

REACTOR CONTAINMENT SUMP BLOCKAGE (NRC BULLETIN 2003-01)

CORNERSTONE: MITIGATING SYSTEMS

APPLICABILITY: This temporary instruction applies to all holders of operating licenses for pressurized-water reactors.

2515/153-01 OBJECTIVE

01.01 The objective of this Temporary Instruction (TI) is to support the Nuclear Regulatory Commission (NRC) review of licensees' activities in response to NRC Bulletin 2003-01, "Potential Impact of Debris Blockage on Emergency Sump Recirculation at Pressurized Water Reactors (PWRs)." This TI requires NRC inspectors to assess whether a licensee either (1) performed a plant-specific evaluation of the emergency core cooling system (ECCS) and containment spray system (CSS) recirculation functions for impact of post-accident debris blockage effects; or (2) effectively implemented reasonable compensatory measures.

01.02 As an ancillary benefit, this TI promotes information gathering to help the NRC staff identify and shape possible future regulatory positions and generic communications.

2515/153-02 BACKGROUND

Generic Safety Issue (GSI) 191 was established to determine whether the transport and accumulation of debris in PWR containments following a loss of coolant accident (LOCA) (or other high energy line break if recirculation is credited) will impede the long-term operation of the ECCS or CSS. In the event of a LOCA, materials in the vicinity of the break, such as thermal insulation, coatings, and concrete, would be damaged and dislodged. A fraction of this material would then be transported to the recirculation sump and accumulate on its screens. Debris accumulating on the sump screens has the tendency to form a bed which, much like a filter, results in an increased head loss across the sump screens. The additional head loss due to the accumulation of debris is a safety concern because it has the potential to exceed the net positive suction head (NPSH) margin required to assure the successful operation of the ECCS and CSS pumps. Sump blockage had previously been evaluated in the early 1980s under unresolved safety issue

(USI) A-43. Although the original regulatory guidance to assume 50% screen blockage was determined to be non-conservative and revised in 1985, a backfit was not then considered justified. However, Generic Letter 85-22 advised licensees to consider the revised (mechanistic) guidance in Regulatory Guide 1.82, Revision 1, "Water Sources for Long-Term Recirculation Cooling Following a Loss-of-Coolant Accident," for the conduct of 10 CFR 50.59 reviews associated with the changeout or modification of thermal insulation.

Subsequent blockage events at BWRs and additional research noted that there could be more and finer debris, accumulating uniformly, and the effect of filtration of particulates by fibers, previously not considered, would result in higher head losses. The Office of Nuclear Regulatory Research (RES) technical review also identified concerns with the potential deleterious effects that both upstream blockage (reducing available NPSH due to lower pool levels) and downstream blockage (from material passing through the screens) could have on ECCS performance. Based upon the findings of its technical evaluation, RES concluded that GSI -191 was a valid concern and recommended detailed plant-specific evaluations to determine the sump-clogging susceptibility of each PWR.

The Office of Nuclear Reactor Regulation (NRR) concurred with RES's conclusion and developed an action plan to resolve GSI-191. Public meetings were held with Nuclear Energy Institute (NEI) and the PWR Owners' Group representatives to discuss development of industry evaluation guidelines for plant-specific sump-clogging evaluations. NRC's plans to revise Regulatory Guide (RG) 1.82 and issue a generic letter to assure closure of GSI-191 were also discussed in the meetings. The staff briefed the Advisory Committee on Reactor Safety on both the draft generic letter and draft revision to Regulatory Guide 1.82 (DG 1107, Reference 1). Their letter dated February 20, 2003, endorsed issuance of the draft RG and draft generic letter to expedite resolution of GSI-191.

