

**Executive Overview**

Process Safety Management (PSM), driven by the OSHA 1910.119 standard, aims to prevent the unwanted release of hazardous chemicals, especially into locations which could expose employees and the environment to serious hazards. One of the elements in the standard that presents a compliance challenge is establishing Mechanical Integrity (MI), which ensures the integrity and safe operation of process equipment through inspection, testing, preventive maintenance and quality assurance. This whitepaper presents an overview of PSM, explains the requirements of a MI program, and illustrates how PSM and MI can be established within an asset management framework.

**Using an Asset Management Framework to Drive Process Safety Management and Mechanical Integrity**

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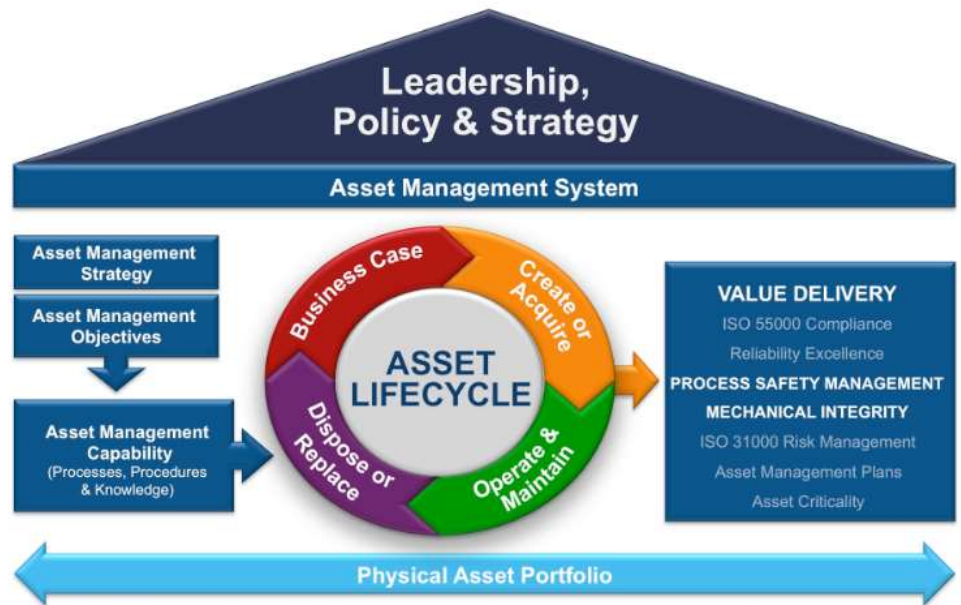
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**Introduction**

As defined in the new ISO 55000 series of standards, asset management identifies the value that assets create for internal and external stakeholders while also understanding and properly mitigating the risks to that value creation. The 2010 San Bruno pipeline explosion, which killed eight people and injured 66, was a result of the pipeline’s owner committing nearly 3,800 violations of state and federal laws and regulations. The result, due to a poor asset management system, was fines exceeding \$2 billion plus a required, significant capital investment in establishing asset management plans along with modernizing the pipeline.

It’s important to recognize that Process safety management and Mechanical integrity are two outcomes of a properly designed asset management system as shown in the Asset Management System Framework below:

**Asset Management System Implementation Framework**



In this whitepaper's conclusion we show that PSM and MI are both outcomes that drive value from establishing a fully functioning asset management system.

### Why the time is right to establish a compliant Process Safety Management (PSM) program supported by an effective Mechanical Integrity (MI) program

Any industry that uses toxic, reactive or flammable liquids and gasses is very familiar with the potential for an accidental release when the chemicals are not properly controlled. Here's how the U.S. Department of Labor's website explains the regulations in place to help protect workers, the workplace, the community and the environment:

To help ensure safe and healthful workplaces, OSHA has issued the [Process Safety Management of Highly Hazardous Chemicals standard](#) (29 CFR 1910.119), which contains requirements for the management of hazards associated with processes using highly hazardous chemicals.

