August 15, 2016

MEMORANDUM TO: Kevin Hsueh, Chief
Licensing Processes Branch
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

FROM: Joseph J. Holonich, Senior Project Manager ***/RA/***
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SUBJECT: SUMMARY OF MAY 5, 2016, MEETING WITH THE ELECTRIC POWER RESEARCH INSTITUTE ON MATERIALS RELIABILITY PROGRAM (MRP)-227-A, "PRESSURIZED WATER REACTOR INTERNALS INSPECTION AND EVALUATION GUIDELINES"

On May 5, 2016, the U.S. Nuclear Regulatory Commission (NRC) staff met with representatives from the Electric Power Research Institute. The purpose of the meeting was to discuss (1) staff's proposed screening criteria for thermal embrittlement (TE) and irradiation embrittlement (IE) of cast austenitic stainless steel (CASS) reactor vessel internals (RVI) components in pressurized water reactor (PWR) and boiling water reactor (BWR) plants and (2) the status of technical reports (TRs) intended to generically address aspects of MRP-227-A "Pressurized Water Reactor Internals Inspection and Evaluation Guidelines," action items (AIs). Under the second item, these reports include PWROG-15032-NP, "PA-MSC-1288 Statistical Assessment of PWR RV [reactor vessel] Internals CASS Materials," PWROG-14048-P, "Functionality Analysis of CASS Lower Support Columns," and a report to be submitted in to NRC in the future on cold work. Information related to the meeting including the presentations can be found in the Agencywide Documents Access and Management System package for the meeting at Accession No. ML15334A120.

At the meeting it was agreed that there were several AIs from the MRP-227-A review that would benefit from being addressed generically, including AI 1 to demonstrate plant-specific applicability of MRP-227-A, and AI 7 for plant-specific evaluation of CASS components. The presentations focused on providing information that would support generic resolution of the topics.

For the screening criteria for TE and IE of CASS RVI in BWR and PWR plants, the staff presented its technical basis for new guidance that would incorporate screening limits of 20 percent delta ferrite for TE and 1 displacement-per-atom (dpa) for IE. The staff indicated it expects to publish these screening criteria in a license renewal interim staff guidance (ISG) document.

As part of the discussion of PWROG-15032-NP, the NRC staff provided five preliminary requests for additional information (RAI) questions. Enclosed are the questions.

With respect to preliminary RAI 1, the PWR Owners Group (PWROG) clarified that the CASS chemical composition data in PWROG-15032-NP was retrieved during searches performed in response to plant-specific RAI questions. Therefore, additional effort would be required to retrieve more plant-specific records. Thus, the report would not include any chemical composition data for RVI components at specific plants that have not yet searched for their records. Therefore, the intent of the PWROG is to use the 95/95 upper bound ferrite based on the data in the report to screen out TE for CASS components without searching for plant-specific chemical composition records going forward. Chemical composition records could potentially be located for such plants, but to have to search for the records would partially defeat the purpose of the TR.

For preliminary RAI 2, related to heat treatment of CASS RVI components, the PWROG representatives confirmed that all CASS RVI components were solution treated and this is called out in material specifications and standards such as American Society for Testing and Materials (ASTM) A351.

With respect to preliminary RAI 3, which asked how the p-values were determined, the PWROG representatives stated during the meeting that the p-values were determined based on the Minitab software. The PWROG representatives also stated that the p-values were only one of the three tools used to assess the fit of the data.

From discussion during the meeting, the staff understands that the 95/95 lower bound fracture toughness values in the report are only used to support the conclusion that all low molybdenum CASS RVI materials will have a toughness well above the 255 kJ/m^2 screening limit used as the basis for the delta ferrite screening criteria in the NRC guidance for TE screening of CASS, and that the 95/95 lower bound fracture toughness values in the report will not be used for any specific flaw tolerance or fracture mechanics evaluations. Since preliminary RAI 4 concerned the conservatism of the determination of the 95/95 lower bound fracture toughness values in the report, based on the above information, a response to preliminary RAI 4 is not needed and RAI 4 would be removed from the formal set of RAI questions.

Preliminary RAI 5 concerned the effect on the overall population 95/95 lower bound ferrite value of the data from the manufacturer Kearsarge, which accounted for over half the data for Grade CF8 CASS, and had a relatively low 95/95 upper bound ferrite value. The PWROG representatives indicated during the meeting that it had not determined a 95/95 upper bound ferrite value for all the data excluding Kearsarge. The PWROG representatives indicated that they believe it is not appropriate to exclude the Kearsarge data because it makes up a large percentage of the data and excluding it would unfairly skew the 95/95 upper bound ferrite value to a higher value.

The staff indicated that it would review the information from the discussion of the five preliminary RAI questions during the meeting and determine if it would be able to eliminate any of the other RAI questions.

