Driving Operational Excellence™

Operational Sustainability, LLC®

Asset Health as a Means for Integrated Asset Performance Management

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Introduction

Asset Performance Management (APM) strives to optimize the performance of production assets across several areas:

- Production throughput and efficiency
- Process safety
- Asset Integrity
- Reliability and availability
- Sustainability

Balancing the needs of each area is a multidimensional task that must take into account varied and sometimes conflicting business drivers. To achieve optimum asset performance – or **Operational Excellence** – the different area objectives for each asset need to be clear. In each area, a target performance may be defined which reflects a best practice level. This optimum point depends on external forces such as market situation, feed stock costs, available resources and changing regulations as well as internal forces such as operating conditions, load levels and equipment conditions. Successfully balancing all of these parameters requires an integrated approach to asset performance management, which is the main goal of Asset Health.

Production Throughput and Efficiency

Production optimization is the main focus for many companies on the journey to Operational Excellence. Facilities constantly look for ways to remove bottlenecks and improve capacity.

The big hidden opportunity is generally on the equipment side of the business. Today, few companies relate the impacts of an incident to total cost. Enter the hidden plant.

A critical element is understanding the strategic value of managing incidents and tying that understanding to financial outcomes (i.e. extended equipment outages due to supply chain issues or lost production).

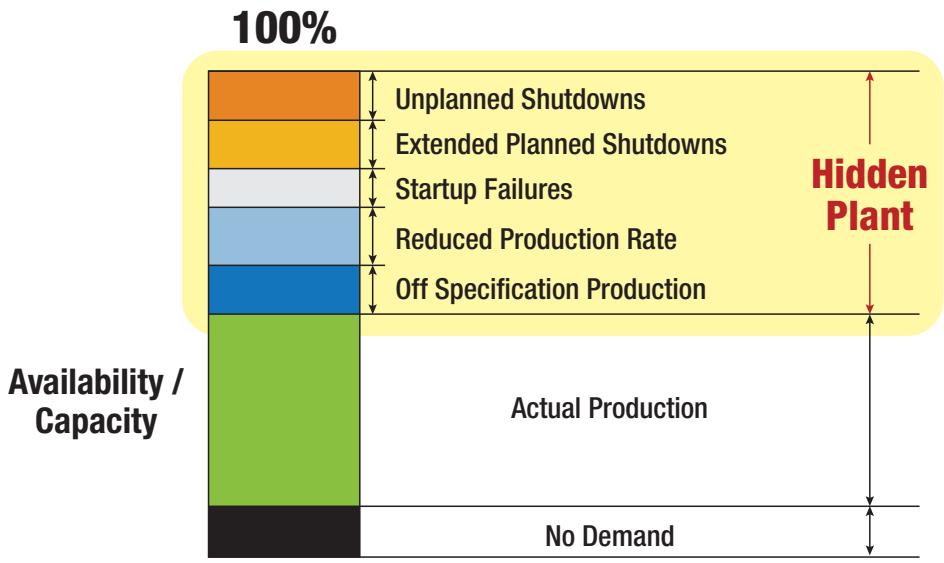


Figure 1 – The Hidden Plant

Asset Health may be used to monitor operating conditions in order to prevent unwanted downtime or production constraints. The operating window indicates if the process is operating under the right conditions with maximum yield and mass or heat balance. Advanced Process Control (APC) may be applied to obtain the optimum process settings and adjust for any deviations in real-time.