Process safety management (PSM) is addressed in specific standards for the general and construction industries. OSHA's standard emphasizes the management of hazards associated with highly hazardous chemicals and establishes a comprehensive management program that integrates technologies, procedures, and management practices.<sup>1</sup>

Data on compliance to the OSHA 1910.119 PSM standard suggests that sites continue to struggle with establishing or remaining in compliance, partly because of a difficulty in establishing a functioning mechanical integrity program. For example, Figure 1 shows inspection results from the OSHA Refinery National Emphasis Program. This graph shows that the number of citations resulting from a lack of Mechanical Integrity (element J), second only to the number of citations resulting from a lack of written operating procedures (element F).

*Data on compliance to the OSHA 1910.119 PSM standard suggests that sites continue to struggle with establishing or remaining in compliance, partly because of a difficulty in establishing a functioning mechanical integrity program*

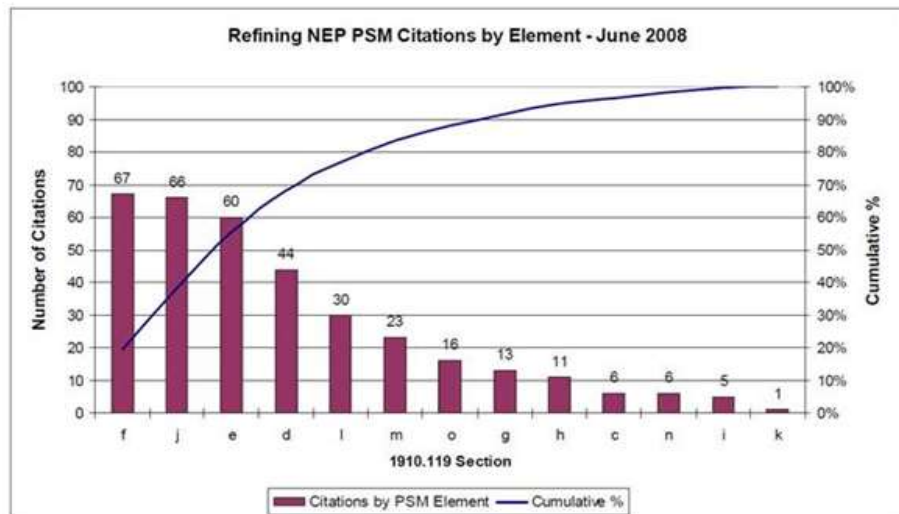


Figure 1. Number of Citations and Cumulative Percentages, By PSM Element

(Reference: OSHA Refinery National Emphasis Program (NEP) Inspection Results, 2008)

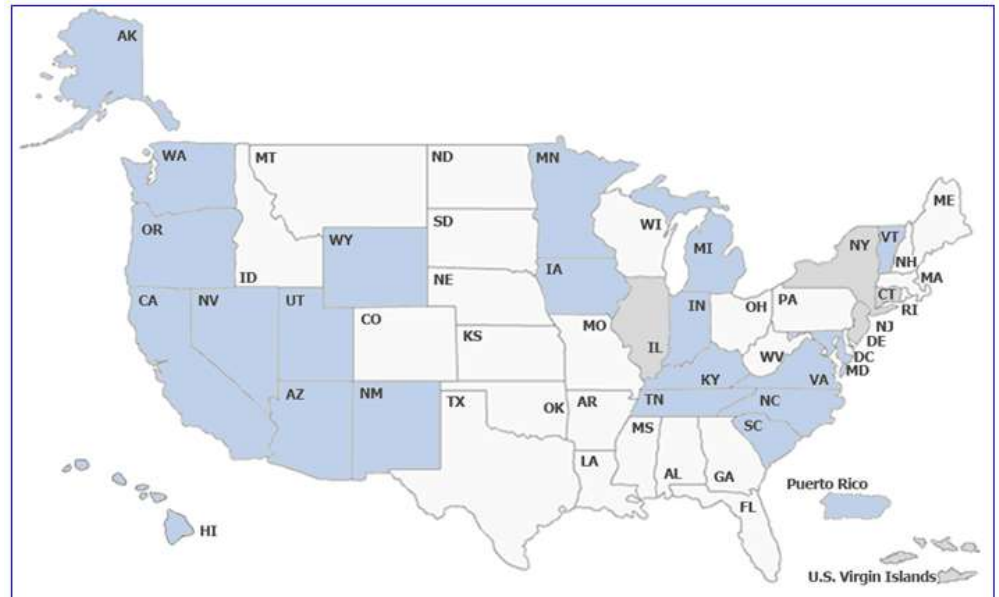
<sup>1</sup> Accessed from United States Department of Labor website: <https://www.osha.gov/SLTC/processsafetymanagement/> on 1/20/15



