

PRESSURIZED-WATER REACTOR SUMP PERFORMANCE GSI-191

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Last Update: 02/09/2016
 Lead NRR Division: DSS
 Supporting Divisions: DE, DORL, DRA, and CMB(RES)

MILESTONES	DATE (T)arget (C)omplete
PART I: BOILING-WATER REACTOR EMERGENCY CORE COOLING SYSTEM SUCTION STRAINER CLOGGING ISSUE	
1. Bulletin (BL) 96-03, "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 (GL) 97-04, "Assurance of Sufficient Net Positive Suction Head (NPSH) for Emergency Core Cooling and Containment Heat Removal Pumps" <ul style="list-style-type: none"> • Complete review of licensee responses • Complete revision of Regulatory Guide (RG) 1.1/RG 1.82, R3 	03/00 (C) 11/03 (C)
PART III: CONTAINMENT COATINGS	
1. GL 98-04, "Potential for Degradation of the Emergency Core Cooling System and the Containment Spray System after a Loss-Of-Coolant Accident (LOCA) Because of Construction and Protective Coating Deficiencies and Foreign Material in Containment"	07/00 (C)
2. NRC-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)

PART IV: GENERIC SAFETY ISSUE (GSI) 191, "ASSESSMENT OF DEBRIS ACCUMULATION ON 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 (PWR) sump blockage • Evaluate need for regulatory action based on research program results (NRR) 		<p>03/99 (C)</p> <p>06/99 (C)</p> <p>04/00 (C)</p> <p>09/01 (C)</p> <p>03/02 (C)</p>
<p>2. Chemical effects: Determine if sump pool environment generates by-products which contribute to sump clogging (Argonne National Laboratory (ANL) 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>05/06 (C)</p> <p>03/06 (C)</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)	
	• Brief NRR Executive Team to obtain approval to prepare GL	02/02 (C)
	• Public meeting with Nuclear Energy Institute, Westinghouse Owners Group (WOG), Babcock & Wilcox (B&WOG), Combustion Engineering (CEOG)	03/02 (C)
	• Advisory Committee on Reactor Safeguards (ACRS) briefing on proposed draft GL	02/03 (C)
	• Committee to Review Generic Requirements (CRGR) briefing on proposed BL 2003-01	04/03 (C)
	• Information Paper to Commission, Issue BL 2003-01	06/03 (C)
	• NEI publish PWR Industry Evaluation Guidelines (Draft)	10/03 (C)
	• CRGR briefing on proposed draft GL	02/04 (C)
	• Proposed draft GL issued for public comment	03/04 (C)
	• GL issuance	09/04 (C)
	• Issue Safety Evaluation (SE) on methodology	12/04 (C)
	• NRC starts reviews of GL responses and selective audits	09/05 (C)
	• GL date for licensees to start modifications	04/06 (C)
	• Interim meeting with ACRS on GSI-191 activities	06/07 (C)
	• Start review of final supplemental responses to GL	02/08 (C)
	• Complete review of supplemental responses to GL	06/09 (C)
	• 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	01/17 (T)
	• Complete Temporary Instruction 2515/166 inspections of plant changes	10/08 (C)
	• Complete plant audits	
	• PWROG submits revised Topical Report (TR) WCAP-16406 on in-vessel downstream effects	04/08 (C)
	• Staff issues final SE revised TR on in-vessel downstream effects	05/06 (C)
	• Staff issues SECY-12-0093	12/07 (C)
	• Commission issues SRM-SECY-12-0093	07/12 (C)
	• PWROG submits TR WCAP-16793	12/12 (C)
	• Staff issues final SE of WCAP-16793	05/07 (C)
	• Staff completes review of RAI responses related to in-vessel downstream effects and revised head loss testing and corresponds with licensees as needed	04/13 (C)
	• STP submits pilot application for Option 2B for closure of GL 2004-02	09/16 (T)
	• STP submits supplement to risk informed Option 2B	11/13 (C)
	• Staff to review and approve STP application	08/15 (C)
	• PWROG submits WCAP-17788	11/16 (T)
	• Staff issues final SE of WCAP-17788	07/15 (C)
	• NRC issues GL 2004-02 closure memo after issuing closure letters to all licensees and closes GSI-191 implementation phase	09/16 (T)
		12/18 (T)

Description:

This action plan was originally prepared to comprehensively address the adequacy of ECCS suction design, and to ensure adequate ECCS pump NPSH during a 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 also includes addressing the potential for debris to affect long term core cooling by blocking flow paths or damaging equipment downstream of the ECCS strainers including within the reactor vessel.

