Technical Advisory Committee of the Nuclear Risk Research Center
Central Research Institute of Electric Power Industry
1-6-1 Otemachi, Chiyoda-ku, Tokyo, 100-8126 Japan

June 6, 2024

Dr. George Apostolakis
Director, Nuclear Risk Research Center
Central Research Institute of Electric Power Industry
1-6-1 Otemachi, Chiyoda-ku
Tokyo, 100-8126 Japan

SUBJECT: PRELIMINARY NRRC RESEARCH PLAN FOR FISCAL YEAR 2025

Dear Dr. Apostolakis:

During the 20th meeting of the Technical Advisory Committee of the Nuclear Risk Research Center (NRRC), May 27-31, 2024, we met with the NRRC staff to review the proposed preliminary research plan for fiscal year 2025. The purpose of our review was to provide comments on the technical merits of the research plan and its relevance for supporting the NRRC's current mission.

CONCLUSIONS AND RECOMMENDATIONS

1. The overall scope of the preliminary research plan for fiscal year 2025 and the technical objectives of the individual projects within each major research area remain consistent with the NRRC short-, intermediate-, and long-term goals.

2. During our review, we identified four individual research activities that merit additional attention in the preliminary plans for fiscal year 2025 and subsequent years. Our recommendations for those activities are summarized in the Discussion section of this report.

BACKGROUND

One of the most important objectives of the research plan is to present the technical context of the research needs, including the rationale for prioritization and scope of the research, current state of knowledge, and potential contributions and significance of the research to the goals of the center. Our review of the preliminary research plan focused on the objectives of each research project and its supporting tasks, the technical relationships and relative priorities among those activities, and any major needs for additional research. We did not review the technical details of individual research activities or their completion milestones, except as needed to understand how those activities are integrated throughout the plan. We will comment separately

on the technical elements of individual research projects in our future detailed reviews of those projects.

DISCUSSION

During this review, we were briefed on continuing and planned projects in each research area, the major technical tasks in each project, the current status of each task, known or potential problem issues, and the estimated schedule for completion of each task. The overall scope of research for fiscal year 2025 and the technical objectives of the individual projects within each major research area remain consistent with the NRRC short-, intermediate-, and long-term goals.

Based on our review of the preliminary research plans and our discussions with the research teams, we offer the following recommendations for further assessments of four individual research activities.

(1) Use of Knowledge from Pilot Plant PRA Peer Reviews

A central NRRC research activity involves the development of methods and guidance to support good quality full-scope probabilistic risk assessments (PRAs) at all Japanese nuclear power plants. Ikata Unit 3 and Kashiwazaki-Kariwa Unit 7 are the industry's pilot plants to demonstrate the PRA models and methods to evaluate the risk from internal initiating events. Groups of international experts are conducting independent peer reviews of both studies to evaluate their consistency with the technical capability requirements in the ASME/ANS PRA Standards. The peer review process provides two important types of knowledge that improve the technical quality of a PRA and its use to support risk-informed decision-making (RIDM) applications.

i. The review identifies areas where the PRA team has not adequately implemented elements of the analyses according to the established technical standards, methods, and guidance. These findings are addressed by the team through refinements of the PRA models and improvements to their supporting analyses.

ii. The review identifies an area where a risk contribution is not adequately addressed, due to lack of a consensus methodology or a technical deficiency in the applied methodology. These findings require improvements in the applied methods or, in some cases, development of new methods.

The NRRC research teams should improve their use of the knowledge from the pilot plant PRA peer reviews to help refine the priorities and the focus of specific research activities. In some cases, the review findings may identify needs for new methods or guidance. In other cases, the findings may help the NRRC teams to identify specific elements of a methodology or guidance which should receive more attention. Both types of enhancements are needed to support the development of high quality PRAs that provide a better platform for RIDM.

(2) Human Reliability Data Collection

One of the major human reliability analysis (HRA) research activities involves the investigation and development of an improved methodology to quantify human error probabilities (HEPs). It is very important that a consistent HRA methodology is used for all Japanese nuclear power plant PRAs. This is an essential element of the overall risk assessment process. Experience has shown that the use of diverse HRA methods can be a source of technical inconsistency for plant-specific and industry-wide risk-informed applications. Furthermore, the use of different methods can also result in variations in the risk profiles which are not associated with differences in fundamental human performance.

