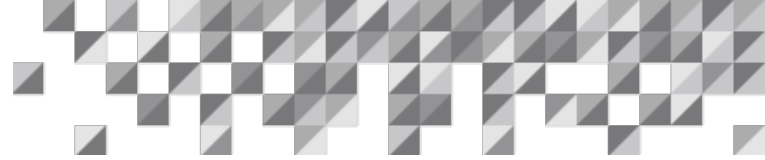


# **Effectively Manage Mechanical Integrity using Process Safety Enterprise<sup>®</sup>**

An ioMosaic White Paper

**Date:** January 8, 2024



## Introduction

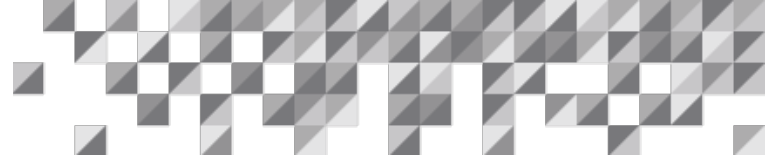
Asset Integrity Management (AIM) or Mechanical Integrity is crucial to the Process Safety Management (PSM) 29 CFR 1910.119 standard. Many companies find AIM difficult to manage since it encompasses the policies, procedures, and workflows to develop and execute Inspection, Testing, and Preventive Maintenance (ITPM) of all PSM equipment and track ITPM deficiencies. Tracking recurring ITPM and the resolution of deficiencies can be difficult without an established workflow and document management system. Losing track of these tasks can jeopardize the safety of employees, the plant assets, the community, and the environment and interrupt business continuity.

An effective AIM program should include capturing the design parameters and specifications of PSM equipment and the Recognized and Generally Accepted Good Engineering Practices (RAGAGEP) used to design the equipment and choose the materials of construction. The manufacturers' operating manual can also be used to identify the required ITPM for equipment bought off-the-shelf (pre-engineered equipment.) A document management system is needed to gather, use, and maintain this important information.

The AIM system should also document the required ITPM and frequencies for the equipment within and in support of the PSM process using the established RAGAGEP and/or manufacturers' recommendations. A workflow works best to document and anticipate the upcoming ITPM, especially for extended shutdowns that require extensive pre-planning. The workflow should specify whether the ITPM can be done with the plant fully functioning, the plant shutdown and energized or de-energized, or the specific equipment de-energized or energized but idle. These distinctions are very important for planning purposes.

The ITPM workflow should also assign the ITPM to qualified internal employees or contractors with the expected start and end dates. Depending upon the site procedures, the managers should seek relevant management approvals from Maintenance, Environmental, Health, and Safety (EHS), Operations, or others.

The workflow should also specify if permits such as confined space entry, hot work, or line breaking are required and if scaffolding or lifting equipment is needed to access the equipment. If critical equipment has been identified, this information should be part of the AIM workflow to allow prioritization when needed. The process should also state whether positive material identification is required when replacing piping, parts, and equipment.



After the ITPM is completed, the report should be saved in a file linked to the equipment, and a qualified person should review and approve the report and determine if any deficiencies must be addressed.

The AIM workflow should manage ITPM deficiencies and provide a process for the qualified person to determine how to address and track them. Typical options include taking the equipment with the deficiency out of service, mitigating the equipment or procedures to operate the equipment safely before the repair can be made, conducting a fitness-for-use evaluation, initiating a temporary repair before the permanent repair can be made, or approving a permanent repair. The decisions and approvals for each option should be included in the workflow with the option of generating a Management of Change if planned modifications are not replacement in kind.

Effective AIM systems help companies document, plan, and execute required ITPM based on RAGAGEP and/or manufacturer's recommendations and address equipment deficiencies. Both workflows help companies comply with the PSM requirements of the 29 CFR 1910.119 standard.

For businesses serious about implementing a comprehensive and evergreen PSM compliance system, ioMosaic offers the Process Safety Enterprise® (PSE) (Figure 1). PSE is a cloud-based platform enabling easy ongoing management of process safety data, helping businesses achieve compliance, manage risk, and remain competitive. Unlike any other system available in the market today, PSE is a centralized web-based application that integrates all PSM elements and workflows, making it THE ultimate solution for managing AIM systems effectively. This white paper will delve into the key features of the AIM workflows and how they benefit companies seeking to improve and elevate their AIM system to eliminate or mitigate catastrophic incidents.

