

Process Safety Management (PSM) 29 CFR 1910.119



- Terms
- Applicability & Exceptions
- Process Hazard Analysis
- Data & Evaluation
- Methods to Describe Systems

- Steps for Each Operating Procedure
- Pre-Startup Review
- Incident Investigation
- Appendix A & B Contents
- Bibliography

Catastrophic release:

- Major uncontrolled emission, fire, or explosion
- Involves one or more highly hazardous chemicals
- Presents serious danger to employees in the workplace



Highly hazardous chemical: a substance possessing toxic, reactive, flammable, or explosive properties and specified by section 1910.119(a)(1)



Process:

- Any activity involving a highly hazardous chemical including use, storage, manufacturing, handling, or the on-site movement of such chemicals, or combination of these activities
- Any group of vessels that are interconnected, &
- Separate vessels which are located such that a highly hazardous chemical could be involved in a potential release
- All considered a single process



- Chemicals addressed in 1910.119, Appendix A at their Threshold Quantities (TQs)

<u>Chemical Name</u>	<u>CAS</u>	<u>TQ</u>
Acetaldehyde	75-07-0	2500
Acrolein (2-Propenal)	107-02-8	150

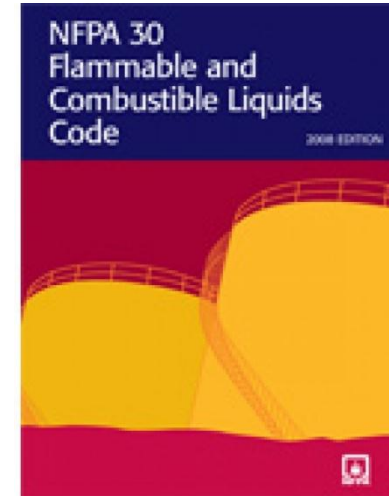
(View complete list of chemicals in Appendix A)

- Process involving a chemical at or above the specified threshold quantities (TQs)

29 CFR 1910.119 Applies To

Category 1 Flammable
Liquid (per 1910.1200)
or

Flammable Liquid with
flashpoint below 100°F
on site at one location
in a quantity of 10,000
lbs or more



29 CFR 1910.119 Exceptions

29 CFR 1910.119 does **NOT** apply to:

- Hydrocarbon fuels used solely for workplace consumption as a fuel not as part of a process containing another highly hazardous chemical
- Flammable liquids with a flashpoint below 100°F stored in atmospheric tanks or transferred kept below their normal boiling point without benefit of chilling or refrigeration



29 CFR 1910.119 Exceptions

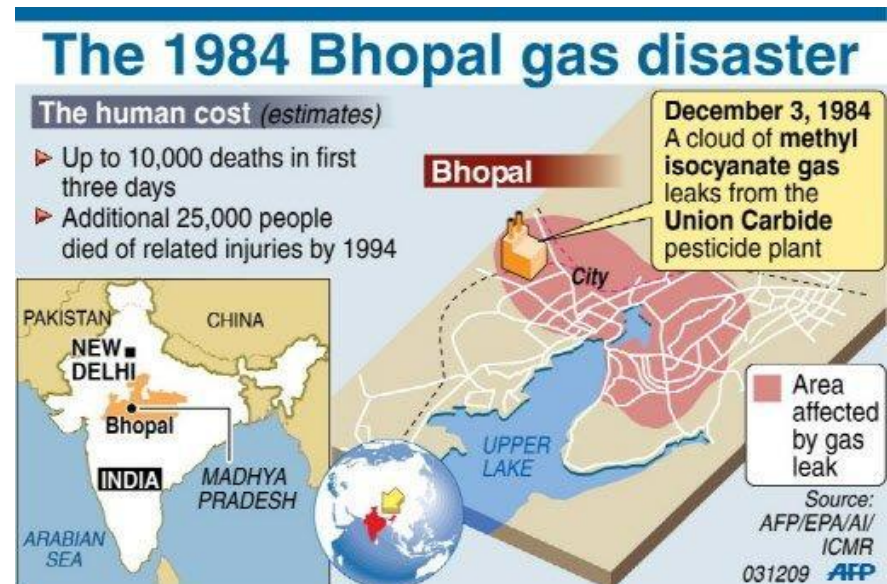
Also does **NOT** apply to:

- Retail facilities
- Oil/gas well drilling or servicing operations
- Normally unoccupied remote facilities



Purpose of Process Hazard Analysis

To plan against events which will disrupt or shutdown a process or to allow a chemical to escape its containment and impact on the plant, personnel and community at large

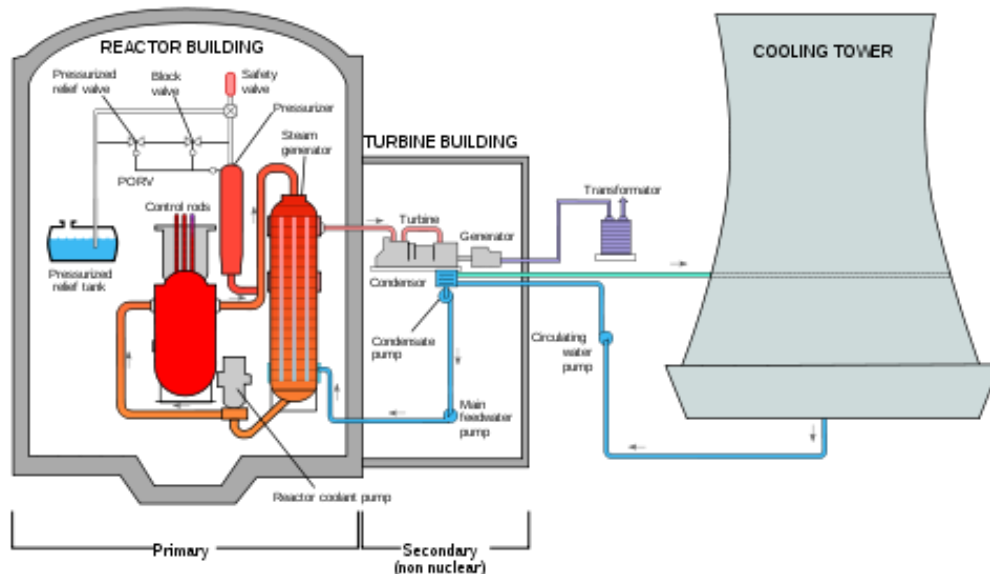


Planning

Through Anticipation or Historic Occurrence:
March 28, 1979, Middletown, Pennsylvania: Although a horrendous event, lessons were learned which benefitted the entire nuclear generating community



Three Mile Island
Nuclear Power Station
(TMI)



