Improving process safety culture: An audit checklist for effective first-line supervision based on common operations failure modes

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Abstract

The Abnormal Situation Management® Consortium funded a study to investigate common failure modes and root causes associated with operations practices. The study team analyzed 20 public and 12 private incidents for common operations practice failure modes including the BP Texas City Incident. A key finding from the analysis was that ineffective first-line supervision was the 2nd most frequent operations practice failure (65 out of 539 observed operations practice failures), representing 12% of all failures. An examination of the common manifestations of the supervision common failure mode identified a list of potential proactive indicators of weaknesses in operations supervision practices. An operations audit checklist is presented to enable plant personnel to assess their potential vulnerability to this common failure mode.

1. Introduction

Process industry plants involve operations of complex human-machine systems. The processes are large, complex, distributed, and dynamic. The sub-systems and equipment are often coupled, much is automated, data has varying levels of reliability, and a significant portion of the human-machine interaction is mediated by computers [1]. These systems are also social in that many plant operations function with a teamwork culture such that activities are managed by crews, shifts, and heterogeneous functional groups [2]. Team members have to cope with multiple information sources, conflicting information, rapidly changing scenarios, performance pressure and high workload [3].

Historically, the reporting of failures has tended to emphasize root causes associated with equipment reliability and less so on human reliability root causes [4]. Consequently, there is limited information available on the frequency and nature of operations failures pertaining to human reliability. This tendency has limited the ability of process industry operations
organizations to identify improvement opportunities associated with their management systems and operations practices.

In an effort to improve on the understanding of the impact of ineffective operations practices and management systems on safe plant operations, the ASM Consortium decided to conduct root cause analysis of existing major incident reports [5]. The study team analyzed 20 public and 12 private incidents for common operations practice failure modes. A key finding from the analysis was that ineffective first-line supervision was the 2nd most frequent operations practice failure (65 out of 539 observed operations practice failures), representing 12% of all failures.

Safety culture is a part of the overall culture of an organization that influences the members’ attitudes and behaviors with respect to health and safety performance [6]. The findings from the BP Texas City incident have helped broaden the process industries’ perspective from an emphasis on personal safety to include process safety as well [7]. Moreover, a review of the literature has shown that management is a key influence on an organization’s safety culture as revealed in findings that employees’ perceptions of management’s attitudes and behaviors regarding safety practices are the most useful metric on safety climate [6]. In addition, a survey of offshore facilities has demonstrated that first-line supervision has a direct impact on safety performance [8].

The ASM Consortium study revealed that ineffective first-line leadership is a significant contributor to process safety incidents [5]. By its very nature, the first-line supervisory role is management’s primary interaction with operations personnel in communicating and enforcing their policies and practices for effective process safety performance. Moreover, we assert that an organization will be challenged to establish an effective process safety culture without an effective first-line leadership.

To that end, this paper examines the root cause manifestations associated with the first-line leadership common failure mode to highlight potential indicators of weaknesses in this influence on process safety culture. An operations audit checklist is presented to enable organizations to assess their potential vulnerability to this common failure mode.

2. Incident Analysis

In general, the purpose of an incident analysis is to generate information to enable an understanding of why an incident occurred and identify corrective actions to address weaknesses in operations practices or management systems that contributed to its occurrence. In the ASM Consortium project, several incidents were analyzed to identify common failure operations practice failure modes to help member companies understand where they may have unacceptable risk to human reliability failures. The project team developed a new approach that goes beyond the typical root cause analysis methodology to identify systemic operations practice failures that are not indicated when looking at root causes alone. A detailed description of the methodology is available [5]. In this section, a high level description of the incident analysis methodology is provided with the findings related to the first-line leadership operations failure mode.

Figure 1 shows the eight step incident analysis approach. In the second step of this methodology, all of the operations failures are clustered into common failure modes using the
operational practice definitions from the ASM Consortium *Effective Operations Practices* guidelines document [9]. While this document is not available to the general public, a process industry organization could develop a similar set of operational definitions based on their operations practice standards, policies and management systems.

Figure 1. Summary of work process for incident analysis and continuous improvement.

The outcome of this second step in the analysis is the identification of the top ten failure modes (See Table 1).

*Ineffective first-line leadership* is the second most common failure mode representing 12% of the identified failures in the ASM approach. A common failure mode represents a common problem across industry sites and characterizes ‘What went wrong’ across the incident sample. The third step in the incident analysis methodology examines the root causes associated with the common operations failure modes (See Figure 1). A root cause describes ‘Why a failure occurred.’ Table 2 shows the top root causes associated with the ineffective first-line leadership failure mode.