There are numerous reasons why the time is right to establish a compliant PSM program supported by an effective MI program:

- OSHA is zeroing in on safety issues with strategic mechanisms such as Site-specific Targeting (SST), National Emphasis Programs (NEP), the Severe Violator Enforcement Program and Corporate Settlement Agreements. In FY 2013, OSHA conducted 39,228 total inspections. This included 185 significant and egregious (instance-by-instance) enforcement actions. In addition, OSHA conducted 22,170 programmed inspections, indicating that OSHA is devoting more resources to proactively target industries and employers that experienced the greatest number of workplace injuries and illnesses. OSHA also conducted 17,058 un-programmed inspections, including employee complaints, injuries/fatalities and referrals. Being found out-of-compliance can be extremely disruptive and costly to operations.
- State and Territory plans for safety and health must be at least as effective as federal OSHA requirement and, in some cases, are requiring additional notification and reporting when major turnarounds are taking place. States and Territories with plans in place are shown in Figure 2.

*The newly released ISO 55000 Asset Management standard provides a framework for the principles and benefits of establishing an asset management system. This standard is expected to be adopted on a scale similar to the quality (ISO 9000) and the environmental (ISO 140001) standards*



**Figure 2: States and Territories with Plans Reviewed by OSHA**

- The newly released ISO 55000 Asset Management standard provides a framework for the principles and benefits of establishing an asset management system. This standard is expected to be adopted on a scale similar to the quality (ISO 9000) and the environmental (ISO 140001) standards. Developing best-in-class asset management capabilities within such a framework can have the additional benefit of creating a system to deliver mechanical integrity.

## An Introduction to Process Safety Management (PSM)

Process Safety Management (PSM), driven by the OSHA 1910.119 standard, has been in force since the early 1990s and addresses the management of assets within industries where hazardous materials are handled in sufficient types and quantities to be a concern and thus, requiring a PSM program. Yet based on the data presented in the overview of this article, many organizations have not been successful in developing and implementing a PSM program that sufficiently addresses MI and management of critical assets from that perspective. Organizations still need help and support to define and implement an effective asset management program that is sufficient and can be used to meet the requirement of the OSHA 1910.119 standard.

PSM requires an ongoing asset management effort to prevent catastrophic accidents involving hazardous process materials and energies. It recommends the application of asset management principles and analytic techniques to reduce risks during the onsite manufacture, use, handling, storage and movement of chemicals or highly hazardous materials (HHMs). Its focus is on hazards related to the materials and energies present in chemical process and similar facilities. Within the PSM standard there are 14 key elements and a brief summary of each of these is given in Table 1, excluding Application (a) and Definitions (b) paragraphs:

