UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
WASHINGTON, DC 20555 - 0001

September 17, 2010

The Honorable Gregory B. Jaczko
Chairman
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Subject: COMMENTS ON SECY-10-0113, "CLOSURE OPTIONS FOR GENERIC SAFETY ISSUE – 191, ASSESSMENT OF DEBRIS ACCUMULATION IN PRESSURIZED WATER REACTOR SUMP PERFORMANCE"

Dear Chairman Jaczko:

During the 575th meeting of the Advisory Committee on Reactors Safeguards (ACRS), September 9-11, 2010, we reviewed the staff response to Staff Requirements Memorandum (SRM), dated May 17, 2010, that required submission of a Notation Vote policy paper on approaches to close Generic Safety Issue (GSI)-191, "Assessment of Debris Accumulation on Pressurized Water Reactor (PWR) Sump Performance." Our Subcommittee on Thermal-Hydraulic Phenomena reviewed the staff response during a meeting on September 7, 2010. During this meeting, we had the benefit of discussions with representatives of the NRC staff, the Nuclear Energy Institute (NEI), and South Texas Project (STP) and the documents referenced.

CONCLUSIONS AND RECOMMENDATIONS

1. The staff has thoroughly reviewed three options to close GSI-191.

2. Option 1, which maintains the current holistic resolution process, and Option 2, which would develop risk-informed guidance that takes into account the lower probability of large-break loss of coolant accidents (LOCAs), are both acceptable, provided that a reasonable schedule for reaching resolution is adopted.

3. Option 3, which would use General Design Criterion (GDC)-4 to exclude debris generation during LOCAs for leak-before-break (LBB) qualified piping, should not be considered further.

4. Although more information and analyses will become available in time, current experience suggests that doses for large scale replacement of insulation at the remaining plants are likely to be at or below the lower end of the range estimated by NEI.

5. In-vessel effects and sump screen performance are inextricably intertwined in determining the efficacy of long-term cooling. While it may delay the ultimate resolution of GSI-191, we recommend against treatment of in-vessel effects as a separate generic issue.

BACKGROUND

GSI-191 was initiated to determine the potential for debris blockage of emergency core cooling system (ECCS) sump screens that might interfere with the long-term cooling of PWRs following a LOCA. Resolution of GSI-191 has proven to be a Herculean task – hydra-like in that whenever an issue was thought to be closed, two more emerged. Because of the complexity of the phenomena, development of predictive models is very difficult. No reliable methods for estimating pressure losses due to debris accumulation on sump screens and in the core are available. Nonetheless, much has been learned since GSI-191 was opened. Resolution based on bounding estimates of the key parameters appears to be within reach. Debris loadings have been generated on the basis of a zone of influence (ZOI) model which we criticized for being insufficiently conservative in some cases and excessively conservative in others, but which we have accepted. Similarly, we and the staff have accepted debris transport models that suspend essentially all fine particles and fibers since more sophisticated settling models are difficult to validate in turbulence conditions prototypical of full-scale plants.

Our October 22, 2008, letter endorsed the staff's efforts towards closure using bounding approaches, including staff-approved testing protocols that account for turbulence and chemical effects, and the current holistic integrated resolution process. In-vessel effects arising from debris that might pass through the sump screens and accumulate in the core still remains an open issue, but progress is being made. Over the next several months, the resolution of this issue will be reviewed and evaluated.

Measures taken, or being taken, with regard to sump screen blockage by 46 of 69 PWR plants are satisfactory, and there is now a clear path forward to resolving GSI-191 provided that in-vessel effects can be dealt with. These measures include increases in sump screen area in all plants, removal of fibrous and particulate insulation in some, and changes of buffering chemicals in others. Because of the complexity of the phenomena involved, the staff has required plant-specific tests, prototypical to the extent possible of the full-scale, to determine pressure losses across the sump screens.

