Technical Advisory Committee of the Nuclear Risk Research Center
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SUBJECT: PRELIMINARY NRRC RESEARCH PLAN FOR FISCAL YEAR 2027

Dear Dr. Apostolakis:

During the 24th meeting of the Technical Advisory Committee of the Nuclear Risk Research Center (NRRC), May 18-22, 2026, we met with the NRRC staff to review the proposed preliminary research plan for fiscal year 2027. 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 2027 and the technical objectives of the individual projects within each major research area remain aligned with the NRRC's short-, mid-, and long-term strategic goals.

2. During our review, we identified a cross-cutting issue and four individual research activities that merit additional attention in the preliminary plans for fiscal year 2027 and subsequent years. Our recommendations for those activities are summarized in the Discussion section of this report.

BACKGROUND

One of the primary objectives of the research plan is to articulate the technical context of the identified research needs, including the rationale for prioritization and scope, the current state of knowledge, and the anticipated contributions and significance of the proposed research to the NRRC's overarching goals. Our review of the preliminary research plan focused on the objectives of each research project and its supporting tasks, the technical interrelationships and relative priorities among those activities, and the identification of any significant gaps requiring further research. We did not review the technical details of individual research activities or their completion milestones, except to the extent necessary to assess their integration within the broader plan. We intend to provide separate comments on the technical aspects of individual research projects in future, more detailed reviews.

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 the preliminary research plan for fiscal year 2027 (FY2027) and the technical objectives of the individual projects within each major research area remain aligned with the NRRC's short-, mid-, and long-term strategic goals

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

(1) Cross-Program Integration in NRRC Research Plans

The individual NRRC research programs are technically valuable and generally well organized. However, when the presentations are reviewed together, it is not always clear how results, open issues, and changes from one activity are being incorporated into related research plans. Several cross-program feedback loops appear to be implicit, rather than reflected explicitly in the planning structure. We discuss several examples to highlight the above concern and offer some recommendations.

One example is the relationship among the Multi-Unit PRA (MUPRA) project, the Seismic PRA Model Plant study, and the overall Risk Assessment research plan for FY2027. The MUPRA research summary identifies important methodological issues, including different seismic control points, comprehensive multi-unit scenario identification, simplified versus detailed quantification, and complexities related to the treatment of seismic correlations. These issues are also related to the Seismic PRA Model Plant work, which is addressing improved hazard and fragility methods, foundation ground deformation, slope failure, partial fragility correlations, and more realistic seismic risk profiles. However, the respective research summaries do not clearly relate how the MUPRA findings and Phase 3 of the Seismic PRA Model Plant work will be integrated into the broader Risk Assessment research plan.

A related concern is that the MUPRA research is described as having no specific plans for FY2027 and beyond, even though some of the issues identified in the MUPRA research appear to depend on, or affect, ongoing work in seismic PRA, Level 2 PRA, and integrated risk assessment. If a research program is terminated before open methodological issues are assigned to another activity, those issues may not be visibly tracked to completion.

A second example is the relationship between the Risk-Informed Decision-Making (RIDM) Regulatory Engagement presentation and the RIDM Promotion Team presentation of the research plan for FY2027. The regulatory engagement presentation identifies application-specific roadmaps for On-Line Maintenance (OLM), Containment Vessel Leak Rate Testing (CVLRT), Risk-Informed Inservice Inspection (RI-ISI), Risk-Informed Technical Specifications, and related methodology enhancements. The RIDM Promotion Team research plan includes supporting activities such as expert reviews of pilot plant PRAs, development and implementation of Japanese PRA peer review guidance, reliability parameter development, OLM guideline revision, CVLRT trial applications, RI-ISI pilot evaluation, integrated risk assessment guidance, and RIDM education. However, the two presentations do not clearly show an application-by-application gap closure path.

For example, OLM is identified as a priority application, but specific gaps such as cumulative risk monitoring, external hazard treatment, Technical Specifications interface, and Nuclear Regulation Authority (NRA) engagement milestones are not clearly tied to FY2027 deliverables. Similarly, the CVLRT discussion identifies missing hazards, including internal fires and internal flooding, as potentially important to the risk evaluation, but the RIDM Promotion Team plan does not clearly identify how those missing-hazard issues will be resolved before regulatory engagement or code endorsement activities proceed.

A third example of our general observation is that the project team for the Seismic PRA Model Plant study identified the need for further research and development of methods to quantify the effects from seismic-induced geotechnical hazards, such as foundation ground deformations, slope failures, and seismic-induced hazards related to vibratory ground motion and geotechnical hazard. The overall Seismic PRA research plan for FY2027 includes activities that are related to certain aspects of geotechnical hazards. However, it is not clear to us how the priorities and focused activities for the Seismic PRA Model Plant study align with the overall research plan. Understanding of the interfaces and relationships among these activities will provide a comprehensive picture of NRRC's seismic PRA projects.

