Condition-Based Maintenance Bolsters the Bottom Line in Power Generation

Innovative approach pays off in lower maintenance costs, higher asset reliability, and availability

Overview

The power generation industry is undergoing a period of rapid transformation. New issues, such as deregulation, the rapid adoption of renewable energy sources, and a new emphasis on extending facility lifecycles, are forcing electric utility operators to carefully consider how they expend their resources and optimize their operations.

One way plant operators are responding to these new pressures is to focus on new, more efficient maintenance strategies. A growing number of operators are considering the adoption of condition-based maintenance (CBM) and other proactive strategies that are driven by the actual condition of an asset rather than planned calendar-based, maintenance schedules. CBM promises to eliminate unnecessary maintenance, minimize unexpected failures, maximize use of resources and allow electric utility operators to increase reliability and availability.

The real advantages of implementing CBM run far beyond lower maintenance costs, however. CBM can play a critical role in ensuring overall fleet availability, reducing the cost of downtime, and meeting regulatory requirements. By tracking asset health in real- time and avoiding unexpected equipment failures, CBM can help electric utilities avoid going off-line and reduce the risk of a forced derating or fines for dispatch schedule deviations. In unregulated markets, it can help utilities avoid losing real-time revenue streams and minimize the costly practice of buying replacement power from competitors. And by linking into popular EAM systems such as SAP® PM and IBM® Maximo®, it can help utilities better plan capacity and manage capital investments.

This white paper will look at the challenges electric utility operators face today and the forces that are driving demand for more proactive maintenance strategies. Next, it will examine how CBM works, and how it offers a more efficient and effective alternative to planned maintenance methodologies. Finally, this paper will look at how electric utility operators are using CBM in concert with OSIsoft's PI System™, an infrastructure for collecting and managing historical and real-time data from both fixed and mobile assets, to create a more comprehensive, correlated, efficient and effective environment for the collection, management, analysis and presentation of data.

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ELECTRIC UTILITIES ADDRESS NEW CHALLENGES

Industry experts predict that electric utilities will undergo more change in the next ten years then they have in the past hundred. That's hardly news to power plant operators. Alternative energy, smart grids, and environmental concerns dominate industry headlines. While maintenance and asset health do not attract the public's attention, a growing number of fleet managers realize that new maintenance strategies can play a key role in making utilities more nimble, cost efficient, reliable, and, ultimately, more profitable.

The following three major trends demonstrate that the value of these new maintenance strategies lies not just in lower maintenance expenses, but extends to higher asset availability, reliability, and effectiveness. Moreover, these new approaches promise to have a considerable impact far beyond simple equipment maintenance. By allowing plant operators to mesh real-time data on asset conditions with other forms of operational data, new approaches to asset maintenance can help plan capacity, develop market strategies, link to ERP or workflow management and reduce utility costs.

Deregulation

Utilities operating in deregulated markets subject to competitive pricing must pay a heavy penalty for asset failure. Their primary concern is to ensure a plant's resources are available at all times so they can maximize revenue from open market sales and avoid expensive energy purchases to meet contract obligations. This critical need for high availability demands new approaches to tracking asset health and maintenance.

Sustainable Energy

Growing interest in carbon-free energy conversion and resulting electricity production is driving many electric utilities to add alternative energy sources such as solar, wind, and geothermal to their fleets. Given the variable performance of sustainable power sources that are dependent upon weather conditions, operators must maintain a diverse combination of power sources across their fleet to meet demand. To perform this task reliably, plant operators must constantly be aware of both the condition and availability of their assets.

Extending Plant Life

Building new power plants is expensive. In an era of rapid technology change, electric utility owners may be especially reluctant to add more capacity to their fleet. Extending plant life through the use of more proactive maintenance strategies can give electric utilities more time to consider options. In addition, almost all life extension business cases can benefit from the use of real-time condition monitoring as opposed to engineering calculations alone. In fact, most regulations governing life extension applications (most especially in nuclear), require the use of real-time condition monitoring.

