POTENTIAL USES OF THE FULL-SCOPE SITE LEVEL 3 PRA PROJECT

Enhancing the Technical Basis for the Use of Risk Information

- *Obtain updated and enhanced understanding of plant risk.* It has been more than 20 years since the NRC last sponsored a Level 3 probabilistic risk assessment (PRA) study (NUREG-1150[1]). Since that time, there have been numerous technical advances in PRA and related fields, such as (1) increased understanding and improved modeling of severe accident phenomena, as demonstrated in the State-of-the-Art Reactor Consequence Analysis (SOARCA) Project, (2) development of improved methods for common cause failure analysis and human reliability analysis, (3) improved quality and quantity of data for initiating events, component failures, and operator errors, and (4) measurable changes in equipment unavailability and initiating event frequencies. Significant changes have also occurred in plant operational performance and safety since the time of the NUREG-1150 studies. Examples of these plant changes include improved operational, maintenance, and training practices; implementation of severe accident mitigation guidelines and extensive damage mitigation guidelines; modifications to meet the station blackout rule (10 CFR 50.63); power uprates; and higher fuel burn-up. As such, a new Level 3 PRA study should provide new insights into plant risk contributors based on these technical advances and plant changes.

- *Inform agency activities regarding emergency preparedness.* It is expected that insights from the current Level 3 PRA study could inform the process for evaluating the potential impact that a multi-unit accident (or an accident involving spent fuel) may have on the efficacy of the emergency planning zone (EPZ) in protecting public health and safety. Such insights would be primarily related to understanding the sensitivity of the calculated offsite health consequences to various modeling assumptions.

- *Integrate site risks within a single, comprehensive study.* Currently, PRAs are generally focused on the risk per reactor unit, and ignore the effects of other units and other sources of risk at the site. As the event at Fukushima in March 2011 demonstrated, events that impact an entire site can pose challenges to operating crews and negate assumptions regarding support from “sister” unit systems, structures, and components (SSCs). The Commission safety goals are currently implemented on a reactor unit basis,[2] and current PRAs provide insights regarding whether the risk from the reactor meets these goals. This study should give insights into whether the integrated site risk, or the risk from multiple units, meets the Commission safety goals. This study should also update our understanding of the relative risk from spent fuel storage.

- *Gain insights regarding the use of a core damage frequency (CDF) of 10^{-4} per reactor year and a large early release frequency (LERF) of 10^{-5} per reactor year as surrogates for the quantitative health objectives (QHOs) regarding individual risk of latent fatalities and early fatalities, respectively.* The surrogate CDF and LERF values were based on the results from the Surry PRA of NUREG-1150. This project, which takes advantage of improved methods

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1 NUREG-1150, “Severe Accident Risk: An Assessment for Five U.S. Nuclear Power Plants,” December 1990.

2 The staff recognizes that the quantitative health objectives (QHOs) from the Commission safety goal policy statement refer to the risks from a nuclear power *plant*, not an individual nuclear power *reactor* (see Volume 51, page 28044, of the *Federal Register* dated August 4, 1986, as revised, “Safety Goals for the Operation of Nuclear Power Plants, Policy Statement”). Currently, the staff applies the QHOs on a reactor unit basis (e.g., Regulatory Guide 1.174, “An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis,” Revision 2, May 2011, and NUREG/BR-0058, “Regulatory Analysis Guidelines of the U.S. Nuclear Regulatory Commission,” Revision 4, September 2004).

and data, can provide insights into the appropriateness of the surrogates for the Vogtle site, as well as more generically. Revisiting the appropriateness of CDF and LERF as surrogates for the QHOs could have broad implications for the numerous regulatory activities where CDF and LERF play a critical role in the decisionmaking. Examples of these activities include risk-informed changes to the licensing bases, evaluation of new regulatory requirements, and assessment of the risk of licensees' performance deficiencies.

- *Inform the agency perspective on consideration of offsite property damage within the regulatory framework.* The results of the Level 3 PRA project should provide an improved understanding of offsite property damage from severe accidents. This improved understanding would inform consideration of offsite property damage within the regulatory framework.

- *Support risk-informed licensing of future reactor designs.* The results of the Level 3 PRA, particularly with regard to integrated site risk, may provide insights to support the resolution of design issues or to enhance the safety focus of reviews for future reactor designs, such as small modular reactors. Level 3 PRA results for an operating reactor site could be used for testing the risk informed framework for future reactor designs (e.g., NUREG-1860[3]) and assessing the framework's acceptance criteria. The Level 3 PRA project may also provide insights into implementing future Commission-approved recommendations associated with the Risk Management Task Force (RMTF) report (NUREG-2150, "A Proposed Risk Management Regulatory Framework" [ADAMS Accession No. ML12109A277]) and the Commission paper on Near-Term Task Force (NTTF) recommendations (SECY-11-0093, "Near-Term Report and Recommendations for Agency Actions Following the Events in Japan" [ADAMS Accession No. ML11186A959]).

