



veriforce®

veriforce.com

Reducing supply chain risk  
to enable better business

White Paper: Implementing Process Safety  
Management to Prevent Industrial Disasters

# Implementing Process Safety Management to Prevent Industrial Disasters

Using Contractor Management Software  
to Improve PSM Compliance



Certain industrial disasters are so devastating that they leave an indelible mark on global consciousness, serving as stark reminders of the grave consequences that arise from failures in hazard recognition and risk management. These incidents, characterized by uncontrolled chemical releases, fires, and explosions, have resulted in significant loss of life, extensive environmental damage, and the destruction of billions of dollars in assets. They stand as a testament to the tragic outcomes that can occur when warnings are ignored, hazards go unidentified, and risks remain unmitigated.



***The gas release exposed over 500,000 people in the city and surrounding areas to the deadly toxin.***

In 1947, the S.S. Grandcamp, a French cargo ship loaded with ammonium nitrate, exploded while docked in Texas City, Texas. The initial explosion triggered a catastrophic chain of events, including a firestorm that claimed the lives of six hundred people, destroyed over 1,000 buildings, and incapacitated the city's firefighting capabilities. The devastation did not end there. Sixteen hours later, a second vessel, also carrying ammonium

nitrate, caught fire, and exploded, further compounding the disaster. With Texas City powerless and its emergency response assets depleted, the city was left defenseless against the ensuing destruction. The Texas City disaster is widely regarded as the worst industrial accident in U.S. history.

Another tragic incident occurred on the night of December 3, 1984, in Bhopal, India. As most residents slept, approximately forty tons of methyl isocyanate, a highly toxic chemical, leaked from the Union Carbide India Limited (UCIL) pesticide plant. The gas release exposed over 500,000 people in the city and surrounding areas to the deadly toxin. Official records list the immediate death toll at 2,259, while legal settlements place the number of fatalities at 3,787. Some estimates suggest that over 8,000 lives were lost due to the disaster. In a 2006 legal filing by the Indian government, it was reported that the chemical release caused 558,125 injuries, including 38,478 temporary injuries and illnesses, and left 3,900 individuals permanently disabled (Government of Madhya Pradesh, 2012). The Bhopal disaster is widely considered the worst industrial catastrophe in the world.



These disasters and many others, such as the Chernobyl nuclear reactor explosion or the BP Deepwater Horizon well blowout, underscore the critical importance of proactive risk management and the need for rigorous safety protocols in facilities and processes that produce, manage, and distribute hazardous chemicals and substances. These catastrophes serve as a sobering reminder of the human and environmental costs of neglecting safety in industrial operations, and they highlight the necessity for continuous vigilance, proper hazard identification, and effective control measures to prevent such tragedies from recurring.

## OSHA's Process Safety Management Standard (PSM)

The promulgation of OSHA's Process Safety Management (PSM) standard in 1992 was a direct response to a series of catastrophic industrial incidents in the 1970s and 1980s, which highlighted significant gaps in the management of hazardous chemicals in industrial settings. These incidents underscored the need for a comprehensive regulatory framework to prevent the uncontrolled release of highly hazardous substances.

The PSM standard, formally codified as 29 CFR 1910.119, established fourteen key elements that employers must address, including process hazard analysis, operating procedures, training, mechanical integrity, and emergency planning.



*The goal of the standard is to ensure that all aspects of chemical processing are managed safely, thereby reducing the likelihood of incidents that could harm workers, the public, and the environment.*

The development of the PSM standard marked a significant shift in industrial safety regulation, moving from reactive to proactive management of hazardous processes. By focusing on the prevention of accidents through systematic risk management, OSHA's PSM standard continues to play a critical role in protecting workers and communities from the dangers associated with highly hazardous chemicals.



# Key Requirements of the PSM Standard

## 1. Process Safety Information

Companies covered by the standard are required to compile and maintain accurate information pertaining to the hazards of the chemicals used in their covered processes. This includes data on the toxicity, physical properties, and reactive characteristics of the chemicals as well as information on the technology used in the process. Companies must document processes to ensure that all data is accessible and relevant to the safety of operations.

## 2. Process Hazard Analysis (PHA)

Companies under the standard must conduct a thorough Hazard Analysis, employing methodologies such as What-If Analysis, Hazard, and Operability study (HAZOP), or Failure Modes and Effects Analysis (FMEA) to identify potential hazards associated with processes. The PHA must be updated periodically, and findings must inform corrective actions and operational changes. This analysis plays a critical role in identifying risks to safety and mitigating potential incidents.