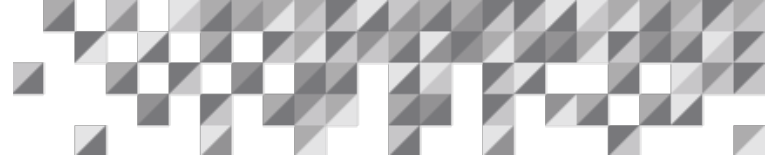
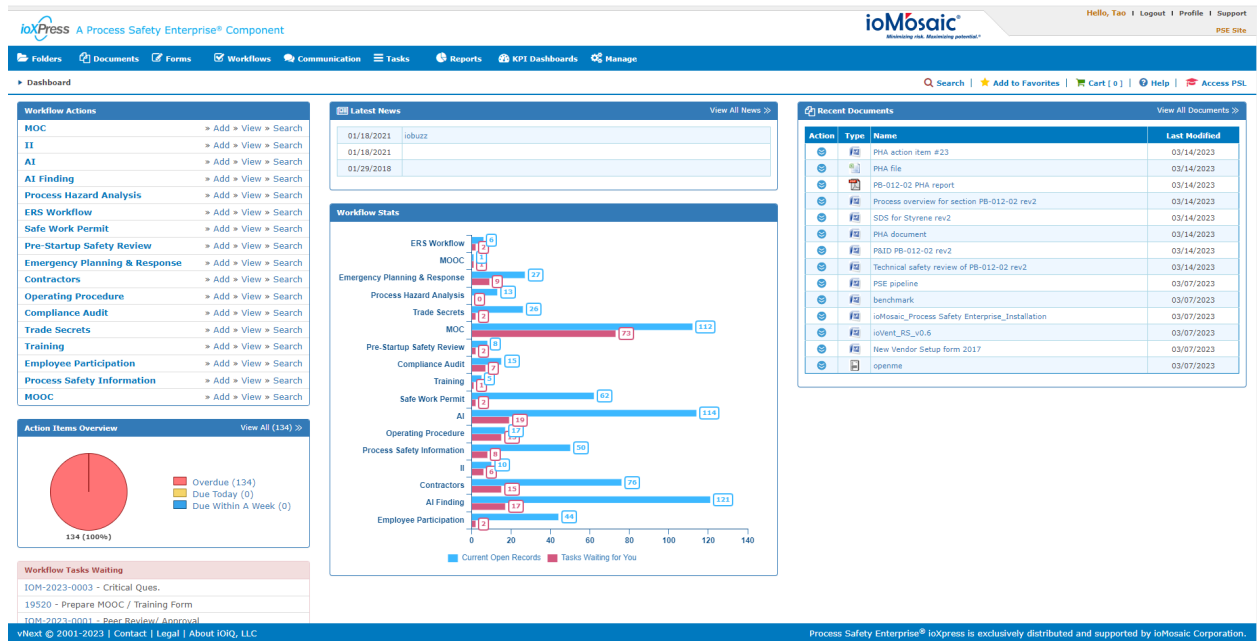


Figure 1. Process Safety Enterprise® (PSE)



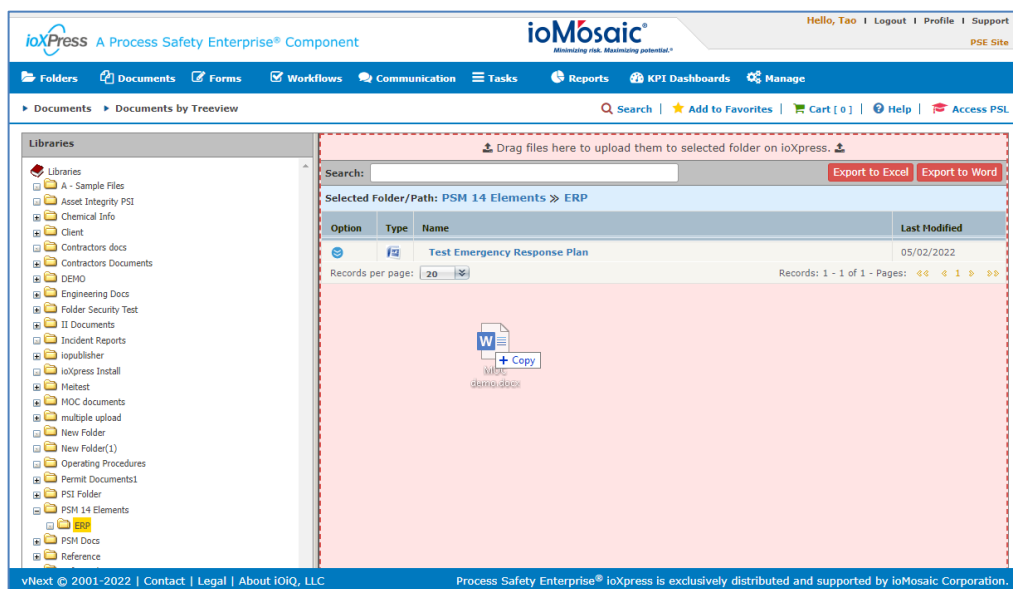
Source: ioMosaic Corporation – PSE

## Document Control System

The document control system of PSE's platform is a key component facilitating easy access to all critical process safety data. It allows users to add documents by simply dragging and dropping (Figure 2) them into the system and quickly organizing them in folders for easy retrieval. With an advanced search function, which indexes all documents with full text, users can find any necessary information quickly. An embedded document viewer feature enhances accessibility, allowing users with view-only permission to access documents remotely without logging onto their computer. This document control component is an effective tool for managing various types of data, including but not limited to engineering data, process safety information (PSI), equipment forms, procedures, records, pictures, videos, animation, and reports. This component further ensures that all stakeholders have easy access to vital information related to the AIM system stored in a centralized location.