Impact on Maintenance

Driven by these trends, fleet managers are altering many of their maintenance practices by:

- Migrating from reactive and preventive maintenance to proactive and predictive maintenance based on real-time conditions
- Moving from static, periodic equipment condition assessments to dynamic real-time online asset health monitoring
- Developing predictive information from asset data to push leading indicators further back in time, giving plant operators more time to plan, increase uptime and reduce spare parts inventory
- Developing monitoring, analytics, and maintenance systems that take advantage of subject manager experts (SMEs), consultants, and OEMs both inside and outside the company who specialize in maintaining specific types of assets such as turbines, pumps, or condensers
- Combining many disparate data systems into a single system for all plant and enterprise information to provide solutions for asset health and plant productivity
- Embracing new technologies that support maintenance requirements, such as less expensive wireless sensors, that can replace inefficient manual data collection techniques and free SMEs and other plant staff to analyze data for condition-based or predictive maintenance

MORE EFFICIENT MAINTENANCE STRATEGIES

Most power and utility plants today use a variety of maintenance strategies to meet their needs. Studies show that the average facility spends over half its maintenance budget on highly expensive reactive, "run-to-failure" maintenance strategies where maintenance only occurs after a piece of equipment fails. Alternative proactive maintenance strategies include preventive approaches that are calendar- or runtime-based, condition-based strategies that use different combinations of either manual or automatic data collection and analysis, and predictive maintenance strategies that use model-based learning systems to more accurately estimate asset lifecycles and give operators more time to plan capital expenditures and maximize availability.

Proactive maintenance strategies use corrective, preventive and predictive processes to complement one another. Industry studies indicate that the average plant spends more than 55% of its maintenance budget on reactive maintenance, which is the highest cost, while the top tier industry plants who utilize predictive technologies and proactive practices end up spending less than 10% of their budget on reactive strategies.

Today, leading utilities continue to expand the adoption of Condition-Based Maintenance (CBM) processes, based on real-time and historical data collection and analytics, to drive down the high cost of reactive maintenance strategies (Figure 1). CBM is generally defined as a set of maintenance processes guided by the collection of data on utility assets to ensure maintenance is performed only when needed. Unlike calendar-based maintenance strategies, CBM leverages asset data to reconcile maintenance schedules with actual asset conditions, organizational priorities and changes in the operating environment.

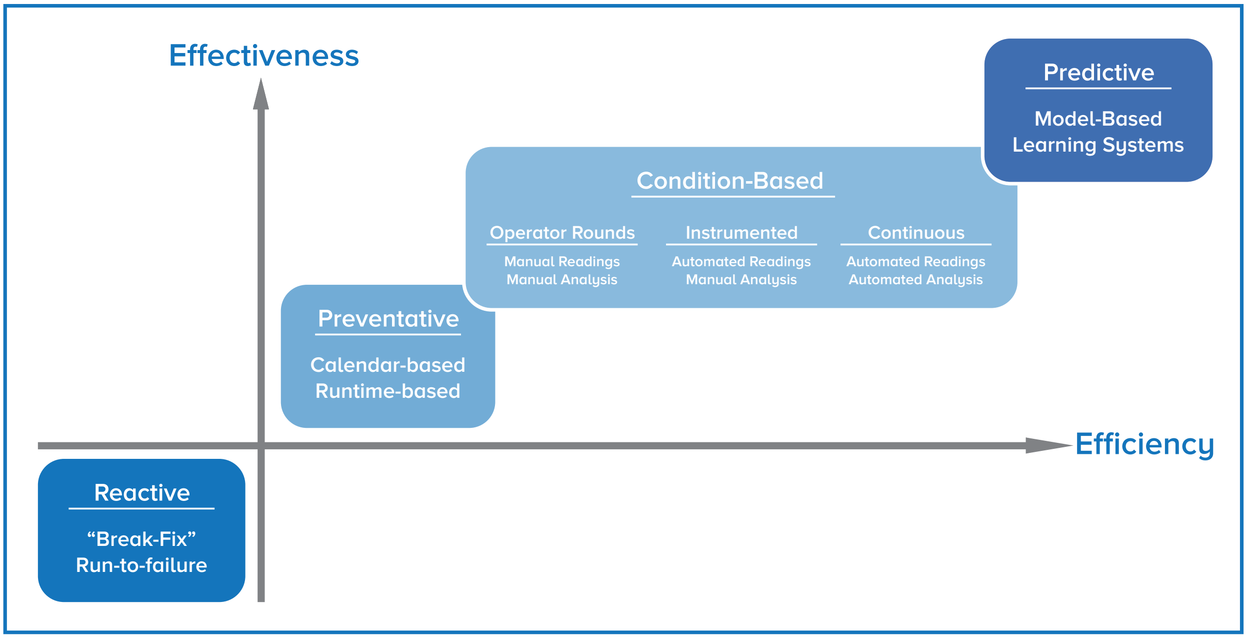


Figure 1: New maintenance strategies offer more efficient and more effective alternatives to reactive approaches.

