Process Safety Management (PSM)

General Awareness Training

By

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This book is intended to provide the reader with a basic general awareness of the Occupational Safety and Health Administration (OSHA) Process Safety Management Standard (PSM).

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Chapter 1 – Why PSM Is Needed?

How did the PSM standard evolve?

The PSM standard started from previous chemical plant incidents that resulted in the deaths of several employees.

The following table illustrates some of the previous incidents that drove the need for OSHA to create the PSM standard.

Year	Location	Brief Description
1984	Bhopal, India	Methyl isocyanate gas leak. 3,800 deaths in local community. **Root Cause:** Process Hazard Analysis.
1989	Pasadena, Texas	Release of ethylene/propylene lead to explosion. 23 deaths and 130 injuries. **Root Cause:** Mechanical Integrity, Training, Hot Work and Contractors
1990	Channelview, Texas	Explosion of storage tank. 21 deaths. **Root Cause:** Mechanical Integrity and Process Hazard Analyses

NOTE: The standard is 29 CFR.1910.119

So, what is Process Safety Management?

Process Safety Management (PSM) is a program that involves managers, employees and contract workers, with the purpose of minimizing

uncontrolled change from design and/or operating intent at their facility or plant.

Therefore, the objective of the PSM standard is to prevent unwanted releases of hazardous chemicals into locations, which could expose employees and others to serious hazards or disaster.

How do you know if your facility requires a PSM program?
If your process involves a chemical at or above the specified threshold quantities listed in Appendix A of 29 CFR 1910.119.

OR

If your process involves a flammable liquid or gas on site in one location, in a quantity of 10,000 pounds (4535.9 kg).

Then a PSM Program is required!

But what is a Process?

A process is any activity involving a highly hazardous chemical including any use, storage, manufacturing, handling, or the on-site movement of such chemicals, or combination of these activities. For purposes of this definition, any group of vessels, which are interconnected and separate vessels, which are located such that a highly hazardous chemical could be involved in a potential release shall be considered a single process.

What is involved with a PSM program?

The OSHA PSM standard requires the implementation of 14 elements in a PSM program. OSHA determined from the root causes of previous catastrophic incidents, that the proper implementation of 14 elements would prevent future events.

The Fourteen Elements of PSM are:

1. Employee Participation
2. Process Safety Information
3. Process Hazard Analyses
4. Operating Procedures
5. Training
6. Contractors
7. Pre-Startup Safety Review
8. Mechanical Integrity
9. Hot Work Permits
10. Management of Change
11. Incident Investigations
12. Emergency Planning and Response
13. Compliance Audits
14. Trade Secrets

The following chapters will provide a little insight into these 14 elements of the PSM standard.

Chapter 2 – Employee Participation

For a PSM program to be successful, it must involve managers, hourly employees, contract workers , etc.
This goes along with the saying that "Two Heads Are Better Than One." Plus a facilities engineers and operators have a wealth of knowledge of what can go wrong with a process.

Employers shall develop a written plan to identify the individual responsible for the management of the program, how employees can be informed about it, and how suggestions can be submitted for improvement.

It is extremely important that contractor employees be included in the development of the PSM program. Previous incidents determined that the contractor was the root cause of the accident. In addition, the contractors can provide valuable information of what can go wrong with a process.

The employer must consult with employees on the development of the facilities or plants PSM program.

This communication of the information about the PSM program to employees can be accomplished by:

- Safety or staff meetings
- Emails

- Company newsletters
- Bulletin boards
- Company websites

In addition, information on the PSM program must be easily accessible to the employees.

Chapter 3 – Process Safety Information (PSI)

In order to properly conduct a Process Hazard Analysis on a process, information needs to be gathered concerning that process.

That information is called Process Safety Information and is
compiled about the process so employees can identify and understands its hazards.

This PSI information is broken down into three sections:

- Information pertaining to the hazards of the chemical.
- Information pertaining to the technology of the process.
- Information pertaining to the equipment of the process.

PSI must be compiled before conducting any Process Hazard Analysis.

Information Pertaining to the Hazards of the Chemical includes:

- Toxicity Information, such as:
  - Lethal Dose
  - Threshold Limit Value (TLV)
- Permissible Exposure Limits
- Physical Data, such as:
  - Boiling point
  - Vapor pressure
  - Vapor density
- Reactivity Data – how the it reacts with various other families of materials.
- Corrosivity Data – effect on containment materials.
- Thermal and Chemical Stability Data, such as:
  - Flammability limits
  - Flash point
  - Autoignition temperature
- Hazard Effects of Inadvertent Mixing of Different Materials

Commonly used references for the above information are:

- Safety Data Sheet (SDS)
- Threshold Limit Values and Biological

Exposure Indices published by the American Conference of Governmental Industrial Hygienists (ACGIH)

- National Institute for Occupational Safety And Health (NIOSH)/OSHA Pocket Guide to Chemical Hazards
- Hazardous Chemicals Desk Reference
- American Society of Mechanical Engineers (ASME), Boiler and Pressure Vessel Code
- American National Standards Institute (ANSI), Piping Code for Process Facilities
- American Petroleum Institute (API)

Information Pertaining to the Technology of the Chemical includes:

- Block Flow Diagram – simplified diagrams showing how the major components are connected in the process.
- Process Chemistry – the nature of the intended reactions needed for the process.
- Maximum Intended Inventory – for all storage tanks, reactors, drums and other vessels of the process.
- Safe Upper/Lower Limits – operating range for example:
  - Pressures
  - Temperatures
  - Flow rates
- Evaluation of consequences of deviations from the safe upper/lower limits, including those affecting safety and health of employees.