## 3. Operating Procedures

Written operating procedures are required for all processes involving highly hazardous chemicals. These procedures should detail safe operating practices, emergency response procedures, and the startup, operation, and shutdown processes for equipment. Properly established protocols help ensure that employees and contract workers understand their roles and responsibilities in maintaining safety.



## 4. Training

The PSM standard mandates that employers provide training to employees who are involved in processes using highly hazardous chemicals. Initial and ongoing training must ensure that workers are familiar with the operating procedures and the hazards associated with their jobs. This also includes training for contractor employees to ensure they are aware of the safety protocols of the host facility.

## 5. Contractor Management

The management of contractors is a critical component of OSHA's PSM standard, as it ensures that workers external to the plant's operations are effectively integrated into an organization's safety protocols, thereby reducing risks associated with hazardous processes. Effective contractor management involves thorough training, clear communication of safety expectations, and continuous monitoring of contractors' compliance with safety standards.

## 6. Mechanical Integrity

Companies must develop and implement a Mechanical Integrity Program to maintain the integrity of critical equipment used in processes involving highly hazardous chemicals. This includes routine inspections, testing, and maintenance of process equipment. Documented procedures must be established to evaluate potential impacts of changes and to ensure that safety protections remain effective.

## 7. Management of Change

The Management of Change (MOC) requirement encompasses all changes to operations, equipment, or personnel that could impact the safety of a process. Documented procedures must be established to evaluate potential impacts of changes and to ensure that safety protections remain effective.

## 8. Incident Investigation

The PSM standard requires an investigation of all incidents that result in, or could have resulted in, a catastrophic release of highly hazardous chemicals. Investigations must be documented, and corrective actions are required to amend deficiencies identified during the incident review. This approach aims to prevent future incidents.

## 9. Emergency Planning and Response

Companies must establish emergency response plans to protect the health and safety of employees and the public in the event of a release of hazardous chemicals. This includes procedures for notifying emergency responders and implementing actions to mitigate the released.



## 10. Audit Requirements

Regular audits are required to evaluate the effectiveness of the implemented PSM program. These audits must be conducted at least every three years, with findings documented to ensure ongoing improvement of safety practices.

## 11. Employee Participation

The PSM standard requires companies to involve employees in the development and implementation of safety procedures. Employee participation is critical as workers possess knowledge and insights of processes and hazards that can enhance safety procedures.

### Key Requirements of the PSM Standard





# The Impact of OSHA's PSM Standard on Process Safety Incidents

The enactment of OSHA's PSM standard, marked a significant shift in workplace safety regulations moving OSHA's enforcement from primarily preventing personal safety incidents to a broader commitment to include the prevention of the release of highly hazardous chemicals that pose catastrophic consequences. The PSM standard was constructed to assist companies in identifying potential safety hazards in process operations, implement risk control measures, and establish an organizational culture with an emphasis on safety.

The effectiveness of the PSM standard can be assessed through statistical analysis of workplace incidents involving hazardous materials. Data compiled by the Bureau of Labor Statistics (BLS) and the Chemical Safety Board (CSB) record notable changes in safety performance metrics since 1992.



## 1. Incident Rate Reduction

A study conducted by the CSB reported that the rate of incidents in the chemical manufacturing industry decreased by 50% from 1992 to 2015. This decline indicates that the implementation of the PSM standard has positively impacted traditional safety metrics.



## 2. Fatalities and Injuries

The BLS reported a decline in workplace fatalities in the chemical manufacturing sector, from a rate of 4.2 per 100,000 workers in 1992 to approximately 2.1 in 2018. This data underscores the effectiveness of the PSM regulation in reducing worker injuries and fatalities.

Research has indicated that organizations that have embraced OSHA's PSM standard report lower incident rates. Meta-analysis has indicated that firms investing in robust risk management and safety protocols experienced a 30% reduction in adverse events compared to non-compliant companies. Despite OSHA's regulatory efforts since 1992, notable incidents have continued to occur, highlighting gaps in compliance, training, and organizational culture surrounding safety.



