



Better Metrics for Improving Human Reliability in Process Safety

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Abstract

- **Current incident reporting systems do not effectively capture the influence of human reliability on process safety performance. Historical and cultural factors have led to the development of reporting systems with an emphasis on reporting of incidents that have equipment reliability causes and personal safety impacts. A root cause analysis of 30 public and private incident reports supports the need to establish a reporting and analysis method that establishes a plant's operations failure.**
- **This paper cites an approach developed in the aviation industry to reduce impact of human reliability as an example of an approach appropriate also for the process industries. An alternative conceptual framework for the process industry illustrates specific types of metrics that can help identify opportunities to improve human reliability and process safety performance.**



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Technical Contributor to the Abnormal Situation Management® (ASM®) Consortium since 1994



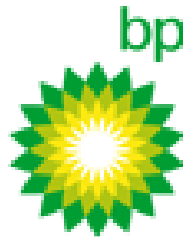
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Founded in 1994

Creating a new paradigm for the operation of complex industrial plants, with solution concepts that improve Operations' ability to prevent and respond to abnormal situations.

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SASOL
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The logo features the letters 'ASM' in a bold, red, serif font, with a teal diamond shape behind the 'A'. To the right, the word 'Message' is written in a teal, sans-serif font with a slight drop shadow.

ASM Message

- Most incident reporting approaches **do NOT effectively capture the influence of human reliability** on abnormal situation management (ASM) and process safety management (PSM) performance
- Establishing effective ASM and PSM metrics can **improve the understanding of how systemic human reliability failures** are associated with operations practices influences



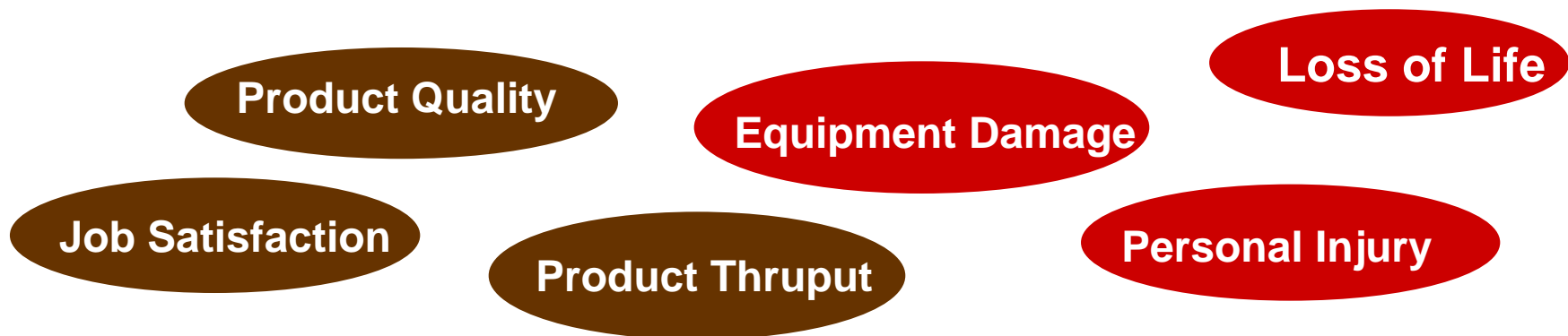
Overview

- Factors that influence human reliability
- What is the typical practice today?
- Aviation industry incident reporting example
- Potential approach for Process Industries
- Concluding comments



What is an Abnormal Situation?

- An industrial process is being disturbed and the **automated control system can not cope...**
- Consequently, the operations team must intervene to supplement the control system.
- Impacts **profitability** in multiple ways:





