May 13, 2008

MEMORANDUM TO: Eric J. Leeds, Director
Office of Nuclear Reactor Regulation

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SUBJECT: FOREIGN TRAVEL TRIP REPORT—NRC STAFF VISIT TO JAPAN TO MEET WITH JAPAN NUCLEAR ENERGY SAFETY (JNES) ORGANIZATION CONCERNING PRESSURIZED-WATER REACTOR CONTAINMENT RECIRCULATION SUMP PERFORMANCE

Three Nuclear Regulatory Commission (NRC) staff members traveled to Japan, on April 6–11, 2008, to discuss pressurized-water reactor (PWR) containment recirculation sump performance with representatives from the Japan Nuclear Energy Safety (JNES) Organization. Among the significant topics discussed during these meetings at JNES headquarters in Tokyo were the current resolution status of PWR sump performance issues in the United States and Japan, integrated chemical effects head loss testing, downstream effects, and boiling-water reactor (BWR) emergency core cooling system (ECCS) strainer performance. In addition, the staff's trip included a visit to the test facility in Yokosuka that was used for the integrated chemical effects head loss testing conducted by JNES. The attached foreign travel trip report describes significant aspects of the staff's meetings with JNES and the visit to the integrated chemical effects head loss test facility.

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Post-Mission Final Trip Report

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Final Trip Report

Travel Dates: April 6 – 11, 2008

Travelers: John Lehning, Matthew Yoder, Michael Scott

Locations: Tokyo and Yokosuka, Japan

Organization/Committee: Japan Nuclear Energy Safety (JNES) Organization

Sensitivity: Public

Desired Outcomes:

(1) Improved understanding of chemical effects phenomena following a postulated loss-of-coolant accident (LOCA), based on discussion of Japanese test results and experiences

(2) Improved understanding of debris transport and strainer head loss phenomena following a postulated LOCA, based on Japanese testing and analytical work.

(3) Gaining understanding of the Japanese strainer performance analysis methodology for boiling-water reactors (BWRs)

(4) Continued cooperation between U.S. and Japan on strainer-related issues.

Results Achieved:

The staff was successful in fulfilling the essential trip missions, as follows:

(1) The staff attained an improved understanding of chemical effects phenomena based on discussions of JNES test results and a trip to the test facility where the JNES tests were conducted. The staff obtained copies of the slides presented by JNES regarding their test results, as well as a copy of a test report that will be translated into English.

(2) The staff attained an improved understanding of debris transport and head loss phenomena from JNES presentations and follow-on discussions. JNES presented the results of head loss testing performed to examine the effect of debris sequencing and size distribution.

(3) The staff attained an improved understanding of the methodology used by the Japanese to analyze BWR emergency core cooling system (ECCS) strainer performance. The guidance used by the Japanese in their recent resolution of BWR strainer issues was similar to the Utility Resolution Guidance (URG) methodology used by U.S. BWRs in the late 1990s. Chemical effects and downstream effects have not been resolved for Japanese BWRs, although some chemical effects testing has been performed by JNES for BWR conditions.

(4) The staff's trip improved co-operation with Japan on strainer performance issues. The information exchanged during the meetings with JNES was valuable to both organizations in deepening understanding of technical issues, helping focus regulatory efforts on issues of significance, and clarifying future plans and potential opportunities for information exchange.

Significant Information from Trip:

- JNES long-term chemical effects testing for a BWR condition suggested that post-LOCA-generated corrosion products in a BWR environment could have the potential to induce significant head loss increases. Although the testing was conducted for Japanese BWR

conditions, which may be different than those of U.S. BWRs, the JNES results reinforce the staff's view that U.S. BWR licensees should consider testing or analysis to understand the potential for chemically generated material that may impact head loss across a strainer. Currently, the NRC staff is discussing the subject of chemical effects testing in a BWR environment with the BWR Owners Group and also performing scoping analysis of this phenomenon to determine whether additional actions are necessary.

- JNES testing showed that debris beds formed with fine fibrous debris resulted in a significantly higher head loss than beds formed with coarser debris. This behavior observed by JNES is consistent with the staff's expectation that a significantly higher head loss typically results from fine debris beds, as compared to debris beds that include shreds or larger debris pieces. The JNES test results also indicated that the threshold quantity of debris necessary to cause a head loss increase associated with thin-bed formation was reduced for fine fibrous debris as compared to larger shreds. These results are also consistent with the NRC staff's expectations based on previous testing. The issue of preparing test debris in a prototypical size range is already addressed in the staff's review guidance for head loss and vortexing.