These examples suggest that the issue is not the technical quality of the individual research activities. Rather, the concern is that cross-program dependencies are not always visible enough to ensure that important findings from one activity are incorporated into related plans, schedules, and deliverables.

Based on the above discussion, we recommend that NRRC establish an explicit cross-program feedback and gap-closure process as part of the research planning structure.

For each significant cross-cutting issue, the planning documents should identify:

- the source activity where the issue was identified,
- the affected research programs or RIDM applications,
- the responsible organization or team,
- the planned resolution path,
- the expected output, and
- the target closure schedule.

For the Risk Assessment research program, this process should map MUPRA-related issues such as seismic control points, correlation treatment, simplified versus detailed evaluation, and Level 2 site risk implications to the Seismic PRA Model Plant study, Level 2 PRA, and integrated risk assessments, as applicable.

For the RIDM Promotion Team research program, this process should map each priority application, such as OLM, CVLRT, RI-ISI, and Risk-Informed Technical Specifications, to its implementation gaps, supporting research activities, regulatory engagement needs, responsible organizations, and target dates.

This process could be implemented through a cross-program issue-tracking table or dependency map in the research plan. The RIDM Promotion Team's plans to support an FY2026 revision of the Japanese nuclear industry Action Plan for the establishment of RIDM, and the next update of the NRRC Risk Assessment research roadmap would be natural places to incorporate this structure. The goal is not to create an additional administrative burden, but to ensure that important findings and open issues are explicitly transferred, tracked, and resolved across related NRRC activities.

(2) Guidance for Risk-Informed Inservice Inspection

We were briefed on the current status and plans for the NRRC to develop methods and guidance for the implementation of Risk-Informed Inservice Inspection (RI-ISI) programs at Japanese plants. This is a very important initiative. Extensive international experience has shown that RI-ISI programs significantly improve the effectiveness of piping examinations by focusing inspection priorities on the most risk-significant systems and locations of potential degradation. These programs have also resulted in substantial reductions in accrued radiation doses to inspection personnel.

Detailed guidance has been developed for implementation of RI-ISI programs in the United States and other countries. We were informed that it may be necessary to revise some elements of the guidance and the supporting industry standards for their application in Japan. The NRRC has initiated an extended research activity to identify issues in the methods and guidance which may require specific Japanese adaptations. Part of that effort involves the performance of a multi-year trial application to assess the feasibility of implementing RI-ISI in Japan, before the methods and guidance are prepared for use by the industry.

The extensive international experience with successful implementation of RI-ISI at a broad variety of plants has confirmed the technical and operational feasibility of these programs. The NRRC should re-examine the priorities and schedule for this research. Because RI-ISI is a proven methodology with extensive international implementation experience, the application of adapted guidance to a pilot plant should generally be achievable on a shorter schedule than what has been proposed, once the necessary plant information is available. Longer schedules should be tied to clearly identified Japan-specific technical, regulatory, or standards issues.

The research team should expedite the identification of specific technical issues which require adaptation of the available methods and guidance for their use in Japan and develop the necessary refinements. In doing so, the NRRC should consider a phased implementation strategy, consistent with the broader U.S.

experience in implementing RI-ISI through pilot applications, regulatory review, and later codification of lessons learned into approved code cases and guidance. The primary basis for this recommendation is technical: a phased approach would allow the NRRC and the utilities to develop implementation expertise, test the methodology under Japanese plant conditions, identify Japan-specific technical issues, and refine the guidance in a timely and disciplined manner.

An initial phase could focus on reactor coolant pressure boundary piping, or the Japanese equivalent of ASME Code Class 1 piping and welds, because the consequence assessment can rely primarily on existing internal events PRA, LOCA modeling, and safety system response, rather than waiting for completion of a full internal flooding PRA. This initial phase could use applicable U.S. RI-ISI experience and ASME Code Case N-716 concepts as the technical reference framework, while identifying any Japan-specific modifications needed for domestic standards. Subsequent phases could expand to other piping classes, where internal flooding PRA or focused flooding consequence analysis may be more important.

The U.S. RI-ISI implementation experience provides a useful precedent. Early pilot applications using the EPRI and Westinghouse methodologies were closely monitored by the NRC. Those pilot applications helped support approval of specific plant applications and contributed to broader acceptance of RI-ISI methods through subsequent standards, code cases, and regulatory guidance.

Therefore, this type of phased technical approach should be coordinated with a parallel regulatory engagement and acceptance process in Japan. This would help ensure that each phase produces results that are not merely research outputs, but are positioned for practical use by licensees once the necessary acceptance has been obtained.

(3) Level 2 PRA Case Studies

The NRRC has issued reports on three case studies that were performed to demonstrate how detailed analysis methods and models can be applied to refine estimates of radionuclide releases to the offsite environment during a severe accident. The case studies were developed for specific accident scenarios, one for a representative advanced boiling water reactor (ABWR) design, and two for typical pressurized water reactors (PWRs). Two studies developed models for fission product removal through specific containment vessel release pathways. Those studies also developed models for fission product distribution and deposition inside plant buildings, before the releases enter the external environment. One study developed models for fission product scrubbing during a specific PWR steam generator tube rupture (SGTR) scenario that bypasses the containment.