ASM Relation to PSM

Safety Pyramid Illustration

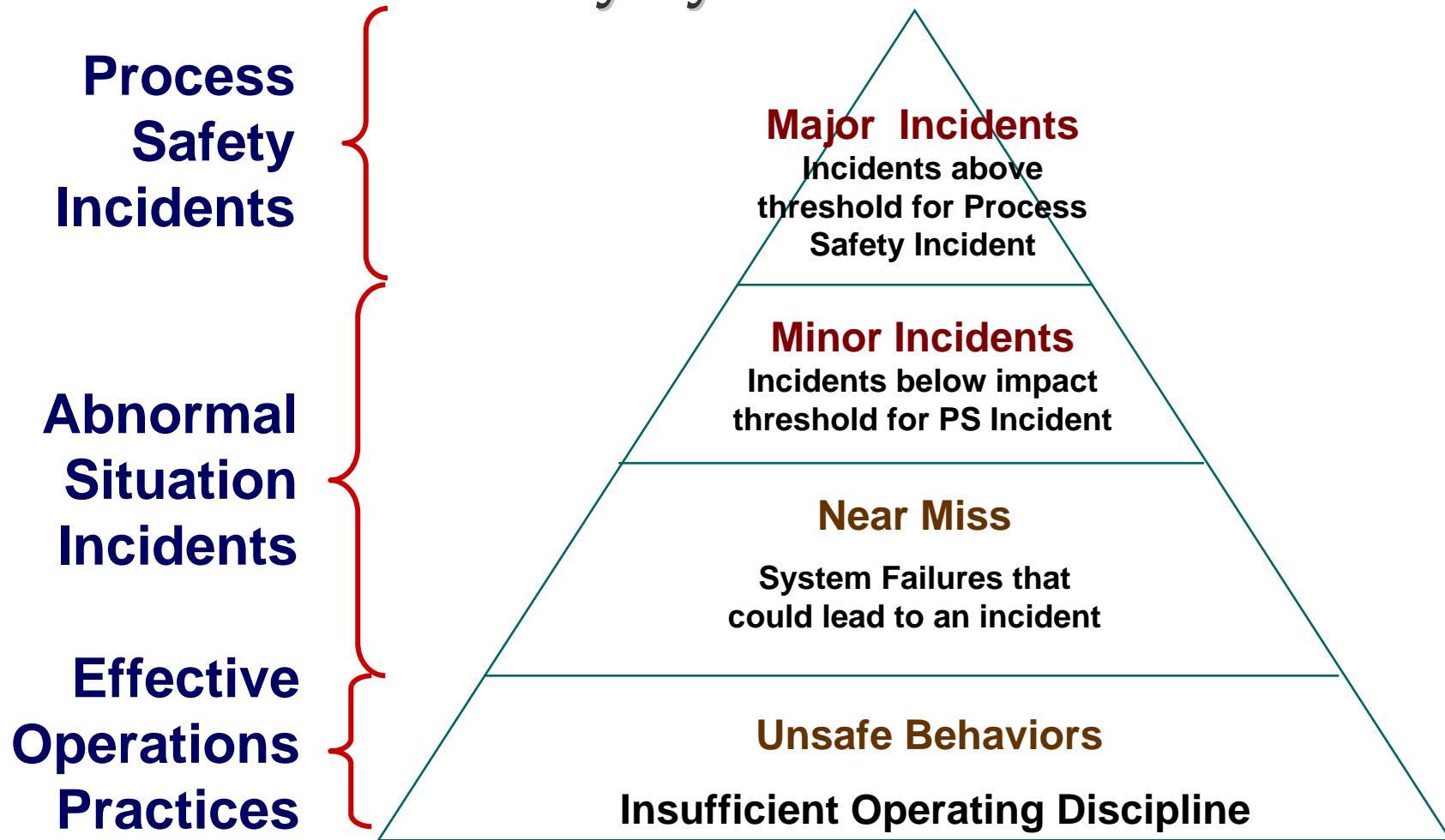
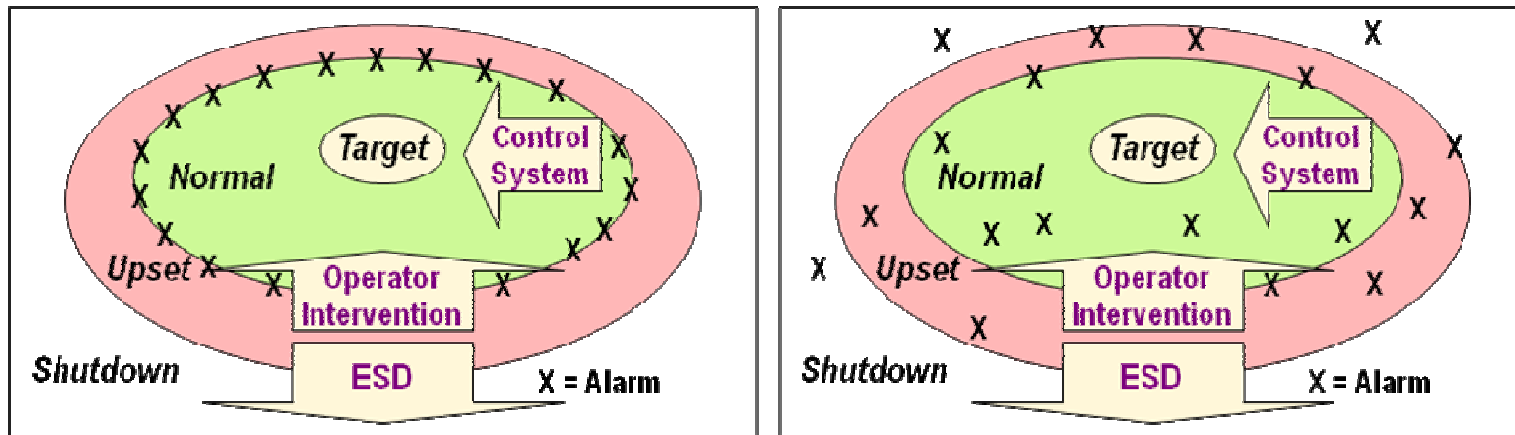


