

## Detailed Status of Generic Issues (GIs)

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## Description of Generic Issues Program

The Generic Issue Management Control System (GIMCS) supplies information relevant to the management and resolution of generic issues (GIs). The resolution of any GI might lead to safety enhancements and the promulgation of new or revised requirements or guidance. The GIMCS is designed to facilitate management of GIs from issue identification through resolution (development of new criteria, management review and approval, public comments, and incorporation into the regulations, as appropriate).

The procedures for processing GIs are contained in Management Directive (MD) 6.4, "Generic Issues Program," and the Office of Nuclear Regulatory Research (RES), Office Instruction TEC-002, "Procedures for Processing Generic Issues." Other program offices may have instructions for handling GIs specific to their organization.

In accordance with Title 10 of the *Code of Federal Regulations* (10 CFR) 10 CFR 52.47(a) (21), applications for design certification must contain:

Proposed technical resolutions of those Unresolved Safety Issues and medium- and high-priority generic safety issues which are identified in the version of NUREG-0933 current on the date up to 6 months before the docket date of the application and which are technically relevant to the design.

Similarly, in accordance with 10 CFR 52.79(a) (20), applications for combined licenses must contain:

Proposed technical resolutions of those Unresolved Safety Issues and medium- and high-priority generic safety issues which are identified in the version of NUREG-0933 current on the date up to 6 months before the docket date of the application and which are technically relevant to the design.

As indicated in MD 6.4, prioritization of GIs was replaced by the screening process, in which a determination is made to either establish the proposed issue as a GI or not accept the issue into the program. For the purposes of 10 CFR 52.47(a) (21) and 10 CFR 52.79(a) (20), any GI established by the MD 6.4 screening process is considered equivalent to a high-priority GI.

In an effort to increase efficiency in the GI Program, the GI process was revised in 2014 to incorporate enhancements identified by a tiger team that was implemented as a business process improvement initiative. The revised process was documented in a revision to MD 6.4, issued on January 2, 2015. Major changes in this revision were:

- program simplification by reducing the number of stages from five to three
- increased management involvement and accountability
- new guidance to identify and act on immediate safety concerns and to document the justification for ongoing operation, such that progress would be made on the GI without the need to implement remedial actions while the GI is in process

Although these changes are anticipated to improve the program, it will likely take months to years for several GIs to go through all three stages of the program (screening, assessment, regulatory office implementation). Therefore, it is still too early to realize the full efficiencies of the process changes.

Nonetheless, a near-term result of these changes is that the GI program has placed greater emphasis on reviews of proposed GIs that are submitted to determine whether the issues constituted an immediate safety concern. Previously, these reviews were done at a very high level, with little or inconsistent documentation. In reviewing the proposed GIs that are currently in the program, the staff has collaborated with the Office of Nuclear Reactor Regulation (NRR) to develop better documentation for the basis for this determination. The staff is also working together to better develop the process for immediate safety concern reviews. The near-term outcomes of these changes are that the GI program staff is promptly responding to issues when they are submitted, tracking steady process of active GIs every quarter, and communicating and coordinating with other offices about issues within the GI Program so that issues can transition between offices in a smooth manner.

## ACRONYMS

|       |  |
|-------|--|
| ACRS  | Advisory Committee on Reactor Safeguards                                     |
| ADAMS | Agencywide Documents Access and Management System                            |
| ASME  | American Society of Mechanical Engineers                                     |
| BNL   | Brookhaven National Laboratory   |
| BWR   | boiling-water reactor  |
| BWROG | Boiling Water Reactor Owners Group   |
| CDF   | core damage frequency  |
| CEUS  | Central and Eastern United States  |
| DCH   | direct containment heat  |
| DE    | Division of Engineering  |
| DORL  | Office of Nuclear Reactor Regulation Division of Operating Reactor Licensing |
| DRA   | Division of Risk Analysis  |
| DSA   | Division of Systems Analysis   |
| DSS   | Division of Safety Systems   |
| CEUS  | Central and Eastern United States  |
| CRGR  | Committee to Review Generic Requirements                                     |
| ECCS  | emergency core cooling system  |
| EDO   | Executive Director of Operations   |
| EPRI  | Electric Power Research Institute  |
| ESP   | early site permit  |
| ESEP  | expedited seismic evaluations process  |
| GI    | generic issue (same meaning as GSI)  |
| GIMCS | Generic Issue Management Control System                                      |
| GL    | generic letter   |
| GR    | guidance report  |
| GSI   | generic safety issue   |
| HPCS  | high-pressure core spray   |
| IN    | information notice   |
| IPEEE | individual plant examination of external events                              |
| LOCA  | loss-of-coolant accident   |
| MD    | management directive   |
| MPVF  | maximum potential void fraction  |
| NEI   | Nuclear Energy Institute   |
| NPSH  | net positive suction head  |
| NRC   | U.S. Nuclear Regulatory Commission   |
| NRO   | Office of New Reactors   |
| NRR   | Office of Nuclear Reactor Regulation   |
| NSIR  | Office of Nuclear Security and Incident Response                             |
| OEGIB | Operating Experience and Generic Issues Branch                               |
| OGC   | Office of General Counsel  |
| PUMA  | Purdue University Multi-Dimensional Integral Test Assembly                   |
| PWR   | pressurized-water reactor  |
| RAI   | requests for additional information  |
| RES   | Office of Nuclear Regulatory Research  |
| RIS   | regulatory issue summary   |
| SBO   | station blackout   |
| SBPB  | balance-of-plant branch  |
| SE    | safety evaluation  |
| SOW   | statement of work  |
| SPRA  | seismic probabilistic risk assessment  |

|      |                                |
|------|--------------------------------|
| SRM  | staff requirements memorandum  |
| SRP  | Standard Review Plan           |
| SSE  | safe shutdown earthquake       |
| SSIB | Safety Issue Resolution Branch |
| TAC  | task action control            |
| TAP  | task action plan               |
| TBD  | to be determined               |
| TI   | temporary instruction          |
| TVA  | Tennessee Valley Authority     |
| USI  | unresolved safety issue        |
| WUS  | Western United States          |

Title: Assessment of Debris Accumulation on PWR Sump Performance

Generic Issue Number: 191

Identification Date: 09/01/1996

Action Level: Regulatory Office Implementation

Office/Division/Branch: NRR/DPR/PGCB

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Technical Assessment: 09/15/2001 (Actual/Complete)

Regulation and Guidance Issuance: 09/30/2004 (Actual/Complete)

Transfer to Regulatory Office for Action: 12/31/2007 (Actual/Complete)

Closure: 12/31/2018 (Estimated)

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#### DESCRIPTION:

This issue concerns the possibility that debris accumulating on the emergency core cooling systems (ECCS) sump screen in pressurized-water reactors (PWRs) could result in a loss of the net positive suction head (NPSH) margin. Loss of NPSH margin could impede or prevent the flow of water from the sump such that the system would not meet the criteria of 10 CFR 50.46, "Acceptance Criteria for Emergency Core Cooling Systems for Light-Water Nuclear Power Reactors." The screening assessment did not identify any immediate safety concerns.

