Process Safety Training
OSHA 29 CRF 1910.119 Process Safety Management (PSM)
PSM Background

> A number of catastrophic accidents have occurred resulting in loss of life and significant property damage.

- Union Carbide: Bhopal, India (Dec 1984)
- Chernobyl: Ukraine (April 1986)
- Piper Alpha: North Sea (July 1988)
- Phillips Chemical: Pasadena, TX (Oct 1989)
- BP: Texas City, TX (Mar 2005)
- Patridge-Raleigh: MS (June 2006)
- Deepwater Horizon: TX (April 2010)
- West Fertilizer: West, TX (April 2013)
Personal Safety vs Process Safety

What is the difference?

**Personal Safety**

- Focus on preventing personal injuries
- Measured using: OSHA recordable, lost time accidents, MVA, etc
- Incident Probability: High
- Incident Severity: Low

**Process Safety**

- A systematic approach to manage the hazardous process to prevent potential release
- Look at entire process – material, equipment, systems
- Measured using all systems function
- Incident Probability: Low
- Incident Severity: High

---

[Personal safety hazards vs process safety hazards video](#) – 3 min
Process Safety

> ‘Process Safety’ involves the prevention of leaks, equipment malfunctions, over pressure, corrosion, metal fatigue, etc.

> Know your process – both physically and in terms of information about the process

> Embodies training and communicating process hazards to all affected employees and contractors

> Analyze the process to understand process (process hazards)

> Maintain the equipment

> Manage and communicate over the life of the process
Scope and Application

> PSM regulation provides requirements for preventing or minimizing consequences of a catastrophic release of chemicals that are:
  
  – Toxic
  – Reactive
  – Flammable or
  – Explosion

> 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
Scope and Application

- A process which involves a chemical at or above the specified threshold quantities (TQ) listed in Appendix A of the Rule. (TQ amounts vary by chemical)
  - e.g., Hydrogen Sulfide (TQ) = 1,500 lbs.
  - OR

- A process which involves a flammable liquid or flammable gas* on site in one location, in a quantity of 10,000 pounds or more
  - e.g., 10,000 lbs. of Natural Gas (0.7 SG) = 200,000 ft³ at STP
  - e.g., 10,000 lbs. of NGL (65°API) = 40 bbl, or 1,680 gal
  - e.g., 10,000 lbs. of Propane = 2,365 gal

* Flammable Liquid (Flash point less than 100 °F)
  Flammable Gas (13% or less with air or flammability range of 12% or greater)
Exemptions to the regulation

> PSM does not apply to:

- Retail Facilities
- Oil or gas well drilling or servicing
- Normally unoccupied remote facilities*
- Hydrocarbon fuels used solely for workplace consumption
- Any flammable liquid stored in atmospheric tanks or transferred which are kept below normal boiling point without benefit of chilling or refrigeration

*Normally Unoccupied Remote Facility* is a facility normally averaging a total of less than 14.5 man-hours per week — including both employees and contractors; geographically separated from other facilities and employees such that employees at other facilities would not be affected by an explosion, vapor cloud of toxic gas, or other consequences of an uncontrolled release at this normally unoccupied remote facility.
PSM Implementation

> PSM goal is protection of personnel

> PSM is not a program with definitive completion point

> PSM is a continuous management system
  – Senior Management direction and support
  – Mid Management commitment
  – Front line implementation

> Compliance is a moving target
  – Gather data, train, implement, monitor change, communication, evaluation, procedures, take corrective action, etc
The Elements of PSM

OSHA 29 CRF 1910.119

1) Employee Participation
2) Process Safety Information
3) Process Hazard Analysis
4) Operating Procedures
5) Training
6) Contractors
7) Pre-Safety Start Up Review
8) Mechanical Integrity
9) Hot Work Permit
10) Management of Change
11) Incident Investigation
12) Emergency Planning and Response
13) Compliance Audits
14) Trade Secrets
## Employee Participation