Process Hazard Analysis

Anticipates events based on the chemicals used in storage and processes

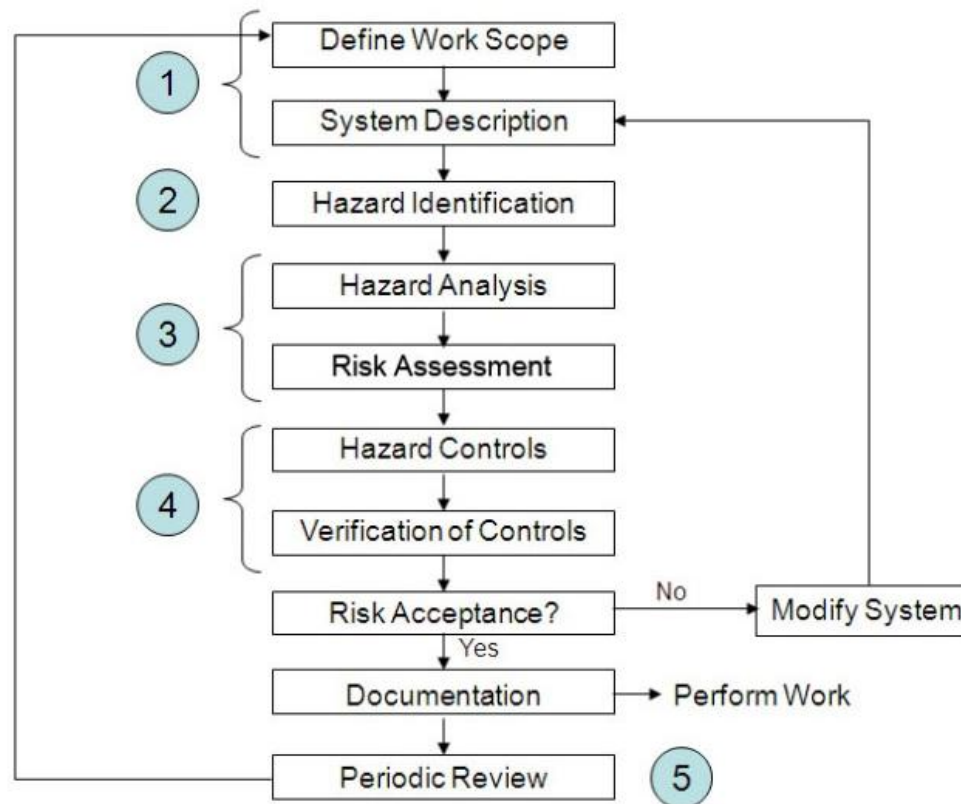
To preclude uncontrolled releases or to minimize their severity if released



A method to determine plant or process chemical hazards and develop policies, procedures and safeguards against emergencies which may occur



PHA Concept



- Employers shall develop a written plan of action for implementation of the employee participation required by 1910.119(c)
- Employers consult with employees/their representatives on conduct and development of process hazards analyses (PHA)

PHA: Employee Participation

- Provide employees and their representatives access to PHA and all other information required to be developed under this standard



Employer:

- Complete written process safety information before conducting any PHA
- To identify/understand hazards posed by those processes
- Include information concerning hazards of the highly hazardous chemicals used or produced by the process
- Information of the technology of the process
- Information of the equipment in the process

Highly Hazardous Chemical Process Information

- Toxicity
- Permissible exposure limits
- Physical data
- Reactivity data
- Corrosivity data

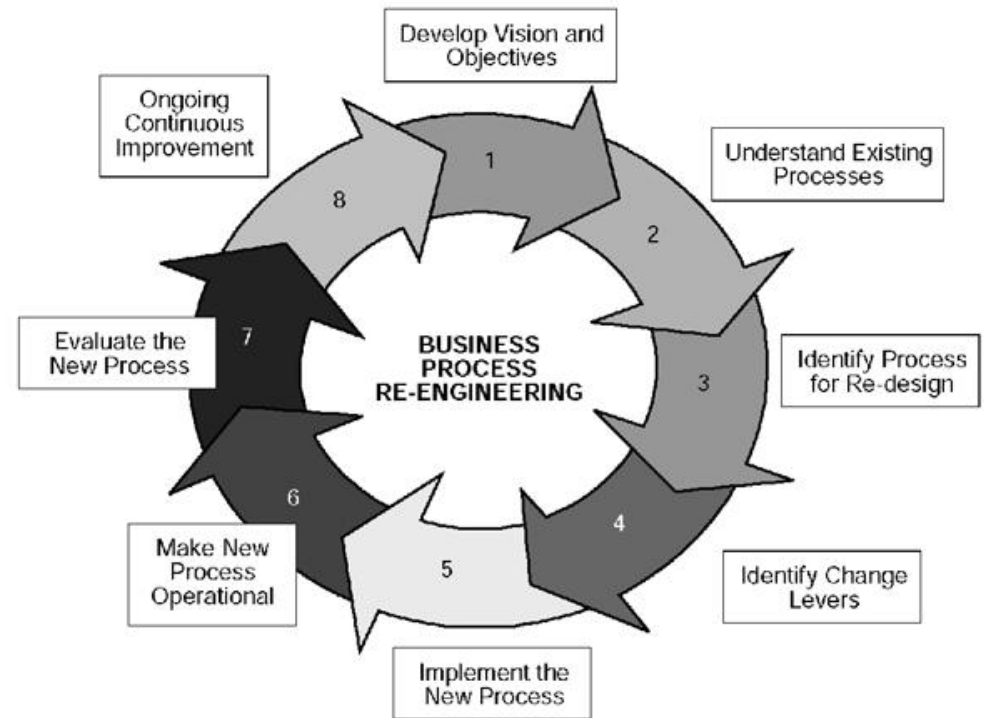


Data Evaluated for PHA

- Thermal and chemical stability data
- Hazardous effects of inadvertent mixing of materials
- Safety Data Sheets (SDS) per 29 CFR 1910.1200(g) may be used to comply



Graphic means which describe the workings of a process for purposes of emergency shutdown, maintenance and system restoration



Methods to Describe Systems

- Block flow diagram
- Process flow diagram
- Piping and instrument diagrams (P&IDs)