#### WORK SCOPE:

The goals of the assessment by the U.S. Nuclear Regulatory Commission (NRC) were to: (1) determine if the transport and accumulation of debris in containment, after a loss-of-coolant accident (LOCA), which could impede the operation of the ECCS in operating PWRs, (2) develop the technical basis for revising the NRC's regulations or guidance as necessary, (3) provide NRC technical reviewers with sufficient information on phenomena involved to facilitate the review of any changes to plants that could be warranted, and (4) issue generic communications and work with industry to evaluate and resolve Generic Issue (GI) 191 for all PWRs.

Preliminary parametric calculations were completed in July 2001 indicating the potential for debris accumulation at operating PWRs. These calculations were representative of the operating PWR population. The Office of Nuclear Regulatory Research (RES) staff completed a technical assessment, "RES Proposed Recommendation for Resolution of GSI-191, "Assessment of Debris Accumulation on PWR Sump Performance" (Agencywide Documents Access and Management System (ADAMS) Accession No. ML012750091) that concluded that GI-191 was a credible concern for the population of domestic PWRs, and that detailed plant-specific evaluations were needed to determine the susceptibility of each licensed PWR to ECCS sump blockage. After the Advisory Committee on Reactor Safeguards (ACRS) review of the staff's technical assessment of the issue in September 2001, the issue was forwarded to the Office of Nuclear Reactor Regulation (NRR) in a memorandum dated September 28, 2001. NRR has the lead for the regulatory office implementation stage of the GIs process for GI-191. NRR evaluated the technical assessment and prepared a task action plan for developing

appropriate regulatory guidance and resolution of GI-191. NRR is currently working toward closure of the issue with all licensees.

#### STATUS:

The NRC issued Bulletin 2003-01, "Potential Impact of Debris Blockage on Emergency Sump Recirculation at Pressurized-Water Reactors," to PWR licensees on June 9, 2003, requesting them to: (1) confirm their compliance with 10 CFR 50.46 (b) (5) and other existing applicable regulatory requirements, or (2) describe any compensatory measures that have been implemented to reduce the potential risk because of post-accident debris blockage, as evaluations to determine compliance proceed. All PWR licensees provided a response to the bulletin, indicating interim compensatory measures that would be implemented. The NRR Safety Issue Resolution Branch (SSIB) reviewed and evaluated the information provided, and determined that the licensees' actions were responsive and consistent with the guidance of Bulletin 2003-01. The NRR Division of Operating Reactor Licensing (DORL) issued close-out letters to the PWR licensees as these reviews were completed. Generic close-out of Bulletin 2003-01 was completed in December 2005.

Nuclear Energy Institute (NEI) provided a guidance report (GR) to the staff in May 2004 containing the industry's proposed evaluation method for performing plant-specific evaluations. The staff reviewed the GR and issued a draft safety evaluation (SE), which resulted in a supplement to the GR. The final SE was issued in December 2004, resulting in an NRC approved method for evaluating the potential effects of debris on the ECCS strainers.

Generic Letter (GL) 2004-02, "Potential Impact of Debris Blockage on Emergency Recirculation during Design Basis Accidents at Pressurized-Water Reactors," was issued in September 2004, requesting licensees to perform plant-specific mechanistic evaluations of sump performance following LOCA and high-energy line break events, and to implement corrective actions as required to ensure compliance with regulatory requirements. GL 2004-02 required licensees to respond within 90 days with their plans for performing the sump evaluation, including the proposed schedule for completion. All PWR licensees responded to the GL on schedule in September 2005. All PWR licensees committed to perform the required mechanistic evaluation of the ECCS strainers and modify their plants as necessary to ensure compliance with regulations. The staff evaluated all 90-day responses to Generic Letter 2004-02 and in early 2006 issued comments to licensees to be addressed in their final response submittals.

One issue that needed to be addressed was 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 Program was started in 2004 to address these concerns, and was completed in August 2005. Chemical precipitation products were identified during the test program, and follow-up testing and analyses were conducted 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" (ADAMS Accession No. ML052570220) was issued on September 16, 2005.

The NRC conducted additional research in certain areas to support evaluation efforts and to provide confirmatory information. These areas include research on chemical effects to determine if the PWR sump pool environment generates byproducts that 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. The staff completed reports regarding chemical effects on one type of PWR post-

LOCA pool chemistry on December 29, 2005 (ADAMS Accession No. ML053550433), and regarding other PWR containments on January 19, 2006 (ADAMS Accession No. ML060190713). Supplement 1 to IN 2005-26 was issued on January 20, 2006 (ADAMS Accession No. ML060170102), specifically to supply more information regarding test results related to chemical effects in environments containing dissolved phosphate. NRR expected that recipients of the notice would review the information for applicability to their facilities and consider taking actions, as appropriate, to avoid similar issues. Research was also conducted and documented 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 research, which included the following topics: (1) thermodynamic simulations of containment sump pool chemical constituents, to predict the chemical reactions/byproducts in the pools, (2) pressure loss across containment sump screens because of fiber insulation, chemical precipitates, and coating debris, and (3) a literature survey to determine the potential contribution of material leached from containment coatings to the chemical products formed in the containment sump pool. Other research activities included development of a revised head-loss correlation and completion of a peer review of the NRC's chemical effects research program. All planned NRC-sponsored research activities for GI-191 have been completed and documented.

Strainer modifications were completed at all PWRs. These modifications typically increased strainer size by one to two orders of magnitude. The NRC believes these modifications have significantly reduced the risk of strainer clogging.

To confirm adequate implementation and resolution of GI-191, the NRC conducted detailed plant audits examining the analyses and design changes used to address the issues. Two pilot audits were performed in 2005 (Crystal River Unit 3 and Fort Calhoun) to provide opportunities to exercise and improve the NRC evaluation process. Nine full-scope plant audits were also performed. To support the audits, NRC staff also visited sump strainer vendor facilities to observe head loss and chemical effects testing. Other limited-scope audits were conducted in 2008 and 2009 to address chemical effects.

In addition to the plant audits identified above, the staff reviewed licensee responses to GL 2004-02 (received in 2008 and 2009) and items identified from NRC regional inspections that were performed using Temporary Instruction (TI) 2515/166 (ADAMS Accession No. ML060760340). These reviews identified the need for additional information from most licensees in order for the NRC to conclude that the licensees have fully addressed the sump issues. Licensee responses to these requests for additional information and subsequent NRC staff reviews of the responses are ongoing.

An emergent issue that needs to be resolved to close GI-191 involves in-vessel downstream effects—the potential for debris to bypass the sump strainers and enter the core. NRC staff determined in 2008 that additional industry-sponsored testing was necessary to support resolution of this issue. The testing resulted in submittal of a topical report to the NRC in April 2009. The staff determined that additional testing was needed to support the topical report conclusions. The PWR Owners Group (PWROG) funded the testing and expected it to be completed by the end of 2009. However, NRC staff identified the need for further testing as some of the tests yielded unexpected results. Further evaluation and testing were performed. 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 (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 sump strainer bypassed fibrous, particulate, and chemical debris on core cooling in PWRs.

Licensees may use the topical report and associated staff SE to evaluate the effects of debris that reach the core.

