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INTRODUCTION

Scope

This training module covers the basic element of Process Safety Management in sufficient detail to allow an engineer to develop and implement a process safety management.

Process safety encompasses technical safety, operational safety and personnel safety. The processes in the plant shall be studied to understand the hazards involved in operation. The goal of process safety is to develop a systematic and comprehensive approach to safety that involves the proactive identification, evaluation, and mitigation or prevention of chemical releases that might occur as a result of failures in the process, procedures, or equipment.

Process safety management (PSM) is the proactive identification, evaluation and mitigation or prevention of chemical releases that could occur as a result of failures in processes, procedures, or equipment. Process safety management is widely credited for reductions in major accident risk to prevent unwanted releases of hazardous chemicals and improved process industry performance. The process safety management standard targets highly hazardous chemicals that have the potential to cause a catastrophic incident. The PSM Rule describes a comprehensive management system containing 14 elements for effective control of process hazards.

An effective process safety management program requires a systematic approach to evaluating the whole process. Using this approach the process design, process technology, operational and maintenance activities and procedures, nonroutine activities and procedures, emergency preparedness plans and procedures, training programs, and other elements which impact the process are all considered in the evaluation.

The final PSM standard mainly applies to manufacturing industries—particularly, those pertaining to chemicals, transportation equipment, and fabricated metal products. Other affected sectors include natural gas liquids; farm product warehousing; electric, gas, and sanitary services; and wholesale trade.

General Design Consideration

For many years, companies focused their accident prevention efforts on improving the technology and human factors. In the mid-1980s, following a series of serious chemical accidents around the world, companies, industries, and governments began to identify management systems (or the lack thereof) as the underlying cause for these accidents. Companies were already adopting management systems approaches in regard to product quality, as evidenced by various Total Quality Management initiatives, with widely reported success.

Companies developed policies, industry groups published standards, and governments issued regulations, all aimed at accelerating the adoption of a management systems approach to process safety. Thus, the initial, somewhat fragmented, hazard analysis and equipment integrity efforts were gradually incorporated into integrated management systems. The integrated approach remains a very useful way to focus and adopt accident prevention activities. More recently, inclusion of manufacturing excellence concepts has focused attention on seamless integration of efforts to sustain high levels of performance in manufacturing activities. Done well, manufacturing excellence deeply embeds process safety management practices into a single, well-balanced process for managing manufacturing operations (CCPS).

Causes of chemical process incidents can be grouped in one or more of the following categories:

- Technology failures
- Human failures
- Management system failures
- External circumstances and natural phenomena

Process safety encompasses technical safety, operational safety and personnel safety. The processes in the plant shall be studied to understand the hazards involved in operation. The plants shall be classified using commonly available risk matrices that consider the potential severity and likelihood of occurrence. Subsequently, control measures shall be implemented to eliminate or reduce the risk to an acceptable level.

The goal of process safety is to develop a systematic and comprehensive approach to safety that involves the proactive identification, evaluation, and mitigation or prevention of

chemical releases that might occur as a result of failures in the process, procedures, or equipment (Kletz, 1998). Positive safety management is an evolving process, where improvements are planned, implemented, continuously monitored and acted upon to maintain a safe working environment.

