



UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
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June 29, 2018

John C. Grubb, BWROG Chairman  
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Wilmington, NC 28402

SUBJECT: CLOSURE OF POTENTIAL ISSUES RELATED TO EMERGENCY CORE  
COOLING SYSTEMS STRAINER PERFORMANCE AT BOILING WATER  
REACTORS

Dear Mr. Grubb:

This letter provides the results of the U.S. Nuclear Regulatory Commission (NRC) review of your letter dated November 20, 2017 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML17326A393), and the supporting documents which describe the results of Phases I-V of your analysis of these issues.

After reviewing your letter and the supporting technical reports made available to the NRC staff, we conclude that no regulatory action is warranted. The evaluation is documented in "BWROG Risk-Informed Debris Analysis – Staff Technical Evaluation" (ADAMS Accession No. ML18058A602).

For boiling water reactors (BWRs), the NRC and the nuclear industry conducted research and testing from 1992 to 2001 to resolve the issue of debris blockage of sump strainers. During that time, the NRC staff issued NRC Bulletin (NRCB) 95-02, "Unexpected Clogging of a Residual Heat Removal (RHR) Pump Strainer While Operating in Suppression Pool Cooling Mode," and NRCB 96-03, "Potential Plugging of Emergency Core Cooling Suction Strainers by Debris in Boiling-Water Reactors." Both bulletins dealt with ensuring that debris generated during a loss-of-coolant accident (LOCA) would not clog emergency core cooling system (ECCS) suction strainers.

After testing, analysis, and planned plant modifications, which included upgraded strainers, the NRC concluded that all BWR licensees had sufficiently responded to the requested actions of NRCB 95-02 and NRCB 96-03 and considered that generic and plant-specific activities associated with these bulletins were complete. This was documented in a memorandum dated October 18, 2001 (ADAMS Accession No. ML012970229).

Following the resolution of the issue for BWRs, pressurized water reactor (PWR) Generic Safety Issue 191, "Assessment of Debris Accumulation on PWR Pump Performance" (GSI-191), was established in 1996 to evaluate the potential for debris to affect PWRs in a similar way. During GSI-191 analysis and evaluations, new information was identified regarding the behavior of debris and its potential effects on the reactor core and other components downstream of the sump strainer(s). The NRC confirmed that PWRs could be susceptible to these effects and issued Generic Letter (GL) 2004-02, "Potential Impact of Debris Blockage on Emergency Recirculation during Design Basis Accidents at Pressurized-Water Reactors." The new

information identified during the evaluation of GL 2004-02 had not been considered during the resolution of the issue for the BWRs in NRCB 95-02 and NRCB 96-03.

For evaluations of debris impacts on sump strainer performance, debris is considered to be any material that may affect the operation of the ECCS. Most debris is generated from insulating materials and coatings within containment. All plants also have some amount of latent debris, such as dust and dirt, present in containment. BWRs also have iron oxide or sludge that is generated during operation and collects in the suppression pool. Finally, debris may come from chemical reactions in the post-LOCA environment. These reactions can result in the precipitation of chemical products in the pool which can then be filtered by a debris bed on the strainer. All of these debris types are predicted to transport to (or remain in) the suppression pool and mix with the coolant due to turbulence caused by flows following a LOCA. ECCS suction strainer clogging due to LOCA generated debris could potentially prevent the ECCS from performing its safety function.

On April 10, 2008, the NRC issued a letter to the BWR Owners Group (BWROG) encouraging them to develop a comprehensive plan to address potential issues related to ECCS performance at BWRs (ADAMS Accession No. ML080500540). The April 2008 letter did not initiate a formal regulatory process and the BWROG conducted its analysis under a voluntary initiative. In this letter, the NRC identified ECCS issues related to post-LOCA debris that should be evaluated to ensure that the earlier BWR resolution was still conservative. The BWROG binned these general issues into the following twelve discrete areas to be addressed in its analysis:

1. downstream effects - components
2. downstream effects - fuel
3. head loss correlations
4. chemical effects
5. assessment of coatings
6. latent debris
7. zone of influence (ZOI) adjustment for air jet testing
8. ZOI of protective coatings
9. debris transport and erosion
10. debris characteristics
11. near-field effects and scaling
12. spherical ZOI

The BWROG used a risk-informed approach to address the identified issues. They used Regulatory Guide (RG) 1.174, "An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis," Revision 2 (ADAMS Accession No. ML100910006) to provide a consistent and logical framework to assess the risk significance of the identified issues. As stated in RG 1.174, Revision 2, "the principles, process, and approach discussed herein also provide useful guidance for the application of risk information to a broader set of activities than plant-specific changes to a plant's LB [licensing basis] (i.e., generic activities), and licensees are encouraged to use this guidance in that regard." Therefore, although the BWROG's analysis was not a license amendment, design change, or compelled by a regulatory requirement, RG 1.174, Revision 2, provided an appropriate framework for the submission and consistency in the staff's evaluation.

Although the Phase IV and V analyses are not a license amendment request, NRC staff evaluated them and concluded that the BWROG adequately addressed each of the five principles of risk-informed decision-making in RG 1.174, Revision 2, and demonstrated that the effect of the added phenomena, predominantly in-vessel and chemical effects, on performance

of the ECCS systems is of low risk significance. This conclusion credits previously completed substantial improvements in the size and design of ECCS strainers. The NRC staff concludes that the BWROG risk-informed evaluation is generally applicable to the currently operating US BWR fleet. The NRC conclusions do not apply to other plant designs or conditions.

The BWROG study was fleet wide and not plant specific. The uncertainties, conservatisms, models, or assumptions do not apply equally to all plants in the BWR fleet. Therefore, the results of the analyses in any of the phases, or any part of those analyses, may not be used for site-specific justification of equipment operability, design basis changes, or licensing changes outside of a formal license amendment request pursuant to Title 10 of the *Code of Federal Regulations* 50.90, subject to a separate review by the NRC.

Several supporting requirements in the 2009 American Society of Mechanical Engineers/American Nuclear Society Probabilistic Risk Analysis (PRA) Standard, as endorsed in RG 1.200, "An Approach for Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk-Informed Activities," Revision 2 (ADAMS Accession No. ML090410014), state that the impact of debris should be modeled in the PRA. Further, according to RG 1.174, Revision 2, risk-informed applications must reflect the as-built, as-operated plant and that the effect of past changes to the plant need to be modeled in future applications. Therefore, the staff expects future risk-informed submittal(s) by US BWRs to follow the endorsed PRA Standard and relevant staff guidance or provide adequate technical justification for any deviations.

If you have questions concerning this letter please contact Joe Golla by electronic mail at [Joe.Golla@nrc.gov](mailto:Joe.Golla@nrc.gov) or 301-415-1002.

Sincerely,

*/RA/*

Mirela Gavrilas, Director  
Division of Safety Systems  
Office of Nuclear Reactor Regulation

SUBJECT: CLOSURE OF POTENTIAL ISSUES RELATED TO EMERGENCY CORE COOLING SYSTEMS STRAINER PERFORMANCE AT BOILING WATER REACTORS DATED:

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