

PRESSURIZED-WATER REACTOR SUMP PERFORMANCE GENERIC SAFETY ISSUE-191

ACTION PLAN UPDATE

TAC Nos. MA6454, MA2452, MA4014, MA0704, M95473, MA6204, MA0698, MB4047, MB6411, MB3103, MB8052, MB7776, MB9470, MB4864, MB9931, MC0307, MC1154, MB9549, MC4272, MC5881, MC6467, MC6470, MB5625, MB4865, MC0725/6, MB5221, MB5964, MB6589, MB7228, MC1627, MB5334, MC2628, MB6946, MC6659, MC6661, MC6730, MC6731, MC7565, MC7564, MC9003, MD1058, and MC9446

Last Update: 09/01/2016
 Lead NRR Division: DSS
 Supporting Divisions: DE, DCI, DORL, DRA, and MEEB (RES)

MILESTONES		DATE (T/C) T=target C=complete
PART I: BOILING-WATER REACTOR EMERGENCY CORE COOLING SYSTEM SUCTION STRAINER CLOGGING ISSUE		
1.	Bulletin 1996-03, "Potential Plugging of Emergency Core Cooling Suction Strainers by Debris in Boiling-Water Reactors"	10/01 (C)
PART II: NET POSITIVE SUCTION HEAD EVALUATIONS		
1.	Generic Letter 1997-04, "Assurance of Sufficient Net Positive Suction Head for Emergency Core Cooling and Containment Heat Removal Pumps"	
	<ul style="list-style-type: none"> • Complete review of licensee responses • Complete revision of Regulatory Guides 1.1 and 1.82, R3 	03/00 (C) 11/03 (C)
PART III: CONTAINMENT COATINGS		
1.	Generic Letter 1998-04, "Potential for Degradation of the Emergency Core Cooling System and the Containment Spray System After a Loss-of-Coolant Accident Because of Construction and Protective Coating Deficiencies and Foreign Material in Containment"	07/00 (C)
2.	Nuclear Regulatory Commission sponsored research program on the potential for coatings to fail during an accident	03/01 (C)
3.	Coatings Condition Assessment Guidance	03/08 (C)
4.	Confirmatory Coatings Transport Testing	06/05 (C)

MILESTONES	DATE (T/C) T=target C=complete
PART IV: GENERIC SAFETY ISSUE 191, "ASSESSMENT OF DEBRIS ACCUMULATION PRESSURIZED WATER REACTOR SUMP PERFORMANCE"	
<p>1. NRC-sponsored research program on the potential for loss of ECCS NPSH during a LOCA due to clogging by debris</p> <ul style="list-style-type: none"> • Preliminary (qualitative) risk assessment (NRR) • Complete collection of plant data to support research program • Integrate industry activities into this action plan • Complete research program on pressurized water reactor sump blockage • Evaluate need for regulatory action based on research program results (NRR) 	<p>03/99 (C) 06/99 (C) 04/00 (C) 09/01 (C) 03/02 (C)</p>
<p>2. Chemical effects: Determine if sump pool environment generates by-products which contribute to sump clogging (Argonne National Laboratory testing)</p> <ul style="list-style-type: none"> • Debris Transport & Head loss: Confirmatory research tests on debris transport of coatings and head losses associated with PWR containment materials with and without chemical effects • Downstream effects: Confirmatory research on the effect of injected debris on high pressure safety injection throttle valve performance <p>3. Resolve ECCS suction clogging issue for PWRs (Regulation/Guidance Development and Issuance, Implementation and Verification Stages of GSI process in MD 6.4)</p> <ul style="list-style-type: none"> • Brief NRR Executive Team to obtain approval to prepare a GL • Public meeting with Nuclear Energy Institute, Westinghouse Owners Group, Babcock & Wilcox, Combustion Engineering • Advisory Committee on Reactor Safeguards briefing on proposed draft GL • Committee to Review Generic Requirements briefing on proposed Bulletin 2003-01 	<p>05/06 (C) 05/06 (C) 03/06 (C) 02/02(C) 03/02(C) 02/03(C) 04/03(C)</p>