### Element 1

<table>
<thead>
<tr>
<th>Employee participation means:</th>
<th>Ways to participate:</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; Provide Input on process</td>
<td>&gt; PID review/verify</td>
</tr>
<tr>
<td>&gt; Consult with employees on process</td>
<td>&gt; SDS</td>
</tr>
<tr>
<td>&gt; Data available to employee</td>
<td>&gt; Operating Procedures</td>
</tr>
<tr>
<td>&gt; Training</td>
<td>&gt; PSSR</td>
</tr>
<tr>
<td></td>
<td>&gt; Monitor and evaluate contractors</td>
</tr>
<tr>
<td></td>
<td>&gt; Work Permits</td>
</tr>
<tr>
<td></td>
<td>&gt; Management of change</td>
</tr>
<tr>
<td></td>
<td>&gt; Emergency planning/drills</td>
</tr>
<tr>
<td></td>
<td>&gt; Process hazard analysis</td>
</tr>
<tr>
<td></td>
<td>&gt; MI: preventive maintenance, corrosion</td>
</tr>
</tbody>
</table>
Process Safety Information (PSI)

Element 2

Hazards of the process

> Safety Data Sheets (SDS)
> Hazardous effect of inadvertent mixing

Technology of the process

> Process Flow Diagram
> Process Chemistry
> Maximum Intended Inventory
> Safety Upper and lower operating limits
> Consequences of Deviation

Equipment in the process

> Piping and instrument diagrams (PID)
> Electrical Classification
> Relief Systems/OPP
> Ventilation system design
> Material of Construction
> Material and energy balance
> Safety Systems (shut downs, interlocks)
> Plot Plan
> Design Codes and Standards
Process Hazard Analysis (PHA)

Element 3

Purpose of a PHA:

> Purpose: PHA is in-depth review of the process to identify its current level or risk to evaluate potential hazards and implement controls within the process

> Goal: Recommendations for hazard mitigation

> Methods: HazOP, What-If, FMEA, Fault Tree, Checklist

Required PHA team:

> Engineering: Company Engineer II or higher

> Operations: Company Operations Technician III or higher

> Process: Company employee expertise in process

> Facilitator: knowledgeable of methodology

> Additional Members:
  – I&E
  – Maintenance
  – Equipment Supplier
  – Operational Safety

West Texas Explosion – 2 min
Process Hazard Analysis (PHA) cont

> Engineer and administrative controls applicable to the hazards such as detection of early warning of releases

> Human Factors

> Facility Siting Study

> The identification of any previous incident which had a likely potential for catastrophic consequences in the workplace.

> Documentation and timely resolution of PHA recommendations

> PHA must be updated and revalidated at least every 5 years and file for the life of the process
Process Hazard Analysis (PHA) Cont

Project engineer or coordinator is responsible for coordinating preparation up-to-date PSI required to conduct PHA:

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSI.01</td>
<td>Will the results of the PHA be communicated to affected employees?</td>
</tr>
<tr>
<td>PSI.02</td>
<td>Are the SDSs available?</td>
</tr>
<tr>
<td>PSI.03</td>
<td>Are the Effects of Mixing available?</td>
</tr>
<tr>
<td>PSI.04</td>
<td>Are the Block Flows or PFDs available?</td>
</tr>
<tr>
<td>PSI.05</td>
<td>Is the Process Chemistry available?</td>
</tr>
<tr>
<td>PSI.06</td>
<td>Is the Maximum Intended Inventory available?</td>
</tr>
<tr>
<td>PSI.07</td>
<td>Are the Safe Upper and Lower Limits available?</td>
</tr>
<tr>
<td>PSI.08</td>
<td>Are the Consequences of Deviations available?</td>
</tr>
<tr>
<td>PSI.09</td>
<td>Are the Materials of Construction available?</td>
</tr>
<tr>
<td>PSI.10</td>
<td>Are the P&amp;IDs available?</td>
</tr>
<tr>
<td>PSI.11</td>
<td>Are the Electrical Area Classification drawings available?</td>
</tr>
<tr>
<td>PSI.12</td>
<td>Is the Relief System Design Basis available?</td>
</tr>
<tr>
<td>PSI.13</td>
<td>Is the Ventilation System Design available?</td>
</tr>
<tr>
<td>PSI.14</td>
<td>Are the Design Codes and Standards available?</td>
</tr>
<tr>
<td>PSI.15</td>
<td>Are the Material and Energy Balances available?</td>
</tr>
<tr>
<td>PSI.16</td>
<td>Are the Cause-and-Effect Diagrams available?</td>
</tr>
<tr>
<td>PSI.17</td>
<td>Is the RAGAGEP documentation available?</td>
</tr>
<tr>
<td>PSI.18</td>
<td>Is documentation of Obsolete Codes, Standards, or Practices available?</td>
</tr>
</tbody>
</table>
Operating Procedures