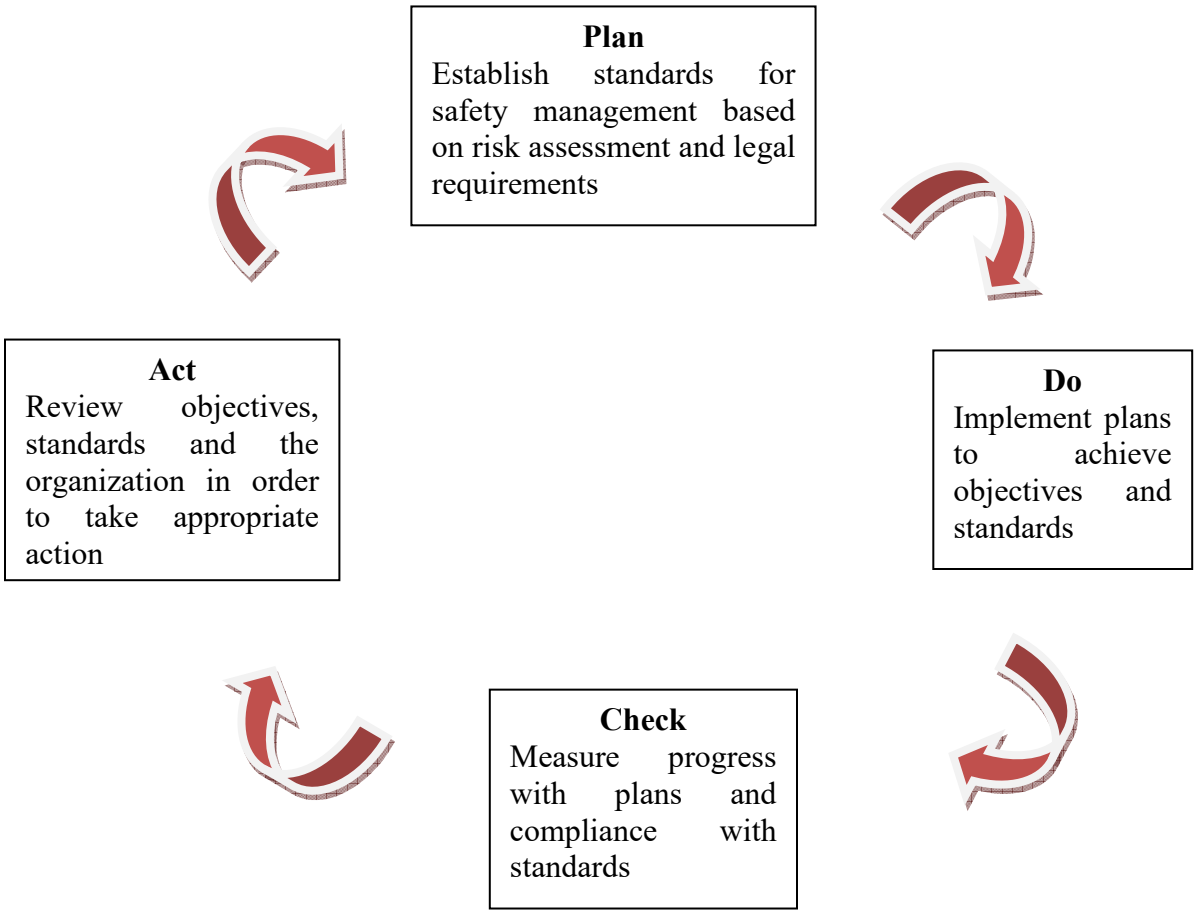

Figure 1: Process in positive safety management

In 1990, two major developments in U.S. process safety occurred: the publication of a proposed standard from the Occupational Safety and Health Administration (OSHA), titled "Process Safety Management of Highly Hazardous Chemicals," and the passage by the U.S. Congress of the Clean Air Act Amendments (CAAA) of 1990. The CAAA provided regulatory oversight of process safety in the chemical industry to OSHA and the U.S. Environmental Protection Agency (EPA). In particular, CAAA identified 14 minimum elements that the OSHA Process Safety Management Standard must require of employers. Below are the CAAA Process Safety Management Standard Requirements

1. Develop and maintain written safety information identifying workplace chemical and process hazards, equipment used in the processes, and technology used in the processes;
2. Perform a workplace hazard assessment, including, as appropriate, identification of potential sources of accidental releases, identification of any previous release within the facility that had a potential for catastrophic consequences in the workplace, estimation of workplace effects of a range of releases, and estimation of the health and safety effects of such a range on employees;
3. Consult with employees and their representatives on the development and conduct of hazard assessments and the development of chemical accident prevention plans and provide access to these and other records required under the standard;
4. Establish a system to respond to the workplace hazard assessment findings, which shall address prevention, mitigation, and emergency responses;
5. Review periodically the workplace hazard assessment and response system;
6. Develop and implement written operating procedures for the chemical processes, including procedures for each operating phase, operating limitations, and safety and health considerations

A plant may have some process areas that are covered by the PSM Rule and others that are not. PSM provisions are invoked for covered processes only. Figure 2 provides a general logic diagram for determining the applicability of the PSM Rule

