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SOLUTIONS FOR SPECIALTIES

Process Safety Roundtable – Day 1

Houston – September 2024

Presented by: Lauren Mercer

Trinity Consultants

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Introductions

Lauren Mercer

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Learning Objectives

- Review the history and intent behind the PSM standard
- Understand who is covered by OSHA's Process Safety Management (PSM) and EPA's Risk Management Program (RMP)
- Obtain a broad understanding of PSM/RMP Requirements, with focus on "key considerations"
- Learn from industry incidents

Review the History and Purpose of PSM

What is Process Safety Management (PSM)?

- **Systematic** approach to evaluating the whole chemical process to **minimize** incident **frequency** and **severity**

Origins of PSM

1985 Union Carbide Bhopal Incident

→

1986 OSHA conducted "Special Emphasis Program" for chemical manufacturers

→

1990 OSHA proposed and passed PSM Standard as part of Clean Air Act Amendments

We often dismiss the "worst case" scenario as not likely to happen, but PSM was created because "worst case" scenarios kept happening (e.g. Bhopal, Piper Alpha in North Sea, etc.)

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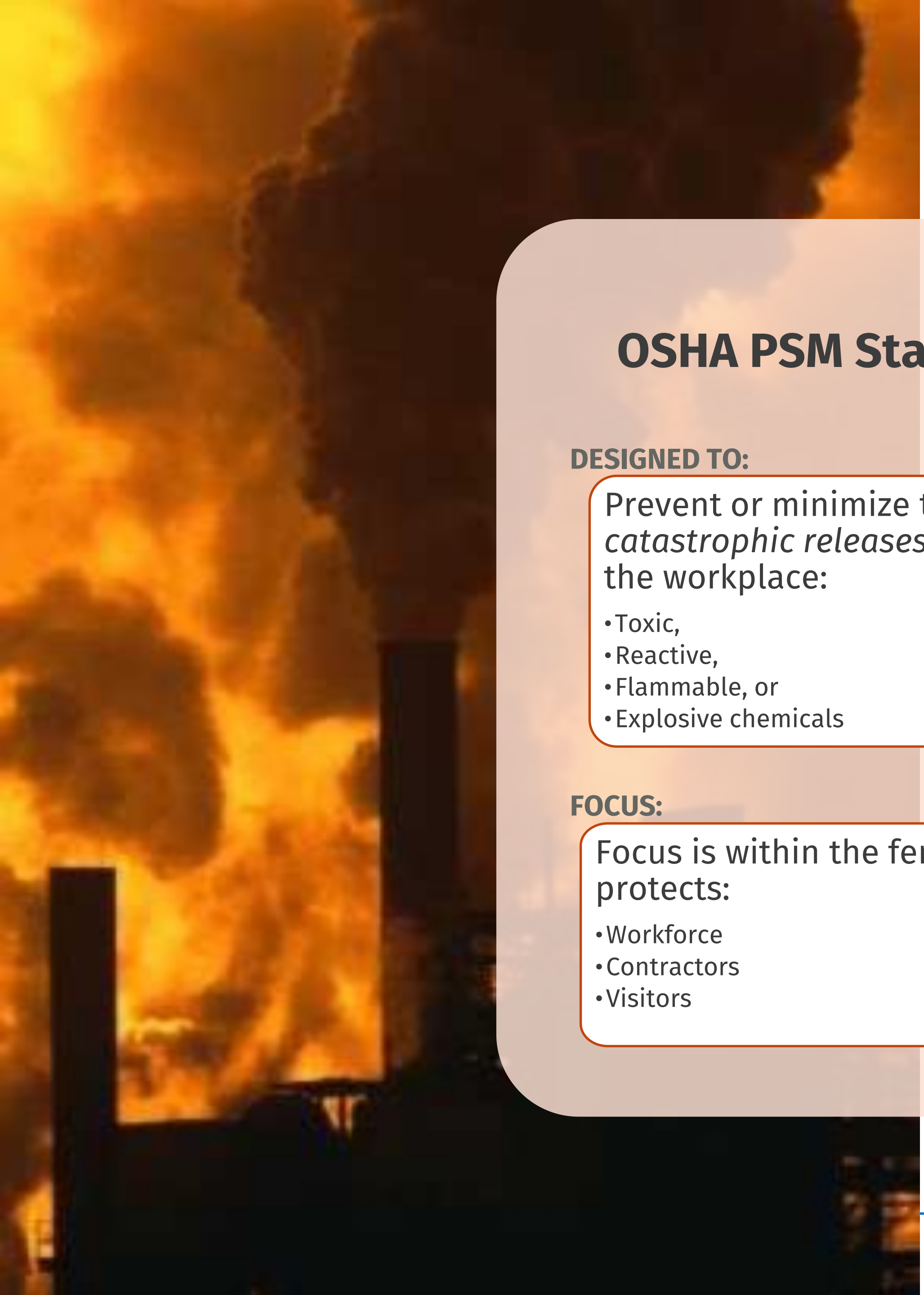


Purpose of PSM and RMP

OSHA PSM Standard (1992)

DESIGNED TO:

Prevent or minimize the consequences of *catastrophic releases* of the following in the workplace:

- Toxic,
- Reactive,
- Flammable, or
- Explosive chemicals

FOCUS:

Focus is within the fence line and protects:

- Workforce
- Contractors
- Visitors

EPA RMP Rule (1994)

DESIGNED TO:

Protect the environment and community by preventing or mitigating offsite consequences of catastrophic chemical releases.

FOCUS:

Focus is outside of the fence line and protects:

- Nearby residents
- General public around the facility
- Adjacent facilities such as schools and hospitals

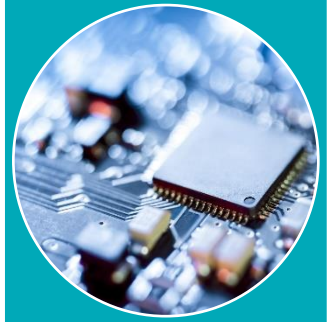
PSM & RMP - Who is Covered?

Chemical

- Manufacturers
- Warehouses
- Wholesalers

Petrochemical

- Refining and Gas Processing Operations
- Plastics and Resins
- Synthetic rubber
- Terminals



Other Manufacturing

- Electronics Semiconductors
- Paper
- Fabricated Metals
- Industrial Machinery
- Furniture
- Textiles

Agriculture

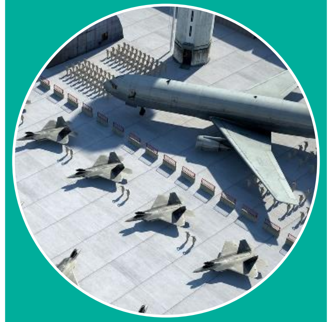
- Fertilizers
- Biodiesel

Utilities

- Public Facilities (Drinking and Wastewater Treatment)
- Electric

Food, Beverage and Cold Storage

- Ammonia Refrigeration



Installations

- Military
- Energy

Your Approach to Process Safety

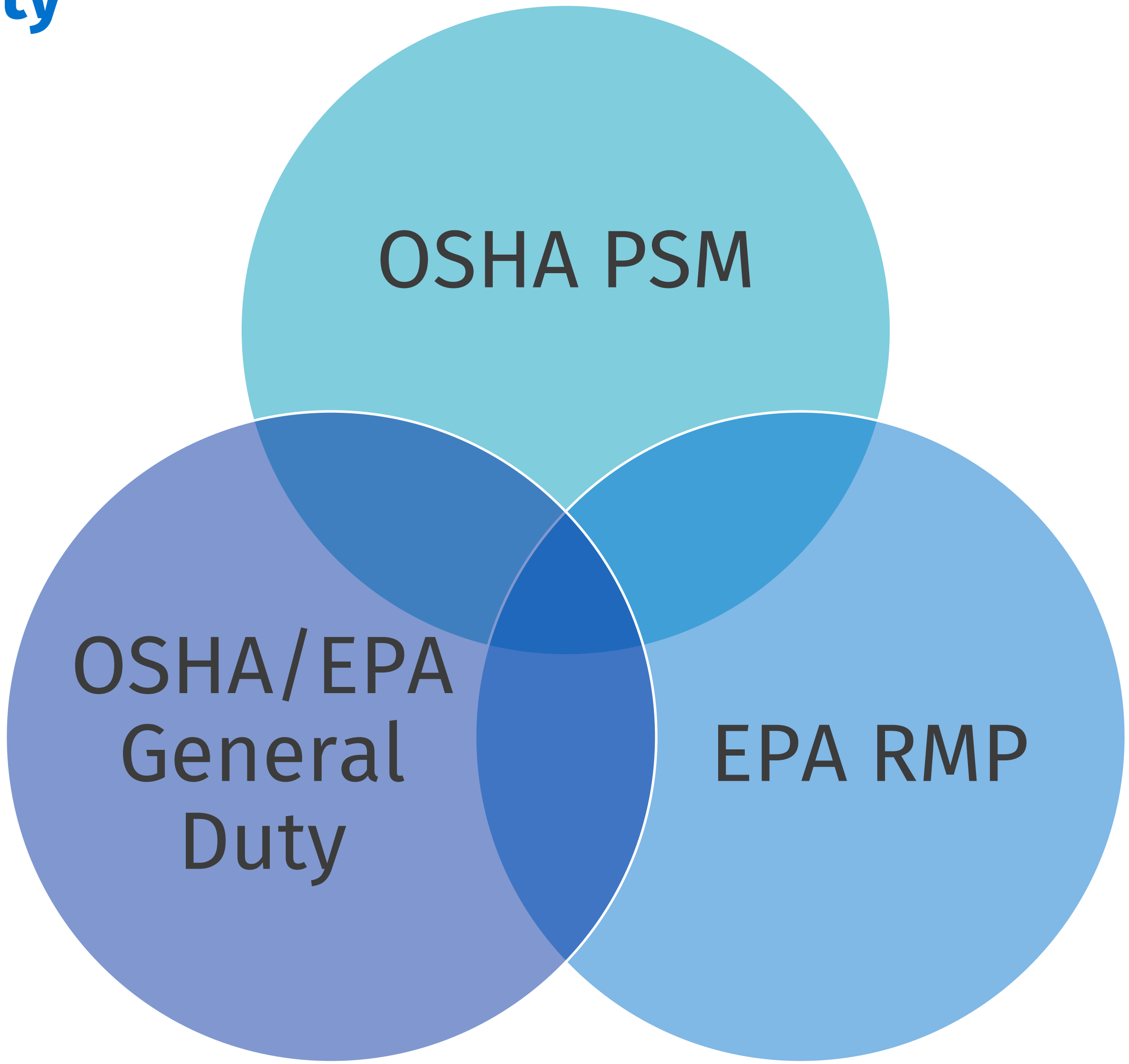
- What is your attitude towards process safety?

- How has my perception of process safety influenced how I approach process safety with my teams?

Impressions impact how we approach our involvement.

Applicability

Applicability



Process Safety Management (PSM) Applicability

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PSM Applicability

PSM applies to a process which involves:

- A chemical at/above the threshold quantity listed in appendix A of the standard in a process.

OR

- A flammable liquid or gas on site in one location above the threshold quantity of 10,000 pounds, with some exceptions.

PSM does not apply to:

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

PSM Applicability

PSM applies to a process which involves:

- A chemical at/above the threshold quantity listed in **appendix A** of the standard in a process.

OR

- A flammable liquid or gas on site in one location above the threshold quantity of 10,000 pounds, with some exceptions.

PSM does not apply to:

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

Appendix A Chemicals

- OSHA lists 137 toxic and reactive chemicals that are covered under PSM, each with their own threshold quantity.
- A few of the chemicals have specific concentration thresholds (e.g. ammonia solutions > 44% ammonia by weight are considered covered).
- When a concentration threshold is not listed, the chemical is exempt if the concentration in mixture is <1% by weight in mixture.

PSM Applicability

PSM applies to a process which involves:

- A chemical at/above the threshold quantity listed in appendix A of the standard in a process.

OR

- A **flammable liquid or gas** on site in one location above the threshold quantity of 10,000 pounds, with some exceptions.

PSM does not apply to:

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

PSM Flammable Liquid or Gas Definition

- Flammable Liquid (from PSM Definition)
  - Flashpoint below 100F (37.8C)
- Flammable Gas (from HAZCOM Physical Hazard definition, Appendix B Physical Hazard Criteria)
  - Category 1 – gas that at ambient temperature & pressure has either
    - LEL at 13% by volume or lower (Ex: Natural Gas)
    - Flammability range wider than 12% by volume, regardless of the lower flammable limit

PSM Applicability

PSM applies to a **process** which involves:

- A chemical at/above the threshold quantity listed in appendix A of the standard in a process.

OR

- A flammable liquid or gas on site in one location above the threshold quantity of 10,000 pounds, with some exceptions.

PSM does not apply to:

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

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PSM Process Definition

PSM Process means

- any activity or combination of activities involving a highly hazardous chemical (HHC) including use, storage, manufacturing, handling, on-site movement.
- “on-site in one location" TQ of HHC within an area under the control of an employer or group of affiliated employers
- A single process is:
  - Any group of vessels that are interconnected
  - Separate vessels located in close enough proximity such that a HHC could be involved in a potential release
- “Vessel” includes reactors, railcars, tanks, cylinders, drums, totes
  - No “de minimis” quantity for RMP or PSM

PSM Applicability

PSM applies to a process which involves:

- A chemical **at/above the threshold quantity** listed in appendix A of the standard in a process.