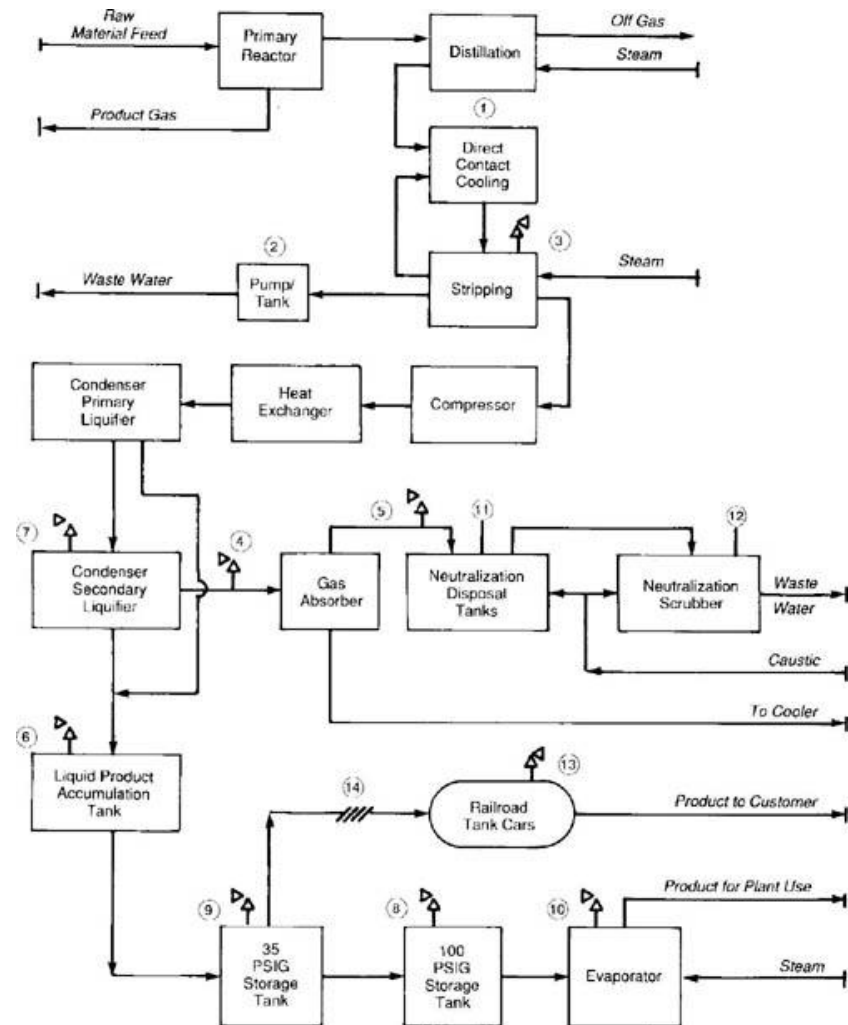


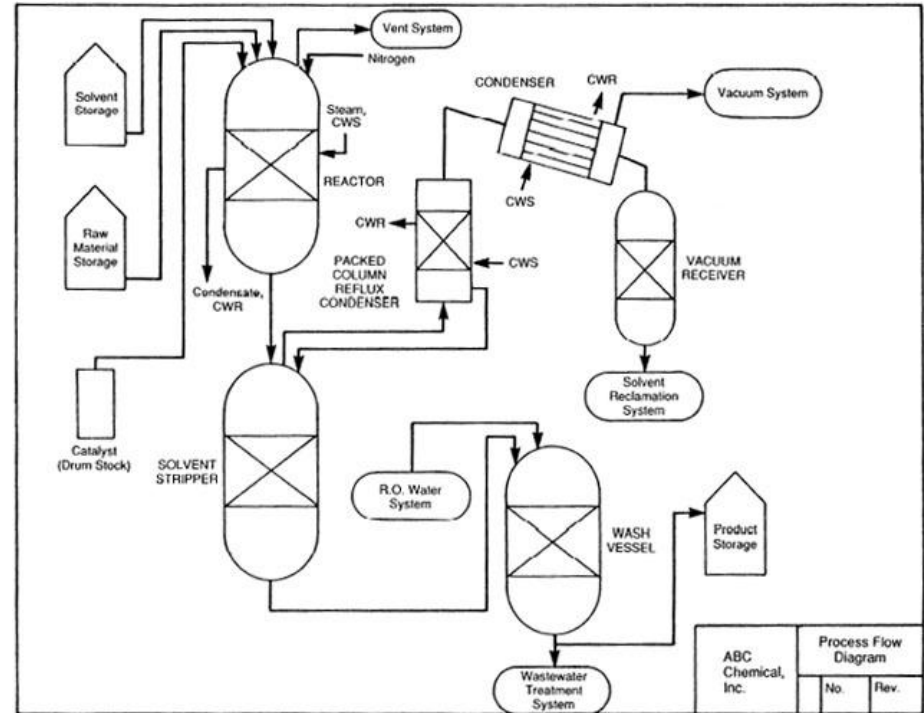
(Block & process diagrams available in 29 CFR 1910.119, Appendix B)

Block Flow Diagram

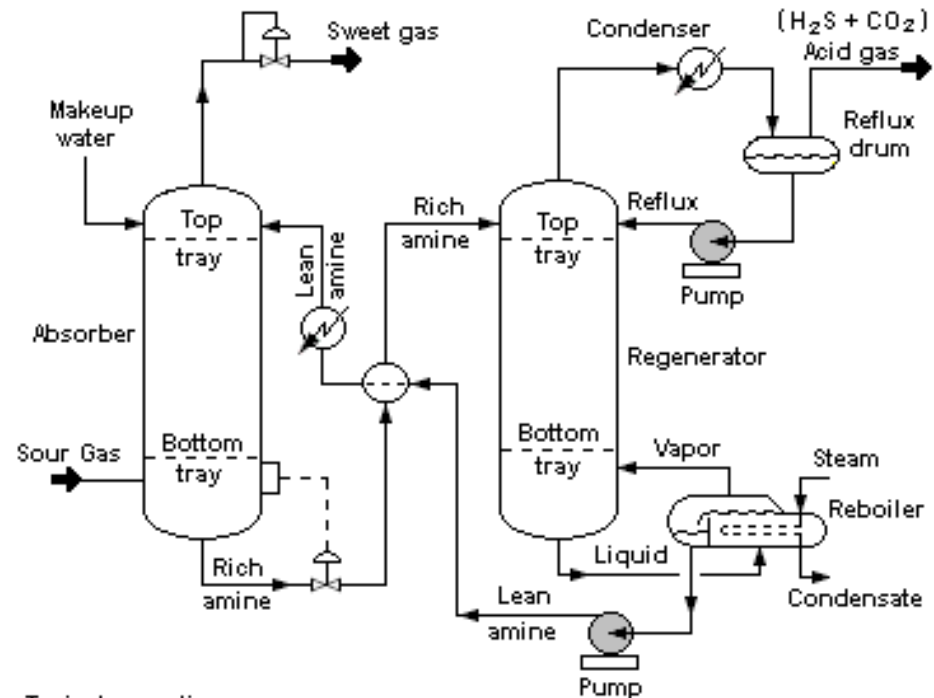
Elements:

- Simplified
- Major process equipment
- Interconnecting flow lines
- Flow rates
- Stream composition
- Temperatures and pressures





- Also known as (P&IDs)
- Describe relationships between equipment and instrumentation
- Computer software may be used