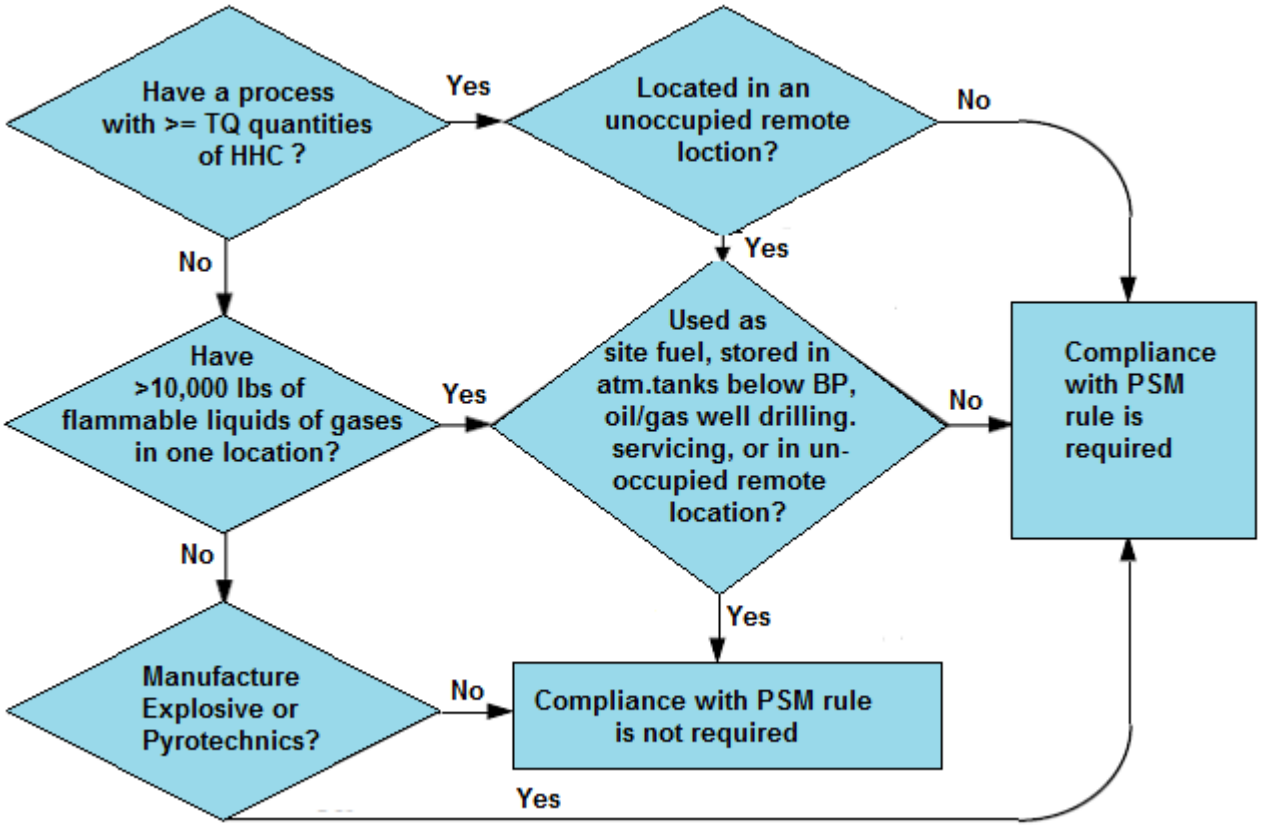

Figure 2: Applicability of the PSM rule (DOE, 1996)