OR

- A flammable liquid or gas on site in one location **above the threshold quantity** of 10,000 pounds, with some exceptions.

PSM does not apply to:

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

Aggregation

- Once the process boundaries have been assigned, aggregate the following chemical inventories independently from each other:
  - Flammable liquids
  - Flammable gases
  - Appendix A chemical (individually)
- For chemical inventories, use maximum intended inventory vs. maximum storage capacity
  - Establish administrative controls when leveraging specific liquid levels
- For toxics, only the weight of the listed toxic is counted towards threshold determination

PSM Applicability

PSM applies to a process which involves:

- A chemical at/above the threshold quantity listed in appendix A of the standard in a process.

OR

- A flammable liquid or gas on site in one location above the threshold quantity of 10,000 pounds, **with some exceptions**.

PSM does not apply to:

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

Flammable Exceptions

- PSM applies to a process which involves a flammable liquid or gas on site in one location in a quantity of 10,000 pounds or more except for:
  - Hydrocarbon fuels used solely for workplace consumption, if such fuels are not part of a process containing other covered chemicals
  - Flammable liquids stored in atmospheric tanks or transferred which are kept below their normal boiling point without benefit of chilling or refrigeration
    - Atmospheric tank means a storage tank which has been designed to operate at pressures from atmospheric through 0.5 psig (3.45 Kpa)
    - Exemption applies to storage and transfer operations, but does not extend to mixing operations

RMP Applicability Determination

RMP Applicability

RMP applies to an owner/operator of a stationary source that has more than a threshold quantity of a regulated substance in a process, with some exceptions.

RMP Applicability

RMP applies to an owner/operator of a **stationary source** that has more than a threshold quantity of a regulated substance in a process, with some exceptions.

Stationary Source Definition

- ***"Stationary source"*** *means any buildings, structures, equipment, installations, or substance emitting stationary activities which belong to the same industrial group, which are located on one or more contiguous properties, which are under the control of the same person (or persons under common control), and from which an accidental release may occur.*
- *The term stationary source does not apply to transportation, including storage incident to transportation, of any regulated substance or any other extremely hazardous substance under the provisions of this part.*
- *A stationary source includes transportation containers used for storage not incident to transportation and transportation containers connected to equipment at a stationary source for loading or unloading.*
- *Transportation includes, but is not limited to, transportation subject to oversight or regulation under 49 CFR parts 192, 193, or 195, or a state natural gas or hazardous liquid program . . .*
- *A stationary source does not include naturally occurring hydrocarbon reservoirs.*
- *Properties shall not be considered contiguous solely because of a railroad or pipeline right-of-way.*

RMP Applicability

RMP applies to an owner/operator of a stationary source that has more than a threshold quantity of a **regulated substance** in a process, with some exceptions.

Regulated Substances

- Regulated Toxic Substances
  - Tables 1, 2 to 68.130
  - A few of the chemicals have specific concentration thresholds (e.g. ammonia solutions > 20% ammonia by weight are considered covered).
  - When a concentration threshold is not listed, the chemical is exempt if the concentration in mixture is <1% by weight in mixture.
- Regulated Flammable Substances
  - Tables 3, 4 to 68.130
  - Exempt if concentration of regulated substance in mixture is <1% by weight in mixture.
  - Flammable mixtures are covered if the mixture meets NFPA-4 criteria.
    - NFPA Flammability rating of 4: Flashpoint <73 F & Boiling Point < 100 F @ 14.7 psia

RMP Applicability

RMP applies to an owner/operator of a stationary source that has more than a threshold quantity of a regulated substance in a **process**, with some exceptions.

RMP Process

- RMP Process definition is equivalent to the PSM process definition.
- EPA RMP guidance available at:

https://www.epa.gov/rmp/guidance-facilities-risk-management-programs-rmp

RMP Applicability

RMP applies to an owner/operator of a stationary source that has more than a **threshold quantity** of a regulated substance in a process, with some exceptions.

Aggregation

- Once the process boundaries have been assigned, aggregate the following chemical inventories independently from each other:
  - Flammable substance (individually)
    - A flammable substance in one vessel is never aggregated with a different flammable substance in another vessel to determine whether a threshold quantity is present.
  - Flammable mixtures
    - If concentration ≥1% by weight, entire weight is treated as regulated substance UNLESS you can demonstrate mixture does not have NFPA flammability rating of 4
  - Toxics (individually)
    - If subject, only the weight of the listed toxic is counted towards threshold determination
- For chemical inventories, use maximum intended inventory vs. maximum storage capacity
  - Establish administrative controls when leveraging specific liquid levels

RMP Applicability

RMP applies to an owner/operator of a stationary source that has more than a threshold quantity of a regulated substance in a process, **with some exceptions**.

RMP Exemptions – Use, Lab, & Article

Regulated substances are exempted from TQ determination:

- Used in
  - Structural component of the stationary source
  - Products for routine janitorial maintenance
  - Employee food, drug, cosmetic, or personal items
  - Process water or non-contact cooling water, drawn from environmental or municipal sources
  - Air as compressed air or as part of combustion
- Ammonia used as an agricultural nutrient
- Lab activities under the supervision of a technically qualified individual
- Contained in an article (manufactured item)

RMP Exemptions – Flammables

- Regulated flammable substances are exempted from TQ determination when they are in:
  - Gasoline when in distribution or related storage for use as fuel
  - Fuel used on site or held for sale as a fuel at a retail facility
  - Naturally occurring hydrocarbon mixtures prior to entry to NG processing or petroleum refining process units

Applicability Differences – RMP vs. PSM

- Clearly list exemptions – RMP vs. PSM
  - Only RMP has the NOHC exemption
  - Only PSM has the NURF exemption
- Flammable Definition –subject if:
  - RMP-listed Mixture meeting NFPA 4 definition
    - Flashpoint <73 F & Boiling Point < 100 F @ 14.7 psia
  - PSM – Class 1 Flammable gas OR liquid flashpoint <100 F
    - Exempt if atmospheric tank & kept below boiling point
- Be aware of differences between NFPA or composition on general SDS, Bill of Lading (BOL), and Certificate of Analysis (COA)
    - SDS paperwork may conservatively list NFPA 4 rating
    - SDS often list ranges – don't assume you can take lowest number unless you've established that number in purchasing specification

General Duty Clause

OSHA – OSH Act of 1970 Section 5(a)(1)

EPA – Clean Air Act Section 112(r)(1) - CAAA November 1990

What is the General Duty Clause?

Employer has a "general duty“ to:

- "provide their employees a place of employment which are free from recognized hazards that are causing or are likely to cause death or serious physical harm to his employees" (OSHA)
- "identify hazards which may result from (such) releases using appropriate hazard assessment techniques, to design and maintain a safe facility taking such steps as are necessary to prevent releases, and to minimize the consequences of accidental releases which do occur.” (EPA)
- General Duty Clause (GDC) Applicability
  - Owners & operators of all stationary sources which have any “extremely hazardous substances”
  - Essentially means any material with a Safety Data Sheet
  - NO limit to type or amount of chemical -> APPLIES TO EVERYONE
- Enforceable by EPA and OSHA

GDC Requirements [112(r)(1)]

- EPA 550-B00-002 (May 2000)
  - Guidance for the Implementation of the General Duty Clause
  - Developed for EPA inspectors but publicly available
  - https://www.epa.gov/sites/production/files/documents/gendutyclause-rpt.pdf

Identify hazards from accidental releases	Design and maintain a safe facility	Minimize the consequences of accidental releases

Covered Process Boundary - Questions

- How do you identify for your site
  - Memorandum with calculations
  - Block flow or process flow diagram
  - P&IDs
  - Conservatively treat all as covered?
  - Conservatively cover one process unit downstream from last unit that exceeds threshold?
- How do you communicate this to
  - Operators
  - Maintenance
  - Management
  - Regulators and inspectors

Process Safety Mindsets

The Elements

The 14 Elements can be grouped into 5 PSM Mindsets™ for easy daily use

Similar to RMP Level 3 Prevention Program

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Every company **PRACTICES PROCESS SAFETY.**

Some are also **REGULATED FOR COMPLIANCE.**

It's about keeping people and assets safe.

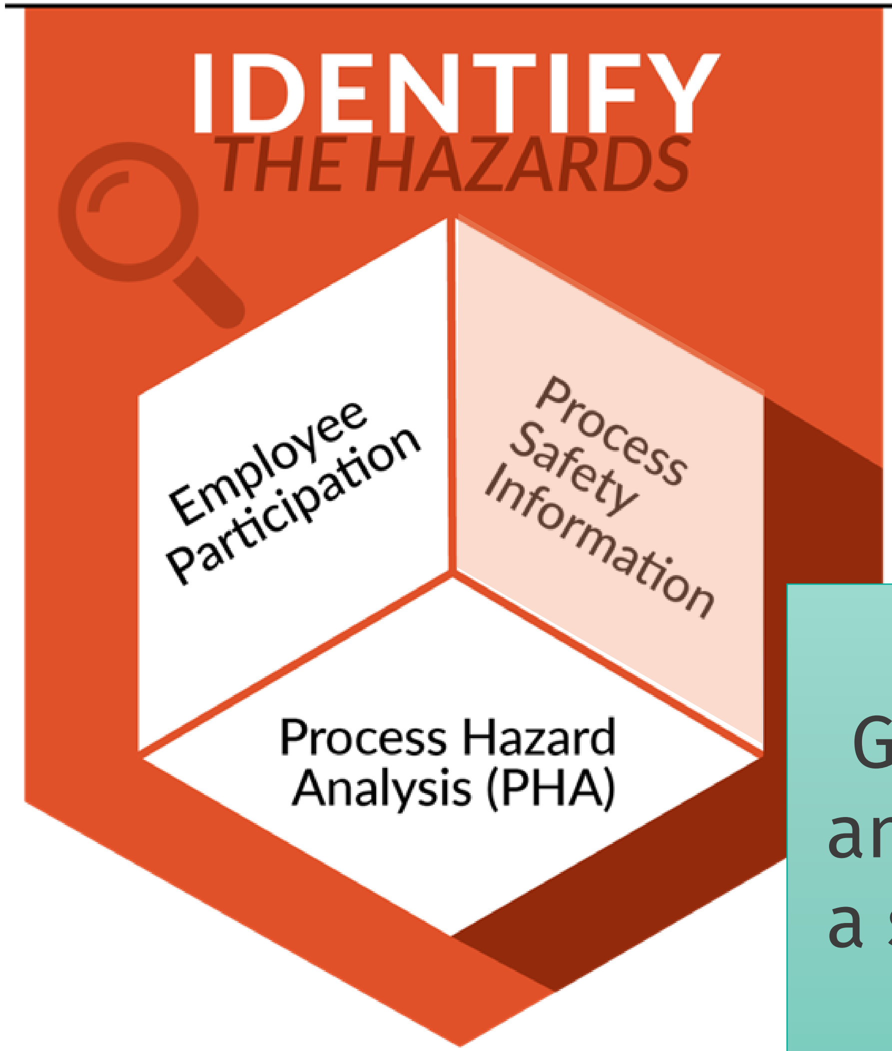
https://youtu.be/Z1KaykPaF8M

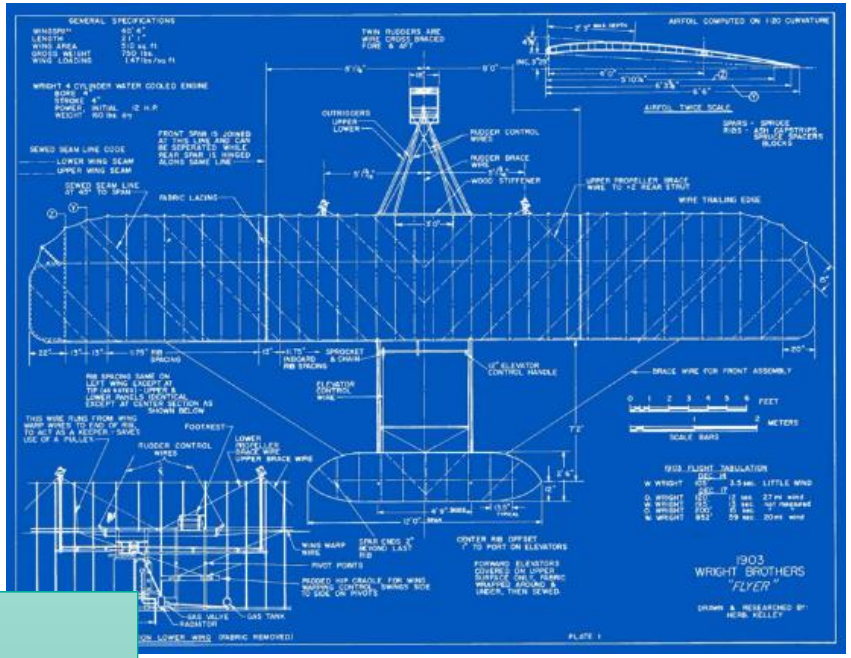
Key Considerations

- While none of the elements are unnecessary for the safe and long-term operation of your facility, a few of the elements are key starting points for implementing a process safety culture:

Key Considerations For Driving a PS Culture

Process Safety Information





GDC: Design and maintain a safe facility

Process Safety Information

- Intent is to provide complete and accurate information concerning the covered process.
- Information must be readily available to all affected employees.