Date	Location	Incident Type	Fatalities/Injuries	Contributing Causes
March 23, 2000	Phillips 66 Pasadena, Texas	Explosion	23 Fatalities 130 Injuries	<ul style="list-style-type: none"> <li>Inadequate safety management practices</li> <li>Procedural deviations</li> <li>Failure to implement management of change</li> </ul>
March 23, 2005	BP Refinery Texas City, Texas	Explosion	15 Fatalities 170 Injuries	<ul style="list-style-type: none"> <li>Organizational culture failure</li> <li>Poor communication</li> <li>Inadequate safety measures</li> <li>Lapses in training</li> <li>Lack of maintenance</li> </ul>
February 7, 2008	Imperial Sugar Wentworth, Georgia	Explosion	14 Fatalities Multiple Injuries	<ul style="list-style-type: none"> <li>Lack of dust management program</li> </ul>
April 20, 2010	BP Deepwater Horizon Gulf of Mexico	Oil Rig Blowout	11 Fatalities	<ul style="list-style-type: none"> <li>Equipment failures</li> <li>Inadequate risk analysis</li> <li>Poor safety management practices</li> </ul>
August 6, 2012	Chevron Facility Richmond, California	Fire	N/A	<ul style="list-style-type: none"> <li>Poor maintenance</li> <li>Inadequate inspection practices</li> <li>Lapse in worker training</li> </ul>
April 17, 2013	West Fertilizer West, Texas	Explosion	15 Fatalities 200+ Injuries	<ul style="list-style-type: none"> <li>Improper chemical storage</li> <li>Failure to follow safety protocols.</li> <li>Insufficient emergency response preparedness</li> </ul>
November 15, 2014	Dupont Chemical Plant LaPorte, Texas	Chemical Release	4 Fatalities	<ul style="list-style-type: none"> <li>Incomplete hazard analysis</li> <li>Inadequate chemical safety systems</li> <li>Poor organizational culture</li> </ul>
August 31, 2017	Arkema Chemical Plant Crosby, Texas	Explosion Fire	N/A	<ul style="list-style-type: none"> <li>Inadequate emergency preparedness</li> <li>Insufficient backup systems</li> </ul>
June 21, 2019	Philadelphia Energy Refinery Philadelphia, Pennsylvania	Fire	N/A	<ul style="list-style-type: none"> <li>Insufficient risk management</li> <li>Poor maintenance</li> <li>Process control deficiencies</li> </ul>
August 21, 2023	Marathon Refinery Garyville, Louisiana	Explosion	5 Fatalities Multiple Injuries	<ul style="list-style-type: none"> <li>Insufficient management of risks</li> <li>Malfunction of safety systems</li> <li>Lapse in training</li> </ul>

Table 2. Summary of Catastrophic Incidents Post-PSM Standard Promulgation





## Contractor Use in PSM and Highly Hazardous Industry Facilities

Companies that fall under OSHA's PSM regulations routinely use contractors and contracted workers to perform installation, maintenance, and repair activities. Many process safety incidents involve contractors at some level. Managing those contractors is critical to ensuring compliance with OSHA's PSM standard to ensure that safeguards are in place to prevent the release of hazardous substances, safeguard employees, protect the environment and surrounding community, mitigate risk, and provide efficient use of company assets. Utilizing contractors also allows these companies to access expertise, manage costs, and maintain flexibility in their operations.



Table 2 summarizes some common examples of contractor use in PSM facilities and other highly hazardous industry locations.

Type of Contractor Participation	Description of Activities
Maintenance and Turnarounds	Extensive maintenance, repairs, inspections, and upgrades during shutdowns.
Non-Destructive Testing	Ultrasonic testing, radiography, and infrared thermography to inspect equipment without causing damage.
Inspections, Audits, and Training (e.g., safety, environmental)	Inspections, audit, and training to meet stringent safety and environmental standards.
Construction and Expansion Projects	Expansions, upgrades, or the construction of new facilities to increase capacity, improve efficiency, or comply with new regulations.
Mechanical and Electrical Services	Installation, testing, and commissioning of new mechanical and electrical systems and components.
Engineering and Design	Expert assistance with design of new systems, equipment, and facilities.
Civil and Structural Work	New structures, foundations, and infrastructure, including the construction of roads, pipelines, and storage tanks.
Installation Service	Installation of new machinery, electrical systems, control systems, and safety equipment.
Parts and Equipment	Production and supply of new and spare parts and equipment, ranging from small components like valves and seals to large machinery like compressors and turbines.
Specialized Goods	Supply of specialized chemicals, catalysts, and materials critical to the chemical processes.
Logistics and Transportation	Delivering raw materials, parts, and equipment to the plant and shipping finished products to customers, including managing the transportation of hazardous materials.
Operational Support Services	Support services essential to day-to-day operations, such as facility management, administrative services, security, IT, and automation support.



# Benefits of Supply Chain Risk Management Software in Contractor Management

Supply Chain Risk Management (SCRM) software offers significant benefits in contractor management within PSM and other highly hazardous industries. By integrating SCRM software into contractor management processes, companies can enhance visibility and control over their supply chains, ensuring that all contractors and suppliers meet stringent safety and compliance standards. This software enables real-time monitoring of contractor performance, adherence to safety protocols, and compliance with PSM regulations, thereby reducing the risk of incidents caused by non-compliant or poorly managed contractors.