Element 4

> Develop and implement written operating procedures consistent with process safety information for:

- Initial start-up and normal start-up
- Normal operations, emergency operations, and transition between
- Normal and emergency shut-down
- Temporary operations
- Operating limits and consequences of deviation
- Hazards presented by the process
- Include safe work practices
  - LOTO, confined space, control over entrance to facility, etc
Operator Procedures Cont

> Must be current and accurate

> Annual review
  – Establish a document control system to manage and track changes

> Must be readily accessible to employees

> Verify competency
  – Observe, test, or both: see training
Element 5

> Emphasis on the specific safety and health hazards of the process

> Emphasis on procedures including:
  - Operating
  - Preventative Maintenance
  - Emergency Shut-down
  - Safe work practices applicable to employee’s job task

> Refresher training at least every three years and provide input on the type and frequency of supplemental training

> Prepare a record which contains:
  - The identity of the employee
  - The date of training
  - The means used to verify that employee understood the training (written, verbal, and observation)
Contractors

Element 6

> Applies to contractors performing maintenance or repair, turnaround, major renovation, or specialty work on or adjacent to a covered process

> Inform contract employees of known hazards related to work

> Obtain and evaluate information regarding safety performance

Does not apply to contractors providing incidental services which do not influence process safety, such as janitorial work, food and drink services.
Pre-Safety Start Up Review (PSSR)

Element 7

> Immediately prior to introduction of high hazardous chemicals, a review must be performed for a new and modified facilities that require a change in the PSM information confirming:
  
  – Construction and equipment is in accordance with design specifications
  
  – Safety, Operating, Maintenance, and Emergency procedures are in place and are adequate
  
  – No unintended hazards are introduced
  
  – Affected employees are trained

> All PHA recommendations are resolved prior to PSSR

> Modified facilities must meet MOC requirements.
Element 8

Mechanical Integrity (MI)

Element 8

> Establish and implement written procedures to maintain the ongoing integrity of process equipment

  – Critical Equipment List
  – Inspection and tests must be performed within
    • Recognized and Generally Accepted Good Engineering Practices
    • Manufacturers’ recommendations
    • Prior operating experience
  – Fit for service

> Train employee overview to ensure safely perform tasks

> Correct deficiencies if equipment is outside acceptable limits to assure safe operation
Hot Work Permit

Element 9

> Must issue a hot work permit for hot work operations conducted on or near a covered process

> Permit must document:
  - Fire prevention requirements have been implemented before starting the hot work;
  - The date(s) authorized for hot work; and,
  - Object identity on which hot work is to be performed.

> Permit must be kept on file until at least the completion of the hot work
Management of Change (MOC)

Element 10

> Replacement in Kind

> Implement written procedures to manage changes to process chemicals, technology, equipment, procedures, and facilities that affect a covered process

  – Emergency MOC
  – Temporary MOC
  – By-passing safety device greater than 24 hours
Management of Change (MOC) cont

> Prior to startup, train and provide information to employees and contractors involved in operating or maintaining a process and whose job tasks will be affected by a change

> Update PSM information and conduct a pre-startup safety review (PSSR) if a change affects previously documented PSM information, operating procedures, or practices
Incident Investigation

Element 11

> Each incident that resulted in, or could reasonably have resulted in, a catastrophic release of a highly hazardous chemical in the workplace must be investigated

> The investigation must be initiated no later than 48 hours following the incident

> An incident investigation team that consists of persons knowledgeable in the incident process must be established and the team must thoroughly investigate and analyze the incident
Incident Investigation (cont)

> A report must be prepared at the conclusion of the investigation:

> The report must contain at a minimum the following: date of incident, date investigation began, description of the incident, factors that contributed to the incident and recommendations resulting from the investigation.

> A system must be developed to promptly address, resolve and document the incident report findings, recommendations and corrective actions.