This plan has four parts, two of which have been completed. First, for Boiling-Water Reactors (BWRs), this issue has been addressed by licensee responses to NRC BL 96-03, "Potential Plugging of Emergency Core Cooling Suction Strainers by Debris in BWR," dated May 6, 1996. Second, the adequacy of licensee (both PWR and BWR) NPSH calculations was evaluated through NRR review of licensee responses to GL 97-04, "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 assesses the adequacy of the implementation and maintenance of licensee coating programs through NRR review of licensee responses to GL 98-04, "Potential for Degradation of the Emergency Core Cooling System and the Containment Spray System after a LOCA 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 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. Office of Regulatory 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, (Agencywide Documents Access and Management System (ADAMS) Package No. ML012750149), RES transferred the lead for 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 NRC staff first addressed ECCS clogging issues in detail during its review of Unresolved Safety Issue (USI) A-43, "Containment Emergency Sump Performance." GL 85-22, "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 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. An event at Barsebäck 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 that high strainer pressure drop could be 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 and its effect not considered. An event at Limerick 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 96-03, "Potential Plugging of Emergency Core Cooling Suction Strainers by Debris in Boiling-Water Reactors," dated May 6, 1996, requested 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. RG 1.82, Revision 2, (RG 1.82), "Water Sources for Long-Term Recirculation Cooling Following a LOCA," 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 Title 10, Section 50.46 of the *Code of Federal Regulations* (10 CFR 50.46), "Acceptance criteria for Emergency Core Cooling Systems for light-water nuclear power reactors". In response to BL 96-03, all affected BWR licensees installed new larger-capacity strainers.

The NRC's 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 96-03. The assessment determined that larger quantities of debris and finer debris increase the potential for clogging of the ECCS sump screens and therefore, PWRs should evaluate the performance of ECCS strainers considering the effects of debris.

Events at a number of plants raised concerns regarding the potential for coatings to become debris during an accident which could clog an ECCS suction path. In several cases qualified coatings delaminated during normal operating conditions. Typically, the root cause has been attributed to inadequate surface preparation. This led the NRC staff to raise questions regarding the adequacy of licensee coating programs. The staff issued GL 98-04, "Potential for Degradation of the Emergency Core Cooling System and the Containment Spray System after a LOCA Because of Construction and Protective Coating Deficiencies and Foreign Material in Containment," dated July 14, 1998, to obtain necessary information from licensees to evaluate how they implement and maintain their coating programs. In addition, RG 1.54, "Quality Assurance Requirements for Protective Coatings Applied to Water-Cooled Nuclear Power Plants," issued June 1973, was revised to update guidance for the selection, qualification, application, and maintenance of protective coatings in nuclear power plants consistent with the then current American Society of Testing and Materials 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 NEI guidance documents 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 RAIs 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 "PWR Containment 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. 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 initially assess concerns regarding the potential for chemical precipitates and corrosion products to significantly block a fiber bed and increase the head loss across an ECCS sump screen, a joint NRC/industry Integrated Chemical Effects Testing (ICET) program was started in 2004 and completed in August 2005. Chemical precipitation products formed in some of the ICET tests, and follow-up testing was performed at ANL to evaluate how chemical precipitates affected head loss across a fiber bed. 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 sponsored additional research in certain areas to support evaluation efforts and provide confirmatory information. These areas include research on chemical effects to determine if the PWR 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," 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. Additionally, ANL evaluated head loss caused by corrosion of aluminum coupons (ADAMS Accession No. ML082340870). ANL also performed an aluminum solubility study (ADAMS Accession No. ML091610696). Follow-on testing sponsored by both the PWROG and by individual licensees has provided additional information concerning the conditions that are more probable to cause 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 NRC 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 publicly 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 96-03 regarding similar issues with BWRs. 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 a 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 operating 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:

10 CFR 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 most limiting single failure.

In April 2010, the NRC 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, "Fluid Systems," (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 GSI-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 GSI-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 GSI-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 amounts in plant containments and have demonstrated that less than 15 grams of fiber per fuel assembly can reach the reactor core. Most of the Option 1 plants are considered to have adequately addressed GL 2004-02.

