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October 1, 2004

Mr. John N. Hannon
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Office of Nuclear Reactor Regulation
Mail Stop O11-A11
U. S. Nuclear Regulatory Commission
Washington, DC 20555-0001

SUBJECT: Safety Evaluation for NEI Guidance Report "Pressurized Water Reactor Containment Sump Evaluation Methodology"

PROJECT NUMBER: 689

Dear Mr. Hannon:

This letter responds to your September 27 letter that provided notification of an opportunity to clarify any factual errors or technical misinterpretations contained in the subject safety evaluation (SE). The enclosure provides a set of detailed comments on the SE.

The industry evaluation guidance was developed to provide a practical and realistically conservative method for resolution of PWR sump performance issues. We believe this objective was accomplished with the document submitted to NRC on May 28, 2004 and supplemented on July 13, 2004.

The industry guidance addresses debris generation, debris size distribution, transport and headloss in a comprehensive fashion that focuses attention and necessary conservatism on the risk-significant event scenarios and phenomena. The SE modifications significantly increase the conservatism of individual aspects of the methodology for all event scenarios without regard to the risk-significance of the affected scenarios and with no apparent recognition of the overall conservatism of the final result. For example, the SE:

- increases the size of the zone affected by break jet impingement by a factor of three for all insulation materials and

- increases the affected zone for qualified coatings by three orders of magnitude.

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These changes significantly increase the level of conservatism for the least risk-significant spectrum of breaks.

The July 13, 2004 supplement to Section 6 of the industry guidance provided an alternative evaluation method that addresses the low-risk spectrum of breaks. The main attribute of this alternative method is the selection of a "debris-generation" break size, above which more realistic inputs, methods and criteria may be used. The SE places limitations and restrictions on the use of the alternative evaluation method that significantly limit its value and use. For example, the guidance allows use of nominal parameters in the calculation of NPSH for the low-risk spectrum of breaks. However, the SE removes any allowance for exceeding the "nominal" parameters during normal operation, thereby necessitating the use of bounding values to avoid numerous operability evaluations.

PWR plants have been proactively working to address GSI-191 in advance of the issuance of the final SE. A number of companies with specialized knowledge on containment sump performance have worked with NEI on the development of the evaluation guidance and have already utilized the guidance for several PWRs. We believe it would be instructive for NRC reviewers to become more familiar with the application of industry evaluation guidance. We encourage, and can help facilitate, meetings between NRC and GSI-191 service vendors so that a greater appreciation of the overall conservatism of the evaluation guidance, methods and results can be obtained. This would also serve to provide an engineering perspective on cumulative results of the evaluation. These meetings can be arranged and conducted quickly, with minimal impact on resolution schedules.

An acknowledged and complicating factor in both NRC and industry efforts to resolve GSI-191 is the continuing need to address new concerns and phenomena. Testing to investigate the potential for adverse chemical effects in the containment following a LOCA will begin in the next few weeks with initial results becoming available after the planned issuance of the final SE and after initiation of efforts by industry to implement resolution guidance. While every effort is being made to address chemical effect concerns in a timely manner, the potential for resolution schedules to be impacted must be acknowledged. The NRC recommendation for PWR plants to incorporate margin in their designs in advance of the test results is not supportable in that there is no basis against which to assess the validity or appropriateness of chosen margin factors.

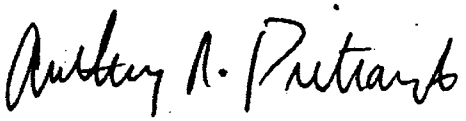
Industry activities and schedule to address the impact of debris passage on systems and equipment downstream of the containment sumps are complicated by ongoing and planned NRC tests. The schedule and scope of these tests is unknown and introduce a significant uncertainty in efforts to address downstream effects. While some downstream effects (e.g., component clearances) can have an impact on containment sump screen design (primarily screen mesh size), these effects are known and are addressed in the industry guidance. Other potential effects,

primarily wear and abrasion concerns, are relatively independent of containment sump screen design in that the screen design acts as a boundary condition for the subsequent treatment and resolution. Given the potential for planned testing to impact the manner in which these downstream effects are addressed, we urge NRC to consider a resolution schedule that is separate from upstream effects and which accommodates the NRC test schedule.

The brief time allotted for review of the DSER has been insufficient to allow the level of review appropriate for this important document. We intend to continue our review, focusing on identification of areas requiring additional clarification, in order to provide the instruction and guidance necessary for proper implementation by PWRs.

Please contact John Butler 202-739-8108, jcb@nei.org, or me if you have any questions on this transmittal or if we can assist in arranging the recommended vendor meetings.