A CBM program begins by monitoring asset parameters, then evaluates parameters in relation to limits, trends and other asset data. Eventually it ties real-time data to comprehensive work management solutions.

CBM implementations offer a number of highly attractive advantages over calendar-based maintenance systems, including:

- Reduced capital costs by extending asset lifecycles
- Lower maintenance costs because equipment that is operating well is not repaired or replaced
- Better asset reliability
- Improved asset availability
- Improved asset utilization including longer lifecycles and better informed capital expenditures
- Minimizing lost production time by better predicting asset failures
- Optimized maintenance intervals

Detecting Maintenance Issues Earlier

How do CBM and proactive maintenance strategies contribute to higher availability? In calendar-based maintenance strategies, asset replacement or repair is driven by vendor recommendations which have historically been time-based. If an asset's lifecycle runs outside the historical norm, utilities and power generation facilities run the risk of increasing costs by replacing or repairing the asset too soon before its end-of-life or too late to avoid a system-wide shut down.

Once an organization starts collecting real-time data on specific equipment parameters, the actual condition of the asset is always known. In CBM/proactive maintenance strategies, the real-time condition of the asset drives maintenance requirements. Because CBM is performed while the asset is operating, system disruptions are minimized.

The P-F curve in Figure 2 illustrates the behavior of equipment as it reaches failure. Point P represents the first possible point on the curve when plant personnel can detect equipment performance degradation. This point can be detected by tracking any of a number of asset characteristics, such as a slight change in temperature, a higher-than-normal vibration rate, or a change in power usage. Point F represents the point of equipment failure. The time between those two points is the organization's opportunity window. The further up the curve point P occurs, the more time maintenance personnel have to replace the asset, order parts or labor, or schedule an outage before the equipment fails.

In any facility, unexpected failures present the greatest risk to availability and often bring the highest repair costs. In a CBM/proactive system, early detection of performance degradation not only reduces or eliminates the unexpected and unplanned costs associated with a reactive maintenance approach, it also gives plant personnel a better opportunity to plan maintenance activities and manage costs.

Source ECG

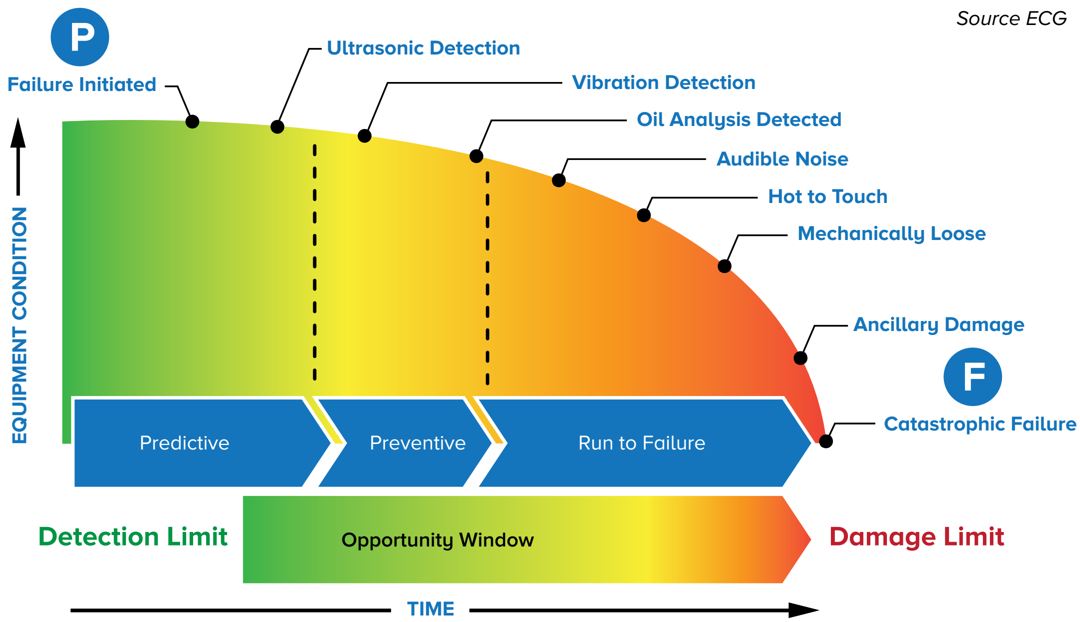


Figure 2: Initial failure detection depicted on a curve. The earlier point P occurs, the more time plant personnel have to solve the problem.