Figure 2. Drag and drop feature to add document(s)



Source: ioMosaic Corporation – PSE

## Intelligent Form Builder

In addition to its document control component, PSE includes an intelligent form builder for efficient data capture and linking to documents in a central digital library. This dynamic form builder enables users to create practical, customizable infrastructure capturing and managing information, such as equipment design parameters and materials of construction. Equipment specifications, criticality, damage mechanisms, and the type and frequency of ITPM can also be easily captured on dynamic forms (Figure 3) and linked to relevant documents.

The dynamic form builder also allows companies to tailor forms to their specific needs, making the AIM process more effective, efficient, and company-centric. The ability to customize forms for unique facility equipment ensures that all necessary data is captured accurately and consistently. Moreover, this feature allows for easy export of data to an Excel format, making data analysis and sharing even more seamless. Implementing a customizable form builder like the one found in PSE streamlines an AIM process by capturing data accurately and efficiently the first time and managing changes going forward.

The equipment forms also have an "Inspection Records" tab for documenting the required ITPM and frequencies. The AI workflow can be accessed directly from this tab to launch the AI workflow to execute the required ITPM.



Figure 3. Example of Equipment Form

General	Construction & Materials	Trays & Internals	Service Conditions Vessel	Damage Mechanism	Nozzles	Service Conditions Jacket	Service Conditions Coil
Inspection Records		Inspection Company		Data History			
Unique ID	15137 <small>*Unique Identifier</small>						
*Company Name	ABC						
*Plant	Post Refinery Kettle: ▾	Unit	B and G ▾				
Plant ID	333-000	Unit ID	444				
*Equipment Number	R-123	*Asset Number	555				
Equipment Name	Reactor 1	*Equipment Type	Reactor ▾				
Equipment Description	Post Refinery Reactor 1						
Pressure Vessel Registration #	456ddddd	Equipment Criticality	B- High ▾				
P&ID	<a href="#">R-123 P&amp;ID.docx [More Details]</a> <input type="text"/> <input type="button" value="Add"/> <input type="button" value="Home"/> <input type="button" value="Search"/> <input type="button" value="Info"/>						
P&ID Number	PRK-BG-R-123						
Equipment	<input type="text"/> <input type="button" value="Add"/> <input type="button" value="Home"/> <input type="button" value="Search"/> <input type="button" value="Info"/>						

Source: ioMosaic Corporation – PSE

## Asset Integrity Workflow

PSE is the only process safety platform that integrates all of OSHA's Process Safety Management (PSM) elements using visual workflows in a single enterprise system. This workflow includes PSM's 14 elements using workflows, action tracking modules, and document control. The Asset Integrity (AI) and Asset Integrity Finding workflows allow companies to access and manage their compliance information more efficiently and easily.

PSE's Asset Integrity workflow module includes pre-built equipment forms for typical equipment, such as pressure vessels, pumps, and interlocks. The forms capture pertinent PSI, such as the equipment specifications, criticality, damage mechanisms, and ITPM tasks and frequencies. These pre-built forms ensure a company's AIM process is consistent and captures all necessary information. Unique equipment forms can also be added easily.

The Asset Integrity workflow establishes steps for initiation, work order generation, approvals, scheduling, reporting, capturing costs, reviewing and approving the work, verifying or changing established tests and intervals, updating documentation, addressing deficiencies, and closing the workflow. The AI workflow can be customized to meet the specific needs of any company.

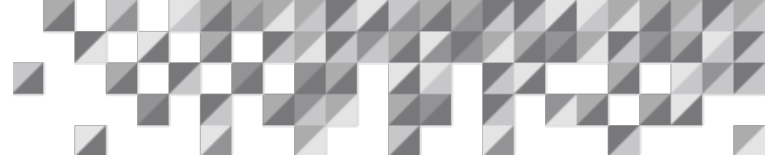
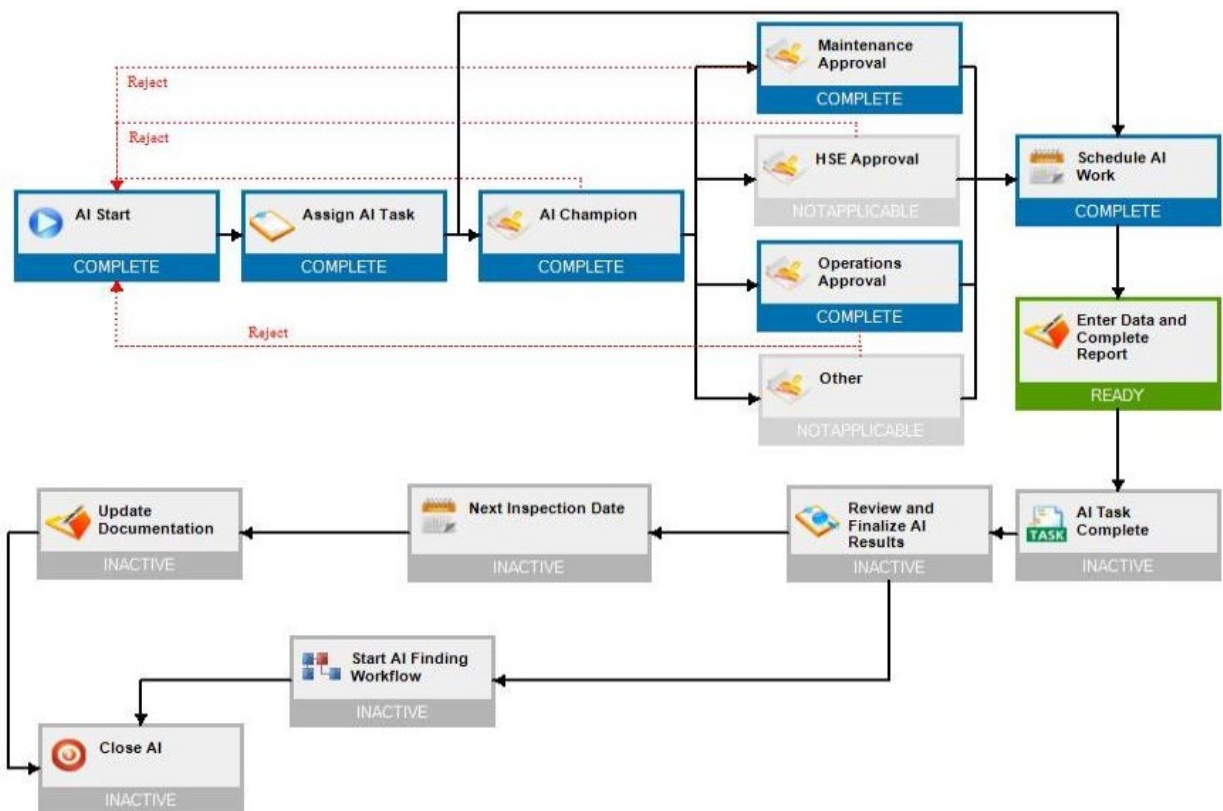


