Process Safety Time (PST)

The Hidden Clock Behind Loss of Containment

Understanding critical timing in preventing safety incidents

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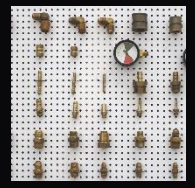
Process Safety Time (PST): The Hidden Clock Behind Loss of Containment

Concept of Process Safety Time

PST measures the critical time window to detect and act before loss of containment occurs.



Role of Protective Layers

Protective layers reduce risk only if they respond faster than process deterioration.

Practical Application and Governance

Standardizing PST calculation and integrating results into safety reviews ensures ongoing risk management.

Agenda – What We Will Cover

Importance of PST

Time is critical in escalation scenarios like pressure surges and control valve failures leading to hazards.

PST Concept Framing

PST is framed as available time versus required response time of safeguards including sensing and action.

Methodology Overview

Scenario selection, escalation characterization, and PST calculation rely on consistent assumptions and standardization.

Case Examples and Findings

Practical case studies demonstrate control valve failures and mitigation strategies to improve safety.

Why It Matters — Loss of Containment Often Occurs When Response Is Too Slow

Time-Based Risk Universality

Many process hazards escalate over time, making timely response critical to prevent loss of containment.

Impact of Aging and Complexity

Aging equipment and increased complexity introduce uncertainties that can delay protective responses and reduce safety margins.

PST Enables Measurable Response Window

Process Safety Time quantifies the critical window for barrier response, revealing vulnerabilities before incidents occur.

Operational Relevance of PST

PST helps operators and reliability teams prioritize risk reduction by focusing on timely and reliable barrier actions.