Typical operating ranges

Absorber : 35 to 50 °C and 5 to 205 atm of absolute pressure

Regenerator : 115 to 126 °C and 1.4 to 1.7 atm of absolute pressure
at tower bottom

Viewed:

- Process chemistry
- Maximum intended inventory
- Safe upper and lower limits
 - Temperatures
 - Pressures
 - Flows
 - Compositions
 - Deviation consequences affecting employee safety and health



- Where original technical information no longer exists
- Information may be developed in conjunction with the PHA in sufficient detail to support the analysis



Equipment in the Process

Include:

- Materials of construction
- Piping and instrument diagrams (P&IDs)
- Electrical classification
- Relief system design and design basis



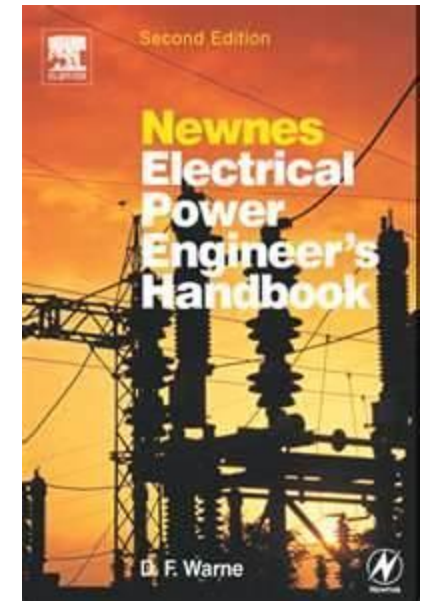
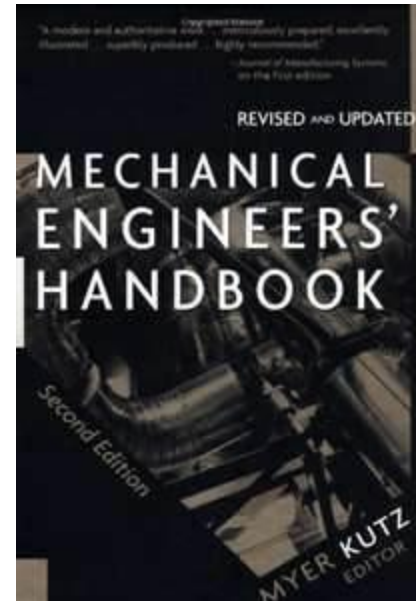
Equipment in the Process

- Ventilation system design
- Design codes and standards employed
- Material and energy balances for processes building after May 26, 1992
- Safety systems (interlocks, detection or suppression systems)



Employer Shall Document

- Equipment complies with recognized and generally accepted good engineering practices
- For existing equipment designed and constructed per codes, standards, or practices no longer in general use, determine and document it is:
 - Designed,
 - Maintained,
 - Inspected,
 - Tested, and
 - Operating in a safe manner



- PHA on processes covered by this standard
- Appropriate to the complexity of the process shall identify, evaluate and control the hazards involved
- Determine and document the priority order for conducting PHA based on extent of:
 - Process hazards
 - Number of potentially affected employees
 - Age of process
 - Operating history of process



PHA Time Lines



- Shall be conducted as soon as possible but no later than (NLT):

<u>NLT</u>	<u>Initial Process completed by</u>
25%	May 26, 1994
50%	May 26, 1995
75%	May 26, 1996
Completed by	May 26, 1997

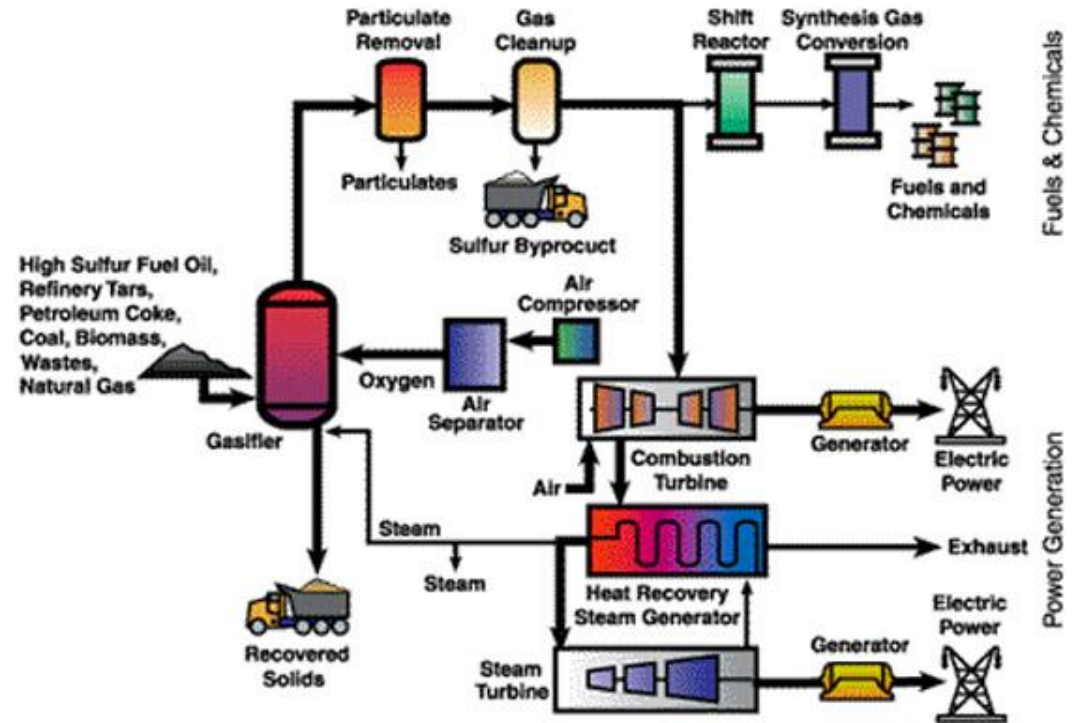
- After May 26, 1997 - Acceptable if requirements of initial PHA are met

Methods used to determine and evaluate hazards:

- What If
- Checklist
- What If/Checklist
- HAZOP (Hazard & Operability Study)
- FMEA (Failure Mode & Effects Analysis)
- Fault Tree Analysis
- An Appropriate Equivalent Methodology

What If

Through developed questions and answers, the effects of component failures or process errors are evaluated



- [illegible]

- Team members evaluate the overall operation by topic area
- Individuals then specifically study such areas as:
 - Material hazards
 - Process hazards
 - Policies and procedures
 - Equipment/instrument design
- Generating the “what if” questions in a checklist fashion

