Project Title

Advanced Mechanistic 3D Spatial Modeling and Analysis Methods to Accurately Represent Nuclear Facility External Event Scenarios

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Program: Nuclear Reactor Technologies, Reactor Concepts, RC-5

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ABSTRACT:

Although there has been assessment of external event risks at nuclear power plants (NPPs) the potential magnitude of external event risks was not fully recognized until recently and methods have not been developed to the same level as for internal event risk assessment. The ability to perform realistic assessments of seismic risk including a mechanistic three-dimensional characterization and full uncertainty analyses for existing commercial plants will be a key contribution of the proposed research.

The project will be performed and managed by four principal contributors with unique expertise. The research team has extensive experience in seismic modeling and structural analysis, and probabilistic risk assessment (PRA) of NPPs. The requested total budget is $800,000 for three years. A total of $100,000 is allocated for the industry collaborator, RIZZO. $15,000 is available for the advisory panel members. The rest of the budget will be used to support three graduate students at OSU by the three PIs, who will manage the project.

The product of this research is a toolset that can be used to advance the state of assessment of seismic risk of commercial nuclear power plants, including a new dynamic failure analysis module, DINOSAUR that will be built within the framework of the MOOSE platform[1]. DINOSAUR will take advantage of the coupled multiphysics capability of the MOOSE solver. DINOSAUR will also interface with and receive input from some legacy soil-structure interaction and structural analysis software (e.g., SASSI[2], SAP2000[3]) that are industry standards and will provide output that can be displayed using licensed software. The output of DINOSAUR in the form of failure probabilities of critical components will be provided to the SAPHIRE[4] computer code to determine the associated Level 1 risk measures. The project will involve the fusion of expertise in seismic structural response modeling and advanced methods of risk assessment. The keys to success of this project are the expertise in seismic analysis and risk assessment of the OSU faculty that will be involved in the project and the inclusion in the team of a private contractor, RIZZO, with extensive knowledge of how seismic PRA is performed by industry today. Sezen and Vaidya will develop the methodology for assessing the seismic hazard for a given NPP site, the seismic structural analysis, and probability of failure of critical structures, systems and components. Aldemir and Denning are world renowned experts in PRA of NPPs. They will develop the PRA and uncertainty analysis elements of the methodology and will oversee the incorporation of the DINOSAUR module within the MOOSE platform.

[1] D. Gaston, G. Hansen, and C. Newman, "MOOSE: A Parallel Computational Framework for Coupled Systems of Nonlinear Equations," INL/CON-08-15008, Idaho National Laboratory, Idaho Falls, ID (May 2009).

[2] SASSI, Structural Analysis Software System Interface, http://www.dnfsb.gov/sites/default/files/Board%20Activities/Letters/2011/ltr_20111227_18206.pdf

[3] SAP2000, Computers and Structures, Inc., Berkeley, CA, www.csiberkeley.com

[4] C. L. Smith, J. Knudsen, M. Calley, S. Beck, K. Kvarfordt, and R. T. Wood, "SAPHIRE Basics: An Introduction to Probability Risk Assessment Via the Systems Analysis Program for Hands-on Integrated Reliability Evaluations," Idaho National Laboratory, Idaho Falls, ID (2005).