Gas Turbine World

September-October 2015

www.gasturbineworld.com

ORAP: transforming to automate data input and increase plant profitability

by Victor deBiasi

Streaming plant data can be automatically recorded and analyzed digitally to predict performance, optimize maintenance and improve efficiency.

Strategic Power Systems (SPS) recently announced a partnership with OSIsoft and MapEx Performance Monitoring to provide electric utility owner-operators with real-time data recording and analytic capability to track power plant performance, enhance data accuracy and fidelity, fine tune maintenance service, improve plant reliability, productivity and profitability.

Following up on that announcement, *Gas Turbine World* asked Sal Della Villa, president and chief executive officer of SPS, for particulars on how this partnership is set up to serve the industry and what it offers in the way of operational benefits. Here are the highlights of that interview.

Q1: Can you provide some background on Strategic Power Systems?

SPS is a niche company working in the energy market since the mid-1980s. We are typically known as the ORAP group – collecting data from operating power plants all over the world to characterize the reliability, availability, maintainability (RAM) and durability of rotating assets in various applications and duty cycles.

SPS' philosophy is 'Data First". Data is what we do. We are experts in the field of data collection, validation, analysis and benchmarking of power plant performance across various technologies.

We provide key performance indicators (or KPIs), following industry standards, to power plant owner-operators, original equipment manufacturers (OEMs) and other industry stakeholders through ORAP.

This information allows them to make informed business decisions related to the performance and operational readiness of their equipment. There is no system in the world that collects power plant data in such a comprehensive way as ORAP.

Today, the market has become more competitive. There is a premium placed on data, analytics and predictive knowledge-based decision-making. None of this is possible unless the data is fast and of high fidelity. This is what drives everything SPS does – every single day. ORAP is changing forever!

Q2: You recently announced a collaboration or partnership with OSIsoft and MapEx; what can you tell me about that?

The collaboration with OSIsoft has been something SPS has been working on for the past four years. Their industry recognition, value proposition, and broad industry acceptance is centered on their PI System or data historian which provides the opportunity to capture and store near real-time data points for future reference.

SPS believes that the opportunity to leverage the streaming plant data, representing time, capacity or production, events (like a trip), and other operating parameters provides real measureable benefits by transforming that near real-time stream into the data required

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by ORAP.

The manual effort of reporting to ORAP can be significantly reduced, focusing only on the component causes of outages and other maintenance. The fidelity and timeliness of the data is greatly improved. For SPS and the industry, this is a game changing opportunity.

Q3: Can you give me some examples?

Sure. By leveraging the data available in the PI System, the questions of data accuracy and timeliness evaporate. Each operating state from start-up to shutdown can be tracked without human effort.

So if a plant has a requirement to be on-line in 10 minutes, there is no question that each transition during the start-up process must be captured; from signal to start, through the permissives, to ignition and flame, to ramping up in speed, to breaker closure, and finally to a pre-set load.

All of the necessary data points and transformations into time, capacity, and events are performed without operator involvement. There is no question that the fidelity of the data is better, and with SPS' transformation logic in place, the actual time to start is determined in the shortest time possible. And no operator input is ever required.

Another example relates to turbine efficiency and profitability. The same approach that I described earlier can be used to dissect a unit's operating run cycle to determine how much fuel is used in the starting and shutdown cycles when no power or revenue is being generated. This can be done for each operating run or mission. This tells you something about the variability around each and every mission or run cycle that the unit experiences.

It also applies to the calculation of aging criteria such as factored hours (or starts), equivalent hours, or cycles. The specific OEM formula, regardless of technology, can be easily embedded in the ORAP transformation logic. In our market today, this is essential for tracking and managing the life and repair cycles of hot gas path parts.

The operating challenges that confront power plants today, from rapid and frequent start-ups, to load-following, to

Power plants face operating challenges. Rapid and frequent start-ups, load-following, the impact of renewables, life limits on capital hot gas path parts, and the need to minimize trips are some of the issues that drive the need for clarity around performance data.

the impact of renewables, to life limits on capital hot gas path parts, to minimizing trips, all drive the need for clarity around performance data.

If OSIsoft's PI System historian is in place at the plant, then leveraging the near real-time data to reduce manual effort and re-focus the operating team on the more challenging issues that confront plant staff each day is absolutely the right thing to do.

The productivity improvement is real, measurable, and sustainable over time; the data is always available to assess the RAM KPI's that are important for the plant. This is the clear benefit of the relationship with OSIsoft.

Q4: You keep referring to transformation logic; can you tell me a bit more about this?