Another emergent regulatory issue involved some licensees taking credit for certain vendor testing as a basis for assuming reduced generation of debris after a LOCA. NRC staff reviewed the report of this testing and developed a number of questions. Despite numerous interactions with the industry on these questions, NRC staff could not conclude that the reduced debris generation assumptions were valid. NRC staff informed the industry in March 2010 that it did not accept the testing. The industry responded that it would conduct a new testing effort to address the staff’s concerns, with the intent of still crediting reduced debris generation. The industry completed this testing in 2011. The industry report has not been formally submitted for staff review, but the staff has performed a review of the testing and associated debris generation evaluations. No plant has referenced the report. If the report is referenced by plants in the future, NRC staff will determine the acceptability of its application to each plant specific condition.

In April 2010, the staff and industry briefed the Commission regarding the status of resolution of GI-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.

#### Current Status of Staff Reviews:

##### Option 1 Plants:

|                |                   |
|----------------|-------------------|
| Catawba        | Units 1 and 2*    |
| McGuire        | Units 1 and 2*    |
| Oconee         | Units 1, 2 and 3* |
| Salem          | Units 1 and 2*    |
| Sequoyah       | Units 1 and 2*    |
| Prairie Island | Units 1 and 2*    |
| Watts Bar      | Unit 1*           |
| Watts Bar      | Unit 2*           |
| Bryon          | Units 1 and 2*    |
| Braidwood      | Units 1 and 2*    |

\* The staff has issued closeout GL 2004-02 documentation for these Option 1 plants.

+ Under staff review

##### Option 2 Plants:

##### Option 2A Deterministic Plants:

|               |               |
|---------------|---------------|
| ANO           | Units 1 and 2 |
| Beaver Valley | Units 1 and 2 |
| Comanche Peak | Units 1 and 2 |

|              |                   |
|--------------|-------------------|
| Davis Besse  |                   |
| D. C. Cook   | Units 1 and 2     |
| Farley       | Units 1 and 2     |
| Fort Calhoun |                   |
| GINNA        |                   |
| Harris       |                   |
| Indian Point | Units 2 and 3     |
| Millstone    | Units 2 and 3     |
| North Anna   | Units 1 and 2     |
| Palo Verde   | Units 1, 2, and 3 |
| Robinson     |                   |
| Surry        | Units 1 and 2     |
| TMI 1        |                   |
| V. C. Summer |                   |
| Waterford 3  |                   |

With respect to the Option 2A plants, public meetings were held in 2014 and 2015 with the PWROG to discuss the testing and analyses being proposed for higher in-vessel debris limits. The staff has completed 3 site visits and 1 audit at the Westinghouse Offices. PWROG) submitted an update to TR-WCAP-17788, "Comprehensive Analysis and Test Program for GSI-191 Closure," on July 17, 2015, that is intended to justify higher fiber limits than approved by the staff. An informational ACRS meeting was held on October 20<sup>th</sup> for the PWROG to provide an overview of WCAP-17788. Additional ACRS subcommittee meetings and an ACRS full committee meeting are planned before the NRC completes its review of the TR, which the staff anticipates in fall 2016. Staff review is scheduled to be complete in November 2016. The Option 2A plants will submit closure letters using the approved topical report. Closure of all 2A plants is estimated by the end of 2017.

#### Option 2B Risk Informed

|                           |               |
|---------------------------|---------------|
| South Texas Project (STP) | Units 1 and 2 |
| Calvert Cliffs            | Units 1 and 2 |
| Diablo Canyon             | Units 1 and 2 |
| Palisades                 |               |
| Seabrook                  |               |
| St Lucie                  | Units 1 and 2 |
| Turkey Point              | Units 2 and 4 |
| Vogtle                    | Units 1 and 2 |
| Callaway                  |               |
| Wolf Creek                |               |

STP is the pilot for Option 2B. STP submitted an application for staff review on November 13, 2013. The staff reviewed the application and issued two requests for additional information (RAIs). Based on interactions with NRC staff, on August 20, 2015, the licensee submitted a supplement to the license amendment detailing a new methodology.

NRC staff expects to complete the STP review in the fall of 2016.

NRC staff and the licensee met with ACRS Subcommittees on Thermal- Hydraulics Phenomena and Reliability and Probabilistic Risk Assessment (PRA) in September 2014 and March 2015. Additional ACRS subcommittee meetings and an ACRS full committee meeting are planned

before the NRC completes its review of the application, which the staff anticipates in fall 2016. All other plants choosing Option 2B will submit applications in a staggered schedule after STP is approved.

### Option 3 Plants

#### Point Beach Units 1 and 2

The staff is developing guidance for the Option 2B and 3 reviews. This guidance will be contained in RG 1.229, "Risk-Informed Approach for Addressing the Effects of Debris on Post-Accident Long-Term Core Cooling." The RG is in concurrence along with the 50.46c rule package. The preparation of the guidance was informed by NRC staff review of the STP risk-informed submittal. The staff anticipates submittal of the Point Beach application after the staff completes the STP review. However, it should be noted that Point Beach may change from Option 3 to Option 2A or 2B because the licensee believes it will be able to treat in-vessel debris deterministically.

NRC staff is also coordinating the development of a risk-informed proposed rulemaking, 10 CFR 50.46c, with the review of the Option 2B plants. The Commission directed the staff to develop a risk-informed option to the 10 CFR 50.46 long-term core cooling requirement with respect to debris.

To provide open communication on NRC activities associated with GI-191 resolution, public meetings or conference calls with NEI and industry representatives continue to be held regularly. Briefings of ACRS have been scheduled periodically to provide opportunities for communication on technical issues and additional public involvement.

#### AFFECTED DOCUMENTS:

- Regulatory Guide 1.82
- Regulatory Guide 1.229
- NUREG-0800 (Sections 6.2.2, "Containment Heat Removal Systems" and 6.3, "Emergency Core Cooling System")
- Bulletin 2003-01
- Generic Letter 2004-02
- Information Notice 2005-26 and Supplement 1

#### REASONS FOR SCHEDULE CHANGES:

The NRC plans to close GI-191 when the staff has completed all reviews of GL 2004-02.

RES changed the status of GI-191 to Regulatory Office Implementation (see ADAMS Accession No. ML071630094) as part of improvements to the GI Program described in SECY-07-0022, "Status Report on Proposed Improvements to the Generic Issues Program," (ADAMS Accession No. ML063460239). This improvement obviates the need for milestones specifically associated with the GI Program after the implementation phase begins. Issue closure will occur in accordance with applicable NRR Office programs as indicated in the remaining milestones.

