

## MODERNIZATION TECHNOLOGY ASSESSMENT

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| MTA Number                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | MTA-EN-011                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |  |  |
| Title                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |  |  |
| Reduce Scope of Tendon Surveillance Program for Containment Structures using Sensors                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |  |  |
| Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |  |  |
| Tendon anchors in containment structures are required to be surveilled to meet American Society of Mechanical Engineers (ASME) Boiler Pressure Vessel Code, Section XI. The examinations include visual inspections of tendon anchorage areas, tendon lift-off test, grease sampling and replacement, and wire extraction for destructive testing. These tests and inspections require large, heavy equipment, high-elevation access, and multiple personnel. Fiber-optic strain gauges can be installed on the tendon anchor head or shims to continuously monitor the prestressing force in the tendon, which could eliminate the need to periodically perform lift-off tests after the sensors are installed. The use of these tendon sensors could (1) reduce the scope of the tendon surveillance program, (2) reduce personnel safety risk by eliminating the need to perform liftoff testing and wire-pulling, and (3) provide the technical basis for extending the surveillance frequency. Typical service life for the sensors is approximately 20 years. |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |  |  |
| Benefits                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |  |  |
| Benefits Estimate                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Level 1 - Savings are less than \$1 million per year, per site. Expected annual savings are in the range of \$50,000 - \$100,000.                                                                                                                                                                                                                                                                                                                                              |  |  |
| Benefits Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <ul style="list-style-type: none"><li>• Increase the interval between tendon surveillance inspections and/or reduce inspection scope resulting in labor and contractor costs as well as reducing risks to personnel safety during tests.</li><li>• Allows sites without adequate past performance for the tendon surveillance extension to justify approval of relief request.</li><li>• No License Amendment Request is required as this is a “minor modification”.</li></ul> |  |  |
| Costs and Schedule                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |  |  |
| Cost                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Level 3 – Implementation cost is less than \$1 million. Implementation costs vary depending on the number of sensors installed, but the EPRI business case analysis indicated that the implementation costs are \$10k-15k per tendon. All-in costs, which would include the lift-off testing, are approximately \$60,000 per tendon.                                                                                                                                           |  |  |
| Schedule                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Less than six months. Typical installation time is four hours per tendon. Installation of the sensors occurs during normal lift-off tests. However, depending on the number of tendons instrumented, up to two outage cycles may be needed for complete installation.                                                                                                                                                                                                          |  |  |
| Scope Context                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Per site.<br><br>The costs and benefits are evaluated for one plant at a utility. These values will depend on the number of tendons instrumented, which is up to each utility to determine.                                                                                                                                                                                                                                                                                    |  |  |
| Risks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |  |  |
| <ul style="list-style-type: none"><li>• The potential for savings is heavily dependent on each utility’s situation (e.g., number of tendons instrumented, approved relief requests, internal versus contracted labor, remaining plant life, etc.).<ul style="list-style-type: none"><li>○ Use of this technology to extend the surveillance frequency may have a positive business case.</li><li>○ Use of this technology to reduce inspection scope may not provide a positive business case due to high initial investment (relative to estimated savings).</li></ul></li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |  |  |

| Administrative Items                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|-------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Date                                            | 12/14/2021                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Functional Area Where Benefits Will Be Realized | Engineering<br>Maintenance                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Reference Implementation Guidance               | Supplemental Report on Containment Tendon Monitoring and on Containment Internal Temperature Monitoring at the R. E. Ginna Nuclear Power Plant (EPRI <a href="#">3002002996</a> )                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Industry SME                                    | EPRI – Samuel Johnson<br>Contact: <a href="mailto:NuclearPlantMod@epri.com">NuclearPlantMod@epri.com</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Previous Implementation                         | Please contact EPRI for more information.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Implementation Enablers                         | Not applicable                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| SWEEP Score                                     | <ul style="list-style-type: none"> <li>• Cost - Level 3 - Implementation cost is less than \$1 million. Implementation costs vary depending on the number of sensors installed, but generally the implementation cost is \$10k-15k per tendon.</li> <li>• Savings - Level 1 - Savings are less than \$1 million, per site.</li> <li>• Payback - Level 1 - Payback period greater than five years</li> <li>• Technical Readiness - Level 3 – The technology is commercially available and is ready for wide operational deployment.</li> <li>• Licensing Readiness - Level 3 - No changes are required for implementation.</li> <li>• Implementation Proficiency - Level 3 – The technology can be implemented by all sites, regardless of digital experience.</li> </ul> |
| Applicability                                   | Reactors with post-tensioned containments<br>All geographic regions                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Keywords                                        | Post-Tensioned Tendons; Tendon Surveillance; Tendon Anchor; Surveillance Extension; NDE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Business Case Analysis Cross-Reference          | Plant Modernization Business Case: Sensors for Post-Tensioned Tendons (EPRI <a href="#">3002021026</a> )                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |

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### **Acknowledgments**

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### **NOTE**

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