BWR OWNERS' GROUP

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Project No. 691

Mr. Robert Taylor
Director, Division of Safety Systems (Acting)
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20555

SUBJECT: Potential Issues Related to Emergency Core Cooling Systems (ECCS) Strainer Performance at Boiling Water Reactors

REFERENCES: All Applicable Administrative and Technical References are Listed on Pages 9 & 10

Dear Mr. Taylor:

The BWROG has completed a detailed and robust assessment of ten (10) of the (12) BWR strainer performance issues identified in References 1 and 2. Assessments of the remaining two (2) issues, downstream effects on fuel and chemical effects (in the fuel), are currently in progress and scheduled to be completed within the coming months. The BWROG concludes that none of the ten (10) issues necessitate a change to the original design methodology, and, they present very low risk to increased core damage frequency, as characterized by Regulatory Guide 1.174 [11]. We are confident that any further evaluation would result in a similar or even lower characterization of their safety significance. We therefore conclude that further investigation into these ten issues is not prudent and would undeservedly divert industry resources from more safety significant issues.

<u>Background</u>

In recognition of the potential for debris fouling of emergency core cooling system (ECCS) suction strainers during postulated loss of coolant accidents, the U.S. Boiling Water Reactor (BWR) industry fleet upgraded and replaced ECCS suction strainers in the late 1990s, following industry and U.S. Nuclear Regulatory Commission (NRC) guidance [5,6,7]. NRC field audits of four BWR strainer designs and containment types officially closed BWR ECCS suction concerns in October of 2001 [8]. Shortly thereafter, NRC initiated research to study similar recirculation sump blockage concerns in pressurized

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water reactor (PWR) ECCS suction strainers, and eventually issued Generic Safety Issue-191 (GSI-191) to the PWR industry. In 2008, the NRC requested the BWROG to investigate differences between the PWR resolution methodology and that used by the BWRs, in response to NRCB 96-03, to ensure any new information was taken into account in ensuring strainer performance.

BWR Strainer Evaluation Program

Based on information provided by the NRC [1] and a self-assessment by the BWROG [2], a list of twelve (12) potential issues was developed affecting BWRs. These twelve (12) issues were presented to the NRC in a series of public meetings at the end of 2010.

1. Downstream Effects – Components
2. Downstream Effects – Fuel
3. Head Loss Correlations
4. Chemical Effects
5. Assessment of Coatings
6. Latent Debris
7. ZOI Adjustment for Air Jet Testing
8. ZOI of Protective Coatings
9. Debris Transport and Erosion
10. Debris Characteristics
11. Near Field Effects and Scaling
12. Spherical Zone of Influence (ZOI)

As a proactive voluntary response, the BWR Owners' Group (BWROG) convened two (2) working committees to determine the best course of action to assess the impact of these issues on the current BWR strainer performance. The first working committee (deterministic) was established to quantify the differences between the BWR Utility Resolution Guidance (URG) methodology and the PWR Methodology presented in NEI-04-07, as well as differences in vendor head loss methods. The deterministic resolution committee also began addressing chemical effects and in-core debris blockage (Items 4 and 2), since these items had not been explicitly evaluated during the BWR resolution to NRCB 96-03.

The second working committee (risk-informed) was established to investigate and characterize the risk significance of the identified issues using an approach considering both the likelihood and the consequence of the potential issues as they relate to the original conclusions. The risk-informed resolution committee compiled information and developed methods needed to address these potential issues using risk quantification methods consistent with agency directives [9,10] and with regulatory guidance [11,12,13,14].

The BWROG Risk-Informed committee took a phased approach in addressing 10 of the 12 issues, starting with a single pilot addressing two issues (Phase I), then addressing all 8 issues for the single pilot (Phase II). Next, we evaluated 8 issues for another pilot plant (Phase III). Finally, we evaluated all 10 issues for the entire fleet (Phase IV). This letter documents the closure of 10 issues for the entire BWR fleet. The details of our investigation and conclusions on Downstream Effects - Fuel and Chemical Effects (In-Vessel Chemical Effects, as Chemical Effects at the suction strainer are addressed in the Phase IV assessment) will be communicated separately upon the completion of our evaluation expected in the next few months.

Phase I – Pilot I	Phase II – Pilot I	Phase III – Pilot 2	Phase IV – Fleet
(3) Head Loss Correlations (8) ZOI of Protective Coatings	(3) Head Loss Correlations (6) Latent Debris (7) ZOI Adjustment for Air Jet Testing (8) ZOI of Protective Coatings (9) Debris Transport and Erosion (10) Debris Characteristics (11) Near Field Effects and Scaling (12) Spherical Zone of Influence (ZOI)	(3) Head Loss Correlations (6) Latent Debris (7) ZOI Adjustment for Air Jet Testing (8) ZOI of Protective Coatings (9) Debris Transport and Erosion (10) Debris Characteristics (11) Near Field Effects and Scaling (12) Spherical Zone of Influence (ZOI)	(1) Downstream Effects Components (3) Head Loss Correlations (4) Chemical Effects (at Strainer only) (5) Coatings Assessments (6) Latent Debris (7) ZOI Adjustment for Air Jet Testing (8) ZOI of Protective Coatings (9) Debris Transport and Erosion (10) Debris Characteristics (11) Near Field Effects and Scaling (12) Spherical Zone of Influence (ZOI)

Evaluation Approach

Expertise was enlisted from SMEs in Probabilistic Risk Assessment, BWR plant operations, thermal hydraulics, BWR strainer design and testing, GSI-191 risk-informed resolution, LOCA accident phenomenology, and ECCS-related regulatory guidance. Initial meetings with NRC confirmed that although this evaluation was voluntary and not a license application, design change, or compelled by a Regulatory requirement, RG 1.174 [11] contains applicable guidance for evaluating these potential issues using a risk-informed approach. All conclusions of this study are in consideration of the applicable criteria of RG 1.174, such as, change in core damage frequency (ΔCDF) and change in large early release frequency (ΔLERF). RG 1.174 provides useful metrics for characterizing risk significance based on ΔCDF and ΔLERF. A comprehensive industry survey was performed to determine the full scope of industry variability with respect to containment type, strainer characteristics, insulation inventories, LOCA-related EOPs, plant design features, and PRA maturity.