During review of the draft generic communications, concerns were elevated regarding the need for near-term determinations as to whether the ECCS and CSS recirculation functions are in compliance with applicable regulatory requirements, in particular the 10 CFR 50.46 requirement for long term cooling, when a mechanistic evaluation of debris generation, transport, and accumulation on the sump screens is used. These concerns were based on recent events such as Davis-Besse Licensee Event Report (LER) 50-346/2002-005-01, which showed the potential for increased failure probability of the ECCS due to debris accumulation and potential debris passage through the screens. Also, LER 50-346/2003-002-00, which stated that the high pressure injection (HPI) pumps had been declared inoperable as a result of the potential for debris to damage the pump internals during the recirculation phase of certain postulated LOCAs when the HPI pumps are required to take suction from the containment recirculation sump. Additionally, in February 2003, Los Alamos National Laboratory published the NRC-sponsored technical report LA-UR-02-7562 (Reference 2) which analyzed the potential risk benefit of operator actions to recover from sump clogging events. The ACRS has recommended expeditious resolution of this issue.

Therefore, consistent with the risk significance of the PWR sump-clogging concern, the staff issued NRC Bulletin 2003-01 to request information on compliance and information on compensatory measures if compliance cannot be demonstrated. The underlying purpose of Bulletin 2003-01 is to make sure that the licensees implement near-term

compensatory measures that reduce the risk associated with sump failure at plants whose sump screens may be degraded or potentially challenged in the event of a LOCA.

The NRC still plans to issue a generic letter to address long-term corrective actions. The NRC recognizes that complex evaluations are required to analyze recirculation performance during design basis accidents if debris generation, transport and accumulation are analyzed mechanistically. The Nuclear Energy Institute (NEI) PWR Sump Performance Task Force reviewed the NRC GSI-191 assessment and supporting research. Based upon this review, the task force is developing Industry Evaluation Guidance that PWR plant operators could use to assess the ability of their containment sumps to perform in a manner consistent with design basis requirements following a LOCA. The initial step of the overall guidance is for plant operators to determine the types of debris sources and their locations inside containment at the time of the LOCA. NEI 02-01, Revision 1, "Condition Assessment Guidelines: Debris Sources Inside PWR Containments," dated September 2002 (Reference 4), provides guidelines for this step. NEI is developing additional guidance to further assist plant operators in determining if their containment sumps are vulnerable to the concerns identified in GSI-191. The NRC staff has reviewed and commented on the industry guidance for condition assessments. Part of the inspection guidance contained in this TI is derived from the NEI guidance document to determine whether the plants are conducting condition assessments as described in the guidance. The information gathered from this inspection activity will help shape future generic communications to assure adequate and timely closure of the issues associated with GSI-191.

For additional background on the technical and safety concerns and descriptions of selected plant events, see the Discussion and Background Sections in Bulletin 2003-01, "Potential Impact of Debris Blockage on Emergency Sump Recirculation at Pressurized-Water Reactors (Accession Number ML031600259)." or <http://www.nrc.gov/reading-rm/doc-collections/gen-comm/bulletins/2003/bl03001.pdf>.

2515/153-03 INSPECTION REQUIREMENTS

General

Review the PWR licensees' responses to Bulletin 2003-01. Specifically, the bulletin allows addressees the option of either (1) reporting that the ECCS and CSS recirculation functions have been analyzed with respect to the potentially adverse post-accident debris blockage effects identified in the bulletin and are in compliance with all existing applicable regulatory requirements; or (2) describing any interim compensatory measures that have been implemented or that will be implemented to reduce the potential risk associated with potentially degraded or nonconforming ECCS and CSS recirculation functions while evaluations to determine compliance proceed.

03.01 Responses Affirming Compliance With Applicable Regulatory Requirements

- a. Licensees may use the guidance in Draft Regulatory Guide 1107 (DG-1107), "Water Sources for Long-Term Recirculation Cooling Following a Loss-of-Coolant Accident," dated February 2003 (Reference 1). The NRC has also published a technical report entitled NUREG/CR-6808, "Knowledge Base for the Effect of

Debris on Pressurized Water Reactor Emergency Core Cooling Sump Performance,” dated February 2003 (Reference 3) to assist in determining on a mechanistic basis whether they are in compliance with 10 CFR 50.46(b)(5) and other existing applicable regulatory requirements concerning the ECCS and CSS recirculation functions.

