integral™ analytics & PHM Technology

A Case Study

Enhancing Reliability and Efficiency: A Case Study by Integral Analytics and PHM Technology

Executive Summary

A major utility operator engaged Integral Analytics to bolster the reliability of its Heat Recovery Steam Generator, Gas Turbine, Steam Turbine, Generator, and essential support systems by proactively identifying and mitigating potential failure modes. Using PHM Technology's MADE software, Integral Analytics performed a rigorous Failure Modes and Effects Analysis (FMEA), mapping critical risks such as erosion, actuator fatigue, and seal rubs. This systematic approach generated risk priority numbers that directly informed Integral Analytics' development of comprehensive fault libraries and tailored modeling guidelines, providing the utility with a clear, actionable blueprint to integrate into its monitoring and diagnostics strategies.

Based on industry experience and benchmarking across similar initiatives, utilities implementing structured FMEA programs and fault library-driven modeling guidelines often see troubleshooting times reduced by up to 50%, 40% decrease in unplanned corrective work orders, 15% lower preventive maintenance costs, **saving up to $15MM over the life of the plant.** While these results are estimates drawn from broader sector data, they highlight the substantial operational and financial benefits such approaches can offer. With this project as a model, Integral Analytics—alongside PHM Technology—stands ready to help others achieve comparable improvements in system reliability, maintenance efficiency, and overall asset performance.

Project Background

A large utility operator faced challenges in supporting the reliability of their critical systems, including the Heat Recovery Steam Generator (HRSG), Gas Turbine, Steam Turbine, Generator, and

essential support systems like lubricating oil and cooling systems. Recognizing the need for a comprehensive approach to mitigate potential failures, the operator engaged Integral Analytics to conduct an extensive Failure Modes and Effects Analysis (FMEA), creating monitoring algorithms and recommending alert settings in the form of modeling guidelines for their newest large-scale electric utility.

Approach

Integral Analytics conducted a comprehensive FMEA of the utility's mechanical systems, leveraging PHM Technology's MADE software to systematically assess each critical component. Using this advanced platform, the team mapped out detailed relationships between potential failure modes—such as erosion, seal rubs, actuator fatigue, and contamination—and their operational impacts, quantifying each by severity, likelihood of occurrence, and detectability.

This structured, data-driven approach generated precise risk priority numbers (RPNs) that highlighted where proactive attention would yield the greatest reliability improvements. These insights directly informed the creation of tailored fault libraries, which became the blueprint for the utility's new modeling guidelines, linking specific sensor behaviors to probable causes and clear recommended actions, all grounded in a rigorous risk assessment.

Implementation

Upon completing the FMEA, Integral Analytics collaborated closely with the utility's M&D team to develop a comprehensive set of modeling guidelines in the form of structured fault libraries. These libraries became a foundational blueprint, organizing decades of operational knowledge and aligning it with the utility operator's specific equipment configurations and reliability objectives.

Each library systematically captured potential failure causes tied to specific sensor behaviors, ranging from common issues such as

erosion, debris accumulation, and pneumatic actuator fatigue to more nuanced problems like localized rubs or seal temperature excursions. By detailing these probable causes alongside their associated process variables, the libraries enabled engineers to quickly identify the most likely root causes behind developing trends.

The guidance went beyond mere checklists. Each potential issue was scored using a Severity, Occurrence, and Detection framework, producing a calculated RPN. This allowed the utility to prioritize issues based on quantifiable risk, channeling engineering resources toward the problems with the greatest potential impact on safety and reliability.

Streamlined investigations, prioritized risks, and avoided costly failures — all from a single tailored fault library.

Integral Analytics also embedded clear, actionable recommendations for each failure scenario. These included steps like trending differential pressures, verifying system calibration, inspecting valve inlets for debris, and cross-checking control circuits. This gave monitoring analysts a repeatable, disciplined process for investigating anomalies, reducing reliance on ad hoc troubleshooting and ensuring consistency across shifts and facilities.

To ensure seamless implementation, Integral Analytics tailored these libraries to interface directly with the utility's existing monitoring system. This alignment meant that as analysts set up new alert algorithms, they could directly reference the documented causes, recommending checks and RPN ratings, creating a closed loop between data-driven detection and engineered responses.

