Integrated Risk-Informed Condition-Based Maintenance Capability and Automated Platform

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ABSTRACT:

The primary objective of this proposed research project is to integrate advancements in online monitoring and data analytic techniques with advanced risk assessment methodologies to reduce operating costs and enhance the reliability of commercial nuclear power plants (NPPs).

One of the major contributors to the total operating costs today is the O&M costs which include labor-intense preventive maintenance (PM) program. The PM program involves manually-performed inspection, calibration, testing, and maintenance of plant assets at periodic frequency and time-based replacement of assets, irrespective of its condition. This has resulted in a *labor-centric business model to achieve high capacity factors*. It's time to transition from this labor-centric business model to achieve optimal maintenance program. To enable this transition, a reliable method is needed based on available advanced technologies to support assessing the condition and risk of equipment failures. This transition will also enable nuclear plants in achieving capacity factors greater than 95%. Fortunately, there are technologies (advanced sensor, data analytics, and risk assessment methodologies) that can enable transition from a labor-centric business model to a *technology-centric business model*. The technology-centric business model will result in significant extension and reduction of time-based maintenance activities; thereby driving down the costs due to rising labor costs and declining technology costs. This approach will lay the foundation for real-time condition assessment of plant asset; allowing plants to undertake condition-based maintenance to enhance safety, reliability, and economics of operation.

The project outlines a comprehensive approach for successful research, development, and demonstration of an integrated risk-informed condition-based maintenance capability. This will enable risk-informed condition-based decision making to schedule maintenance activities without impacting plant operation; thereby reducing preventive maintenance frequencies and driving down costs. The pilot demonstration of the capability will be undertaken with Public Service Enterprise Service and Group (PSEG) Nuclear LLC at their Salem Nuclear Generating Station, and at the Hope Creek Nuclear Generating Station.

To achieve the project objective, three goals are defined. They are

Goal 1: Develop a risk-informed approach to optimize equipment maintenance frequency

Research and development activities are planned that will result in a new capability that will enable optimization of preventive maintenance frequency of plant equipment based on a risk-informed approach. This new approach will be combined with classical approaches currently in use by industry that employ statistical data and failure analysis to leverage the substantial knowledge, data, and expertise already available about equipment maintenance and trending, but provide the added capability of risk-informed insights to prioritize and inform maintenance decision making.

Goal 2: Develop a risk-informed condition-based maintenance approach

Research and development activities will be performed using advancements in sensor technologies and advanced data analytics to develop and deploy digital monitoring and to develop automated diagnosis and prognosis of plant equipment health condition for selected equipment and associated components. Using the capability developed through the first Goal, these research and development activities will employ advanced monitoring and diagnostic and prognostic models to recommend condition-based maintenance activities on plant equipment. This will move maintenance activities away from frequency-based scheduled activities to activities that are performed when necessitated by conditions – informed by advanced monitoring, analytics, and models of the equipment itself – to substantially reduce the amount and types of maintenance that are performed. This marks the transition to technology-enabled condition-based and risk-informed maintenance activities.

Goal 3: Develop and demonstrate a digital, automated platform to centralize implementation of monitoring technologies

The move from scheduled to condition-based maintenance will represent a significant shift in both the methods and the tools for plant monitoring and cost reduction. The greatest economies of scale are to be realized when these technologies are centralized – that is deployed in multiple plant settings or in a fleet of plants – to monitor a fleet of components or fleets of components. Research and development activities will be performed to integrate the capabilities developed in Goals 1 and 2 into a centralized automated platform to support implementation of technologies for use by industry to the broadest extent in order to achieve the greatest returns on investment and economies of scale. The platform will automate business processes like automatic generation of work orders, inventory parts managements, align it with right skilled and trained field worker, and update the system with the feedback once the work package is complete. The platform will provide a schedule optimization tool to track and realign (if required) activities to ensure on-time completion.

The potential impact to the U.S. nuclear fleet from implementing this overall approach is a significant reduction in Operations & Maintenance (O&M) costs through the reduction in time-based maintenance activities and the transition to condition based. Figure 1 below provides a visual of this potential impact.

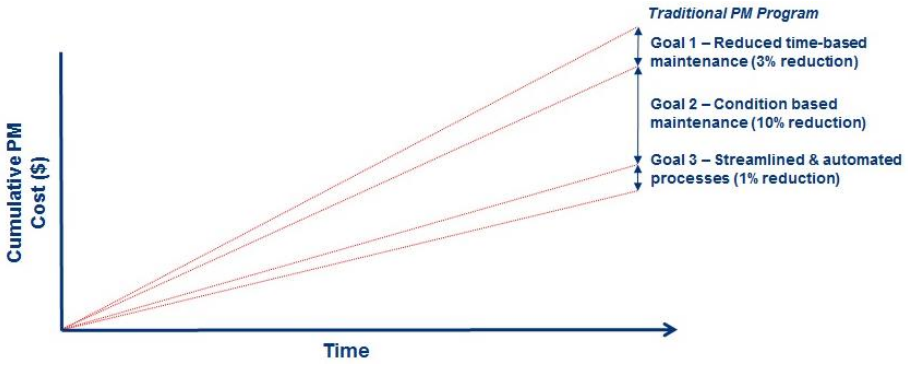

Figure 1. Potential Impact to annual O&M Cost

The proposal has identified thirteen (13) tasks that will be executed in parallel over a 24 months period of performance. The outcomes of the project will provide technologies that will enable industry led innovation and technology deployment in the current fleet of U.S. NPPs to ensure the nuclear industry as a whole remains an economically competitive and viable option in the energy market, while also supporting the development and construction of advanced reactors.