#### PROBLEM/RESOLUTION:

Licensees submitted supplemental responses to GL 2004-02 in 2008 to the present. The staff's initial review of these responses is complete. However, reviews completed to date have

identified the need for more information from some licensees. Staff reviews of the additional information will continue.

| Milestone  | Projected Date | Completed Date |
|--|----------------|----------------|
| NRR user need request sent to RES  | 12/01/1995     | 12/01/1995     |
| User need request assigned to GSIB/RES   | 01/01/1996     | 01/01/1996     |
| Reassessment declared a new GSI  | 09/01/1996     | 09/01/1996     |
| Issued statement of work (SOW) for Evaluation of GSI A-43  | 11/01/1996     | 11/01/1996     |
| Completed evaluation of GSI A-43   | 04/01/1997     | 03/01/1997     |
| Issued SOW for reassessment of debris blockages in PWR containments impact on ECCS performance                               | 09/01/1998     | 09/01/1998     |
| Completed collection and review of PWR containment and sump design and operation data  | 12/01/1999     | 12/01/1999     |
| Completed all debris transport tests   | 09/01/2000     | 08/01/2000     |
| Complete parametric evaluation   | 07/01/2001     | 07/31/2001     |
| Proposed recommendations to ACRS   | 08/31/2001     | 08/31/2001     |
| ACRS review completed  | 09/30/2001     | 09/14/2001     |
| Issue transferred from RES to NRR  | 09/28/2001     | 09/28/2001     |
| Completed reassessment of debris blockages in PWR containments impact on ECCS performance                                    | 09/30/2001     | 09/28/2001     |
| Completed estimate of average CDF reduction, benefits, and costs   | 04/01/2002     | 09/28/2001     |
| Prepared memo discussing proposed recommendations (end of technical assessment stage of generic issue process)               | 04/01/2002     | 09/28/2001     |
| Issued Bulletin 2003-01  | 05/01/2003     | 06/01/2003     |
| Completed development of models and methods for analyzing impact of debris blockages in PWR containments on ECCS performance | 04/01/2001     | 06/09/2003     |
| Discussed Regulatory Guide (RG) 1.82, Revision 3, with ACRS Subcommittee on Thermal Hydraulic Phenomena                      | 08/20/2003     | 08/20/2003     |
| Presented final version of RG 1.82, Revision 3, to ACRS full committee   | 09/11/2003     | 09/11/2003     |
| ACRS sent letter on final version of RG 1.82, Revision 3   | 09/30/2003     | 09/30/2003     |
| Drafted industry guidance for plant-specific analyses  | 10/30/2003     | 10/31/2003     |
| Issued RG 1.82, Revision 3   | 09/30/2003     | 11/30/2003     |
| Received industry guidance for plant-specific analyses   | 09/30/2003     | 05/28/2004     |
| Briefed ACRS Subcommittee on proposed generic letter   | 06/22/2004     | 06/22/2004     |
| NRC met with stakeholders  | 06/29/2004     | 06/29/2004     |
| Developed generic letter for resolution of GI  | 07/07/2004     | 07/07/2004     |

|   |            |            |
|---|------------|------------|
| Briefed full ACRS Committee on proposed generic letter  | 07/07/2004 | 07/07/2004 |
| Met with CRGR on proposed generic letter  | 08/10/2004 | 08/10/2004 |
| Issued Generic Letter 2004-02   | 09/13/2004 | 09/13/2004 |
| Met with ACRS on safety evaluation of NEI 04-07   | 10/07/2004 | 10/07/2004 |
| ACRS responds to safety evaluation of NEI 04-07   | 10/18/2004 | 10/18/2004 |
| EDO briefed ACRS on status  | 09/09/2005 | 09/09/2005 |
| Received all GL responses addressing plant-specific analyses  | 05/31/2005 | 09/15/2005 |
| Issued Information Notice (IN) 2005-26  | 09/16/2005 | 09/16/2005 |
| Issued Supplement 1 to IN 2005-26   | 01/20/2006 | 01/20/2006 |
| Completed review of licensee responses to GL 2004-02  | 01/20/2006 | 01/20/2006 |
| Completed research programs evaluating coating transportability and surrogate throttle valve debris ingestion | 02/28/2006 | 02/28/2006 |
| Completed testing and analysis associated with initial phase of chemical effects research                     | 05/30/2006 | 05/30/2006 |
| Completed containment material head loss testing  | 06/15/2006 | 06/15/2006 |
| Completed thermodynamic simulation of containment sump chemical constituents                                  | 09/30/2006 | 09/30/2006 |
| Completed last audit report   | 05/23/2008 | 06/19/2008 |
| Regions completed TI inspections  | 06/30/2008 | 06/30/2008 |
| Received last TI verifications from regions   | 08/11/2008 | 08/11/2008 |
| Completed review of TI verifications  | 08/25/2008 | 06/30/2009 |
| Staff issued SECY-12-0093   | 07/09/2012 | 07/09/2012 |
| PWROG submitted WCAP 16793,in-vessel downstream effects   | 07/20/2012 | 07/20/2012 |
| Issued final safety evaluation for in-vessel downstream effects on WCAP-16793                                 | 04/08/2013 | 04/08/2013 |
| STP submitted pilot application for risk informed Option 2B for closure of GL 200402                          | 11/13/2013 | 11/13/2013 |
| PWROG submitted update to WCAP-17788  | 06/30/2015 | 07/17/2015 |
| STP submitted supplement to risk informed Option 2B   | 08/20/2015 | 08/20/2015 |
| Issue closure of all Option 1 plants  | 04/30/2016 |            |
| Staff to review and approve STP application   | 11/30/2016 |            |
| Staff to review and issue SE approving WCAP-17788   | 11/30/2016 |            |
| Staff to review and close all Option 2A plants for GL 2004-02   | 05/30/2017 |            |
| Industry submit staggered basis all other Option 2B application   | 05/31/2017 |            |
| Staff to review and approve Option 2B plants  | 05/31/2018 |            |
| Staff to review and approve Option 3 plants   | 05/31/2018 |            |
| Issue closure memo for GSI-191  | 12/31/2018 |            |

Title: BWR ECCS Suction Concerns

Generic Issue Number: 193

Identification Date: 05/10/2002

Action Level: In Assessment

Responsible Office/Division/Branch: RES/DSA/RSAB

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RES Technical Assessment: 07/30/2015 (Actual/Complete)

GI Program Assessment: 12/30/2015 (Planned/Projected)

Closure Date: 04/30/2016 (expected)

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#### DESCRIPTION:

Generic Issue (GI) 193, "BWR ECCS Suction Concerns", evaluates possible failure of the emergency core cooling system (ECCS) pumps (or degraded performance) because of unanticipated quantities of non-condensable gas in the suction piping that could cause gas binding, vapor locking, or cavitation. Non-condensable gas can be present in the suppression pools in boiling-water reactor (BWR) Mark I, II, and III containments during loss-of-coolant accident (LOCA) conditions following downcomer flow from the drywell into the suppression pool. The screening assessment did not identify any immediate safety concerns.

#### WORK SCOPE:

Evaluate the dynamics of gas bubbles in the suppression pool, and the effect on ECCS pump performance.

Quantify the gas void fraction present at different locations in the suppression pool as a function of time after a LOCA.

Provide licensees with insight on how to calculate the post-LOCA suppression pool ECCS pump suction strainer "exclusion zone" and the suppression pool void fraction distribution based on their plant-specific geometrical and operational characteristics. The "exclusion zone" is defined as the volume below or around the down comer exhaust, which is expected to contain a large concentration of non-condensable gas from the drywell. The "exclusion zone" will help define boundary zones such that if a suction strainer is located in a boundary zone, the ECCS pump may be vulnerable.