MILESTONES	DATE (T/C) T=target C=complete
<ul style="list-style-type: none"> • Information Paper to Commission, Issue BL2003-01 	06/03(C)
<ul style="list-style-type: none"> • NEI publish draft PWR Industry Evaluation Guidelines 	10/03(C)
<ul style="list-style-type: none"> • CRGR briefing on proposed draft GL 	02/04(C)
<ul style="list-style-type: none"> • Proposed draft GL issued for public comment 	03/04(C)
<ul style="list-style-type: none"> • GL issuance 	09/04(C)
<ul style="list-style-type: none"> • Issue safety evaluation on methodology 	12/04(C)
<ul style="list-style-type: none"> • NRC starts reviews of GL responses and selective audits 	09/05(C)
<ul style="list-style-type: none"> • GL date for licensees to start modifications 	04/06(C)
<ul style="list-style-type: none"> • Interim meeting with ACRS on GSI-191 activities 	06/07(C)
<ul style="list-style-type: none"> • Start review of final supplemental responses to GL 	02/08(C)
<ul style="list-style-type: none"> • Complete review of supplemental responses to GL 	06/09(C)
<ul style="list-style-type: none"> • Staff completes and documents reviews of request for additional information (RAI) responses (except those related to in-vessel downstream effects) and, as appropriate, identifies need for additional interactions with affected licensees 	06/09(C) 10/08(C)
<ul style="list-style-type: none"> • Complete Temporary Instruction 2515/166 inspections of plant changes 	04/08(C)
<ul style="list-style-type: none"> • Complete plant audits 	06/08(C)
<ul style="list-style-type: none"> • PWROG submits revised topical report on in-vessel downstream effects 	07/12(C)
<ul style="list-style-type: none"> • Staff issues final SE of PWROG revised TR on in-vessel downstream effects 	04/13(C)
<ul style="list-style-type: none"> • Staff issued SECY-12-0093 	07/12(C)
<ul style="list-style-type: none"> • Staff completes review of RAI responses related to in-vessel downstream effects and revised head loss testing and corresponds with licensees as needed 	01/17(T)
<ul style="list-style-type: none"> • South Texas Project submitted pilot application for risk informed Option 2B for closure of Generic Letter 2004-02 	11/13(C)
<ul style="list-style-type: none"> • South Texas Project submitted supplement to risk informed Option 2B 	08/15(C)
<ul style="list-style-type: none"> • Staff to complete review and approve South Texas Project application 	09/17(T)
<ul style="list-style-type: none"> • PWROG submitted update to WCAP-17788 	07/15(C)
<ul style="list-style-type: none"> • Staff issues final safety evaluation of PWROG revised topical 	04/17(T)
<ul style="list-style-type: none"> • NRC issues GL 2004-02 closure memo after issuing closure letters to all licensees and closes GSI-191 implementation phase 	12/18(T)

Description:

This action plan was originally prepared to comprehensively address the adequacy of emergency core cooling system (ECCS) suction design, and to ensure adequate ECCS pump net positive suction head net positive suction head (NPSH) during a loss-of-coolant accident (LOCA). Specifically, the concern is whether debris could clog ECCS suction strainers or sump screens during an accident and prevent the ECCS from performing its safety function. The plan is risk informed.

This plan has four parts, two of which have been completed. First, for boiling-water reactors (BWR), this issue has been addressed by licensee responses to Bulletin (BL) 1996-03. Second, the adequacy of licensee (both Pressurized-Water Reactor (PWR) and BWR) net positive suction head (NPSH) calculations was evaluated through the Office of Nuclear Reactor Regulation (NRR) review of licensee responses to Generic Letter (GL) 1997-04, "Assurance of Sufficient Net Positive Suction Head for Emergency Core Cooling and Containment Heat Removal Pumps," dated October 7, 1997. The third part of the plan assessed the adequacy of the implementation and maintenance of licensee coating programs through NRR review of licensee responses to GL 1998-04, "Potential for Degradation of the Emergency Core Cooling System and the Containment Spray System After a Loss-of-Coolant Accident Because of Construction and Protective Coating Deficiencies and Foreign Material in Containment," dated July 14, 1998. This part of the plan was reopened to track development of guidance for coatings condition assessment and the U.S. Nuclear Regulatory Commission (NRC) confirmatory coatings transport testing program.

The remaining part of the action plan is an evaluation of the potential for clogging of PWR ECCS recirculation sumps during a LOCA. The Office of Research (RES) completed its assessment of the potential for debris clogging to support the resolution of GSI-191, "Assessment of Debris Accumulation on PWR Sump Performance." By memorandum dated September 28, 2001, RES transferred the lead for Generic Safety Issue (GSI) 191 to NRR.