Think of the transformation logic like an

"app" in today's smart phone environment. It processes the OSIsoft PI System data tags or points and organizes them into information that has more interpretive meaning; like how long it took to start, how much fuel was used in start-up, how many start attempts were made, how long the operating run was, how much power was produced, did the unit trip or have a safe shutdown, and on and on.

The transformation logic is the key to the process, providing the opportunity to add "apps" that support the plant's need for meaningful information. Reporting across the spectrum is now made much more simple and accurate.

In today's competitive environment, plant staff don't need more work to do, they are already challenged by regulatory reporting such as NERC GADS (North American Electric Reliability Corporation Generating Availability Data System) on top of all the other

reporting that is required to satisfy asset owners.

The way to get more with less is by supporting the required reporting through this new ORAP process… meeting all reporting needs, including NERC GADS. One client remarked that what once took days or hours to do, now takes only minutes. This is a real productivity benefit.

Q5: How does this compare to remote monitoring?

It really doesn't; they are two different things for two different, but very important needs.

Remote monitoring is performed to ensure that preventive action at the plant can be taken should an issue be imminent or evolving that could trip the unit or plant. Remote monitoring is ahead of alarm and trip limits, capitalizing on equipment knowledge and expertise to take action to protect the operating asset. This is undoubtedly an important service.

What SPS is offering through our collaboration with OSIsoft and MapEx is something that complements remote monitoring. It is different. It is the transformation logic that essentially turns the process tags or points into the data required to understand the ongoing reliability, availability, starting reliability, capacity and service factors of the operating asset, ultimately reflecting the performance of the plant.

If you want to drive down costs and improve the productivity of operating staff, this is the way to do it.

Q6: What about MapEx; what is the benefit there?

MapEx is a "first principles" based thermal performance monitoring system. MapEx will be integrated with ORAP since the same PI System data set is used by both applications. This is effectively the first time that RAM and thermal performance are available side-by-side to influence maintenance and outage planning requirements.

MapEx performs a detailed gas turbine heat-balance that determines the firing temperature, the compressor efficiency, the expander efficiency, and the exhaust gas flow rate from measured data. The stage-by-stage gas and blade metal temperatures are estimated by a model of the gas turbine expander.

With today's technology, firing temperatures are higher, with thermal barrier coatings playing an increasingly important role in protecting the life of hot gas path parts. The operational impacts of ambient conditions, degradation and trips have an influence on TBC integrity, component life limits and repair intervals. The combination of ORAP and MapEx provides an important tool for correlating thermal efficiency and life as key criteria necessary for meaningful maintenance planning. Again, this is a unique and important capability.

For example, environmental conditions and equipment degradation change the firing temperature and first stage metal temperatures even when a gas turbine is operating at steady-state baseload. High ambient temperature and compressor efficiency degradation both cause the temperature of the cooling air extracted from the compressor to increase, which in turn increases blade metal temperatures.

Degradation in expander efficiency also decreases the firing temperature because the exhaust temperature control curve attempts to maintain constant temperature by adjusting for changes in the compressor pressure ratio. However, it does not account for changes in the turbine efficiency.

Part-load operation typically involves an increase in exhaust temperature which may increase last-stage blade metal temperatures. MapEx takes all of these factors into account and calculates the part-life impact of the variation of blade metal temperatures as operating conditions change over time.

This information allows the plant operator and the maintenance staff to make decisions that strongly influence the life of the asset and the profitability of the plant.

Q7: How does all this work and what does the architecture look like?

The architecture is pretty simple and straightforward. Data from the PI System flows to SPS through a secure process called PI Cloud Connect. All the data points required by ORAP and MapEx are available for transformation as the data flows to SPS' secure data center.

Once the data has been transformed it is available for further processing by the specific "app" including; ORAP RAM, Life Calculator, Operating Profile, Maintenance Forecast and RAM KPIs as well as the MapEx efficiency model.

The results are available for review and benchmarking through the ORAP Portal. Each "app" contains specific analytics designed to meet the needs of the operating plant. Included is ORAP NERC for direct reporting to the NERC GADS system.
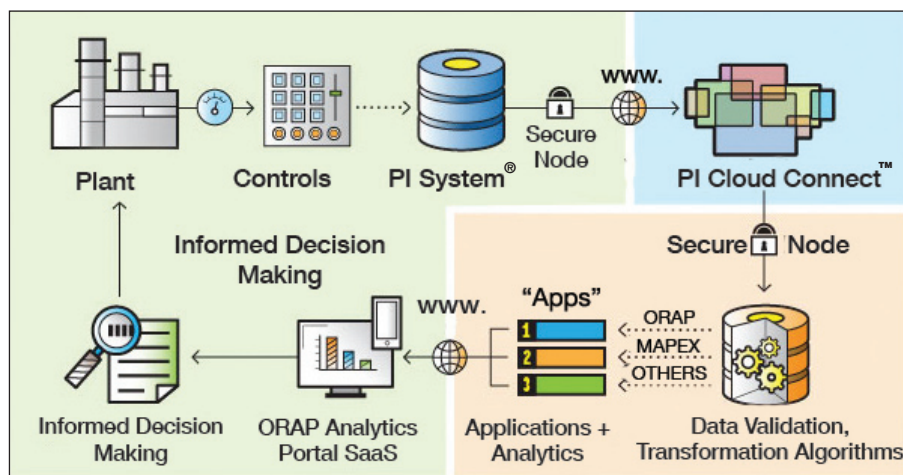
ORAP Asset Insight process. There are no limitations to the number of applications, simple or complicated, that can be developed and added to the ORAP Asset Insight toolbox.