Figure 4 illustrates the steps in the AI workflow, with blue Complete steps, gray Not applicable steps, and green Ready steps. The two green Ready steps illustrate that the current ITPM can be finalized while the AI Finding workflow is started. The workflow cannot be closed until all required steps are completed for the ITPM and deficiencies. If no deficiencies are found, the Start AI Finding workflow step will be gray and Not Applicable.

The AI workflow within PSE is an essential tool that ensures the PSM equipment and equipment that supports the PSM process, such as fire equipment, are routinely maintained based on RAGAGEP and/or manufacturers' recommendations.

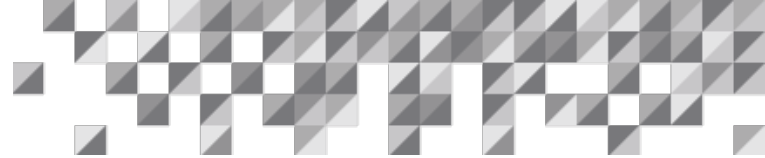
**Figure 4: Example of Asset Integrity Workflow**



Source: ioMosaic Corporation – PSE

## Asset Integrity Finding Workflow

PSE's Asset Integrity Finding workflow module can be initiated from the AI workflow or directly within the Finding workflow. If this workflow is generated from the AI workflow, the essential information will be pre-populated to save time and ensure that the two workflows have identical data.