<b>Table 1: Overview of PSM Elements</b>	
<b>Element Title</b>	<b>Element Description</b>
Employee Participation (c)	Ensure that workers and their representatives are consulted and have access to information regarding all PSM elements.
Process Safety Information (d)	Maintain complete and accurate information on the process technology, process equipment and hazardous characteristics and physical properties of all chemicals and intermediates for all covered processes.
Process Hazard Analysis (e)	Identify and assess process hazards for each covered process and take action to manage risk.
Operating Procedures (f)	Provide clear written instructions for safely conducting activities at each covered process that address operating limits, safety and health considerations and safety systems and their function.
Training (g)	Provide initial and refresher training with a means of verifying employee understanding for all employees involved operating a covered process.
Subcontractor Safety (h)	Ensure that subcontractor operations do not compromise the level of safety on or in the vicinity of a process using HHMs.
Pre-Startup Safety Review (i)	Perform safety reviews for new and modified facilities prior to operation when the modification is significant enough to require a change in the process safety information.
<b>Mechanical Integrity (j)</b>	<b>Ensure the integrity and safe operation of process equipment through inspection, testing, preventive maintenance and quality assurance.</b>

*PSM is the proactive identification, evaluation and mitigation or prevention of chemical releases that could occur as a result of failures in process, procedures or equipment resulting in a catastrophic incident.*

Non-routine Work Authorizations (k)	Ensure that appropriate measures are taken any time non-routine operations are performed on or near covered process areas that might initiate or promote a release.
Management of Change (l)	Establish and implement written procedures to manage changes (except for replacements in kind) to process chemicals, technology, equipment, and procedures and to facilities that affect a covered process.
Incident Investigation (m)	Using a written procedure, provide a team investigation of any incident which results in, or could reasonably result in, a catastrophic release of a highly hazardous chemical. Each investigation must be documented in a written report and findings and recommendations resolved in a timely manner.
Emergency Planning and Response (n)	Establish and implement an emergency action plan for the entire plant that is in compliance with 29 CFR 1910.38(a) and that also addresses small releases.
Compliance Audits (o)	Ensure that the PSM program is operating in an integrated and effective manner in compliance with PSM requirements.
Trade Secrets (p)	Ensure all information is available to support the PSM Rule. When necessary, confidentiality or nondisclosure agreements may be used.

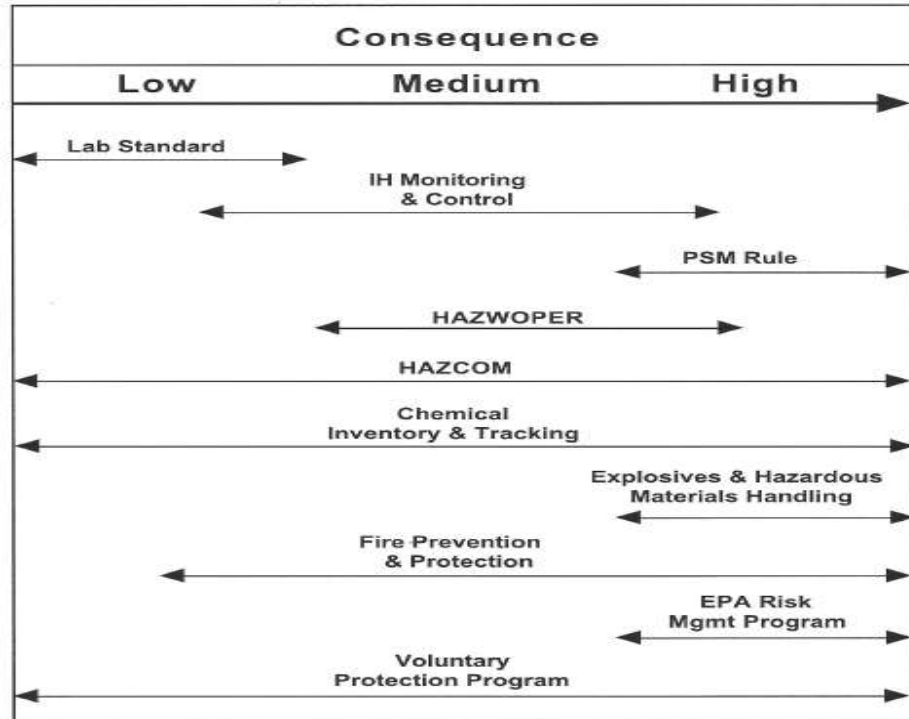
An effective PSM program requires a systematic approach to evaluating the whole process and the assets included within its boundaries. Using this approach the process design, process technology, operational and maintenance activities and procedures, and other elements which impact the process are all considered in the evaluation. The various lines of defense that have been incorporated into the design and operation of the process to prevent or mitigate the release of HHMs need to be evaluated and strengthened to assure their effectiveness at all levels. PSM is therefore the proactive identification, evaluation and mitigation or prevention of chemical releases that could occur as a result of failures in process, procedures or equipment resulting in a catastrophic incident. This OSHA standard is required by the Clean Air Act Amendments as is the Environmental Protection Agency's Risk Management Plan. Organizations who merge these two sets of requirements into their PSM program plus the principles of an effective Asset Management system, will better assure full compliance with each as well as enhancing their relationship with their employees and surrounding neighbors.