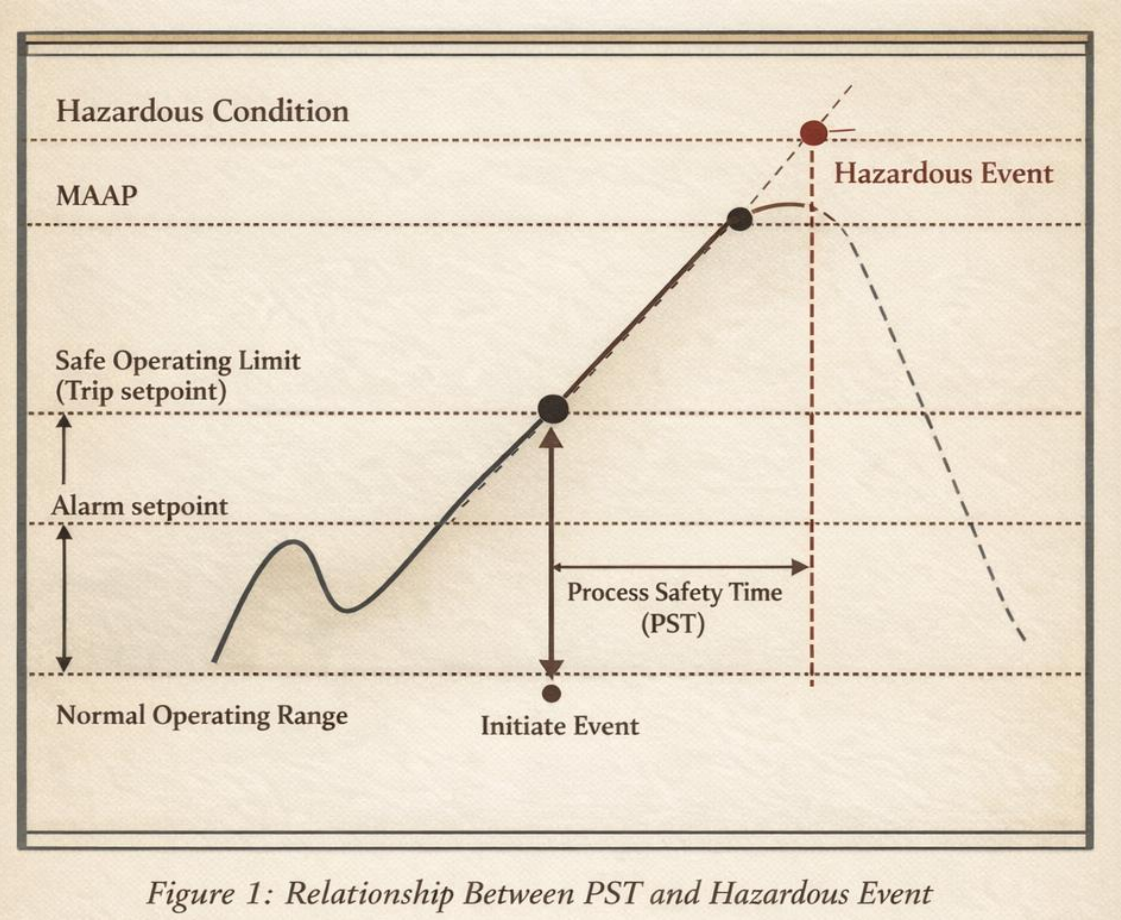


Figure 1: Relationship Between PST and Hazardous Event

PST Definition – Process Safety Time in Simple Terms

Definition of Process Safety Time

PST is the time between an abnormal condition onset and reaching a hazardous threshold causing potential harm.

Required Response Time Components

Response time includes detection, logic processing, actuation, and human intervention components to prevent hazards.

Scenario Dependence of PST

PST varies with process parameters and is a link between process engineering and functional safety disciplines.

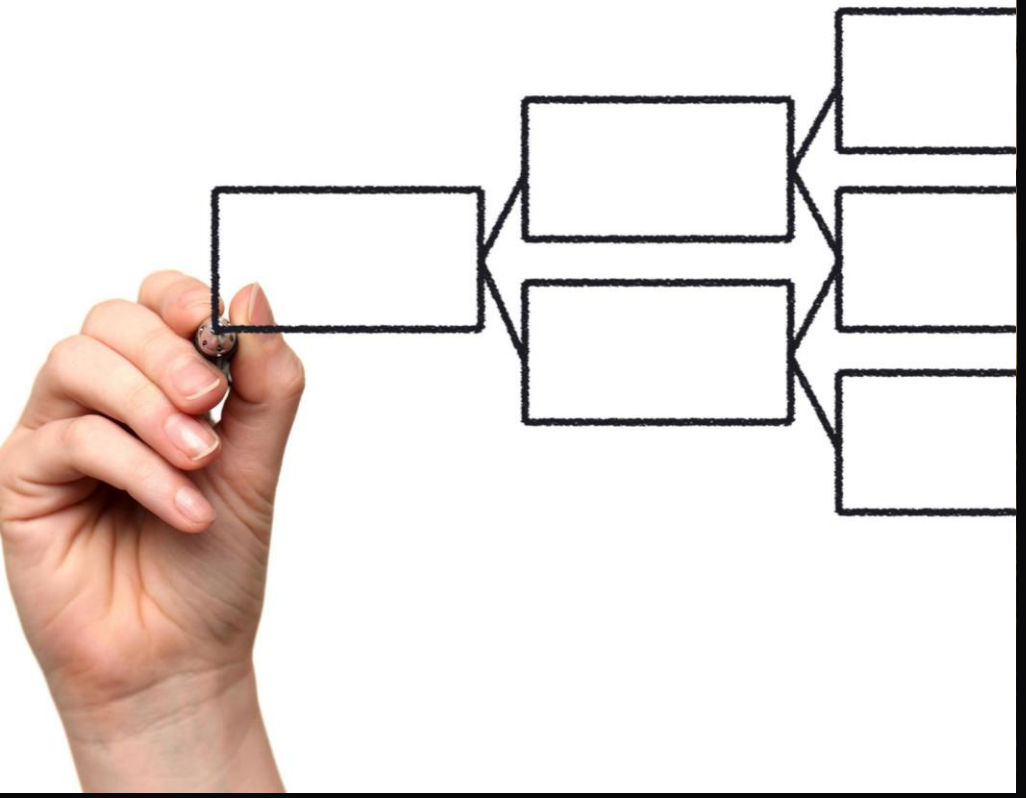
Importance of Inequality in Safety

Available time must be greater than or equal to required response time to ensure effective safety barriers.