Historical Background:

During licensing of most domestic power plants, consideration of the potential for loss of adequate NPSH due to blockage of the ECCS suction by debris generated during a LOCA was inadequately addressed by both the NRC and licensees. The staff first addressed ECCS clogging issues in detail during its review of Unresolved Safety Issue (USI) A-43, "Containment Emergency Sump Performance." GL 1985-22, "Potential for Loss of Post-LOCA Recirculation Capability Due to Insulation Debris Blockage," dated December 3, 1985, documented the NRC's resolution of USI A-43. NUREG-0897, Revision 1, "Containment Emergency Sump Performance" (October 1985), contained technical findings related to USI A-43, and was the principal reference for developing revised regulatory guidance.

Since the resolution of Unresolved Safety Issue (USI) A-43, new information, including events and research, challenged the adequacy of the NRC's conclusion that no new requirements were needed to prevent clogging of ECCS strainers in BWRs. The Barsebäck event demonstrated that the potential exists for a pipe break to generate insulation debris and transport a sufficient amount of the debris to the suppression pool to clog the ECCS strainers.

Events at the Perry Nuclear Power Plant demonstrated high strainer pressure drop caused by the filtering of suppression pool particulates (corrosion products or "sludge") by fibrous materials adhering to the ECCS strainer surfaces. The effect of particulate filtering on head loss had been previously unrecognized. Therefore, its effect had not been considered. An event at Limerick Generating Station, Unit 1 demonstrated the importance of foreign material exclusion practices to ensure adequate suppression pool and containment cleanliness. In addition, the event re-emphasized that materials other than fibrous insulation could clog strainers.

BL 1996-03, "Potential Plugging of Emergency Core Cooling Suction Strainers by Debris in Boiling-Water Reactors," was issued on May 6, 1996, requesting BWR licensees to implement appropriate procedural measures and plant modifications to minimize the potential for clogging of ECCS suction strainers by debris generated during a LOCA. Regulatory Guide (RG) 1.82, Revision 2, "Water Sources for Long-Term Recirculation Cooling Following a Loss-of-Coolant Accident," was issued in May 1996 to provide non-prescriptive guidance on performing plant-specific analyses to evaluate the ability of the ECCS to provide long-term cooling consistent with the requirements of 10 CFR 50.46. In response to BL 1996-03, all affected BWR licensees have installed new larger-capacity passive strainers.

RES conducted an evaluation of the potential for PWRs to lose NPSH due to clogging of ECCS sump screens by debris during an accident because of new information learned during the development and resolution of BL 1996-03. With more and finer debris, the potential for clogging of the ECCS sump screens becomes greater, leading to the need to evaluate the potential for clogging of PWR sumps. RES's evaluation included a risk assessment.

Events at a number of plants raised concerns regarding potential for coatings to form debris during an accident which could clog an ECCS suction path. In several cases qualified coatings have delaminated during normal operating conditions. Typically, the root cause has been attributed to inadequate surface preparation. This led the staff to raise questions regarding the adequacy of licensee coating programs. The staff issued GL 1998-04, to obtain necessary information from licensees to evaluate how they implement and maintain their coating programs. In addition, RG 1.54 was revised to update guidance for the selection, qualification, application, and maintenance of protective coatings in nuclear power plants to be consistent with the then current American Society for Testing and Materials (ASTM) standards. RES also conducted research aimed at providing technical information regarding the failure of coatings. The program evaluated the failure modes of coatings, the likely causes, the characteristics (e.g., size, shape) of the debris, and the timing of when coatings would likely fail during an accident.

The PWR Industry is implementing a two-step program to assess the current sump conditions and evaluate sump recirculation performance. The program consists of the performance of actions recommended in two Nuclear Energy Institute (NEI) guidance documents in order to address an NRC BL and an NRC GL. The first guidance document, NEI 02-01, "Condition Assessment Guidelines: Debris Sources inside Containment," was published in September 2002. Consistent with the risk significance of the PWR sump clogging concern, the staff issued BL 2003-01 on June 9, 2003, requesting information on compliance with applicable regulatory requirements within 60 days or information on interim compensatory measures to reduce risk until an evaluation to determine compliance is completed. The staff issued requests for additional information (RAI) for the bulletin as needed, completed the review of licensee's responses, and issued closeout letters. NEI submitted the second guidance document, NEI 04-07 "Pressurized Water Reactor Sump Evaluation Methodology," on May 28, 2004. This

document recommended methodologies for evaluating a PWR's susceptibility to sump clogging. The staff SE of the methodology, issued December 6, 2004, provided licensees an NRC-approved methodology to complete the site-specific evaluations called for in GL 2004-02, "Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized-Water Reactors."