Organization-Wide Impact

In a more generic sense, condition monitoring practices used in CBM can be extended to determine the "health" of assets in a facility. In this scenario, maintenance personnel collect multiple pieces of data on an asset, analyze the data by looking at rates of change or comparing values to a norm, create an algorithm for a group of assets based on multiple indicators, and then calculate a "health" score for each asset based on how it rates compared to other pieces of equipment in its peer group. By comparing maintenance histories of similar assets, plant operators can build confidence in recommendations and reduce inventory costs and overall operational variability. This type of data collection can be highly useful not only for maintenance programs, but also for guiding future capital expenditures or defining work prioritization schedules.

Ultimately, the early detection of degradation in equipment can help utilities avoid going offline and, in the process, reduce the risk of a forced outage or derating and paying fines for schedule deviations. In unregulated markets it can help utilities avoid buying expensive replacement power to meet commitments.

Moreover, with an open infrastructure such as OSIsoft's PI System utilities can now use advanced pattern recognition (APR) modeling tools, developed by third parties, to leverage the data collected by real-time systems even further. By automatically analyzing large amounts of data, these APR tools can reduce the need for manual monitoring, detect anomalies in critical equipment very early in the performance degradation process, and help support operations by avoiding equipment failures and optimizing maintenance schedules.

CBM/proactive maintenance strategies can be easily scaled from pilot projects and individualized pieces of equipment to fleet-wide implementations. The PI System's highly scalable infrastructure, for example, enables plant operators to integrate fleet maintenance requirements into corporate management systems such as SAP PM or IBM Maximo.

Obstacles to CBM Implementation

Companies considering the implementation of CBM face a number of challenges. From a technology perspective, the CBM system must first and foremost ensure that each person has access to the data they need to make effective decisions. At the enterprise level, this typically requires the collection of data from disparate systems. Data must be consistently formatted, displayed, viewed, analyzed, and correlated. Data collected in real time must be time-stamped in a uniform manner to correctly attribute it to specific events. Finally, users must be able to simply and easily access and share data across the organization.

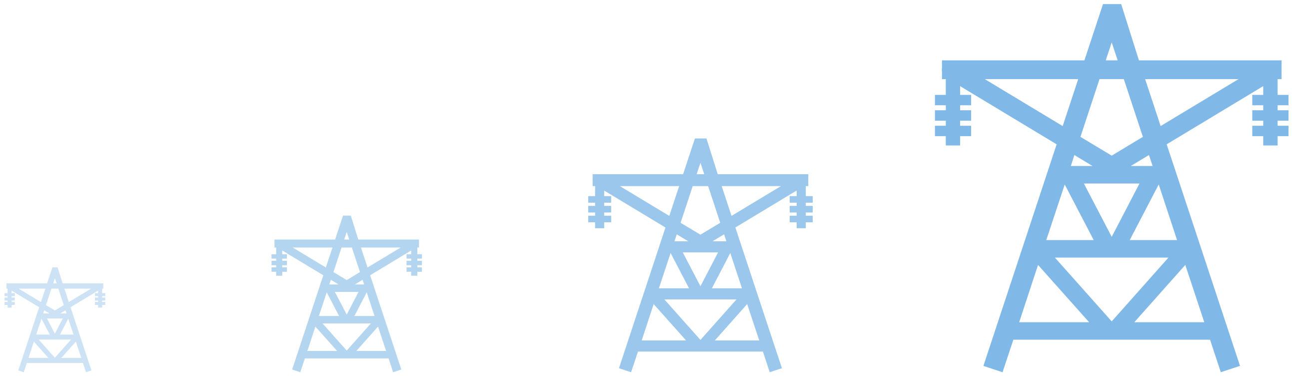
Aligning asset hierarchies to data points and building effective and accessible data visualization strategies are also critical to the success of any CBM system. Fortunately, recent advances in CBM tools have simplified this task.