<u>Improving the PRA State-of-Practice</u>

- *Demonstrate new methods for site risk assessments.* Some previous risk studies have been performed for spent fuel pools (e.g., NUREG-1738[4]) and dry cask storage (e.g., NUREG-1864[5]). However, due to the specific objectives of these previous studies, the methods used may need to be enhanced for use in the Level 3 PRA (e.g., in the areas of success criteria determination, human reliability analysis, accident phenomena, and source term analysis). In addition, the Level 3 PRA project includes risk assessment of areas for which no established methods currently exist, such as addressing multi-unit risk. This project will help develop new risk assessment technology and apply risk assessment technology in areas where it has not been broadly applied, thus improving our PRA state of knowledge.

- *Support development of PRA screening processes.* Screening analyses are performed throughout PRAs (e.g., screening of initiating events; structures, systems, and components; human failure events; and hazards) to determine the necessary scope and level of detail required in developing the various models that support the overall PRA model. Currently,

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[3] NUREG-1860, "Feasibility Study for a Risk-Informed and Performance-Based Regulatory Structure for Future Plant Licensing," Volumes 1 and 2, December 2007 (ADAMS Accession Nos. ML080440170 and ML080440215).

[4] NUREG-1738,"Technical Study of Spent Fuel Pool Accident Risk at Decommissioning Nuclear Power Plants," February 2001.

[5] NUREG-1864, "A Pilot Probabilistic Risk Assessment of a Dry Cask Storage System at a Nuclear Power Plant," March 2007.

there is no consensus within the PRA community on a consistent set of screening criteria for determining the needed scope and level of detail. This study should provide insights regarding technically acceptable screening processes.

- *Pilot expert elicitation guidance.* In response to the Commission direction in the staff requirements memorandum (SRM) (ADAMS Accession No. ML120380251) resulting from SECY-11-0172, "Response to Staff Requirements Memorandum COMGEA-11-0001, 'Utilization of Expert Judgment in Regulatory Decision Making,'" (ADAMS Accession No. ML112020602), the staff will use the Level 3 PRA project for the pilot application of staff guidance on expert judgment elicitation.

- *Enhance low power/shutdown PRA modeling.* There may be a wide variance in risk assessment results for low power/shutdown conditions due to the different equipment out of service or in maintenance. In current low power/shutdown models, the equipment out of service is set individually for each unique shutdown. This Level 3 PRA study may provide new insight into a more consistent modeling technique.

- *Identify areas for further PRA research.* Although the project is for a specific plant, it is still likely to identify phenomena and failure modes not clearly understood, particularly associated with assessing the risk of the spent fuel pool and dry cask storage, and provide some insights relative to their importance. These insights can assist in identifying future research needs to gain an improved and more realistic understanding and ability to model these phenomena and failure modes. Moreover, it can also provide insights in confirming areas where no additional development is needed; that is, where our understanding of the various phenomena and failure modes is sound.

- *Increase understanding of PRA uncertainties.* Successful implementation of risk-informed decision making requires a thorough understanding of the uncertainties inherent in PRAs. The Level 3 PRA project should provide insights regarding what are the sources of uncertainty and how they are manifested in the PRA. Many of these will be more generic in nature and not necessarily unique to the design and operation of Vogtle Units 1 and 2. The project should confirm our current understanding of the sources of uncertainty, and identify sources where our experience in PRA is more limited (e.g., for spent fuel pools and dry cask storage). The Level 3 project will provide the opportunity to systematically identify, characterize, and document the sources of uncertainty for a full-scope site PRA.

<u>Identifying Safety and Regulatory Improvements</u>

- *Identify potential safety improvements that may be voluntarily implemented by licensees.* This study has the potential to identify accident prevention, accident mitigation, and emergency planning safety improvements for the reactor, the spent fuel pool, and dry cask storage that the licensee may choose to voluntarily implement. For example, the Level 3 PRA study should provide insights regarding the overall integrated risk of all major site radiological sources,[6] which could be used by the licensee to prioritize accident management strategies for responding to accidents involving more than one of these

[6] Including all reactor cores, spent fuel pools, and dry storage casks on site, but excluding fresh nuclear fuel, radiological waste, and minor radiological sources (e.g., calibration devices).

sources. Also, NUREG-1150 and the individual plant examination studies identified plant features that provided safety improvements and that could be applied to other plants (e.g., for flooding scenarios, designing door swing-out directions based on which side of the door the flood water will likely be encroaching from and whether it is more beneficial to have the water flow out of the room of interest or remain contained within it). The Level 3 PRA study may also identify safety improvements that may be voluntarily implemented at other plants.