GL 2004-02, issued in September 2004, called for evaluations of sump performance in the presence of plant-specific post-LOCA debris loading. It also stated that these evaluations, and any needed plant modifications to show satisfactory sump performance, should be completed by December 31, 2007.

The NRC staff received GL responses from all PWR licensees. The staff found that additional information was needed and sent RAIs to each PWR licensee in February 2006. The staff subsequently determined that licensees could address the intent of the RAIs in conjunction with each licensee's final supplemental response to GL 2004-02, which the staff expected to receive by December 31, 2007. This date was subsequently extended to February 28, 2008.

One aspect of the sump performance issue, the potential for chemical effects on strainers and downstream components, has revealed itself to be particularly challenging. To address concerns regarding the potential for chemical precipitates and corrosion products to significantly block a fiber bed and increase the head loss across an emergency core cooling system sump screen, a joint NRC/industry Integrated Chemical Effects Testing program was started in 2004 and completed in August 2005. Chemical precipitation products were identified during the test program, and follow-up testing and analyses were performed to address the effect on head loss. Information Notice (IN) 2005-26, "Results of Chemical Effects Head Loss Tests in a Simulated PWR Sump Pool Environment," was issued on September 16, 2005.

The NRC conducted additional research in certain areas to support evaluation efforts and provide confirmatory information. These areas include research on chemical effects to determine if the pressurized-water reactor sump pool environment generates byproducts which contribute to sump clogging, research on pump head losses caused by accumulation of containment materials and chemical byproducts, and research to predict the chemical species that may form in these environments. Supplement 1 to IN 2005-26, "Additional Results of Chemical Effects Tests in a Simulated PWR Sump Pool Environment," specifically provided additional information regarding test results related to chemical effects in environments containing dissolved phosphate (e.g., from trisodium phosphate) and dissolved calcium. The results discussed in the INs clearly demonstrated the potential for chemical effects to be significant. Follow-on testing sponsored by some licensees has also shown the potential for substantial head loss increases from chemical effects.

Research was also conducted on the transportability of coating chips in containment pool environments, and on the effect of ingested debris on downstream valve performance. Between July and September 2006, the staff completed additional research on various subjects of the sump clogging issue. All planned NRC-sponsored research activities related to PWR sump clogging are now complete and documented, though information obtained as the staff reviews industry activities to support issue closure may indicate the need for additional NRC-sponsored research.

The NRC has developed a web page to keep the public informed of regulatory and research activities related to PWR sump performance:

<http://www.nrc.gov/reactors/operating/ops-experience/pwr-sump-performance.html>

This web page provides links to information regarding NRC interactions with industry (industry submittals, meeting notices, presentation materials, and meeting summaries) and publically available regulatory and research documents. The NRC will continue to update these web pages as new information becomes available.

Proposed Actions:

This action plan involves an evaluation of PWR sumps based on new information learned during and following the staff's resolution of BL 1996-03. RES conducted a program to evaluate PWR sump designs and their susceptibility to blockage by debris. Risk insights supported the conclusions drawn relative to the need for licensees to address the potential for ECCS suction clogging. The results of the RES parametric evaluation form a credible technical basis for concluding that sump blockage is a generic concern for PWRs. As a result of research work and plant experience, the NRC additionally requested that PWRs evaluate potential downstream and chemical effects as part of the resolution of GSI-191.

Originating Document: Not Applicable.

Regulatory Assessment:

Title 10 of the *Code of Federal Regulations* (10 CFR), Section 50.46 requires that licensees design their ECCS systems to meet five criteria, one of which is to provide the capability for long-term cooling. This criterion requires that, following a successful system initiation, the ECCS shall be able to provide cooling for a sufficient duration such that the core temperature is maintained at an acceptably low value. In addition, the ECCS shall be able to continue decay heat removal for the extended period of time required by the long-lived radioactivity remaining in the core. The ECCS is designed to meet this long-term cooling criterion, assuming the worst single failure.