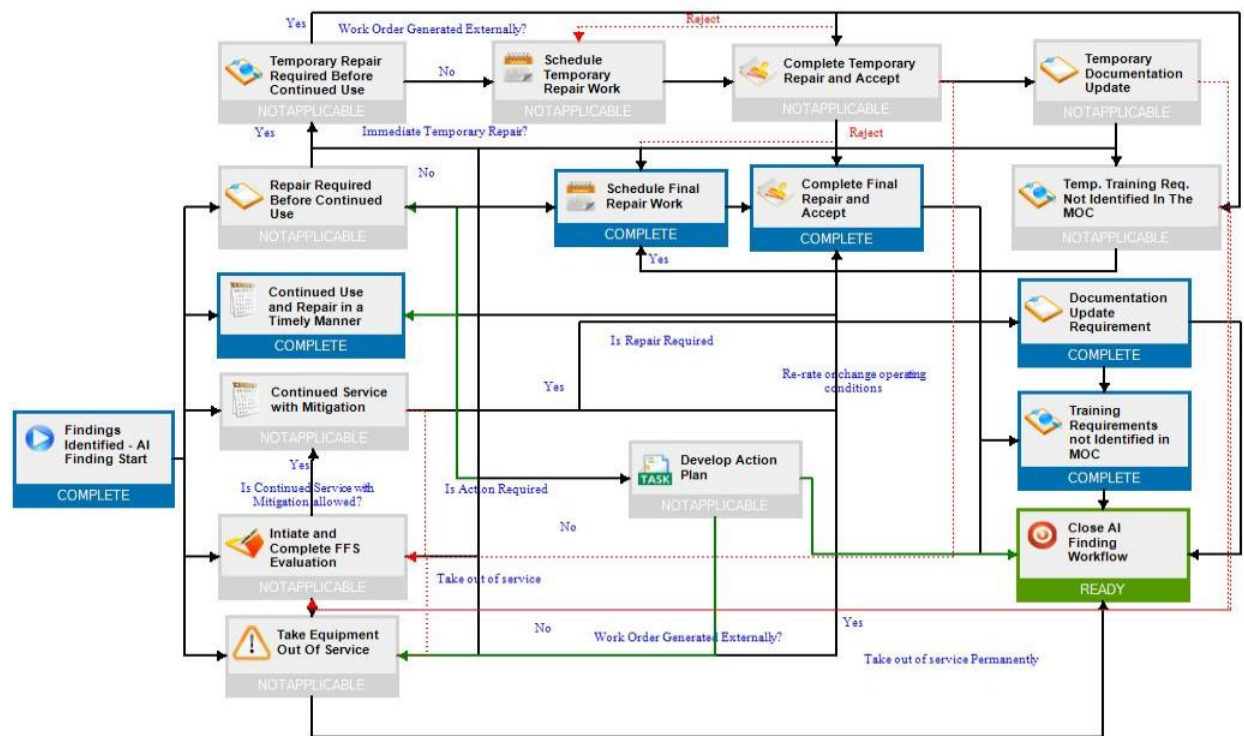


The Asset Integrity Finding workflow establishes steps for initiation, various workflows depending upon how the finding will be managed, completing and approving the chosen action, updating documentation, conducting training, and closing the workflow. Management of Change (MOC) is either required or an option within the workflow, depending upon the action taken. For example, taking equipment out of service would require an MOC. If an MOC is required, the MOC workflow can be initiated from the AI Finding workflow and will pre-populate the key information. The AI Finding workflow can be customized to meet the specific needs of any company.

Figure 5 illustrates the steps in the AI finding workflow, including Take Equipment Out of Service, Initiate and Complete a Fitness-for-Service (FFS) Evaluation, Continued Service with Mitigation, Continued Use and Repair in a timely manner with the option of a Temporary Repair Required Before continued Use, and Repair Required Before Continued Use. This workflow has the same blue Complete steps, gray Not applicable steps, and green Ready steps. If a step does not apply or is not needed (i.e., no training is required), the step will be gray and Not Applicable.

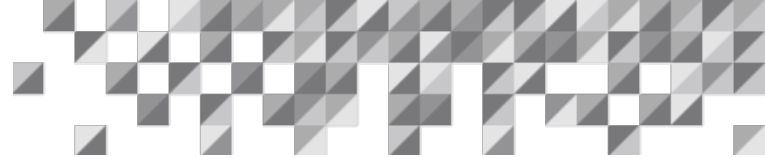
The AI Finding workflow within PSE is crucial for documenting and tracking the timely resolution of equipment deficiencies to completion.

Figure 5: Example of Asset Integrity Finding Workflow



Source: ioMosaic Corporation – PSE

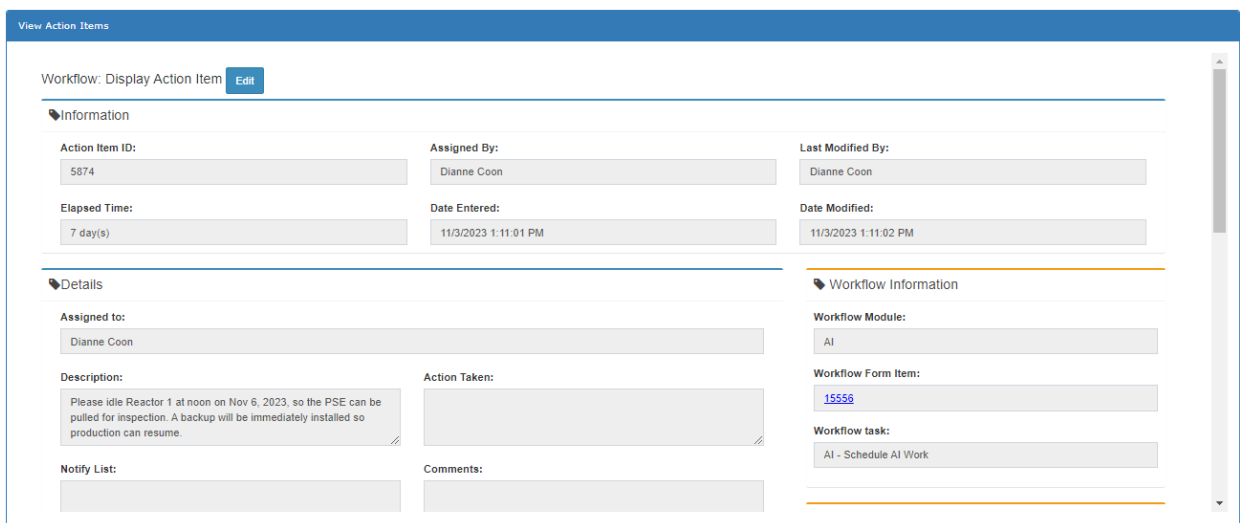




## Action Tracking System

PSE features a comprehensive action item management system (Figure 6) that tracks all tasks related to each process safety management workflow, such as AI and AI Finding. This feature ensures that all action items are managed within the platform, reducing or eliminating the risk of overlooked or forgotten tasks. Additionally, the automatic reminders ensure that all tasks are completed on time.