Process Safety Information

- The employer must compile written process safety information on:
  - Hazards of chemicals
  - Process design basis (i.e. technology)
  - Equipment design basis
- Ensure it is up to date before conducting any PHA
- Must document that equipment complies with recognized and generally accepted good engineering practices (RAGAGEP)

Process Safety Information

- The following information is required:

Information pertaining to the hazards of the chemicals

- SDS
- Inadvertent mixing of materials

Information pertaining to the technology

- PFD
- Process Chemistry
- Maximum Intended Inventory (MII)
- Safe Upper and Lower Limits
- Consequences of deviations

Information pertaining to the equipment

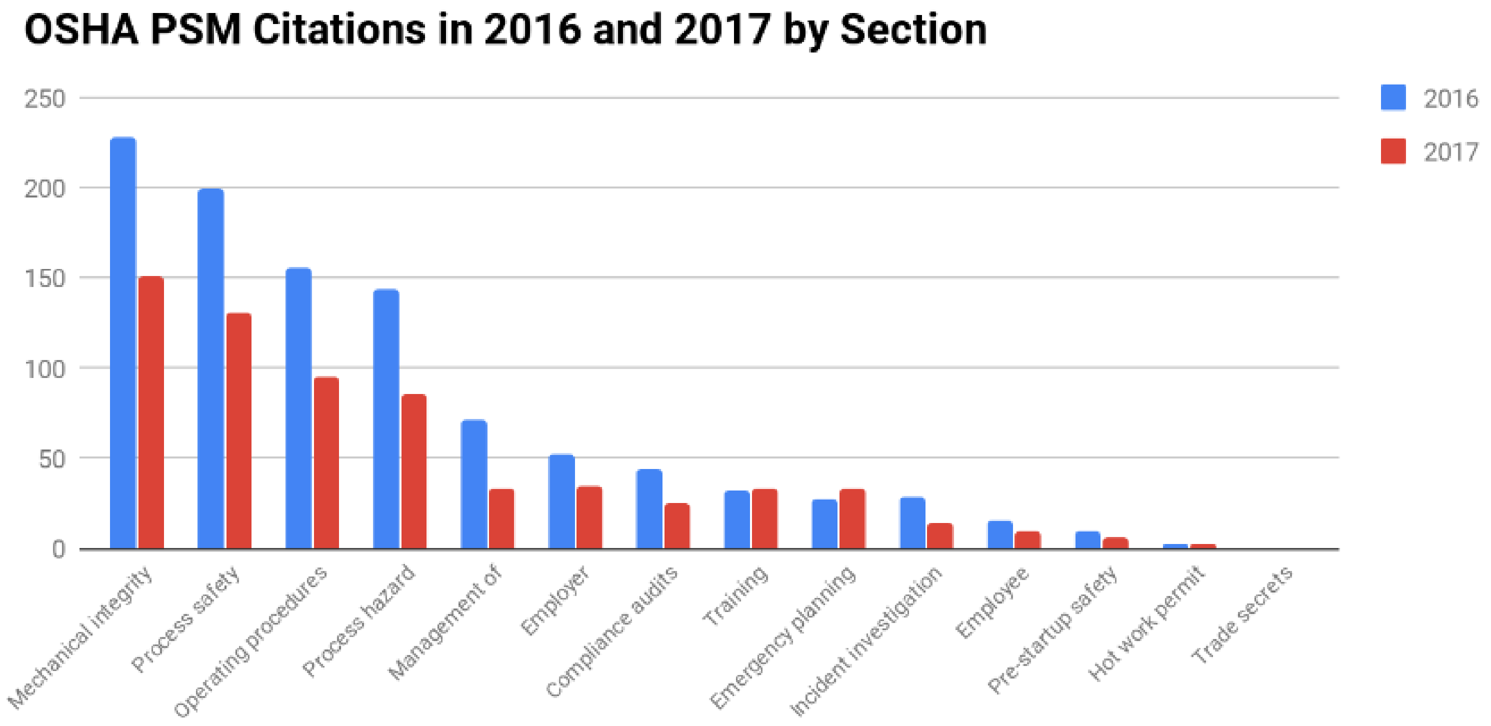
- Material of Construction
- P&IDs
- Electrical Classification
- Relief system design basis
- Ventilation system design
- Design codes and standards employed
- Heat and Material Balances
- Safety Systems

Users of PSI

- The compiled information will be a necessary resource to a variety of users including:
  - The team that will perform the process hazards analysis
  - Those developing the training programs and the operating procedures
  - Contractors whose employees will be working with the process
  - Those managing/review MOCs and conducting PSSRs
  - Those managing/performing inspection/maintenance activities
  - Local emergency preparedness planners
  - Insurance and enforcement officials

Historical Citation Data Review

- A data company summarized OSHA citations from 2016 and 2017 and found that PSI came in second for most citations



Hazards of the Chemicals

Code: 29 CFR 1910.119(d)(1)

(1) *Information pertaining to the hazards of the highly hazardous chemicals in the process.* This information shall consist of at least the following:

- (i) Toxicity information;
- (ii) Permissible exposure limits;
- (iii) Physical data;
- (iv) Reactivity data:
- (v) Corrosivity data;
- (vi) Thermal and chemical stability data; and
- (vii) Hazardous effects of inadvertent mixing of different materials that could foreseeably occur.

Note: Safety data sheets meeting the requirements of 29 CFR 1910.1200(g) may be used to comply with this requirement to the extent they contain the information required by this subparagraph.

Safety Data Sheets

- For the bulk of the hazard requirements, use your SDS
- Ensure the SDS do in fact contain the necessary information
- Most, if not all, SDS do not contain inadvertent mixing information

(1) *Information pertaining to the hazards of the highly hazardous chemicals in the process.* This information shall consist of at least the following:

(i) Toxicity information;

(ii) Permissible exposure limits;

(iii) Physical data;

(iv) Reactivity data:

(v) Corrosivity data;

(vi) Thermal and chemical stability data; and

(vii) Hazardous effects of inadvertent mixing of different materials that could foreseeably occur.

Note: Safety data sheets meeting the requirements of 29 CFR 1910.1200(g) may be used to comply with this requirement to the extent they contain the information required by this subparagraph.

Make sure the SDS has this information

Inadvertent Mixing

- Develop an inadvertent mixing credibility chart
  - List all unit chemicals and document if mixing is credible or not
- Once credible mixing cases are identified, develop an inadvertent mixing consequence chart
  - Document consequences such as: cancer causing, explosion, flammable gas formation, runaway reaction, etc.
- Consider using a PHA-type team/methodology to develop the charts

Inadvertent Mixing

Chemical					
A	A				
B	x	B			
C	o	x	C		
D	x	x	o	D	
E	o	x	x	o	E

Credible
Not Credible

Chemical					
A	A				
B	x	B			
C	GF	x	C		
D	x	x	F	D	
E	GF	x	x	E	E

GF: Flammable gas formation
F: Fire
E: Explosion

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Inadvertent Mixing – Chemical Reactivity Worksheet

- The Chemical Reactivity Worksheet (CRW) is a free software program you can use to find out about the chemical reactivity of thousands of common hazardous chemicals, compatibility of absorbents, and suitability of materials of construction in chemical processes.

NFPA Flammability	NFPA Health	NFPA Reactivity	Compatibility Chart for Example Created by: E Zample on 8/25/2024 Last Reviewed by: unknown This chart is only valid for the following mixing scenario: Ambient temperature (up to 35° C) mixing of 2 chemicals in an insulated vessel that is not air tight. Storage of the mixture for less than 1 day.	BENZENE	HYDROGEN PEROXIDE, STABILI	MINERAL OIL	NITRIC ACID, OTHER THAN RED	SODIUM HYDROXIDE SOLUTION	SULFURIC ACID	WATER	XYLENE, [MIXED ISOMERS]
3	2	0	BENZENE	X							
0	3	3	HYDROGEN PEROXIDE, STABILIZED	N	X						
1	0	0	MINERAL OIL	Y	N	X					
0	4	0	NITRIC ACID, OTHER THAN RED FUMING	N	N	N	X				
0	3	1	SODIUM HYDROXIDE SOLUTION	Y	N	Y	N	X			
0	3	2	SULFURIC ACID	N	N	N	C	N	X		
?	?	?	WATER	Y	N	Y	C	C	C	X	
3	2	0	XYLENE, [MIXED ISOMERS]	Y	N	Y	N	Y	N	Y	X

LEGEND	
X	No self reaction
N	Not Compatible
C	Caution
Y	Compatible
SR	Self Reactive

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https://www.aiche.org/ccps/resources/chemical-reactivity-worksheet

Technology

Code: 29 CFR 1910.119(d)(2)

(2) *Information pertaining to the technology of the process.*

- (i) Information concerning the technology of the process shall include at least the following:
  - (A) A block flow diagram or simplified process flow diagram (see appendix B to this section);
  - (B) Process chemistry;
  - (C) Maximum intended inventory;
  - (D) Safe upper and lower limits for such items as temperatures, pressures, flows or compositions; and,
  - (E) An evaluation of the consequences of deviations, including those affecting the safety and health of employees.
- (ii) Where the original technical information no longer exists, such information may be developed in conjunction with the process hazard analysis in sufficient detail to support the analysis.

Block Flow or Process Flow Diagram

- A block flow diagram is used to show the major process equipment and interconnecting process flow lines and show flow rates, stream composition, temperatures, and pressures when necessary for clarity. The block flow diagram is a simplified diagram.
- Process flow diagrams are more complex and will show all main flow streams including valves to enhance the understanding of the process, as well as pressures and temperatures on all feed and product lines within all major vessels, in and out of headers and heat exchangers, and points of pressure and temperature control.

Process Chemistry

- Should contain enough details to understand the series of chemical reactions
- If your process does not contain chemical reactions (e.g. ammonia refrigeration, LPG storage), make sure to document as such

Process Chemistry

Surfactants are made by reacting [redacted] and/or [redacted] with any of the following:

- Blends of detergent range or other fatty alcohols including:
  - [redacted]
- Blends of fatty acids including:
  - [redacted]
- Glycols including:
  - [redacted]
- Glycol Ethers including:
  - [redacted]
- Alky phenols including
  - [redacted]

CATALYST ADDITION:

ROH (or ROOH) + [redacted] + K^+ [redacted]

Alcohol or Fatty Acid ... Potassium

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Maximum Intended Inventory

- Maximum Intended Inventory (MII) does not necessarily equal capacity
- Uses:
  - Determining if a threshold quantity if present
  - Submitted to the EPA on the RMPlan
  - Determining the equipment with the largest inventory for the worst-case offsite consequence analysis (RMP)
  - Evaluating equipment for alternative-case offsite consequence analyses (RMP)

Maximum Intended Inventory

- Development methodology:
  - Generate fixed equipment listing in the unit
  - Document composition in each equipment
  - For equipment with a covered chemical, calculate volume of covered chemical via:
    - Equipment dimensions
    - Liquid level (high level alarm)
    - Density
  - Aggregate interconnected and co-located equipment
  - Increase inventory by a percentage (e.g. 10%) to account for piping
  - Ensure documentation of logic/assumptions

Safe Operating Limits and Consequences of Deviation

- Operating limits beyond which would be considered upset conditions
  - Include pressures, flows, temperatures, and compositions
- Qualitative estimate of the consequences or results of deviation that could occur if operating beyond the established process limits

Ammonia Safe Operating Limits & Consequences of Deviation	Controls / Indicators	Units	Safe Operating Limits: Low	Interlocks: Low	Alarms: Low	Std Oper Cond: Min	Std Oper Cond: Target	Std Oper Cond: Max	Alarms: High	Interlocks: High	Safe Operating Limits: High	Consequence of safe operating limit deviation	Troubleshooting guide / reference Alarms reference alarm responses Interlocks reference interlock responses	
Flowrates														
Aqua Ammonia flow	FIC-766	lb/min		-	80	100	140	200	-	-		**No flow:** No flow for extended period will rsult in SO2 loss to the environment. Other pump should automatically start upon loss of flow. Need to confirm other pump is functioning properly then troubeshoot the pump that failed.	AMOP_801 AMOP_864	No flow alarm
Flow - Ammonia/Water	FFIC-504	%		-	15	21	23	24	25	-		**Not at target:** Possible environmental release may occur	AMOP_849	
Flow - Anhydrous Ammonia	FIC_D504	lb/min		-	-	30	40	100	550	-		**Hi Alarm -** Will trigger the ammonia ratio control which will shutdown the unloading process		
Flow - Water to mixer	FIC_D520	lb/min		-	-	600	920	2000	2500	-		**Hi Alarm -** Will trigger the ammonia ratio control which will shutdown the unloading process		
Pressure Drops														
Differential Pressure - Ammonia Cooler	PDI-505	psig		-	-	19	20	21	40	-		**Low differential pressure:** the Aqua Ammonia entering the storage tank is above 80 degrees F, which can resultin gassing off of ammonia in the storage tank.	AMOP_825 Low Diff. Press.	DPV Lo
Levels														
Ammonia Storage Tank	LI-514	%		-	10	12	40	65	80 Hi 85 Hi Hi	-		**High level** will lead to overflow of aqua ammonia to the environment. Low level will lead to loss of SO2 to the environment.	AMOP_807 - High High alarm - 85% - emerency stop AMOP_810 - High alarm AMOP_813 - Low alarm	PV Lo/Hi
Level High - Ammonia Storage Area Sump	LI-517	%		-	-	20	50	85	90 Hi 99 Hi Hi	-		**High Level**: Sump Pump P-D355 should start at 85%	AMOP_828	PV Hi
Monitors / Instrumentation														
Area monitors														
Gas Detect - Ammonia Pumphouse	D526 A&B	ppm		-	-	0	0	0	20 Hi 35 Hi Hi	-		**High gas concentration**: Ammonia release to the environment, personnel exposed to high levels of Ammonia	AMOP_840 HI Hi AMOP_843 HI	PV Hi
Gas Detect - Anhydrous Ammonia Railcar Unloading Area	D 525 A,B,C,&D	ppm		-	-	0	0	0	20 Hi 35 Hi Hi	-		**High gas concentration**: Ammonia release to the environment, personnel exposed to high levels of Ammonia	AMOP_846 HI Hi AMOP_845 HI	PV Hi
Ammonia Building Energency Ventilation Fan Alarm	EA 526 A or B	ppm		-	-	0	0	0	30	-		**High gas concentration**: Ammonia release to the environment, personnel exposed to high levels of Ammonia	AMOP_861	PV Hi
Pressures														
Pressure High in Ammonia Storage Tank Shell	PSH-511	inches water		-	-			10	-	-		**High pressure**: indicates possible leak of inside tank which would create HazMat response if it ruptures	AMOP_816	PV Hi
Pressure Low - Aqua Ammonia Distribution	PIC-528	psig		Lo Lo will start 2nd pump	30 Lo 20 Lo Lo	30	40	50	-	-		**Low pressure**: loss of aqua ammonia to environment, loss of SO2 to environment	AMOP_819	PV Low
Pressure - Ammonia Supply	PI-503	psig		80 to start unload	-	60	120	140	150	170		**High Pressure**: System rupture - release of anhydrous ammonia to the environment	AMOP_852 HI AMOP_855 Lo	PV Hi
Ammonia Vaporizer Relief Valve	PSH-523	psig		-	-				250	-		**High Pressure**: System rupture - release of anhydrous ammonia to the environment	AMOP_858	PV Hi
Temperatures														
Temperature High - Aqua Ammonia to Storage	TIC-510	degrees F		-	-	40	60	70	90 Hi 100 Hi Hi	> 90 for 15 Min >100 for 2 Sec		**High liquid temperature:** gassing off of ammonia in the storage tank. If more than 90 degrees F for 15 minutes or more than 100 degrees F for 2 minutes, the Ammonia railcar unloading system shuts down.	AMOP_822	PV Hi