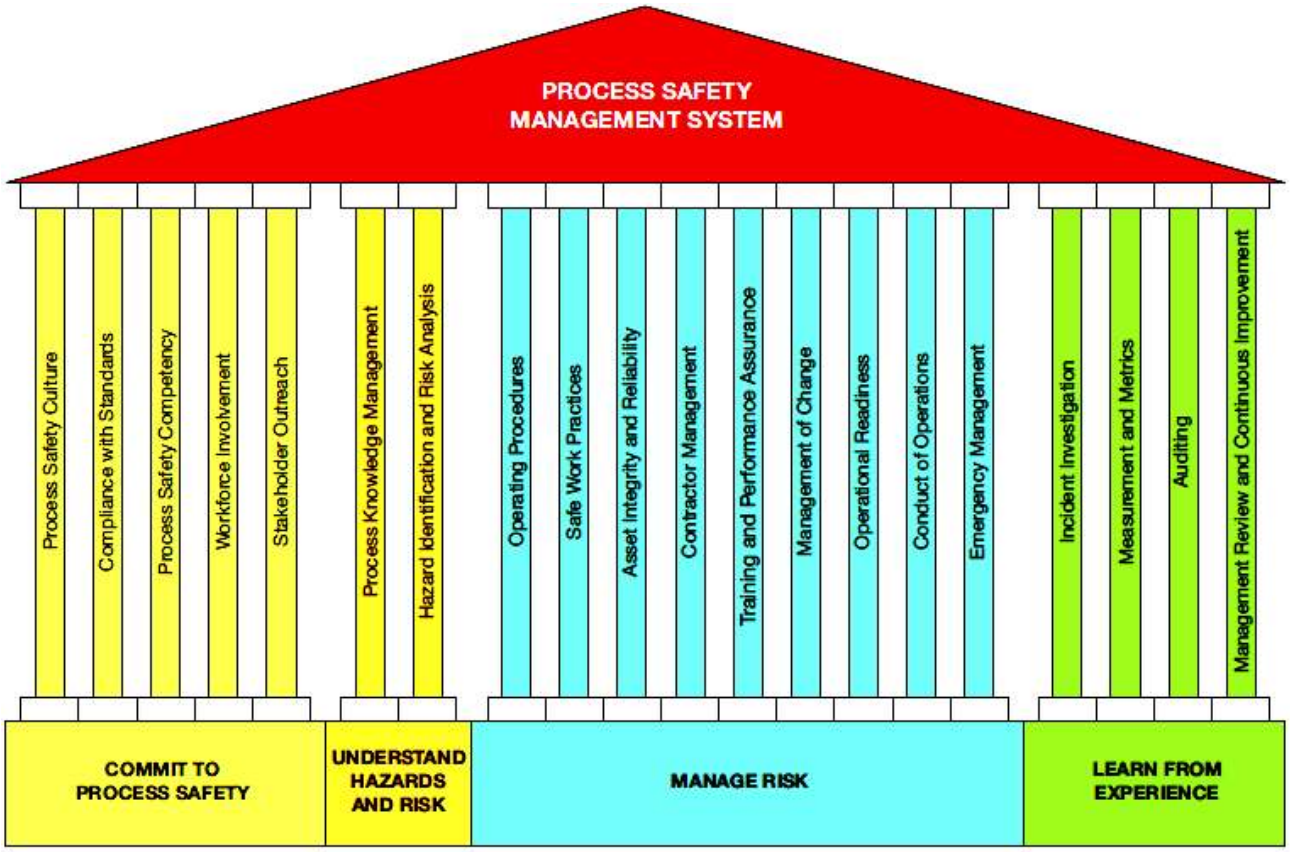

Figure 3: Pillars (Foundational Blocks) and associated Elements (CCPS)

Commitment to process safety

Authentic commitment to process safety is the cornerstone of process safety excellence. Management commitment has no substitute. Organizations generally do not improve without strong leadership and solid commitment. The entire organization must make the same commitment. A workforce that is convinced that the organization fully supports safety as a core value will tend to do the right things, in the right ways, at the right times, even when no one is looking. This behavior should be consistently nurtured, and celebrated, throughout the organization. Once it is embedded in the company culture, this commitment

to process safety can help sustain the focus on excellence in the more technical aspects of process safety.

1. Process safety culture

Process safety culture has been defined as, “the combination of group values and behaviors that determine the manner in which process safety is managed”. More succinct definitions include, “How we do things around here,” “What we expect here,” and “How we behave when no one is watching.” The following four essential features will help achieve and maintain a sound process safety culture.

- Establish process safety as a core value.
- Provide strong leadership.
- Establish and enforce high standards of performances.
- Document the process safety culture emphasis and approach.

2. Compliance with standards

Standards is a system to identify, develop, acquire, evaluate, disseminate, and provide access to applicable standards, codes, regulations, and laws that affect process safety. Knowledge of and conformance to standards helps a company operate and maintain a safe facility, consistently implement process safety practices, and minimize legal liability. The following essential features help ensure that process safety management activities are executed dependably across a facility involving a variety or people and situations:

- Ensure consistent implementation of the standards system.
- Identify when standards compliance is needed.
- Involve competent personnel.
- Ensure that standards compliance practices remain effective

3. Process safety competence

Developing and maintaining process safety competency encompasses three interrelated actions: (1) continuously improving knowledge and competency, (2) ensuring that appropriate information is available to people who need it, and (3) consistently applying what has been learned. Normally, one or more of several conditions are necessary for an organization to invest in process safety competency:

- a business case describes the expected benefits and the level of resources that must be invested to achieve those benefits,
- the organization inherently values technology and places particular value on enhancing its process safety competency,
- the organization believes that decisions should be based on knowledge that is supported by facts, and any significant improvement in the body of knowledge will lead to better decisions, thereby reducing risk and improving performance.

4. Workforce involvement

Workforce involvement provides a system for enabling the active participation of company and contractor workers in the design, development, implementation, and continuous improvement of management system. When a company identifies or defines an activity to be undertaken, that company likely wants the activity to be performed correctly and consistently over the life of the facility. For the workforce involvement practice to be executed dependably across a company or facility involving a variety of people and situations, the following essential features should be considered:

- Ensure consistent implementation.
- Involve competent personnel.

5. Stakeholders outreach

Stakeholder outreach is a process for (1) seeking out individuals or organizations that can be or believe they can be affected by company operations and engaging them in a dialogue about process safety, (2) establishing a relationship with community organizations, other companies and professional groups, and local, state, and federal authorities, and (3) providing accurate information about the company and facility's products, processes, plans, hazards, and risks. This process ensures that management makes relevant process safety information available to a variety of organizations. This element also encourages the sharing of relevant information and lessons learned with similar facilities within the company and with other companies in the industry group. Finally, the outreach element promotes involvement of the facility in the local community and facilitates communication of information and facility activities that could affect the community. In order for outreach activities to be executed dependably across a company

involving a variety or people and situations, the following essential features should be considered:

- Ensure consistent implementation.
- Involve competent personnel.
- Keep practices effective.