At this point, it would appear that if fibrous insulation, which is the main offender for sump screen blockage and in-vessel effects, were to be replaced or protected, and the staff-accepted testing protocols followed for the remaining 23 plants, then GSI-191 could be resolved, provided that no surprises await with regard to in-vessel effects. Because most of the remaining 23 plants would need to replace or protect much fibrous insulation, industry has been exploring alternatives that would reduce the amount of LOCA debris generation that must be considered by trying to modify the current staff-accepted ZOI model and take credit for debris settling.

The Commission has directed the staff to submit a policy paper on approaches to close GSI-191, addressing factors such as worker radiation dose and hazardous material exposures, and risk-informed versus deterministic approaches. In SECY-10-0113, the staff has submitted a discussion of closure options together with supporting documents. This report comments on the staff submittal.

DISCUSSION

In response to the SRM, the staff thoroughly reviewed three main options to close GSI-191. Option 1, which contains three sub-options, essentially maintains the current holistic integrated resolution process for the remaining plants and includes an evaluation of any new industry testing to justify reductions in debris generation and credit for debris settling. The differences

among the various sub-options are related to the schedule for completion of the resolution process. The first sub-option (Option 1a) sets a near-term schedule for licensees to address the full spectrum of LOCAs. The second sub-option (Option 1b) is risk-informed in the sense that it would set a near-term schedule, comparable to that in Option 1a, for the smaller and more likely LOCAs and a longer-term schedule for the larger and less likely LOCAs. The third sub-option (Option 1c) does not set a schedule, which could extend the period for closure of GSI-191 indefinitely as work continues on efforts to reduce the amount of generated debris that must be considered in testing and to justify credit for settling of fine debris. We find the current holistic integrated resolution process in Option 1 acceptable in general, provided that reasonable schedules for resolution are adopted. The schedules, which might differ depending on the requirements for specific plants, should provide sufficient time for planning and adoption of measures to reduce radiation doses and exposures of workers to hazardous materials, as well as optimization of testing.

Option 2 deals with developing additional risk-informed guidance for GSI-191 based on either extending the guidance in Section 6 of NEI 04-07 and the corresponding Safety Evaluation (SE) (Option 2a) or the proposed 10 CFR 50.46(a) rule, if the rule is promulgated (Option 2b). Risk-informing GSI-191 is already possible under Section 6 of the SE for NEI 04-07, but Option 2a would develop additional guidance to facilitate its application. Additional flexibility in the use of non-safety grade equipment for long-term cooling would be more readily available under Option 2 than under Option 1a or 1b. The staff has suggested that a combination of Options 1b and 2 would set an implicit resolution schedule. We also found Option 2 acceptable provided that an explicit schedule be specified if this Option is adopted.

Option 3 would use GDC-4 to exclude debris generation during LOCAs for LBB-qualified piping. Should this option be allowed, it may eliminate requirements to remove significant portions of the high fibrous insulation from some of the remaining 23 plants. For these plants, this option would result in reductions in worker dose and hazardous material exposure.

The staff believes, and we agree, that expanding the scope of GDC-4 to allow LBB credit for resolving ECCS performance issues is a policy matter. We also agree with the staff that the option would be inconsistent with the basic defense-in-depth principles of the NRC. In particular, this option enables a LOCA to disable both the system that prevents core damage (ECCS) as well as the system that mitigates offsite releases (containment spray). The Statement of Considerations for GDC-4 specifically prohibited ECCS from GDC-4 exclusions. Furthermore, the Commission SRM for the development of a risk-informed 10 CFR 50.46(a) rule specifically directed the staff to ensure that this rule would maintain the capability for mitigation of large-break LOCAs. In our considerations of the risk-informed 10 CFR 50.46(a) rule, we have also emphasized the need to maintain the capability to mitigate large-break LOCAs. Therefore, we recommend that Option 3 not be considered further.