The more imposing challenges might come from an organizational point of view. CBM requires a culture change. Any effort to move from a calendar-based or reactive maintenance approach to one based on online condition health information requires a significant initial setup stage that typically brings with it major organizational disruptions. Personnel in a wide variety of roles must participate in the implementation process. Getting everyone aligned and available at the same time can be difficult.

Before the transition begins, management must instill faith across the organization in the new systems. Typically, a CBM program affects a wide range of assets. Usually there is no single solution for one asset type. The prospect of making such a wholesale transition can seem overwhelming to many personnel. One way managers can overcome this concern is by starting a CBM implementation with just a few critical assets. Power utilities can use the PI System to develop leading indicators and understand the value of the system. Then, they can use the inherent scalability in the PI System to expand CBM to other areas of the enterprise.

Finally, before implementing CBM, management should consider the following up-front costs and potential liabilities:

- Staff training costs
- Equipment monitoring & instrumentation costs
- Older assets that might require modifications to retrofit the system with sensors
- Fatigue or uniform wear failures, which are not easily detected with CBM measurements
- Unpredictable maintenance periods



How the PI System Supports CBM

The PI System is a vital infrastructure for collecting, managing, analyzing, and presenting operational, business, event, and real-time data. It can bring together, compare, augment, and contrast data from isolated sources across the enterprise, allowing plant management, engineering, SMEs, operations, and maintenance staff to share information to solve problems.

Without the PI System, periodic assessments may miss critical equipment changes that can be detected in real- time. Collecting data from multiple sources is a time-consuming task. Why require an engineer to spend valuable time collecting data with different tools and technologies when that time could be better spent on the PI System analyzing collected data and making recommendations?

By using the PI System for CBM, power utilities gain multiple advantages. First, using the PI System alters the process from a static or periodic assessment to an online, dynamic, real-time assessment of asset health. Second, with the PI System engineers can create a more comprehensive data environment that can be used to conduct a more complete analysis of current conditions. Finally, with the PI System engineers can transform real-time data into extremely useful information and create event frames to supplement this new, highly detailed data analysis (Figure 3).

Key capabilities of the PI System for CBM are:

- Capturing and sharing data in its original fidelity without averaging or aggregating, using proven methods that scale to an enterprise
- Providing efficient real-time data management from a wide variety of operational sources in a highly secure manner
- Standardizing and centralizing data to make it accessible across the enterprise
- Displaying asset health information in ways that can be consumed by a wide variety of users
- Developing performance trending and analysis systems to determine each asset's maximum reliable capacity
- Using an Asset Framework to organize data streams and related process information by asset and plant topology, giving the data functional and operational context
- Providing advanced analytics that convert raw data streams into meaningful events and values
- Implementing predictive warning notifications that send alerts to facilitate fast response to potential production or equipment problems
- Serving up data to other advanced analytical tools and engines
- Integrating business and operational systems to connect employees, business partners, suppliers, and markets

Power generation suppliers use the PI System to better manage entire fleets of generator units, including reducing forced unit outages. A tiny decrease in forced outages can increase margin by millions of dollars. In addition, converting forced outages to planned outages further increases margins by allowing the outage to be scheduled during a lower margin window.