In the incident analysis approach, the value of the analysis of operations practice failure modes is that it establishes the context for understanding the root cause information. Most importantly, understanding the causes of failures establishes the opportunity to make improvements to mitigate the risk of plant incidents. Neither the aggregation across operations failures or root causes on their own provides sufficient detail to identify potential improvement opportunities.

Hence the fourth step in the methodology (Figure 1), the team identified ‘How’ operational failure modes are expressed in real operations settings by examining the manner in which each root cause was manifested in the incident sample. The individual manifestations were clustered together around common themes indicating how the operations practice failed. Table 3 below
shows the result of the manifestation analysis for the two most frequent common root causes associated with *the Ineffective first-line leadership* failure mode.

**Table 1. Top 10 common failure modes across all the incidents.**

<table>
<thead>
<tr>
<th>Common Failure Modes</th>
<th>#</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Implement a comprehensive hazard analysis and communication program</td>
<td>79</td>
<td>15%</td>
</tr>
<tr>
<td>Establish effective first-line leadership roles to direct personnel, enforce organizational policies, and achieve business objectives</td>
<td>65</td>
<td>12%</td>
</tr>
<tr>
<td>Establish an effective and comprehensive program to continuously improve the impact of people, equipment, and materials on plant productivity and reliability</td>
<td>60</td>
<td>11%</td>
</tr>
<tr>
<td>Develop a strong safety culture</td>
<td>36</td>
<td>7%</td>
</tr>
<tr>
<td>Establish initial and refresher training based on competency models that address roles and responsibilities for normal, abnormal, and emergency situations</td>
<td>30</td>
<td>6%</td>
</tr>
<tr>
<td>Establish effective protocol for task-oriented collaborative communications within operations</td>
<td>29</td>
<td>5%</td>
</tr>
<tr>
<td>Implement a comprehensive Management of Change (MOC) program that specifically includes changes in staffing levels, organizational structures, and job roles and responsibilities</td>
<td>28</td>
<td>5%</td>
</tr>
<tr>
<td>Establish good, periodic communication across plant functional responsibilities</td>
<td>23</td>
<td>4%</td>
</tr>
<tr>
<td>Ensure compliance with an explicit policy on the use of procedures in plant operations</td>
<td>15</td>
<td>3%</td>
</tr>
<tr>
<td>Use design guidelines and standards for consistent, appropriate implementation of process monitoring, control, and support applications</td>
<td>14</td>
<td>3%</td>
</tr>
<tr>
<td>Other failure modes</td>
<td>160</td>
<td>30%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>539</td>
<td>100%</td>
</tr>
</tbody>
</table>

**Table 2. The top root cause profile associated with the Ineffective First-line Leadership operations practice failure mode.**

<table>
<thead>
<tr>
<th>Root Cause</th>
<th>#</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>No supervision</td>
<td>22</td>
<td>20%</td>
</tr>
<tr>
<td>Crew teamwork needs improvement (NI)</td>
<td>18</td>
<td>17%</td>
</tr>
<tr>
<td>SPAC not followed</td>
<td>10</td>
<td>9%</td>
</tr>
<tr>
<td>Management of Change needs improvement (NI)</td>
<td>6</td>
<td>6%</td>
</tr>
<tr>
<td>No communication</td>
<td>6</td>
<td>6%</td>
</tr>
<tr>
<td>Pre-job briefing needs improvement (NI)</td>
<td>5</td>
<td>5%</td>
</tr>
<tr>
<td>Other</td>
<td>41</td>
<td>38%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>108</td>
<td>100%</td>
</tr>
</tbody>
</table>
Table 3. Common root cause manifestations for two common root causes associated with the Ineffective first-line leadership operations failure mode.

<table>
<thead>
<tr>
<th>Root Causes</th>
<th>Common Manifestations</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Supervision</td>
<td>Not checking procedure progress for area of responsibility</td>
</tr>
<tr>
<td></td>
<td>Not at job site and maintaining situation awareness</td>
</tr>
<tr>
<td></td>
<td>Fail to identify and address risk to personnel</td>
</tr>
<tr>
<td></td>
<td>Fail to monitor high risk activities for problems/issues</td>
</tr>
<tr>
<td>Crew Teamwork NI</td>
<td>Not enforcing violations of practices/procedures</td>
</tr>
<tr>
<td></td>
<td>Not ensuring team members stays coordinated</td>
</tr>
<tr>
<td></td>
<td>Not correcting or communicating known problems</td>
</tr>
<tr>
<td></td>
<td>Team members not questioning when evidence of problems</td>
</tr>
<tr>
<td></td>
<td>Not keeping track of big picture; losing sight of hazards</td>
</tr>
</tbody>
</table>

The examination of all common root cause manifestations for the first-line leadership failures revealed supervision problems, teamwork, and enforcing policy and work practices (i.e., MOC and pre-job briefings). A critical component to effective leadership is being at the work site to provide work direction. Teamwork issues were often due to team members failing to question improper readings, indications, or directions by the person-in-charge. Another critical role that leaders have is to communicate and enforce policy and work practices. Several failures occurred because leaders failed to ensure standards, policies, and administrative controls were used, adhered to, and followed correctly.