Radiation dose to workers is a concern when replacing or protecting fibrous insulation. It was suggested by NEI that doses could be in the range of 100-600 person-rem with an average of 200 person-rem. No data were provided to support these estimates. Replacement of large quantities of fibrous insulation at Beaver Valley resulted in a total dose of about 110 person-rem for the two units. STP has estimated 81 person-rem per unit for their large-scale insulation replacement. These results suggest that doses for the remaining 23 plants are likely to be at or below the lower end of the range estimated by NEI.

The sump screens and the core act in concert to filter debris in the recirculation system. Their action cannot be considered separately, since large area screens may allow more recirculation

flow, but allow more debris to pass through potentially blocking regions of the core. Because of the evident coupling between the sump screen head loss and in-vessel effects issues, we agree with the staff and recommend that they be considered together and that the in-vessel effects issue not be separated into another generic issue.

At present, the staff is evaluating industry submissions on in-vessel debris blockage experiments, some of which indicate that fuel designs with apparently similar thermal hydraulic characteristics can exhibit large differences in pressure losses due to debris blockage. These findings will need to be factored into whichever option is chosen. It is already evident that in-vessel blockage increases with increased fiber loads, so reduction or protection of fibrous insulation is a step in the right direction. What is not clear is whether the measures taken to resolve the GSI-191 issue with regard to sump screen blockage, while going a long way towards alleviating problems, will be sufficient to also resolve GSI-191 for potential in-vessel blockage.

Sincerely,

/RA/

Said Abdel-Khalik
Chairman

References:

1. SECY 10-0113, “Closure Options for Generic Safety Issue – 191, Assessment of Debris Accumulation on Pressurized Water Reactor Sump Performance,” 08/26/2010, (ML101820212)

2. SRM M100415, “Staff Requirements – Briefing on Resolution of Generic Safety Issue (GSI) – 191, Assessment of Debris Accumulation on Pressurized Water (PWR) Sump Performance, 9:30 A.M., Thursday, April 15, 2010, Commissioners’ Conference Room, One White Flint North, Rockville, Maryland (Open to Public Attendance),” 05/17/2010, (ML101370261)

3. SRM, Staff Requirements - SECY-07-0082 - Rulemaking to Make Risk-Informed Changes to Loss-of-Coolant Accident Technical Requirements; 10 CFR 50.46a, "Alternative Acceptance Criteria for Emergency Core Cooling Systems for Light-Water Nuclear Power Reactors," 08/10/2007 (ML072220595)

4. Letter to to Nils J. Diaz, NRC Chairman, “Draft Final Revision 3 to Regulatory Guide 1.82, “Water Sources for Long-Term Recirculation Cooling following a Loss-of-Coolant Accident,” 9/30/2003, (ML032731487)

5. Letter to Dale E. Klein, NRC Chairman, “Status of Resolution of Generic Safety Issue-191, “Assessment of Debris Accumulation on PWR Sump Performance,” 10/22/2008, (ML082810710)

6. Letter from NEI to Eric Leeds, Director of NRR, “Reconsideration of General Design Criterion 4 (GDC-4) Application to Generic Safety Issue,” 04/07/2010 (ML101050354)

7. Letter from NEI to Gregory B. Jaczko, NRC Chairman, “Additional Information in Support of April 15 Commission Briefing on GSI-191,” 04/27/2010 (ML102280039)

8. Letter to Dale E. Klein, NRC Chairman, Draft Final Rule to Risk-Inform 10 CFR 50.46, “Acceptance Criteria for Emergency Core Cooling Systems for Light-Water Nuclear Power Reactors,” 11/16/2006 (ML063190465)

9. Letter to Nils J. Diaz, NRC Chairman, “Generic Safety Issue 191 - Assessment of Debris Accumulation on PWR Sump Performance,” 04/10/2006 (ML061020275)

10. U.S. Nuclear Regulatory Commission, Generic Letter 2004-02, “Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized-Water Reactors,” 09/13/2004 (ML042360586)

11. D. V. Rao, B. Letellier, C. Shaffer, S. Ashbaugh, and L. Bartlein, "GSI-191 Technical Assessment: Parametric Evaluation for Pressurized Water Reactor Recirculation Sump Performance," NUREG/CR-6762, Volumes 1-4, August 2002 (ML022470074, ML022470076, ML022470093, ML022480182, ML022480262)