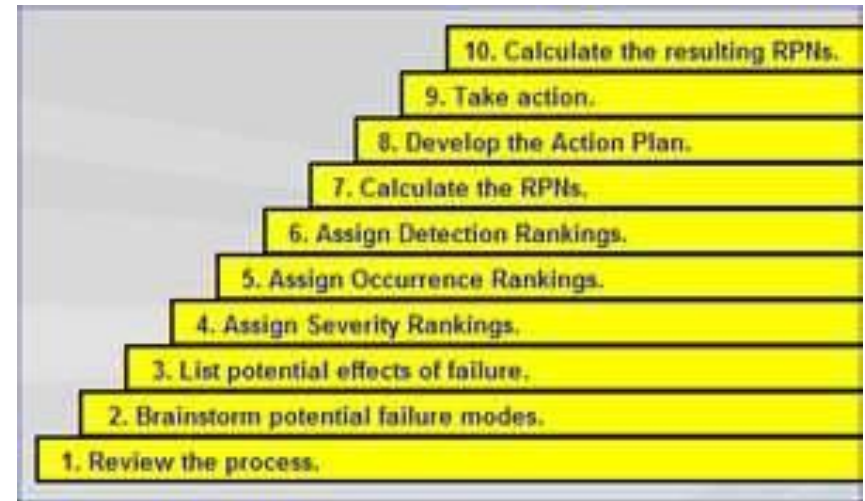
What if Checklist

Equipment-specific Questions	Topic-area Questions
Piping Have thermal relief valves been installed in piping runs where thermal expansion of trapped fluids would separate flanges or damage gaskets? ⋮	Human factors Are displays and gauges visible near the places where the process must be adjusted or controlled? ⋮
Vessels Is a vacuum relief system needed to protect the vessel during cooldown or liquid withdrawal? ⋮	Maintainability Have efforts been made to minimize the need for special tools, methods, or parts for maintaining this equipment? ⋮
Compressors Are air compressor intakes protected against contaminants (rain, birds, flammable gases, etc.)? ⋮	Installation issues Have steps been taken to isolate sensitive equipment from the vibration of rotating equipment? ⋮

- Also called HAZOP
- Determination of deviation from their design basis
- Diagrams of the facility's piping, electrical system and instrumentation can be used



- Component failure study
- Analyzed would be:
 - Mode of failure
 - Consequences
 - Designation of classification of failure
 - Likely failure probability
 - How a failure would be detected
 - How such a failure could be compensated
- Single as well as multiple failures could also be considered in planning



*RPN=Risk Priority Number

- Risk Priority Number assigned to assist in prioritizing failure modes in a process
- Assigned by the PHA team during planning
- RPNs range from 1 (best) to 1,000 (worst)
- Formula used:

$$(S \times O \times D) = RPN$$

www.fmea-fmeca.com/fmea-rpn.html

$$(S \times O \times D) = RPN$$

Where:

- S=severity assigned relative to the effect perceived
- O=Occurrence of likelihood that the cause will produce the failure mode
- D=Detection is effectiveness of controls to prevent/detect the cause of the failure mode before the failure results

FMEA RPN Example

Examples:

S x O x D = RPN

System #1 5 x 10 x 3 = 150

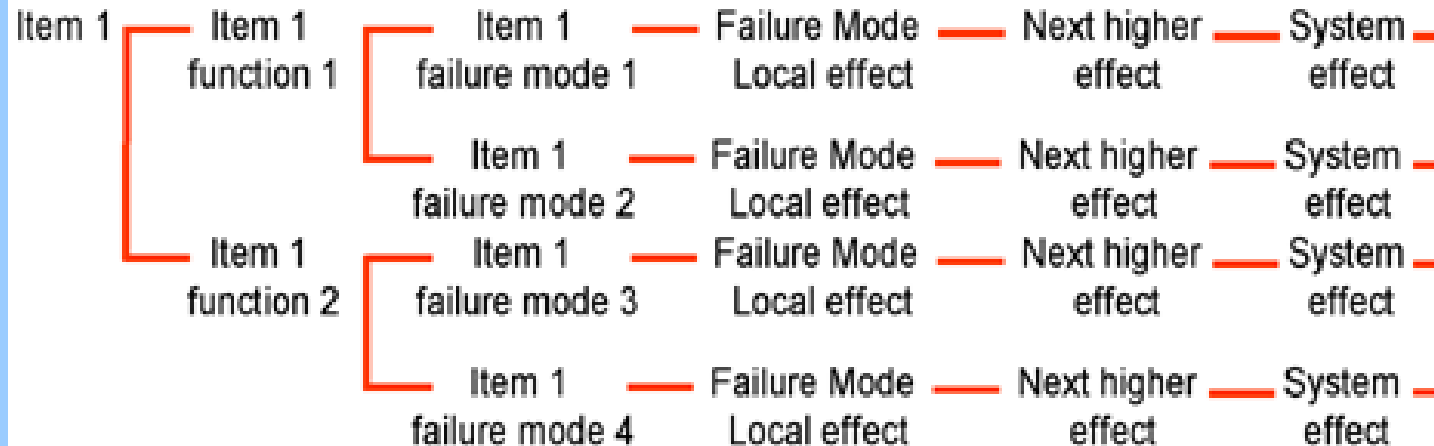
System #2 3 x 3 x 3 = 27

System #3 2 x 2 x 2 = 8

- System #1 has a higher number, but System #3 may be more important to the overall operation
- Once RPNs are determined, always address the high severity failure modes no matter their RPNs
- This RPN ranking assists in the overall planning process