Understand hazards and risk

Organizations that understand hazards and risk are better able to allocate limited resources in the most effective manner. Industry experience has demonstrated that businesses using hazard and risk information to plan, develop, and deploy stable, lower-risk operations are much more likely to enjoy long term success.

1. Process knowledge management

The knowledge element primarily focuses on information that can easily be recorded in documents, such as written technical documents and specifications; engineering drawings and calculations; specifications for design, fabrication, and installation of process equipment, and; other written documents such as material safety data sheets (MSDSs). The term process knowledge will be used to refer to this collection of information. The knowledge element involves work activities associated with compiling, cataloging, and making available a specific set of data that is normally recorded in paper or electronic format. Accurate and complete process knowledge is required to thoroughly identify process hazards and analyze risk. Establishing a dependable practice to collect, maintain, and protect a company's process knowledge helps protect an important asset which simply makes good business sense. The management system should include the essential features listed below:

- Ensure consistent implementation.
- Define the scope.
- Thoroughly document chemical reactivity and incompatibility hazards.
- Assign responsibilities to competent personnel.

2. Hazard Identification and Risk Analysis (HIRA)

Hazard Identification and Risk Analysis (HIRA) is a collective term that encompasses all activities involved in identifying hazards and evaluating risk at facilities, throughout their life cycle, to make certain that risks to employees, the public, and/or the environment are consistently controlled within the organization's risk tolerance. For the risk management system to be executed dependably across a facility involving a variety of people and situations, the following essential features should be considered:

- Document the intended risk management system.
- Integrate HIRA activities into the life cycle of projects or processes.
- Clearly define the analytical scope of HIRAs and assure adequate coverage.
- Determine the physical scope of the risk system.
- Involve competent personnel.
- Make consistent risk judgments.
- Verify that HIRA practices remain effective.

Managing risk

Managing risk focuses on three issues:

- Prudently operating and maintaining processes that pose the risk.
- Managing changes to those processes to ensure that the risk remains tolerable.
- Preparing for, responding to, and managing incidents that do occur.

Managing risk helps a company or a facility deploy management systems that help sustain long-term, incident-free, and profitable operations.

1. Operating procedures

Operating procedures are written instructions (including procedures that are stored electronically and printed on demand) that (1) list the steps for a given task and (2) describe the manner in which the steps are to be performed. Good procedures also describe the process, hazards, tools, protective equipment, and controls in sufficient detail that operators understand the hazards, can verify that controls are in place, and can confirm that the process responds in an expected manner. Procedures critical to the safe operation or maintenance of equipment should reference hazard review information (as appropriate) and include consequence of deviation warnings. Procedures should also provide instructions for troubleshooting when the system does not respond as expected.

Procedures should specify when an emergency shutdown should be executed and should also address special situations, such as temporary operation with a specific equipment item out of service. Operating procedures are normally used to control activities such as transitions between products, periodic cleaning of process equipment, preparing equipment for certain maintenance activities, and other activities routinely performed by operators.

2. Safe work practices

Procedures are generally divided into three categories.(1) Operating procedures govern activities that generally involve producing a product; (2) Maintenance procedures, generally involve testing, inspecting, calibrating, maintaining, or repairing equipment; (3) Safe work procedures, which are often supplemented with permits (i.e., a checklist that includes an authorization step), fill the gap between the other two sets of procedures. Safe work practices help control hazards and manage risk associated with non-routine work.

3. Asset integrity and realibility

The asset integrity element is the systematic implementation of activities, such as inspections and tests necessary to ensure that important equipment will be suitable for its intended application throughout its life. Specifically, work activities related to this element focus on: preventing a catastrophic release of a hazardous material or a sudden release of energy and ensuring high availability (or dependability) of critical safety or utility systems that prevent or mitigate the effects of these types of events.

4. Contractor management

Contractor management is a system of controls to ensure that contracted services support both safe facility operations and the company's process safety and personal safety performance goals. This element addresses the selection, acquisition, use, and monitoring of such contracted services. In order for the contractor management practice to be executed dependably across a company or facility involving a variety of people and situations, the following essential features should be considered:

- Ensure consistent implementation.
- Identify when contractor management is needed.
- Involve competent personnel.

- Ensure that practices remain effective.

5. Training and performance assurance

Training is practical instruction in job and task requirements and methods. It may be provided in a classroom or workplace, and its objective is to enable workers to meet some minimum initial performance standards, to maintain their proficiency, or to qualify them for promotion to a more demanding position. Performance assurance is the means by which workers demonstrate that they have understood the training and can apply it in practical situations. Performance assurance is an ongoing process to ensure that workers meet performance standards and to identify where additional training is required.

