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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- Specializes in human performance in process industry operations
- Technical Contributor to the Abnormal Situation Management® (ASM®) Consortium since 1994

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Helping People Perform
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ASM Abnormal Situation Management®
A Joint Research and Development Consortium

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.

www.asmconsortium.org
• 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

Process Safety Incidents

Abnormal Situation Incidents

Effective Operations Practices

- Major Incidents: Incidents above threshold for Process Safety Incident
- Minor Incidents: Incidents below impact threshold for PS Incident
- Near Miss: System Failures that could lead to an incident
- Unsafe Behaviors: Insufficient Operating Discipline

Alarm System Relevance

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

  - 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.

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Influential Solution Elements
Key ASM Operations Practice Areas

Operator Interface Design
Automation
Workplace Design

Organizational Structure
Leadership
Communications
Procedures
Training

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

<table>
<thead>
<tr>
<th>Operations Failures</th>
<th>#</th>
<th>%</th>
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<tbody>
<tr>
<td>Hazard analysis/ communication</td>
<td>79</td>
<td>15%</td>
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<tr>
<td>First-line leadership</td>
<td>65</td>
<td>12%</td>
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<tr>
<td>Continuous improvement</td>
<td>60</td>
<td>11%</td>
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<tr>
<td>Safety culture</td>
<td>36</td>
<td>7%</td>
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<tr>
<td>Initial and refresher training</td>
<td>30</td>
<td>6%</td>
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<tr>
<td>Task communications</td>
<td>29</td>
<td>5%</td>
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<tr>
<td>Comprehensive MOC</td>
<td>28</td>
<td>5%</td>
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<tr>
<td>Cross functional communication</td>
<td>23</td>
<td>4%</td>
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<tr>
<td>Compliance with procedures</td>
<td>15</td>
<td>3%</td>
</tr>
<tr>
<td>Design guidelines and standards</td>
<td>14</td>
<td>3%</td>
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<tr>
<td>Other failure modes</td>
<td>160</td>
<td>30%</td>
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<tr>
<td><strong>TOTAL</strong></td>
<td>539</td>
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- 32 incidents were analyzed using TapRoot incident investigation methodology
- Top 10 covered 70% of identified operations practice failures

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<tr>
<td>Non USA</td>
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<td>5</td>
<td>11</td>
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<tr>
<td><strong>Total</strong></td>
<td>20</td>
<td>12</td>
<td>32</td>
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</table>
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

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

Figure from Shappell & Wiegmann, 2001
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.

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

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

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

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

• 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
<table>
<thead>
<tr>
<th>Organizational Influences</th>
<th>System Influences</th>
<th>Supervisory Influences</th>
<th>Individual Influences</th>
<th>Human Performance</th>
<th>Equipment &amp; Process Performance</th>
<th>Plant Performance</th>
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<tr>
<td>Policy</td>
<td>Experiential</td>
<td>Oversight</td>
<td>Personal Readiness</td>
<td>Orienting</td>
<td>Component Failure</td>
<td>Production Cost</td>
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<td>Communications</td>
<td>Operations Planning</td>
<td>Mental State</td>
<td>Evaluating</td>
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<td>Operating Cost</td>
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<td>Knowledge &amp; Skill Development</td>
<td>Problem Resolution</td>
<td>Physiological State</td>
<td>Acting</td>
<td>Undesirable Chemical Reaction</td>
<td>Capital Expenditure</td>
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<td>Culture</td>
<td>Procedures</td>
<td>Activity Authorization</td>
<td>Human Capacity</td>
<td>Assessing</td>
<td>Loss Incidents</td>
<td>Employee Satisfaction</td>
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<td>Workplace Environment</td>
<td>Authorization</td>
<td>Operating Costs</td>
<td>Breakdown</td>
<td>Corrosion Fault</td>
<td>Customer Satisfaction</td>
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<td></td>
<td>Process Equipment</td>
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<td>Breakdown</td>
<td>Undesirable Chemical Reaction</td>
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<tr>
<td></td>
<td>Control &amp; Information Systems</td>
<td>Activity</td>
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<td>Capital Expenditure</td>
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<td>Management of Change</td>
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</table>

Each category has **descriptive indicators** for identification.

**ASM Effective Operations Practice Categories**
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.
ASM Q & A

• Thanks you!

• Questions and/or Comments?