Systematic Enterprise Risk Management by Integrating the RISMC Toolkit and Cost-Benefit Analysis

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ABSTRACT:

To promote the sustainability of the U.S. nuclear fleet, a Systematic Enterprise Risk Management (ERM) Framework is proposed for satisfying short- and long-term Regulatory Design Standards, and short- and long-term for improving safety, cost savings and avoiding production loss. The proposed risk assessment approaches enhance the Risk Informed Safety Margin Characterization (RISMC) Toolkit by adding the interactions of Socio-Technical Maintenance Performance to equipment status through the interface of Generalized Renewal Process (GRP), considering the progression of underlying degradation mechanisms using RISMC. This proposal offers two paths on how to implement cost reduction and ERM strategies to satisfy the NEI Nuclear Promise, while satisfying regulatory requirements. A Streamlined Approach is proposed, which can provide information for both regulatory safety requirements and ERM decision-making by performing a scientific reduction of the industry burdens in responding to less safety-significant issues by challenging 'over-design' regulatory adequacy standards (i.e., prescriptive requirements and Risk Regions) resulting from emerging requirements related to fire, flood, seismic, Loss Of Coolant Accidents (LOCA), etc. Using the streamlined approach, utilities can evaluate the plant-specific need for further investigation and justification for satisfying safety margins to determine if advanced approaches are needed. For the streamlined approach, location-specific Initiating Event (IE) information should be generated using the Risk-Informed Safety Margin Characterization (RISMC) Toolkit, which can provide information to ERM scenarios, providing physical plant status metrics, and insights from maintenance models – including the socio-technical linkage between the two. To understand the key drivers of risk in ERM, the Advanced Approach is proposed, which will be applied for empirically derived high-cost generation events, utilizing in-depth physical modeling via the RISMC Tools GRIZZLY and RAVEN, integrated with Socio-Technical Maintenance Performance models through GRP modeling. The Systematic ERM will structure pre-event decision-making options, GRP outputs, and post-event decision-making options into empirically derived 'high-cost event' scenarios using Dynamic Decision Trees (i.e., similar to the RISMC Toolkit RAVEN). The results of the underlying simulation modules will provide inputs to Dynamic Decision Trees through chance nodes representing uncertainties surrounding decision making (i.e., estimated using socio-technical performance modeling), and probabilities of physical plant status generated by GRIZZLY and RAVEN. The Systematic ERM will allow users to explore the full range of decision making options, chance nodes, end nodes and their associated costs calculated using mixed Cost-Benefit Analysis methods. In the scope of this three-year project, a case study of high cyclic fatigue affecting the Reactor Coolant System will be used to demonstrate the proposed framework and methodology. The results of this project will help utilities bound the risk associated with uncertainty in long-term operational scenarios and risk-informed regulatory activities, and is closely related to cost savings asked for in the "Cost & Benefit" lower tier initiative in the NEI "Delivering the Nuclear Promise" initiative.