Figure 6. AI Action item



The screenshot shows a web interface for viewing an action item. At the top, it says 'View Action Items' and 'Workflow: Display Action Item' with an 'Edit' button. The main content is divided into sections: 'Information', 'Details', and 'Workflow Information'. The 'Information' section includes fields for Action Item ID (5874), Assigned By (Dianne Coon), Last Modified By (Dianne Coon), Elapsed Time (7 day(s)), Date Entered (11/3/2023 1:11:01 PM), and Date Modified (11/3/2023 1:11:02 PM). The 'Details' section includes Assigned to (Dianne Coon), Description (Please idle Reactor 1 at noon on Nov 6, 2023, so the PSE can be pulled for inspection. A backup will be immediately installed so production can resume.), Action Taken, Notify List, and Comments. The 'Workflow Information' section includes Workflow Module (AI), Workflow Form Item (15556), and Workflow task (AI - Schedule AI Work).

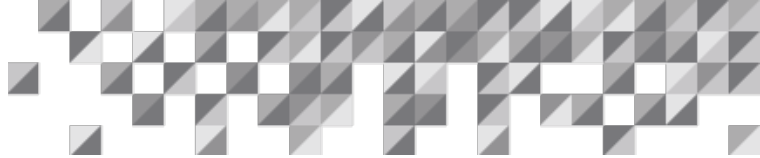
Source: ioMosaic Corporation – PSE

## Reporting and Dashboard/KPI

PSE's reporting and dashboard (Figures 7 and 8) capabilities are an invaluable 'must-have' asset for any data-driven enterprise solution looking to increase performance and productivity. With well-designed dashboards featuring various widgets such as bar charts, pie charts, line charts, and tables, PSE provides a comprehensive overview of the PSM program from a single source. These dashboards allow business owners to make faster decisions based on real-time data.

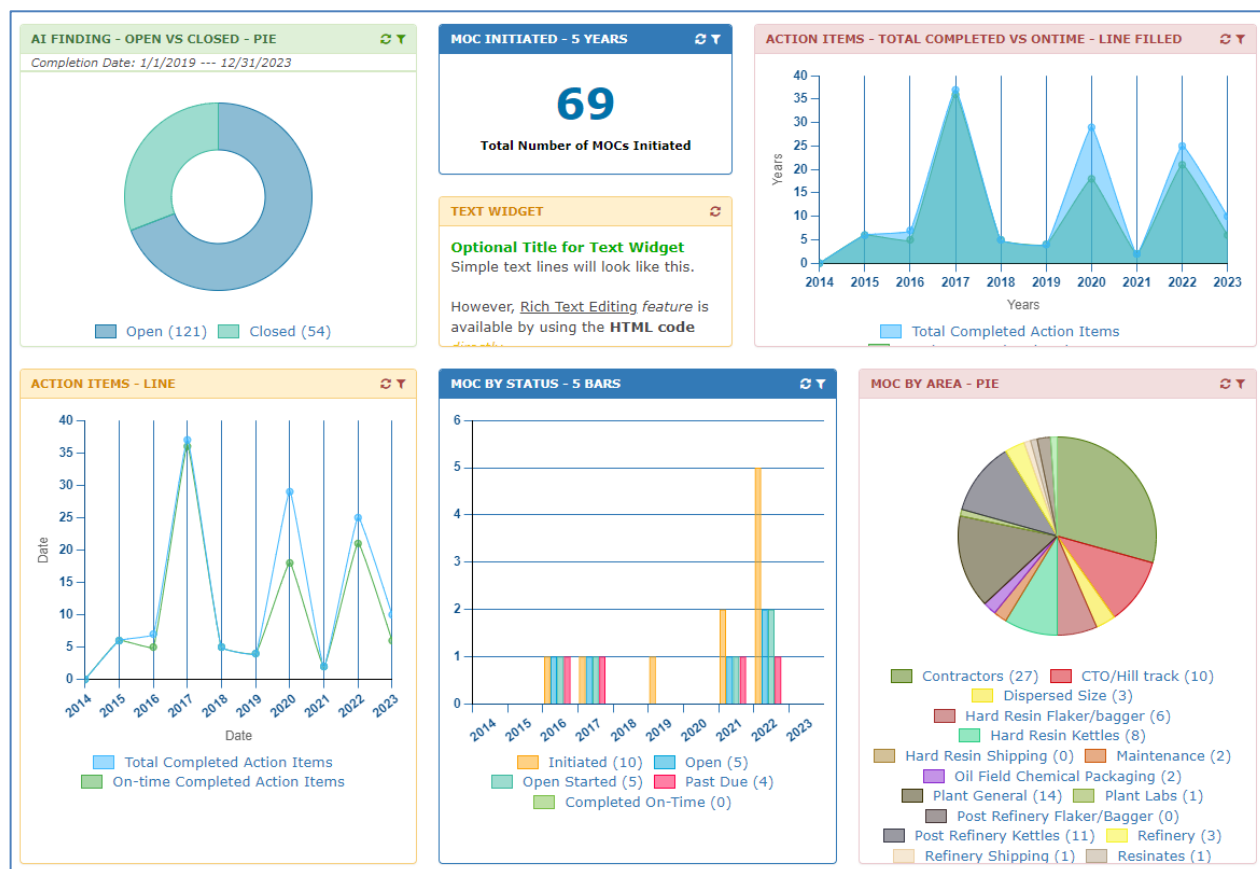
Customizable reports are available for Inspections and Findings. The inspection Report tracks ITPM due within the timeframe chosen at the top, and Overdue Inspections show all ITPM past its due date. The Findings Report shows the same information for Findings currently being worked on (open) and those past their expected resolution date.