- *Identify potential safety improvements that may lead to regulatory improvements*. As stated above, this study has the potential to identify accident prevention, accident mitigation, and emergency planning safety improvements for the reactor, the spent fuel pool, and dry cask storage. Some of these safety improvements could have generic implications, not limited to the subject site, and may warrant further evaluation by the NRC and possible inclusion in the Generic Issues Program or other regulatory action.

- *Reducing unnecessary conservatism.* Insights from the Level 3 PRA study may provide the basis for reducing unnecessary conservatism within the regulatory framework. Consistent with the Commission's PRA Policy Statement,[7] any such potential regulatory changes should appropriately consider uncertainties and support the NRC's traditional defense-in-depth philosophy.

- *Broaden understanding of risk contributors.* Although industry has been updating their PRAs to meet the NRC endorsed PRA standard, it is only for a Level 1 and LERF PRA for internal and external hazards at power. The industry PRAs typically do not address a full Level 2, or address Level 3, and do not include low power and shutdown conditions. This Level 3 project should provide a better understanding of the potential reactor accident progression (e.g., what are the key phenomena, etc.) and risk contributors for all internal and external hazards and under all plant operating modes, while accounting for plant-specific features.

- *Inform the agency perspective on International Atomic Energy Agency (IAEA) standards*. In activities such as the IAEA's Integrated Regulatory Review Service or the development of the agency's regulatory guides, the staff is often asked to explain its regulatory programs in the context of IAEA safety requirements and guidance. Some IAEA guidance (such as standards for severe accidents) applies more directly to new reactor designs, but should also be considered for operating reactor designs to the extent practical. The Level 3 PRA may identify potential safety improvements that have generic applicability and could be used to demonstrate how the agency considers such potential improvements in the context of the IAEA safety standards.

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[7] 60 FR 42622, "Use of Probabilistic Risk Assessment Methods in Nuclear Regulatory Activities," August 16, 1995.

Supporting Knowledge Management

- *Develop in-house PRA technical capabilities and support PRA knowledge management and risk communication activities.* As this project progresses, the NRC staff's understanding of PRA will be enhanced, particularly in areas where current experience is limited (e.g., calculating dry cask and spent fuel pool risk). Improving the staff's PRA skills will increase the NRC's ability to support risk assessment in-house. Familiarity with PRA methods and approaches will be needed if the staff begins to exercise a new risk informed framework for future reactor designs (e.g., NUREG-1860[8]), or possibly be needed to support implementation of future Commission-approved RMTF or NTTF recommendations. Additionally, the Level 3 PRA model will be a maintainable PRA tool that can continue to support future PRA training, research, and other regulatory applications (e.g., evaluating emerging technical issues).

- *Enhance PRA documentation practices.* A key aspect of any PRA is the adequacy of the supporting documentation. It is the documentation that provides the basis for the technical acceptability of the study. The Level 3 PRA project will be examining ways to more effectively and efficiently meet PRA documentation needs. In addition, it should provide insights into how to perform the documentation in a consistent manner, compatible with the documentation guidance in Regulatory Guide 1.200,[9] which would improve the efficiency of NRC and industry PRA reviews.

- *Enhance knowledge regarding cost and resources.* There is a good understanding regarding the cost and resources needed to develop a Level 1 and limited Level 2 PRA for a reactor at-power for both internal and external hazards. This project should provide insights regarding the cost and resources needed to perform a full-scope, integrated site PRA, including the relative costs and resources for reactor Level 1 PRA for low power and shutdown, reactor Level 2 and Level 3 PRA for all operating modes and internal and external hazards, Level 1, 2 and 3 PRA for spent fuel pool and dry cask storage, and multiple unit risk.

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8 NUREG-1860, "Feasibility Study for a Risk-Informed and Performance-Based Regulatory Structure for Future Plant Licensing," Volumes 1 and 2, December 2007 (ADAMS Accession Nos. ML080440170 and ML080440215).

9 Regulatory Guide 1.200, Rev. 2, "An Approach for Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk-Informed Activities," March 2009 (ADAMS Accession No. ML090410014).