Course Overview

This course teaches how good hazard recognition can prevent or influence an incident. The course addresses the difference between personal safety hazards and process safety hazards, how incidents occur through a breakdown of process safety hazard controls. Students will explore an industry case study and the impact of hazard recognition on the incident. Students will also analyze typical process scenarios and make determinations on hazard recognition and preventative measures.

I. Curriculum Criteria: Process Safety Hazard Recognition

Topics	**Course Content/Criteria** **Target Audience – Process Operators and Maintenance Crafts, and Front Line Supervision**	**Evaluation Criteria**
Topic 1: Importance of hazard recognition and how process safety incidents occur. **Estimated length of this topic:** 60 minutes	**Learning Objectives:** 1. Understand the difference between personal safety hazards and process hazards. 2. Recognize how process incidents occur when layers of protection/hazard barriers break down. 3. Understand that good hazard recognition can prevent or influence an incident. **Content:** 1. Review the difference between process hazards and personal safety hazards. Convey the following information. a. Process safety hazards are those that may result from a refinery or chemical facility process. Typical process safety incidents involve the escape of toxic substances or the	1. Students shall be able to recall an example of at least one process safety incident and how hazard recognition affected the outcome.

	release of flammable material which may or may not result in fires or explosions. Process safety incidents may damage the plant, cause injuries or fatalities, or have the potential to impact the local community. b. Personal safety hazards are those that affect individuals but have little to do with the processing activity of the plant. Typically they refer to incidents such as slips, trips, falls, electrocutions, or vehicle accidents. 2. Explain how process incidents occur using a simplified version of James Reason's Swiss Cheese model: a. Hazards are contained by multiple layers of protection. b. Each layer of protection may have weaknesses or "Holes." c. When holes align, the potential for process safety incidents increases (refer to 1a for examples). d. Layers of protection may be physical, engineered, containment, procedural or behavioral controls dependant on people. e. Holes can be existing, develop over time, or be actively opened by people. f. Give examples what operators and craftsmen can do to plug the holes in the Swiss cheese.	

	3. Explore an industry case study. Show an example of a major industry incident (e.g. Bhopal, BP Texas City; Tesoro, etc). a. Discuss causal factors and lessons learned. b. Discuss how process safety hazard recognition (or lack thereof) influenced the incident. c. Draw relationships between the Swiss Cheese Model and the incidents exampled above. 4. OPTIONAL: Show an example of a company related incident. a. Discuss causal factors and lessons learned. b. Discuss how process safety hazard recognition (or lack thereof) influenced the incident. c. Draw relationships between the Swiss Cheese Model and the incidents exampled above.	
Topic 2: Importance of Process Safety Controls in preventing process safety incidents. **Estimated length of this topic:** 90 minutes	**Learning Objectives:** 1. Know the importance of process safety controls in preventing incidents and the interaction between operators and craftsmen to sustain such controls. 2. Understand that process safety incidents occur when multiple process safety controls break down and those effective controls can protect people from process safety hazards.	1. Students shall be able to explain the purpose of process safety controls. 2. Students shall be able to recognize their roles in maintaining a safe operating envelope.

	Content: 1. Explain how process safety relates to the quantity, quality, and variety of controls or protective features that protect people, the environment, and property from process hazards. 2. Review the most common process safety controls that operators and craftsmen have job interaction with. During the discussion, ask students: • To identify their roles/interaction in the following layers of protection. • The potential hazards that would exist if the control was not in place. a. Alarms/Detection Sys/DCS • Control room, fire, toxic gas alarms and detection systems, redundant alarm and shutdown devices, interlocks and automatic shutdown devices, process containment and upset controls, b. Safety Instrumented Systems (SIS) • SIS is designed to bring the process to a safe state when unacceptable or dangerous process conditions are detected. They are independent from regular control systems.	

	c. Relief valves • Valves designed to open before pressure reaches a hazardous level. d. Operator rounds • Early identification and communication of process safety hazards. (for example: identify leaks, excessive vibration on equipment or lines, identify permit deviations). e. Maintenance PM Checks • Early prevention of process safety hazards. f. Inspections • Systematic inspections of fixed and rotating equipment and piping. g. Management of Change (MOC) • The methods to track and inform employees of changes. h. Pre-Startup Safety Review (PSSR) • Method to assure safe and trouble free unit start up. i. Hazard and Operability Studies (HAZOPS) • An examination of a planned or existing process or operation in order to identify and	

	evaluate problems that may represent risks to personnel or equipment, or prevent efficient operation. j. Accurate Process Safety Information (PSI) • Process safety information shall include information pertaining to the hazards of the highly hazardous chemicals used or produced by the process, information pertaining to the technology of the process, and information pertaining to the equipment in the process. k. Procedures and Training • Accurate operating procedures and the associated training to verify that employees can perform the procedures. • Emergency operations drills/what-ifs (utility loss; unplanned shut-down). l. Safe work practices (SWPs) • They are the general do's and don'ts of common work activities. SWPs	