Illustration based on: CCPS *Process Safety Leading and Lagging Metrics*.



Alarm System Relevance

- **Critical Process Alarms indicate abnormal situation events**
• & are potential triggers for near-miss process safety events



Effective

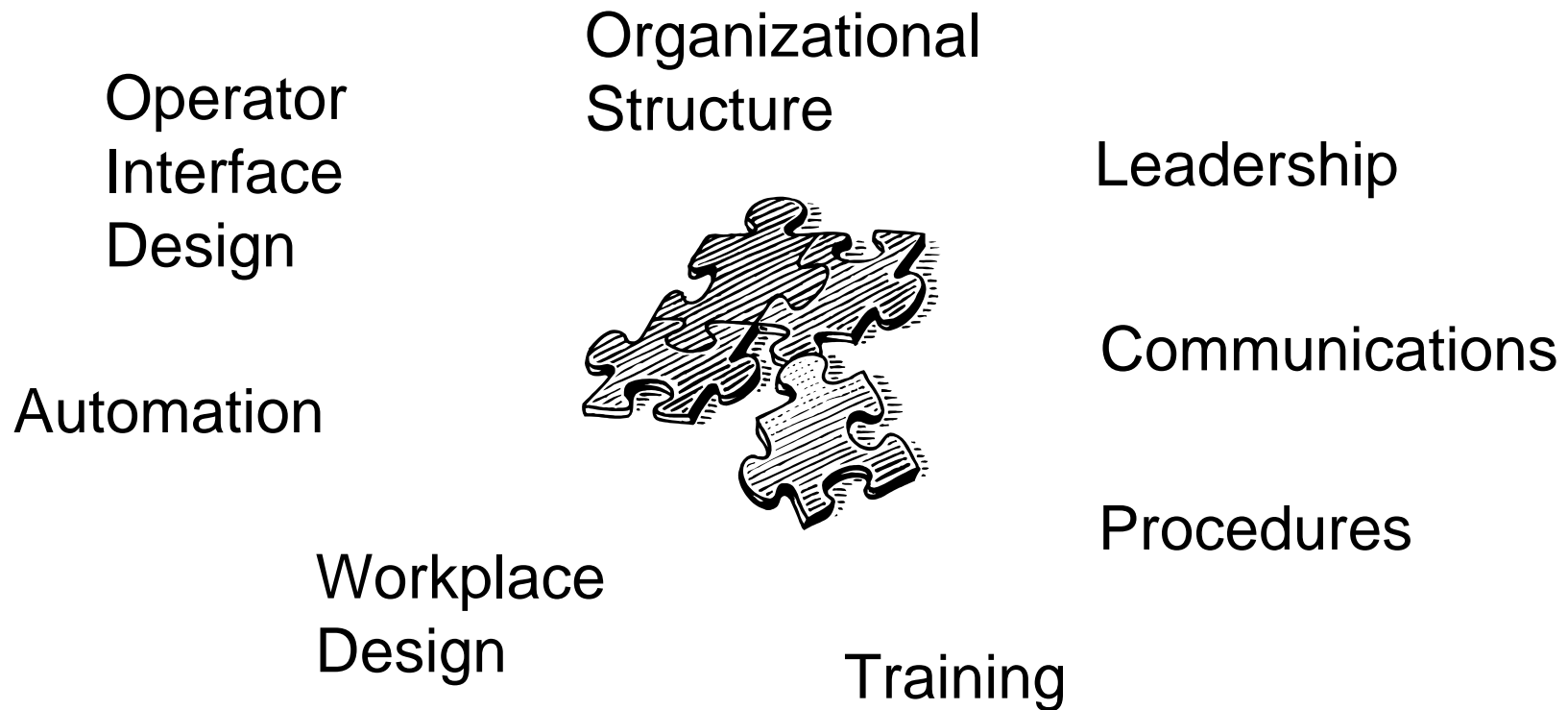
Ineffective

- Illustration of the difference between an effectively designed alarm system and an ineffectively designed alarm system (excerpt from EEMUA, 2007)
- In an effectively rationalized alarm system, **the count of alarms represents the count of transitions into the “upset” region.**



