ABS Group

MIDSTREAM AND DOWNSTREAM ASSET INTEGRITY MANAGEMENT

A COMPREHENSIVE SOLUTION FOR EFFECTIVE AND EFFICIENT OPERATIONS

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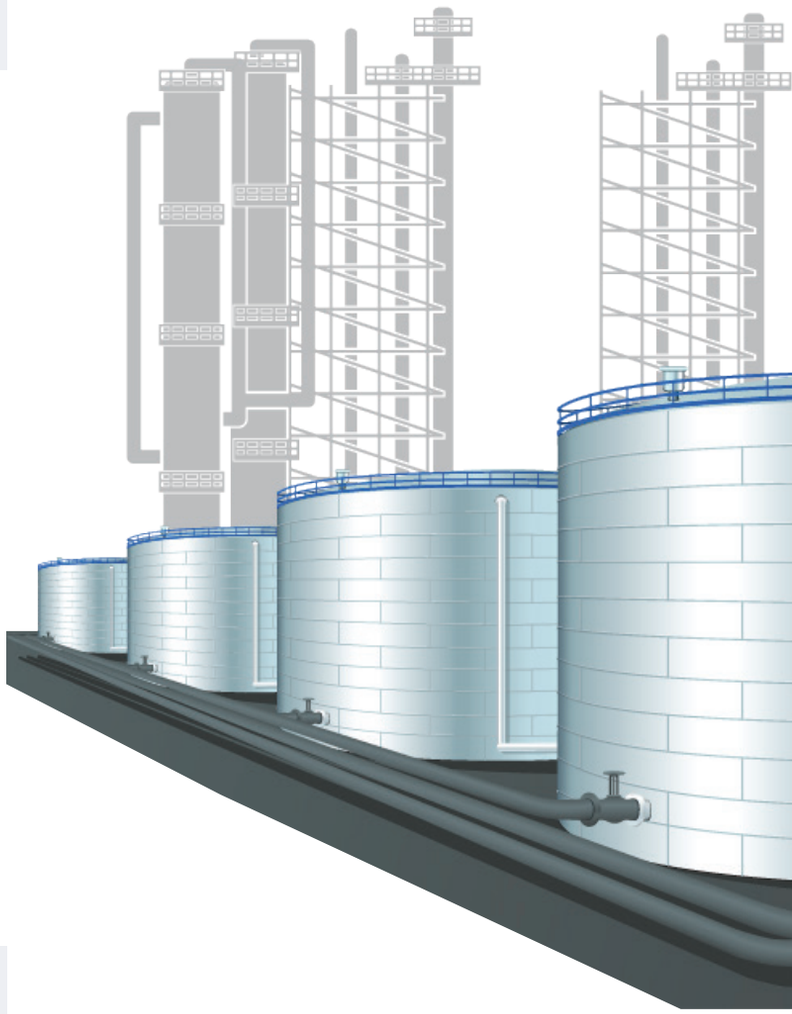
WHAT IS AN EFFECTIVE AIM STRATEGY?

Safe, reliable and economic operation of oil, gas and chemical processes depends on maintaining high integrity levels of pressure containing equipment such as pressure vessels, tanks and piping. Understanding how to effectively manage a facility's pressure containing equipment in order to reduce the risk of failures is crucial to avoiding costly delays and downtime.

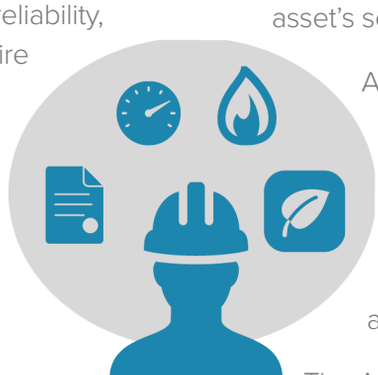
Asset integrity management (AIM) programs have evolved from engineering design standards (e.g. boiler and pressure vessel design standards) into a more data driven, technically robust and better integrated solution, with business practices that promote cost-effective and efficient asset performance. This white paper will examine the elements that comprise a comprehensive, risk based AIM solution combining engineering, inspection and support services to help asset owners understand the full risk picture with the goals of improving uptime, reducing inspection costs, facilitating regulatory compliance and driving operational excellence.



