November 9, 2015

Ms. Lesa Hill, Chairman
Boiling Water Reactor Owner's Group
Southern Nuclear Operating Company
c/o GE Hitachi
BWROG
3901 Castle Hayne Road
M/C F-12
Wilmington, NC 28401

SUBJECT: BOILING WATER REACTOR OWNERS' GROUP EMERGENCY CORE COOLING SYSTEM SUCTION STRAINER PROJECT - U.S. NUCLEAR REGULATORY COMMISSION STAFF AUDIT SUMMARY OF A RISK-INFORMED APPROACH TO POTENTIAL ISSUE(S) RESOLUTION

Dear Ms. Hill:

On August 11 and 12, 2015, the U.S. Nuclear Regulatory Commission (NRC) staff conducted a regulatory audit at the Albuquerque Nuclear Safety Divisions (NSD) branch of Alion Science and Technology in Albuquerque, New Mexico. The objective of the audit was to gain a better understanding of the Boiling Water Reactor Owners' Group (BWROG) approach to implementing a risk-informed evaluation of the technical issues identified in the John A. Grobe (NRC) to Richard Anderson (BWROG) letter dated April 10, 2008, "Potential Issues Related to Emergency Core Cooling Systems (ECCS) Strainer Performance at Boiling water Reactors" (Agencywide Documents Access and Management System (ADAMS) Accession No. ML080500540). The BWROG first introduced its risk-informed approach in December of 2014 during a public meeting with NRC staff (ADAMS Accession No. ML14357A048).

The NRC regulatory audit followed a public meeting on June 10, 2015, with representatives of the BWROG ECCS Suction Strainer Risk-Informed Project Committee (ADAMS Accession No. ML15210A139), where an agreement was reached between the NRC staff and BWROG representatives to hold the audit at the Alion Science and Technology offices. A specific goal of the NRC staff was to evaluate the BWROG's technical approaches implemented in support of the methodology for its risk-informed approach and to identify related verification and validation activities.

The enclosure to this letter describes the results of the NRC staff's audit and some of the key technical issues highlighted by the staff during the audit. The NRC staff and the BWROG will continue discussions for resolution of the technical issues during the future interactions.

Please contact Jason Drake at 301-415-8378 or via e-mail at Jason.Drake@nrc.gov with any questions you may have regarding this letter.

Sincerely,

/RA/

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

Project No. 691

Enclosure:
NRC Staff Audit Summary

cc w/encl: See next page

Please contact Jason Drake at 301-415-8378 or via e-mail at Jason.Drake@nrc.gov as soon as you are ready to arrange for the teleconference.

Sincerely,

/RA/

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

Project No. 691

Enclosure:
NRC Staff Audit Summary

cc w/encl: See next page

DISTRIBUTION:

PUBLIC	SSmith	RidsNrrOd	RidsResOd
KHsueh	MYoder	RidsNrrDss	RidsNroOd
VCusumano	ARussell	RidsNrrLADHarrison	PLPB R/F
SRosenberg	JDrake	RidsEdoMailCenter	
GKulesa	RidsNrrDpr	RidsOgcMailCenter	
CJFong	RidsNrrDprPlpb	RidsACRS_MailCTR	

ADAMS Accession Nos.: ML15238B610 (Summary); ML15187A267 (Package); *via e-mail NRR-106

OFFICE	NRR/DPR/PLPB	NRR/DPR/PLPB*	NRR/DRA/APLA	NRR/DE/ESGB	NRR/DSS/SSIB	NRR/DPR/PLPB
NAME	JDrake	DHarrison	SRosenberg	GKulesa	VCusumano	KHsueh
DATE	10/29/2015	10/02/2015	10/29/2015	11/02/2015	11/03/2015	11/09/2015

OFFICIAL RECORD COPY

Boiling Water Reactor Owner's Group Project No. 691
cc:

BWROG Chairman
Lesa Hill
Southern Nuclear Operating Company
c/o GE Hitachi
BWROG
3901 Castle Hayne Road
M/C F-12
Wilmington, NC 28401
lphill@southernco.com

BWROG Project Manager
Michael Iannantuono
GE-Hitachi Nuclear Energy
PO Box 780 M/C A-70
3901 Castle Hayne Road
Wilmington, NC 28402
Michael.iannantuono@ge.com

BWROG Program Manager
Greg Holmes
GE-Hitachi Nuclear Energy
PO Box 780 M/C A-70
3901 Castle Hayne Road
Wilmington, NC 28402
gregoryK.holmes@ge.com

BWROG ECCS Suction Strainers Risk-Informed
Committee Chairman
Larry Naron
stephen.naron@exeloncorp.com

NRC STAFF AUDIT SUMMARY

BOILING WATER REACTOR OWNERS' GROUP

RISK-INFORMED EMERGENCY CORE COOLING SYSTEM

SUCTION STRAINER PROJECT

1.0 BACKGROUND

The objective of this audit was to gain an overall understanding of the Boiling Water Reactor Owners' Group (BWROG) proposed methodology that would address the technical issues identified in the John A. Grobe (NRC) to Richard Anderson (BWROG) letter dated April 10, 2008, "Potential Issues Related to Emergency Core Cooling Systems (ECCS) Strainer Performance at Boiling Water Reactors" (Agencywide Documents Access and Management System (ADAMS) at Accession No. ML080500540). A description of these issues and the proposed BWROG risk-informed approach is available at ADAMS Accession No. ML14337A227. The audit was conducted at the Alion Science and Technology (BWROG contractor) offices in Albuquerque, New Mexico on August 11 and 12, 2015. The audit was conducted in accordance with Office of Nuclear Reactor Regulation Office Instruction LIC-111 (ADAMS Accession No. ML082900195).

The following NRC staff members participated in the audit:

- Victor Cusumano, Chief, Safety Issues Resolution Branch (overall NRC lead)
- CJ Fong, Technical Reviewer, Probabilistic Risk Assessment (audit team leader)
- Stephen Smith, Technical Reviewer, Debris Generation & Transport
- Matt Yoder, Technical Reviewer, Coatings
- Jason Drake, Project Manager
- Osvaldo Pensado, NRC Contractor/SwRI
- Stuart Stothoff, NRC Contractor/SwRI

The BWROG was represented by the following personnel:

- Larry Naron, BWROG/Exelon
- Rob Choromokos, BWROG/SIA
- Larry Lee, ERIN Engineering
- Bruce Letellier, Alion Science & Technology
- Benjamin Bridges, Alion Science & Technology
- Dominic Muñoz, Alion Science & Technology
- William Cook, Alion Science & Technology
- Jeremy Tejada, SIMCON
- Kent Sutton, iNgrid Consulting
- Michael Iannantuono, BWROG/GEH

Note: In general, the audit team focused on the BWROG 1st Pilot Plant Evaluation (designated as "Phase II"). The team also discussed the 2nd Pilot Plant Evaluation (Phase III) and the final, fleet-wide evaluation (Phase IV) to a limited extent.

Enclosure

2.0 Technical Areas Discussed During the Audit

The audit team met the objectives defined in the audit plan, which included:

A. Probabilistic Risk Assessment (PRA)

- Scope, Level of Detail, and Technical Adequacy

  The audit team reviewed information provided by the BWROG related to the scope, level of detail, and technical adequacy of the PRA needed to support the Phase II final report. This included a review of event and fault trees and detailed information on modifications that were made to the base PRA model to assess the risk impact of the issues identified by the Grobe letter. The team also noted language in the draft Phase II report indicating that the pilot plant was selected (in part) because its PRA met all applicable supporting requirements at Capability Category II[1].

