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 11, 2018
Revision 1

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

SUBJECT: IMPLEMENTATION GUIDE ON DATA COLLECTION FOR PROBABILISTIC RISK ASSESSMENT

Dear Dr. Apostolakis:

During the ninth meeting of the Technical Advisory Committee of the Nuclear Risk Research Center (NRRC), May 21-25, 2018, we met with representatives of the NRRC staff to discuss the status of guidance for the collection of equipment performance data at Japanese nuclear power plants. This letter report documents our review of the draft "Implementation Guide on Data Collection for Probabilistic Risk Assessment (PRA)".

CONCLUSION AND RECOMMENDATIONS

1. The current scope of the guidance covers the collection of plant operating experience that is needed to derive component failure rates. The format of the documentation for the individual plant data collection records is consistent with state-of-the-practice methods that provide traceability of decisions regarding the equipment condition, the basis for categorizing specific events, and the derivation of relevant operating and testing exposure data.

2. The data collection guidance should clearly state that historical operating experience should be compiled from all nuclear power plants, including plants that have restarted, plants that are planned to restart, and plants that will remain shutdown permanently. That practice will provide the best possible generic database for use in all Japanese PRAs.

3. The guidance should be improved to better define the scope of the systems, component types, and failure modes for which data will be collected at all nuclear power plants. This will ensure that the database will consistently support the development of high-quality plant-specific and generic data for the Japanese

nuclear industry. The Discussion section of this report contains our suggestions about how to achieve these improvements.

BACKGROUND

To support the development of high-quality probabilistic risk assessments (PRAs) and to establish a comprehensive database that can be maintained and updated as additional operating experience is compiled, the NRRC has developed draft guidance for the collection of data at each Japanese nuclear power plant. The current guidance addresses the compilation of operating experience that will be used to derive individual component failure rates (i.e., component failure events and the corresponding number of component demands, operating hours, and test intervals). Additional guidance is planned for the compilation of operating experience that will support the development of data for common cause failure parameters and equipment unavailability due to maintenance and other causes.

The version of the draft report that was provided for our review did not contain the annexes, which describe details for specific elements of the guidance, database records, and documentation. Therefore, our observations and recommendations in this letter report are limited to the material in the main body of the draft guidance, supplemented by our discussions with the NRRC experts during our meeting.

DISCUSSION

The overall guidance is generally consistent with state-of-the-practice methods for the collection of plant-specific operating experience that will be used to derive individual component failure rates (e.g., failures to function on demand and failures during operation). In particular, the systematic documentation of decisions by plant personnel regarding the technical basis for categorizing specific events provides a fully-traceable record of the assessed extent of the equipment condition, without the need to re-examine all details of the original operating and maintenance records. The documentation of the equipment exposure data similarly provides a clear summary of the operating experience, testing records, and methods that are used to derive the relevant number of component demands, operating hours, and standby equipment test intervals.

We understand that the detailed documentation of these tasks will be retained by each plant, and only the relevant records of component failures and exposure data will be submitted to the NRRC. The NRRC data analysis experts will then use the evidence from each plant to derive the component failure rates. The data from all plants will also be used to develop a comprehensive and consistent generic database that applies for the entire Japanese industry.

Realistic and consistent operating experience from all Japanese nuclear power plants is needed to support the development of a comprehensive database that will be used in high-quality full-scope Level 1 and Level 2 PRAs that evaluate the risk from all internal and external hazards during all plant operating modes. To support development of a fully inclusive generic database, relevant data should be collected

from as many plants as possible. We understand that no formal decision has yet been made regarding the collection of data from plants that will remain shutdown permanently. The historical data from those plants are equally relevant to the industry experience before March 2011 as the historical data from plants that have restarted or plan to restart. Therefore, the data collection guidance should clearly state that historical operating experience should be compiled from all nuclear power plants, including plants that have restarted, plants that are planned to restart, and plants that will remain shutdown permanently. That practice will provide the best possible generic database for use in all Japanese PRAs.

We and the NRRC data experts clearly recognize the fact that a very substantial amount of effort is needed to collect this information. Furthermore, that effort requires critical involvement of valuable plant personnel who are most familiar with their own plant's operating, testing, and maintenance records, and who can interpret the available information to understand the extent to which a component's condition was affected during a particular event. It is essential that these activities are performed efficiently to make the best use of the available resources and to ensure that all relevant operating experience is compiled consistently at each plant. This is especially true for the initial efforts to collect the historical operating experience, before the establishment of plant programs and data management systems that will be used for regular compilation of future data.

Our review of the guidance identified some areas where the screening criteria and examples seem to be too narrowly focused. These criteria seem to require that the plant data collection engineers must make difficult decisions regarding the applicability of specific failure modes for individual components in each system as they review their plant's operating experience. Different interpretations and applications of these detailed criteria may result in significant plant-to-plant differences in the ways that data are collected for specific systems, component types, and failure modes. Those differences would then result in gaps or inconsistencies in the operating experience that is used to support a comprehensive and traceable generic Japanese industry database. Furthermore, the need for difficult screening decisions by each plant data collection engineer will increase the effort that is needed to compile and document the operating experience that consistently correlates data for specific failure modes with the corresponding equipment exposure data.