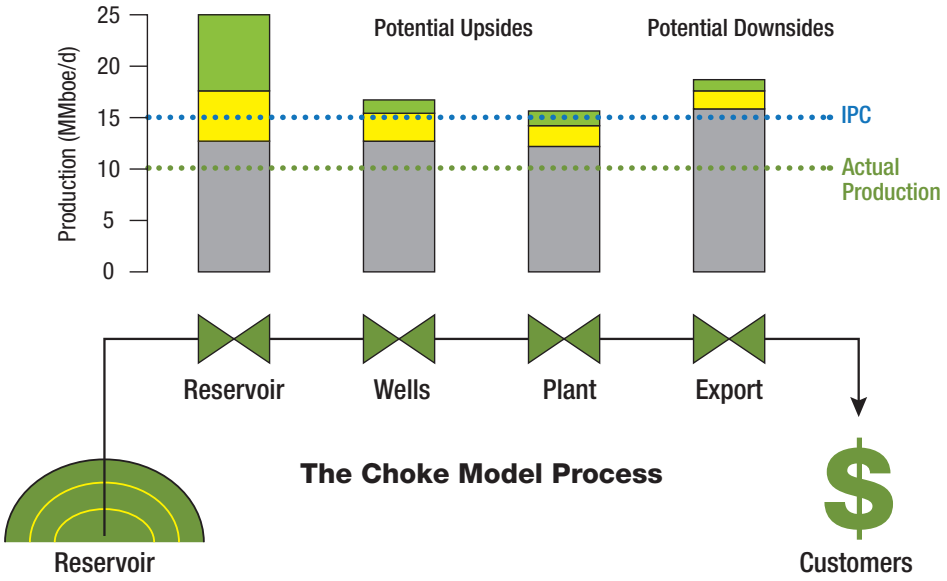


Figure 2 – Production Efficiency Improvement Choke Model

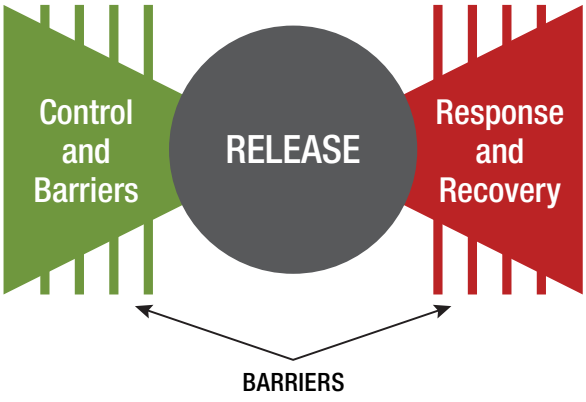
Process Safety

The risks of hazardous events are identified in a Process Hazards Analysis (PHA) or Hazardous Operations (HAZOP) study during the design of process equipment or in a reassessment in the operating phase. From these assessments controls are defined to mitigate the risk in a Bow Tie or Layers of Protection Analysis (LOPA). The status of these barriers or barrier health needs to be monitored to ensure safe operation. An impairment of any barrier should be identified immediately and notice given to operations staff for appropriate measures. Asset Health takes an integrated view of risk as it pertains to asset performance and helps operating companies ensure their APM is risk-aware.

Keep within Control Limits

Reduce Likelihood

- Technical standards and procedures
- Equipment testing and certification
- Balance of Plant (BOP), etc.
- Competent staff
- Rig safety case
- Robust multiple barriers



Mitigate Consequences

Plan for Recovery

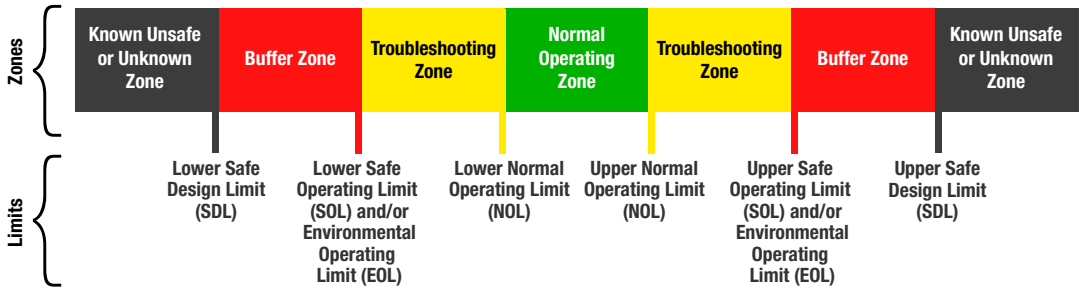
- Well Control Incident Plan
- Oil Spill Response Plan
- Gulf of Mexico Oil Spill Containment System
- Technical expertise