- Consistency Between PRA Model and As-Built Plant, Including Process for Comparing Representative Plant to Specific Plants

  The audit team questioned whether the results from pilot plant analyses (Phases II and III) would be applicable to the entire BWR fleet. The BWROG stated that Phase IV would seek to integrate insights from Phase II and Phase III and would provide sufficient information for the NRC staff to conclude that no "outliers" (i.e., plants with significantly greater risk attributable to debris) exist, or that those outliers would be specifically evaluated.

- Treatment of Uncertainties/Sensitivity Studies

  The BWROG presented the results of sensitivity studies that were used to explore the effects of alternate assumptions about debris generation, transport, head loss, and other phenomena. In all cases, the reported increase in risk met the Regulatory Guide (RG) 1.174 risk acceptance guidelines. This included one sensitivity case ("S1001") that assumed that all thick beds (debris beds with at least 1/8 inch of fiber) would lead to strainer failure. Many of the issues raised by the Grobe letter pertain to the use of correlations and the testing conducted to provide their empirical basis. Therefore, the NRC staff noted that this sensitivity study, if validated, might alleviate many of the staff's concerns.

- Comparison to RG 1.174 Risk Acceptance Guidelines

  There was agreement between the audit team and BWROG personnel that the risk acceptance guidelines in RG 1.174 are a useful quantitative metric by which to judge the results of the Phase II report. The basis for this agreement was the language in RG 1.174, which states that:

[1] In general, Capability Category II (as defined in the ASME PRA Standard) is considered acceptable for regulatory applications. See RG 1.200 for additional information.

"…the principles, process, and approach discussed also provide useful guidance for the application of risk information to a broader set of activities… (i.e., generic activities) and licensees are encouraged to use this guidance in that regard."

- Quality Assurance and Expected Documentation Related to PRA

  The BWROG discussed the format and content of the Phase II final report and subsequent documentation with the audit team. The audit team noted that some documentation called for by RG 1.174 (e.g., site-specific information) would not be expected until Phase IV of the project.

- Cumulative Risk

  The audit team stated an expectation that once the BWROG identifies the key factors most likely to affect performance during a debris generation event, it would propose a process by which to monitor and track these factors (consistent with RG 1.174, Principle 5) to ensure that safety would not be eroded by future plant changes.

B. Deterministic Methodologies

- Head Loss (Correlations, Near Field Effects, and Debris Characteristics)

  Correlations, near field effects, and debris characteristics are related in that each of these can affect the functional form of the correlation or model developed to predict the extent of head loss as a function of the debris types and amounts that arrive at the strainer. A sensitivity study found only a small increase in risk even if all debris beds with a fiber component that attains or exceeds a 1/8 inch theoretical thickness are assumed to fail the strainer. The NRC audit team noted that the 1/8 inch fiber bed threshold is likely conservative if chemicals and problematic debris types (microporous insulations) are not present. However, the staff stated that this threshold would have to be justified and validated by the BWROG. If the 1/8 inch thickness threshold were found to be valid in general, it would allow the BWROG to demonstrate that the use of correlations with a level of uncertainty to calculate strainer head loss has, at most, a small risk impact. The staff stated that plants with higher fiber loads and/or smaller strainers than the pilot plant may need to provide additional information in order to demonstrate low frequency of strainer failure under the 1/8 inch fiber bed threshold criterion.

- Debris Generation, Transport, and Erosion

  The BWROG conducted sensitivity studies that indicate that increasing the amount of debris that arrives at the strainers by a given amount has limited impact on plant risk metrics.

- Coatings Assessment

  The staff stated that the BWROG should confirm that there is adequate testing to justify that any coatings assumed to fail as chips would actually do so. The staff also

stated that if the use of a 1/8 inch threshold for the theoretical fiber contribution to the debris bed thickness is accepted and found to result in only a small contribution to risk, concerns with the treatment of coatings could be considered addressed with respect to the Grobe Letter.