- b. The inspector will inspect the licensee’s response and supporting basis which show that the ECCS and CSS recirculation functions have been analyzed with respect to the potentially adverse post-accident debris blockage effects as specified in the bulletin for a determination of compliance. The inspector should verify that the determination is based on a mechanistic (plant specific) evaluation of debris generation, transport and accumulation, rather than arbitrary (generic) assumptions, such as 50% blockage of the sump screens. A detailed review by the inspector of the analysis and supporting documentation is not expected in assessing responses by licensees choosing Option 1 of the Bulletin.

03.02 Responses Describing Interim Compensatory Measures

- a. Plants electing Option 2 of the Bulletin should establish interim compensatory measures to reduce the risk associated with degraded recirculation performance pending detailed analyses. The inspector will verify the licensee’s response describing any interim compensatory measures that have been implemented to reduce the potential risk of ECCS and CSS recirculation degradation.
- b. The inspector should verify that the interim compensatory actions identified in the response have been implemented or are planned and scheduled for implementation consistent with the response. This review should include interviews with operators, review of training records, procedures, documentation of containment inspections and foreign material control activities, to the extent these are included in the licensee response.

03.03 Inspection of the Containment Sump and Condition Assessment

- a. NEI has developed guidance entitled "NEI 02-01, Revision 1, Condition Assessment Guidelines: Debris Sources Inside PWR Containments," dated September 2002. The inspector will review the implementation of condition assessments that may have been conducted following this guidance.

2515/153-04 GUIDANCE

General

The bulletin states that NRC (NRR) will review and accept the response, and will notify the licensee if concerns are identified. The inspector should use the submitted licensee response and NRC acknowledgment letter as the basis for assessing licensee response for the inspection.

04.01 Responses Affirming Compliance With Applicable Regulatory Requirements.

The NRC supports the development of generic industry guidance and the coordination of addressees' responses to this bulletin as a means of increasing efficiency and streamlining the regulatory verification process. The Boiling Water Reactor Owners' Group developed Industry guidance (General Electric Report NEDO-32686-A, "Utility Resolution Guidance for ECCS Suction Strainer Blockage," October 1998) to resolve the similar strainer blockage issue of NRC Bulletin 96-03. Individual addressees may also develop alternative approaches to those mentioned in this paragraph for determining the status of their regulatory compliance; however, additional staff review may be required to assess the adequacy of alternative approaches.

- a. To assist in determining on a mechanistic basis whether they are in compliance with 10 CFR 50.46(b)(5) and other existing applicable regulatory requirements concerning the ECCS and CSS recirculation functions, licensees may use the guidance in Draft Regulatory Guide 1107 (DG-1107), "Water Sources for Long-Term Recirculation Cooling Following a Loss-of-Coolant Accident," dated February 2003. The NRC has also published a technical report entitled NUREG/CR-6808, "Knowledge Base for the Effect of Debris on Pressurized Water Reactor Emergency Core Cooling Sump Performance," dated February 2003 (Reference 3), which is designed to serve as a reference for plant-specific analyses with regard to whether a sump would perform its function without preventing the operation of the ECCS and CSS pumps.
- b. The inspector should contact NRR Plant Systems Branch contacts for this TI for any questions regarding detailed aspects of compliance determinations.