Figure 3 – Barriers

Asset Integrity

Many production assets are coming of age because they were built in the 1950-1970 time period and are now reaching end of life. This implies that the condition of the assets is deteriorating and Mechanical Integrity (MI) is at stake. We need appropriate Asset Integrity strategies through the integrated Asset Health view to manage the risks of leaks and loss of primary containment associated with aging assets. Risk-Based Inspections (RBI) are a way to assess integrity risks and define the optimum inspections regimes. Apart from inspection strategies to assess actual asset condition, we can monitor the Integrity Operating Window (IOW) of the process to anticipate potential increased risk levels. IOW may be an extension of the production operating windows. Exceedance of the production operating window leads to suboptimum process performance or reduced yield or quality, while operating outside integrity window limits may lead to technical deterioration of the equipment itself. Asset Health integrates the information from these common Asset Integrity strategies to help ensure that assets aren't operating in a way that may lead to reaching safe operating limits and shutdown of the equipment, with its attendant production losses, downtime, possible loss of containment, and other negative consequences.

Figure 4 – Integrity Operating Windows



Reliability and Availability

TTechnical failures and human errors are the main causes of unplanned equipment downtime. As an asset deteriorates, the likelihood of failures may increase, decrease, or remain constant over time. Studies by Nowlan and Heap in 1978 led to development of Reliability-Centered Maintenance (RCM), which is now a widely-applied common practice in industry. RCM promotes the use of Condition-Based Maintenance (CBM) to maximize the useful life of the assets. Condition monitoring techniques are applied to determine the P-F interval between an early warning signal or potential failure (P) and the functional failure (F) when the equipment is no longer capable of fulfilling its function.

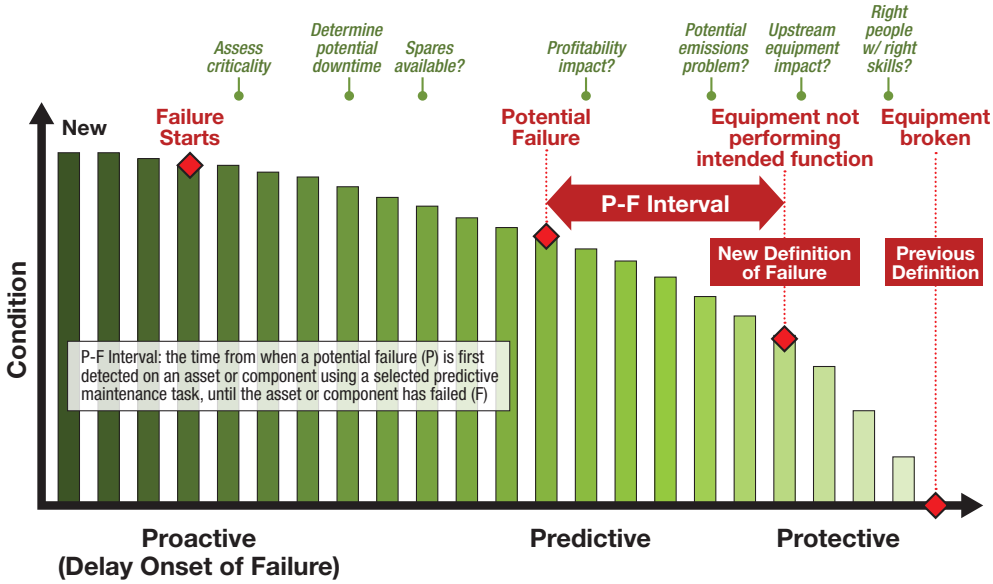


Figure 5 – OS Advanced Onset of Failure Diagram

Traditional CBM applies single indicators such as vibration level, temperature or oil quality to predict the likelihood of failures. More advanced predictive maintenance techniques apply multivariable models based on real-time sensors or monitoring of process variables to generate early warnings long time ahead of the actual failure (up to several weeks). Prescriptive maintenance and analytics show a lot of promise. By analyzing large data sets using specific algorithms, companies can see risks and patterns before they manifest into unwanted events. Early prediction is the key to continuous improvement. Reporting frameworks like API 754 give organizations the opportunity to correct situations before they become incidents. These condition monitoring methods are key ingredients for successful management of integrated Asset Health.