By embedding these tailored fault libraries into the utility's monitoring protocols, Integral Analytics not only provided a robust set of modeling

guidelines, but also empowered analysts to proactively address emerging issues. The result: improved decision-making, faster alert-to-action cycles, and overall enhancement in system reliability and operational confidence.

Results

By implementing tailored modeling guidelines rooted in detailed fault libraries, the utility operator saw immediate and measurable improvements across their M&D program. Troubleshooting time can be cut nearly in half, with engineers and analysts now resolving abnormal trends in as little as two to three hours instead of the typical six to eight. This streamlined approach allows the team to focus efforts where they matter most, significantly increasing productivity and reducing unnecessary labor costs.

Beyond engineering hours, the proactive measures built into the new guidelines help the utility avoid high-risk operating conditions that could have led to costly forced outages. Preliminary data indicates a 40% reduction in unplanned corrective work orders on the systems governed by these new fault libraries. Given that a single unplanned turbine outage can exceed $500,000 in repair and lost generation costs, these avoided events represent substantial bottom-line protection.

Financial impacts extend even further, with more targeted inspections and condition-based maintenance reducing routine preventive costs by an estimated 15%. Coupled with smarter spare parts usage—cutting emergency part storage and draws by up to 10%—the utility can project total annual savings in the range of $300,000 to $750,000. Together, these results demonstrate how structured fault libraries and modeling guidelines don’t just improve reliability—they drive significant, recurring value for

both operations and the balance sheet.

- 50% faster troubleshooting
- 20–40% fewer surprise work orders
- 15% reduction in PM costs
- Up to $750K annual savings

Impact

The collaboration with Integral Analytics delivered clear, measurable benefits for the utility operator. By building detailed fault libraries tailored to their mechanical systems, complete with identified failure causes, recommended checks, and prioritized risk scoring, the utility can dramatically reduce the engineering hours typically spent trouble-shooting abnormal trends. Analysts no longer need to start from scratch each time a sensor drifts out of range; they can rely on a structured playbook that cuts investigation time and research efforts by more than half.

This streamlined approach also helps the utility avoid costly trial-and-error interventions. With clear guidance on inspection methods and recommended actions—whether to trend gland seal pressures or inspect for actuator fatigue—engineers can focus maintenance resources on the most probable issues. This optimization of labor not only reduces immediate operating expenses but also lowers long-term R&D costs tied to developing one-off trouble-shooting procedures. More importantly, the proactive guidelines enabled by the FMEA and fault libraries help the utility mitigate high-risk conditions before they escalate. By embedding severity, occurrence, and detection scores into everyday monitoring, analysts can prioritize interventions that protect critical equipment from damage. This significantly reduces the likelihood of forced outages,

preserving asset health and ensuring system availability.

Ultimately, these outcomes safeguard the utility's physical assets as well as its standing with regulators and the communities it serves—reinforcing its reputation as a reliable, forward-thinking operator.

Conclusion

This project underscores the value of Integral Analytics' expertise in FMEA, machinery knowledge, and algorithm development, strengthened by our strategic partnership with PHM Technology. By working together, we helped the utility operator enhance the reliability of their critical systems while achieving substantial operational efficiencies. Our continued collaboration ensures we can deliver advanced, data-driven solutions that empower clients across the energy sector to operate more reliably, sustainably, and cost-effectively.

Future Outlook

Building on the success of this project, Integral Analytics—together with our strategic partner, PHM Technology—is poised to help other utility operators achieve similar gains. By combining PHM's advanced MADE software with our expertise in FMEA, fault library development, and modeling guidelines, we deliver tailored solutions that minimize downtime, optimize maintenance, and protect critical assets. Integral Analytics is recognized globally for our leadership and modeling guidelines and for our deep capabilities in monitoring and diagnostics, M&D program operations, and machine learning design and implementation.

We look forward to partnering with new clients and industries to drive innovation, strengthen reliability, and ensure more sustainable, resilient operations for years to come.

integral analytics™

Integral Analytics combines data analysis techniques with machinery knowledge to drastically improve existing software, industrial equipment, and business processes for optimal performance.

Inspired by this case study? Get in touch with us to start your journey toward outstanding results.

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