MANAGING THE FULL LIFE CYCLE RISK

Critical pressure assets used in oil, gas and chemical operations must function with maximum reliability, safety and efficiency over the assets' entire life cycle. Managing asset risks helps organizations improve stakeholder value by

- Preserving the organizational license to operate
- Achieving/improving the return on net asset value



This full life cycle risk management begins with verifying proper equipment design, fabrication and installation and then progresses to appropriate operational, inspection and testing practices, and finally the proper management of identified equipment damage and degradation. Not minimizing the importance of the proper design, most of the asset risk management activities need to focus on the in-service operational phase of the life cycle because it represents the longest, most critical phase of an asset's service life.

As operating organizations focus on core business operations, many facilities have found the need to utilize independent third parties that assist with asset/mechanical integrity programs in order to efficiently manage asset risks.

The ABS Group Asset Integrity Management (AIM) program focuses on improving operational performance, increasing asset efficiency, decreasing downtime and eliminating unnecessary costs. Through an integrated offering of technical services and tools, our comprehensive framework addresses three primary areas: Structural Integrity, Mechanical and Machinery Integrity and Control System Integrity.

Through our holistic approach to risk management, extensive technical knowledge and understanding of the regulations and safety legislation affecting plants and refineries, our comprehensive AIM strategy can help clients mitigate risk, improve safety and promote compliance. Asset owners must apply intelligent data-driven strategies to optimize performance, increase efficiency and reduce operational costs.

AN INTEGRATED SOLUTION

A. Damage Mechanism Assessment/Review

A key technical activity that is often missing from many inspection programs is performing a damage mechanism assessment/review (DMA/R). A DMA/R is a systematic analysis process that is designed to determine credible damage mechanism susceptibilities of pressure-containing equipment. DMA/Rs are used to help formulate inspection plans to mitigate the risk of loss of containment and/or unplanned outages.

Properly performed DMA/Rs provide a sound technical basis for inspection programs and are the building blocks for activities such as risk based inspection (RBI) and corrosion management. In addition to the technical value, DMA/Rs can provide an economic benefit to many programs via reduced inspection costs.

The following types of items are damage mechanisms which should be considered when developing an AIM program and documenting potential hazards in your facility:

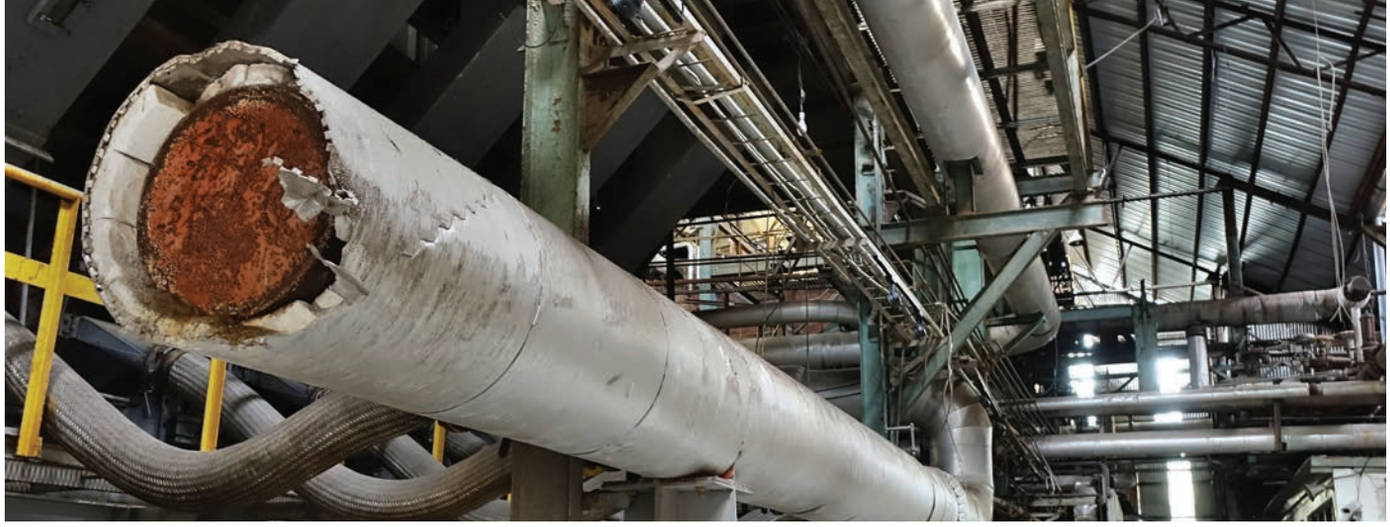
- Mechanical loading failures (such as fatigue)
- Erosion
- Uniform corrosion, localized corrosion and pitting
- Thermal-related failures
- Cracking
- Embrittlement

