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PSM Issues from Non-Operational Departments

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Abstract

This paper explains the role that non-operational departments such as Purchasing, Project management, Human resources, Shipping/Receiving, Accounting, and Others have in process safety. The paper presents many examples where these non-operational departments have impacted process safety and provides examples of how to integrate these departments into the goals of process safety.



Introduction

Understanding the Process Safety Management (PSM) elements includes understanding the typical operations, engineering, and maintenance roles, responsibilities, and daily tasks for PSM implementation. Every PSM element has a role in controlling risk and the same is true for most of a facility's non-operational departments. These departments, though not directly involved with day-to-day operations, provide support functions, playing a vital role in effective day ongoing PSM implementation. Companies must be deliberate in identifying interdepartmental management systems that can impact PSM and ensure management system features are included, for effective, PSM compliance. Additionally, PSM tasks and responsibilities must be defined in each department's management system functions and their job descriptions. Information management systems must be capable of supporting these PSM departmental tasks, directly or indirectly supporting PSM implementation.

Human error increases when management systems developed and executed by these non-operational departments do not consider PSM. When an incident investigation team gathers data and identifies the human errors and equipment failures that directly lead to the near miss or loss event, data is also gathered to identify root causes [management system weaknesses that allowed the human error (typically the at-risk employee – operator or maintenance tech) to occur]. A quick look at a root cause map (**Figure 1**) shows some root causes related to weaknesses in management systems governing or executed by these non-operational departments.

