Safety Maturity: Let Us Be Your Trusted Advisor

DEKRA's Organizational Process Safety consulting services enables leadership to understand and address the underlying factors that contribute to catastrophic safety risk, uncover organizational blind spots, and identify cultural and leadership factors that contribute to effective exposure control.

As a starting point, DEKRA assesses the critical factors that influence the level of organizational risk, effectiveness of risk mitigation, and sustainability of exposure control. The assessment results allow leadership to identify targeted solutions that address the most impactful issues facing your organization.

DEKRA's approach combines our world-renowned technical expertise in Process Safety with industry-leading scientific perspectives on Organizational Safety and Reliability. DEKRA provides a comprehensive solution set and organizational change model with a focus on culture change, governance, leadership development, employee participation, and risk control systems. We work with your team to understand why early warning signals are overlooked and what can be done to improve identification and response.

We also work with you to build a Learning Organization where risks are systematically identified, controls sustainably implemented, and performance is monitored in order to develop the attributes of a HRO and reduce the potential for catastrophic incidents.

Contact us to learn more about moving your team toward becoming a High Reliability Organization.

References

[i] MGPI Processing, Inc. Toxic Chemical Release Final Report released on 01/03/2018, Chemical Safety Board, **https://www.csb.gov/mgpi-processing-inc-toxic-chemical-release-/**

[ii] Feds indict MGP Ingredients for releasing chlorine gas cloud over Atchison, by James Dornbrook, March 6, 2019; Kansas City Business Journal, **https://www.bizjournals.com/kansascity/news/2019/03/06/feds-indict-mgp-ingredients-chlorine-gas-cloud.html**

[iii] MGPI pleads guilty, faces $1M fine for releasing chlorine gas over Atchison, by James Dornbrook, Nov. 19, 2019, **https://www.bizjournals.com/kansascity/news/2019/11/19/mgp-guilty-plea-clean-air-act-fine.html**

[iv] NFPA 45 Standard for Fire Protection for Laboratories using Chemicals, 2019 Ed.

[v] Guidelines for Risk Based Process Safety, © 2007 by AIChE, a John Wiley & Sons, INC publication

[vi] Report on the UH Hydrogen/Oxygen Explosion of March 16, 2016. US Center for Laboratory Safety, June 29, 2016, **https://cls.ucla.edu/images/document/Report%201%20UH.pdf**

[vii] Fire Investigation Report Number 2016HFD0015761, City and County of Honolulu, Honolulu Fire Department, Date of Report: March 30, 2016, **https://www.documentcloud.org/documents/2805224-2016-05-30-Honolulu-Fire-Department-Report-on.html**

[viii] Spark from pressure gauge caused University of Hawaii explosion, fire department says, by Jyllian Kemsley, Chemical & Engineering News, April 19, 2016, **https://cen.acs.org/articles/94/web/2016/04/Spark-pressure-gauge-caused-University.html**

[ix] Lac-Megantic runaway train and derailment investigation summary, Report R13D0054, Transportation Safety Board of Canada, **https://www.tsb.gc.ca/eng/rapports-reports/rail/2013/r13d0054/r13d0054-r-es.html**

[x] Agricultural Dust Explosions Research, Purdue University, initiative supported by the National Grain and Feed Association, NGFA, data reports posted via the web are from 2015 – 2018, **https://engineering.purdue.edu/FFP/research/dust-explosions**

[xi] NFPA 61 Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Processing Facilities, 2020 Ed.

[xii] United States Department of Labor Mine Safety and Health Administration, Coal Mine Safety and Health Report of Investigation, Fatal Underground Mine Explosion, April 5, 2010, Upper Big Branch Mine-South, Performance Coal Company Montcoal, Raleigh County, West Virginia, ID No. 46-08436

Would you like to get more information?

Contact Us

Subscribe to our Newsletter

DEKRA