As industry continues to recognize the value of conducting and documenting DMA/Rs to enhance mechanical integrity programs and mitigate the risk of loss of containment events, the results of these DMRs

Performing a damage mechanism assessment/ review (DMA/R) has become an important step in developing effective mechanical integrity plans in the refining and chemical processing industries. DMA/Rs aid in formulating inspection plans to mitigate risk from loss of containment and unplanned outages, and are the subject of the corresponding API Recommended Practice 571.

can also provide additional relevant information for assisting PHA and Management of Change review teams in identifying potential hazardous scenarios for processes. ABS Group can assist in:

- Performing DMA/Rs
- Determining a risk based approach and developing tools for using DMA/Rs in a process hazard analysis (PHA)



B. Corrosion Management

Another potential safety issue that can incur significant operational costs as industrial assets age is corrosion. Operators are seeking the most advanced and data-driven technical solutions to support a full life cycle approach for controlling the risk of corrosion. Corrosion management and AIM should be integrated as part of an overall cost-effective maintenance effort that optimizes service life, safety and operational performance.

Corrosion Under Insulation (CUI) is a pervasive damage mechanism that affects almost every facility in the world. While many leaks and failures have been attributed to this damage mechanism, current CUI inspection programs may not provide a holistic approach. ABS Group can help facility owners minimize CUI failures and increase operational efficiency by effectively organizing and executing a CUI implementation program. Our experienced asset integrity engineers and corrosion specialists are well-versed in CUI program applications and program auditing.

C. Risk Based Inspection (RBI)

An RBI program can benefit the overall approach to AIM for maintaining higher specification assets so that equipment can perform at optimal levels. As an alternative to traditional prescriptive and time-based programs, RBI relies on a predictive–and preventative –maintenance strategy.

The goal is greater attention to detail and procedures that work toward continuous improvement of high-performance assets and high-utilization equipment through careful, risk-informed planning. ABS Group's approach involves assessing the risk factors, benchmarking the appropriate RBI methodology and implementing a data-driven assessment program that tracks progress and return on investment.

The basic elements in the development of an RBI program integrate well with our AIM solution. These elements include:

- Determination of risks introduced by the potential failures of each component
- Identification of degradation mechanisms that can lead to component failures
- Selection of effective inspection techniques
- Development of an optimized inspection program
- Analysis of data obtained from the inspections and any installation changes

ABS Group is an American Society of Mechanical Engineers (ASME) Accredited Authorized Inspection Agency and a voting member of the ASME and API joint committee on fitness for service (API 579-1/ASME FFS-1).

D. Fixed Equipment Inspection and Certification

In order to protect their licenses to operate, facility owners must verify that their in-service equipment demonstrates the appropriate levels of safety, integrity and reliability. Operators set annual targets to maintain maximum production and avoid unnecessary downtime due to mechanical failure or loss of integrity. To support these objectives, maintaining equipment documentation facilitates better asset management.

Documentation may be used to:

- Safeguard against catastrophic failures
- Describe how the equipment, tool or product operates to provide assurance of continuous operation
- Provide information such as an instruction manual to explain how to use, install and/or configure the product
- Comply with regulatory and jurisdictional requirements
- Establish a record of operational maintenance and management throughout the equipment's service life

Plant operators require an efficient and cost-effective process for assessing mechanical integrity and documenting jurisdictional compliance. For pressure equipment that has minimal or no design and construction documentation, ABS Group will verify the mechanical integrity of existing facility equipment using these five steps to comply with inspection code and standard requirements:

1. Inspect, assess and document the asset's current condition and identify damage mechanisms
2. Define design parameters and prepare drawings
3. Perform design calculations and a fitness for service assessment
4. Engage an Authorized Inspector to witness and confirm pressure testing requirements
5. Once the integrity levels for the maximum working pressure/temperature and minimum allowable thickness is verified and the process documented, attach the nameplate or stamp the equipment

F. Data Support and System Management

Data-driven, intelligent maintenance and integrated database management systems are widely used in asset-intensive industries for a variety of purposes, including industrial control, communication and monitoring. To support safer, more reliable industry practices related to maintaining data management systems, facility owners and managers must improve their understanding of the common vulnerabilities and potential consequences that could interrupt business operations when these systems are compromised.