We have not yet reviewed details of the proposed HEP quantification methodology. However, we understand that it relies on the use of human performance data that are collected from the utilities' simulator training programs. It is very important that the supporting data should be a comprehensive compilation of the Japanese training experience. Furthermore, the scope of the data that are collected at each plant, and the data format, should be consistent with its intended use in the quantification methodology. The HRA research team should ensure that the data collection methods and guidance are clearly understood by the training personnel at each plant. The team should also audit the data collection activities at each utility to ensure that they are being performed in a comprehensive and consistent manner.

(3) Seismic Fragility Correlation Methodology

Experience from Japanese and international PRAs has shown that coincident failures of similar equipment are often an important contribution to the overall risk from seismic events. The NRRC research program includes several continuing activities that are developing methods and guidance for more realistic evaluations of seismic hazards and fragilities. The research plan also includes an activity to develop methods and guidance for an evaluation of the risk from events that affect multiple units at a site. The multi-unit PRA (MUPRA) research is a particularly challenging activity, due to a general lack of international experience and practical methods for these complex analyses.

The effects from intra-unit and inter-unit coincident failures must be evaluated in a consistent manner to quantify the risk from earthquakes that affect a single-unit site, earthquakes that result in damage to only one unit at a multi-unit site, and earthquakes that damage multiple units. To support these analyses for all Japanese sites, the research teams should ensure that consistent methods are developed to evaluate correlations among the structural and equipment fragilities for applications in single-unit and multi-unit risk assessments.

(4) Risk from Volcanic Ash-Fall

The research plan includes activities to develop methods and guidance for an evaluation of the risk from volcanic ash-fall. Those activities include a probabilistic analysis of the ash-fall hazard, an assessment of the plant vulnerabilities to consequential damage from the deposition or ingestion of airborne ash and the

intake of waterborne pumice, and a demonstration of the PRA methods and models that are used to evaluate the risk.

Unlike most initiating events that are analyzed in a PRA, volcanic eruptions can continue for periods of several days or even weeks, with widespread dispersals of large amounts of ash. Volcanic ash can impact plant systems, structures, and components, as well as impacting actions of operators. For example, ash accumulation can affect the performance of safety systems, such as emergency diesel generators, cooling water intakes, and ventilation systems. Other possible impacts from ash-fall include:

- Volcanic ash with humidity is electrically conductive and can cause short circuits and electrical insulation failures.

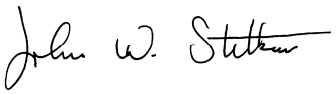
- Ash can cause contamination of plant surfaces and surroundings, potentially leading to radiation exposure risks.

- Ash-fall incidents can challenge the adequacy of emergency preparedness and response plans.

Therefore, it is critical to develop a systematic evaluation of the impact on the plant initial response, as well as the plant performance following the initial response. This evaluation should consider the ash-fall duration and intensity, as well as the plant response (both the design features and procedures) to ash-fall. To this end, data collection and evaluation of these topics are critical for developing a systematic incorporation of ash-fall into the PRA to enable operators to enhance the resilience of their facilities against volcanic hazards and ensure comprehensive risk management in the face of this hazard. As part of their development of the probabilistic ash-fall hazard analyses, the research team should compile data from Japanese and international historical records regarding the durations of volcanic eruptions and ash-fall accumulations.

We look forward to our continuing interactions with the NRRC research team to review the overall research program and individual research projects, and to help the NRRC and the Japanese nuclear industry achieve their goals of comprehensive risk-informed decision-making.

Sincerely,



John W. Stetkar
Chairman

REFERENCES

1. "NRRC Overview: Research Program for FY2025, Risk Informed Decision Making Promotion Team," Presentation to NRRC Technical Advisory Committee, May 27, 2024, Proprietary.

2. "NRRC Overview: Research Program for FY2025, Risk Assessment," Presentation to NRRC Technical Advisory Committee, May 27, 2024, Proprietary.

3. "NRRC Overview: Research Program for FY2025, External Natural Events," Presentation to NRRC Technical Advisory Committee, May 27, 2024, Proprietary.

4. ASME/ANS RA-Sb-2013, Addenda to ASME/ANS RA-S-2008, "Standard for Level 1 / Large Early Release Frequency Probabilistic Risk Assessment for Nuclear Power Plant Applications," American Society of Mechanical Engineers, September 2013.

5. ANS/ASME 58.22-2015, "Requirements for Low Power and Shutdown Probabilistic Risk Assessment", American Society of Mechanical Engineers, 2015 (approved for trial use only).

6. ASME/ANS RA-S-1.2-2014, "Severe Accident Progression and Radiological Release (Level 2) PRA Standard for Nuclear Power Plant Applications for Light Water Reactors (LWRs)," American Society of Mechanical Engineers and American Nuclear Society, January 2015 (version for trial use and pilot applications).