	are often used to support procedures to reduce repetitive information and prevent injury and incidents. m. Operating Limits • Safe limits of operation for process units.	
Topic: 3 How do <u>You</u> recognize and prevent Process Safety Incidents **Estimated length of this topic:** 60 minutes	**Learning Objectives:** 1. Recognize common hazardous process scenarios, understand the interaction of hazard recognition and suggest preventative measures. **Content:** 1. Show an industry statistic that breaks down the main triggers/factors that cause process incidents. Summarize main triggers/factors as being in the categories of Equipment/Engineering, Training/Procedures, and Human. Give examples of each. 2. Given common process scenarios, challenge the students to determine the opportunities for hazard recognition and preventative measures. a. The information may be presented through a class breakout session OR instructor led discussion.	

	b. Choose 5 scenarios from TABLE 1. c. Students will be asked to fill-in or comment on the Process Safety Hazard Recognition and Preventative Measures for each scenario. d. The Process Safety Hazard Recognition and Preventative Measures Columns are potential answers for the instructors to use as guidance. ***Note:*** *Table 1 may be customized to reflect specific site or company process hazards and terminology.*	

II. Definitions

1. **Process Safety Hazard Recognition:** For the purposes of this course, *hazard recognition* is the ability to independently identify hazards. Hazards are anything that have the potential to cause harm to people or to damage property or the environment.
2. **Process Safety Hazards:** Hazards associated with the loss of primary containment of a hazardous substance. *Process Hazards* include fire, explosion, and toxic release. These hazards are associated with incidents which occur at low frequencies, but can have catastrophic consequences.
3. **Personal Hazards:** *Personal Hazards* refers to those occupational hazards not usually associated with the loss of containment of a hazardous material. These hazards include slips, trips, and falls as well as other hazards typically addressed through PPE or worksite conditions. These hazards are associated with occupational incidents which occur at higher frequencies, but typically only affect a single employee.

4. **Equipment Factors:** *Equipment Factors* are those factors which may contribute to process hazards and are not associated with error by those operating the equipment. Equipment factors include design problems, specification problems, defective equipment or parts, problems with predictive or preventative maintenance, or other items unrelated to human factors.
5. **Procedural/Training Factors:** Human factors specifically associated with inadequate training or operating or maintenance procedures. See *Human Factors* below.
6. **Human Factors:** *Human Factors* are those factors which may contribute to process hazards which are associated with human errors and the causes of human errors. Human factors include problems with procedures, training, communication, human/machine interfaces, oversight, work direction and other items related to causing human error.
7. **Process Safety Controls**: Multiple Layers of Protection, such as Operator Rounds, Maintenance PM Checks, Inspections, Management of Change, Pre-Start Up Safety Reviews, Hazardous Energy Control, Training, Procedures, Hazard and Operability Studies, Process Safety Information, Safe Work Practices, Operating Limits, Alarms,/DCS, Safety Instrumented Systems (SIS) and Relief Valves.
8. **Process Controls:** The means by which a process is operated within its safe operating limits and by which it is operated and maintained safely. The term *Process Controls* is typically associated with a Distributed Control System where a console operator can remotely monitor and control an operating process.
9. **Abnormal Situations**: In the process industry, *Abnormal Situations* are generally associated with non-steady state operation. Examples of non-steady state operations include process upsets, start-ups, shutdowns, or other atypical modes of operation.

III. Student Evaluations

Method of Student Evaluations:

1. Written test: 15 to 20 questions based on the learning objectives and evaluation criteria. Questions shall be weighted equally across the material presented.
2. Test shall consist of fill in the blank, maching, multiple choice, or short answer. True/false questions shall not be used.
3. Passing grade is 100% with remediation.

IV. Course Structure

1. The Course Shall:
    a. Be instructor-led class
    b. Include group interactive exercises.
    c. Target craftsman & operators.
    d. Be 4 hours in duration, including testing.
    e. Have a maximum attendee to instructor ratio of 24 to 1.
    f. Include TABLE 1 as a training aid.

Table 1

This information may be presented through a class breakout session OR instructor lead discussion.
in the Process Safety Hazard Recognition and Preventative Measures for each

Scenario	Potential Hazards & Impacts	Process Safety Hazard Recognition
A block valve is closed in the path of a pressure relief/safety valve.	Loss of containment. Fire, explosion, injury, fatalities.	A closed block valve in a relief path can defeat overpressure protection. As a result the relief valve does not operate properly during overpressure condition.
Equipment is operating above its design temperature while an exchanger is offline for cleaning.	Catastrophic equipment failure. Loss of containment. Fire, explosion, injury, fatalitiies	Operating equipment outside of the safe operating limits is prohibited and can cause a catastrophic failure.
While opening a flange on pump a hydrocarbon leak is observed.	Loss of containment and/or personnel exposure to hazardous materials. Fire, explosion, injury, fatalitiies.	Leaking material indicates one of the following: Energy sources are not properly isolated, or An isolation device is leaking through, or The equipment has not been properly prepared for maintenance.