Information Pertaining to the Equipment and the Chemicals includes:

- Materials of Construction – which materials were used in the construction of the process.
- Piping and Instrument Diagrams that depict information such as:
  - All components
  - All piping
  - Flow directions
  - All valves
  - Symbols of each instrument
- Electrical Classifications – defined by National Fire Protection Association (NFPA) with respect to its potential for causing an electrically generated fire.
- Relief System Design and Design Basis – rationale for providing safety relief valves in certain locations, the selection of the size, establishment of set points, etc.
- Ventilation System Design and Design Basis, such as:
  - Air flow calculations
  - Equipment sizing calculations
- Design Codes and Standards Employed – used to form the design basis of the process.
- Material and Energy Balances for Processes Built after May 26, 1992.
- Safety Systems such as:
  - Lightning protection systems
  - Control interlocks
  - Systems designed to detect toxic or flammable materials

- Equipment complies with recognized and generally good engineering practices.
- Equipment designed/constructed to codes/standards no longer in general use, employer shall determine/document that the equipment is designed, maintained, inspected, tested, and operating in a safe manner.

Chapter 4 – Process Hazard Analysis (PHA)

The PHA is extremely important since it is an effort to identify and analyze the possible hazard scenarios within a process.

The PHA will basically look for:

- Potential causes and consequences of fires, explosions and toxic releases.
- Equipment failures, human errors and external events that may cause accidents.

OSHAs PSM standard dictate that the following methodologies can be used to identify and analyze the possible hazards:

- **What-If** – Uses "What If" questions, such as "What if water enters the process?"
- **Checklist** – Prepared questions to stimulate discussion about the hazards of the process. A question could be "Where can water enter the process?"
- **What-If/Checklist** – combination of What If/Checklist
- **Hazard and Operability Study (HAZOP)** - Investigates each element of a system for all of the ways in which important parameters can deviate from the intended design conditions to create hazards and operability problems.
- **Failure Modes and Effects Analysis (FMEA)** - looks at all the components of a system to see how it can fail and what would the effect of this failure have on downstream of this system.
- **Fault Tree Analysis** - A graphical, model, which shows an undesired top event and then all the lower level events that have to occur in order to achieve the undesired top event. It uses Boolean logic to combine these lower level events to lead up to the undesired top event.
- Other Methods are Acceptable with OSHA approval.

According to OSHAs PSM standard, the PHA must address the following:

- **Hazards of the process** – examples are fire and explosion, toxic releases, etc.
- **Identification of any previous incidents** – lessons learned from incidents can be analyzed. Could use incidents from similar processes.
- **Engineering controls** – examples could be ventilation, exhausts, etc.
- **Administrative controls** – examples could be minimizing the number of personnel in the vicinity of a hazardous operation.
- **Consequences of failure** of engineering and administrative controls – what happens when these controls fail?
- **Facility siting** – looks at the impacts to structures, equipment, and nearby personnel if a fire and explosion or the release of toxic substances.
- **Human Factors** – looks at operator intervention with the process
- **Qualitative evaluation** of range of the possible safety and health effects of failure of controls on employees in the workplace
    - A severity, likelihood and risk-ranking scheme could be used.

Therefore, the PHA must identify:

- All credible causes and consequences for hazard scenarios
- Include the causes of previous incidents
- All safeguards for the process

OSHA requires that a team approach be used when performing a PHA. For a PHA team:

- One member must have knowledge of the methodology used,
- One member must have experience and knowledge specific to the process,
- One member must have expertise in engineering and process operations.

The PHA team could also generate recommendations to make the process safer. If this happens, then the employer must establish a system to:

- Address and resolve recommendations in a timely manner
- Document resolutions and actions taken
- Written schedule for completion of actions
- Communicate actions to employees whose work may be affected

In order to keep the PHAs current, they must be revalidated every 5 years and will:

- Use same team approach as when PHA was initially completed
- Ensures PHA is still consistent with the current process and that should include modifications.

NOTE: All revisions of the PHA must be kept on file for the entire life of the process.

Chapter 5 – Operating Procedures

Another important element for safe operation of a process is the establishment of operating procedures.

OSHA requires that operating procedures provide clear instructions for safely operating the process. Make sense doesn't it?

Operating procedures must address ten steps for the operating phase of a process. They are:

- Initial startup
- Normal operations
- Temporary operations
- Emergency shutdown
- Emergency operations
- Normal shutdown
- Startup following a turnaround or shutdown
- Operating limits (pressures, flow rates, temperatures)
- Safety and health considerations
- Safety systems and their functions (example: Lightning protection systems, Control interlock, or Systems designed to detect toxic or flammable materials)

Operating procedures must also implement safe work practices:

- Lockout/Tagout (29 CFR 1910.147)
- Confined space entry (29 CFR 1910.146)
- Opening process equipment or piping

- Control over facility entrance for non-essential employees

In order to minimize the risk of operating procedures being the cause of an incident, they must be annually certified that they are current and accurate with the process.

Operating procedures must also be made accessible to employees that work the process.

NOTE: While processing the Space Shuttle for launch, NASA requirements dictated that the operators of the processes have a hard copy of their operating procedures when performing work. This reduced the risk of steps being missed and reduced the likelihood of an incident occurring. There was also a process in place for traceability to identify which operator performed a task that assisted with incident investigations.