Sincerely,



Anthony R. Pietrangelo

c: Mr. Michael Johnson, U.S. Nuclear Regulatory Commission
Mr. David L. Solorio, U. S. Nuclear Regulatory Commission

October 1, 2004

Comments on 9/20/04 Draft Safety Evaluation Report on Guidance Document "Pressurized Water Reactor Sump Performance Evaluation Methodology"

General Comment:
It would be helpful to summarize guidance exceptions in a stand alone section. At present the guidance exceptions are distributed throughout the document including: the executive summary, sections entitled "Staff Evaluation for Section XXX", sections entitled "Staff Conclusions Regarding Section YYY", Table 3-6 entitled "Non-Conservative Assumptions in the Baseline Evaluation Methodology", the chapter entitled "Conditions and Limitation", and the chapter entitled "Conclusion".

Page vi, fourth paragraph
The DSER states:

> **For plants needing to evaluate secondary-side piping such as main steam and feedwater pipe breaks, break locations should be postulated in a manner consistent with the guidance in Section 3.3 of this SER**

This should be modified to state that secondary side break locations should be postulated in a manner consistent with the plant licensing basis. Section 3.3 of the DSER (specifically section 3.3.4) excludes the use of BTP MEB 3-1 on the basis that its application for debris generation purposes does not meet the intent of 10 CFR 50.46. Irrespective of the validity of this basis, it is not applicable to secondary side breaks.

Page ix, ES.4 second paragraph
Guidance should be provided that one alternative for proving that large pieces do not transport is through verification with a detailed CFD model. Using pool velocity data from only one plant, as referenced in the DSER, can be misleading.

Page x, ES.6 Analytical refinements
Computational fluid dynamics (CFD) models were extensively used and were an accepted basis in BWR resolutions in regards to debris transport. The DSER conclusions regarding application of CFD methods are unclear. The Executive Summary states:

> **For debris transport, two methods for computing flow velocities in a sump pool – i.e. network method and the computational fluid dynamics methods – are provided -----. However, the staff finds the guidance offered in either option to be insufficient to provide an acceptable alternative to the baseline approach.**

Page 96, Staff Conclusions Regarding Section 4.2.4 states:

> **Consistent with Regulatory Guide 1.82, Revision 3, the staff accepts (1) the CFD method and (2) the nodal network method as an alternative method to**

> **calculate debris transport onto the sump screens. However, the licensees using the nodal network method should support it using experimental data to ensure that the debris transport estimates are conservative with respect to the quantities and types of debris transported to the sump screen. The GR recommended debris transport model in Section 4.2.4 that assumes using a uniform distribution of debris across the sump floor is not acceptable because the debris entrance into the pool is not uniform. Appendices III and VI provide additional staff guidance on adapting the debris transport methodologies for refined analyses.**

The Executive Summary and/or staff conclusions on page 96 should be revised to be consistent.

Page xii, ES.11 Downstream Effects
The DSER directs licensees to consider the downstream effects of particles larger than the screen openings and axially-oriented particles that pass through the screen.

This requirement is excessively conservative. The differential pressure expected across the screens is very low, and would not be expected to extrude debris. Also, the transportability of larger particulate is comparatively less than smaller particulate. Thus the bypass fraction for large or axially oriented particulate, even for clean screens, would be expected to be much lower than for small particulate. As the fiber bed forms, this bypass fraction quickly reduces to very near zero. This requirement should be deleted.

Page xii, ES12 Chemical Effects
The DSER states the following in several areas:

> **Initially, licensees should evaluate whether the current chemical test parameters, which are available in the test plan for the joint NRC/Industry Integrated Chemical Effects Tests, are sufficiently bounding for their plant specific conditions. If they are not, then licensees should provide technical justification in order to use any of the results from the tests in their plant-specific evaluation.**

This language would appear to be in conflict with the test plan (developed jointly by NRC-research and industry) which was designed to provide data for a "representative" recirculation ECCS recirculation system and containment. One of the objectives stated in the test plan is: "Determine, characterize and quantify the chemical reaction products that may develop in a representative post-LOCA containment sump environment."

It is recognized that the intent of the SER statements may be to restrict licensees from placing excessive amounts of reactive material (such as aluminum scaffolding) which may result in formation of reaction products which may contribute to head loss into containments. However, creation of material restrictions in containment was not intended in the development of the present chemical effects test program nor have the sensitivity of various materials vis-à-vis head loss been determined.

This language should therefore be removed from the SER. Once the final results from these chemical effects and possible necessary future chemical effects tests are available, and if there are issues discovered which affect sump screen head loss, appropriate guidance can be developed.