12. 53 FR 11311, “Leak-Before-Break Technology; Solicitation of Public Comment on Additional Applications,” published 04/06/1988

13. 52 FR 41288, “Modification of General Design Criterion 4 Requirements for Protection Against Dynamic Effects of Postulated Pipe Ruptures,” published 10/27/1987

14. 51 FR 12502, “Modification of General Design Criterion 4 Requirements for Protection Against Dynamic Effects of Postulated Pipe Ruptures,” published 04/11/1986

7. Letter from NEI to Gregory B. Jaczko, NRC Chairman, “Additional Information in Support of April 15 Commission Briefing on GSI-191,” 04/27/2010 (ML102280039)

8. Letter to Dale E. Klein, NRC Chairman, Draft Final Rule to Risk-Inform 10 CFR 50.46, “Acceptance Criteria for Emergency Core Cooling Systems for Light-Water Nuclear Power Reactors,” 11/16/2006 (ML063190465)

9. Letter to Nils J. Diaz, NRC Chairman, “Generic Safety Issue 191 - Assessment of Debris Accumulation on PWR Sump Performance,” 04/10/2006 (ML061020275)

10. U.S. Nuclear Regulatory Commission, Generic Letter 2004-02, “Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized-Water Reactors,” 09/13/2004 (ML042360586)

11. D. V. Rao, B. Letellier, C. Shaffer, S. Ashbaugh, and L. Bartlein, "GSI-191 Technical Assessment: Parametric Evaluation for Pressurized Water Reactor Recirculation Sump Performance," NUREG/CR-6762, Volumes 1-4, August, 2002 (ML022470074, ML022470076, ML022470093, ML022480182, ML022480262)

12. 53 FR 11311, “Leak-Before-Break Technology; Solicitation of Public Comment on Additional Applications,” published 04/06/1988

13. 52 FR 41288, “Modification of General Design Criterion 4 Requirements for Protection Against Dynamic Effects of Postulated Pipe Ruptures,” published 10/27/1987

14. 51 FR 12502, “Modification of General Design Criterion 4 Requirements for Protection Against Dynamic Effects of Postulated Pipe Ruptures,” published 04/11/1986

Distribution:
See next page

Accession No:ML102560368 **Publicly Available (Y/N):** Y **Sensitive (Y/N):** N
If Sensitive, which category?
Viewing Rights: ☐ NRC Users or ☐ ACRS only or ☐ See restricted distribution

OFFICE	ACRS	SUNSI Review	ACRS	ACRS	ACRS
NAME	IBerrios	IBerrios	CSantos	EHackett	EHackett for SAbdel-Khalik
DATE	9/17/10	9/17/10	9/17/10	9/17/10	9/17/10

OFFICIAL RECORD COPY

Letter to the Honorable Gregory B Jaczko, Chairman, NRC, from Said Abdel-Khalik, Chairman, ACRS, dated September 17, 2010

SUBJECT: COMMENTS ON SECY-10-0113, "CLOSURE OPTIONS FOR GENERIC SAFETY ISSUE – 191, ASSESSMENT OF DEBRIS ACCUMULATION IN PRESSURIZED WATER REACTOR SUMP PERFORMANCE"

Distribution:
ACRS Staff
ACRS Members
B. Champ
A. Bates
S. McKelvin
L. Mike
J. Ridgely
RidsSECYMailCenter
RidsEDOMailCenter
RidsNMSSOD
RidsNSIROD
RidsFSMEOD
RidsRESOD
RidsOIGMailCenter
RidsOGCMailCenter
RidsOCAAMailCenter
RidsOCAMailCenter
RidsNRROD
RidsNROOD
RidsOPAMail
RidsRGN1MailCenter
RidsRGN2MailCenter
RidsRGN3MailCenter
RidsRGN4MailCenter