The PSM Rule is a performance based rule; this means that it does not prescribe how each element is to be implemented. However, there are numerous Department of Energy (DOE) and OSHA rules that are general industrial hazards, industrial hygiene, and radiation protection programs. Thus, PSM is just one program in a comprehensive safety management system designed to address high consequence events. Figure 3 shows how PSM and other OSHA chemical safety programs apply to the accident consequence continuum.





*MI encompasses the activities necessary to ensure that equipment/assets are designed, fabricated, installed, operated and maintained in such a way that they provide the desired performance in a safe, environmentally protected and reliable fashion.*



**Figure 3: Chemical Safety Programs Related to Accident Consequences**

### What is *Mechanical Integrity* (MI)?

MI is just one of the 14 elements included in the PSM rule but is significant in terms of the asset coverage involved. For example, MI includes any and all equipment/assets used to produce products made from specific quantities of defined hazardous materials on the list covered by the PSM standard. System examples include fixed equipment such as pressure vessels and storage tanks, piping systems and associated hardware (valves, fittings, etc.), relief devices and vent hardware and emergency shutdown/control systems. Rotating equipment/assets, such as pumps, blowers, fans, and compressors that may be used to move hazardous materials within these systems are also included. In many cases, this means that all equipment within the boundaries of a facility is subject to the PSM standard.

MI encompasses the activities necessary to ensure that equipment/assets are designed, fabricated, installed, operated and maintained in such a way that they provide the desired performance in a safe, environmentally protected and reliable fashion. In short, it is the Life Cycle Asset Management process, including the above plus procurement, testing, commissioning and disposal of the assets. MI is a sub-set of an effective reliability program and overall asset management, specific to equipment types, and more tactical in nature including the evaluation of condition requirements through regular monitoring and inspection of the condition of these assets.

## What are the requirements of a MI Program?

Organizations have worked diligently to address the PSM Rule requirements since its inception, specifically focused on those programs related to safety and management of risk associated with handling hazardous materials covered by the standard. However, many continue to struggle with the **Mechanical Integrity**, element **(j)**, and how it relates to an effective Asset Management system that addresses not only safety requirements, but also provides effective asset policy, strategy, objectives and plans to ensure best-in-class management of assets that mitigates risk over the entire life cycle of the assets.

The key phases of MI program development, shown in Table 2, include management responsibility, equipment selection, and implementation through inspection, testing and application of proactive maintenance strategies. Properly trained and certified personnel conducting these activities are also a key part of an effective MI program.

Mechanical Integrity Requirements		
<p><b>Phase 1</b> <b>Management Responsibility</b></p> <ul style="list-style-type: none"> <li>• Facility Leadership Roles and Responsibilities</li> <li>• Organizational Roles and Responsibilities</li> <li>• Reporting</li> <li>• Auditing</li> </ul>	<p><b>Phase 2</b> <b>Equipment Selection</b></p> <ul style="list-style-type: none"> <li>• Selection Criteria</li> <li>• Level of Detail to be Addressed</li> <li>• Documentation Requirements</li> </ul>	<p><b>Phase 3</b> <b>Inspection, Testing and Pro-Active Maintenance</b></p> <ul style="list-style-type: none"> <li>• Task Planning</li> <li>• Task Selection</li> <li>• Task Scheduling</li> <li>• Task Execution and Monitoring</li> </ul>
	<p><b>Personnel Qualification</b></p> <ul style="list-style-type: none"> <li>• Skills/Knowledge Assessment</li> <li>• Training Required</li> <li>• Training Verification and Documentation</li> <li>• Certification Requirements</li> <li>• Refresher Training</li> <li>• Contractor Training Requirement</li> </ul>	