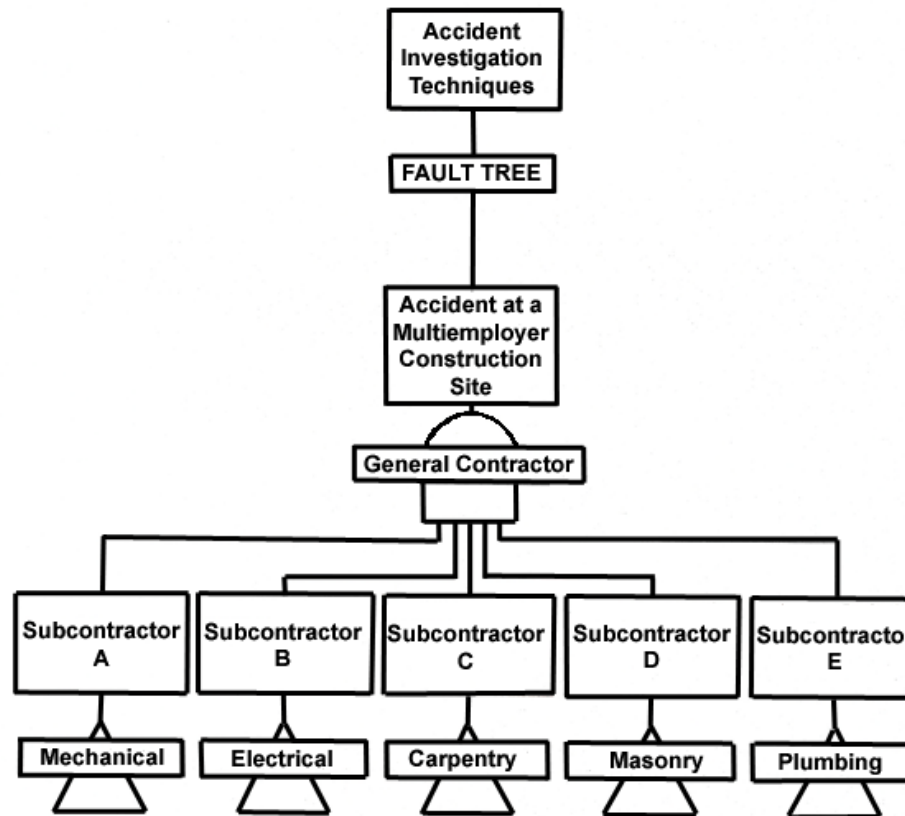
Failure Mode & Effects

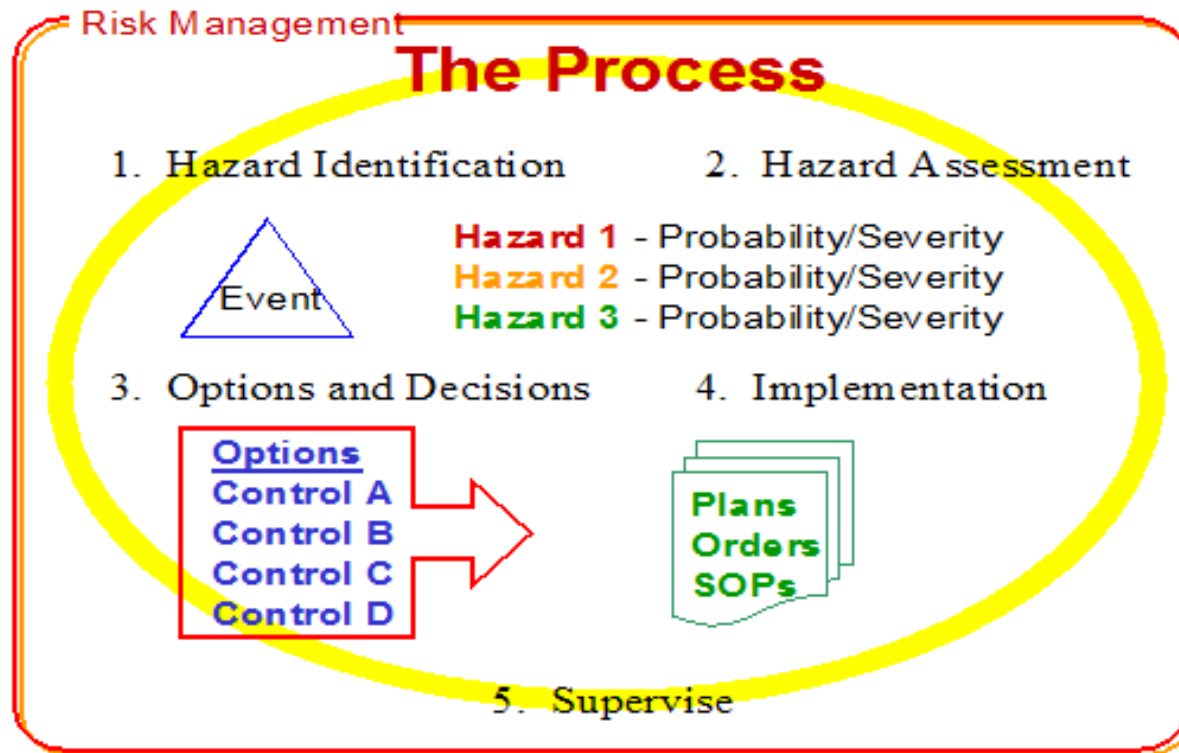
Failure Modes and Effects Analysis (FMEA)



- Views potential event sequences which may result in an incident
- Diagram looks like a tree
- Each branch lists sequence of events (failures) for different paths to the end event
- Probabilities assigned to each event then used to determine the statistical probability to the end event which is posed
- An appropriate equivalent methodology may also be adopted for use

Fault Tree Analysis





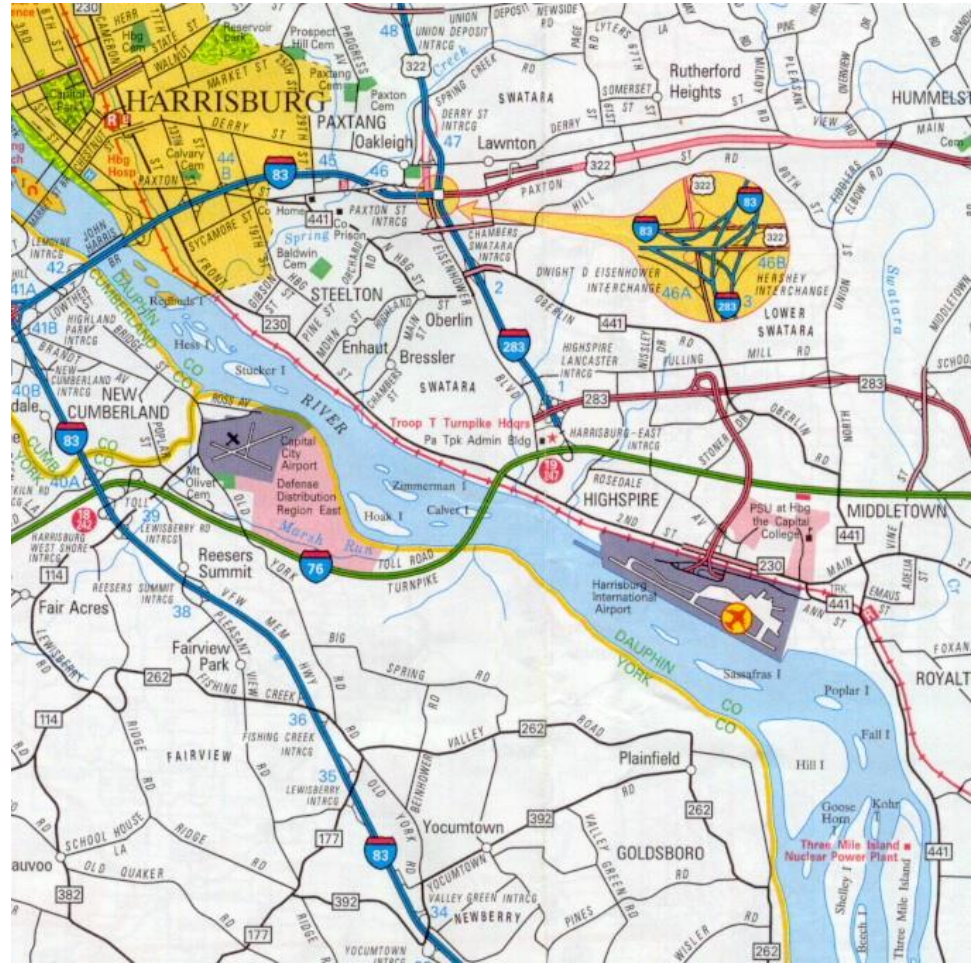
PHA Shall Address

- Hazards of the process
- Previous incident with likely potential of catastrophic consequences
- Engineering & administrative controls applicable to hazards
- Consequences of engineering & administrative control failures