To avoid potential gaps and inconsistencies, the guidance should be improved to better define the scope of the systems, component types, and failure modes for which data will be collected at all nuclear power plants. We offer the following suggested enhancements for two elements of the guidance.

Scope of Systems and Components for Data Collection

It is very useful for the guidance to contain a "master list" of the systems for which every plant will compile their operating experience. This generic master list should contain every system that is included in the PRA models for any nuclear power plant in Japan. The master list improves confidence that each plant data collection engineer clearly knows "what is in" and "what is out" of their scope of work.

Selection of the master list of systems is a critical element of the guidance. The authors of the guidance should develop a preliminary list, based on their experience from a broad variety of PRAs that have been performed for operating PWRs and BWRs. The authors should then confer with the PRA analysts at each Japanese nuclear power plant to understand the scope of the systems that are included in their current PRA models and systems that may be added as the PRA scope is extended.

In practice, the master list may contain a small number of systems that are not included in the current scope of a particular plant-specific PRA. Some of those systems may be added to the models as the PRA is extended to evaluate additional hazards and operating modes, and to evaluate the risk from offsite releases. Other systems may not be directly relevant for the particular plant PRA, but the data for equipment in those systems are relevant for other plants. In any case, regardless of the details in a particular plant-specific PRA model, the actual equipment operating experience from that plant is directly relevant to the development of a comprehensive, consistent, and traceable database that can be used throughout the Japanese industry. Therefore, the data should be collected to support the generic database.

Within this framework, each plant data collection engineer will compile data for all equipment in each system in the master list. The plant data collection engineers do not need to have a detailed understanding of the plant-specific PRA, its current scope, possible future extensions, assumptions about models for specific components and failure modes, etc. The engineers can then focus their efforts on their specific area of expertise – efficient compilation and understanding of the plant operating experience.

This practice improves overall efficiency of the data collection effort, and it retains a consistent focus on the systems and components that are potentially important to plant risk. It also avoids sources of inconsistency that may arise if individual data collection engineers have different interpretations of the potential relevance of specific systems or components at each plant.

Scope of Component Types and Failure Modes

The plant data collection engineers should compile the operating experience for all component types and failure modes in every system from the master list. This effort should not apply distinct screening criteria for individual component failure modes. For example, the plant-specific PRA models may include only the "fail to open" failure mode for a particular motor-operated valve. However, the operating experience for that valve will include evidence for both the "fail to open" and the "fail to close" failure modes. The evidence for both failure modes is relevant to the data for similar motor-operated valves at that plant, and it is relevant to the data for similar motor-operated valves at other plants. Therefore, the plant data collection engineers should not screen out the operating experience for specific failure modes.

Again, experience has shown that this practice improves overall efficiency, improves consistency within the plant-specific data, and improves consistency and completeness in the generic industry data. That is because each plant data collection engineer does not need to make sometimes difficult decisions about subtle

details of a specific event, how those details might affect the PRA models, and how those considerations affect the final categorization of the event.

The guidance in NUREG/CR-6928, "Industry-Average Performance for Components and Initiating Events at U.S. Commercial Nuclear Power Plants," contains a list of component types and failure modes that are used in many PRAs performed in the U.S. It may be useful for the authors of the NRRC data collection guidance to refer to that report to ensure that the scope of the data collection effort does not inadvertently omit plant operating records for specific component types and failure modes. However, care must be exercised when the lists in NUREG/CR-6928 are compared with the data needs for Japanese PRAs. In particular, the component boundaries that are defined in NUREG/CR-6928 are slightly different from those in current Japanese PRA models. Those differences will affect how the data are compiled and analyzed for some types of components, such as circuit breakers, instrumentation, relays, elements of solid state or digital control circuits, etc. The guidance should contain clear examples to ensure that the plant data collection engineers understand these distinctions and to ensure that the operating experience for these types of components and failure modes is not inadvertently omitted from the database.

We look forward to continuing our review of this important guidance for plant data collection, as it is extended to include other types of data. We also look forward to reviewing the guidance and methods that will be used by the NRRC data analysis experts to develop the Japanese industry generic database and to combine the plant-specific and generic data for use in each plant's PRA.

Sincerely,

John W. Stetkar
Chairman

REFERENCES

1. Nuclear Risk Research Center (NRRC), Central Research Institute of Electric Power Industry (CRIEPI), "Implementation Guide on Data Collection for Probabilistic Risk Assessment (PRA)," Revision 1, Draft (without Annexes), April 2018.

2. "Development of PRA Parameter Database (Implementation Guide on Data Collection for PRA)," NRRC Staff Presentation to NRRC Technical Advisory Committee, May 22, 2018 (confidential).

3. "Development of PRA Parameter Database - Supplement," NRRC Staff Presentation to NRRC Technical Advisory Committee, May 22, 2018 (confidential).

4. U.S. Nuclear Regulatory Commission, "Industry-Average Performance for Components and Initiating Events at U.S. Commercial Nuclear Power Plants," NUREG/CR-6928, February 2007.

5. U.S. Nuclear Regulatory Commission, "Industry-Average Performance for Components and Initiating Events at U.S. Commercial Nuclear Power Plants," NUREG/CR-6928, Component Reliability Data Sheets, 2015 Update, available at https://nrcoe.inel.gov/resultsdb/AvgPerf.