Sustainability

A further drive to monitor Asset Health is to minimize potential impact to the environment by reducing emissions, leaks or spills. The United Nations have defined 17 Sustainable Development Goals (SDG) in the 2030 agenda for sustainable development. Many companies have made far reaching commitments to SDGs to become completely climate neutral by 2050. Today, these goals have been adopted by companies to address their core values and social responsibility. In the near future, many of these goals will be translated into regulation and standards, which will become mandatory for the privilege to operate.

Figure 6 – United Nations Sustainable Development Goals
(Source: https://www.un.org/sustainabledevelopment/)

Specific sustainability goals will also be defined for their specific industry uses and monitored in an Asset Health program. In asset intensive industries, energy consumption is one the highest cost drivers and at the same time creates highest environmental impact (e.g., SDG 13: Climate Action). Energy efficiency monitoring identifies the big consumers in the plant but may also be used to optimize production process performance in terms of yield vs energy use vs process risks (e.g., overload, increased wear). Emissions of CO2 and other greenhouse gasses should be monitored to reduce the carbon footprint. Trade-in emission quotas and taxations may stimulate further reduction and ultimately lead to increased savings.

Wastewater quality is another environmental impact that needs continuous monitoring in an asset health program, which contributes to SDG 6: Clean Water and Sanitation. Analyzers to monitor water quality and concentration of toxic or harmful substances in the wastewater flow provide information of the health of your plant (leakages) and production processes. In the optimization of overall asset health, these parameters should be controlled to achieve an optimum asset output with minimum risks to people and environment against lowest operational cost and highest sustainable performance.

Asset Data Quality

The basis for any effective asset strategy is good quality asset data. While having an asset strategy is important, companies must also have the ability to execute an effective strategy – and execution requires a solid asset data set.

In the development of asset strategies, many assumptions are made on failure mechanisms, failure or corrosion rates, and operating conditions which are, in most cases, uncertain. Failure history is often poorly documented in maintenance management systems or no data is available at all (e.g. new facilities). Then generic failure data is applied to estimate Mean Time Between Failure (MTBF) from industry data bases. The quality of an asset strategy is only as good as the input data quality. Asset Health can contribute to refining the asset strategies by measuring actual conditions and identifying early signs of deterioration. While initial (wrong) assumptions can detract from the quality of an asset strategy in the absence of an integrated Asset Health approach, these assumptions do not detract from the value of Asset Health monitoring. In other words, Asset Health monitoring and data can correct wrong asset data assumptions and enable the outcomes your asset strategies are designed to deliver.

Asset Health Implementation

Asset Health implementation should follow a structured maturity model to ensure the foundational elements are addressed first, with additional systems and categories of data integrated in a logical flow.

Phase 1 is focused on safe operation or license to operate. Asset Health is applied to monitor the health of barriers to control EH&S and PSM risks. Process safety alarms or other controls defined in a bowtie risk analysis are monitored in real time on an Asset Health dashboard. The impairment of a barrier triggers a workflow of necessary actions to restore barrier health.

Phase 1	**"Basic Asset Health"** **Process monitoring; condition monitoring; real-time insights**
Phase 2	**"Intermediate Asset Health"** **Trending and alarms; performance monitoring; variance reduction**
Phase 3	**"Advanced Asset Health"** **Predictive models; scenario simulation; performance optimization**
Phase 4	**"Mature Asset Health"** **Full integration of views; balancing value drivers; overall performance optimization**

Figure 7 – Asset Health Maturity Roadmap

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Phase 2 focuses on reliable asset operation. Condition Based Maintenance (CBM) strategies may be defined in FMEA or RCM studies. The asset condition is followed in real time by implementing maintenance triggers in the Asset Health dashboard. Logical combinations of asset health indicators may be applied to define a workflow of appropriate actions such as generation of an inspection work order, RCA initiation or, a planned repair work order.

