Driving Operational Excellence™

Operational Sustainability, LLC®

Minimizing Operational Risk and Maximizing Uptime

MI Overview

Companies have been increasingly focused on Asset Integrity Management (AIM), Mechanical Integrity (MI), and regulatory compliance for some time. Societal viewpoints and significant industry incidents continue to pressure companies to focus on running a safe, reliable plant at the lowest cost, leading to maximized production and minimized risk.

While a number of regulatory drivers including OSHA 1910.119 (j), SEMS 30 CFR Part 250.1916, and ABSA AB-512 provide detailed frameworks, suggested practices such as the CCPS Guidelines for Mechanical Integrity provide additional guidance to industry. More recent examples of regulations for midstream oil and gas includes the Department of Transportation PHMSA Gas Transmission Integrity Management rule per CFR 192.

While many companies think of MI as minimizing the potential for a loss of containment involving hazardous chemicals, **reliability** is really the core of an MI program. The purpose of MI is to ensure that process equipment and systems are designed, fabricated, installed, maintained, inspected, tested, and replaced to prevent failures, process upsets, and accidental releases (see Figure 1). Clearly, an effective MI program relies on solid Asset Strategy Management (ASM). As companies advance in their maturity, they need to embed ASM to prioritize inspection and maintenance of their assets.

Figure 1 -
Key Elements of Mechanical Integrity

Component	Examples
Design	**Corrosion allowances,** expected life & rates, inspection access
Fabricate	**Minimum standards,** OEM spare parts, material quality verification
Install	Welding specifications & testing, **construction standards,** inspections
Operate	Surveillance, data collection, KPI's, training, **Integrity Operating Windows**
Maintain	Surveillance, data collection, training, **predictive and preventive maintenance**
Inspect	Online/offline inspection, engineering reviews, fit-for-service, **RBI**
Test	**Testing of SIS & ESD,** audit safety systems, offline SIS inspections
Decommission	Decommissioning, de-inventorying, inspections, **monitoring**

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Mechanical Integrity (MI) Capabilities

A holistic MI program covers Maintenance, Asset Integrity, and Reliability, and contributes to an Asset Performance Management (APM) strategy.

Key aspects of MI include:

- Time/Rule-Based Inspection
- Risk-Based Inspection (RBI)
- Integrity Operating Windows (IOWs)
- Risk Management – Process Hazard Analysis (PHA) including damage mechanisms
- Reliability Engineering – FMEA/FMECA, Weibull Analysis, Monte Carlo
- Failure Reporting and Corrective Action Management System (FRACAS)
- Condition Assessment
- Asset Strategy Management
- Asset Life Extension Management
- Asset Health
- Work Management – Work Notifications and Work Orders, Bill of Materials, Job Plans
- Condition Based Maintenance to identify potential failures (CBM)
- Prescriptive Maintenance (equipment health monitoring and machine-to-machine learning)
- Management of Change (MOC)

An effective Mechanical Integrity Program is critical to achieving PSM compliance, while maximizing the uptime of equipment in operating facilities. Companies need to consider how they are going to address their operational risks, as many facilities are operating beyond their productive life.

Many companies continue to focus on traditional aspects of an MI program, but more recently some are looking into Integrity Operating Windows (IOWs), and predictive algorithms. As equipment sensors and data nodes become more prevalent, traditional approaches to MI are likely to change. For instance, companies will rely more heavily on 24/7 monitoring of equipment versus the traditional approach of having technicians focus on scheduled vibration monitoring.

In addition, operating companies need management systems and procedures for inspection and testing that are aligned with Recognized and Generally Accepted Good Engineering Practices (RAGAGEP). Training and competency programs need to complement written procedures to ensure the ongoing integrity of equipment.

Best-in-class, next-generation MI programs also include good design, procurement, construction, and decommissioning and link those to operation of the facility. Programs include application of RAGAGEP such as ASME, API, ISA, NFPA, ANSI, ASNT, etc. They also include training for MI identified activities such as maintenance tasks, inspection activities, and testing procedures (see Figure 2).