**Table 2: Key Phases of Work Necessary for an Effective MI Program Development**

### *Management Responsibility:*

“Everyone has responsibility for safety” is a phrase that we often hear within a facility. It’s just as true that “everyone has responsibility for reliability”, i.e. effective management of assets. However, an effective asset management program must be driven from the “top down” and effectively implemented from the “bottom up”.

Management must be visible and actively involved in a facility’s hazard management system in order to help prevent incidents. Key responsibilities are:

- Provide the right people for the job
- Set the direction through effectively communicated policy and strategy discussions
- Insist that schedules are planned and met
- Ensure that appropriate system controls are in place

Roles and responsibilities for the asset management processes should be well-defined using a Responsible, Accountable, Support and Informed (RASI) matrix which is visible and well communicated. Reports on MI compliance should be data-driven and focused around compliance metrics and recognized gaps that need to be addressed by the site leadership.

The classic Plan, Do, Check, Act audit process should be employed to understand the effectiveness of the MI activities. Reinforcement for proper behavior around identifying and closing gaps to improve the program is a must, and best delivered from site leadership or corporate management.

#### *Equipment Selection:*

Early in the development of the MI program, the boundaries for equipment within the program must be identified. This is often accomplished through establishment of an MI Team. A screening process to prioritize operating units within the site can also be used to direct the MI Team to the most critical and significant value-contributing assets on site for early consideration. This process includes:

- Consistent review and application of program objectives
- Application of a documented equipment selection criteria
- Selection of appropriate level of detail for specific assets
- Documentation of all aspects of the program in the site's Enterprise Asset Management or Computerized Maintenance Management systems

#### *Inspection, Testing and Proactive Maintenance:*

Once the scope of the MI program has been defined and equipment selected, the level of detail of "task" to be done by asset or asset group is defined. Each task should be properly planned and effectively executed, documented and monitored.

A logical combination of proactive technologies, along with planned inspections (preventive tasks) consistent with current recognized and generally accepted good engineering practice (RAGAGEP) should be defined and included in the Asset Management Plan (AMP). Review of field data obtained through these processes should be reviewed by properly qualified and/or certified personnel to define current or future actions required.

#### *Personnel Qualifications:*

It is obvious but must be reinforced that personnel involved in an MI program must be properly and continually trained to bring the necessary skills to bear when considering or impacting the health of an asset. A requirement of an effective MI program is to validate and document training effectiveness, i.e. whether the person can execute effectively on what they just learned. Certifications are important to ensure that your program is recognized by OSHA, your insurance carrier or anyone conducting program audits or assessments.

Contractors, consultants and any other individual that can become engaged in the MI program must also be trained to understand fully the hazards that are present and mitigating strategies that are in place to manage potential incidents.





## What are the requirements of a MI Program?

The process that pulls all these phases and MI considerations together is shown in Figure 4. Additional detail can be “built out” for each step in this process. The emphasis here is that everything discussed around the key phases of MI program development is included in this process as well as effective asset management principles, such as management responsibilities for policy, strategy and objectives that can be molded into effective AMPs for application and use in the field.