#### STATUS:

As a result of the initial screening (Agencywide Documents Access and Management System (ADAMS) Accession No. ML032940708) completed in October 2003, a task action plan (TAP) for the technical assessment of this issue was approved in May 2004 (ADAMS Accession No. ML041450208). The staff completed a literature search for information on ECCS pump performance and suppression pool behavior after downcomer flow in the suppression pool in March 2005 (ADAMS Accession No. ML050910465). The literature search was updated in January 2013 and is summarized in a draft document (ADAMS Accession No. ML13079A396). This search identified several experimental test programs that addressed the concerns of this GI. The staff found experimental evidence that gas might reach the ECCS pumps during

a LOCA. The experiments showed that the tested pumps recovered after exposure to non-condensable gas below a particular void fraction for a limited time period. The next phase will attempt to quantify the gas void fraction present at different locations in the suppression pool as a function of time after a LOCA.

Discussions were started in NRC about commonality between GI-193 and a proposed generic letter (later issued as Generic Letter (GL) 08-01) addressing gas accumulation in ECCS suction piping covering all reactors. The Office of Nuclear Regulatory Research (RES) began work with Office of Nuclear Reactor Regulation (NRR) to issue an appropriate generic communication to affected licensees. In 2007, RES and NRR agreed not to include this activity in GL 08-01, "Managing Gas Accumulation in Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems." Also in 2007, RES and NRR requested BWR Owners Group cooperation to support the ongoing assessment of this GI. Based on a staff request (ADAMS Accession Nos. ML092920376 and ML092920023), the BWROG agreed to provide voluntary input that would offer insights into the characteristics of LOCA phenomena at the earliest stages of the postulated accidents plus general information about wet well geometries in relation to ECCS suction strainers. This proprietary input was received on October 29, 2009.

Computational fluid dynamics (CFD) models and analyses have been completed for several tests performed at the Purdue University Multi-Dimensional Integral Test Assembly (PUMA) and Finnish test facilities. (Geometry and data only supported the CFD model development for two tests facilities; documentation from the German GKSS test facility did not provide sufficient information to support CFD model development and did not provide sufficiently detailed test data). A scaling method using data from the considered tests was used to refine a method to scale the test results to full-scale geometry. An initial scaling analysis was completed in February 2014. The developed scaling method was applied to test facilities and to an idealized full-scale suppression pool geometry, and was compared to the CFD analysis of test facilities and of an idealized full scale suppression pool geometry. The initial scaling analysis provided valuable insights that helped in the selection of parameters for the CFD runs. However, upon further investigation it was determined that using such methods to scale data from the smaller scale test programs to full scale conditions was unfeasible. CFD models and analyses for several tests from the two test programs have been performed. CFD analyses, using computational methods used for the two test programs, to simulate full scale Mark I suppression pool behavior following a large break LOCA have been completed. Results from the full-scale CFD analyses can be used to determine a time dependent "exclusion zone."

#### AFFECTED DOCUMENTS:

- GE Topical Report NEDO-33526, "Assessment of NRC Generic Issues, GI-193," October 29, 2009.
- NUREG/CR-7186, "Experimental Measurement of Suppression Pool Void Distribution during Blowdown in Support of Generic Issue 193," September 2014.

#### PROBLEM/RESOLUTION:

As described above, some elements of the original TAP were deferred in favor of staff attempts to pursue other avenues of resolution. For example, the staff attempted to incorporate a request for licensee input via inclusion in GL 08-01, "Managing Gas Accumulation in Emergency Core Cooling, Decay Heat Removal, and Containment Spray Systems." Ultimately, this approach was not chosen because of dissimilarities in the phenomenology involved. Because of the complexity of bubble formation, transport and its impact on pump performance the staff



supplemented the analytical approach with a focused, experimental program. The purpose of the program, completed in 2011 at the PUMA test facility, was to provide clarification as to the potential for bubbles formed from simulated LOCA blowdown to be transported in the wetwell to the ECCS pump inlets and, consequently, to be ingested into ECCS pump impellers. The updated literature review completed in January 2013 provides a recommendation for a void fraction range at the ECCS pump intake that would result in acceptable pump operation and the void fraction range that would result in unacceptable pump operation. Criteria for acceptable pump recovery following non-condensable gas injection which results in unacceptable pump operation are also provided.

**REASONS FOR SCHEDULE CHANGES:**

NRC staff developed independent verification of the test data from the two previously performed test programs and completed CFD modeling. A method to scale data from the smaller scale test programs to full scale conditions was investigated and determined to be unfeasible. CFD analyses, using computational methods from the two test programs, to simulate full scale Mark I suppression pool behavior following a large break LOCA have been completed. Results from the full-scale CFD analyses were used to determine a time dependent “exclusion zone” that can form the basis for a comprehensive GI-193 assessment. Using the information in the technical report, the GI review panel has completed an assessment and found the issue does not present a significant safety hazard. Therefore, the issue will not proceed to regulatory office for implementation. The panel is scheduled to present its final assessment report to the Director of RES in April 2016.

| Milestone   | Projected Date | Completed Date |
|---|----------------|----------------|
| Completed task action plan for a technical assessment           | 03/31/2004     | 05/24/2004     |
| Conducted ECCS pump performance literature search               | 03/31/2005     | 03/31/2005     |
| Issued request for proposal to BNL for technical assistance     | 04/26/2005     | 04/26/2005     |
| Received proposal for technical assistance from BNL             | 06/03/2005     | 06/03/2005     |
| Requested information from Technical Research Center of Finland | 09/12/2005     | 09/12/2005     |
| Evaluated experimental results on thermal-hydraulic phenomena   | 09/30/2005     | 09/30/2005     |
| Complete literature search for thermal-hydraulic phenomena      | 09/30/2005     | 09/30/2005     |
| Assigned new task manager                                       | 05/15/2006     | 05/15/2006     |
| RES decides to work with NRR on generic communication           | 08/31/2006     | 08/31/2006     |
| Arranged meeting with BWROG and obtained its input              | 06/30/2007     | 06/06/2007     |
| Reviewed BWROG data and determined regulatory action            | 09/30/2007     | 12/31/2007     |
| Assigned new task manager                                       | 04/15/2008     | 04/15/2008     |
| Queried BWROG for background information                        | 09/04/2008     | 09/04/2008     |
| Queried Finnish researchers to share current information        | 11/30/2008     | 01/30/2009     |