Influential Solution Elements

Key ASM Operations Practice Areas



Does your incident reporting system allow you to identify the influence of these solution elements on human reliability?



Incident Reporting Typical Practice Today

- Current incident reporting systems have evolved within the safety departments
- Outcome metrics tend to emphasize personnel safety and impact on injuries and lost work days
- Causal metrics tend to focus on equipment reliability
- Operations interested in capturing production related events are evolving separate reporting systems,
 - Often with separate causal factors
- **All cause factors tend to lack description at level of solution elements**



Why do we care?

- Organizations lack common understanding of sources and impact of abnormal situations related to production losses and process safety risk
- Better understanding of abnormal situations indicate opportunities to improve both equipment, process and human reliability
- **Improved human reliability reduces exposure to process safety incidents**



ASM Incident Analysis Study

Common Operations Failures

Top 10 Operations Failures	#	%
Hazard analysis/ communication	79	15%
First-line leadership	65	12%
Continuous improvement	60	11%
Safety culture	36	7%
Initial and refresher training	30	6%
Task communications	29	5%
Comprehensive MOC	28	5%
Cross functional communication	23	4%
Compliance with procedures	15	3%
Design guidelines and standards	14	3%
Other failure modes	160	30%
TOTAL	539	

- 32 incidents were analyzed using TapRoot incident investigation methodology

	Public	Site	Total
USA	14	7	21
Non USA	6	5	11
Total	20	12	32

- Top 10 covered 70% of identified operations practice failures



Aviation Industry Problem Statement

- 70-80% of accidents were attributed to human error
- Accident reporting system was not built around conceptual framework of human error
- Hence accident data bases do not enable human reliability analysis making intervention strategies onerous

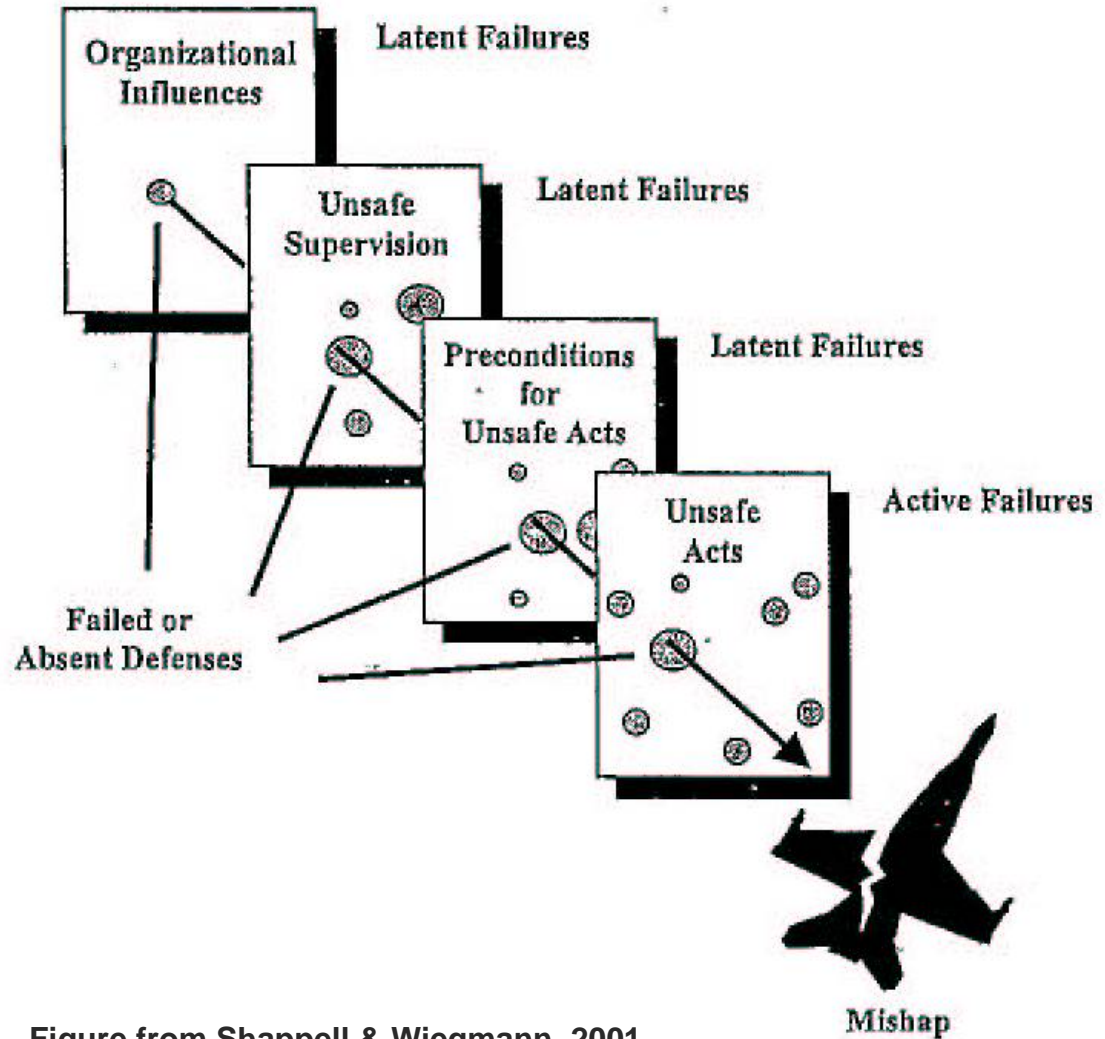
Shappell, S.A. & Wiegmann, D.A. (2001) Applying Reason: the human factors analysis and classification system (HFACS). *Human Factors and Aerospace Safety* 1(1), p.59-86.