C. Integrated (PRA and Deterministic)

- Defense in Depth

  The audit team reviewed information provided by the BWROG that described various defense-in-depth measures that could be implemented if strainer clogging were to occur. The team noted that while the Phase II report described a number of such measures (e.g., strainer backflush), the details of exactly how these measures could be used (e.g., timing considerations, ability to cross-tie with other unit) would be site-specific and therefore discussed in the Phase IV report.

- Safety Margins

  The audit team reviewed a variety of information related to the expected safety margins for those scenarios where strainer failure is not expected. For example, the team observed that the net positive suction head required calculation in CASA Grande is performed using design basis assumptions, rather than a 40 percent assumed reduction frequently adopted in "best estimate" calculations. The audit team suggested that the final report contain a summary of conservatisms that could be used to verify that adequate safety margins would be maintained under the proposed approach.

- Implementation and Monitoring

  See previous discussion on cumulative risk.

2.1 Exit Meeting

The audit team presented the following comments to the BWROG representatives and contract staff at the conclusion of the audit:

1. The audit team and BWROG representatives confirmed the risk-informed report submittal dates and anticipated content for each of the following phases:

   - Phase II – Final pilot-plant report submission to NRC staff by October 16, 2015
   - Phase III – Presentation of material at 2015 end-of-year BWROG public meeting
   - Phase IV – Final risk-informed report submission to NRC staff by the 2nd quarter of 2016

2. The audit team recognized the potential merits of the BWROG's decision to use a 1/8 inch debris bed thickness in the aforementioned sensitivity study, but noted that further evidence that this is an appropriate threshold value would be needed. The audit team added that a review of historical stacked disk strainer test data could be valuable for adding credibility to the use of 1/8 inch as a fiber debris bed thickness threshold.

3. The audit team expressed interest in how the Phase IV final report would be applied to the BWR fleet. The definition of all critical metrics, survey data and bounding parameters was stressed by the audit team as necessary report contents. The audit team added the BWROG should maintain a long-term monitoring approach with focus on public health and safety.

3.0 OPEN ITEMS

1. The audit team noted that the analysis did not consider plant response to debris with one train unavailable (planned or unplanned). The BWROG acknowledged this issue and stated that further evaluation would be performed.

2. The BWROG justified the omission of a change in large early release frequency (ΔLERF) calculation by noting that, for most sensitivities, even assuming that ΔLERF = change in core damage frequency (ΔCDF) would not exceed the risk acceptance guidelines. The audit team noted that for S1001 (perhaps the most important sensitivity study) this was not true. The BWROG acknowledged this issue and agreed to perform a LERF calculation in accordance with RG 1.174.

3. The audit team questioned whether parametric uncertainties in the PRA (e.g., LOCA frequency epistemic uncertainty) were properly propagated to the CASA Grande computations. The team pointed to lessons learned from the PWR pilot, including comments by the NRC staff and ACRS related to the state-of-knowledge correlation (i.e., frequencies of debris-generating events sampled in the PRA should be properly correlated to corresponding frequencies sampled in the CASA Grande code). The BWROG agreed to re-examine this issue and provide additional information.

4.0 REFERENCES

1. April 10, 2008 NRC Letter, “Potential Issues Related to Emergency Core Cooling Systems (ECCS) Strainer Performance at Boiling water Reactors”, ADAMS Accession No. ML080500540.

2. December 4, 2014 Summary of Public Meeting with the Boiling Water Reactor Owners’ Group (BWROG), ADAMS Accession No. ML14356A148.

3. April 13, 2015 Summary of Public Teleconference with the Boiling Water Reactor Owners’ Group (BWROG), Emergency Core Cooling System, Suction Strainer Risk-Informed Project Committee, ADAMS Accession No. ML15140A359.

4. June 10, 2015 Summary of Public Meeting with the Boiling Water Reactor Owners’ Group (BWROG), Emergency Core Cooling System, Suction Strainer Risk-Informed Project Committee, ADAMS Accession No. ML15210A153.