|  |            |            |
|--|------------|------------|
| Established Work Scope for Experimental Program at Purdue University to study void transport phenomena   | 05/01/2009 | 09/01/2009 |
| Received BWROG response to staff information request   | 12/31/2008 | 10/29/2009 |
| Proposed and developed draft experimental test plan  | 02/01/2010 | 03/01/2010 |
| Finalized experimental test plan   | 04/01/2010 | 06/01/2010 |
| Began steady state and transient tests   | 11/01/2009 | 06/15/2010 |
| Received draft report from university contractor   | 12/30/2009 | 12/15/2010 |
| Concluded steady state and transient tests   | 12/31/2010 | 12/31/2010 |
| Received final report from university contractor   | 03/31/2011 | 03/31/2011 |
| Staff evaluates PUMA test findings   | 07/31/2011 | 02/29/2012 |
| Conducted updated literature search  | 01/31/2013 | 01/31/2013 |
| Updated BWR chronological scenario   | 01/31/2013 | 01/31/2013 |
| Reviewed applicability of PUMA test facility   | 01/31/2013 | 01/31/2013 |
| Developed next step activities to determine if safety concern exists. Assessment method and criteria to be applied to plant geometries   | 01/31/2013 | 01/31/2013 |
| Perform CFD analyses of two test facilities  | 11/25/2013 | 01/31/2014 |
| Purdue U and Lappeenranta U performed scaling assessment of two test facilities  | 09/13/2013 | 02/28/2014 |
| Compared CFD and scaling analyses to improve calculation methods and verify techniques. Compared scaled results to the calculated CFD results for an idealized full scale suppression pool                                     | 12/06/2013 | 10/30/2014 |
| Applied CFD and scaling approaches to plant conditions. Qualitatively compared scaled results to the calculated CFD results for a full scale suppression pool.   | 04/25/2014 | 03/31/2015 |
| Documented assessment approach for plant geometries to define suppression pool area where gas injection in ECCS pump could pose problems. Prepared draft report providing assessment approach for plant geometries for review. | 06/06/2014 | 04/07/2015 |
| Documented CFD analysis methods and results in draft report  | 03/30/2015 | 04/07/2015 |
| Addressed NRR comments on draft technical report   | 08/31/2015 | 02/28/2014 |
| RES/DSA completed technical report   | 10/31/2015 | 07/15/2015 |
| Formed Generic Issues Review Panel (GIRP)  | 10/08/2015 | 10/08/2015 |
| GIRP issue assessment report   | 04/30/2016 |            |
| RES/DSA to publish technical report as a NUREG   | 06/30/2016 |            |

Title: Implications of Updated Probabilistic Seismic Hazard Estimates in Central and Eastern U.S. on Existing Plants

Generic Issue Number: 199

Identification Date: 05/25/2005

Action Level: Regulatory Office Implementation

Office/Division/Branch: NRR/JLD

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Safety Risk Assessment: 09/02/2010 (Actual/Complete)

Transfer to Regulatory Office for Action: 09/02/2010 (Actual/Complete)

Closure Date: To be determined

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#### DESCRIPTION:

Newer data and models indicate that estimates of the potential for earthquake hazards for some nuclear power plants in the Central and Eastern United States sites could be larger than previous estimates. Although it has been determined that currently operating plants remain safe, the newer seismic data and models warrant further study and analysis. The analysis will allow the U.S. Nuclear Regulatory Commission (NRC) to better understand margins at operating plants for earthquakes. The screening assessment did not identify any immediate safety concerns.

#### WORK SCOPE:

The Office of Nuclear Reactor Regulation (NRR) staff review of the first early site permit (ESP) applications found that the proposed safe shutdown earthquake (SSE) ground motions for some of the new sites exceeded the SSE ground motion for the co-located operating units. This resulted from the application of more recent seismic hazard models for the ESP applications, which estimated higher seismic hazards for some regions of the CEUS.

Based on the evaluations conducted under the individual plant examination of external events (IPEEE) program in the 1990s, the staff determined that seismic designs of operating plants in the CEUS provided an adequate level of protection. However, in light of the staff's review of the ESP applications and confirmatory analysis using the U.S. Geological Survey (USGS) seismic models, the staff recognized that the probability of exceeding the SSE at some currently operating sites in the CEUS may be higher than previously understood. Therefore, the staff initiated this generic issue (GI) to assess the impact of increased seismic hazard estimates on selected nuclear power plants in the CEUS region.

#### STATUS:

In August 2005, the Office of Nuclear Regulatory Research (RES) issued a task order for a contractor to develop a probabilistic screening analysis for exceedance of the SSE ground motion on nuclear power plants in the CEUS. The contractor was to use information provided by the NRC to perform this task in accordance with guidelines of Section 3.3 and Appendix B.3.2 to NUREG-1489, "A Review of NRC Staff Uses of Probabilistic Risk Assessment." The information to be provided by the NRC included Electric Power Research Institute (EPRI) Report NP-6395-D, "Probabilistic Seismic Hazard Evaluations at Nuclear Power Plant Sites in the Central and

Eastern United States: Resolution of the Charleston Earthquake Issue,” April 1989. In May 2007, the NRC directed the contractor to stop work on this task order because the NRC and EPRI had not resolved issues with releasing the copyrighted EPRI Report NP-6395-D to the NRC contractor for performing this task.

In April 2007, RES decided to complete the USGS update of seismic hazard assessment of CEUS plants and use this information to perform the screening analysis for this GI. In May 2007, the staff developed a plan to complete the screening analysis for GI-199 by February 2008 and began work on initial tasks described in this plan. In June 2007, the staff decided to focus the screening analysis efforts on using existing USGS seismic hazard information to address the seven criteria for screening GIs described in SECY-07-0022, “Status Report on Proposed Improvements to the Generic Issues Program,” dated January 30, 2007 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML063460239). In July 2007, the staff completed their preliminary screening analysis and, in August 2007, gave it to the screening analysis review panel.

In October 2007, the staff determined that the screening analysis should consider seismic hazard data and models besides those available from the USGS. This determination was based on the staff’s ongoing interactions with stakeholders to develop a new performance-based approach for assessing seismic hazards for new reactors as described in a memorandum to the Commission, “A Performance-Based Approach to Define the Safe Shutdown Earthquake Ground Motion,” dated July 26, 2006 (ADAMS Accession No. ML052360044).

The staff completed the screening analysis using guidance contained in Management Directive (MD) 6.4, “Generic Issues Program,” and SECY-07-0022 in December 2007, and reconvened the screening panel in January 2008. On February 1, 2008, the RES Director approved the screening panel recommendation (ADAMS Accession No. ML073400477) to begin the safety/risk assessment stage of the GI process. On February 6, 2008, the staff met with the public and stakeholders to discuss the results of the Screening Stage of GI-199. The meeting took place at NRC headquarters in Rockville, MD.

EPRI performed an independent evaluation of the implications of changes in seismic hazard estimates. The staff interacted with EPRI (under a Memorandum of Understanding) to discuss data, methodology, and their conclusions.

In June 2009, the staff completed the review and analysis of seismic data in support of the safety/risk assessment. Several Safety/Risk Assessment Panel meetings were held in July and August 2009. From November 2009 through March 2010, RES staff held internal briefings with NRR, the Office of New Reactors (NRO), and NRC regional offices. The Safety/Risk Assessment Panel reconvened in March 2010 and in June 2010 to review its recommendations. The Safety/Risk Assessment Panel Report was issued on September 2, 2010. The panel recommended transferring lead responsibility for subsequent GI-199 actions to NRR for regulatory office implementation, and that further actions be taken to address GI-199 outside the GI Program (i.e., obtain information and develop methods, as needed, to complete plant-specific value impact analyses of potential backfits to reduce seismic risk). The issue was transferred to NRR on September 2, 2010, for regulatory office implementation.