Moreover, PSE's reporting and dashboard capabilities provide real-time visibility into AIM-related activities, allowing organizations to quickly identify trends and areas of concern. This capability



enables timely corrective action, reducing the risk of incidents and non-compliance. PSE's robust reporting and dashboard/KPIs are essential tools for any enterprise looking to optimize its operations and mitigate potential risks.

Figure 7. Dashboard/KPI



Source: ioMosaic Corporation – PSE

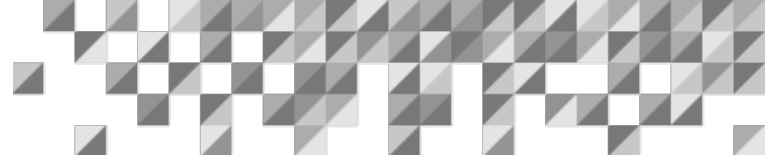


Figure 8. Inspection Report (Due and Overdue)

AI Dashboard | Inspection Reports | Findings Reports

Start Date: 11/10/2023 | End Date: 5/10/2024

Equipment Type: Select Item(s) | Inspection Type: Select Item(s) | Plant Site: Select Item(s) | Units Name: Select Item(s) | Equipment Criticality: Select Item(s)

Run Report

Export to Excel | Display 10 records | Per Page

Equipment Number	Form Name	Equipment Type	Inspection Type	Next Inspection Date	Plant Site	Unit Name	Equipment Criticality	PM17	Operation Status	Inspection workflow started?	AI Due Date
P-444	15061 - dddd / AI - Centrifugal Pump	Pump - Centrifugal	Lube Equipment	12/6/2023	Dispersed Size	B and G	B- High	Yes	Full production	No	N/A
P-444	15061 - dddd / AI - Centrifugal Pump	Pump - Centrifugal	Vibration	12/13/2023	Dispersed Size	B and G	B- High	Yes	Full production	No	N/A
222	15487 - / AI - Agitator	Agitator	Functionality Check	1/9/2024	CTO/Hill track	Asphalt Plant	B- High	No	Equipment energized & idle (not producing material)	No	N/A

Page 1 of 1 | 1 | Total Records: 3

Export to Excel | Display 10 records | Per Page

Equipment Number	Form Name	Equipment Type	Inspection Type	Next Inspection Date	Plant Site	Unit Name	Equip Criticality	PM17	Operation Status	Inspection workflow started?	AI Due Date
A-123	15120 - R-123 Agitator / AI - Agitator	Agitator	Vibration	1/18/2020	Hard Resin Kettles	B and G	B- High	No	Full production	AI Workflow 15122	08/27/2020
P-234	14839 - P-234 / AI - Piping Circuit	Piping Circuit	Thickness	7/1/2020	Post Refinery Kettles	Asphalt Plant	C- Medium	No	Full production	No	N/A
444	14687 - 444 / AI - Pressure Vessel	Column - Packed	Electrical PM	7/1/2020	Hard Resin Flakery/bagger	B and G	C- Medium	No	Pit SD & de-energized	No	N/A
PSV-222	14932 - xsss / AI - Relief Valve	Other	Pull for inspection	8/5/2020	Post Refinery Kettles	B and G	A - Very High	No	Equipment energized & idle (not producing material)	No	N/A

Source: ioMosaic Corporation – PSE

## Case Study – The Consequences of a Deficient AIM Program

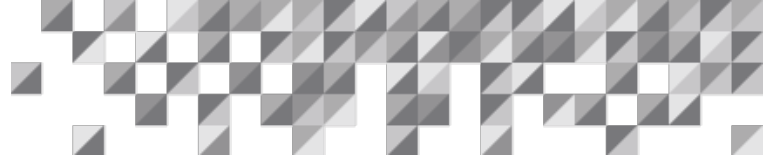
### The Challenge

The US Chemical Safety and Hazard Investigation Board (USB) investigated the January 9, 2014, Freedom Industries chemical spill in West Virginia. According to the USB, Freedom Industries spilled approximately 11,000 gallons of a mixture that primarily contained Methylcyclohexane methanol (MCHM) and a lesser amount of polyglycol ethers into the Elk River. Tank 396 was found to have internal pitted corrosion that created the two holes that leaked the mixture.

The mixture made it downstream to the West Virginia American Water (WVAV) water treatment plant, which could not treat and remove all the chemical mixture from the drinking water. WVAV issued a do-not-use order for the drinking water, which impacted about 300,000 residents. Even with the order, 369 emergency room visits were believed to be linked to people exposed to the water. Symptoms included nausea, vomiting, and abdominal pain. Many businesses, schools, and public offices were also closed.

The CSB found no documentation of prior inspections or maintenance for tank 396. They also found the dike that should have contained a tank spill to have cracks and holes the leak traveled through. Freedom was aware of the dike's issues but did not repair them before the incident. Finally, the leak traveled down a deteriorated underground culvert and reached the river.