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Compressor

Capacity	Operating Limits	Consequences of Deviation	Steps To Avoid Consequences of Deviation
Discharge Pressure - Low	90 psig	May have trouble getting adequate ammonia liquid to low pressure vessels.	Check load on system. Check operation of compressor.
Discharge Temperature - Normal	140-150 deg F		Continue normal monitoring.
Discharge Temperature - High	205-210 deg F	High temperature alarm on Micro Processor Panel will activate.	Check oil level. Check operation of thermostatic oil temperature control valve.
Discharge Temperature - High	210 deg F	Compressor will shut down due to high temperature cutout.	Check thermosyphon operation. Check lubrication system and components. Verify transducer reading against temperature reading.
Discharge Temperature - Low	140 deg F	May result in the inability to lubricate the compressor.	During winter operation make sure condensers are operating properly. Verify transducer reading against temperature reading.
Suction Pressure - Normal	5 psig to 5 in. hg.		Continue normal monitoring.
Suction Pressure - High	Over 5 psig	Inability to refrigerate properly.	Check Compressor loading position. Check accuracy of transducer.
Suction Pressure - Low	7 in. hg.	Low suction pressure cutout will activate and shut down compressor.	Check load on system. (Liquid solenoids and liquid pumps). Check compressor loading position.
Suction Pressure - Low	6 in. hg.	Suction pressures between normal and low will cause excessive energy consumption.	Check suction valve position. Check accuracy of transducer. Check compressor to verify it is on Stop/start control. Check suction strainer for signs of plugging.
Oil Pressure - Normal	120-180 psig		Continue normal monitoring.
Oil Pressure - High	200 psig	Potential damage to compressor if oil pump discharge is restricted.	Check operation of oil pump. Check operation of oil pressure regulating valve. Check accuracy of pressure transducer.
Oil Filter Pressure Differential - Normal	0 to 15 psi		Continue normal monitoring.
Oil Filter Pressure Differential - High	25 psi	Alarm on high oil filter differential pressure. Compressor may overheat due to insufficient lubrication.	Check valve positioning. Check oil pump operation. Check condition of inline oil filters for signs of abnormal build-up.
Oil Temperature - Normal	120 to 135 F		Continue normal monitoring.
Oil Temperature - High	165 F	High oil temperature alarm will activate.	Check operation of Amot thermostatic temperature control valve.

Equipment

Code: 29 CFR 1910.119(d)(3)

(3) *Information pertaining to the equipment in the process.*

(i) Information pertaining to the equipment in the process shall include:

(A) Materials of construction;

(B) Piping and instrument diagrams (P&ID's);

(C) Electrical classification;

(D) Relief system design and design basis;

(E) Ventilation system design;

(F) Design codes and standards employed;

(G) Material and energy balances for processes built after May 26, 1992; and,

(H) Safety systems (e.g. interlocks, detection or suppression systems).

Materials of Construction

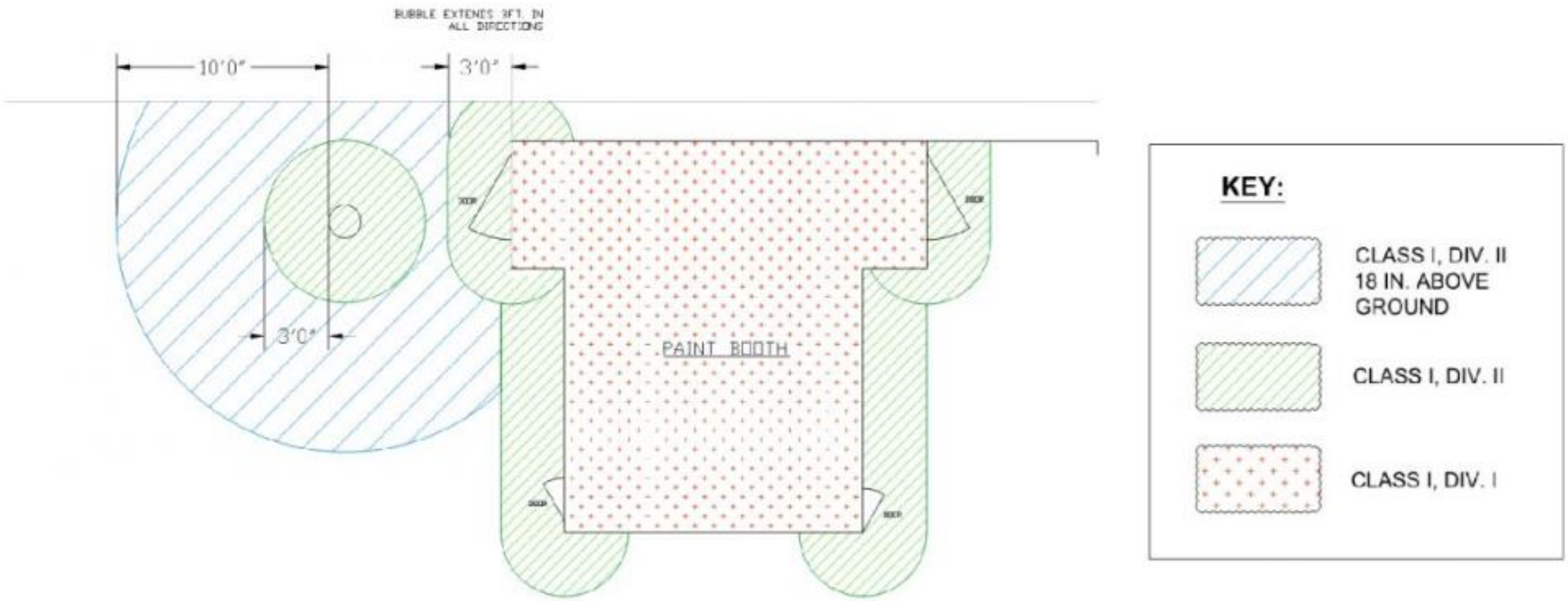
- Addressed via equipment documents, e.g.
  - Pressure vessel U1s and drawings
  - Pump/compressor specification sheets and curves
  - Tank specification sheets
  - Pipe specifications/line class index

P&IDs

- Used to describe the relationships between equipment and instrumentation
- Some companies include equipment specifications on the P&IDs
- Consider using standard symbology to ensure consistency/easy of understanding
- RAGAGEP considerations for symbology include but are not limited to:
  - ISA Instrument Society of America
  - PIP Process Industry Practices
  - ISO International Standards Organization

Electrical Classification

- Identify electrical equipment locations with potential fire and explosion risks based on the type, properties, and severity of the hazard
- RAGAGEP considerations include but are not limited to:
  - NFPA 70 National Electrical Code, (NEC) Article 500.4
  - NFPA 30 Flammable and Combustible Liquids Code
  - NFPA 497 Recommended Practice for the Classification of Flammable Liquids, Gases, or Vapors and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas
  - OSHA 1910.307 Hazardous (classified) locations
  - API 500 Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class 1, Division 1, and Division 2
- The result of the EAC process is a set of drawings that designate the physical areas in which any flammable and combustible chemicals may be present that allows engineers and maintenance to determine the correct level of equipment safety needed to comply


BUBBLE EXTENDS 3FT. IN
ALL DIRECTIONS
10'0"
3'0"
3'0"
PAINT BOOTH
KEY:
CLASS I, DIV. II
18 IN. ABOVE
GROUND
CLASS I, DIV. II
CLASS I, DIV. I

Relief Systems Design

- At a fundamental level, pressure relief systems are designed to prevent a loss of containment
  - Relief valves are the last line of defense in a facility
- RAGAGEP considerations include but are not limited to:
  - API 520
  - API 521
  - API 2000
  - CGA
  - ASME

Relief Systems Design

1. The Causes of Overpressure
2. How to Qualify Scenarios
3. How to Quantify Relief Loads
4. How to Stop the Overpressure
5. How to Get Rid of the Relief Material

Relief Systems Design

- **The Causes of Overpressure**
- How to Qualify Scenarios
- How to Quantify Relief Loads
- How to Stop the Overpressure
- How to Get Rid of the Relief Material

▸ What is overpressure?

- As the name implies, overpressure is an abnormal increase in pressure
- Likewise, underpressure is the corresponding term for an abnormal decrease in pressure less than zero gauge pressure; overvacuum

▸ What causes overpressure?

- The expansion of fluid in a closed system
- The generation of vapor from a boiling liquid
- Cramming too much material into a system and not letting enough material out of a system
- Chemical reactions
- Transitions of state
- Thermal expansion
- Lots of stuff!

Relief Systems Design

- The Causes of Overpressure
- **How to Qualify Scenarios**
- How to Quantify Relief Loads
- How to Stop the Overpressure
- How to Get Rid of the Relief Material

- The causes of overpressure are numerous, but not all overpressures are credible.
- Examples:

Water Storage Tank
A water storage tank is very unlikely to be exposed to fire if there is nothing flammable near it

Valve
An isolation valve is unlikely to be opened inadvertently if is locked closed and other administrative controls ensure that operators never open it.

Centrifugal Pump
A centrifugal pump may be blocked-in, but its pump curve may fall short of an overpressure.

Vapor-Filled Vessel
Fire may occur around a vapor-filled vessel, but poor internal convection within the vessel may cause the vessel to fail before the vapor heats up, expands, and causes an overpressure

Relief Systems Design

- The Causes of Overpressure
- How to Qualify Scenarios
- **How to Quantify Relief Loads**
- How to Stop the Overpressure
- How to Get Rid of the Relief Material

- The causes of overpressure are numerous, but not all overpressures are credible.
- Examples:

Heat Input
If we know the heat input from a fire, we can calculate how much vapor is generated from a liquid.

Failed-Open Control Valve
If we know how big a failed-open control valve is, and what the upstream conditions are, we can calculate the flow rate into a protected system.

Blocked-In Pump
If we have a curve for a blocked-in centrifugal pump, we can find the flow rate at relief conditions.

