
Process Safety Indicators

Presentation to
Canada-Newfoundland and
Labrador Offshore Petroleum
Board Safety Forum

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Overview

- Background to Process Safety Indicators
 - Two significant industrial accidents:
 - Texas City
 - Buncefield
 - The Process Safety Triangle
 - Tiered classification; definitions for classifications; examples.
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Industrial Accident Case #1**BP Refinery - Texas City**

March 23, 2005

- 15 fatalities, 180 injuries and resulted in financial losses exceeding \$1.5 billion.
- During startup of an isomerization unit a raffinate splitter tower was overfilled
- All of the fatalities occurred in or near office trailers
- 43,000 people were given a shelter-in-place order.
- CSB investigation: cause was multiple technical, system and organizational deficiencies.

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Industrial Accident Case #2**Buncefield Fuels Terminal - UK**

December 11, 2005

- 43 people injured; no fatalities
- Destroyed large parts of the Buncefield fuels depot
- Widespread damage to neighbouring properties
- About 2000 people evacuated from their homes
- Overfilled tank during delivery from pipeline

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Accident Follow Up – Process Safety Indicators



BP Refinery - Texas City

- Incidents investigated by government authorities
 - US Chemical Safety Board (CSB)
 - UK Major Incident Investigation Board (MIIB)
- CSB final report (March 2007) found:
 - No effective system of indicators to evaluate performance and continually improve the control of process safety risks.
 - Typically using personal safety indicators.

Buncefield Fuels Terminal - UK

- MIIB (final report December 2008) called for the adoption of better measures of performance for the major hazards sectors than injury rates and other measures that are primarily occupational safety-related.
- American Petroleum Institute (API) published Recommended Practice 754 – Process Safety Performance Indicators for Refining and Petrochemical Industries in April 2010.
- UK Petroleum Industry Assoc (UKPIA) has adopted the use of API RP 754.


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Investigation Summaries



- Process safety incidents can have catastrophic effects
- Safety is multi dimensional – includes personnel safety and process safety, distinguished by the type of hazard
 - Process Safety hazards – associated with processing activity and typically involve loss of containment of hazardous material
 - Personnel Safety hazards – incidents such as falls, cuts, electrocutions, and vehicle accidents
- Must use Indicators that specifically relate to the hazard being managed:
 - Key learning from Texas City incident was that we cannot rely on injury data to assess how well process safety is being managed.


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Process Safety Event Triangle

Key Principles

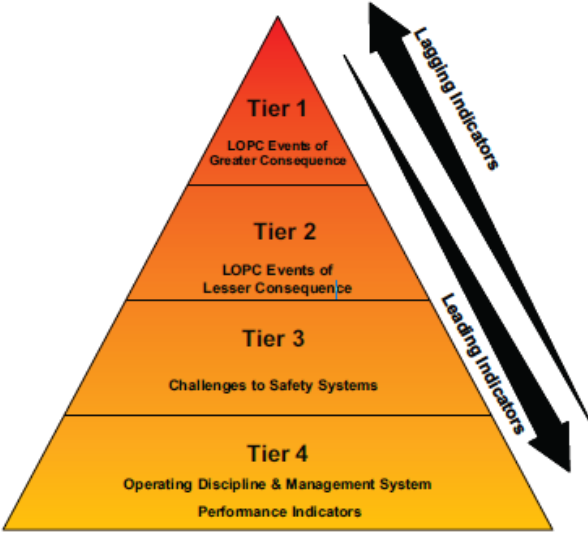
- The now-familiar accident triangle was introduced in 1931.
- The accident triangle represents two key concepts:
 - safety accidents can be placed on a scale representing the level of consequence;
 - many precursor incidents occurred with lesser consequences for each incident that occurred with greater consequences.
- The model represents a predictive relationship between lower and higher consequence personal safety events.
- It is believed that a similar predictive relationship exists between lower and higher consequence events that relate to process safety.



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Process Safety Event Triangle

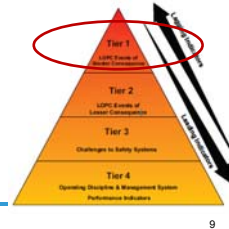


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Process Safety Event Categories



- Tiers 1 and 2 are suitable for industry-wide benchmarking (API) and Tiers 3 and 4 are intended for internal use at individual sites and not benchmarked.
- Tier 1 Events – Loss Of Primary Containment (LOPC) Events that results in:
 - Fatality and/or Loss Time Incident (LTI), or
 - A third-party fatality, or injury/illness that results in a hospital admission, or
 - A fire or explosion that causes \$25,000 or more of direct cost, or
 - Officially declared community evacuation or shelter-in-place, or
 - Acute (≤ 1 hour) releases within Tier 1 threshold quantities.
- Examples:
 - An operator slipped and fell while responding to a small spill of liquid with a flash point < 23 degC (e.g. less than 7 bbl in 1 hour) resulting in a days away from work injury. This would be a Tier 1 PSE since the operator was responding to a LOPC.