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 GSI-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 GSI-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 GSI-191.

Current Status:

The staff continues to hold regular public meetings with stakeholders including the ACRS, PWR licensees, strainer vendors, engineering consultants, and NEI and its members regarding progress in resolving GSI-191. Meetings with NEI, licensees, and industry consultants occur as needed.

As GSI-191 approaches resolution, the NRC staff is using several approaches to obtaining reasonable assurance that sumps will perform adequately following a LOCA. First, the staff has reviewed each licensee's supplemental response to GL 2004-02. In addition, the staff has conducted 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 staff concluded that it would be appropriate to perform additional audits focusing only on chemical effects. The staff performed chemical effects audits at North Anna and Palisades.

The NRC staff reviewed an industry TR developed to support evaluation and testing of chemical effects. Review of another TR that addresses effects of debris downstream of sump strainers on components such as pumps and valves has also been completed. SEs for both reports have been issued. An additional TR 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 TR WCAP-16793-NP-A, "Evaluation of Long-Term Cooling Considering Particulate, Fibrous and Chemical Debris in the Recirculating Fluid," Revision 2 (ADAMS Accession No. ML13239A114) 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 (ADAMS Accession No. ML13084A152), NRC staff issued an SE on TR WCAP-16793-NP, Revision 2, finding it an acceptable model for assessing the effect of fibrous, particulate, and chemical debris on core cooling in PWRs.

Many licensees have completed integrated head loss testing. Some of these licensees may have to retest because they used potentially non-conservative test methods or assumptions to establish test conditions. The testing being performed by some 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 containment spray pump operation in recirculation. Licensees are also conducting testing to determine how much debris may pass through the strainer and affect downstream components.

All PWRs have substantially enlarged their sump strainers, typically by one to two orders of magnitude.

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References:

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 (ADAMS Accession No. ML003740187).

NRC Bulletin 93-02, "Debris Plugging of Emergency Core Cooling Suction Strainers," May 11, 1993 (ADAMS Accession No. ML082320674).

NRC Bulletin 93-02, Supplement 1, "Debris Plugging of Emergency Core Cooling Suction Strainers," February 18, 1994 (ADAMS Accession No. ML031190684).

NUREG/CR-6224, "Parametric Study of the Potential for BWR ECCS Strainer Blockage Due to LOCA Generated Debris," October 31, 1995 (ADAMS Accession No. ML083290498).

NRC Bulletin 95-02, "Unexpected Clogging of Residual Heat Removal (RHR) Pump Strainer While Operating in Suppression Pool Cooling Mode," October 17, 1995 (ADAMS Accession No. ML082490807).

NRC Bulletin 96-03, "Potential Plugging of Emergency Core Cooling Suction Strainers by Debris in Boiling-Water Reactors," May 6, 1996 (ADAMS Accession No. ML082401219).

GL 97-04, "Assurance of Sufficient Net Positive Suction Head for Emergency Core Cooling and Containment Heat Removal Pumps," October 7, 1997 (ADAMS Accession No. ML031110062).

GL 98-04, "Potential for Degradation of the Emergency Core Cooling System and the Containment Spray System after a LOCA Because of Construction and Protective Coating Deficiencies and Foreign Material in Containment," July 14, 1998 (ADAMS Accession No. ML031110081).

Memorandum from K. Kavanagh to G. Holahan, "Report on Results of Staff Review of NRC Generic Letter 97-04, 'Assurance of Sufficient Net Positive Suction Head for Emergency Core Cooling and Containment Heat Removal Pumps,'" June 26, 2000 (ADAMS Accession No. ML003726567).