Page 21, 3rd bullet:

> **The staff position is that licensees should use a coatings ZOI equivalent to 10D or a ZOI determined by plant specific analysis. The specified ZOI of 10D is based upon the previous staff position used for BWR sump analysis.**

The staff position for estimating coatings debris based on a 10D ZOI should be clarified. The 10D ZOI defined in the BWR URG is a cone-shaped volume with double 10 degree subtended angles of expansion. The cone-shaped jet extends 20 feet from a 2 ft diameter pipe break and affects an equivalent coated flat surface of 302 square feet. The BWR URG then assumes that another 302 square feet of coated surface, positioned between the pipe break and the 20 foot outward extension of the jet, are affected by the jet, bringing the total affected coated surface area to 604 square feet.

The DSER implies that a 10 D spherical ZOI be considered. Use of a 10D spherical ZOI would result in an impacted surface area that is orders of magnitude greater than that utilized as part of the BWR URG or industry guidance.

Section 3.4.2.2

The DSER reduces destruction pressures by 40% for debris sources tested with AJIT to account for uncertainties related to two-phase fluid effects. This requirement imposes unreasonable conservatism upon a baseline analysis approach that is already laden with conservatism. The presumption of 40% more damage is not substantiated by testing, and is little more than a "fudge factor" to account for an effect observed in a single test of different material composition. It places an undue emphasis on the maximizing sump screen debris loading in lieu of analyzing for the thin bed, which is the more probable scenario. This modification to the guidance is unwarranted.

Page 31

Staff Evaluation for Section 3.4.2.6

> **The sample calculation is inconsistent with the baseline methodology discussed above because it implies that potentially affected insulation type with the minimum destruction pressure can be selected from within an accounting region in the vicinity of the break rather than from the entire containment inventory as specified in Section 3.4.2.2.**

It was not the intent to construct a sample calculation to define a ZOI in conflict with the criterion of Section 3.4.2.2. The sample calculation should have stated that the two types

of insulation inside containment were fiberglass and RMI, then identified the regions affected by the ZOI and resulting debris volumes.

Page 37, "Staff Evaluation for Protective Coatings Quantification:"

Staff Evaluation for Protective Coatings Quantification: The staff finds that the quantity of coating debris that will be generated as a result of a LOCA jet should be based on the following:

- For plants that substantiate a thin bed, use of the basic material constituent (10 μm sphere) to size coating debris is acceptable.
- For those plants that can substantiate no formation of a thin bed at which particulate debris can collect, the staff finds that coating debris should be sized based on plant specific analyses for debris generated from within ZOI and from outside the ZOI. Such an analysis should conservatively assess the coating debris generated with appropriate justification for the assumed particulate size or debris size distribution. Degraded qualified coatings that have not been remediated should be treated as unqualified coatings. Finally, testing regarding jet interaction and coating debris formation could provide insight into coating debris formation and help remove some of the potential conservatism associated with treating coatings debris as highly transportable particulate. If coatings, when tested at corresponding LOCA jet pressures and temperatures, are found to fail by means other than erosion or the erosion is limited, the majority of debris may be larger, less transportable or pose less of a concern for head loss."

The GR identifies use of a 10 μm coating debris size when applicable experimental data is not available. Licensees that have plant specific test data of coating systems should be able to use this data to characterize the debris size for coatings assumed to fail inside and outside the ZOI. Licensees should be able to apply this data for either the thin bed or non-thin bed cases.

Page 38, section 3.4.3.4

> **The staff concludes that the baseline alternatives to plant specific data for the determination of the coatings thickness may not be conservative and are not acceptable without plant specific justification. Rather, the staff concludes that each plant should perform a plant specific evaluation of their respective coatings to determine conservative coating thicknesses. This conclusion was drawn despite the perceived conservatism of the recommendations of assuming all unqualified coatings in containment fail and all coating debris forms a fine 10 micron particulate. It is considered reasonable for each plant to assess their respective coatings thicknesses as well as the soundness of their coatings rather than assume an indefensible default recommendation.**

While the DSER acknowledges the conservatism of the GR treatment of unqualified coatings, we do not agree that it is a reasonable expectation for each plant to fully assess

the coatings thicknesses on potentially hundreds of individuals items in containment (pumps, motor operators, electrical cabinets, junction boxes, light fixtures) that possess unqualified coatings.

Page 39, Section 3.4.3.6
We agree that use of plant specific data is desirable with respect to defining insulation characteristics, but in situations when explicit data is not available, a level of flexibility must be afforded to utilize generic insulation information.

Page 46, Section 3.5.2.2.2
Regarding equipment tags, stickers and placards, the staff evaluation states that, if they remain intact and are transported to the sump screen, the sump screen flow area should be reduced by an area equivalent to the original single-sided surface area of the tags. If there is information that the tags will not remain intact, the staff recommends that the equivalent mass of the tags be treated as fibers.