A valve is opened out of sequence.	Loss of containment and/or personnel exposure to hazardous materials. Fire, explosion, injury, fatalitiies.	Not following the proper procedure or practice when operating process equipment can lead to exceeding safe operating limits such as temperature, pressure, or flow. Exceeding safe operating limits can lead to catastrophic failure of equipment.
The burner lighting sequence is not followed.	Fire box explosion, over temperature or overpressure. Loss of containment; fire; injury; fatalitiies.	Failure to follow proper procedures when lighting off a heater can lead to an explosive air-fuel mixture in the firebox. Firing a heater without flow through the tubes can lead to overheating the tubes and subsequent tube rupture.
A pipe is exhibiting excessive vibration.	Equipment damage, leak, loss of containment. Fire, explosion.	Vibration induced fatigue is a serious concern and has led to many significant incidents. All materials of construction are susceptible to this damage mechanism.

A compressor seal is leaking.	Leak, loss of containment. Fire, explosion, injury, fatalitiies.	Compressor and pump seal failures are a leading cause of major fires in refineries. A leaking seal will typically get worse to the point of failure.
An individual enters a vessel without a proper confined space entry permit.	Injury; fatalitiies.	There are a number of hazards associated with confined spaces that may not be obvious to the naked eye. Due to the confined nature of the vessel flammable or toxic gases may be present or may accumulate slowly over time without proper ventilation. Confined spaces are also concerns for potential oxygen deficient atmospheres for the same reason. There may also be hazards from overhead work above you in a confined space as well as sparks or fumes from grinding or welding activities. Some residues remaining in vessels even after cleaning may be pyrophoric.

Due to workload, a scheduled round/unit surveillance was missed.	Failure to identify a small problem before it becomes a big one.	Operator rounds are a part of a mechanical integrity program. Rounds are an inspection of the unit for anomalies using the senses as well as local instrumentation. Rounds help identify problems before they get out of control. Problems such as unusual sounds, vibrations, smells, small leaks, small fires, abnormal pressures, temperatures, or levels on local instruments.

Students will be asked to fill Scenario.

Preventative Measure(s)
Carefully consider the installation of block valves in relief paths during the process design, including an evaluation of potential hazards. Where block valves are used in these installations they must be rigorously managed, such as with a car seal or Lock with a checklist. Conduct a PSSR walk down before each start-up which includes verification of open relief paths.
Design equipment for abnormal operating scenarios. Set and honor appropriate alarm limits. Training on critical process variables and proper response to deviations. Follow operating procedures.
Safe work permits including verification of LOTO. Verifying LOTO and cleanliness through physical checks or verifications prior to beginning maintenance work. Periodically recheck to ensure hazardous materials are not present during ongoing work.

Always follow procedures. Always honor safe operating limits. Adhere to training, and ask questions if you're not sure.
Always follow procedures. Adhere to training, and ask questions if you're not sure. Check the firebox for an explosive mixture before attempting to light any burners. In most cases flow must be established through the heater tubes before firing main burners.
Consider the need for vibration dampening equipment, spring hangars, and pipe supports when designing piping systems. Be alert for abnormal situations: sounds, physical vibration, leaking, etc. and report them when they occur. Conduct visual inspections during transient conditions like start-up, shutdown, and upsets when flow may be unstable. Report any pipe movement or hammering flow. Watch for damage that is indicative of high vibrations such as damage to insulation jacketing.

Consider engineering controls to minimize the risk from seal failures such as tandem seals when designing equipment. Be alert for abnormal situations: sounds, physical vibration, leaking, etc. and report them when they occur. Take the leaking equipment out of service if possible and write a work order for repair. Visually inspect seals periodically on all rotating equipment for damage, leaks, or other obvious signs of potential problems.
Always complete a Safe Work Permit before entering any confined space. Verify physical isolation and LOTO before entering or allowing anyone else to enter a confined space. Proper atmospheric testing must be completed before entry, and periodically after entry to ensure the atmosphere remains safe. Be aware of any other work going on in the same space that might affect you. Ask the confined space attendant if you are not sure. The confined space attendant must remove entrants from the space if conditions inside or outside the vessel become unsafe or uncertain.

Procedures for conducting operator rounds must be followed, and training for rounds must be adhered to. Rounds should be intentionally designed to check critical variables, verify board/field mounted instruments, and detect abnormal situations throughout the unit. Each company should develop a policy on how to manage missed or altered rounds due to unexpected circumstances.