Technical Advisory Committee of the Nuclear Risk Research Center
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SUBJECT: INTERIM REVIEW OF RISK-INFORMED ON-LINE MAINTENANCE GUIDELINE

Dear Dr. Apostolakis:

During the 21st meeting of the Technical Advisory Committee of the Nuclear Risk Research Center (NRRC), November 18-22, 2024, we met with representatives of the NRRC staff to discuss the current status of the guidance for implementation of risk-informed on-line maintenance programs at Japanese nuclear power plants. This letter report documents our review of the July 2024 version of the "On-Line Maintenance Guideline," and additional information about the guidance that was discussed during our meeting

This is a revision of our November 26, 2024 letter report on this topic. It clarifies our understanding of one item that was identified by your staff after our original letter report was issued.

CONCLUSIONS AND RECOMMENDATIONS

1. The Guideline is a positive and constructive step forward toward enabling safety and performance improvements through the use of risk-informed, performance-based on-line maintenance. It is very important that the guidance should fully recognize and accommodate the current status of the PRA models at each Japanese plant. The Guideline should be made available for a preliminary pilot application as soon as practical after the issues that are discussed in this letter report are resolved.

2. To ensure the timely and effective release of the Guideline, additional deliberative sessions should be conducted before our May 2025 meeting to ensure all comments regarding the July 2024 version of the Guideline and their proposed resolutions are fully understood and adequately addressed. Two major comments are:

- There is a need for effective and practical guidance on applying a structured approach to address the total risk associated with equipment being out of service. This structured approach should utilize integrated risk management techniques that incorporate both quantitative and qualitative assessments of all internal and external hazards. Additionally, the approach should provide guidance on implementing both preventive and mitigative measures to manage total plant risk, as well as methodologies for monitoring performance.

- The methods and guidance for demonstrating compliance with the Nuclear Regulation Authority's provisional performance objective for the frequency of cesium-137 releases during the on-line maintenance period should be expanded and clarified.

BACKGROUND

International experience has demonstrated that conducting equipment inspections and preventive maintenance during plant power operation significantly enhances both safety and operating efficiency. These proactive maintenance strategies allow better and more timely maintenance, thereby reducing the likelihood of unexpected failures and minimizing risks associated with equipment malfunctions. In Japan, however, these critical maintenance activities are currently restricted to periods when a plant is shut down for refueling. This approach limits the opportunity for timely interventions that could enhance operational reliability and safety while the plant is online. By restricting maintenance to outages, there is a possibility of accumulating maintenance tasks and potential equipment degradation that may not be addressed promptly.

Other countries have embraced on-line maintenance (OLM) practices that allow for the seamless integration of maintenance tasks into regular operation, maximizing availability and ensuring that plants operate at their highest efficiency. The Japanese nuclear industry is planning to benefit from adopting such practices to improve integrated risk management and overall plant performance. This shift not only aligns with international best practices, but it also supports ongoing efforts to enhance public confidence in the safety and reliability of nuclear power operations in Japan.

At the core of a risk-informed, performance-based OLM program is a comprehensive assessment and management of risks associated with each proposed maintenance activity. By systematically evaluating these risks, the industry ensures that the overall plant risk remains very low during periods when specific equipment is out of service. The assurance of safety is augmented by the introduction of additional risk management measures tailored to particular activities. These measures are designed to address any unique risks that may arise during the maintenance tasks, thereby reinforcing the protection of both the plant and the public. Careful and continuous monitoring of the plant's safety status throughout the OLM period further enhances this assurance, allowing for real-time adjustments and interventions as necessary.

In conclusion, the Japanese nuclear industry's commitment to implement OLM in

conjunction with a risk-informed, performance-based methodology is a significant step forward in ensuring the safety and integrity of nuclear operations. This initiative not only aims to minimize risks, but it also fosters a culture of safety and reliability that is consistent with best practices in nuclear management.

The NRRC guidance for implementation of these OLM programs is based on the fundamental principles of risk-informed decision-making (RIDM). Those principles are described in U.S. Nuclear Regulatory Commission (NRC) Regulatory Guide 1.174, International Atomic Energy Agency (IAEA) TECDOC-1909, and Atomic Energy Society of Japan (AESJ) Standard AESJ-SC-S012E:2019. The NRRC guidance also benefits from the Nuclear Energy Institute (NEI) guidance in NUMARC 93-01, which is endorsed by U.S. NRC Regulatory Guide 1.160.

DISCUSSION

The implementation of risk-informed, performance-based on-line maintenance is a groundbreaking initiative within the Japanese nuclear industry.

A critical aspect of this initiative is the development of guidelines and methods that are consistent with international standards and best practices. Such alignment is paramount in ensuring that all stakeholders (the utilities, the regulator, and the Japanese public) understand how the transition to this program improves both plant availability and overall safety. Moreover, it is very important that these guidelines fully recognize and accommodate the current status of the PRA models at each Japanese plant. Acknowledging this context allows the guidelines to be realistic and achievable, fostering a smoother transition to more advanced risk management practices. By doing so, each plant can target improvements where they are most needed and ensure that resources are allocated efficiently.

Incorporating insights from international experience is particularly beneficial. For example, U.S. utilities have continually improved their use of quantitative methods over time. These advancements have led to the timely implementation of improvements and innovations in safety protocols, risk assessment, and operational practices. Japan's OLM initiative greatly benefits from such lessons, as it opens avenues for steady enhancements in its own risk management processes.

Our members have provided the NRRC research team with several comments on the July 2024 version of the Guideline, specifically highlighting elements that may require further clarification and improvement. Those observations were supplemented by additional feedback received during this meeting, encompassing various critical aspects of the guidance.