04.02 Responses Describing Interim Compensatory Measures

- a. Compensatory measures are intended to be an interim step to reduce risk associated with sump failure or to otherwise enhance the capability of the ECCS and CSS recirculation functions. Since conditions at specific PWRs vary with respect to susceptibility to post-accident debris blockage, and since various options are available to addressees for preventing or mitigating the effects of debris blockage, addressees may consider a range of potential interim compensatory measures and may elect to implement those which they deem appropriate, based upon the specific conditions associated with their plants. Possible interim compensatory measures may include, but are not limited to, the following:
 1. operator training on indications of and responses to sump clogging
 2. procedural modifications, if appropriate, that would delay the switchover to containment sump recirculation (e.g., shutting down redundant pumps that are not necessary to provide required flows to cool the containment and reactor core, and operating the CSS intermittently)
 3. ensuring that alternative water sources are available to refill the refueling water storage tank (RWST) or to otherwise provide inventory

to inject into the reactor core and spray into the containment atmosphere

4. more aggressive containment cleaning and increased foreign material controls
5. ensuring containment drainage paths are unblocked; and
6. ensuring sump screens are free of adverse gaps and breaches

In addition to the measures listed above, addressees may also consider implementing unique or plant-specific compensatory measures, as applicable. Commensurate with the potential risk-significance of post-accident debris blockage effects, addressees electing to implement interim compensatory measures in response to this bulletin should ensure the interim measures are implemented as soon as practical. The implementation of certain compensatory measures involving containment entry may not be feasible until the next outage.

As stated above, the risk benefit of certain interim compensatory measures is demonstrated by the NRC-sponsored technical report LA-UR-02-7562. However, due to the generic nature of the probabilistic model used, licensees may find that additional or alternative measures are appropriate to minimize the risk as well as to accurately estimate the risk benefit of recovery actions and other interim compensatory measures for their specific facilities. The inspector should check whether the licensee has examined site-specific aspects that could further reduce risk. The results of the review should be documented in the inspection report to help the NRC staff identify future generic communications.

- b. In assessing the appropriateness of the licensee's schedule for implementing compensatory measures later than the Bulletin response, the inspector should evaluate the licensee's schedule to determine if licensee risk insights are appropriately used (e.g., more risk significant measures taken earlier than less risk significant measures). Reasonable judgement is expected of the inspector in making this assessment; however the intent of the Bulletin is that the actions be based on risk reduction; which are very plant specific. Therefore, schedules for implementing interim compensatory measures should be considered in light of the plant-specific risk improvement. In addition, the inspector should contact the NRR Project Manager for guidance if the NRR acknowledgment letter is not issued.

It is possible that interim compensatory actions to address ECCS and CSS recirculation performance may include modifications at some plants. The Bulletin does not require modifications in advance of detailed plant evaluations. If the licensee has performed modifications, the inspector should review the licensee's 10 CFR 50.59 evaluations. Any in-depth inspection of modifications should be conducted as part of the baseline inspection program using IP 71111.17, "Permanent Plant Modifications," 71111.02, "Evaluations of Changes, Tests, or Experiments," and/or IP 71111.23, "Temporary Plant Modifications," as appropriate. Appropriate credits could be taken for the baseline inspection samples.

04.03 Inspection of the Containment Sump and Condition Assessments. One purpose of this TI is to support NRR/DSSA/SPLB by inspecting and reporting on the licensees' performance of containment condition assessments. The inspection purpose is to assist the staff in determining whether additional measures are warranted to ensure that PWR licensees are performing containment walkdowns for debris sources in a timely manner. NEI has guidance entitled NEI 02-01, Revision 1, "Condition Assessment Guidelines: Debris Sources Inside PWR Containments," dated September 2002.

2515/153-05 REPORTING REQUIREMENTS

Document inspection results including findings, if applicable, in a resident inspectors' integrated inspection report (i.e., quarterly inspection report) and send a copy of the applicable sections to NRR/DSSA/SPLB, Attention: Ralph Architzel or REA@NRC.GOV.

At a minimum, the inspectors should be able to briefly describe the areas reviewed and results of the inspection including answers to the following questions and inspection observations in Section 4OA5, "Other," of the next integrated inspection report. (This is an interim deviation from the requirements of IMC 0612).