Relief Systems Design

- The Causes of Overpressure
- How to Qualify Scenarios
- How to Quantify Relief Loads
- **How to Stop the Overpressure**
- How to Get Rid of the Relief Material

- How do we stop the overpressure?
  - Pressure relief devices (PRDs)
- PRDs allow a system to relieve an overpressure in a controlled manner
- PRDs are almost always self-contained mechanical devices that do not rely on external control to operate
- PRD selection depends on the application
  - “Pressurized” applications typically use relief valves
  - Low pressure” applications, like tanks, might use PVSVs, vacuum breakers, or open vents

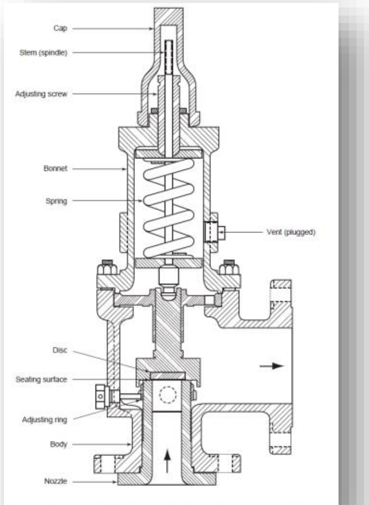


Figure 1—Conventional PRV with a Single Adjusting Ring for Blowdown Control

Relief Systems Design

1. The Causes of Overpressure
2. How to Qualify Scenarios
3. How to Quantify Relief Loads
4. How to Stop the Overpressure
5. **How to Get Rid of the Relief Material**

SAVE IT

- Small, predictable quantities of low-volatility liquids or specialty chemicals

BURN IT

- Anything gaseous, flammable, toxic, unsalvageable, uncontainable, or hazardous
- Segregated services

DISCHARGE IT TO ATMOSPHERE

- Anything that can discharge to atmosphere safely: steam, N_2, air, light hydrocarbons

Ventilation System Design

- Design documentation must be kept for the following examples cases:
  - Where ventilation is used to declassify or alter the Electrical Area Classification (EAC) of a building
  - Where a covered chemical is housed within a building, the building should be ventilated
- RAGAGEP considerations include but are not limited to:
  - NFPA 58, section "Structure or Building Ventilation"
  - NFPA 30, section "Ventilation"
  - IIAR "Guidelines for Ammonia Machinery Room Ventilation"

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Ventilation System Design

- The documentation should include
  - What code or standard was used as the design basis
  - Description of fan control, alarm signals, normal vs. emergency ventilation, etc.
  - Fan specifications (airflow, static pressure, motor type, blade material)
  - Room characteristics (dimensions, volume, make-up air dampers)
  - All assumptions and calculations
- Ventilation may be mechanical or natural (vents and louvers)

Design Codes and Standards Employed

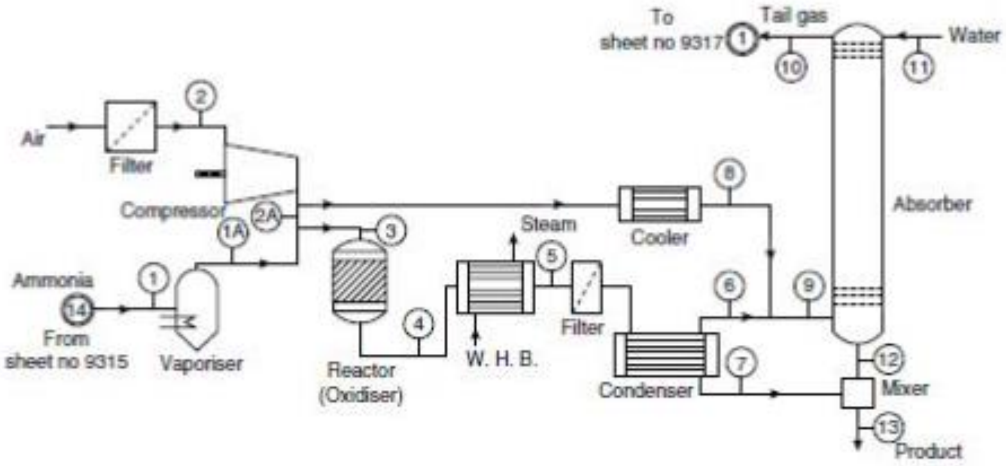
- Similar to materials of construction, addressed via equipment documents

Material and Energy Balances

- Only required for processes built after May 26, 1992
  - Per a letter of interpretation, if a new line, unit, or "train" is added to supplement the process, these could be considered new processes requiring material and energy balances. If new or different chemistry is used, such as a chemical reaction in place of a unit physical operation, this would be a new process requiring the material and energy balance calculation.

Material and Energy Balances

- You may choose to add the material and energy balance to the PFD, have it as a stand-alone document, or leverage a process simulation software



Flows kg/h Pressures nominal

Line no. Stream Component	1 Ammonia feed	1A Ammonia vapour	2 Filtered air	2A Oxidiser air	3 Oxidiser feed	4 Oxidiser outlet	5 W.H.B. outlet	6 Condenser gas	7 Condenser acid	8 Secondary air	9 Absorber feed	10 Tail(2) gas	11 Water feed	12 Absorber acid	13 Product acid	C & R Construction Inc
NH_3	731.0	731.0	—	—	731.0	Nil	—	—	—	—	—	—	—	—	—	Nitric acid 60 per cent
O_2	—	—	3036.9	2628.2	2628.2	935.7	(935.7)[1]	275.2	Trace	408.7	683.9	371.5	—	Trace	Trace	100,000 t/y
N_2	—	—	9990.8	8644.7	8644.7	8668.8	8668.8	8668.8	Trace	1346.1	10,014.7	10,014.7	—	Trace	Trace	Client BOP Chemicals
NO	—	—	—	—	—	1238.4	(1238.4)[1]	202.5	—	—	202.5	21.9	—	Trace	Trace	SLIGO
NO_2		—	—	—	—	—	Trace	(?)[1]	967.2	—	—	967.2	(Trace)[1]	—	Trace	Trace Sheet no. 93
HNO_3		—	—	—	—	—	Nil	Nil	—	850.6	—	—	—	—	1704.0	2554.6
H_2O		—	—	Trace	—	—	1161.0	1161.0	29.4	1010.1	—	29.4	26.3	1376.9	1136.0	2146.0

Safety Systems

- Typically, safety systems are listed in either the necessary operating procedures, or there is a single facility for the unit/facility
- Safety systems should include critical alarms (i.e. alarms necessary for process safety), interlocks, monitors, deluge systems, etc
- A great place to start is the PHA!

https://www.youtube.com/watch?v=8j8EprZP4IE&t=2s

RAGAGEP

Code: 29 CFR 1910.119(d)(3)(ii) and 29 CFR 1910.119(d)(3)(iii)

(ii) The employer shall document that equipment complies with recognized and generally accepted good engineering practices.

(iii) For existing equipment designed and constructed in accordance with codes, standards, or practices that are no longer in general use, the employer shall determine and document that the equipment is designed, maintained, inspected, tested, and operating in a safe manner.

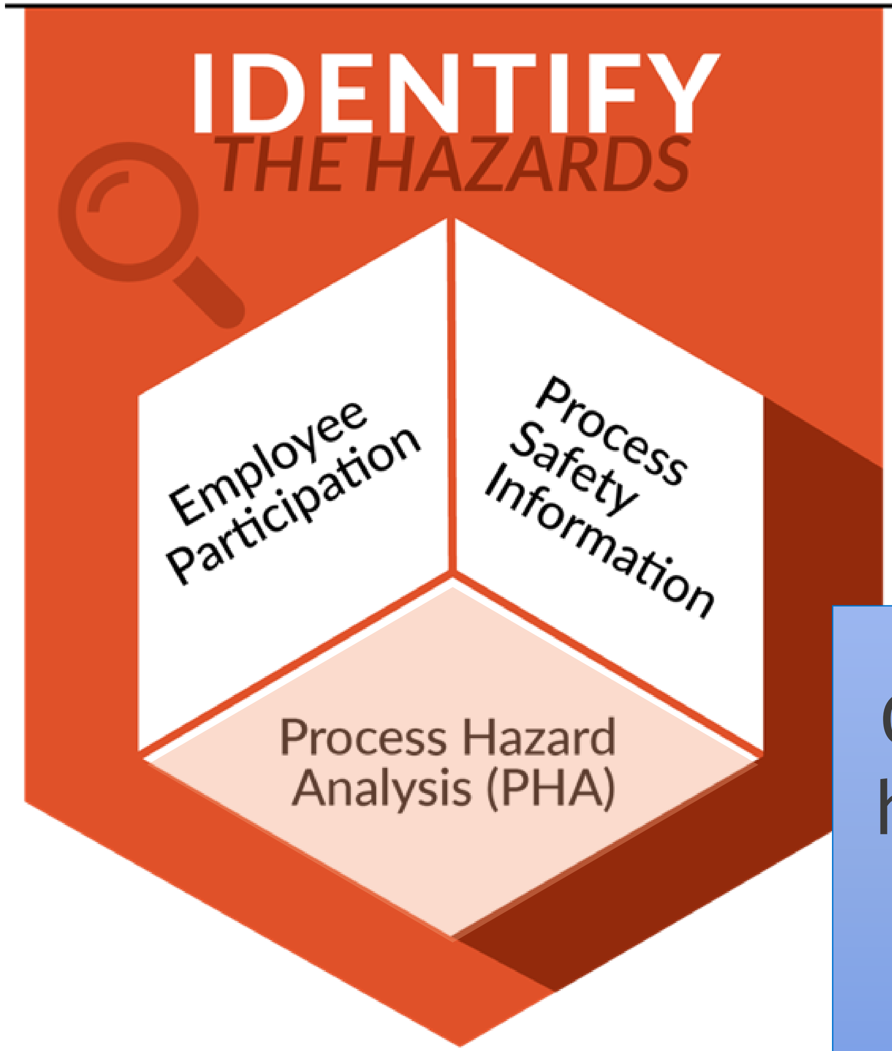
RAGAGEP

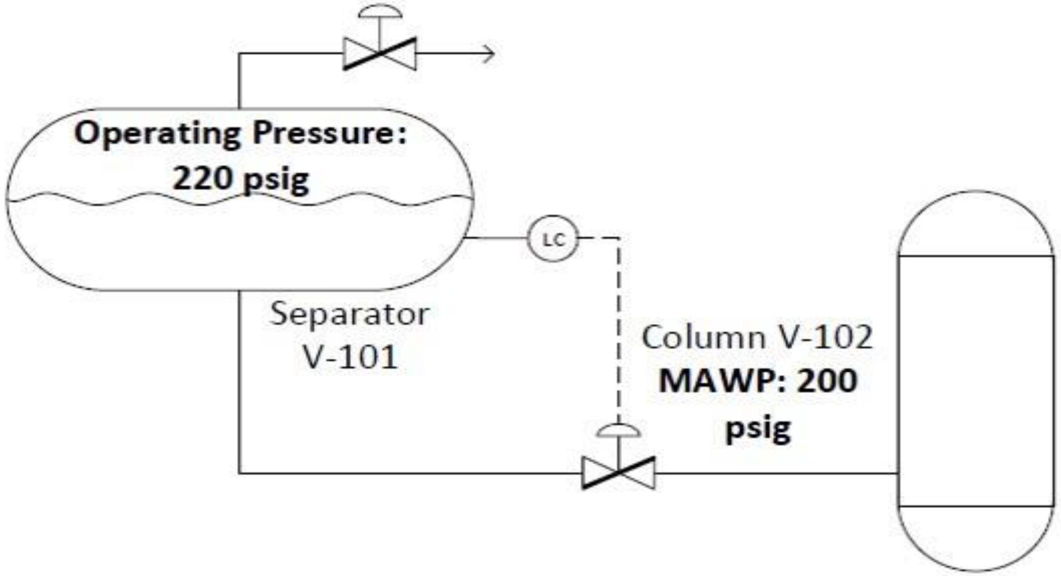
- From a PSM/RMP perspective, an owner/operator should select RAGAPEP that is appropriate to the process to minimize the hazards.
  - Recognized and Generally Accepted Good Engineering Practices
  - Other authorities having jurisdiction (e.g. Fire Marshall) may specify RAGAGEP to be used.
- A single RAGAGEP source may not control all hazards and therefore multiple RAGAGEP sources may be necessary.

PSI - Questions

- Where is the PSI located?
- Who has responsibility for maintaining the files?
- Are P&ID drawings and block flow diagrams current?
- What standards and codes apply to your process? Have these been documented?
- Is PSI readily available to all employees?
- Is PSI available and current for PHAs?

Process Hazard Analysis





GDC: Identify hazards from accidental releases

Process Hazards Analysis

- The intent of this element is to provide a systematic method for identifying, evaluating and controlling process hazards in the covered process

- The PHA is also an opportunity for operations, engineering and others to take an active role in understanding the processes' function and operation and "what can go wrong." They can be used as a learning opportunity for a variety of personnel.

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PHA Methods

- PHAs are required for:
  - New facilities during design
  - Changes to technology and facilities
  - Shut down or dismantlement
  - Where regulated

- PHA Methodologies
  - Checklist
  - **What-If / Checklist**
  - **Hazard and Operability Study (HAZOP)**
  - Failure Mode and Effects Analysis (FMEA)
  - Fault Tree Analysis
  - Equivalent Methodology

PHA Selected Methods

Checklist	HAZOP	What-if
• Highly structured • Extremely specific to a process • Inflexible	• Structured • Thorough • Clear cause/effect (easier to apply to risk assessment) • Slower	• Versatile • Requires higher degree of process knowledge • Faster

PHA Requirements

- The PHA shall address:
  - The hazards of the process
  - The identification of any previous incident which had a likely potential for catastrophic consequences
  - Engineering and administrative controls applicable to the hazards
  - Consequences of failure of engineering and administrative controls
  - Facility siting
  - Human factors
  - A qualitative evaluation of the range of possible safety and health effects

Identify hazards from accidental releases

Minimize the consequences of accidental releases

PHA Team Requirements

- Multi-disciplined and required to include
  - At least one person experienced and knowledgeable in the process
  - One person knowledgeable in the PHA methodology
- Recommend including experts in
  - Operations - operator in the covered process
  - Maintenance - mechanics, electricians, instrument techs
  - Process & Equipment Design - engineers
  - Safety and Environmental staff
  - A PHA is only as good as the team

PHA Team Best practices

Who should be involved

- Keep the team nimble (3-7)
- Have other players available (instrumentation, rotating, etc.) when needed.

What key PSI is used?