A Mechanical Integrity work process should encompass the following key activities:

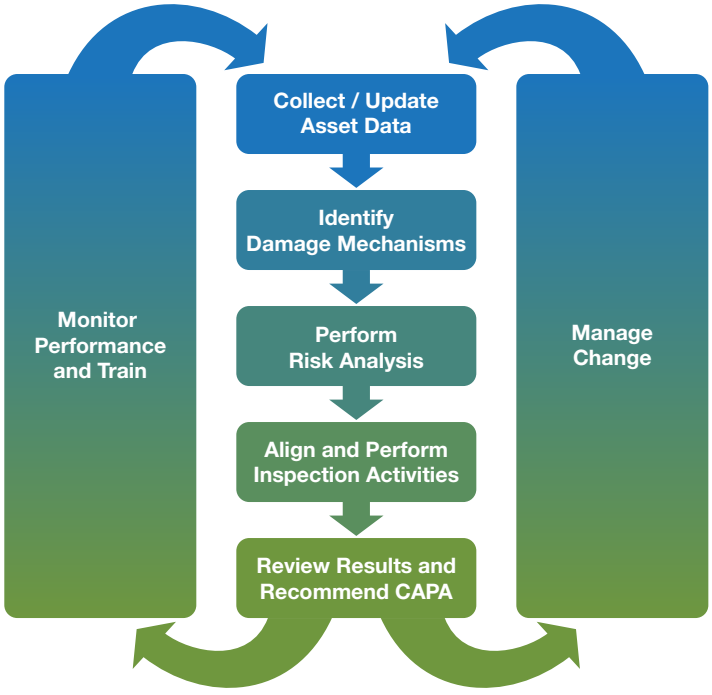

Figure 2 - Next-Generation Mechanical Integrity

Typical fixed equipment covered by MI includes:

1. Pressure Vessels
2. Piping Systems
3. Storage Tanks
4. Relief Devices
5. Associated Hardware (valves, fittings, etc.)
6. Vent Hardware
7. Emergency Shutdown Systems

Typical rotating equipment covered by MI includes:

1. Pumps
2. Fans
3. Blowers
4. Compressors

When part of a facility is removed from operation for an extended period, decommissioning of that equipment must be managed. Often out-of-service equipment can be the most dangerous equipment in a facility. Managing out-of-service equipment is not limited to de-inventory, isolation, and notification; it also includes maintenance and inspection to assure it is safe to continue the out-of-service condition or the removal of the equipment.

MI Design

Regulations require MI programs to manage the following:

- Written MI procedures
- Training for MI activities
- Inspections of process equipment
- Testing of Safety Instrumented Systems and Emergency Shutdown Systems
- Managing equipment deficiencies
- Quality Assurance

The program is to be in place for prevention of releases of toxic chemicals, fires or explosions, where maintenance and inspection of equipment is essential. MI plans and activities correctly executed will reduce the risk of releases. For existing facilities, these plans must begin with the current physical condition, operation, and MI tasks of the facility and merge in existing programs or the beginning of new programs. For new facilities, the plans must start with the design and planned operation of the facility and then move forward as programs are created or implemented. Challenges to MI include accuracy of historical maintenance, inspection, and testing data, accurate prediction of equipment lifecycle, and the ease of reviewing the data. Further challenges are the current capabilities of maintenance, inspection, and testing service providers.

Summary

MI is a program that manages critical process equipment to ensure it is designed and installed correctly and that it operates and is maintained properly. An MI program takes into account the maintenance, inspection, and testing of the equipment using RAGAGEP, and the suitability of newly fabricated equipment for usage. Established written procedures are implemented, and employees who are tasked with maintaining the ongoing integrity of process equipment are adequately trained.

Managing MI benefits an organization in terms of enhanced personnel and plant safety, environmental safety, and profitability. MI plans provide clear understanding of the design, fabrication, installation, maintenance, inspection, testing, and decommissioning required to manage the ongoing operating risk of facilities and equipment.

Best-in-class operators go beyond meeting regulatory requirements to lowering the cost of operations. This means MI is designed into the operating facilities through selecting materials that reduce the risk of damage mechanisms being active and designs that reduce consequences.

Operational Sustainability, LLC® provides the solutions and delivery team to help clients assess current work practices, leverage information technology and develop next-generation, best-in-class MI programs.

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