Pitfalls and Core Method

Why PST Is Often Overlooked — Common Pitfalls

- **Outdated Assumptions Risk**
- **Underestimated Response Delays**
- **Misapplied Worst-Case Basis**
- **Inconsistent Methods and Documentation**
- **Governance and Review Gaps**



Method Overview – From Scenario to Pass/Not Pass Decision

Identifying Credible Scenarios

Start by identifying physically plausible risk scenarios relevant to the facility with meaningful consequences.

Defining Escalation and Thresholds

Define escalation paths and hazardous thresholds based on pressure, level, or temperature scenarios.

Calculating Available Time (PST)

Calculate available time using inventory and escalation rate with conservative assumptions for comparability.

Decision and Action Link

Decide Pass or Not Pass based on PST and IPL response time; link Not Pass to mitigation actions.

Two Approaches – Static Calculation Sheet vs Dynamic Model

Static Calculation Sheet

- Simple to use
- More conservative than dynamic model

Dynamic Model

- More complex via Typical Simulation program
- Represent an actual PST

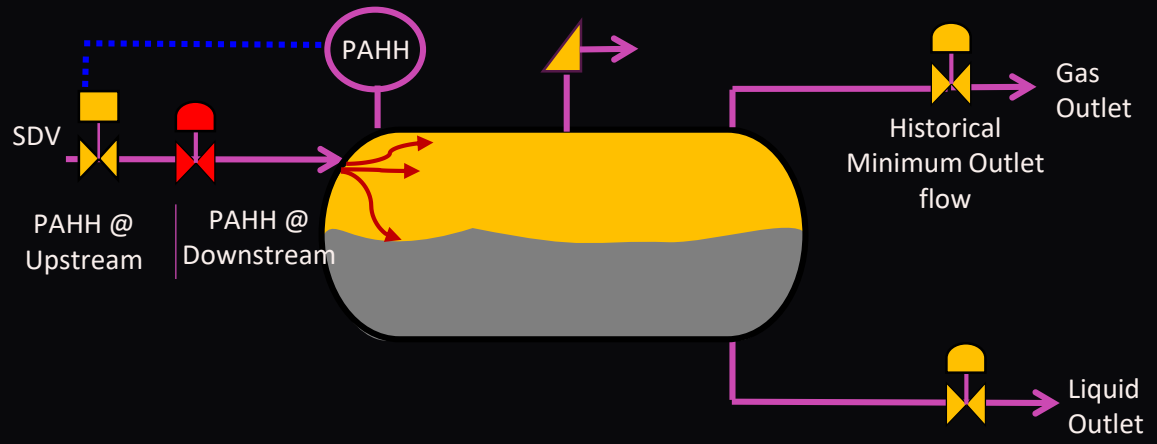
Example results from Static Calculation Sheet and Dynamic model

Tag	Process	Static PST (s)	Dynamic PST (s)
PAHH-xxxx	Field A Inlet Separator	5.5	15.3
PAHH-xxxx	Field B Suction Scrubber	4.6	6.0

PST values derived from static calculations are typically more conservative than dynamic simulations, due to the conservative assumptions applied.