6. Management of change

The MOC element helps ensure that changes to a process do not inadvertently introduce new hazards or unknowingly increase risk of existing hazards. The MOC element includes a review and authorization process for evaluating proposed adjustments to facility design, operations, organization, or activities prior to implementation to make certain that no unforeseen new hazards are introduced and that the risk of existing hazards to employees, the public, and/or the environment is not unknowingly increased. It also includes steps to help ensure that potentially affected personnel are notified of the change and that pertinent documents, such as procedures, process safety knowledge, and other key information, are kept up–to-date.

7. Operational readliness

The readiness element ensures that shut down processes are verified to be in a safe condition for re-start. This element addresses startups from all types of shut down conditions and considers the length of time the process was in the shutdown condition. Some processes may be shut down only briefly, while others may have undergone a lengthy maintenance/modification outage, or they may even have been mothballed for an extended period. Other processes may have been shut down for administrative reasons, such as a lack of product demand; for reasons unrelated to production at all; or as a precautionary measure, for example, because of an approaching hurricane. In addition to the shutdown duration, this element considers the type of work that may have been conducted on the process (e.g., possibly involving line-breaking) during the shutdown period to help focus the readiness review prior to startup. Records should be maintained

concerning readiness activities so that performance and efficiency can be periodically evaluated.

- Ensure consistent implementation.
- Determine types of and triggers for the readiness practice.
- Determine the scope of readiness reviews.
- Involve competent personnel.
- Ensure that readiness practices remain effective.

8. Conduct of operations

Conduct of operations (operations) is the execution of operational and management tasks in a deliberate and structured manner. It is also sometimes called “operational discipline” or “formality of operations”, and it is closely tied to an organization’s culture. Conduct of operations institutionalizes the pursuit of excellence in the performance of every task and minimizes variations in performance. Workers at every level are expected to perform their duties with alertness, due thought, full knowledge, sound judgment, and a proper sense of pride and accountability.

9. Emergency management

Emergency management includes: (1) planning for possible emergencies, (2) providing resources to execute the plan, (3) practicing and continuously improving the plan, (4) training or informing employees, contractors, neighbors, and local authorities on what to do, how they will be notified, and how to report an emergency, and (5) effectively communicating with stakeholders in the event an incident does occur.

Learning from experience

Learning from experience involves monitoring, and acting on, internal and external sources of information. Despite a company’s best efforts, operations do not always proceed as planned, so organizations must be ready to turn their mistakes – and those of others – into opportunities to improve process safety efforts. The most cost effective ways to learn from experience are to:

- Apply best practices to make the most effective use of available resources.
- Correct deficiencies exposed by internal incidents and near misses.

- Apply lessons learned from other organizations.

In addition to recognizing these opportunities to better manage risk, companies must also develop a culture and infrastructure that helps them remember the lessons and apply them in the future. Metrics can be used to provide timely feedback on the workings of RBPS management systems, and management review, a periodic honest self-evaluation, helps sustain existing performance and drive improvement in areas deemed important by management.

1. Incident investigation

Incident investigation is a process for reporting, tracking, and investigating incidents that includes: (1) a formal process for investigating incidents, including staffing, performing, documenting, and tracking investigations of process safety incidents and (2) the trending of incident and incident investigation data to identify recurring incidents. This process also manages the resolution and documentation of recommendations generated by the investigations. Investigations are a responsibility that is typically shared across many personnel in the company. In order to achieve consistency, investigators need a defined process and clear expectations. The more detailed the guidance provided to the teams through the program documentation and through an element expert, the greater the level of consistency that will be achieved.

2. Measurements and metrics

A combination of leading and lagging indicators is often the best way to provide a complete picture of process safety effectiveness. Outcome oriented lagging indicators, such as incident rates, are generally not sensitive enough to be useful for continuous improvement of process safety management systems because incidents occur too infrequently. Measuring process safety management performance requires the use of leading indicators, such as rate of improperly performed line breaking activities. Defining roles and responsibilities, which metrics data should be collected and how often, and the necessary technical expertise of personnel is critical to having an effective metrics system. Records should be maintained concerning metrics activities so that performance and efficiency can be periodically evaluated.

- Establish consistent implementation.
- Determine triggers for metrics collection and reporting.

- Ensure that the scope of the metrics is appropriate.
- Involve competent personnel.
- Keep metrics practices effective.

3. Auditing

The audits element is intended to evaluate whether management systems are performing as intended. The audits element comprises a system for scheduling, staffing, effectively performing, and documenting periodic evaluations as well as providing systems for managing the resolution of findings and corrective actions generated by the audits. The audits element should be documented to an appropriate level of detail in a procedure or a written program addressing the general management system aspects previously.