- a. For units that entered refueling outages (RFOs) after August 31, 2002, and subsequently returned to power: Was a containment walkdown to quantify potential debris sources conducted by the licensee during the RFO?
- b. For units that are currently in a RFO: Is a containment walkdown to quantify potential debris sources being conducted during the current RFO?
- c. For units that have not entered a RFO between September 1, 2002, and the present: Will a containment walkdown to quantify potential debris sources be conducted during the upcoming RFO?
- d. Did the walkdowns conducted check for gaps in the sumps' screened flowpath and for major obstructions in containment upstream of the sumps?
- e. Are any advanced preparations being made at the present time to expedite the performance of sump-related modifications, in case it is found to be necessary after performing the sump evaluation?

Nonetheless, if modifications are included in the set of interim actions to address recirculation performance, the inspector should assess the modifications and include the results in the applicable inspectable areas of the inspection report (i.e., 1R02, 1R17, 1R23).

2515/153-06 COMPLETION SCHEDULE

The inspection activities identified in this TI should be completed by October 31, 2004.

2515/153-07 EXPIRATION

This TI will expire on December 31, 2004.

2515/153-08 CONTACT

For questions regarding the performance of this TI and emergent issues, contact Ralph Architzel at (301) 415-2804 or REA@NRC.GOV, or Gregory Cranston at (301) 415-2073 or GVC@NRC.GOV.

2515/153-09 STATISTICAL DATA REPORTING

All direct inspection effort expended on this TI is to be charged to 2515/153 for reporting by the Regulatory Information Tracking System (RITS) reporting with an IPE code of SI. All indirect inspection effort on this TI is to be charged to specific inspection report number with an IPE code GIP/GIPD.

2515/153-10 ORIGINATING ORGANIZATION INFORMATION

10.01 Organizational Responsibility

This TI was initiated by the Plant Systems Branch (NRR/DSSA/SPLB).

10.02 Resource Estimate

The estimated direct inspection effort to perform this TI is estimated to be 15 to 40 hours per PWR unit.

10.03 Training

No specialized training is needed to perform inspection requirements in this TI beyond basic training for inspectors (specified in IMC 1245, "Inspector Qualifications"). However, if technical support is needed during the inspection of licensees' determinations of compliance or interim compensatory actions, contact SPLB

10.04 References

Draft Regulatory Guide 1107, "Water Sources for Long-Term Recirculation Cooling Following a Loss-of-Coolant Accident," dated February 2003 (accession number ML030420318).

Los Alamos National Laboratory Technical Report LA-UR-02-7562, "The Impact of Recovery From Debris-Induced Loss of ECCS Recirculation on PWR Core Damage Frequency," dated February 2003 (accession number ML030690174).

NUREG/CR-6808, "Knowledge Base for the Effect of Debris on Pressurized Water Reactor Emergency Core Cooling Sump Performance," dated February 2003; available at

<http://www.nrc.gov/reading-rm/doc-collections/nuregs/contract/cr6808/cr6808.pdf> (or accession numbers ML030780733 and ML030920540).

NEI 02-01, Revision 1, "Condition Assessment Guidelines: Debris Sources Inside PWR Containments," dated September 2002 (accession number ML030420318).

Generic Letter 98-04, "Potential for Degradation of the Emergency Core Cooling System and the Containment Spray System After a Loss-of-Coolant Accident Because of Construction and Protective Coating Deficiencies and Foreign Material in Containment."

10 CFR 50.59, "Changes, Tests, and Experiments."

NRC Staff Responses to Industry Pre-Meeting Questions and Comments on Bulletin 2003-01 Provided in Support of June 30, 2003 NRC Public Meeting, June 30, 2003 (accession number ML031810371).

Revised NRC Staff Responses to Three Industry Questions on Bulletin 2003-01 Submitted Prior to the June 30, 2003, Public Meeting, August 7, 2003 (accession number ML032180011).

END