The staff considers continued operation of PWRs during the implementation of this action plan to be acceptable because the probability of the most challenging initiating event (i.e., large break LOCA) is extremely low. More probable (although still low probability) LOCAs (small, intermediate) will generate smaller quantities of debris, require less ECCS flow, take more time to use up the water inventory in the refueling water storage tank, and in some cases may not require the use of recirculation from the ECCS sump because the flow through the break would be small enough that the operator will have sufficient time to safely shut the plant down. In addition, all PWRs have received approval by the staff for leak-before-break credit on their largest RCS primary coolant piping. While leak-before-break is not acceptable for demonstrating compliance with 10 CFR 50.46, it does demonstrate that leak-before-break-qualified piping is of sufficient toughness that it will most likely leak (even under safe shutdown earthquake conditions) rather than rupture. This, in turn, would allow operators adequate opportunity to shut the plant down safely. Additionally, the staff notes that there are sources of margin in PWR designs which may not be credited in the licensing basis for each plant. For instance, NPSH analyses for most PWRs do not credit containment overpressure (which would

likely be present during a LOCA). Any containment pressure greater than assumed in the NPSH analysis provides additional margin for ECCS operability during an accident. Another example of margin is that in many cases, ECCS pumps would be able to continue operating for some period of time under cavitation conditions. Some licensees have vendor data demonstrating this. Design margins such as these examples may prevent complete loss of ECCS recirculation flow or increase the time available for operator action (e.g., refilling the refueling water storage tank) prior to loss of flow. Finally, the staff believes that continued operation of PWRs is also acceptable because of PWR design features which may minimize potential blockage of the ECCS sumps during a LOCA. The RES study on sump blockage attempted to capture many of the PWR design features parametrically. However, it is not possible for a generic study of this nature to capture all the variations in plant-specific features that could affect the potential for ECCS sump blockage (piping layouts, compartments, insulation location within containment, etc.). Therefore, evaluation on a plant-specific basis is necessary to determine the potential for ECCS sump clogging.

As part of the GSI-191 study, Los Alamos National Laboratory, performed a generic risk assessment to determine how much core damage frequency (CDF) is changed by the findings of the parametric analysis. Utilizing initiating event frequencies that consider leak-before-break credit consistent with NUREG/CR-5750, Los Alamos National Laboratory calculated an overall CDF of 3.3 E-06 when debris clogging as a failure mechanism is not considered, and an overall CDF of 1.5 E-04 when debris clogging is considered. However, these CDFs were calculated without giving any credit for operator action, and without consideration of whether the ECCS or containment spray pumps would be able to continue operating if the headloss across the sump screen exceeds the calculated licensing basis NPSH margin. The change in CDF is also dominated by small and very small break LOCAs, events for which significant operator actions can be taken to prevent core damage. The risk benefit of certain interim compensatory measures is demonstrated by the NRC-sponsored technical report LA-UR-02-7562, "The Impact of Recovery from Debris-Induced Loss of ECCS Recirculation on PWR Core Damage Frequency," dated February 2003. On this basis, the schedule for issuing generic communications and follow-on actions to address the PWR sump clogging issue is considered to be appropriate.

Current Status:

The staff continues to hold regular public meetings with stakeholders, including the Advisory Committee on Reactor Safeguards (ACRS), PWR licensees, strainer vendors and the NEI sump performance task force on the progress in resolving GSI-191. Meetings with NEI, licensees, and sump strainer vendors occur as needed.

As GSI-191 approaches resolution, the staff is using several approaches to obtaining reasonable assurance that sumps will perform adequately if called upon following a LOCA. First, the staff is reviewing each licensee's final supplemental response to GL 2004-02. In addition, the staff is conducting inspections at each PWR to verify that licensees have made changes to which they have committed in correspondence with the NRC. Finally, the staff conducted comprehensive audits of corrective actions for GL 2004-02 at a sample of PWRs. Audits have been completed and reports issued for Watts Bar, San Onofre, Prairie Island, Millstone, Oconee, Waterford, North Anna, Salem, and Indian Point. Since licensees' chemical effects evaluations were not complete during these audits, the NRC concluded that it would be

appropriate to perform additional audits focusing only on chemical effects. The staff performed chemical effects audits at North Anna, Palisades, and is considering one more candidate plant.