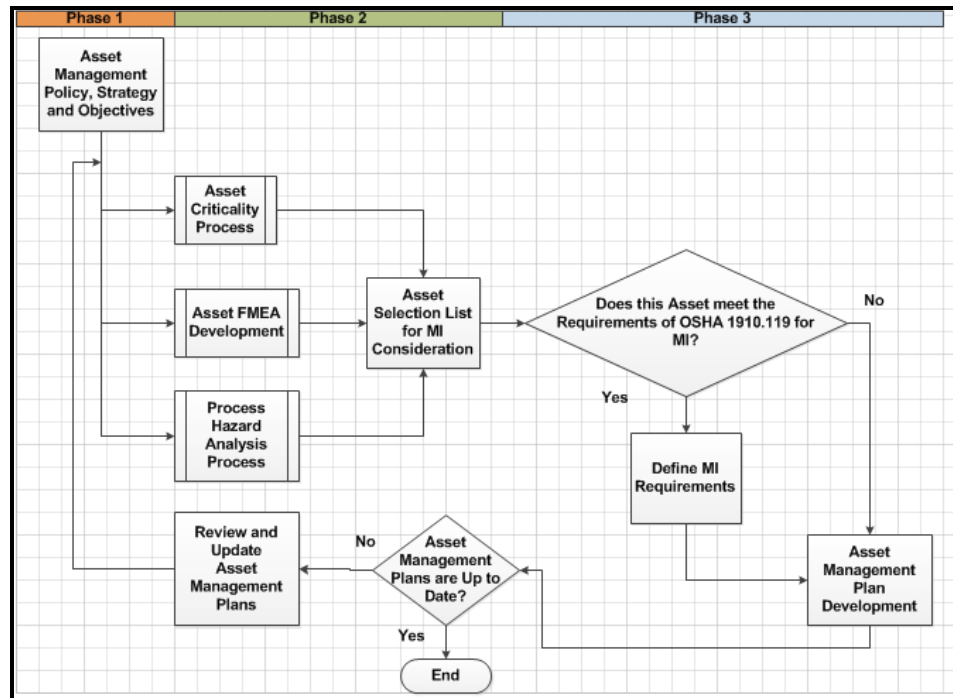


Figure 4: Asset Management Process with MI Considerations

## How can PSM and MI be established within an asset management framework?

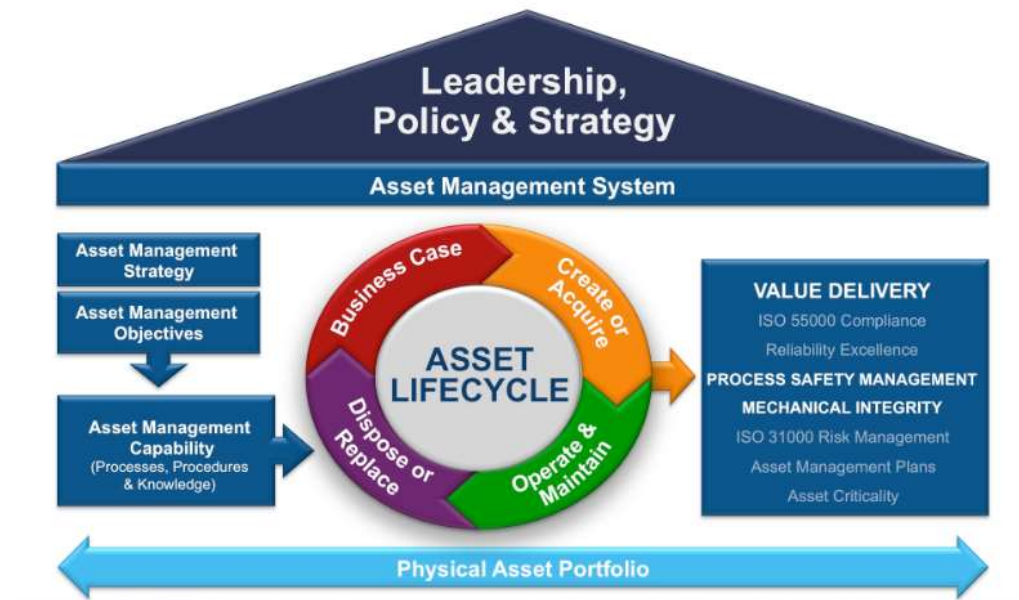
The discipline of asset management is currently undergoing substantial change. Several key, interrelated catalysts are driving these changes:

- As companies continue to improve their manufacturing operations there is an emerging realization that asset reliability is critical to successful lean and operational excellence initiatives.
- Government regulations, especially with regard to safety and mechanical integrity, are mandating that companies significantly upgrade their maintenance and reliability capabilities.
- Companies are more sophisticated and knowledgeable regarding lifecycle asset management and the enormous benefits resulting from establishing processes that efficiently manage an asset from conception through disposal.
- The newly released ISO 55000 Asset Management standard provides a framework for the principles and benefits of establishing an asset management system. This standard is expected to be adopted on a scale similar to the quality (ISO 9000) and the environmental (ISO 140001) standards.

These catalysts share the common objectives of achieving value from assets and the optimization of cost, risk and performance across the lifecycle of the asset.

In response to changing industry dynamics, Life Cycle Engineering has developed an Asset Management System Framework that demonstrates the linkages between the important elements of an asset management system and key outputs. A properly implemented asset management system is a prerequisite for delivering the value necessary for adapting to the various changes to physical asset management that are discussed above.

## Asset Management System Implementation Framework



### Elements of the Asset Management System Framework

The Asset Management System Framework reflects and incorporates the key features of the ISO 55000 management system for asset management standard. The Leadership, Policy and Strategy elements, positioned at the top, are related to the broader application of running the entire company, as well as to the specific reference to the ISO 55000 standard's common management system elements. They are interchangeable with regard to their importance.

From an ISO 55000 perspective, leadership, policy and strategy are overarching elements necessary for establishing governing principles that describe how asset management will contribute to meeting organizational goals (policy) while defining the strategies necessary to achieve the required outcomes of its asset management activities (the strategic asset management plan or SAMP). Policy and strategy must both be cascaded throughout the organization with clear connectivity between strategy, objectives and results. This "line of sight" within the management system ensures that the organization not only gets results, but gets planned results (leadership).

As the asset management strategy takes shape the organization must develop objectives. Asset management objectives transform outcomes into activities and provide an essential link back to the overall organization's objectives. Asset management objectives are performance-based and often serve as KPIs designed utilizing a SMART-based goal-setting approach.

The organizational pledge to establishing an asset management system is largely defined, shaped and communicated through the various activities related to leadership commitment to the development of governing policy, strategy and asset management objectives. It is the next phase in the model that really begins to define the "how" behind implementing the system. The value of an asset management system will be defined by the effectiveness of its asset management capabilities as defined by the processes, procedures and organizational knowledge. The requirements for such capabilities are identified in ISO 55002, management system element 8.1, Operational Planning and control: "The organization should establish operational planning and control processes in order to support the effective delivery of the activities contained within the asset management plans."

*Numerous outcomes can define the value resulting from implementing a fully integrated asset management system, including Process Safety Management and Mechanical Integrity programs that comply with the OSHA 1910.119. Standard.*

#### How an Asset Management System Framework Delivers Value

LCE's Asset Management System Framework organizes these operational planning and control processes largely through the stages of the asset lifecycle. LCE's implementation methodology comprises more than 50 key processes and six critical knowledge domains that span the entire asset lifecycle. When fully implemented, the resulting asset management capabilities define a best-in-class asset management system designed to achieve maximum, risk-based value from your physical asset portfolio. Numerous outcomes can define the value resulting from implementing a fully integrated asset management system, including Process Safety Management and Mechanical Integrity programs that comply with the OSHA 1910.119 standard.

#### For Further Information

Life Cycle Engineering has helped numerous organizations develop their Process Safety Management and Mechanical Integrity Programs. To find out more about how we can help your organization implement asset management best practices and comply with OSHA regulations, please visit [www.LCE.com](http://www.LCE.com) or contact us at [info@LCE.com](mailto:info@LCE.com).