Key areas of concern include the effective use of both qualitative and quantitative risk assessment approaches, which are essential for a comprehensive understanding of the risk profiles during the OLM period. Members have emphasized the importance of considering a full range of internal and external events, along with their associated uncertainties, to ensure that all potential risk factors are adequately addressed. Comments have also highlighted the importance

of fully integrating all elements of RIDM, as outlined in Regulatory Guide 1.174 and the AESJ Standard.

The Nuclear Regulation Authority has reached a consensus on a provisional performance objective that the frequency of a release of more than 100 terabecquerels (TBq) of cesium-137 (Cs-137) should remain below 10^{-6} event per year. This performance objective extends beyond the risk considerations that are used in the reference U.S. guidance and methods. Therefore, it is important that the Guideline includes clear methods and consistent guidance to ensure that this objective is met during the OLM period.

Another significant point raised is the necessity for robust performance monitoring programs that facilitate continual management of component capability, reliability, and availability. Clear and concise delineation of the steps embedded within those programs is also crucial, particularly as they pertain to meeting current regulatory expectations and practices.

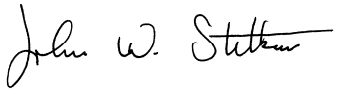
Path Forward

At this stage of our review, it is imperative to engage in further discussions and deliberations with the NRRC research team. Those interactions will improve mutual understanding of our members' comments and development of viable solutions to the questions raised. Such engagement will be vital in refining the Guideline and ensuring that it aligns with regulatory expectations and industry best practices, and is ready for practical use.

Nevertheless, it is equally critical to initiate the use and application of the Guideline as soon as practical, for example by piloting the guidance for an actual plant application. Implementing the methods and guidance on a trial basis will provide valuable insights and feedback, allowing for real-time adjustments that can enhance their effectiveness.

Considering these needs, we respectfully request the scheduling of one or more interactive meetings with participation of the research team and all of our members prior to our May 2025 meeting. This will help the research team to better understand key considerations in our comments and questions. It will also allow our members to better understand the reasons behind the research team's responses. This process will help us to formulate a more responsive set of conclusions and recommendations during our deliberations in our May meeting. If it is feasible, our review would also benefit significantly from an updated version of the July 2024 Guideline, incorporating the research team's consensus changes.

Sincerely,



John W. Stetkar
Chairman

REFERENCES

1. United States Nuclear Regulatory Commission, Regulatory Guide 1.174, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis," Revision 3, January 2018.

2. Nuclear Energy Institute, NUMARC 93-01, "Industry Guideline for Monitoring the Effectiveness of Maintenance at Nuclear Power Plants," Revision 4f, April 2018.

3. United States Nuclear Regulatory Commission, Regulatory Guide 1.160, "Monitoring the Effectiveness of Maintenance at Nuclear Power Plants," Revision 4, August 2018.

4. United States Nuclear Regulatory Commission, NUREG-1855, "Guidance on the Treatment of Uncertainties Associated with PRAs in Risk-Informed Decision making", Revision 1, March 2017.

5. International Atomic Energy Agency, IAEA-TECDOC-1909, "Considerations on Performing Integrated Risk Informed Decision Making," 2020.

6. Atomic Energy Society of Japan, Standard AESJ-SC-S012E:2019, "Implementation Standard Concerning Integrated Risk-Informed Decision Making for the Continuous Safety Improvements in Nuclear Power Plants: 2019," March 2022.

7. Nuclear Risk Research Center, "On-Line Maintenance (OLM) Project in Japan," Presentation to NRRC Technical Advisory Committee, May 2022, Proprietary.

8. Nuclear Risk Research Center, "Briefing on Risk-Informed OLM," Presentation to NRRC Technical Advisory Committee, November 2022, Proprietary.

9. Nuclear Risk Research Center, "On-Line Maintenance Guidelines (Draft)," January 2023, Proprietary.

10. Nuclear Risk Research Center, "Draft Guidelines for On-Line Maintenance," Presentation to NRRC Technical Advisory Committee, May 2023, Proprietary.

11. Nuclear Risk Research Center, Research Report NR23002, "On-Line Maintenance Guideline," October 2023.

12. Nuclear Risk Research Center, "Recent Activities by RIDM Team," Presentation to NRRC Technical Advisory Committee, November 2023, Proprietary.

13. Stetkar, J. W., "Comments and Questions on On-Line Maintenance Guideline, CRIEPI Report NR23002," December 1, 2023, Confidential.

14. Miraucourt, J-M., "Comments and Questions on On-Line Maintenance Guideline, CRIEPI Report NR23002," February 1, 2024, Confidential.

15. Nuclear Risk Research Center, "Revisions to the On-Line Maintenance (OLM) Guideline," Presentation to NRRC Technical Advisory Committee, May 2024, Proprietary.

16. Nuclear Risk Research Center, Research Report NR24001, "On-Line Maintenance Guideline (Rev. 2024) – Expansion of Scope of Application (Simultaneous Implementation of Multiple Systems, etc.)," July 2024, Proprietary.

17. Technical Advisory Committee individual members' comments and questions on "On-Line Maintenance Guideline (Rev. 2024) – Expansion of Scope of Application (Simultaneous Implementation of Multiple Systems, etc.), CRIEPI Report NR24001," September 2, 2024, Confidential.

18. Nuclear Risk Research Center, "Policy on Responding to the OLM Guidelines Based on Reviews from TAC Members," Presentation to NRRC Technical Advisory Committee, November 2024, Proprietary.