The NRC reviewed an industry topical report developed to support evaluation and testing of chemical effects. Review of another topical report that addresses effects of debris downstream of sump strainers on components such as pumps and valves has also been completed. Safety evaluations for both reports have been issued. An additional topical report addressing the downstream effects of post-LOCA debris inside the reactor vessel was submitted to the NRC for review in June 2007. NRC staff and ACRS identified technical issues with the WCAP and, therefore, the PWROG conducted additional testing to respond to these issues. On July 20, 2012, the PWROG submitted to the NRC for review and approval Topical Report (TR)-WCAP-16793-NP-A, "Evaluation of Long-Term Cooling Considering Particulate, Fibrous and Chemical Debris in the Recirculating Fluid," Revision 2 to address the effects of debris on the reactor core. The TR guidance and acceptance bases were developed through analyses and flow testing using representative fuel assemblies and ECCS flow rates. On April 8, 2013, NRC staff issued an SE on TR WCAP-16793-NP, Revision 2 (ADAMS Accession No. ML13084A152), finding it an acceptable model for assessing the effect of sump strainer bypassed fibrous, particulate, and chemical debris on core cooling in PWRs.

Other current work includes a scoping study sponsored by RES to consider whether certain potential issues raised with regard to chemical effects need additional work. Draft NUREG/CR-6,988 on this topic is close to being published. RES is evaluating what future chemical effects research work is warranted. The staff is also interacting with vendors who are performing strainer testing for licensees. The purpose of these discussions, as well as ongoing staff observations of strainer tests, is to gain confidence that the test practices involved are rigorous in order to support reasonable assurance that the technical issues associated with GSI-191 have been addressed.

Many licensees have completed integrated head loss testing. Some of these licensees may have to retest based on staff questions regarding the test procedures that were used. These licensees are currently performing additional testing, or are scheduled to test when test facilities become available. The testing being performed by these licensees is termed "test for success." The test for success program tests various plant configurations including the current configuration, and if required, modified plant configurations containing less debris. The test defines any modifications that the plant will have to make to demonstrate adequate ECCS and CS pump operation in recirculation.

All PWRs have substantially enlarged their sump strainers, typically by one to two orders of magnitude. Some licensees have obtained permission from NRC to complete certain corrective actions later than the December 31, 2007 due date in GL 2004-02. The staff has based authorization for such extensions (typically for a few months) on information provided by the requesting licensee that shows the extension to be of low risk and on criteria the staff identified to the Commission in SECY-06-0078, Status of Resolution of GSI-191, "Assessment of [Effect Of] Debris Accumulation on PWR Sump Performance," dated March 31, 2006.

In April 2010, the staff and industry briefed the Commission regarding the status of resolution of GSI-191. Representatives from industry summarized the actions taken to address the issue and suggested that these actions have resolved the safety implications of this GI. The industry representatives further recommended resolution and closure through the application of

10 CFR 50, Appendix A, General Design Criterion 4 (GDC-4). This criterion allows crediting, for certain purposes, the high likelihood that a reactor coolant leak would be detected before a major piping rupture would occur; NRC staff has not allowed this credit for resolving sump performance issues. The staff acknowledged the industry's actions to address this issue. However, the staff stated its position is that the issue remains of concern for plants that have not demonstrated adequate sump performance using methods acceptable to the NRC. Based on the information presented, the Commission directed the staff to provide information on potential approaches for bringing GI-191 to closure. The staff provided this information in SECY-10-0113, "Closure Options for Generic Safety Issue-191, Assessment of Debris Accumulation on Pressurized Water Reactor Sump Performance," dated August 26, 2010 (ADAMS Accession No. ML101820296). The Commission issued its staff requirements memorandum (SRM) in December 2010. The Commission determined that it was prudent to allow the nuclear industry to complete testing on in-vessel effects and zone of influence in 2011, and to develop a path forward by mid-2012. The SRM directed the staff to evaluate alternative approaches, including risk-informed approaches, for resolving GI-191 and to present them to the Commission by mid-2012.

Based on the interactions with stakeholders and the results of the industry testing, NRC staff developed three options to resolve GI-191. These options were documented and proposed to the Commission in SECY-12-0093, "Closure Options for Generic Safety Issue 191, 'Assessment of Debris Accumulation on Pressurized Water Reactor Sump Performance,'" dated July 9, 2012 (ADAMS Accession No. ML121310648). All options would require licensees to demonstrate compliance with 10 CFR 50.46. The options are summarized as follows:

Option 1

Allows the use of approved models and test methods. Licensees choosing this option will have relatively low fiber plants that can demonstrate that less than 15 grams of fiber per fuel assembly can reach the reactor core.