4. Management review and continuous improvement

Management review is the routine evaluation of whether management systems are performing as intended and producing the desired results as efficiently as possible. It is the ongoing “due diligence” review by management that fills the gap between day-to-day work activities and periodic formal audits.

The final PSM standard mainly applies to manufacturing industries—particularly, those pertaining to chemicals, transportation equipment, and fabricated metal products. Other affected sectors include natural gas liquids; farm product warehousing; electric, gas, and sanitary services; and wholesale trade. It also applies to pyrotechnics and explosives manufacturers covered under other OSHA rules and has special provisions for contractors working in covered facilities.

The process safety management standard targets highly hazardous chemicals that have the potential to cause a catastrophic incident. OSHA’s standard applies mainly to manufacturing industries–particularly those pertaining to chemicals, transportation equipment, and fabricated metal products. Other affected sectors include those involved with:

- natural gas liquids
- farm product warehousing
- food processing
- electric, gas, and sanitary services

- wholesale trade
- pyrotechnics and explosives manufacturers

The PSM standard does not apply to:

- retail facilities
- oil or gas well drilling or servicing operations
- normally unoccupied remote facilities
- hydrocarbon fuels used solely for workplace consumption as a fuel (e.g. propane used for comfort heating, gasoline for vehicle refueling), if such fuels are not a part of a process containing another highly hazardous chemical covered by this standard
- flammable liquid stored in atmospheric tanks or transferred which are kept below their normal boiling point without benefit of chilling or refrigerating and are not connected to a process

The PSM Rule describes a comprehensive management system containing 14 elements for effective control of process hazards. The word system implies the integration of all management elements with a method for assessing the efficiency and effectiveness of implementation. The elements of the PSM Rule discussed in this section are an interrelated set of management systems associated with the process, people, production, and preparedness.

The final PSM standard was promulgated in 1992 by OSHA and is enforced by that office in coordination with EPA. The standard emphasizes the management of hazards through a comprehensive program that integrates management technologies, practices, and procedures and includes 14 mandatory elements that correlate to the CAAA requirements. Under CAAA, EPA has responsibilities relating to the prevention of accidental release, inventories of chemicals, and development of risk management plans (RMP), among other things.

1. Process Safety Information
2. Process Hazard Analysis
3. Operating Procedures
4. Training

5. Contractors
6. Mechanical Integrity
7. Hot Work
8. Management of Change
9. Incident Investigation
10. Compliance Audits
11. Trade Secrets
12. Employee Participation
13. Pre-startup Safety Review
14. Emergency Planning and Response

Table 1: Overview of PSM Elements (DOE, 1996)

Elements	
Process Safety Information	Maintain complete and accurate information on the process technology, process equipment, and hazardous characteristics and physical properties of all chemicals and intermediates for all covered processes.
Process Hazard Analysis	Identify and assess process hazards for each covered process, and take action to manage risk.
Operating Procedures	Provide clear written instructions for safely conducting activities at each covered process that address operating limits, safety and health considerations, and safety systems and their functions.
Training	Provide initial and refresher training with a means of verifying employee understanding for all employees involved in operating a covered process.
Subcontractor Safety	Ensure that subcontractor operations do not compromise the level of safety on or in the vicinity of a process using HHCs.

Mechanical Integrity	Ensure the integrity and safe operation of process equipment through inspection, testing, preventive maintenance, and quality assurance
Hot Work	A permit must be issued for hot work operations conducted on or near a covered process.
Management of Change	Establish and implement written procedures to manage changes (except for replacements in kind) to process chemicals, \ technology, equipment, and procedures, and to facilities that affect a covered process.
Incident Investigation	Using a written procedure, provide a team investigation of any incident which results in, or could reasonably result in, a catastrophic release of a highly hazardous chemical. Each investigation must be documented in a written report and findings and recommendations resolved in a timely manner.
Compliance Audits	Ensure that the PSM program is operating in an integrated and effective manner in compliance with PSM requirements.
Trade Secrets	Ensure all information is available to support the PSM Rule. When necessary, confidentiality or nondisclosure agreements may be used.
Employee Participation	Ensure that workers and their representatives are consulted and have access to information regarding all PSM elements.
Pre-Startup Safety Review	Perform safety reviews for new and modified facilities prior to operation when the modification is significant enough to require a change in the process safety information.
Emergency Planning and Response	Establish and implement an emergency action plan for the entire plant and that also addresses small releases.

DEFINITIONS

Audit (Process Safety Audit) - An inspection of a plant or process unit, drawings, procedures, emergency plan, and/or management systems by an independent team.