Letter from Gary M. Holahan to James F. Klapproth, "NRC Staff Review of GE Licensing Topical Report NEDC-32721P, 'Application Methodology for the General Electric Stacked Disk ECCS Suction Strainers,' TAC Number M98500," June 21, 2001 (ADAMS Accession No. ML011730036).

Memorandum from Ashok C. Thadani to Samuel J. Collins, "RES Proposed Recommendation for Resolution of GSI-191, 'Assessment of Debris Accumulation on PWR Sump Performance,'" September 28, 2001 (ADAMS Accession No. ML012750149).

Memorandum from Robert B. Elliott to Gary M. Holahan, "Completion of Staff Reviews of NRC Bulletin 96-03, "Potential Plugging of Emergency Core Cooling Suction Strainers by Debris in Boiling-water Reactors," and NRC Bulletin 95-02, "Unexpected Clogging of a Residual Heat Removal (RHR) Pump Strainer While Operating in Suppression Pool Cooling Mode,'" October 18, 2001 (ADAMS Accession No. ML012970261).

NEI 02-01, "Condition Assessment Guidelines: Debris Sources inside Containment," Revision 1 September 30, 2002 (ADAMS Accession No. ML030420318).

NUREG/CR-6762, "GSI-191: Parametric Evaluations for Pressurized Water Reactor Recirculation Sump Performance," August 30, 2002 (ADAMS Package Accession No. ML022470077).

NRC Bulletin 2003-01, "Potential Impact of Debris Blockage on Emergency Sump Recirculation at Pressurized-Water Reactors," June 9, 2003 (ADAMS Accession No. ML031600259).

Regulatory Guide 1.82, Revision 3, "Water Sources for Long-Term Recirculation Cooling Following a Loss-of-Coolant Accident," November 30, 2003 (ADAMS Accession No. ML033140347).

Letter from Mario V. Bonaca to Nils Diaz, "Draft Final Revision 3 to Regulatory Guide 1.82, 'Water Sources for Long Term Recirculation Cooling Following a Loss of Coolant Accident,'" September 30, 2003 (ADAMS Accession No. ML032800711 (non-public)).

Technical Letter Report LA-UR-02-7562, "The Impact of Recovery from Debris-Induced Loss of ECCS Recirculation on PWR Core Damage Frequency," February 28, 2003 (ADAMS Accession No. ML030690174).

NUREG/CR-6808, "Knowledge Base for the Effect of Debris on Pressurized Water Reactor ECCS Sump Performance," February 28, 2003 (ADAMS Package Accession No. ML030920542).

GL 2004-02, "Potential Impact of Debris Blockage on Emergency Recirculation During Design Basis Accidents at Pressurized Water Reactors," September 13, 2004 (ADAMS Accession No. ML042360586).

NEI 04-07, "Pressurized Water Reactor Sump Performance Evaluation Methodology," May 28, 2004 (ADAMS Accession No. ML041550661).

GSI-191 Safety Evaluation, "Pressurized Water Reactor Containment Sump Evaluation Methodology," December 6, 2004 (ADAMS Accession No. ML043280641).

NRC Information Notice 2005-26, "Results of Chemical Effects Head Loss Tests in a Simulated PWR Sump Pool Environment," September 16, 2005 (ADAMS Accession No. ML052570220).

NRC 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).

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Letter from Catherine Haney to all pressurized water reactor licensees, "Alternative Approach for Responding to the Nuclear Regulatory Commission Request for Additional Information Letter Re: Generic Letter 2004-02," March 28, 2006 (ADAMS Accession No. ML060870274).

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WCAP-16406-P, "Evaluation of Downstream Sump Debris Effects in Support of GSI-191," May 31, 2006 (ADAMS Accession No. ML061580184).

SECY-12-0093, "Closure Options for Generic Safety Issue - 191, Assessment of Debris Accumulation on Pressurized-Water Reactor Sump Performance," July 9, 2012 (ADAMS Accession No. ML121320270).

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WCAP-16793-NP-A, "Evaluation of Long-Term Cooling Considering Particulate, Fibrous and Chemical Debris in the Recirculating Fluid," Revision 2, July 31, 2013 (ADAMS Accession No. ML13239A114).