Option 2

Requires implementation of additional mitigative measures until resolution is completed and allows more time for licensees to resolve issues through further industry testing or use of a risk informed approach. Licensees choosing this option generally have more problematic materials in containment or desire additional margin for their in-vessel debris limits.

Option 2A

Deterministic: Industry performed more testing and analysis. Industry submitted update to TR WCAP-17788 for NRC review and approval (in-vessel only).

Option 2B

Risk Informed: Industry to develop a risk informed approach to quantify the risk associated with GI-191 and submit a license amendment request for NRC review and approval.

Option 3

Involves separating the regulatory treatment of the sump strainer and in vessel effects. The ECCS strainers will be evaluated using currently approved models while in-vessel will be addressed using a risk-informed approach.

The options allowed industry alternative approaches for resolving GI-191. The Commission issued a Staff Requirement Memorandum SRM-SECY-12-0093 on December 14, 2012 (ADAMS Accession No. ML12349A378), approving all three options for closure of GI-191.

NRR Lead PMs: Serita Sanders, NRR/DPR/PGCB 415-2956 (GL 2004-02)

NRR Lead Branch Chief: Victor Cusumano, NRR/DSS/SSIB, 415-4011

NRR Technical Contacts: Ashley Smith, NRR/DSS/SSIB, 415-3201 (NPSH, Head loss, and Downstream Effects)
Paul Klein, NRR/DE/ESGB, 415-4030 (Chemical Effects)
Matt Yoder, NRR/DE/ESGB, 415-4017 (Coatings)
Steve Smith, NRR/DE/SSIB, 415-3190 (Head Loss Testing)

RES Technical Contacts: Rob Tregoning, RES/DE, 301-415-2324
John Burke, RES/DE/SGSEB, 301-415-2343

References:

1. Regulatory Guide 1.54, "Quality Assurance Requirements for Protective Coatings Applied to Water-Cooled Nuclear Power Plants" (Draft DG-1076, Proposed Revision 1, published March 1999), June 1973.
2. Bulletin 1993-02, "Debris Plugging of Emergency Core Cooling Suction Strainers," May 11, 1993.
3. Bulletin 1993-02, Supplement 1, "Debris Plugging of Emergency Core Cooling Suction Strainers," February 18, 1994.
4. NUREG/CR-6224, "Parametric Study of the Potential for BWR ECCS Strainer Blockage Due to LOCA Generated Debris," October 1995, ADAMS Accession No. ML083290498.
5. NUREG-0897, Revision 1, "Containment Emergency Sump Performance," October 1985, ADAMS Accession No. ML112440046.
6. Information Notice 2005-26, Supplement 1, "Additional Results of Chemical Effects Tests in a Simulated PWR Sump Pool Environment," January 20, 2006, ADAMS Accession No. ML060170102.

7. Bulletin 1995-02, "Unexpected Clogging of Residual Heat Removal (RHR) Pump Strainer While Operating in Suppression Pool Cooling Mode," October 17, 1995.
8. Bulletin 1996-03, "Potential Plugging of Emergency Core Cooling Suction Strainers by Debris in Boiling-Water Reactors," May 6, 1996.
9. Bulletin 2003-01, "Potential Impact of Debris Blockage on Emergency Sump Recirculation at Pressurized-Water Reactors," June 9, 2003, ADAMS Accession No. ML031600259.
10. Regulatory Guide 1.82, Revision 3, "Water Sources for Long-Term Recirculation Cooling Following a Loss-of-Coolant Accident," November 2003, ADAMS Accession No. ML033140347.
11. Generic Letter 1997-04, "Assurance of Sufficient Net Positive Suction Head for Emergency Core Cooling and Containment Heat Removal Pumps," October 7, 1997.
12. Generic Letter 1998-04, "Potential for Degradation of the Emergency Core Cooling System and the Containment Spray System after a Loss-of-Coolant Accident Because of Construction and Protective Coating Deficiencies and Foreign Material in Containment," July 14, 1998.
13. Memorandum from Richard J. Barrett to John N. Hannon, "Preliminary Risk Assessment of PWR Sump Screen Blockage Issue," March 26, 1999.
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