Chemical Process Hazard Analysis

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PDH: 8

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Module 1: Introduction

Learning Objectives

By the end of this section, you will be able to:

- **Identify** the regulatory foundations and 14 elements of the OSHA Process Safety Management (PSM) Rule.
- **Evaluate** the mandatory compliance requirements for DOE contractors regarding Process Hazard Analysis (PrHA).
- **Select** appropriate resources and team expertise levels required to maintain organizational competence in PrHA.

Executive Summary: The PSM Rule (29 CFR 1910.119) establishes a comprehensive 14-element safety program designed to prevent catastrophic chemical accidents. For DOE contractors, compliance is mandated by DOE O 440.1 and 10 CFR 851, centering on the systematic identification of hazards through Process Hazard Analysis (PrHA) before process startup and every five years thereafter.

Regulatory Framework and Compliance

The Occupational Safety and Health Administration (OSHA) implemented **29 CFR 1910.119** to protect employees by preventing or minimizing the consequences of accidents involving highly hazardous chemicals.

- **The PSM Rule:** Prescribes a total safety management program consisting of **14 defined elements**.
- **DOE Mandates:** DOE O 440.1 requires all covered chemical processes within the Department of Energy to comply strictly with the PSM Rule.
- **Worker Safety and Health Rule:** 10 CFR 851 requires contractors to adhere to all applicable portions of 29 CFR 1910.

⚠️ **Safety Constraint:** The Process Hazard Analysis (PrHA) and all other PSM elements **must** be in place prior to the startup of any covered process.

Fundamentals of Process Hazard Analysis (PrHA)

The PrHA is considered one of the most critical elements of the PSM Rule. It requires a systematic approach to identifying hazards and potential accident scenarios.

- **Methodology Selection:** While the PSM Rule allows for various analysis methods, the selected method **must** be appropriate for the specific process being analyzed.
- **Lifecycle Requirements:** PrHAs are not one-time events; they must be **reviewed and updated at least every 5 years** to remain valid.

💡 **Design Tip:** While this handbook provides summary descriptions and step-by-step instructions, it is basic information. You should utilize the **Guidelines for Hazard Evaluation Procedures (CCPS, 1992)** as your primary technical reference.

Personnel and Organizational Competence

Maintaining competence in PrHA is a continuous requirement for any facility storing or using hazardous chemicals in above-threshold quantities.

- **Knowledge Requirements:** Every DOE facility must have staff specifically knowledgeable in PrHA.
- **Team Expertise:** At least one member of the PrHA team **must** be fully knowledgeable in the specific process methodology (e.g., HAZOP, FMEA) being utilized for the study.
- **Professional Development:** Engineers should engage with relevant professional organizations through technical meetings, books, and continuing education to maintain their edge.

Checkpoint Quiz

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1. **Which regulation serves as the primary driver for Process Safety Management of highly hazardous chemicals in the United States?**
   a) 10 CFR 830
   b) 29 CFR 1910.119
   c) DOE O 440.1
   d) CCPS 1992

Answer: (b). 29 CFR 1910.119 (the PSM Rule) is the foundational OSHA regulation that prescribes the 14 elements of a safety management program.

2. **At a minimum, how often must a Process Hazard Analysis (PrHA) be reviewed and updated?**
   a) Annually
   b) Every 3 years
   c) Every 5 years
   d) Only when a process change occurs

Answer: (c). The PSM Rule mandates that PrHAs be reviewed and updated at least every 5 years to ensure they reflect current process conditions.

3. **According to DOE requirements, what is a mandatory staffing requirement for a PrHA team?**
   a) All members must be certified safety professionals.
   b) The team must consist of exactly 14 members to match PSM elements.

c) At least one member must be knowledgeable in the specific analysis methodology being used.
d) Only federal employees can lead the analysis.

Answer: (c). At least one member of the PrHA team must possess expertise in the specific methodology chosen for the analysis.

Module 2: Overview of Requirements for Process Hazard Analysis Under the PSM Rule

Learning Objectives

By the end of this section, you will be able to:

- **Evaluate** the critical components of Process Safety Information (PSI) required as a prerequisite for a PrHA.
- **Analyze** the mandatory scope, scheduling, and team composition requirements for conducting a compliant PrHA under the PSM Rule.
- **Select** acceptable hazard analysis methodologies based on process complexity and regulatory criteria.

Executive Summary: The PrHA element mandates a systematic identification of hazards and accident scenarios for highly hazardous chemicals. Success depends on comprehensive Process Safety Information (PSI)—covering chemicals, technology, and equipment—and a multidisciplinary team employing approved methodologies to establish long-term safety controls and documentation.

Design Fundamentals: Process Safety Information

The PSM Rule requires that up-to-date **Process Safety Information (PSI)** exists before conducting a PrHA. This documentation is a prerequisite for the analysis team and is essential for training, operating procedures, and emergency planning.

Information About Highly Hazardous Process Chemicals

Information must be comprehensive enough to assess fire, explosion, reactivity, health hazards, and corrosive effects. Requirements include:

- **Toxicity and Limits:** Toxicity information and permissible exposure limits.
- **Physical Data:** Boiling/freezing points, densities, vapor pressure, flash point, autoignition temperature, and flammability limits (LFL/UFL).
- **Reactivity and Corrosivity:** Ignition/explosion potential and effects on metals or organic tissues.
- **Incompatibilities:** Dangerous contaminants and inadvertent mixing hazards.
- **Thermal Data:** Heat of reaction and combustion.

💡 **Design Tip:** Current **Material Safety Data Sheets (MSDSs)** are acceptable tools to help meet these chemical information requirements.

Information About Process Technology

Technology documentation must define the "safe envelope" of operation. Required elements include:

- **Flow Diagrams:** Block flow diagrams or simplified process flow diagrams.
- **Process Chemistry:** Detailed chemical interactions and reactivity.
- **Inventory and Limits:** Maximum inventory levels and defined upset conditions (process limits).
- **Consequence Estimates:** Qualitative estimates of deviations if limits are exceeded.

Block flow diagrams should illustrate major equipment, flow lines, rates, compositions, temperatures, and pressures. For complex systems, **Piping and Instrumentation Diagrams (P&IDs)** are more appropriate to show control loops and utility details.

Information About Process Equipment

Documentation must confirm that equipment is designed, built, and operated safely. Essential data includes:

- **Design Basis:** Materials of construction, P&IDs, and electrical classifications.
- **Safety Systems:** Relief system design, ventilation design, and material/energy balances.
- **Codes and Standards:** Identification of applicable codes (e.g., **ASME, ASTM, API**).

⚠️ **Safety Constraint:** If applicable codes are not current, the contractor **must** document that the equipment remains suitable for its intended use.

Process Hazard Analysis

A PrHA is the systematic method used to improve safety and reduce the consequences of unplanned releases. It analyzes fires, explosions, toxic releases, and major spills by focusing on equipment, human actions, and external factors.

Scheduling Requirements

- **Initial Implementation:** PrHAs **must** be in place prior to process startup.
- **Revalidation:** Each PrHA must be updated and revalidated at least **every 5 years**.

Scope of Analysis

To ensure thoroughness, the PrHA must address:

- **Process Hazards:** Identified through methods like a Preliminary Hazard Analysis (PHA).

Purchase this course to see the remainder of the technical materials.