

MODERNIZATION TECHNOLOGY ASSESSMENT

MTA Number	MTA-EN-008		
Title			
Reduce Dose and Maintenance Costs of Flow-Accelerated Corrosion Piping Inspections using Structural Health Monitoring Ultrasonic Sensors			
Description			
Carbon steel piping exposed to flowing water and wet steam conditions may be susceptible to Flow-Accelerated Corrosion (FAC) or similar wear mechanisms. Wall thinning due to FAC especially impacts components with high fluid velocity, low pH, and low dissolved oxygen concentrations, such as feedwater piping and drain lines. Wall thickness data are traditionally collected using manual, periodic ultrasonic (UT) inspection techniques during planned outages. The volume of FAC piping inspections performed is large and therefore expensive, accounting for over 95% of all inspections performed in the plant FAC program. Re-inspection of piping within a 10-year window accounts for 10-20% of total inspection locations for a given outage. Common re-inspection locations present an opportunity for dose and maintenance cost savings by replacing manual inspections with Structural Health Monitoring (SHM) using permanently installed single-point and mat array UT sensors to provide continuous monitoring for wall loss. SHM eliminates manual inspection preparation activities (e.g., pipe preparation, scaffolding, and insulation removal) for selected piping to reduce overall contract labor costs. SHM on FAC piping is generally cost effective for more frequently inspected locations and is not intended to replace manual inspections for the entire FAC program.			
Benefits			
Benefits Estimate	Level 1 - Savings are less than \$1 million per year, per unit. Estimated savings are approximately \$50,000 per year. Savings will vary based on plant specific volume of common re-inspection locations driven by the FAC program history and requirements.		
Benefits Description	• Reduction in contract labor costs by saving time spent on manual inspection preparation activities. • Reduction in dose exposure by decreasing manual inspection volume. • Reduction in maintenance costs associated with delay in, or avoidance of repairs. • Improvement in understanding of component health using permanently installed UT sensors. The piping condition can be monitored while in operation and at a shorter time interval, leading to additional inspection insights on wear rates and wear patterns while online and during any system changes.		
Costs and Schedule			
Cost	Level 3 – Implementation cost is less than \$1 million. Estimated implementation costs are \$270,000 per unit and ongoing costs are \$10,000 annually.		
Schedule	Six months to one year. SHM equipment installation can be performed during a scheduled inspection. SHM implementation can be incorporated with a phased approach (i.e., not all selected piping needs to be implemented during the same outage).		
Scope Context	Per unit. Initial implementation costs include internal labor for SHM placement optimization and site preparation, contracted labor for device installation, and device procurement. The SHM device costs approximately \$12,000 per piping location. The implementation costs do not include the cost of implementation enablers. Ongoing costs include the cost of software licensing as well as maintenance and calibration of SHM instrumentation.		

Risks	
- SHM technologies installed in fixed locations do not produce wall thickness measurements in as many locations on a component as can be obtained during a manual inspection. An adjusted approach for evaluating FAC damage, such as a follow-up revision to the EPRI recommended approaches to inspecting/monitoring FAC, will mitigate this risk. - IT risks such as cybersecurity and Electromagnetic Compatibility (EMC) are associated with integrating with the existing plant network, data storage, and analysis software. Following the appropriate NRC requirements will mitigate these risks. - Sensors may be affected by temperature and radiation effects. Commercially available sensors can operate continuously at temperatures up to 500°C. Research is being performed to understand further effects of thermal cycling and radiation exposure on UT sensors for FAC piping.	
Administrative Items	
Date	12/14/21
Functional Area Where Benefits Will Be Realized	Engineering Maintenance
Reference Implementation Guidance	Flow-Accelerated Corrosion in Power Plants Revision 2 (EPRI 3002008071) Recommendations for Effective Flow-Accelerated Corrosion Program (NSCAC-20L-R4) (EPRI 3002000563) Field Guide: Flow-Accelerated Corrosion and Erosion (EPRI 3002008124)
Industry SME	EPRI – Dylan Cimock EPRI – Maria Guimaraes Contact: NuclearPlantMod@epri.com
Previous Implementation	Please contact EPRI for more information.
Implementation Enablers	Wi-Fi or connection to a wired network for data transfer. Wi-Fi enabler guidance includes: - MTA-MA-003 – Implement a Wireless Network Infrastructure Using a Distributed Antenna System (DAS) - MTA-MA-004 – Implement a Wireless Network Infrastructure Using Wi-Fi
SWEEP Score	- Cost - Level 3 - Implementation cost is less than \$1 million per unit. Estimated implementation costs are \$270,000 per unit and ongoing costs are \$10,000 annually. - Savings - Level 1 - Savings are less than \$1 million per year, per unit. Estimated savings are \$50,000 per year. Savings are driven by a decrease in manual inspection volume and subsequent reduction in contract labor costs. - Payback - Level 1 - Payback period greater than five years. Estimated payback period is six years for a single-unit plant. - Technical Readiness - Level 3 – The technology is commercially available and is ready for wide operational deployment. - Licensing Readiness - Level 3 - No changes are required for implementation. - Implementation Proficiency - Level 3 – The technology can be implemented by all sites, regardless of digital experience.
Applicability	All reactor types All geographic regions

This MTA can be accessed from <http://www.epri.com\nuclearplantmod>. For more on MTA's please see EPRI product 3002020578

Keywords	Flow-accelerated corrosion; FAC; structural health monitoring; SHM; mat array ultrasonic sensors; single-point ultrasonic sensors; UT; wall thinning; erosion
Business Case Analysis Cross-Reference	Plant Modernization Business Case: Monitoring Piping Subjected to Flow-Accelerated Corrosion (EPRI 3002018480)

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