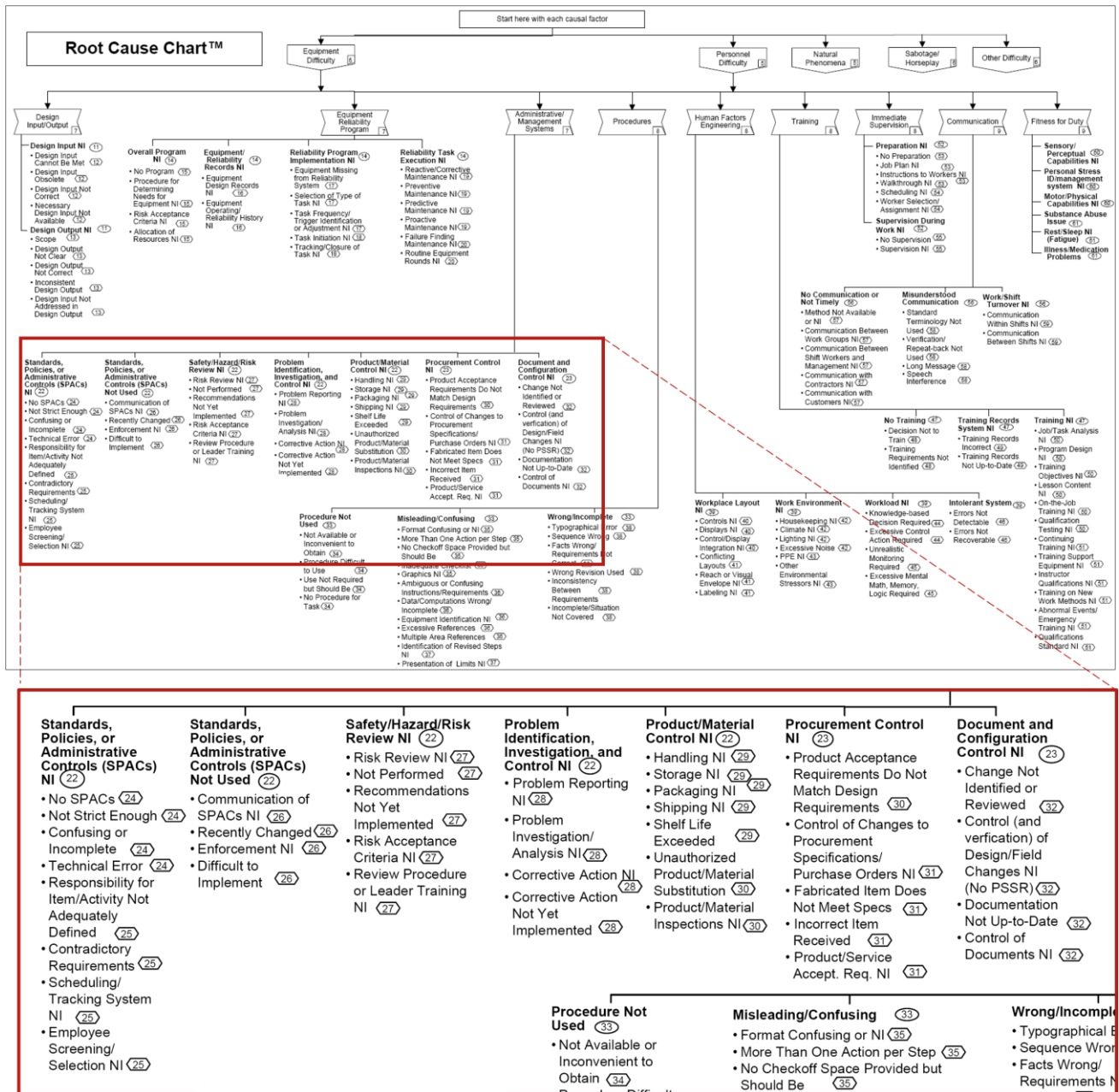


Figure 1. Root Causes Related to Non-Operational Departments

Non-Operational Departments and Their Management System Deficiencies

Let's identify these non-operational departments, their management system deficiencies that can negatively impact PSM implementation, and how to integrate and align their functions to support process safety goals. The non-operational departments include:

- Human Resources
- Project Management



- Purchasing
- Shipping
- Receiving/Warehousing
- Asset Management
- Accounting
- Information Technology
- Other

Human Resources

No PSM Organizational Chart

Implementing process safety management requires many job functions across numerous departments. When companies lack an organizational chart, PSM responsibilities for each PSM element, and support roles, may not be well understood, including an incomplete understanding of how each PSM role relates to other roles. This graphical representation helps managers identify staffing gaps and promote effective communication between departments and within departments. Developing a PSM organizational chart that is aligned with PSM goals is vital

Omitting PSM Responsibilities from Job Descriptions

Job descriptions define the skills, training, education, experience, and certifications necessary to fulfill the job requirements and what is expected from the employee. Specifically, job descriptions describe the job functions, helping to define additional required training employees need to execute their job successfully. Typically, there is some reference to organizational structure to show how the job relates to the organization. Overall job descriptions written to include PSM roles and responsibilities, and the necessary skills and experience to support PSM, help a facility more effectively implement PSM. **Table 1** provides some examples. Additionally, not updating job descriptions as the PSM program matures and evolves can lead to improper execution of PSM tasks.

Holding annual reviews of job tasks, roles/responsibilities, assignments, and staffing levels, along with including organizational staffing, and job descriptions changes in the facility's MOC scope help the facility maintain job descriptions, and the associated organizational chart, aligned with PSM goals.



Table 1. Examples of PSM Skills and Responsibilities for Job Descriptions

Job function	Skills/Responsibilities
Operators	<ul style="list-style-type: none"> Reading P&IDs Understanding the MOC System Authoring and Reviewing SOPs Leading Incident Investigations / Root Cause Analysis (RCA), especially for near misses Participating in MOC risk reviews / PHAs Leading MOCs, especially for changes to SOPs Process Safety Systems (alarms/shutdowns)
Maintenance	<ul style="list-style-type: none"> Specific skills and certifications to perform preventive and corrective maintenance and any specialty work such as welding or confined space entry, etc. Understanding the MOC System Understanding the Computerized Maintenance Management System (CMMS)/Work order system Leading Incident Investigations / Root Cause Analysis (RCA), especially for near misses
Process Engineers	<ul style="list-style-type: none"> Responsibilities for developing/updating Process Safety Information (PSI) Responsibilities/participation in MOC technical and risk reviews Process Hazards Analysis (PHA) team membership

Not Maintaining Process Safety Competency and Institutional Knowledge

Competency is the skill or ability to do something well enough to meet a standard. An individual gains competency through the combination of natural abilities, general education, experience, and specific skill/task training (classroom and hands-on), as shown in **Figure 2**. Some of these components, such as education or experience (knowledge), can be measured directly and minimum standards established. However, evaluation of the competency level requires demonstrating the ability and judgment by others who are already competent. Progressive competency levels are achieved over time by participation in specific activities and achievement of specific milestones. Increasing levels of expertise are mastered and maintained through training and mentoring, cross-functional and cross-departmental sharing of resources and information, stewardship of organizational guidelines and standards, and external engagement with other experts in sharing and developing new knowledge.