Phase 3, Advanced AH, looks at economic operation of the assets. Optimum setpoints for efficient economic operation are defined using mass balance or heat balance models. Algorithms calculate the optimum settings in a dynamic model to obtain optimum product throughput and quality. The operator receives immediate feedback from the Asset Health dashboard to ensure the process remains within the optimum operating window. If the process moves outside of the optimum window, no alarm is triggered as long as it remains within the acceptable operating window limits. The next step is the integrity operating window (IOW). The alarm limits for the IOW are determined as a result of an RBI study and successive IOW definition according to API 584 guidelines. Exceedance of the IOW triggers a Root Cause Analysis (RCA) or Management of Change (MOC) workflow to define necessary actions.

In **Phase 4**, companies integrate predictive models into Asset Health. With this step, advanced predictive models are implemented to generate early warning signals. The modeling of failure patterns and validation of model accuracy require advanced analytical skills and data scientists with deep understanding of the process and reliability parameters. Integration of modeling and simulation software is required to feed the Asset Health dashboard with real-time early warning signals. At the Mature AH level, the targets may be defined to operate the assets in line with the actual asset performance goals.

What Does an Integrated Asset Health View Look Like?

Asset Health synthesizes asset data sources into asset health information and provides actionable intelligence for asset management via a dashboard – providing a cockpit for reliable operations. Reliability engineers and technical authorities can monitor asset health across the assets from one integrated platform. Decisions such as when to employ a corrective action, perform an extra inspection, initiate Root Cause Analysis (RCA), or a start a Management of Change (MOC) impact analysis to change the overall asset strategy, asset design, or spare strategy can be made with assurance and implemented quickly and easily.

One option that delivers this level of seamless integration is the **OESuite™ Asset Health solution**. It uses real-time data from sensors and process historians and transactional data from work orders, operator rounds or inspection reports to give