Information notices were issued to inform stakeholders of the GI-199 Safety/Risk Assessment report and results. Information Notice (IN) 2010-18 was issued on September 2, 2010, to nuclear power plants and independent fuel storage installations. IN 2010-19 was issued September 16, 2010, to fuel cycle facilities. A public meeting was held on October 6, 2010, and

a presentation to the ACRS Siting Subcommittee was held November 30, 2010. NRR developed a draft Generic Letter GL-2011-XX, "Seismic Risk Evaluation for Operating Reactors" (ADAMS Accession No. ML111710783) that was issued on September 15, 2011, for public comment. The public comment period ended on December 15, 2011. The agency incorporated GI-199 into the work done by the Japan Lessons-Learned Project Directorate in response to the March 2011 Japan nuclear event. GI-199 activities in NRR are being addressed in the Title 10 of the *Code of Federal Regulations* (10 CFR) 50.54(f) letters on Recommendations 2.1 and 2.3 of the Near-Term Task Force (NTTF).

The NRC has requested that all nuclear power plants reevaluate seismic hazards using present-day guidance and methods. Plants in the CEUS submitted their seismic hazard reevaluations in March 2014 and plants in the Western United States (WUS) submitted their seismic hazard reevaluations in March 2015. Depending on the comparison between the reevaluated seismic hazard and the design basis, the resulting outcome is either no further risk evaluation for the plant (screened-out) or performance of a plant risk assessment if the reevaluated hazard exceeds the plant's design basis (screened-in). If the reevaluated hazard only exceeds the design basis above 10Hz, then the licensee needs to perform a high-frequency confirmation.

NRC staff has finished reviewing the reports and issued a final determination letter for seismic risk evaluations on October 27, 2015 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML15194A015). The final determination letter updates the preliminary screening letters that the NRC issued on May 9, 2014 (for the CEUS plants) and May 13, 2015 (for WUS plants). The final determination letter includes a staggered schedule for licensees to submit the seismic risk evaluations to the NRC for those sites that screen in, with the earliest in March 2017 and the latest in December 2019. Of the 61 sites (58 CEUS and 3 WUS), 20 operating reactor sites (18 CEUS and 2 WUS) have screened-in thus far, requiring licensees to complete seismic probabilistic risk assessment SPRAs. Of the remaining 41 sites, 9 sites have screened-out of any further evaluations, and the remaining 32 sites are required to perform limited-scope evaluations (i.e., high-frequency evaluation, low-frequency evaluation, or spent fuel pool evaluation).

In addition to the SPRAs, out of the 61 sites, 48 were originally required to complete near-term expedited seismic evaluations process (ESEP) reports of key equipment needed to protect the reactor core following a beyond-design-basis seismic event. This was later reduced to 34 sites (33 CEUS and 1 WUS). All ESEP reports for the CEUS plants were received by December 2014, and the ESEP report for the 1 WUS plant was received during the second quarter 2016. Staff evaluation of all 33 CEUS ESEP reports were completed during second quarter 2016, and NRC staff expects to complete an evaluation of the 1 WUS ESEP report by May 2016. Some plant modifications are required as a result of the ESEP reports, e.g., 15 plants have identified potential plant upgrades. Plant upgrades not requiring an outage will be completed by December 2016 for CEUS plants and by June 2018 for WUS plants.

#### AFFECTED DOCUMENTS:

- IN 2010-18, "Implications of Updated Probabilistic Seismic Hazard Estimates in Central and Eastern United States on Existing Plants"
- IN 2010-19, "Updated Probabilistic Seismic Hazard Estimates in Central and Eastern United States"

#### PROBLEM/RESOLUTION:

The screening analysis was delayed when the copyrighted EPRI Report NP-6395-D was not released to the NRC contractor. RES considered alternatives for proceeding with the screening assessment of GI-199 in accordance with MD 6.4 and SECY-07-0022. From April 2007 through September 2007, staff performed the initial screening analysis of GI-199 using currently available seismic hazard information from the USGS. In October 2007, the staff determined that the screening analysis should consider seismic hazard data and models besides those available from the USGS. The RES staff worked with technical experts from NRR and NRO to complete a screening analysis and develop an approach for the safety/risk assessment stage. NRC staff considers the previous problems to be resolved.

#### REASONS FOR SCHEDULE CHANGES:

Schedule delays involving the initial screening analysis were caused by not identifying an amenable solution for EPRI release of NP-6395-D to the NRC contractor for performing the screening analysis task. Based on discussions with the USGS, the staff determined the time frame for obtaining current seismic hazard update information for CEUS plant sites would be mid-2008 as opposed to October 2007. Accordingly, the staff changed the date for the milestone: "Receive Seismic Hazard Update Results for Selected CEUS Plants from USGS," from October 30, 2007 to June 30, 2008. In support of completing the screening analysis, consistent with timeliness targets described in SECY-07-0022, the staff decided to base the screening analysis on currently available seismic hazard information from the USGS. Following this approach, the staff completed the milestone: "Generate Screening Analysis," on July 27, 2007, and then completed the milestone: "Screening Panel Meeting," on September 12, 2007.

In October 2007, the staff determined that the screening analysis should consider seismic hazard data and models besides those available from the USGS. This determination is based on the staff's ongoing interactions with stakeholders to develop a new performance-based approach for assessing seismic hazards for new reactors as described in a memorandum to the Commission, "A Performance-Based Approach to Define the Safe Shutdown Earthquake Ground Motion," dated July 26, 2006 (ADAMS Accession No. ML052360044). The staff's ongoing work on this performance-based approach resulted in issuance of NRC Regulatory Guide 1.208, "A Performance-Based Approach to Define the Site-Specific Earthquake Ground Motion," dated March 2007 that endorses the performance-based approach. After the Director of RES approved the Screening Panel's recommendation (ADAMS Accession No. ML073400477) to conduct a safety/risk assessment stage, a milestone was added for completion of this stage.

The Safety/Risk Assessment Panel was extended because of the complexity of additional evaluations and the desire for internal and external stakeholder agreement. The RES Director approved the safety/risk assessment and panel recommendation September 2, 2010.

| Milestone  | Projected Date | Completed Date |
|--|----------------|----------------|
| Issued request for proposal to contractor (ISL) for technical assistance.                  | 07/07/2005     | 07/07/2005     |
| Received proposal from ISL.  | 08/11/2005     | 08/11/2005     |
| Generated screening analysis.  | 10/31/2006     | 07/27/2007     |
| Screening panel met.   | 11/30/2006     | 09/12/2007     |
| Prepared screening analysis applying criteria from MD 6.4 and SECY-07-0022.                | 12/15/2007     | 12/31/2007     |
| Reconvened screening panel.  | 12/15/2007     | 01/11/2008     |
| Provided screening panel recommendation memo for RES Director approval.                    | 01/31/2007     | 01/25/2008     |
| Issued screening analysis and panel recommendation approved by RES Director.               | 12/31/2006     | 02/01/2008     |
| Received seismic hazard update results for selected CEUS plants from USGS.                 | 10/30/2007     | 10/15/2008     |
| Received information from EPRI.  | 05/30/2008     | 12/03/2008     |
| Scheduled and Conducted safety/risk assessment panel.                                      | 09/30/2008     | 08/31/2009     |
| GI-199 transferred to NRR for regulatory office implementation.                            | 06/30/2009     | 09/02/2010     |
| Issued RES Director–Approved safety/risk assessment and panel recommendation.              | 01/31/2010     | 09/02/2010     |
| Information Notice 2010-18 issued.   | 09/02/2010     | 09/02/2010     |
| Information Notice 2010-19 issued.   | 09/16/2010     | 09/16/2010     |
| Conducted public meeting.  | 06/30/2009     | 10/06/2010     |
| Presented to ACRS subcommittee.  | 11/05/2009     | 11/30/2010     |
| Presented to CRGR.   | 06/30/2011     | 08/02/2011     |
| Issued draft generic letter for public comment.  | 07/31/2011     | 09/01/2011     |
| Presented to ACRS subcommittee.  | 10/13/2011     | 10/13/2011     |
| Presented to ACRS subcommittee.  | 10/31/2011     | 11/08/2011     |
| Transferred activities to the Japanese Lessons Learned Project Directorate (JLD).          | 03/08/2012     | 03/08/2012     |
| CEUS plants submit seismic hazard reevaluations  | 03/31/2014     | 03/31/2014     |
| WUS plants submitted seismic hazard reevaluations.   | 03/12/2015     | 03/12/2015     |
| CEUS plants completed expedited seismic evaluations.                                       | 12/31/2014     | 12/31/2014     |
| WUS plant to complete expedited seismic evaluations.                                       | 01/31/2016     | 1/31/2016      |
| CEUS: Installation of plant upgrades (not requiring outage)                                | 12/30/2016     |                |
| WUS: Installation of plant upgrades (not requiring outage)                                 | 06/30/2018     |                |
| Responses to be received from licensees performing seismic probabilistic risk assessments. | 12/31/2019     |                |