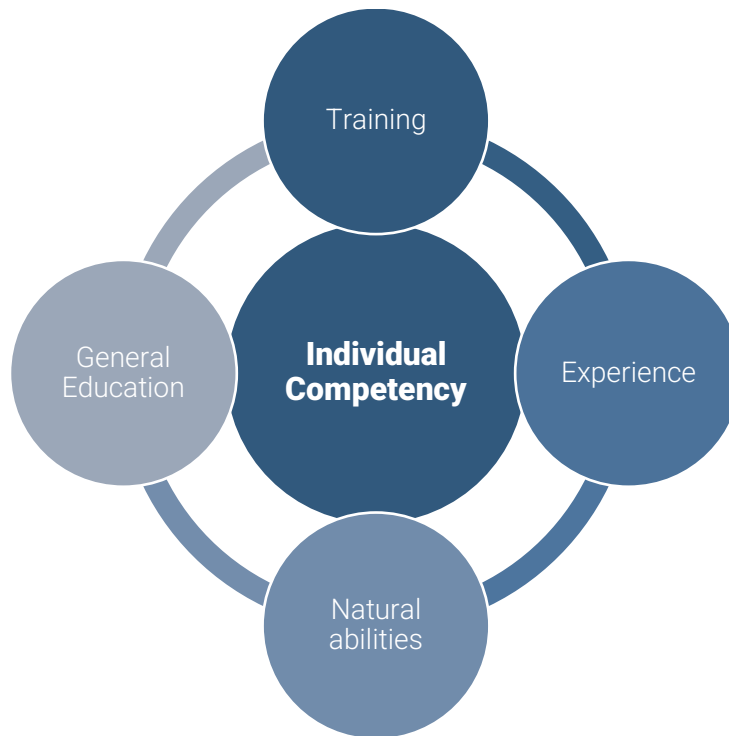


Figure 2. The Make-Up of Competency for an Individual
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Developing and Maintaining Organizational Competency (**Figure 3**) includes the identification and development of the requisite skills, but skills alone are not sufficient. Organizational competency also requires that information is developed and shared, that a learning culture (supportive, nurturing, and encouraging) is maintained to ensure that the skills are developed and applied in an effective manner, and that performance measures are monitored to continuously evaluate performance and reevaluate organizational needs. Programs to improve overall knowledge and competency in process safety and overall knowledge management involve a robust PSM skills development program, information sharing and accessibility to information and standards.



Figure 3. The Make-Up of Competency for an Organization
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In-house PSM capabilities and the ability to monitor overall PSM subject matter expertise are critical to avoid gaps in institutional knowledge and ability to execute PSM responsibilities (PHA leadership, MOC recognition and evaluation, SOP writing, incident investigation, etc.). Additionally, not maintaining competency and institutional knowledge results in promoting individuals not ready to manage PSM responsibilities and ties back to not following and/or poorly defined job descriptions.

Not Implementing a Fitness for Duty Program

Supporting programs for ensuring employees are physically and mentally capable of doing their job on a given day is a necessary component of human error prevention. Poor or no control of high mental fatigue for staff in operations and maintenance, especially during turnarounds, leads to increased error rates and eventually near misses and accidents. Human Resource (HR) policies for work schedules and overtimes policies, along with Employee Assistance Programs to provide employees with support services to navigate wellness, legal and other issues are the cornerstones to mental fatigue management and subsequently effective risk control.

Project Management

Omitting PSM from Project Management Policies and Procedures

To ensure process safety is addressed during all capital project phases, facility management and project management must identify and plan for PSM tasks in the project scope. Project management procedures must include PSM deliverables required at each project phase. See **Table 2** for a summary of PSM deliverables for each major capital project phase. Budgets need to include PSM related tasks.