- P&IDs
- PFDS/H&MBs
- Operating Conditions
- Design Conditions
- Pump/Compressor Data
- Reactivity

PHA – Facility Siting

- Facility Siting review may include:
  - Hazards created on main or construction entry and emergency exit routes
  - Plant routes compromised by changes
  - Temporary (due to construction or repairs)
  - Permanent due to new installations
  - Construction and location of control rooms
    - Hazardous process exhaust to office area

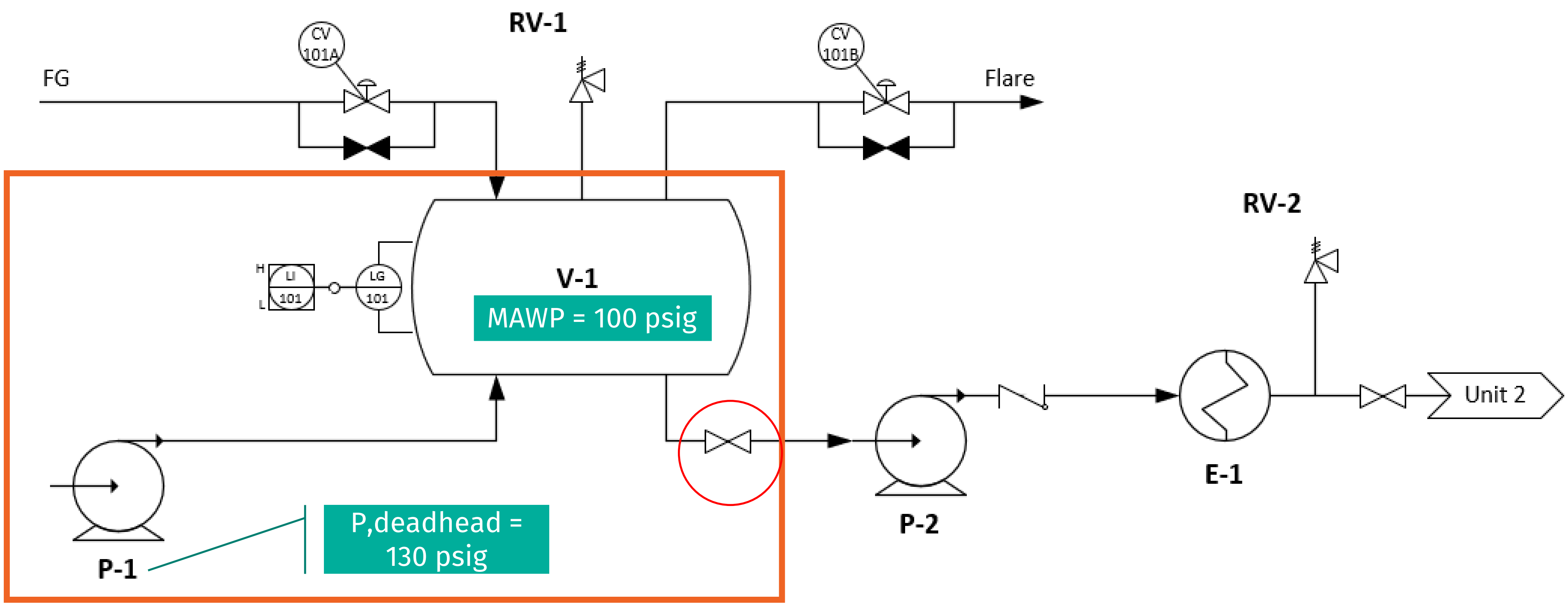
- Key Points – *has the arrangement of equipment introduced or increased hazards, made equipment difficult to maintain, or react to the process*

PHA – Human Factors Questions

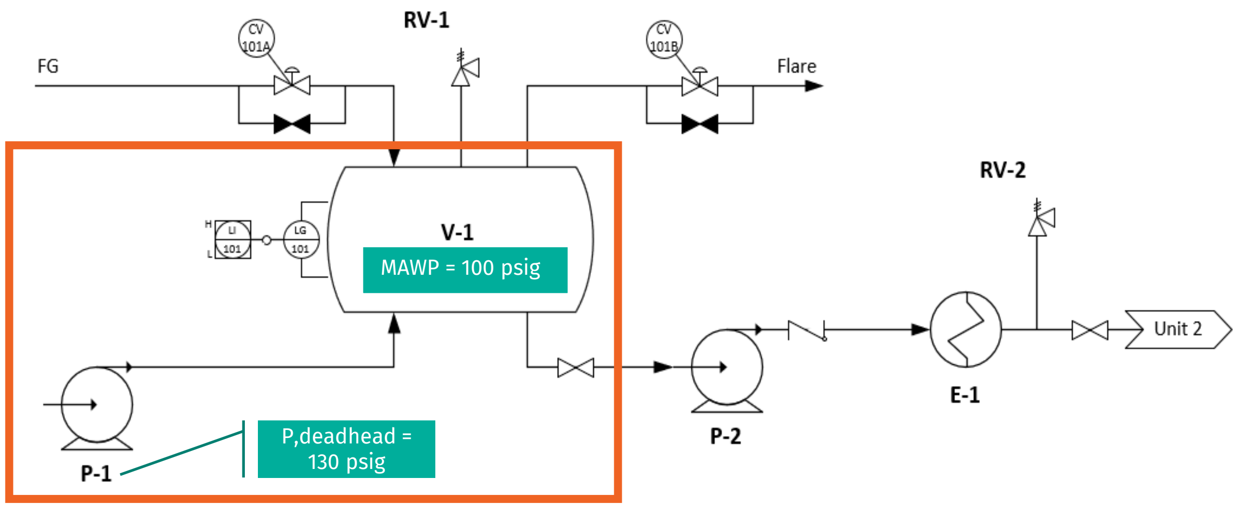
- Human factors review may include:
  - Operator/process and operator/equipment interfaces
  - Number and frequency of tasks operators perform
  - Extended or unusual work schedules
  - Clarity and simplicity of control displays & alarms
  - Automatic instrumentation vs. manual procedures
  - Clarity of signs and labeling

- Key points – *where operations interacts with the process is an extremely common source of error/hazard. How can these points be improved or modified?*
- Other benefit: Human factors analysis is a great opportunity to get feedback from operations – how can we fix the process, make it better, easier to maintain, etc.

Example PHA Scenario



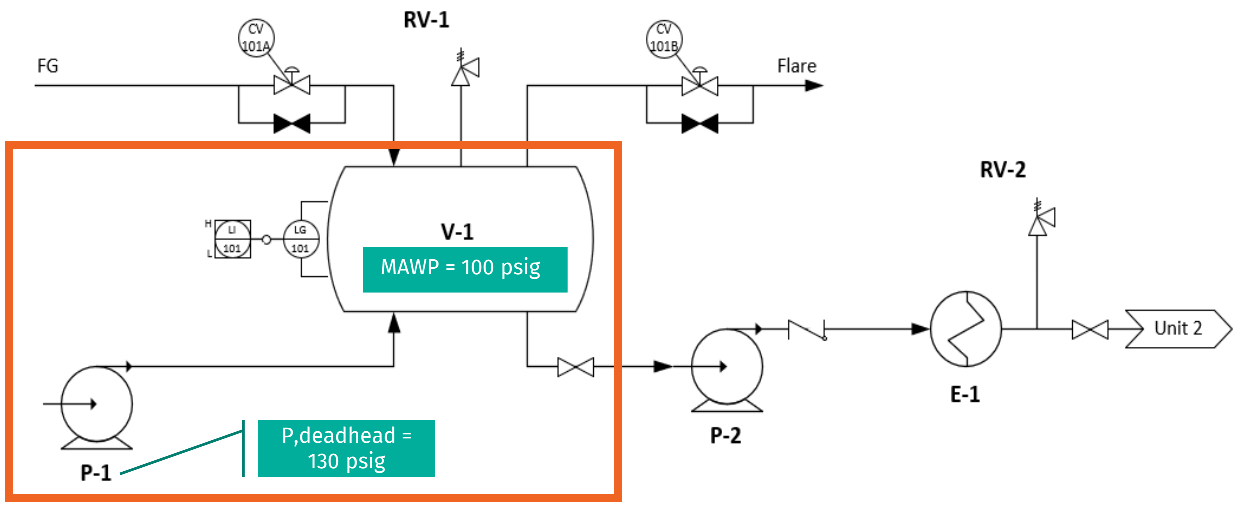
Example What-if Scenario



Equipment	What if?	Consequences	Safeguards	Risk Ranking
V-1	High liquid level in V-1	Overfill V-1. Potential for increased pressure in V-1 (130 psig) to greater than 1.25 X MAWP (100 psig). Potential for gasket leak, loss of containment. Potential for fire, personnel exposure. Team agreed to a Medium Severity based on personnel exposure	RV-1 set at 100 psig – TEAM NOTED this device was not sized for overfilling	Medium

- Note – what-if does not have a direct cause listed, thus the probability of the specific cause does not play a role in risk evaluation. This can make some risk methodologies more difficult to use (LOPA, Fault tree, etc.). This can also lead to overestimating risk if the specific cause is complicated and unlikely

Example HAZOP Scenario



- Note – HAZOP handles specific causes very well, but depending on the team, finds complex multi-step causes more difficult to handle.

Deviation	Cause	Consequences	Likelihood	Severity	URR	Safeguards	MRR
No Flow	Valve on V-1 liquid discharge misaligned closed	Potential for decreased flow of liquid from V-1. Potential to overfill V-1. Potential for increased pressure in V-1 (130 psig) to greater than 1.25 X MAWP (100 psig). Potential for gasket leak, loss of containment. Potential for fire, personnel exposure. Team agreed to a Medium Severity based on personnel exposure	Frequent	Medium	Medium	RV-1 set at 100 psig – TEAM NOTED this device was not sized for overfilling	Medium

PHA Recommendations

- The final result of a PHA is often a huge report that is infrequently used.
- The biggest “deliverable” from a PHA is the list of recommendations to resolve any risk gaps or improve safety at the facility.
- Writing good recommendations accomplishes the following
  - Faster resolution of items
  - Clear understanding of what should be done and why

Good vs Bad Recommendations

+

- Provide detail – the resolving parties don't want to flip through the entire PHA
- Provide optionality – don't force the resolving party into a box unless that is the goal
- Focus on risk resolution/reduction.

–

- Are sparse
- State only what should be done, don't allow for options
- Generic
- Are not related to risk management

State requirement

- Provide 1 safeguard

Consequence scenario

- Provide 1 safeguard for the scenario of overfilling V-1

Potential options/details

- Provide 1 safeguard for the scenario of overfilling V-1. Team noted that RV-1 is not currently sized for overfilling and LAH does not provide adequate time for response. Either would provide 1 safeguard if modified

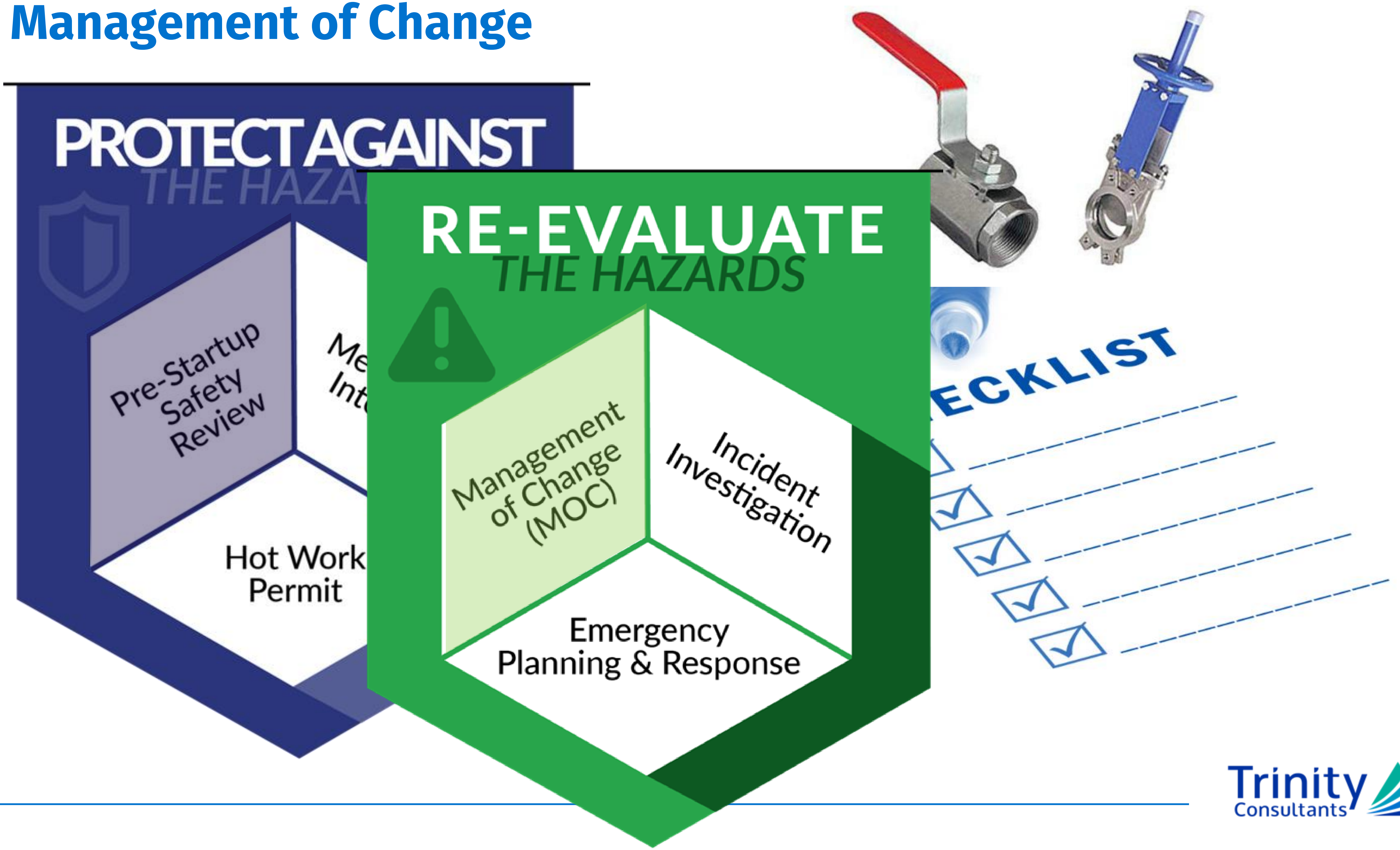
PHA Documentation Requirements

- Establish a system to track recommendations
  - Develop & maintain written schedule
  - Specific actions taken on recommendations
  - Communicate the actions to all affected employees
- Include recommendations and actions taken to resolve them with PHA report
- Retain PHA documentation for the life of the process
- PHAs require revalidation at least every 5 years for regulated facilities, even if there are no changes

PHA - Questions

- Who evaluates MOC / PSSR changes to determine if a is PHA required?
- Who maintains the schedule for PHA revalidations?
- What are your PHA Leader training credentials?
- How are PHA team members selected?
- Are previous related incidents and MOCs incorporated in a PHA revalidation?
- Are PHA recommendations addressed promptly and communicated to affected personnel?
- Where are historical PHA files maintained?