We were briefed on these studies during our November 2025 meeting. They demonstrate the types of analytical methods, models, and tools that can be developed and applied to refine estimates of offsite releases during the examined accident scenarios for a specific plant configuration. These case studies are useful for methodology development, analyst training, and improving understanding of selected fission product transport and retention phenomena. The research team plans to further enhance specific elements of these case studies.

Further refinement of scenario-specific case studies should be prioritized after considering more comprehensive information about the most important contributors to the Level 2 risk for Japanese plants. The specific case study models, analyses, and assumptions may not be directly applicable to an integrated Level 2 plant risk assessment. In practice, other refinements may be more important for utility analysts and managers to understand the most important contributors to the overall plant risk profile and to use PRA models and results for practical risk-informed decisions. Those refinements may be needed for other initiating events, accident scenarios, containment challenges, release pathways, or phenomena that have greater impact on release frequency, release magnitude, release timing, uncertainty, or Level 3 consequences.

Therefore, efforts to further refine these specific case studies should be supported by a clear risk-informed justification. Additional work should be prioritized based on whether it addresses risk-significant accident progression release categories, important source term uncertainties, phenomena applicable to multiple plants or scenarios, or information needed to support RIDM, Level 3 PRA, or risk communication.

The NRRC should re-examine the risk-informed justification for further refinements to these scenario-specific case studies, accounting for experience from international and Japanese Level 2 PRAs for a variety of plant designs and initiating event scopes. The objective should be to ensure that future Level 2 PRA research is prioritized toward the phenomena, scenarios, and uncertainties that are most important to plant risk and to practical risk-informed decision-making.

(4) Methods and Guidance for Integrated Risk Assessment

Our November 27, 2022 letter report on "Proposed NRRC Research Plan for Fiscal Year 2023" recommended that the NRRC should "initiate a research activity to develop methods and practical guidance for the integration of all supporting PRA models and results to provide a full-scope assessment of the overall plant risk and its contributors." Our report also discussed some important technical issues that affect integration of the analyses and results to derive the overall plant risk profile, including a consistent evaluation of the risk contributors and their uncertainties. The NRRC began preliminary research on this topic in fiscal year 2023.

During our November 2025 meeting, we were informed of a proposed industry initiative to develop a multi-hazard Level 2 PRA demonstration study, and we strongly endorsed this initiative. We received additional information about the proposed multi-hazard project during this meeting. The project will provide numerous benefits for the industry, the NRA, and the Japanese public, and it will support a mutual understanding of the technology needed to perform a full-scope evaluation of overall plant risk.

The Integrated Risk Assessment research plan indicates that the NRRC will develop the risk aggregation methodology from FY2027 through at least FY2029, in parallel with the industry's performance of the multi-hazard PRA study. We were not provided with a clear schedule and milestones for development of the methodology and guidance.

Careful consideration of how the various risk contributors are combined can affect the methods used to construct the PRA models, evaluate initiating event frequencies, and define plant damage states and release categories. Therefore, the integration methodology should be developed as early as practical, because it may affect how the PRA models are developed and quantified.

It is important that the industry should begin the multi-hazard PRA study as soon as possible. That project should not be delayed until after the NRRC develops the final risk aggregation guidance. Instead, these efforts should proceed in parallel. The NRRC should increase the priority and accelerate the schedule for developing the key technical elements of the methods, guidance, and tools needed to support efficient integration of the risk from all hazards, so that those elements can be considered during the early stages of the multi-hazard PRA study. This is important, because some elements of the aggregation methods and guidance may affect how the PRA logic models for specific hazards are structured, or how the results are quantified to facilitate their integration into the overall plant risk profile.

(5) Seismic PRA and Seismic PRA Project Using a Model Plant

The plans presented for seismic PRA research and the Seismic PRA Model Plant study (Phases 1, 2, and 3) deal only with the Level 1 PRA risk of core damage. The RIDM Promotion Team research summary indicates that the international expert peer reviews for the Ikata Unit 3 and Kashiwazaki-Kariwa Unit 7 pilot plant PRAs are being performed against the technical requirements for a Level 1.5 PRA. The NRA has also recently indicated that there are no obstacles to applying Level 1.5 PRA models for containment vessel failure during their inspections for nine currently operating units.

Level 1.5 PRAs have been used routinely and effectively to support RIDM activities. We recommend that the Seismic PRA research program should explicitly include the evaluation of seismic effects on containment heat removal, pressure control, and isolation functions as a next practical step, and demonstrate implementation of those methods by extending the Level 1 Seismic PRA Model Plant study to a Level 1.5 PRA. This extension should be prioritized in conjunction with the development plan for Level 1.5 PRA evaluations of internal events. The Level 1.5 Seismic PRA will provide insights that are useful for RIDM and for technical interactions with NRA, without waiting for full Level 2 Seismic PRA development.

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

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