Responsibilities must be assigned, and tasks built into the project schedule to support completing PSM Implementation tasks prior to and during startup. Projects that do not include PSM tasks and deliverables can result in incomplete or inaccurate PSI collection, especially if there is no audit or validation of PSI accuracy. Additionally, a common oversight is the lack of a process to convert PSI from project centric organized data to operational centric data management to support day-to-day use of PSI for PSM implementation tasks during operation. Prior to startup the availability of PSI is required for the project team members and facility personnel, during latter project phases, to develop operating procedures, training guides, safe work practices (SWPs), equipment files, maintenance procedures, inspection, testing, preventive maintenance plans (ITPMs), emergency response procedures, etc. Document archiving methods that are not indexed, indexable, or searchable are nearly worthless to operating facilities. Other omissions are PHAs not being conducted at the required project phases, failure to have future operators author the operating procedures, failure to require a PHA of procedures for critical tasks, and inadequate PHA recommendation tracking and closure. Including requirements for PSM tasks in project budgets and schedules help the project team design, construct, and commission a PSM compliant project, that meets the required PSM regulatory requirements, the facility’s risk criteria, and is aligned with PSM goals.

Table 2. PSM Deliverables Developed During Project Phases

Project Phase	Key PSM Element Development for each Phase (using US OSHA PSM as template/example, OSHA PSM regulation in parentheses)
Conceptual	<ul style="list-style-type: none"> . Process safety information, including chemical hazards, chemical reactivity, hazards of inadvertent mixing, inventories, applicable codes, and standards (d) . Baseline info for future PHA (e) . Baseline info for future MI (j) . Begin inherently safer concept . Begins leadership . Begins employee participation (c)
Preliminary Design	<ul style="list-style-type: none"> . Process safety information, including applicable codes and standards, process flow diagram, thermal/kinetic chemistry information, material and energy balances, and materials of construction (d) . Facility siting basis set . Beginning emergency response plans and procedures (n) . Baseline info for future PHA (e) and perform initial PHA (e) for the project scope . Baseline info for future MI (j) . Continue employee participation (c)



Project Phase	Key PSM Element Development for each Phase (using US OSHA PSM as template/example, OSHA PSM regulation in parentheses)
Detailed Design	<ul style="list-style-type: none"> . Process safety information, including applicable codes and standards, P&IDs, revised materials of construction, safety interlocks and controls, equipment design basis and some final equipment details (d) . Multiple layers of protection . Detailed info for future PHA (e) and update initial PHA (e) for the project . Detailed info for future MI (j) . Begin detailed emergency planning and response (n) . Continue employee participation (c)
Final Design	<ul style="list-style-type: none"> . Process safety information (revisions) (d) . Multiple layers of protection (revisions) . Revised details building toward final project PHA (e) and update PHA (e) . Revised data for MI, including development of inspection, test, PM plans and populating databases (j) . Begin detailed consideration of human factors . Data and recommendations for developing operating and maintenance procedures (f) & (j) . Continue employee participation (c)
Commissioning	<ul style="list-style-type: none"> . Process safety information (revisions) (d) . Multiple layers of protection (revisions) . Revise MI plans, procedures, and database (j) . Complete detailed consideration of human factors . Continue employee participation (c) . Complete development of emergency planning and response procedures (n) . Complete operating procedures (f) . Complete the final project PHA (e) by conducting PHA of startup, shutdown, and online maintenance procedures; this becomes the complete “initial” PHA (e) for the new unit . Complete initial training (g) & (j) & (h) . Develop remaining elements of PSM, including MOC procedures and incident reporting and investigation system (l) & (m) . Conduct initial PSSR (i)
Post-Startup	<ul style="list-style-type: none"> . Initial PHA Revalidation (completed much earlier than the required 5-year cycle) (e) MOC (l) . Incident investigation (for lessons learned in first 3-6 months) (m)

Not Adhering to Management of Change After Design Freeze

The process narrative, equipment specifications, process flows, operating limits, control narrative and other design information are reviewed and approved through design and risk reviews through Project Management Phases or MOCs. Project Management interfaces with purchasing, and through checks and balances, these procedures help ensure specifications are followed during the procurement process.