It is important to point out that in all of the handling of the ORAP data, the key is accuracy and data fidelity. Over 600 engineering rules are used to validate the data. In addition all outage events are reviewed by an engineer to make sure that the information makes sense and is reliable.

If you look at RAM reporting, for example, the operating PI system data is automatically transformed resulting in gas fuel consumption, average net heat rate, GT fired hours and peak fired hours, factored hours, and other key inputs.

None of this data is entered by operating or maintenance staff. The RAM statistics (KPIs) are all calculated from the transformed data. The same holds true for the Mission Profile, Factored Starts and Hours Summary, a 20-year forecast for major maintenance, as well as the current unit status.

This is not just a focus on "big data;" it is a focus on productivity and value-added information. And the key is that no human input is required.

Q8: Then what's next in this process?

The next step is predictive analytics. Predictive health monitoring of the equipment in the plant is a step into the future. We are working with another potential partner to utilize a "first principles" model developed and verified on operating plants to expand the "app" available through the ORAP Asset Insight toolbox.

Their model is impressive because it is based on "first principles," a thermo-dynamic assessment of the plant, with embedded Fault Trees on a system-by-system basis identifying failure modes and effects.

It is not trending and it is not fuzzy logic. It is based on sound reliability engineering principles. SPS and other subject matter experts supported this potential partner in the development of the failure mode and effects based on engineering and O&M knowledge.

I can't wait until we put this predictive analytics capability to the test in one of our ORAP customer plants. This is clearly the next step.

Historic ORAP data collection, review, validation process

Since 1987, SPS has processed and entered in its ORAP database plant operational, failure, and maintenance data representing over 29 000 unit years of service and more than 450 000 forced, scheduled, and unscheduled outages.

Information from more than 2600 individual gas and steam turbines is streamed to SPS monthly for review and validation. Additionally, ORAP currently has 4.8 billion records of wind data.

These data provide the energy industry RAM benchmarks for both heavy frame and aeroderivative gas turbine plants across the various OEMs, technologies, applications, and duty cycles.

Information is received from a variety of sources, including plant O&M and headquarters operations personnel. In some cases, operating data – not outage details – are received directly from the unit control system or onsite historian.

Regardless of the source, no plant data can be added to the ORAP database until it passes both a Manual Data Validation (MDV) and an Automated Data Validation (ADV) process. Industry standards, such as IEEE 762 and ISO 3977, underpin the validation process.

Each piece of data received is reviewed by an SPS Customer Service Engineer with a focus on reasonableness and technical accuracy. Any questions that arise in the data must be addressed directly with the participating plant's representative as soon as possible.

An SPS customer service engineer is in almost constant contact with plant staff to address questions and issues with the information provided, or to address questions and issues regarding the data or ORAP RAM metrics provided to them.

SPS says it takes full responsibility for the accuracy and quality of reported data and spends whatever engineering time is required to achieve the highest level of quality possible. In particular, significant emphasis placed on all reported outages – forced, scheduled, and unscheduled – down to one-tenth of an hour.

When assessing forced outages, the objective is to clearly understand the symptom, corrective action, and eventually the root cause of failure. In terms of scheduled or unscheduled maintenance, the emphasis includes the time to perform and the frequency of maintenance compared with recommended OEM practice.

SPS engineers analyze information from all outages to ensure that the assignment of a standard equipment code, at a system and component level, is accurate and reflects the performance of the specific technology. EPRI Standard Equipment Codes are used in this effort.

There are many ADV rules for automatically reviewing and assessing data for accuracy. However, only after completion of the MDV process can plant data be submitted for inclusion in the ORAP database. Customer reports cannot be issued until the responsible customer service engineer passes reviewed and approved plant data to the reporting database.

The SPS data review and validation process is rigorous and time-consuming; it is critical to achieving the level of quality demanded by the industry. It is also essential that the review of field data be performed by experienced engineers who understand plant equipment and have a strong attention to detail.