> The incident report must be made available to affective employees, contractors and retained for at least 5 years.
Emergency Planning and Response

Element 12

> Emergency Action Plan must be developed to ensure the safe evacuation of employees

> Plan must address the means and methods necessary to protect employees responding to an uncontrolled release of a process chemical


> 29 CFR 1910.120 (a), (p), (q) (Hazardous waste operations and emergency response)
Compliance Audits
Element 13

> The adequacy of procedures and practices must be evaluated and certified at least every three years

> The compliance audit must be conducted by at least one person knowledgeable in the process

> A report of audit findings must be developed

> Appropriate response and any corrective action for each audit findings must be documented

> The two most recent compliance audit reports must be retained
Trade Secrets

Element 14

> Trade secret information must be made available to persons responsible for:

- Compiling the process safety information;
- Developing process hazard analysis, operating procedures and emergency planning and response; and
- Conducting incident investigations and compliance audits.

> Confidentiality agreements are permitted
OSHA

> 2009: National Emphasis Program on Petroleum Refinery

> 2011: National Emphasis Program Chemical Facilities

> 2013: President Obama Executive Order Improving Chemical Facility Safety and Security (results of the NEP, incidents)

> 2013/2014: OSHA request for Information/Comment Process Safety Management Enforcement/Policy update

> 2014: Chemical Safety Board (CSB) comments to potential revisions

> Present: No changes made (anticipate summer 2016 due to EPA Rule Changes)
Proposed Enforcement Changes

- Clarifying exemption to atmospheric storage tanks
- Oil and Gas Well Drilling and Servicing
- Oil and Gas Production Facilities
- Expanding Coverage
- Updating list Highly Hazardous Chemicals Appendix
- Require additional management system elements
- Applicable RAGAGEP
- Safety Critical Equipment
- MOC

- Emergency Planning with local response authorities
- Compliance Audit to third party
- Add dismantling and disposal of explosives, blasting agents, pyrotechnics
- Updating 1910.106 and 1910.107 on applicable consensus (Flammable/Combustible materials)

- RMP: PHA, Emergency Preparedness, Public Availability of information, data submitted on RMP
## PSM and RMP requirements, by RMP Plan

<table>
<thead>
<tr>
<th>Regulatory Requirements</th>
<th>Non-Regulatory Best Practices</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PSM &amp; RMP Program 1</strong></td>
<td><strong>CCPS Risk Based Process Safety Elements</strong></td>
</tr>
<tr>
<td>Employee Participation</td>
<td>Workforce Involvement</td>
</tr>
<tr>
<td>Process Safety Information</td>
<td>Compliance with Standards</td>
</tr>
<tr>
<td>Process Hazards Analysis</td>
<td>Process Knowledge Management</td>
</tr>
<tr>
<td>Operating Procedures</td>
<td></td>
</tr>
<tr>
<td>Training</td>
<td></td>
</tr>
<tr>
<td>Contractors</td>
<td></td>
</tr>
<tr>
<td>Pre-startup Safety Review</td>
<td>Hazard Identification and Risk Analysis</td>
</tr>
<tr>
<td>Mechanical Integrity</td>
<td></td>
</tr>
<tr>
<td>Hot Work Permit</td>
<td>Operating Procedures</td>
</tr>
<tr>
<td>Management of Change</td>
<td></td>
</tr>
<tr>
<td>Incident Investigation</td>
<td>Safe Work Practices</td>
</tr>
<tr>
<td>Emergency Planning and Response</td>
<td></td>
</tr>
<tr>
<td>Compliance Audits</td>
<td></td>
</tr>
<tr>
<td>Worst-Case Release Analysis</td>
<td>Auditing</td>
</tr>
<tr>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>5-year Accident History</td>
<td>N/A</td>
</tr>
<tr>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Reference: [https://www.osha.gov/chemicalexecutiveorder/psm_terminology.html](https://www.osha.gov/chemicalexecutiveorder/psm_terminology.html)
Training/References/Questions

> CCPS – Center Chemical Process Safety

> Mary Kay O’Connor: Process Safety Center (Texas AM Engineering)

> OSHA – Occupational Safety Health Administration

> ABS Consulting

> Prima Tech