These findings illustrate that the detail in the common manifestations for each root cause profile provides:

- Specific reasons the failures occurred across incidents
- Manifestations are “indicators” of failures
- Potential candidates for leading indicators of incidents

Consequently, improvement opportunities are identified by extracting the root cause manifestations for each root cause profile for the top common failure modes. After collecting this information, the continuous improvement program is in a better position to analyze gaps in their management systems and operations practices and identify specific solutions to reduce vulnerability to systemic and repeating root causes. The ASM project team used the information from common root cause manifestations to develop an audit check list. In fact, the audit checklist can serve as a gap analysis tool in step 5 of the incident analysis and continuous improvement work process (Figure 1).
3. Audit Checklist

The purpose of the checklist is to help plant and operations managers conduct audits to identify the presence of a common failure mode for significant process industry incidents. Also, the audit checklist can serve as a gap analysis tool as part of the plant continuous improvement work process. The manifestations or expression of the root causes associated with the Ineffective first-line leadership failure mode provide the basis for the audit items in this check list. The audit check list items are expressed in positive terms of the practice elements that the auditor is looking for in his/her observations of current site operations practice for first-line leadership.

**ASM Operation Practice Guideline:** Establish effective first-line leadership roles to direct personnel, enforce organizational policies, and achieve business objectives.

- The supervisor maintains a presence in the control room and field areas with face-to-face contact periodically throughout a shift to ensure good situation awareness of operations and maintenance activities.
- The supervisor is easily accessible via radio contact by any team member to answer questions and respond to problems.
- The supervisor assigns a stand-in responsibility when leaving the job site.
- The supervisor ensures that the behaviors of personnel are compliant with site policy and work practices, and does not allow individuals to operate in the presence of known hazards without taking adequate precautions.
- The supervisor ensures that team members stay coordinated with appropriate plant disciplines, each other and him or herself.
- The supervisor establishes an open communications culture, where there is two-way dialog and team members feel free to question each other when there is evidence of problems.
- The supervisor establishes effective mechanisms to communicate known problems to all shift team members and shift teams, and ensure that corrective actions are assigned and tracked for timely completion.
- The supervisor frequently monitors progress of procedural activities and ensures compliance with site policy on use of procedures; especially as a safety observer for high risk activities.
- The supervisor enforces clear guidelines on when and how to conduct pre-job briefings.
- The supervisor is involved in the review of safety issues and hazards during pre-job briefings; specifically in the comprehensive identification and mitigation of risk to personnel.

4. Conclusion

Ineffective first-line leadership was the 2nd most frequent operations practice failure identified in an analysis of 32 major process industry incidents [5]. Not surprising, first-line supervision had previously been identified as having a critical role in the management of safety [8]. Moreover,
this previous HSE research found that the aspects of supervisor behavior that impacted on subordinate safety performance included:

- valuing subordinates
- visiting the worksite frequently
- work group participation in decision making
- effective safety communication

In the present study, an examination of the common manifestations of the supervision common failure mode identified a list of potential proactive indicators of weaknesses in operations supervision practices. The operations audit checklist has a similar theme in terms of the specific aspects of first-line supervisor behaviors that contributed to major process safety incidents.

By its very nature, the first-line supervisory role is management’s primary interaction with operations personnel in communicating and enforcing their policies and practices for effective process safety performance. Any organization seeking to establish a strong safety culture needs to ensure that there is an effective first-line leadership practice. The operations audit checklist provides a set of leading indicators for assessing potential vulnerabilities associated with first-line supervision.

5. Acknowledgements

This study was funded by the ASM® Consortium, a Honeywell-led research and development consortium. ASM is a registered trademark of Honeywell International, Inc. The Abnormal Situation Management® (ASM®) Consortium (www.asmconsortium.org) is a long-running and active research and development consortium of 16 companies and universities concerned about the negative effects of industrial plant incidents. The consortium identifies problems facing plant operations during abnormal conditions, and develops solutions. Deliverables from the collaboration among member companies include products and services, guideline and other documents, and information-sharing workshops; all incorporating ASM knowledge.

6. References