Additionally, SCRM software helps in identifying and mitigating potential risks in the supply chain before they lead to disruptions or safety incidents. For highly hazardous industries, this proactive approach is crucial in preventing accidents that could result from substandard materials, inadequate safety practices, or delays in critical supplies. By leveraging SCRM software, companies can foster stronger collaboration with contractors, ensure continuous compliance with safety regulations, and enhance the overall safety and reliability of their operations.

Some specific advantages of SCRM software in managing contractors and supply-chain risk are as follows.



## Risk Assessment and Mitigation

SCRM software provides organizations with tools to identify potential risks within the contractor's operations. By leveraging data analytics, companies can pinpoint suppliers and contractors with a history of safety violations or inferior performance.



## Streamlined Communication

Effective communication is crucial in safety management. SCRM software can enhance communication channels between contractors and facility management, ensuring all parties are on the same page regarding safety protocols and expectations.



## Documentation and Compliance Tracking

SCRM software can help manage contractors, maintain records of compliance with OSHA regulations, evaluate safety policies and procedures, track worker compliance training, and other industry specific standards. This feature enables organizations to track contractor performance over time and provide documentation during audits.




## Emergency Preparedness

SCRM tools can facilitate better planning for emergencies by providing access to real time data on contractor personnel and equipment. This ensures a timely response and coordination in an emergency, promoting overall site safety.



## Data-Driven Decision Making

SCRM software allows organizations to analyze trends and patterns, guiding decision-making regarding contractor selection and risk management strategies. By using historical data, organizations can improve their mitigation tactics and develop more effective safety programs.



## Summary and Key Takeaways

OSHA's PSM Standard represents a critical framework for preventing catastrophic incidents involving highly hazardous chemicals. The historical context of major industrial disasters, such as the Texas City Disaster and the Bhopal incident, underscores the necessity for comprehensive safety management practices. These tragedies highlight the devastating consequences of neglecting process safety, including loss of life, environmental devastation, and substantial economic impacts.

The PSM Standard addresses these issues by mandating proactive measures, including hazard analysis, training, and continuous improvement through audits and emergency response planning. Since its implementation, the standard has contributed to a notable decrease in incident rates within the chemical manufacturing sector, reinforcing its positive impact on worker safety and organizational accountability. However, the analysis of ongoing incidents reveals that compliance and cultural factors still present significant challenges in the effective implementation of PSM principles.

To enhance safety further and prevent future disasters, organizations must cultivate a strong safety culture that prioritizes the identification and mitigation of hazards, starting in the design phase of processes. Preventing human error through systemic design and robust management practices will yield

safer workplaces. Additionally, effective contractor management—an often-overlooked aspect of PSM—is vital for reinforcing safety protocols in environments where external workforce participation is prevalent.

As industries evolve, continuous adaptation and reinforcement of the PSM Standard and associated safety practices are imperative. Investing in prevention through design, conducting thorough risk assessments, and leveraging technology such as Supply Chain Risk Management software can further fortify safety measures. By embracing these comprehensive strategies, organizations can not only comply with regulations but also foster a culture of safety that protects workers, communities, and the environment. Moving forward, a commitment to continuous improvement and innovation in safety practices will be essential in the pursuit of a safer industrial landscape.

Contractor management software is designed to streamline the complex process of managing multiple contractors, ensuring they meet all necessary regulatory and company-specific requirements. This software centralizes information, automates processes, and provides real-time insights, making it easier to manage contractor compliance with PSM regulations.



Veriforce partners with companies every day to create a safer workforce.

Contact [safety@veriforce.com](mailto:safety@veriforce.com) to learn more.

## About the Author



**James A. Junkin, MS, CSP, MSP, SMS, ASP, CSHO** is the chief executive officer of Mariner-Gulf Consulting & Services, LLC and the chair of the Veriforce Strategic Advisory Board and the past chair of Professional Safety journal's editorial review board. James is a member of the Advisory Board for the National Association of Safety Professionals (NASP). He is Columbia Southern University's 2022 Safety Professional of the Year (Runner Up), a 2023 recipient of the National Association of Environmental Management's (NAEM) 30 over 30 Award for excellence in the practice of occupational safety and health and sustainability, and the American Society of Safety Professionals (ASSP) 2024 Safety Professional of the Year for Training and Communications, and the recipient of the ASSP 2023-2024 Charles V. Culberson award. He is a much sought after master trainer, keynote speaker, podcaster of The Risk Matrix, and author of numerous articles concerning occupational safety and health.