What can be done?

Aviation Industry Example

- Human Factors Analysis & Classification System (HFACS)
- 4 levels of failures to identify systemic problems
- Currently deployed for FAA, NASA, all four branches of US Military & Canadian forces for incident reporting & investigation





Aviation Study Basis

James Reason “Swiss Cheese Model”

- Reason’s model has 3 types of proactive process metrics to assess organizational factors that influence resistance to losses:
 - **Unsafe acts** – active failures (immediate causes) resulting from unintentional human error or individual violations of rules and regulations.
 - **Local workplace factors** – latent failures (basic causes) resulting from substandard work conditions or substandard mental or physical states.
 - **Organizational factors** – latent failures (basic causes) resulting from ineffective plant leadership, management systems and work processes.

Reason, J. (1997). *Managing the Risks of Organizational Accidents*. Aldershot, UK: Ashgate Publishing, Ltd.



Aviation Industry Example

Unsafe Supervision Category

Inadequate Supervision

- Failed to provide guidance
- Failed to provide operational doctrine
- Failed to provide oversight
- Failed to track qualifications
- Failed to track performance

Failed to Correct Known Problem

- Failed to correct document in error
- Failed to identify an at-risk aviator
- Failed to initiate corrective actions
- Failed to report unsafe tendencies

Inappropriate Operations Plans

- Failed to provide correct data
- Failed to provide adequate brief time
- Improper manning
- Mission not compliant with regulations
- Provided inadequate time for crew rest

Supervisory Violations

- Authorized unnecessary violations
- Failed to enforce rules and regulations
- Authorized unqualified crew for flight