Changes are inevitable. Reviewing and approving design changes help guarantee the process safety design is not invalidated due to late phase design changes. New hazards can be introduced due to uncontrolled changes such as adding equipment, equipment design specifications changes, process flow configuration changes, removal of independent protection layers (IPLs) required to control risk, etc. Once the detailed design phase PHA is completed (except for non-routine mode of operations) and the design is frozen, the process safety design for acceptable risk finalized. Failing to implement an MOC system within the Project Management System leads to unapproved design changes and increased risk. Typically, for a large project, there are 4 to 6 PHAs throughout the project phases (perhaps over a period of 24 to 30 months) that build upon the prior project PHAs.

Other project management deficiencies can also compromise process safety:

- Not adhering to Recognized and Generally Accepted Good Engineering Practices (RAGAGEP), or codes and standards
- Poor documentation quality and formats for Piping and Instrument Diagrams (P&IDs)
- Inaccurate/incomplete calculations, specifications, Original Equipment Manufacturer (OEM) documents
- Poor quality or omitting vendor shop inspections & vendor quality assurance (QA)/positive material identification (PMI) programs
- Poor QA during fabrication, leading to Operational Readiness Review (ORR) or Pre-Startup Safety Review (PSSR) failures that are nearly impossible to catch
- Not following or completing MOC documentation
- Poor contractor program (pre-qualification and documentation); for construction management/trades and engineering (consultants)

Including requirements for MOC, and checks and balances for confirming the project team is adhering to RAGAGEPs and QA protocols, to ensure the project is constructed and installed to meet approved design, all aid the facility in designing, constructing, and commissioning a PSM compliant project meeting the required PSM regulatory requirements and the facility's risk criteria, and aligned with PSM goals.

Purchasing

Purchasing personnel must be trained in the importance of not introducing change at the procurement level, and how not following procurement procedures and specifications can increase process safety risk. Purchasing procedures should address training on how deviation from specifications lead to safety, quality, and efficiency problems, and increased costs. Change procedures define the required steps and communication with operations, maintenance, and engineering when equipment specifications cannot be met due to availability, timing, etc. All changes require approval through operations, engineering and maintenance departments utilizing MOC procedures. Additional purchasing related PSM deficiencies are:



- Staff not qualified to read, interpret, and enforce specifications (more than price or schedule negotiator)
- Staff not following specifications, including not procuring qualified contractors or inspectors (going with “cheaper options” that are not “same” as specified)
- Staff (or technical experts) not conducting contractor pre-qualification and audit programs
- Staff not following or completing MOC documentation or change order procedure for purchasing
- Delayed delivery or wrongly agreed delivery date resulting in delayed inspection or replacement per ITPM
- Vendor or contractor qualifications not established or ignored

If maintenance materials, chemicals, spare parts, and other items, that do not meet specifications, are allowed into the facility, the process safety risk can be compromised. Purchasing procedures that do not address PSM issues establish a direct route for introducing change into the facility. These departmental management practices must guard against a change being forced on the plant. Developing and implementing a PSM training program for Purchasing and developing strict change order policies and procedures will support the facility in meeting PSM goals.

Shipping

Deficient Shipping Area management systems can also compromise process safety. Typical factors impacting risk include:

- Storing incompatible materials together
- Poor material handling skills and practices resulting in damage to shipping equipment and containers, subsequent leaks, and contamination

To help the facility meet PSM goals, the shipping department’s procedures and equipment configuration must be reviewed and analyzed (including tanker/railcar loading areas, equipment layout, and storage areas). Furthermore, the facility must ensure the site’s incompatibility matrix (required under PSI) includes the facility’s final products. Shipping can then overlay any incompatibilities with the equipment layout and operational tasks to identify potential hazards and implement preventive measures (design and procedures) to minimize potential releases and to help the facility meet PSM goals.