Title: Flooding of Nuclear Power Plant Sites after Upstream Dam Failures

Generic Issue Number: 204

Identification Date: 07/19/2010

Action Level: Regulatory Office Implementation

Responsible Office/Division/Branch:  
NRR/JLD

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Transfer to Regulatory Office for Action:

03/06/2012

Closure Date:

(To Be Determined)

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#### DESCRIPTION:

The U.S. Nuclear Regulatory Commission (NRC) has started a formal evaluation of potential generic safety implications for dam failures upstream of U.S. commercial nuclear power plants. The complete scope of the generic issue (GI) includes the effects of flooding from upstream dam failures on nuclear power plants sites, spent fuel pools, and sites undergoing decommissioning with spent fuel stored in spent fuel pools. The NRC began examining this issue after inspection findings at two plants. Staff completed a draft of the screening analysis in July 2011. The issue was officially declared as GI-204 in February 2012.

#### STATUS:

Although this screening analysis did not identify any immediate safety concerns, inspections or other reviews at individual plants have led to those plants taking actions regarding flooding scenarios on site-specific basis. GI-204 has been subsumed as part of the implementation of the recommendations from the agency's Japan Near-Term Task Force (NTTF), which was assembled in response to the earthquake/tsunami and reactor accident at the Fukushima Dai-ichi site.

Although the NTTF used preliminary information from the GI screening analysis and discussed flooding in its July 2011 report (Agencywide Documents Access and Management System (ADAMS) Accession No. ML111861807), the issue related to flooding from the upstream dam failure came to the staff's attention long before the earthquake/tsunami and reactor accident at the Fukushima Dai-ichi site. New sources of information on this issue have accumulated over the past few years. This information includes inspections of flood protection and related procedures, as well as recent re-evaluations of dam failure frequencies and possible flood heights at some U.S. nuclear power plants, suggesting that flooding effects in some cases may be greater than previously expected.

The NTTF's review of the Fukushima accident led to recommendations regarding the potential for flooding from all hazard mechanisms at operating reactors. In March 2012, the holders of operating licenses and construction permits received letters from the NRC that requested the reevaluation of all floods hazards (including dam failures) using present-day guidance and methodologies. (Note: Sites undergoing decommissioning, which are part of the GI, are not included in the NRC's activities related to reevaluation of flood hazards.)



Nuclear power plant designs include protection against serious but very rare flooding events, including flooding from dam failure scenarios. Dam failures can occur as a consequence of earthquakes, overtopping, and other mechanisms, such as internal erosion and operational failures. A dam failure could potentially cause flooding at a nuclear power plant site depending on a number of factors including the location of the dam, reservoir volume, dam properties, flood routing, and site characteristics.

The July 2011 screening analysis of potential nuclear plant safety issues from upstream dam failures is available in “Screening Analysis Report for the Proposed Generic Issue on Flooding of Nuclear Power Plant Sites Following Upstream Dam Failures” (ADAMS under Accession No. ML113500495). The March 2012 transfer of the GI from the Office of Nuclear Regulatory Research to the Office of Nuclear Reactor Regulation for regulatory office implementation is available in ADAMS under Accession No. ML120261155. The March 2012 request for information letter related to the reevaluation of flood hazards is available in ADAMS under Accession No. ML12053A340. Finally, the May 2012 letter stating the flood hazard reevaluation due dates is available in ADAMS under Accession No. ML12097A509. This letter describes the criteria used to place each site into one of three completion date categories. As of August 2015, most sites have completed flood hazard reevaluations in response to the March 2012 request. Some sites have requested and been granted extensions, as appropriate. The staff expects to complete the technical staff assessments documenting the Flood Hazard Reevaluation Report (FHRR) review performed by 2016. Staff issued COMSECY-15-0019, providing the Commission with a plan for closing Near-Term Task Force (NTTF) Recommendation 2.1 on the reevaluation of flooding hazards for operating nuclear power plants (ADAMS Accession No. ML15153A104). Those sites that had flood-causing mechanisms that exceeded the current design basis are required to perform additional analysis (e.g. focused evaluation (due in mid-2017) or integrated assessment (due by the end of 2018), depending on the hazard) to evaluate the site response to the updated flood hazard. This graded approach will focus on the areas with the most potential safety benefit. The focused evaluations are due in mid-2017 and the integrated assessments are due by the end of 2018.

| Milestone   | Projected Date | Completed Date |
|---|----------------|----------------|
| Issue declared a generic issue.   | 02/29/2012     | 02/29/2012     |
| Transferred activities to the Japan Lessons Learned Project Directorate.  | 03/06/2012     | 03/06/2012     |
| Received flooding hazard reevaluations for Category 1 sites.  | 03/12/2013     | 03/12/2013     |
| Received flooding hazard reevaluations for Category 2 sites.  | 03/12/2014     | 03/12/2014     |
| Received flooding hazard reevaluations for Category 3 sites.  | 03/12/2015     | 03/12/2015     |
| NRC granted extension to licensees needing additional research to complete flooding hazard reevaluations flooding hazard reevaluations. | 03/12/2015     | 03/12/2015     |
| Staff issued COMSECY-15-0019, providing the Commission with a plan for closing Near-Term Task Force (NTTF)                              | 06/30/2015     | 06/30/2015     |

Recommendation 2.1 on the reevaluation of flooding hazards for operating nuclear power plants.

NRC staff to complete review of the technical staff assessments documenting the Flood Hazard Reevaluation Report (FHRR) 12/30/2016

Those sites that had flood causing mechanisms that exceeded the current design basis are required to perform focused evaluation to evaluate the site response to the updated flood hazard. 06/30/2017

Or, those sites that had flood causing mechanisms that exceeded the current design basis are required to perform an integrated assessment to evaluate the site response to the updated flood hazard. 12/30/2018