The NRC staff presented a status of its review of PWROG-14048-P Rev. 0, which is complete and documented in a publically available safety assessment. The PWROG representatives in the presentation indicated they are working on Revision 1 to PWROG-14048-P in which it intends to demonstrate applicability of the conclusions of the report to all Combustion Engineering and Westinghouse-design PWRs and address staff recommendations from the

safety assessment of PWROG-14048-NP, Rev. 0. The revised report is expected to be submitted for information early in the second quarter of 2017. Once the revised report is approved by the staff, AI 7 could be resolved for lower support columns, the main CASS component of interest in Combustion Engineering and Westinghouse-design RVI.

The PWROG representatives also presented a status of the development of report PWROG-15105-NP, which documents the review of RVI fabrication records for cold worked components. MRP-227, AI 1, in part, requires a verification that there are no components with cold work not assumed during development of MRP-227-A, as such components have a higher risk of stress corrosion cracking. The report would provide a basis to eliminate plant-specific searches for fabrication records for cold work. The PWROG intends to submit this report to the NRC for information in the near term.

In closing it was agreed that once the information discussed at the meeting was docketed and if the supporting reports are found acceptable by the NRC staff, the licensees could reference the generic reports for AI 7 and the cold-work aspect of AI 1. This would eliminate the need for plant-specific data searches or analysis to resolve the action item.

The sole action item from the meeting was for the NRC staff to review the information from the discussion of the five preliminary RAI questions during the meeting and determine if the RAI questions could be eliminated.

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As stated

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PRELIMINARY INFORMATION FOR MAY 5, 2016, MEETING

REQUEST FOR ADDITIONAL INFORMATION
PRESSURIZED WATER REACTOR OWNERS GROUP REPORT
PWROG-15032-NP, REVISION 0, "PA-MSC-1288 STATISTICAL ASSESSMENT OF PWR RV INTERNALS CASS MATERIALS"

1. Based on Section 4.1 of Pressurized Water Reactor Water Owners Group (PWROG)-15032, Revision 0 (the topical report, TR), it appears that many specific components in specific plants can be traced to specific material heats in the dataset. Since it would be more accurate use the component-specific composition to estimate the ferrite content when this information is known, rather than the TR methodology, the staff requests the PWROG to state if it intends to allow the use the 95/95 upper bound ferrite value for any component regardless of whether the component-specific composition is known, or only when the component-specific composition is unavailable (i.e., certified material test report (CMTR) is missing). If the intent is to allow the statistical approach even when the CMTR is available, the staff requests the PWROG to provide a technical justification.

2. TR Section 4.3, on p. 4-6 states that a further conservatism is that, in practice, CASS components would have been heat treated, using a least a partial solution treatment. Does the PWROG have documentation that heat treatment was performed on CASS components? If not, the staff recommends this statement be removed from the TR.

3. TR Section 4.6, p. 4-8 indicates p-values were used as a tool to determine the validity of the application of the normal or lognormal distribution, with an acceptance criterion that p be greater than 0.05 (95 percent confidence). Provide examples of the calculation of the p-values for some of the manufacturer's distributions – one for a p-value meeting the acceptance criteria and one example for a distribution where the p-value does not meet the acceptance criterion. Provide a reference for the use of p-values in this manner.

4. In the TR methodology, fracture toughness for each heat in the dataset was estimated using the NUREG/CR-4513 equations as modified by NUREG/CR-7185, for material with a known chemical composition. The 95/95 lower bound fracture toughness for the population was then determined based on these fracture toughness values. The staff notes that toughness can vary significantly for CASS materials with identical estimated ferrite content but different chemical compositions. Since the TR is intended to be used for material for which no CMTR is available, it would be more conservative to use lower-bound fracture toughness based on the equations in NUREG/CR-4513/7185 for known ferrite content and unknown chemical composition. Comparison of the lower bound fracture toughness for each manufacturer, material grade and casting method shows that the NUREG/CR-4513/7185 equations for material of known ferrite content but unknown composition yield lower fracture toughness values. For example, for static cast Grade CF8 with >15 percent ferrite, the NUREG/CR-4513 equation yields a lower bound toughness of 364 kJ/m^2. By comparison, using the methodology of the TR, TR Table 5-5 indicates that for the six manufacturers of static-cast Grade CF8 with a 95/95

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upper bound ferrite greater than 15 percent, the 95/95 lower bound toughness values range from 364-448 kJ/m^2.
In light of the above, justify using the equations based on known chemical composition to estimate the fracture toughness values used to determine the 95/95 lower bound toughness.

5. Kearsarge accounts for over 50 percent of the CASS heats in the dataset. Since the 95/95 upper bound ferrite is relatively low for Kearsarge, this tends to skew the overall population. Therefore, it may be nonconservative to use the overall population 95/95 upper bound ferrite for components of unknown manufacturer, especially if the component is of a type not known to be manufactured by Kearsarge. The Kearsarge data would also increase the 95/95 lower bound fracture toughness, if determined for the overall population. The staff requests the PWROG to:

    a. Justify using the overall population 95/95 upper bound ferrite value when the manufacturer is unknown, considering the bias due to the Kearsarge data.

    b. Provide a 95/95 upper bound ferrite value for the overall population excluding Kearsarge.

    c. Describe how the conclusions about the fracture toughness would change if the Kearsarge data were excluded.