Inspection Documentation

- *Equipment inspection and piping isometric drawings*
- *Condition monitoring location placement*
- *Inspection and testing procedures*

ABS Group can develop a statistical approach to analyze equipment reliability data in order to develop a list of prioritized systems, equipment and components. For large, capital-intensive projects that generate vast amounts of data, the ABS Group Global Inspection Management System enables more efficient project quality management and collaboration with clients, as well as improves the way in which they manage, access and archive these data for ongoing use.

F. Training: Mechanical Integrity

To support the development of a robust mechanical integrity program, the ABS Group Training Center provides a training course addressing OSHA process safety management and EPA risk management program mechanical integrity requirements. Attendees learn how to develop and implement an efficient mechanical integrity program, as well as increase knowledge of both the inspection, test and preventive maintenance (ITPM) activities for equipment in the petrochemical industry and the recognized and generally accepted good engineering practices (RAGAGEPs) that are the bases for equipment design, fabrication, installation and ITPM plans.

In addition, the course covers the mechanical integrity program requirements for equipment inclusion, procedures, training, deficiency management and quality assurance. Attendees receive the latest OSHA and EPA expectations by discussing recent citations from the National Emphasis Programs (NEP) and receive a copy of the Center for Chemical Process Safety's book, *Guidelines for Mechanical Integrity Systems*. This high-quality training course is designed to help attendees implement programs using proven techniques in the areas of safety, security, risk, reliability, quality and the environment.

PROJECT PROFILE: IMPROVING PRESSURE EQUIPMENT INTEGRITY FOR ASME COMPLIANCE

Pressure vessels are storage containers designed to withstand pressures above 15 pounds of force per square inch and used in applications such as oil and gas refining operations. According to the U.S. Department of Labor's Occupational Safety and Health Administration (OSHA), recent pressure vessel inspections show that there are a considerable number of cracked and damaged vessels in operation, which could potentially result in leakage or rupture failures. Pressure vessel failures are not only costly to operators while critical equipment is taken out of service for repairs, but these material and mechanical breakdowns could potentially have a catastrophic effect on life and property.

To prevent the loss of integrity, these critical industrial assets must have safer, more reliable designs and should be installed, operated and maintained in accordance with the latest material and fabrication guidelines such as the ASME Boiler & Pressure Vessel Code (BPVC).

ABS Group conducted a root cause analysis (RCA) to examine potential root causes that led to the mechanical failure of a pressure vessel operating as a separator in an oil and gas application. Understanding that the manufacturing and fabrication process can introduce low fracture toughness and cause brittle failure in steel, our engineers analyzed the mechanical properties based on ASME BPVC material and fabrication guidelines to identify performance gaps and develop corrective actions. These findings may be used to improve the manufacturing and fabrication process with the goal of preventing brittle failure and other mechanical integrity issues in pressure equipment operations.

ABS Group helped the client:

- Review pressure vessel service life
- Identify the location of the corrosion mechanism
- Determine the failure sequence that led to the accidental release
- Assess the vessel's design using the ASME Code
- Identify performance gaps in the manufacturing process