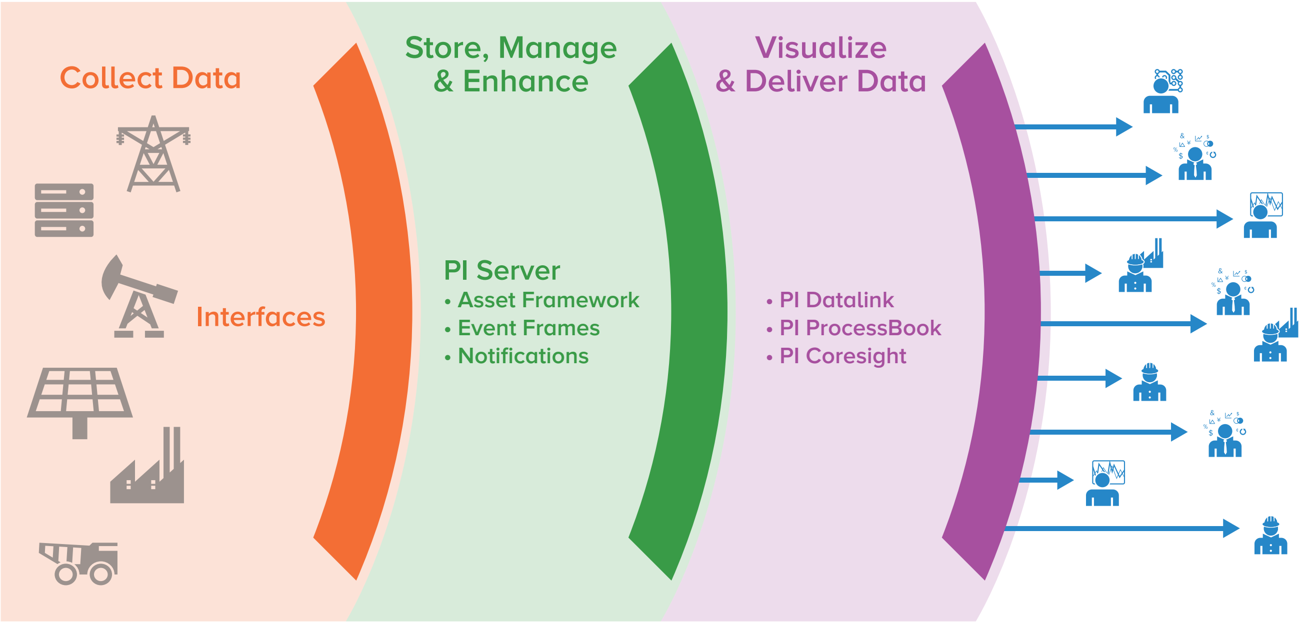


Figure 3: The PI System has three key functions for CBM

KEY PI SYSTEM COMPONENTS FOR CBM

Data Collection

PI Interfaces™ are a foundation of the PI System infrastructure and provide a standard mechanism for collecting data from disparate data sources. OSIsoft supports more than 400 standard interfaces.

Power generation plants can use PI Interfaces to connect to data sources such as DCS, supervisory control and data acquisition (SCADA) systems, and energy management systems, sensors, servers, applications, networks, and other databases.

Storing, Managing and Enhancing Data

An essential PI System component, PI Server™ receives, archives, and distributes real-time and historical process data from operations and other sources. By organizing streams of business-critical data into a single comprehensive format, PI Server enables plant managers and executives to maximize plant productivity and efficiency, and more accurately plan future business operations.

Asset Framework (AF) enhances data comprehension by identifying organizational assets and equipment using a consistent naming convention or representation that can be understood by all PI System users. To provide an understanding of these elements, AF associates attributes to these elements such as real-time, relational, or calculated data.

AF specifies each asset and its attributes in an easy-to-navigate infrastructure for accessing data, naming assets, and defining process for an entire organization, ranging from the fleet level down to individual pieces of equipment. Users can access or manage data when they need to identify problems and simplify decision making. The use of standard templates simplifies the definition and addition of models, assets, processes, and calculations to the framework (Figure 4).

Event Frames automatically bookmark the PI System data related to a specific asset and a related condition. Each event frame has a start and end time, enabling users to calculate the duration of an event and capture the associated data or condition. This helps engineers and business users find, analyze and report data for faster decision making.

Notifications leverages the flexibility of AF by allowing users to configure custom alerts based on any data source. With Notifications, users can configure the platform to send alerts whenever specified equipment exceeds pre-set parameters. This capability helps operators detect potential maintenance problems as early as possible.

Data Visualization and Delivery

A Microsoft® add-on, PI DataLink™ uses a web browser to retrieve data from the PI System for display in a Microsoft Excel® spreadsheet format. Combined with Excel's computational, graphic, and formatting capabilities, PI DataLink offers powerful tools for gathering, monitoring, analyzing, updating, and displaying PI System data and events.

PI ProcessBook™ allows users to gain insight into plant operations by creating interactive graphical displays. Users can create displays using either real-time or historical data residing in the PI System or other sources. By observing process behavior, users can compare current data with past events to quickly identify issues and remedy problems.

Using graphical information and displays from PI ProcessBook, PI Coresight™ is an intuitive, web-based tool that delivers fast, easy, and secure access to PI System data and other applications from any desktop or mobile device. Users can easily perform ad hoc analysis, discover answers, share displays and insights with other users, encouraging collaboration across the enterprise.