Receiving/Warehousing/Retrieval

As previously discussed, when chemicals, maintenance materials, spare parts and other items do not meet specifications, the process safety risk can be compromised. Errors made at design, specification and procurement can be identified through other departments’ checks and balances defined in their policies procedures. However, these departments - Receiving, Storage/warehousing (includes retrieving from storage) can also lack adequate procedures and practices needed to avoid uncontrolled changes



being introduced into the facility. These departments also include Asset Integrity, discussed in the next section.

Receiving - Initial Inspection Misses Damaged Equipment or Wrong Material/Equipment Received

Deficient receiving practices include:

- Not verifying delivery meets specifications by not comparing purchase order specifications against shipping papers (packing list)
- Inaccurate or missing positive material identification (PMI) for composition of new and replacement components, and bulk materials (piping, welding rods, vessels, chemicals)

Warehousing/Plant Stores Management System Deficiencies

- Inadequate labeling system
- Mislabeling/binning
 - Missing label
 - Wrong label
 - Damaged label not replaced correctly
 - Placement in wrong bin
 - Bin mislabeled
- Wrong storage environment (i.e., humidity, temperature, rain, flammable...), poor bulk materials control/separation
- Stored in wrong physical position or orientation (i.e., Pressure Safety Valve [PSV], large control valves)
- No preventive maintenance (PM) while in storage (such as for large shafts that must be turned periodically)
- Inventory control - Not using First In / First Out (FIFO) warehousing practices, resulting in expired or deteriorated material

Retrieving from Storage Management System Deficiencies

Deficient retrieval practices include:

- No procedures for retrieving spare parts, etc. after hours (off shifts/weekends)
- Inadequate data management systems to drive control of the retrieval process
 - Inadequate interface between inventory management system and the CMMS to support Replacement In Kind (RIK)/avoid change
 - Work orders not requiring fixed asset number/spare part number
 - No verification of approved spare part associated with the fixed asset number/equipment specifications



Receiving/Stores/Warehousing management systems must interface with the CMMS to ensure replacement parts, maintenance materials, chemicals and other supplies received meet design specifications, stored items are not incorrectly identified, damaged, or mismanaged, and retrieved items are RIK or approved through MOC for the fixed asset associated with the work order - all necessary to minimize introducing uncontrolled change. All are mechanisms for introducing uncontrolled change – equipment that does not meet design specifications – and should be addressed in these departments’ policies and procedures to align with the facility’s PSM goals.

Asset Integrity (mostly but not always considered a PSM department)

Quality Assurance for Installations Management System Deficiencies

Asset integrity involves new installations (project based or process changes), corrective maintenance (RIKs, repairs) and ITPM. For all these types of maintenance tasks, a quality assurance program to ensure the work was completed correctly is mandatory or equipment may not function as designed, possibly leading to loss of containment. Not establishing or not fully implementing these key management system features can compromise process safety. The asset integrity management system must have a written QA program to confirm the construction and installation meet design specifications and must address the factors impacting maintenance work quality listed in **Table 3**. Not addressing these management system requirements and not ensuring these work components are implemented can directly lead to installation quality problems.

Table 3. Factors Impacting Quality of Maintenance Work

Factor	Root Causes
Poor quality of the spare part /maintenance materials	(Also mentioned previously) . Incorrect design . Ordering the wrong part . Poor quality part/item manufactured and received . Receiving the wrong part . Storage deficiencies . Retrieving the wrong item These are all root causes for poor quality of replacement item/maintenance items
Poor quality of installation	. Inadequate maintenance technician training, skills, experience . Inadequate or unavailable maintenance procedures . Broken/unavailable tools and equipment . Outdated or unavailable P&IDs and other applicable drawings
MOC	. Installing changes or modifications to equipment without approved MOC . And by not following maintenance procedures or not using approved spare parts/materials



Factor	Root Causes
PSSR	. Not conducting a PSSR for process changes or not performing a QA inspection for RIKs/repairs/ITPM (not maintenance responsibilities but would catch any installation issues)

Accounting

Accounting directives not aligned to support PSM compliance can ultimately affect the reliability and safety of the facility:

- Reluctance to invest in stocking spare equipment, as this may not align with cost controlling strategies and goals. Unreliable equipment and downtime can create opportunities for introducing change (deviating from design) to the process. Even controlled changes can increase risk, however uncontrolled changes typically result in higher risk
- Change in inventory control that affect ordering critical spare parts and stocking numbers
- Authorizing "or equivalent" replacement parts, over-riding, or nullifying specifications
- Authorizing bulk purchasing practices for pricing discounts that increases on-site inventory, or increases the amount of material delivered for a single order
- Driving headcount control practices that diminish PSM compliance by not maintaining the minimum positions needed to support process safety
- Delaying PSM audits, PHAs or inspections for budget control or to cut costs

Cost control decisions that impact PSM implementation tasks should be reviewed like other changes to ensure process safety is not compromised and long term help the facility meet PSM goals.

Other Functional Groups

Labs

Deficient standards for calibrating equipment can lead to inaccurate lab results and lead to incorrect process adjustments (controlled changes or uncontrolled changes) that could impact process safety.

Information Technology

An underfunded budget that does not provide and support necessary infrastructure/information management systems for executing PSM systems, and managing design data and implementation proof documents, can negatively impact effective PSM implementation. Examples:

- CMMS, including specific databases for non-destructive testing (NDTs), PSV testing, etc.
- Electronic MOC system
- Incident investigation/root cause database
- LMS (training courses, training matrices, training records, tracking)



- Action Item Trackers (PHAs, Incidents, Audits)
- Systems to support access to and document control for Process Safety Information, SOPs, etc.
- Data management (including moving towards use of big data) for process safety dashboards and predictors

Process Engineering

Engineering is mentioned within many of the departments' activities discussed previously. Here are a few other factors that can negatively impact process safety and are best addressed with practices mentioned under HR:

- Maintaining institutional knowledge, such by development of engineering standards
- Reviewing and evaluating in-house expertise versus contract
- Maintaining training requirements and access to specific training to address process safety engineering tasks such as:
 - PSV sizing
 - Leading PHAs
 - Leading major incident investigations
 - Consequence modeling

Security

Security can impact process safety by allowing unauthorized personnel, contractors, and deliveries into the facility. Factors include:

- Lack of knowledge on how to report deviations from security standards that could impact process safety
- Allowing unauthorized bulk chemical railcars/tanker truck to enter the site
- Not notifying required personnel when bulk deliveries arrived and entered and departed the site
- Allowing unapproved/unauthorized contract companies or individual contract personnel on site

Personnel with Security oversight must ensure security procedures address the factors above and ensure security staff receive initial training and refresher training on all security functions, and how deviations from procedures can impact process safety. Program audits should also be included.

Summary

Overall, a facility must be properly staffed with personnel who meet well defined job descriptions that contain process safety roles, responsibilities, skills, and training. An organizational chart, showing the required positions to support PSM, filling those positions with staff qualified and experienced in PSM, helps ensure Operations are adequately supported to meet PSM goals and to operate at acceptable risk. Every department mentioned above interfaces with operations and has a role in controlling risk.



Understanding each department's function, and the required management system features to support PSM, and by addressing the deficiencies if present, listed above, the facility's non-operational departments will be better aligned to effectively support PSM implementation.

Acronyms

CCPS: Center for Chemical Process Safety

CMMS: Computerized Maintenance Management System

FIFO: First In / First Out

HR: Human Relations

IPL: Independent Protection Layer

ITPM: Inspection, Test, Preventative Management

LMS: Learning Management System

LOPA: Layers Of Protection Analysis

MI: Mechanical Integrity

MOC: Management of Change

NDT: Non-Destructive Testing

OEM: Original Equipment Manufacturer

PHA: Process Hazard Analysis

P&ID: Piping and Instrument Diagram

PM: Preventative Management

PMI: Positive Material Identification

PSI: Process Safety Information

PSM: Process Safety Management

PSSR: Pre-startup Safety Review

PSV: Relief Valve / Pressure Safety Valve

QA: Quality Assurance

RAGAGEP: Recognized and Generally Accepted Good Engineering Practices

RCA: Root Cause Analysis

RIK: Replacement-In-Kind

SOP: Standard Operating Procedure



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