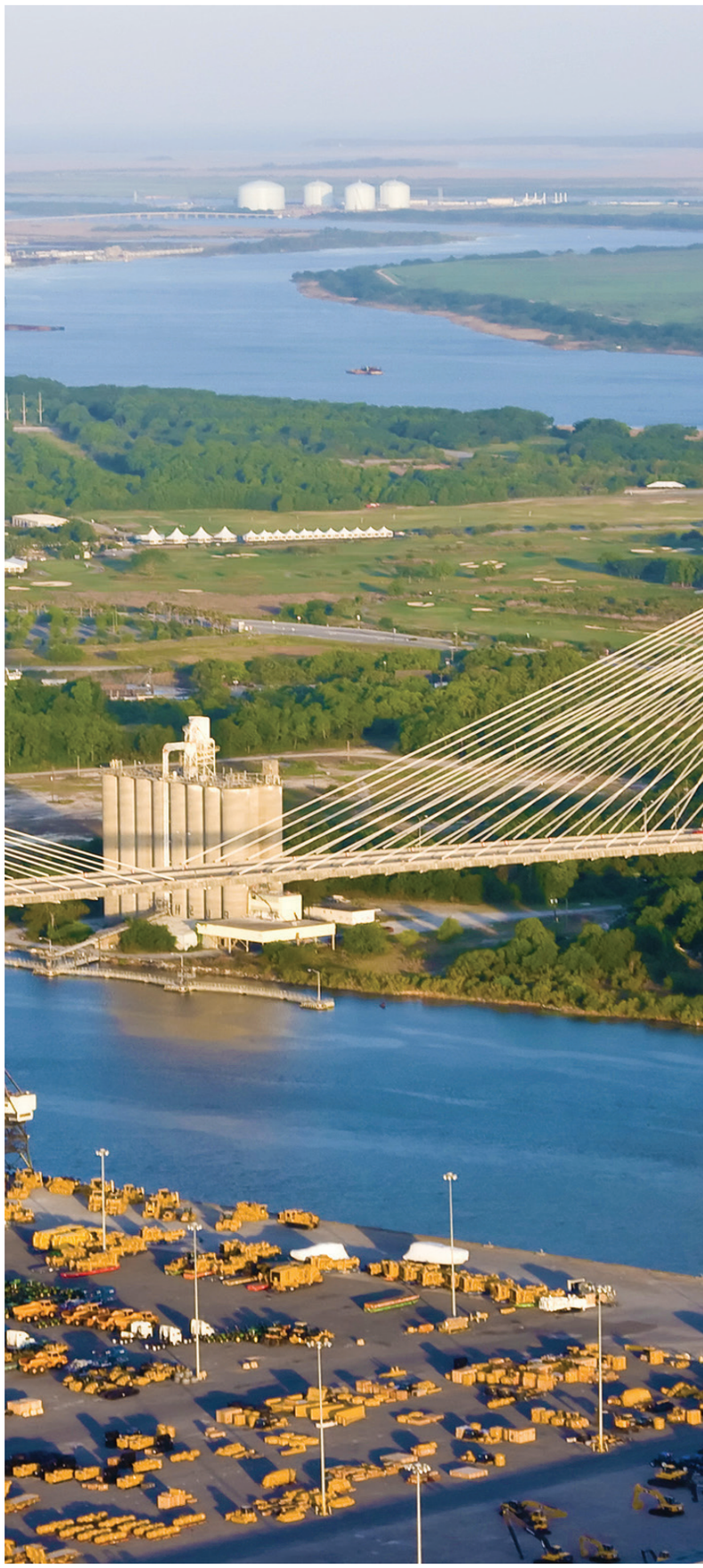
PROJECT PROFILE: REDUCING PIPING INSPECTION COSTS FOR LNG TERMINAL

ABS Group is assisting an energy infrastructure company in establishing mechanical integrity for an LNG regasification terminal process. Our efforts include developing an inspection work process related to damage mechanism assessment, risk based inspection (RBI), systematization and circuitization of equipment and piping, and condition monitoring location (CML) placement.

These work processes have resulted in significant cost savings due to more technically based and robust determination of inspection and nondestructive evaluation (NDE) requirements. For example, the systematization and circuitization and CML placement work processes developed by ABS Group have resulted in the following reductions:

- Approximately a 20% reduction in the number of piping circuits (based on another consultant's circuitization of the piping; this results in a 20% reduction in piping inspection costs
- Approximately a 50% to 60% reduction in number of pressure vessel and piping CMLs (over traditional CML placement approach); this reduction was accomplished by the ABS Group CML placement that bases the CML placement on damage mechanisms and risk

These two reductions, without considering the impact of the RBI analysis approach, equate to an estimated 30% reduction in inspection and NDE requirements for the new process, with estimated savings of USD $300,000 per inspection cycle.



ACHIEVING SAFETY AND PRODUCTIVITY GAINS

Industrial manufacturing and heavy process facilities contain critical assets that must be managed carefully throughout their service life cycle in order to perform their required functions with maximum reliability, safety and efficiency. As a holistic, risk-based approach to asset health monitoring and maintenance, our AIM solution will help industrial asset owners improve efficiencies in the planning, inspection and repair process as well as reduce nonproductive time for more reliable operations and increased profitability.

Discover more insights on asset integrity management by requesting our Mechanical Integrity Toolkit. Learn more at ABS-Group.com/Knowledge-Center

ABOUT ABS GROUP

ABS Group of Companies, Inc. (www.abs-group.com), through its operating subsidiaries, provides technical advisory and certification services to support the safety and reliability of high-performance assets and operations in the industrial manufacturing, oil, gas and chemical, alternative energy, marine, offshore and public sectors, among others. Headquartered in Houston, Texas, ABS Group operates with 1,300 professionals in over 30 countries. ABS Group is a subsidiary of ABS (www.eagle.org), a leading marine and offshore classification society.

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