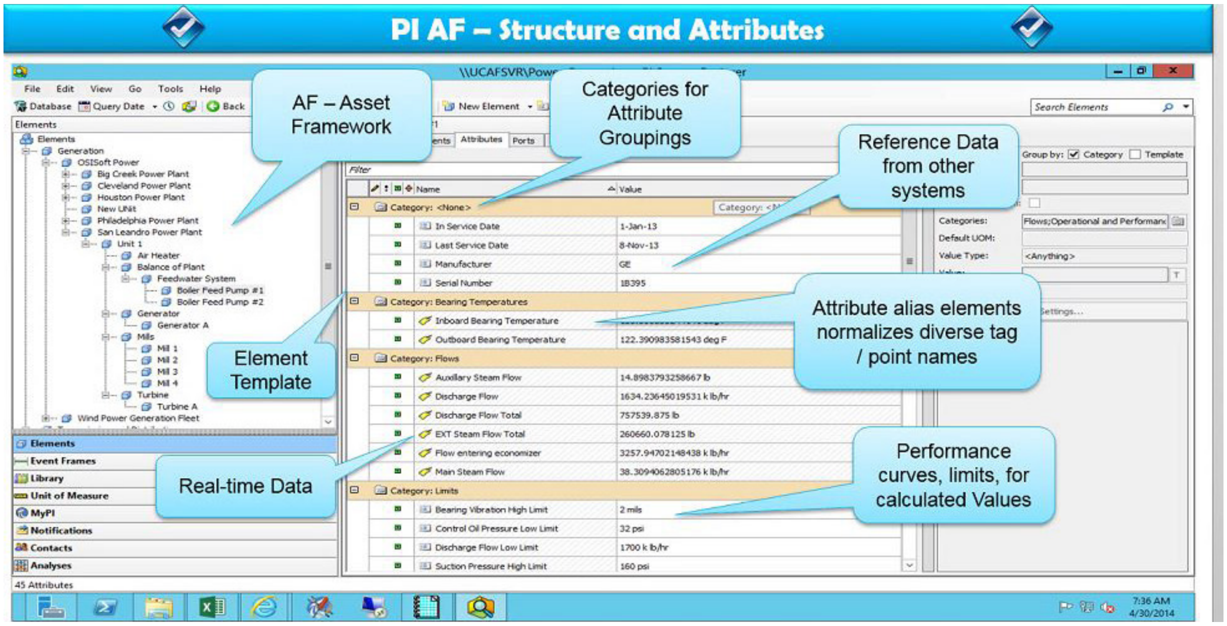


Figure 4. Asset Framework identifies organizational assets and equipment using a consistent naming convention

CONCLUSION

Today's power generation market demands electric utilities deliver high reliability, assured availability, and high efficiency at low cost. Yet, many facilities today use multiple, disparate data systems with limited employee use beyond their assigned function, static equipment condition assessments, and have a high reactive maintenance impact. The key to utilities reducing maintenance costs will be rapid adoption of proactive CBM-based techniques based on the collection of real-time data.

Moreover, these proactive strategies can impact processes across the enterprise. CBM-based data can be employed in asset management strategies, vendor performance reviews and root cause analysis techniques as well as environmental monitoring and regulatory compliance. Eventually, CBM can be used to optimize operations well beyond the control room to boost plant and system efficiency and optimize outage planning.

OSIsoft's PI System provides utilities with a universal data infrastructure that is capable of collecting, managing and analyzing information from multiple isolated sources across the enterprise and presenting that data in a way that allows management, engineering, operations and maintenance staff to share information and solve problems faster.

About OSIsoft

With the belief that people can improve process efficiency, manage assets and mitigate risk if they have access to the data they need, OSIsoft created the PI System as a common data infrastructure to capture and store real-time data and make it available for visualization and analysis. For over 30 years, OSIsoft has delivered the PI System with the singular goal of connecting people around the enterprise with data and systems.

Today, the PI System is embedded in operations and critical infrastructure in over 125 countries. Sixty-five percent of the Global 500 process companies use the PI System to help transform operations. Our customer base includes Fortune 100 and Fortune 500 companies in power generation, oil and gas, utilities, metals and mining, transportation, critical facilities and other industries. OSIsoft remains faithful to its original mission – to push the edges of innovation and create software that brings high fidelity data from disparate sources to people in all corners of our customers' enterprises – wherever, whenever and however it is needed. To see any of the 1100+ customer success stories, product descriptions or global initiatives, please visit www.osisoft.com.

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