Management of Change



Pre-Startup Safety Review (PSSR)

- The intent of this element is to make sure that, for new facilities and for modified facilities when the modification necessitates a change to process safety information, certain important considerations are addressed before any highly hazardous chemicals are introduced into the process

- This is used as an opportunity to ensure that processes are operationally ready to safely start up.

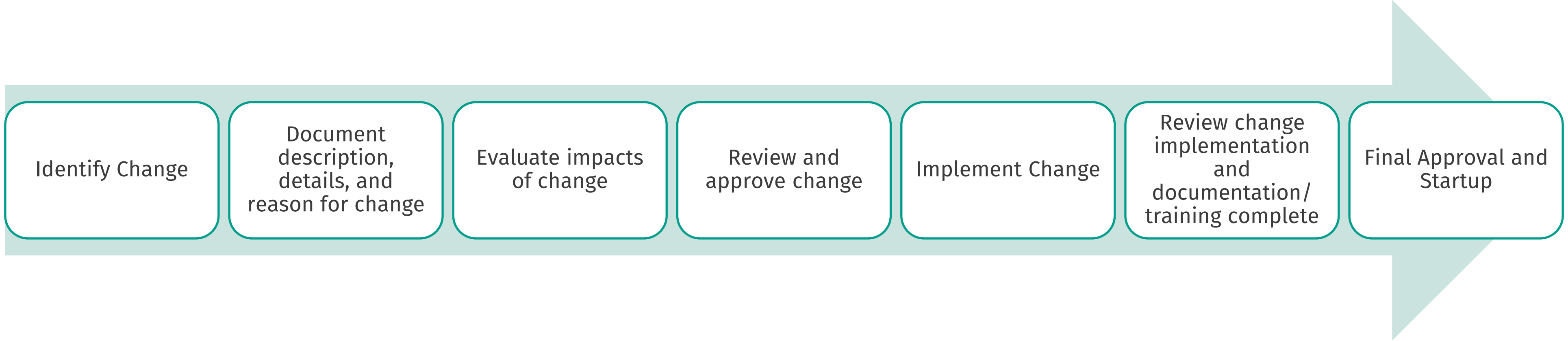
Management of Change

- All changes have the potential to introduce hazards which must be carefully evaluated and mitigated.
- The intent of this element is to require management of all modifications to equipment, procedures, raw materials and processing conditions other than "replacement in kind" by identifying and reviewing them prior to implementation of the change.
  - Includes temporary and emergency changes to the covered process system

Importance of MOC/PSSR

- Many of the catastrophic accidents over the past few decades can be traced, in large part, to a management of change system that was not in place or was not functional
- Process changes potentially invalidate prior hazard assessments and create new hazards
  - All process changes to the documented technology must be reviewed
- MOC complexity should correspond to the level of safety criticality

Critical Elements of an MOC/PSSR Process



MOC/ PSSR processes can be scaled to the complexity of the process or facility it is being completed at but generally follow similar workflows.

Critical Elements of an MOC/PSSR Process

Change identification is the critical first step in any good MOC process. Change does not only include physical changes to equipment, but also changes to critical documents such as operating procedures or process safety information, critical organizational changes, process technology, etc.

Best Practice: This can be achieved through small adjustments to existing processes such as questions built into project development processes and/or maintenance work order/ scheduling processes.

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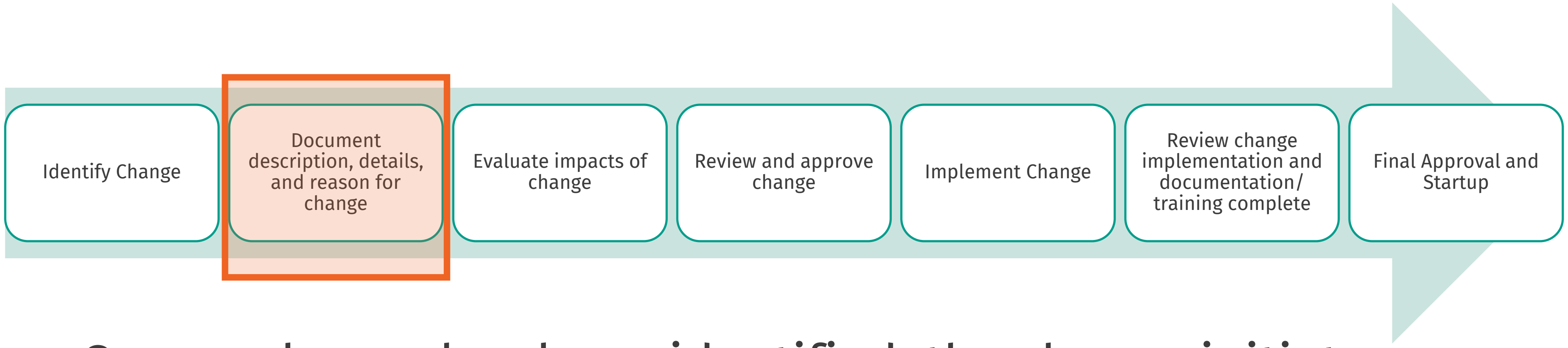
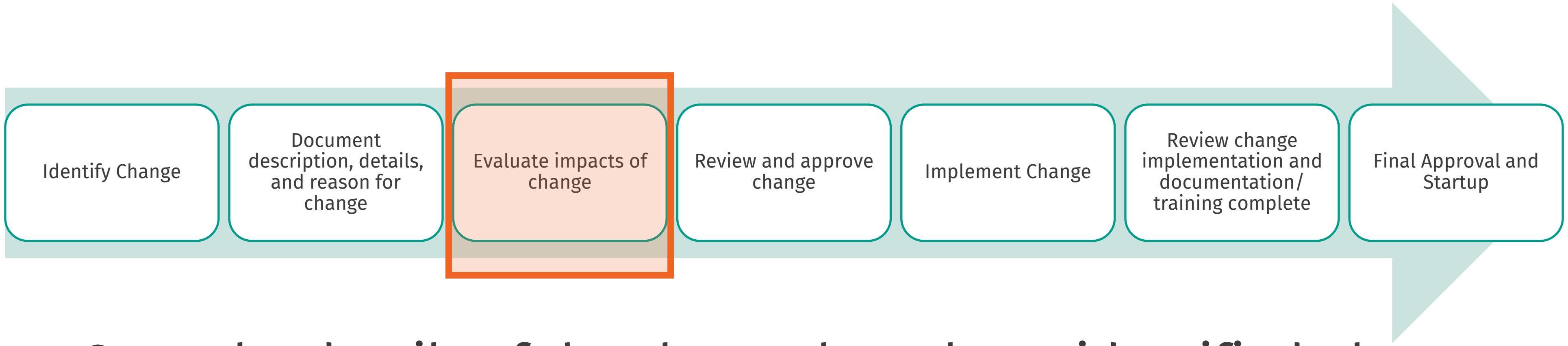
Critical Elements of an MOC/PSSR Process



Once a change has been identified, the change initiator should develop a description of the change, technical basis for the change, and begin to review potential impacts of the change.

Best Practice: Facilities may utilize prebuilt forms or software tools which requires this information to be populated. Checklists can be developed to help identify the complexity of the change and provide consistent evaluation of affected groups and documents.

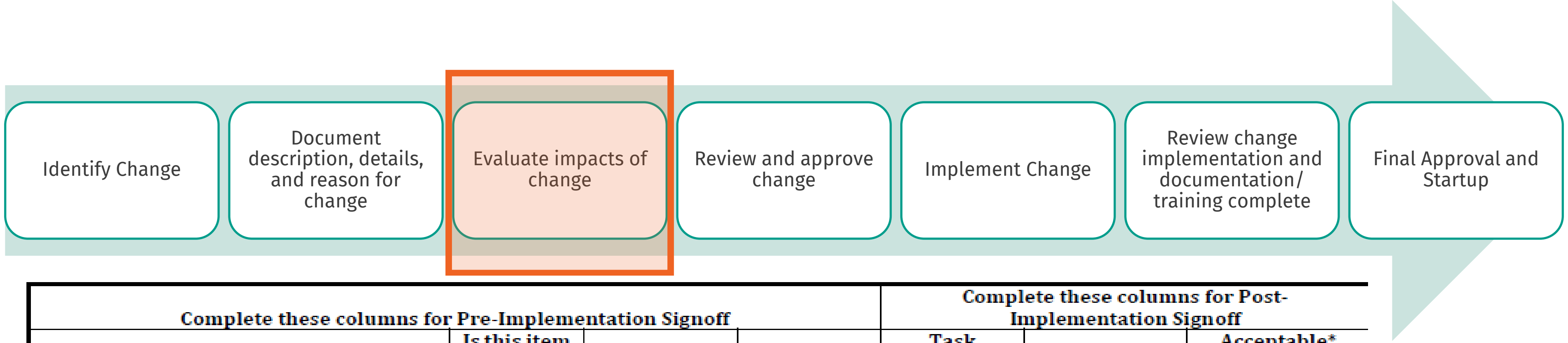
Critical Elements of an MOC/PSSR Process



Once the details of the change have been identified, the impacts must be evaluated. This should involve stakeholders from throughout the facility to provide a thorough evaluation of the safety and health impacts of a change.

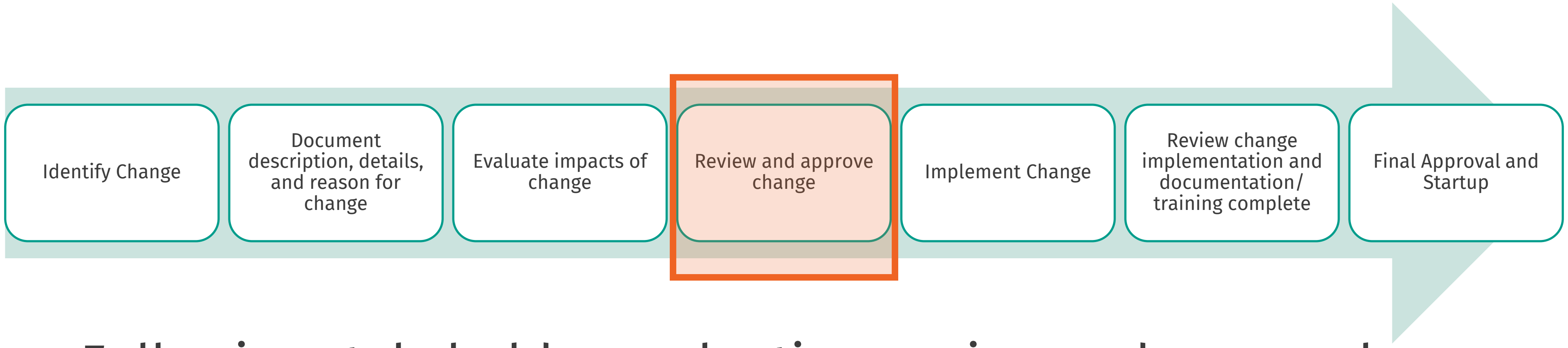
Best Practice: Checklists can be utilized to improve consistency of reviews. These may be completed as a team or by individual disciplines for their area of expertise. At this stage, the team may begin redlining affected documentation and developing training materials for the change.

Critical Elements of an MOC/PSSR Process



Complete these columns for Pre-Implementation Signoff					Complete these columns for Post-Implementation Signoff		
	Process Task	Is this item required? (Yes/No)	Explanation of Task	Responsible Personnel	Task Completion Date	Review (Initial/Date)	Acceptable* (Yes, No, or With Changes)
1.	Pre installation Engineering Review (Review the modification plan for adherence with good engineering practices, i.e. National Fire Protection Association, API, ASME, etc.)						
2.	Is a Formal Hazard Evaluation (Process Hazards Analysis) required? If "Yes", see #21.						
3.	Determine if recommendations from Process Hazards Analysis have been resolved prior to start-up.						
4.	Are updates to the Operating Procedures necessary?						
5.	Are updates to the Maintenance Inspection and Testing (Preventative Maintenance plan) and procedures required?						