## References

- Almiki, A., & alzharani, A. (2019). Contractor performance assessment criteria. A review and comparative analysis. *Journal of Construction Project Management and Innovation*, 9(2), 2565-2578
- Brent Coon & Associates. (2004). *Texas City Refinery Fatality History: 1974 – Present*
- Bureau of Labor Statistics. (2019). *Census of fatal occupational injuries in the United States*. U.S. Department of Labor. <https://www.bls.gov>
- Chemical Safety Board. (2001). Investigation report. Explosion and fire at the Phillips 66 Company chemical plant. [https://www.csb.gov/assets/1/20/phillips66\\_report.pdf](https://www.csb.gov/assets/1/20/phillips66_report.pdf)
- Chemical Safety Board. (2007). Final investigation report: BP Texas City refinery explosion. <https://www.csb.gov/assets/1/20/CSBFinalBPReport.pdf>
- Chemical Safety Board. (2009). Investigation report: Imperial Sugar Company explosion and fire: [https://www.csb.gov/asets/1/20/imperial\\_sugar\\_report.pdf](https://www.csb.gov/asets/1/20/imperial_sugar_report.pdf)
- Chemical Safety Board. (2013). Chevron refinery fire in Richmond, California. [https://www.csb.gov/assets/1/20/Chevron\\_Final\\_Report.pdf](https://www.csb.gov/assets/1/20/Chevron_Final_Report.pdf)
- Chemical Safety Board. (2016). Investigation report: West Fertilizer Company explosion. [https://www.csb.gov/assets/1/20/West\\_Fertilizer\\_Investigation-Report.pdf](https://www.csb.gov/assets/1/20/West_Fertilizer_Investigation-Report.pdf)
- Chemical Safety Board. (2018). Arkema chemical plant explosions and fires. [https://www.csb.gov/assets/1/20/Arkema\\_Investigation\\_Report.pdf](https://www.csb.gov/assets/1/20/Arkema_Investigation_Report.pdf)
- Chemical Safety Board. (2020). Summary of findings: Philadelphia energy Solutions refinery fire. [https://www.csb.gov/assets/1/20/PES\\_Investigation\\_Summary.pdf](https://www.csb.gov/assets/1/20/PES_Investigation_Summary.pdf)
- Chemical Safety Board. (2024). Marathon refinery explosion investigation report. [https://www.csb.gov/assets/1/20/Marathon\\_Report.pdf](https://www.csb.gov/assets/1/20/Marathon_Report.pdf)
- Government of Madhya Pradesh. (2012). Bhopal Gas Tragedy Relief and Rehabilitation Department. Immediate Relief Provided by the State Government. <https://mp.gov.in/bgtrrdmp/relief.htm>
- Hendershot, D. (2009), A history of process safety and loss prevention in the American Institute of Chemical Engineers. *Process Safety Progress*, 28(2), 105-113.
- Huang, X. (2017). A framework for contractor management in the construction industry. *International Journal of Project Management*, 35(7), 1338-1347.



## References cont.

Kletz, T. (2009). What went wrong? Case histories of process plant disasters and how they could have been avoided (5th ed.). Burlington, MA: Elsevier

Lehtola, M., Rantala, T., & Jantunen, E. (2022). Evaluating contractor safety management practices in connection with PSM: A study of perceptions and safety culture.

National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling. (2011). Deepwater: The Gulf oil disaster and the future of offshore drilling. <https://www.govinfo.gov/content/pkg/GPO-OILCOMMISSION/pdy/GPO-OILCOMMISSION.pdf>

Occupational Safety and Health Administration. (1992). Regulations (Standards – 29 C.F.R. § 1910.119

Occupational Safety and Health Administration. (2017). Process Safety Management for Small Businesses. <https://osha.gov/sites/default/files/publications/OSHA3908.pdf>

Occupational Safety and Health Administration. (n.d.). Process Safety Management (PSM). <https://osha.gov/chemical-exposure/pathogens>

Sexton, K., McGowan, S., & Marcus, A. (2021). Managing risks associated with contractor safety in process industries: A review of current practices and recommendations. *Journal of Safety Research*, 77, 1-12. <https://doi.org/10.1016/j.jsr.2021.06.001>

Shokri, A., & O'Neill, A. (2021). Suppl chain risk management, A strategic approach to Minimizing disruptions in construction projects. *Construction Management and Economics* 39(2), 178-192

Smith, J., John, L., & Martinez, R. (2021). An analysis of process safety management and safety performance metrics in the chemical industry. *Journal of Safety Research*, 75, 203-210

Zhao, J., Yan, X., & Wang, Y. (2020). Exploring the role of supply chain risk management in Safety performance of construction projects. *Risk Analysis*, 40(4), 724-737