Examples are simplified/anonymized for sharing

Case Applications and Engineering Logic



Example Application 1 – Gas Control Valve Failure Open Upstream of a Vessel (PAHH)

Examples are simplified/anonymized for sharing

Scenario Credibility

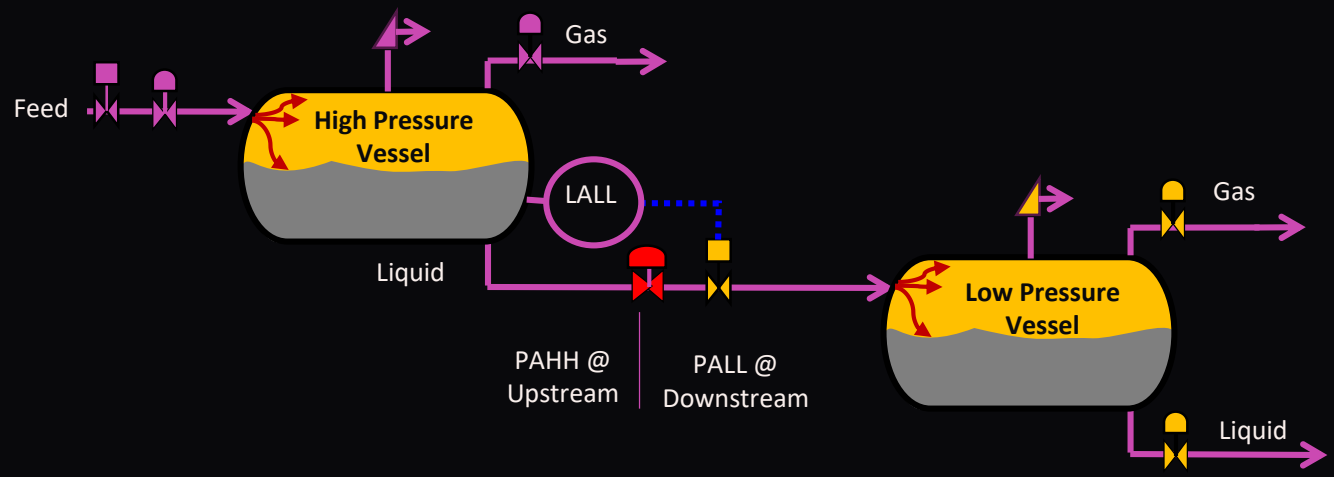
Gas control valves can fail open due to actuator, instrument air, positioner failures, or human error. This failure is a credible initiating event.

Pressure Escalation Mechanics

The vessel accumulates gas mass when inflow exceeds outflow, causing pressure to rise governed by compressible gas behavior.

PST Calculation

PST equals inventory difference between safe and hazardous limits divided by maximum credible net inflow from valve failure.



Example Application 2 – Gas Blowby to a Downstream Vessel from Liquid CV Failed Open (LALL / PALL)

Valve Failure Impact

Liquid control valve failure open causes gas blowby to downstream low-pressure vessel, risking abnormal conditions.

Hazardous Condition Identification

Engineers must define hazardous thresholds clearly, considering level and pressure parameters for escalation scenarios.

Protection and Response Measures

Safety Instrumented Functions and operator alarms provide safeguards requiring timely detection and action workflow.

Examples are simplified/anonymized for sharing

Findings

Key Findings – Insufficient PST Exists and May Go Unnoticed

Observations on PST Timing

Multiple cases show PST is smaller than safeguard response time, risking escalation beyond protection.

Latent Risks from Design Assumptions

Original design assumptions may no longer hold due to operational drift, affecting PST and response times.

Pitfalls Causing Time Mismatch

Wrong assumptions, missing delays, and lack of standardization create inconsistent PST and response evaluations.

Need for Systematic PST Assessment

A systematic approach identifies time mismatches, enabling prioritized corrective actions without assigning blame.

Key Takeaways – Making the Hidden Clock Visible

- **PST Defines Timely Safety Action**
- **Standardization Reduces Hidden Assumptions**
- **Governance Ensures Relevance Overtime**

Q&A

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QR Code - Evaluation