PHA Shall Address

- Facility siting
- Human factors
- Qualitative evaluation of possible safety and health effects of failure of controls on employees



Employer's System

- Address team's findings and recommendations
- Assure team's recommendations are resolved
- Document resolution
- Document needed actions
- Complete actions as soon as possible



- Develop a written schedule
- Communicate actions to operating, maintenance and other employees in the process and who may be affected by actions



- Updated and revalidated by a team meeting at least every 5 years
- Update and retain the PHA for each process for the life of the process

Operating Procedures

- Written, for safely conducting activities involved in each covered process

Steps for each Operating Procedure

Addresses at least:

- Initial set-up
- Normal operations
- Temporary operations
- Emergency shutdown
- Emergency operations
- Normal shutdowns



Steps for each Operating Procedure

- Startup following turnaround or emergency shutdown
- Operating Limits
- Consequences of deviation
- Steps required to correct or avoid deviation



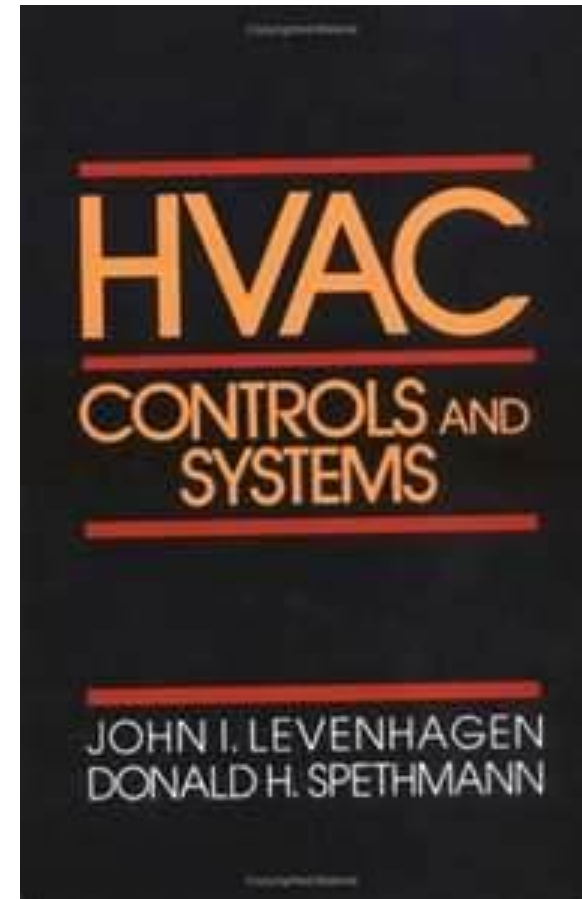
Process chemicals

- Properties
- Hazards



Precautions to Prevent Exposure

- Engineering controls
- Administrative controls
- PPE

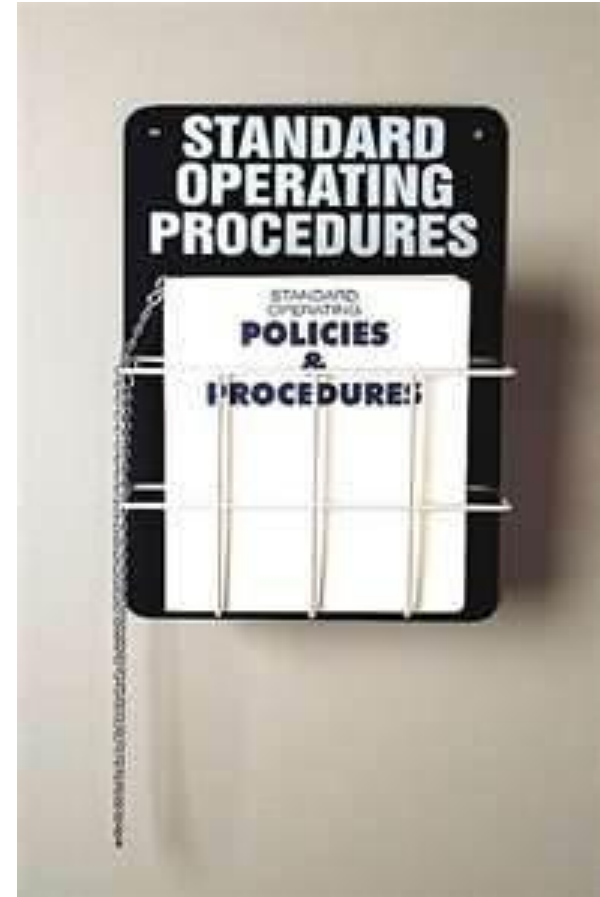


Control measures against:

- Physical contact
- Airborne exposure
- Quality control for raw materials
- Control of hazardous chemical inventory levels
- Special/unique hazards
- Safety Systems/functions

Operating Procedures

- Readily accessible to those working in or maintaining a process
- Reviewed as necessary
- Reflect current operating practice



Safe Work Practices

Hazard control during operations

- Lock-out/tag-out
- Confined space entry
- Opening process equipment/piping
- Facility entrance control by maintenance, contractor, laboratory, support personnel



Initial: those operating a process

- Overview
- Procedures
- Safety/health hazards
- Emergency operations/shutdown
- Safe work practices

Train each employee involved in maintaining the on-going integrity of process equipment

Training: Contractors

- Applies to contractors performing:
- Maintenance, repair or adjacent to a covered process
- Does not apply to:
Contractors supplying incidental services



- Obtain and evaluate contract employer's safety performance and programs
- Inform contract employers of known potential fire, explosion, or toxic release hazards
- Explain to contract employers the applicable provisions of emergency action plan

Employer's Responsibilities



- Develop, implement safe work practices to control the entrance, presence and exit of contract employers and contract employees in covered process areas
- Periodically evaluate performance of contract employers
- Maintain a contract employee injury and illness log related to the contractor's work in process areas

Contractor's Responsibilities

- Assure each employee is trained in work practices necessary
- Document each employee has received/understood required training
- Keep training record on each employee
- Assure each employee follows facility safety rules
- Advise employer of unique hazards presented by/found by contract employer