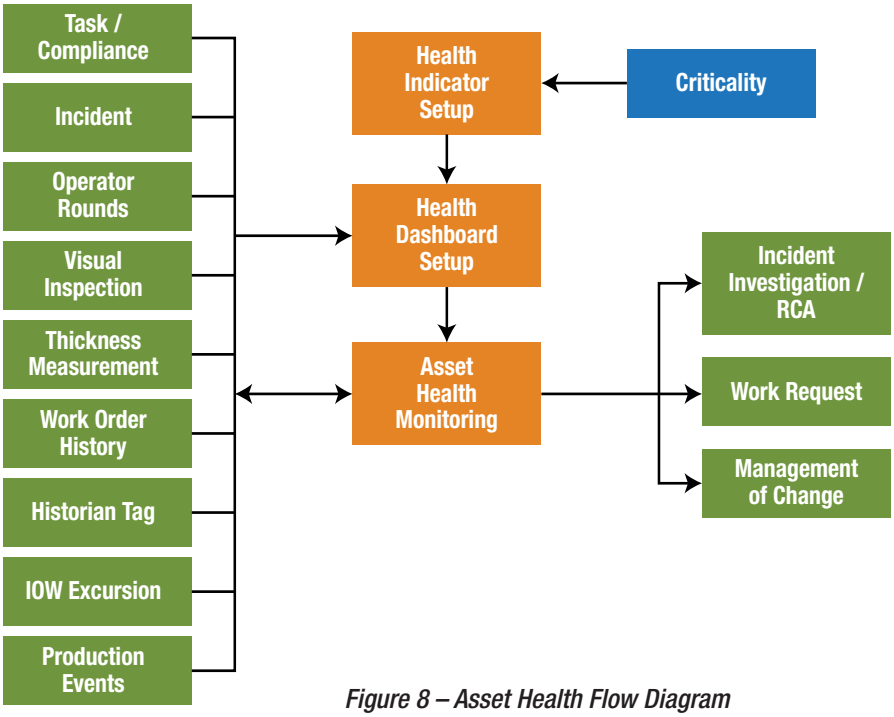
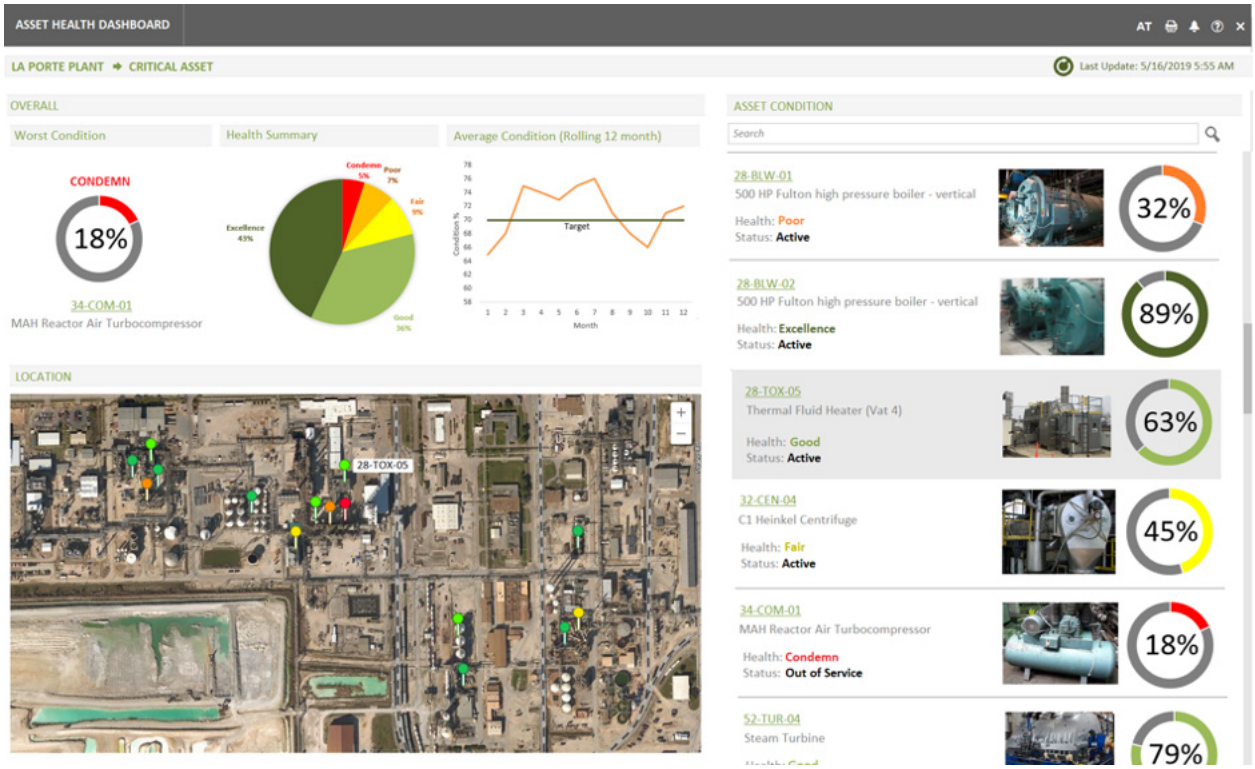


Figure 8 – Asset Health Flow Diagram

companies a comprehensive view of asset health. Events can be automatically generated based upon trend analysis and limit exceedances, or other logical combinations of triggers.

The Asset Health and Visual Operations functionality can be used to monitor the entire fleet because OESuite's Asset Health dashboard capability can be leveraged to display asset health in location context. Site leadership can quickly assess trending problem areas and mobilize resources to intervene early. A strong Asset Health program will not only extend asset life, but also helps plan maintenance and inspection actions to minimize their impact on operations.



An effective system such as the **OESuite™ Asset Health dashboard** uses data connectors to integrate data from data historians such as OSI PI and IP.21 to create triggers and build workflows from calls to action. Data connections to the maintenance management systems help monitor and track follow through and can modify P-F intervals as conditions change in the plant.

For more information email us at info@DrivingOE.com or call (713) 355-2900.