- JNES testing showed that adding the 30-day quantity of acid generated post-LOCA at the start of a chemical effects test resulted in a large pH swing and caused an increasing measured head loss trend to be suddenly and drastically reduced. Although non-prototypical, JNES had expected that adding the full quantity of acid at the start of the test would be conservative by maximizing corrosion. However, following the completion of the JNES chemical effects tests, in light of the observed effect on head loss, this conclusion was questioned. The NRC staff noted that similar questions had earlier been raised regarding the Alion/VUEZ test protocol, which also specified the addition of the 30-day quantity of acid at the beginning of integrated chemical head loss testing. The staff will consider the JNES information in evaluating the similar issue for the Alion/VUEZ testing.

- JNES test results exhibited significant variation in measured head loss in response to variations in the debris addition sequence. The debris sequencing tests indicated that addition of rockwool debris before calcium silicate caused the highest head loss. The other debris addition sequences examined were (1) calcium silicate prior to rockwool, and (2) a homogeneous mixture of rockwool and calcium silicate. The JNES results showing a lower head loss for the homogeneous addition sequence are similar to results obtained previously by NRC-sponsored research. However, the staff noted that a recent head loss test performed by a U.S. strainer vendor demonstrated different behavior than the JNES tests. The U.S. vendor's tests showed that, for one plant's debris loading, adding the fibrous debris before the particulate debris resulted in a relatively low head loss, whereas adding the particulate before the fiber resulted in a significantly higher head loss. The staff considered the U.S. strainer vendor's testing to be more representative of a plant condition than the JNES testing, since the U.S. vendor's test had been performed on a full-scale strainer module (as opposed to a small flat plate) and the debris bed had been formed under prototypical flow. The issue of debris sequencing is already addressed in the staff's review guidance for head loss and vortexing.

- The JNES testing included a limited examination of techniques for forming debris beds. The test results demonstrated that allowing debris to approach the test screen in a representative flow stream results in a higher head loss than pouring debris directly onto the test screen. The JNES test results are consistent with observations made by the NRC staff regarding Alion/VUEZ testing, which employs a similar bed-pouring methodology to form debris beds

that the staff considers non-prototypical of debris beds formed by a representative flow. The staff will consider the JNES information in evaluating the similar issue for the Alion/VUEZ testing.

- Based upon presentations made by JNES, the staff observed that the recent Japanese resolution of BWR strainer blockage issues was based upon the NRC-approved guidance for BWRs developed in the mid-1990s. Few improvements to this guidance appeared to have been implemented based on new research and staff positions associated with the resolution of GSI-191 for PWRs. As a result, many of the same disparities between the approved guidance for analyzing BWR and PWR strainer performance identified by the NRC staff for U.S. plants appear to be present in Japan, (and likely other countries that have similarly based their methodologies on U.S. guidance). Therefore, the planned NRC effort to analyze these disparities for U.S. plants will likely have the added benefit of resulting in other countries subsequently reconsidering and addressing disparities as necessary for their plants.

Additional NRC Staff Presentations:

The NRC staff presentations included the following: (1) status of the resolution of PWR strainer performance issues in the U.S., (2) a summary of NRC staff efforts on chemical effects, (3) NRC staff review of downstream effects topical reports, (4) NRC staff efforts to assess the need to re-evaluate certain issues for BWR ECCS strainers, (5) NRC staff positions on coatings debris, and (6) NRC staff review of head loss testing performed for U.S. PWRs. Some points regarding these discussions that are worthy of mention follow.

With regard to downstream effects, JNES indicated that the issue is seen as “long-term” in Japan. They have not done significant work that added to the staff’s knowledge base in this area. The NRC staff representatives indicated that future testing regarding downstream effects, particularly in-vessel effects, would be very helpful to enhancing the global state of knowledge in this area. The JNES participants agreed to consider performing such tests.

The Japanese appear to be somewhat behind the U.S. in reconsideration of BWR strainer issues. However, their chemical effects testing is potentially of use in ongoing NRC staff discussions with industry regarding whether additional work is needed to address BWR ECCS strainer performance, as discussed above.

Next Steps:

The staff is planning to have the test report for the JNES integrated chemical effects head loss testing translated into English. After reviewing the translated test report, the staff will further assess the results of the JNES integrated chemical effects head loss tests with respect to potential insights for U.S. plants. The NRR travelers plan to share the information obtained from the JNES test simulating BWR conditions with the NRC Office of Nuclear Regulatory Research as an input to the scoping analysis of chemical effects in a post-LOCA BWR environment requested in a User Need Request Memorandum dated August 24, 2007. The staff has requested permission from JNES to share the results of the JNES testing with the BWR Owners Group, which has stated that additional analysis or testing to address the potential for chemical effects for BWRs is not necessary. JNES stated that they would consider this request.

Were policy issues or other items of Commission interest raised?

No.

If yes, how will the Commission be informed?

Not applicable.

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