- Perform for new or modified facilities when modification is significant enough to require a change in process safety information
- Shall confirm that prior to introduction of highly hazardous chemicals to a process
- Construction and equipment is in accord with design specifications
- Safety, operating, maintenance and emergency procedures are in place



New Facilities

- PHA performed and recommendations resolved or implemented before startup
- Modified facilities meet requirements contained in management of change section (1910.119(I))
- Training of each employee involved in operating a process is completed



Mechanical Integrity

Applies to following process equipment:

- Pressure vessels and storage tanks
- Piping systems
- Piping components such as valves
- Relief and vent systems and devices
- Emergency shutdown systems
- Controls
 - Monitoring devices
 - Sensors
 - Alarms
 - Interlocks
- Pumps



Written Procedures

- Written to maintain the on-going integrity of process equipment
- Specific to the needs and to promote safety



On process equipment:

- Procedures shall follow recognized and accepted good engineering practices
- Frequency consistent with applicable manufacturers' recommendations
- More frequently if determined necessary
- Document deficiencies and corrective actions before further use

New plants: to determine equipment is suitable for process application

- Checks & inspections:
 - Equipment is suitable for process application
 - Consistent with design specifications
 - Manufacturer's instruction



Hot Work Permit

- For hot work conducted on or near a covered process
- Document fire prevention & protection requirements implemented (per 29 CFR 1910.252(a))
- Permit kept on file until work operations are completed

Front

**CUTTING • WELDING
PERMIT NO. _____**

This permit applies to:
Date _____
Location _____
Purpose _____
Work by _____

PRECAUTIONS BEFORE WORK

- ☐ Inspect Area
- ☐ Remove Combustibles
- ☐ Cover Combustibles with Non-Combustible Tarps
- ☐ Arrange Fire Watch
- ☐ Arrange Protection
- ☐ Inspect Equipment

(Date Issued) _____ (Approved by)

CUTTING • WELDING PERMIT NO. _____

Keep this stub until top portion is returned at completion of work. Retain both parts in file.

(Date Issued) _____ (Approved by)

Issued to _____
Location _____

Back

PRECAUTIONS DURING WORK

- ☐ Automatic Protection in Service
- ☐ Portable Protection on Hand
- ☐ Fire Watch Present
- ☐ Floor Swept Clean - Wood Floors Wet Down
- ☐ Combustibles Within 30' Removed or Covered
- ☐ All Wall and Floor Openings Covered

Time Started _____ ☐ A.M. ☐ P.M.
Time Finished _____ ☐ A.M. ☐ P.M.

PRECAUTIONS AFTER WORK

- ☐ Impact Area
- ☐ Remove Covers Used
- ☐ Fire Watch Remains On-Hand During Breaks or Halts
- ☐ Fire Watch Remains On-Hand for 30 minutes after Completion

Welder's Signature _____

- Written procedures to manage changes (except for “replacements in kind”)
- Prior to any change, address:
 - Technical basis for proposed change
 - Impact on safety and health



Discuss:

- Modifications to operating procedures
- Time period for the change
- Authorization for the change
- Employees and contract employees affected by change are informed and trained in the change prior to process start-up
- If change results in change in process safety information, update accordingly

Incident Investigation

- Investigate each incident resulting in, or which could have resulted in a catastrophic release of highly hazardous chemical in the workplace
- Initiate as soon as possible but not later than 48 hours following the incident



Investigation Team

- At least one person knowledgeable in the process
- A contract employee if incident involved work of the contractor
- Other persons with appropriate knowledge and experience to thoroughly investigate and analyze the incident



Incident Report

At investigation's conclusion:

- Date of incident
- Date investigation began
- Incident description
- Contributing factors
- Recommendations resulting



- Establish a system to address and resolve the incident
- Affected personnel review the report
- Retain reports for 5 years



- Establish an emergency action plan for entire plant (per 29 CFR 1910.38)
- Plan will also have procedures for handling small releases (per 29 CFR 1910.120(a)(p)(q))



Compliance Audits

- Employers certify they have evaluated compliance with provisions of this section at least every 3 years to verify the procedures and practices are adequate and being followed
- Audit shall be conducted by at least 1 person knowledgeable in the process
- Audit findings shall be developed
- Determine and document response to each of the findings
- Document deficiencies have been corrected
- Retain the 2 most recent compliance audit reports



- Employers shall make all information needed to comply available to those:
 - Compiling the process safety information
 - Assisting in development of the PHA
 - Responsible for developing the operating procedures
 - Involved in:
 - Incident Investigations
 - Emergency Planning and Response
 - Compliance Audits
- Nothing in this paragraph shall preclude the employer from requiring the persons receiving the information to enter into confidentiality agreements

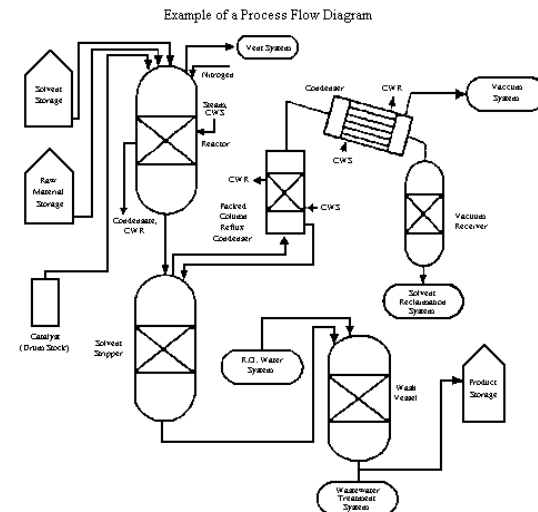
- Contains a listing of toxic and reactive highly hazardous chemicals which present a potential for a catastrophic event at or above the threshold quantity

• Chemical Name	CAS*	TQ**
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* Chemical Abstract Service Number

** Threshold Quantity in Pounds (Amount necessary to be covered by this standard)

- Block Flow Diagram and Process Flow Diagram



- Provides guidance on following items involved in the Process Safety Management program:
 - Introduction to Process Safety Management
 - Employee Involvement
 - Process Safety Information
 - Process Hazard Analysis
 - Operating Procedures and Practices
 - Employee Training

- Contractors
- Pre-Startup Safety
- Mechanical Integrity
- Non-routine Work Authorizations
- Managing Change
- Investigation of Incidents
- Emergency Preparedness
- Compliance Audits



- 29 CFR 1910.38, Emergency Action Plans
- 29 CFR 1910.119 and Appendices, Process Safety Management of Highly Hazardous Chemicals
- 29 CFR 1910.252, Subpart Q, Welding, Cutting and Brazing
- www.fmea-fmeca.com/fmea-rpn.html
- "Process Safety Management: An OSHA Compliance Manual," J.J. Keller & Associates, Inc., Neenah, WI

Questions