Catastrophic release - a major uncontrolled emission, fire, or explosion, involving one or more highly hazardous chemicals, that presents serious danger to employees in the workplace.

Change - Any alteration in process chemicals, technology, procedures, equipment, ppurtenances, or facilities.

Event - An occurrence involving process, equipment, or human performance either internal or external to a system that causes system upset. In terms of accidents, an event is either a cause or contributing cause of a near miss or accident, or a response to the accident-initiating event

Facility - The plants, units, buildings, containers, or equipment that contain or include a process.

Fault-Tree Analysis - A logic model that graphically portrays the potential combinations of events, such as equipment failures, control system failures, or human errors that can lead to a major incident, as defined in this subsection.

Failure Modes and Effects Analysis (FMEA) - A systematic, tabular method for evaluating and documenting the causes and effects of known types of component failure

Hazardous Material - A substance (gas, liquid or solid) capable of creating harm to people, property or the environment (e.g. materials which are flammable, toxic, etc.).

Hazard and Operability Study (HAZOP) - A systematic method in which process hazards and potential operating problems are identified using a series of guidewords to investigate process deviations.

Highly Hazardous Chemical (HHC) - A substance possessing toxic, reactive, flammable, explosive, or other dangerous properties exposure to which could potentially result in death or serious physical harm.

Hot Work - Electric or gas welding, cutting, brazing or any similar heat, flame, or spark-producing procedures or operations.

Inherent Safety - An approach to safety that focuses on eliminating or reducing the hazards associated with a set of conditions. A process is inherently safer if it reduces or eliminates the hazards associated with materials or operations used in the process, and this reduction or elimination is permanent and inseparable from the material or operation.

Initiating Cause - An operational error, mechanical failure, or other internal or external event that is the first event in an incident sequence and marks the transition from a normal situation to an abnormal situation.

Major Change - Introduction or alteration of a process, process equipment, substance or process chemistry, or any other alteration that may introduce a hazard which has the potential to result in death or serious physical harm.

Mechanical Integrity - State or quality of process equipment, controls, and appurtenances that takes into account fabrication from the proper materials of construction, design and use for the intended purpose, proper installation, inspection, maintenance and replacement.

Near Miss - An event that did not result in an accidental release of a highly hazardous chemical, but which could have, given another “failure.” Near misses, sometimes called “precursors,”

Process - Any activity involving a highly hazardous material, including use, storage, manufacturing, handling, or on-site movement.

Process Safety Culture - The core values and behaviors resulting from a collective commitment by leaders and individuals that emphasize safety over competing goals in order to ensure protection of people and the environment.

Process Safety Management - The application of management principles to ensure the safety of chemical process facilities.

Process Hazard Analysis (PHA) - The action of identifying undesired events which could lead to the materialization of a hazard and the estimation of the magnitude and likelihood of any harmful effects resulting from this materialization.

Process Flow Diagram - A drawing showing the major equipment and design flows of a process in diagrammatic form. The drawing is intended to show the process design basis in the form of temperatures, pressures, heat balance and mass balance.

Process Hazard - A physical situation with a potential for human injury, damage to property or damage to the environment through the release of energy in the form of fire, explosion, toxicity or corrosivity.

Risk - the potential for performance shortfalls, which may be realized in the future, with respect to achieving explicitly established and stated performance requirements in any one or more of the mission execution domains of safety, technical, cost, and schedule

Root Cause - Underlying reasons, such as deficiencies in management systems, which if corrected would prevent or significantly reduce the likelihood of the problem's reoccurrence.

Safeguard - A device, system or action that interrupts the chain of events following an initiating cause, or that mitigates the impacts of an incident.

Safety - defined as freedom from those hazards that can result in failure to meet one or more safety objectives by causing death, injury, or illness in humans, adversely affecting the environment, and/or causing damage to or loss of equipment or property.

Trade secret - means any confidential formula, pattern, process, device, information or compilation of information that is used in an employer's business, and that gives the employer an opportunity to obtain an advantage over competitors who do not know or use it.

NOMENCLATURE

BLEVE	boiling-liquid-expanding-vapor explosion or
BP	Boiling Point
CAAA	Congress of the Clean Air Act Amendments
EPA	Environmental Protection Agency
FMEA	Failure Modes and Effects Analysis
FTA	Fault tree analysis
HAZOP	Hazard and Operability Study
HHC	Highly Hazardous Chemicals
MI	Mechanical Integrity
MOC	Management of Change
MSDS	material safety data sheet
OSHA	Occupational Safety and Health Administration
PHA	Process Hazard Analysis
PSI	Process Safety Information
PSM	Process safety management
RMP	risk management plans
SOP	Standard Operating Procedures