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Process Safety Event Categories



- Tier 2 Events - LOPC Events that results in:
 - A recordable injury; or
 - A fire or explosion that causes \$2500 or more of direct cost; or
 - Acute (≤ 1 hour) releases within Tier 2 threshold quantities.
- Examples:
 - A bleeder valve is left open after a plant turnaround. On start-up, an estimated 15 bbl of fuel oil, a liquid with a flashpoint above 60 degC, is released at 38 degC (below its flashpoint) onto the ground within an hour and into the plant's drainage system before the bleeder is found and closed. This is a Tier 2 PSE.



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Process Safety Event Categories



- Tier 3 Events (Not Industry Benchmarked)
 - Purpose of Indicator: A Tier 3 PSE typically represents a challenge to the barrier system that progressed along the path to harm, but is stopped short of a Tier 1 or Tier 2 LOPC consequence.
 - Indicators at this level provide an additional opportunity to identify and correct weaknesses within the barrier system.
- Tier 3 indicators are intended for internal Company use. The API RP provides example indicators and requires companies to develop and use Tier 3 indicators.
- Example Tier 3 indicator categories:
 - Events with Consequences below Tier 2 Thresholds
 - Challenges to Safety Systems - Demands on Safety Systems
 - Other near miss events.



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Process Safety Event Categories



- Events with Consequences below Tier 2 Thresholds
 - Other LOPC Events (minor spills and gas releases)
 - Other Process Fires
 - should reflect potential process safety hazards rather than health or environmental hazards.
 - Other Process Fires intended to capture fires not related to a LOPC. For example electrical fires.
- Other near miss events.
 - events or conditions that under slightly different circumstances could have resulted in a loss of primary containment.
 - Examples:
 - Dropping loads within damage range of equipment containing flammable or toxic material.
 - Failure to properly isolate or clear equipment for mechanical work.



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Process Safety Event Categories



- Challenges to Safety Systems
 - Demands on Safety Systems (DOSS)
 - All events that are initiated by a process or mechanical condition at or beyond the predetermined value selected for the safety system activation.
 - Includes demands on safety systems regardless of the phase of operation.
 - These are typically devices either manual or automatic that prevent a loss of primary containment and return a process to a safe state.
 - Examples:
 - A Safety Instrumented System trip with a valid danger signal such as high-high pressure or low-low level.
 - Activation of fire heat detectors, smoke detectors and detectors.

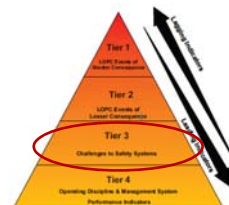
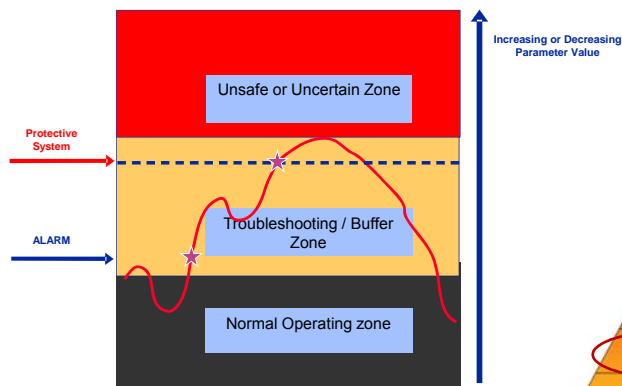


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Process Safety Event Categories



- Tier 3 Events include:
 - Challenges to Safety Systems
 - Safe Operating Limit Exceedances (SOLE)
 - Safe Operating Limit (SOL) exceedances are events resulting in operating equipment outside design parameter(s). These events could progress and result in a loss of primary containment incident.

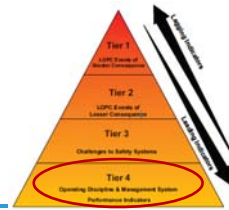


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Process Safety Event Categories



- Tier 4 Management System Performance and Execution
 - Purpose of indicator: represent performance of individual components of the barrier system.
 - Tier 4 indicators are intended for internal Company use. The API RP provides example indicators and requires companies to develop and use Tier 4 indicators.
 - API provides examples such as:
 - Process Hazard Evaluations Completion
 - Training Completed on Schedule
 - Management of Change and Pre Start-up Safety Review Compliance



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Process Safety Indicators - Summary



- High Consequence – Low Probability Events have higher frequency – lower consequence precursors.
- Personnel safety indicators not always a measure of process safety. Need to use indicators specific to process safety to measure effectiveness and operating discipline.
- Process safety event reporting and indicator collection necessary to identify weaknesses to allow for strengthening of process safety management.
- Process Safety Saves

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