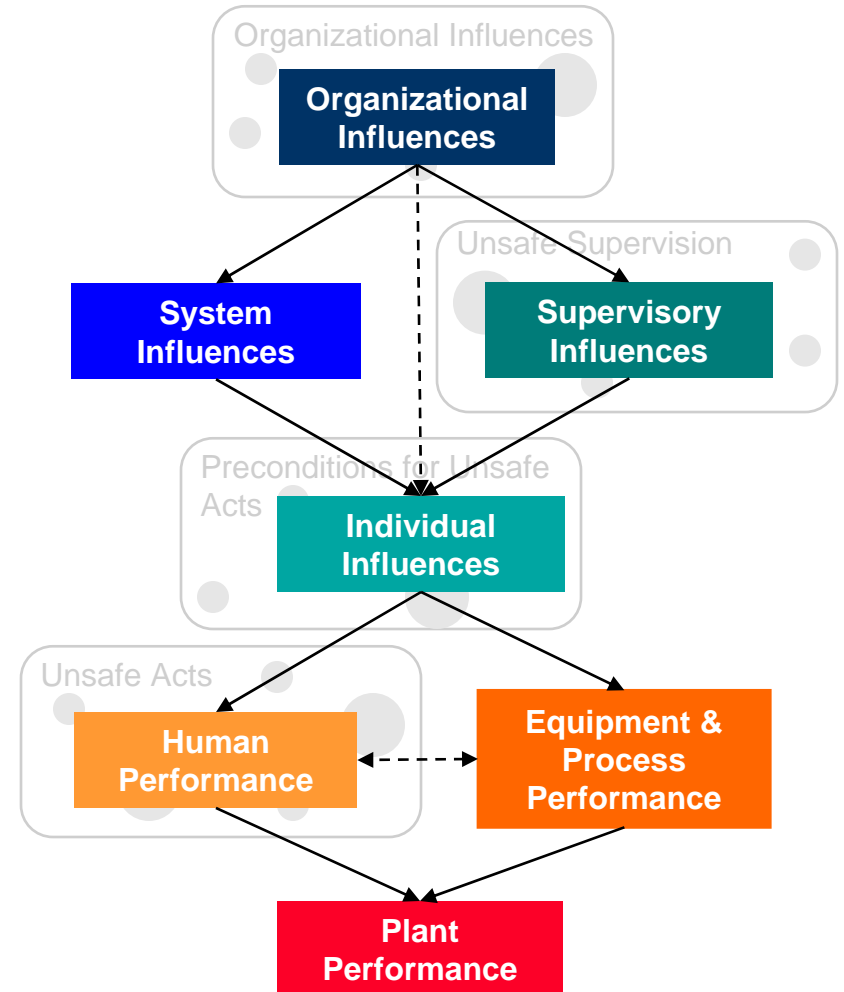
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ASM Cause-Effect Framework

- **ASM Research Project** developed framework for Process Industries
- **Literature Review**
 - Human performance & reliability
 - Incident investigation & reporting
 - Quantifying cost/benefits
 - Past ASM metrics work – case studies
- Conceptual model has not yet been put into practice

ASM Cause-Effect Framework



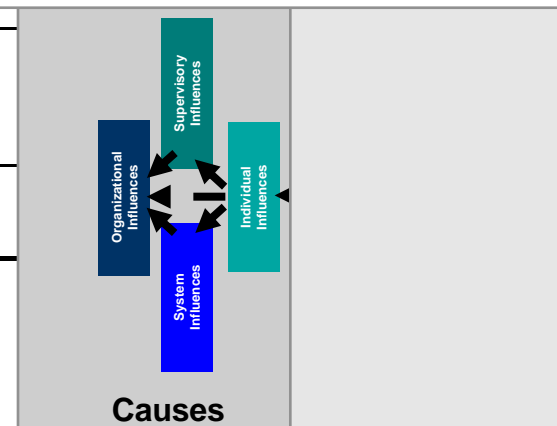


ASM Cause-Effect Framework

Influence & Performance Categories

Organizational Influences	System Influences	Supervisory Influences	Individual Influences	Human Performance	Equipment & Process Performance	Plant Performance
Policy	Experiential Learning	Oversight	Personal Readiness	Orienting Breakdown	Component Failure	Production Cost
Structure	Communications	Operations Planning	Mental State	Evaluating Breakdown	Corrosion Fault	Operating Cost
People	Knowledge & Skill Development	Problem Resolution	Physiological Response	Acting Breakdown	Undesirable Chemical Reaction	Capital Expenditure
Culture	Procedures	Activity Authorization	Human Capacity			Incidents
	Workplace Environment		Personnel Selection			Employee Satisfaction
	Process Equipment					Customer Satisfaction
	Control & Information Systems					
	Management of Change					

ASM Effective Operations Practice Categories



Each category has descriptive indicators for identification



Procedure Category

Proposed Root Cause Indicators

- 1. Inconvenient or no access from job location**
- 2. Inappropriate format for conditions of use**
- 3. Unclear instructions**
- 4. Incomplete instructions**
- 5. Inaccurate instructions**
- 6. Insufficient warning of hazards**
- 7. Incomplete coverage**
- 8. Lack effective method to handle procedural deviations**
- 9. Error in performance support or job aid application**



Conclusion

- Current incident reporting approaches **do NOT** effectively **capture the influence of human reliability** on abnormal situation management and process safety performance
- Establishing integrated ASM & PSM metrics can **improve the understanding of how systemic human reliability failures** are associated with operations practices influences



- Thanks you!
- Questions and/or Comments?