The reduction of the sump screen surface area by the area equivalent to the original single-sided surface area of tags, stickers and placards is very conservative. Past practices in evaluating screen blockage of larger particulates allowed for some overlap of the particulates, typically about a 50% overlap. This accepted practice should be maintained.

The treatment of tags, stickers and placards as fully fibrous is overly conservative. Consideration should be given for treatment of these materials in a more realistic fashion.

Page 55, second paragraph,
It is not clear what is meant by large "flocks" – are these to be considered anything larger than 4 inches?

Page 59, first paragraph
In BWR applications utilization of flow reduction via operator actions was allowed to be credited for reducing pump flow from maximum runout conditions to a throttled flow condition. Can such an approach be utilized for PWR applications? Maximum conditions typically specified are at runout, and do not necessarily represent the plant configuration. Credit for operator action, especially if it is defined in EOPs and has been validated in simulator applications should be allowed to be credited to reduce this over conservative input with respect to debris head loss.

Page 78, 6th paragraph
This paragraph states that it is not conservative to truncate the ZOI whenever it intersects a robust structure implying that the ZOI should be re-sized. This is apparently in contradiction to the second paragraph of page 30.

Page 95
The SER basically finds the uniform debris deposition in the pool at the onset of recirculation unacceptable. This is an initial condition that allows for the development of

the transport fraction. Is there a size of debris that would be uniformly distributed (e.g. fines or small pieces)? For example if the large pieces were retained by debris interceptors to the SG compartment, can it be assumed that all the fines and small pieces are uniformly distributed in the pool from blowdown, washdown and fillup?

Page 96

At the end of 2nd paragraph the DSER instructs the licensee to use the four (4) size categories used in both Appendices III and VI for fibrous debris. The classifications are: 1) fines, 2) small pieces, 3) large pieces and 4) intact blankets (jacketed). Appendix III and VI are essentially the 6772 Separate Effects Characterization, 6773 Integrated Debris Transport Tests and 6369 Drywell Debris Transport Studies and provide a fibrous debris category distribution of 7% fines, 26% small pieces, 32% large pieces, 35% intact pieces. However, in Appendix VI, page VI-8, middle of the page, is a rather large disclaimer "Neither the debris size distributions nor the overall transport fractions in this report are valid for plant specific evaluations." This seems to contradict the DSER direction on pg 96 of the SER to utilize the information contained in the appendices. Transport is predicated on debris size distribution and the DSER has limited application of industry guidance and directed the use of incomplete guidance. Additional information is needed on what NRC would find acceptable, i.e., the DDTS, 6772 and 6773

Page 99, 5.1.5:

> **"However, coating systems that are currently unqualified could be qualified through appropriate testing. Depending upon the rigors of the ASTM standards, some of this testing might be accomplished in place to avoid destructive sample collection from existing surfaces."**

ASTM Committee D-33, Protective Coatings and Linings for Power Generation Facilities, has examined in-situ qualification of coatings in containment on several occasions. Committee D-33 does not endorse nor recommend this approach to upgrading safety-related coatings, and there are no plans to prepare new or revised standards to provide for in-situ DBA testing of coatings. As such, "appropriate testing" based on accepted standards does not currently exist.

Page 117, Section 6.4.7

The GR guidance in Section 6 allows use of nominal parameters as part of the design basis analysis of Region II breaks. Use of nominal parameters implies a recognition that normal operational values will sometimes be higher and sometimes be lower. In recognition of this, the GR includes an accommodation for application of GL 91-18 guidance. We believe the Region II analysis is sufficiently conservative to accommodate operation outside the nominal value for a short period.

The DSER revokes this accommodation for GL 91-18 and will result in the need to use bounding values instead of nominal values. This significantly limits the application of Section 6 guidance and is contrary to the intent of the analysis.

Page 137, 1st full paragraph:

> **"Specifically, this includes the plant-specific consideration of larger sized chips, flakes or other forms of breakdown which is realistically-conservative."**

This concept of the failure morphology of containment coatings is flawed for a number of reasons, primarily because it is based on the spontaneous in-service failure of one particular coating system and subsequent failure by the affected licensee to clean up coating debris in accordance with good housekeeping practices.

Industry has demonstrated that one of the most significant concerns in PWR sump failure analysis is the thin-bed effect, which is exacerbated by small particulate debris. The coatings which may fail and produce transportable debris post-LOCA or post-HELB will all produce debris which, when exposed to the sump pool environment, will conservatively produce small (10μm -50 μm) particles.

No experimental evidence exists to support the staff's premise that containment coatings will fail to produce "larger sized chips, flakes or other forms of breakdown."