Freedom Industries could have prevented this disaster if they had created an Asset Integrity Management program that required the identification and execution of Inspection, Testing, and



Preventive Maintenance (ITPM based on Recognized and Generally Accepted Good Engineering Practices (RAGAGEP). This article, [The Price of a Deficient Asset Integrity Program](#), can help your company understand the consequences of a deficient AIM program and access training information and checklists to begin creating or improving your AIM program.

An AIM program that relies on individuals to track required ITPM and repairs is prone to human error and competing priorities. Creating a documented AIM program that relies on an electronic platform for documenting the AIM program policies and procedures, tracking ITPM, and correcting deficiencies can improve process safety oversight, employee and community safety, and equipment reliability. An overall program can also reduce the risk of catastrophic events due to equipment malfunction or failure.

## Our Approach

PSE Asset Integrity and the Asset Integrity Finding Workflows can meet your specific needs. This evergreen, server-based platform provides a centralized database accessible and visible to all employees and contains step-by-step guided workflows. ioMosaic can integrate multiple sites and various data into one uniform AI system by:

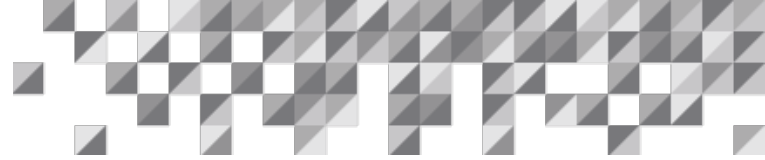
- Developing a unique ID system to differentiate facilities and areas
- Setting up sign-on access for users at all facility sites
- Identifying and developing consistent data definitions and metrics
- Standardizing search queries to ensure data quality
- Devising site-specific and corporate reporting capabilities

ioMosaic can customize workflow tasks that are not currently within PSE and can assist with creating unique equipment forms.

The standard built-in features of PSE, such as the automatic assignment of approvals, action item tracking, document linking, and email notifications, all contribute to ensuring the documentation and execution of ITPM and the correction of deficiencies are properly captured and visible to employees.

## The Benefits

PSE is a user-friendly Computerized Maintenance Management System (CMMS) that is scalable and affordable for those companies who do not want to implement a large and complicated system. The Asset Integrity workflows can be used as-is or customized to your requirements.



The equipment forms streamline the process of documenting and maintaining the Process Safety Information for pressure vessels, tanks, piping, and other equipment within the covered process or that supports it. The equipment forms provide a tab for creating and documenting the required ITPM and frequencies for each piece of equipment or controls. The AI workflow can be initiated from that tab to execute the ITPM, or the user can go straight to the AI workflow. Any deficiencies found within the AI workflow can prompt initiating the AI Finding workflow from the workflow. Key information is automatically populated to the Finding workflow to save time and ensure data consistency.

The PSE AI workflow can also be used to plan extensive shutdowns with reports that can be built by the user with the required information, such as the equipment identification number, location, criticality, required safe work practices, positive material identification indicator, and the date the ITPM must be completed.

Finally, the PSE workflows have metrics that can track overdue workflows and the percentage of workflows completed on time (or not completed on time). The metrics are graphed with interactive data that allows the user to drill down to the specific data. This feature saves time as the user investigates potential issues with the AIM program.

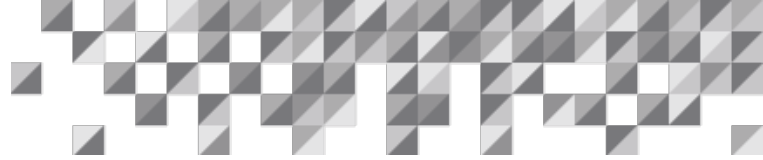
## Conclusion

Managing an AIM program can be challenging; fortunately, PSE provides an integrated solution that makes the AIM process more efficient and effective. With its dynamic form builder, action tracking feature, and integrated workflows to standardize the process, companies reduce the risk of incidents and non-compliance.

PSE offers additional benefits, including enhanced collaboration, improved data management, and increased compliance with process safety regulations. With the reporting and dashboard capabilities, organizations can easily identify trends and potential areas of concern, gaining real-time visibility into all process safety-related activities. The automatic notification system sends reminders and alerts to stakeholders, ensuring you are on top of status and timely on deadlines.

PSE's customizable AIM workflow modules include AI integrity and AI Findings workflows with review, approval, and closure, ensuring that all necessary information is captured in one centrally located platform.

PSE stands apart in the market by providing the only all-inclusive process safety compliance platform that makes compliance easy.



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## Useful Links

PSE [link](#) to software demo requests

PSE [link](#) to PSE overview

AIM basic training information [Link](#)

AIM intermediate training information [Link](#)

AIM checklist [Link](#)

Additional PSE White Papers:

[PSM Compliance Made Easy with Process Safety Enterprise®](#)

[Effectively Manage Changes to Processes, Chemicals, Equipment, and Personnel Using PSE](#)

[Process Safety Enterprise® Asset Integrity Management Service \(AIMS\) and KPI Dashboard](#)