Critical Elements of an MOC/PSSR Process



Following stakeholder evaluation, review and approval should be obtained to ensure that all hazards identified in the evaluation have been addressed by the team prior to implementation.

Best Practice: This approval is usually completed by one or more supervisors or managers for the area affected by the change.

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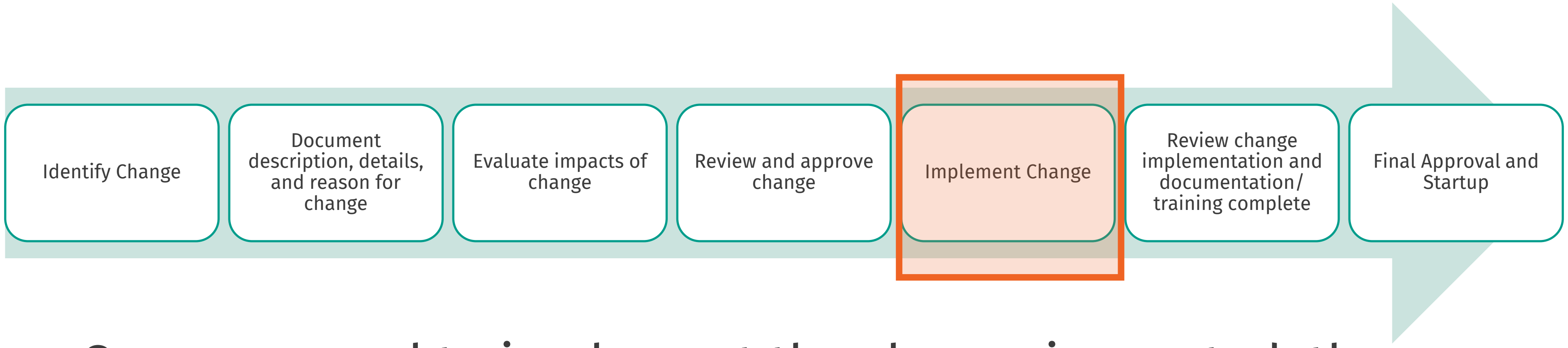
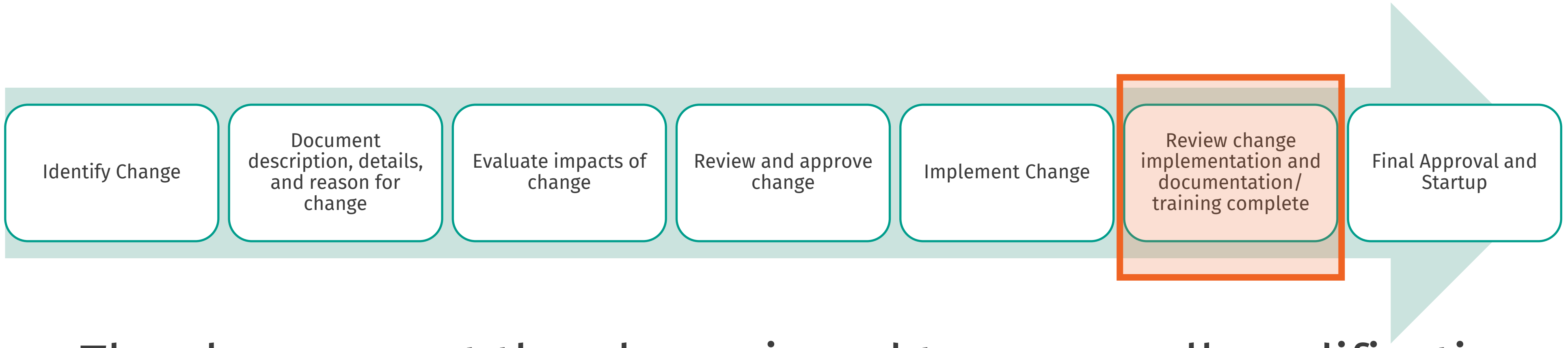
Critical Elements of an MOC/PSSR Process



Once approval to implement the change is granted, the change may be implemented. If the change impacts process safety information, such as a physical equipment change, the change is still not ready to start up. The changes may be built but the PSSR and final approval must still occur prior to introducing any hazard material to the new or modified equipment.

For simple changes which do not affect Process Safety Information, this may complete the MOC process.

Critical Elements of an MOC/PSSR Process



The change must then be reviewed to ensure all modifications were made as designed, hazards were all appropriately addressed, training has been completed, and all documents including procedures and process safety information has been completed prior to introducing any hazardous materials.

Best Practice: Assemble a team with expertise in multiple disciplines including engineering, operations, maintenance, and safety to walk the change and review completed documentation changes. Checklists are a very useful PSSR tool.

Critical Elements of an MOC/PSSR Process

Once the PSSR is completed, final approval can be granted to startup the new or modified process.

Best Practice: Similar to the change approval, this approval is usually completed by one or more supervisors or managers for the area affected by the change. Following startup, the process should be monitored carefully to ensure that the change did not introduce any unexpected consequences.

MOC/PSSR Documentation

- PSSRs determine that
  - All elements of RMP/PSM have been appropriately addressed
  - Construction and equipment is in accordance with design specifications
  - Safety, operating, maintenance & emergency procedures are in place & adequate
  - New facilities- PHA was conducted & findings resolved or implemented prior to startup
  - Modified facilities - the requirements of management of change are met

- MOCs document
  - Purpose and technical basis of change
  - PSI being modified, if any
  - Review of impact of change on safety, health and environmental considerations
  - Modifications to operating procedures or practices
  - Training of affected employees and/or contractors, prior to startup of the process or change
  - Necessary time period for change

MOC/PSSR Tracking System

- Method to Request MOC/PSSR, track status and ensure that
  - Other affected elements are identified (procedures, P&IDs, etc)
  - Action items initiated from the MOC / PSSR are promptly addressed
- Retain MOC /PSSR records until they are incorporated in a PHA revalidation

Should the following changes trigger MOC/PSSR?

- Replacing a carbon steel line with a stainless steel line?
- Replacing a thermocouple in a thermal well (sensitivity of 2-5 degrees) with a RTD (resistance thermal detector with sensitivity of 0.1 degrees) in the same thermal well?
- Replacing a pump with seals with a seal-less pump?
- A change in a key staff member involved in the PSM covered process?
- Making a revision to the SOP for a troubleshooting response?

MOC/PSSR – Questions

- Who is responsible for MOC / PSSR elements?
- Are processes started up without completed P&ID's, updated operating procedures, training? Without PHA update or implementation of key PHA recommendations?
- Who's involved in deciding if just an MOC or a PSSR is required after a change? Is EHS involved?
- Do we address temporary / emergency changes?
- How are PSSR / MOC documents tracked?
- How do we know recommendations and training are completed before the process restarts?

Learning from Industry Incidents

https://youtu.be/goSEyGNfiPM

What Went Wrong?

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https://www.csb.gov/bp-amoco-thermal-decomposition-incident/

Recent Incidents

- September 2024: A process upset caused a large fire at a chemical plant in Baytown
- August 2024: A railcar carrying hydrogen peroxide overpressured and exploded at an Evonik facility in Mobile, AL
- June 2024: Release of hydrofluoric acid that seriously injured one worker at a Honeywell facility in Geismar, LA; this incident came a year and half after a heat exchanger rupture resulted in the release of hydrogen fluoride (HF) gas, chlorine gas, and various other process fluids
- May 2024: Worker at a liquid nitriding facility in Chattanooga was fatally injured following a chemical release/eruption of chemicals from a process vessel
- April 2024: Three people were injured when a fire broke out at a storage terminal in Galena Park; the fire broke out while workers were performing maintenance activities
- July 2023: Multiple explosions occurred in the Dow Louisiana Operations Glycol II Ethylene Oxide Finishing unit in Plaquemine, Louisiana
- November 2023: A fire event at the Hydrodeoxygenation Unit recycle furnace; one operator sustained serious burn injures as a result of the fire

Conclusion

Learning Objectives

- Review the history and intent behind the PSM standard
- Understand who is covered by OSHA's Process Safety Management (PSM) and EPA's Risk Management Program (RMP)
- Obtain a broad understanding of PSM/RMP Requirements, with focus on "key considerations"
- Learn from industry incidents

Your Approach to PSM/RMP

- What is your attitude towards process safety?

- How has my perception of process safety influenced how I approach process safety with my teams?

Impressions impact how we approach our involvement.

Questions?

Process Safety Roundtable – Day 2

Houston – September 2024

Presented by: Lauren Mercer

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Day 1 Recap

Learning Objectives

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The Elements

The 14 Elements can be grouped into 5 PSM Mindsets™ for easy daily use

Similar to RMP Level 3 Prevention Program

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Key Considerations

- While none of the elements are unnecessary for the safe and long-term operation of your facility, a few of the elements are key starting points for implementing a process safety culture:

Your Approach to PSM/RMP

- What is your attitude towards process safety?

- How has my perception of process safety influenced how I approach process safety with my teams?

Impressions impact how we approach our involvement.

Breakout Discussion: Scenarios

Scenario #1

A mislabeled drum containing a highly reactive chemical was mistakenly charged into a reactor. The chemical reaction generated excessive pressure, leading to an over-pressurization event. The relief valve failed to adequately relieve the pressure, resulting in a near-catastrophic situation.

Scenario #1

What process safety elements immediately come to mind?

A mislabeled drum containing a highly reactive chemical was mistakenly charged into a reactor. The chemical reaction generated excessive pressure, leading to an over-pressurization event. The relief valve failed to adequately relieve the pressure, resulting in a near-catastrophic situation.

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Scenario #1

Per element you identified, list questions you would ask the facility.

Process Safety Information

- Did the inadvertent mixing table identify this potential mixing situation?
- Was the relief valve sized appropriately?

Process Hazard Analysis

- Was this scenario identified in the PHA?
- If so, what other safeguards (other than the relief valve) were identified?

Operating Procedures

- What procedures are in place for reactor loading?
- What procedures are in place for troubleshooting?

Training

- Are operators receiving the proper initial training and refresher training?

Incident Investigation

- Was the incident investigated?
- What were the root causes?

Emergency Planning & Response

- What actions did the operators take?

Scenario #1

Pretend you identify a gap in the process safety program, how would you correct this gap?

Identified Gap	Correction Plan
• Element: PSI • Gap: Relief valve was found to be inadequate	• Mitigate inadequacy on relief valve in question • Determine if all relief valves have a relief systems design basis • Review design basis to ensure they reflect as-built status and there are no concerns • Mitigate identified concerns

Scenario #2

A specialty chemical plant upgraded a piece of equipment to improve efficiency. The upgrade altered the pressure dynamics within the system, but the change was not evaluated for its impact on the overall process. This oversight led to an over-pressurization event, causing a release of hazardous materials.

Scenario #2

If you were in an MOC evaluation meeting for this change, what questions would you ask?

- Do you have a redlined P&ID?
- Do you have the design conditions for the new piece of equipment?
- Does this change modify or invalidate the existing PHA?
- Does this change impact the relief systems design basis?
- Have impacts to the safe operating limits been evaluated?

Scenario #2

What should the facility do to improve change awareness?

- Ensure the MOC policy defines change vs replacement in kind
- Provide training to all necessary employees specifically on recognizing change
- Review the MOC process to ensure the MOC process is not discouraging MOCs (i.e. ensure it is not too cumbersome)
- Periodically audit maintenance work orders to monitor for changes occurring without MOCs

Scenario #3

A valve failure in a chemical processing plant led to the release of a flammable material. The spill created a vapor cloud that ignited, resulting in a fire. The incident caused significant damage to the facility and posed a serious risk to personnel and the environment.

Scenario #3

What process safety elements immediately come to mind?

A valve failure in a chemical processing plant led to the release of a flammable material. The spill created a vapor cloud that ignited, resulting in a fire. The incident caused significant damage to the facility and posed a serious risk to personnel and the environment.

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Scenario #3

Per element you identified, list questions you would ask the facility.

Process Safety Information

- Did the electrical area classification consider this leak scenario?
- Is the equipment in the area rated to the appropriate electrical classification?

Process Hazard Analysis

- Did the facility siting evaluation consider the potential scenario?

Mechanical Integrity

- Are valves and their flange connections being visually inspected during the piping visual inspections?

Incident Investigation

- Was the incident investigated?
- What were the root causes?

Emergency Planning & Response

- What actions did the operators take?

Scenario #3

Pretend you identify a gap in the process safety program, how would you correct this gap?

Identified Gap	Correction Plan
• Element: PHA • Gap: Facility siting was found to be a bare-minimum checklist in the PHA	• Consider performing a facility siting study in accordance with RAGAGEP (e.g. API 752) • Improve on the checklist being utilized in the PHA • Ensure recommendations from the facility siting study/review are treated with the same respect as other PHA recommendations

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Scenario #4

A manufacturing plant changed its operating procedures to streamline production. The new procedures inadvertently bypassed a critical safety step, leading to an uncontrolled release of toxic gas.

Scenario #4

If you were on the incident investigation team, what questions would you ask?

- Was an MOC performed for the procedural change?
- What approval process did the procedural change go through?
- What was the critical safety step that was bypassed?
- Did the PHA evaluate this scenario?
- If there are other safeguards present, did they fail?
- Were workers impacted by the toxic release?
- Did the release go offsite?

Scenario #4

Brainstorm other consequences of not performing a procedural MOC.

- Potential for mixing incorrect chemicals, resulting in a runaway reaction
- Failing to identify impacts to troubleshooting steps
- Missing impacts to operating limits
- Not recognizing the need for training of operators on the change