Two pilot plants were selected. They encompassed the majority of the salient risk significant attributes, as well as the majority of the technologies in use in the US BWR fleet. A BWR/4 with a Mark I containment was selected to represent plants having compact containment geometry and a toroidal suppression pool, and a BWR/5 with a Mark II containment was selected to represent plants having a higher thermal power output, higher inventories of microporous insulation, and larger containment / transport regions. Computer aided design (CAD) models were available for both plants which describe spatial relationships between pipe break locations and target materials, including thermal insulation and coatings. The two CAD models allowed mapping plant-specific insulation types and piping layouts relative to the common GE containment designs. Plant specific PRA models for both of the pilot plants were used to evaluate the mitigation capabilities that exist within the two BWR vintages and containment designs. The plant specific PRA models were enhanced to incorporate additional debris-induced failure modes of the ECCS suction strainers.

ECCS strainer failure probabilities were calculated using CASA Grande, a code developed for GSI-191 resolution that calculates debris generation and transport for all possible break sizes and break directions at every weld location. Both CASA Grande and the PRA models apply identical LOCA initiating event frequencies obtained from NUREG 1829 [14]. All break scenarios were partitioned into Large, Medium and Small breaks occurring either above or below top of active fuel. These categories directly match existing initiating events in the plant PRA. CASA Grande accumulates debris on plant-specific strainer areas using plant-specific flow rates for each system drawing suction from the suppression pool.

Several strainer failure criteria were developed and exercised during the Pilot Plant studies, including predictive head-loss correlations that combine debris types and plant-specific strainer qualification tests. A simplifying generic failure criterion was established. Declaring strainer failure once reaching 1/8" theoretical thickness (manufactured density) of fiber at the strainer is consistent with industry evaluating experience and can be applied across the entire BWR fleet. CASA Grande tracks accumulation of fiber as a function of time for all active strainers and reports the break scenario as a failure if any single strainer accumulates greater than 1/8" of fiber.

Failure of the ECCS strainer does not necessarily lead to core damage. BWR plants are designed and operated with recognition that loss of ECCS suction strainers is a potential complication during accident conditions. A key risk insight from both the Phase II and Phase III pilot plant studies is that the small risk increase associated with post-debris LOCA impacts is dominated by Loss of RPV Inventory Makeup scenarios should the operator fail to align alternate external RPV makeup. The high reliability of operators aligning external RPV injection further reduces the already low risk of post-LOCA debris generated risk impacts. The time available to align RPV makeup directly affects the reliability for the operators. The longer time available, to diagnose and evaluate degraded ECCS suction strainer performance, increases the reliability for operators to align alternate external RPV injection.

Given the diversity of available external RPV makeup systems and the associated procedures and training for the U.S. BWR fleet, the BWROG commissioned a survey of the BWR fleet to identify:

- The list of alternate external RPV injection systems that are proceduralized and credited in the plant specific Probabilistic Risk Assessment (PRA) model, and
- The Human Reliability Analysis (HRA) to support the calculation of Human Error Probabilities (HEP) for the alignment of external RPV makeup systems credited in the plant specific PRA model

Despite the diversity in the alternate external RPV makeup systems for the BWR fleet, the BWROG Emergency Procedures Committee (EPC), who conducted the survey, concluded that the training and procedures at typical U.S. BWRs would support consistency in the ability to diagnose and mitigate potential loss of ECCS suction strainer issues (e.g., pump cavitation). The consistency in the operator's ability to diagnose potential loss of ECCS suction strainer issues supports the implementation of a common methodology for the BWROG Phase IV risk evaluation for the extension to the U.S. BWR fleet.

The plant responses to the BWROG survey identify that all sites rely and train on the use of multiple and diverse alternate external RPV makeup systems in the plant which are therefore credited in the PRA models.

For the Phase IV risk evaluation, an operator action for aligning only one (1) alternate external RPV injection path (e.g., Service Water crosstie) is conservatively credited for each plant.

In addition to limiting credit for operator action, the Phase IV analysis also conservatively assumes:

- No credit for Feedwater / Condensate or RCIC
- Limited credit for HPCI (HPCS) for selected plants and selected scenarios (e.g., Small LOCA)

Other conservatisms are detailed in the Phase IV risk evaluation report.

The interface between CASA Grande and the EPRI CAFTA PRA software used for the Pilot Plant PRA models was developed while performing numerous parameter studies to vary each of the 10 risk-informed topics and to study them in aggregation to identify possible interactions. A typical parameter study involved increasing or decreasing a threshold in a more conservative direction relative to baseline values. For example, the size of the LOCA damage zone (zone of influence) was increased by 10% in one case to capture uncertainty in industry guidance related to that parameter. The tools and methods used are sufficiently mature to support multiple case studies for all plants in the fleet while applying best available plant-specific information from the plant survey.

Over the course of the phased evaluation, the BWROG actively communicated progress to the NRC which also included three (3) contractor audits [15]. A summary of the individual issues and resolution is provided in Table 1 (Description of ECCS Suction Strainer Potential Issues).

<u>Results</u>

The Phase IV analysis enabled the characterization of plant risk associated with the potential strainers issues. The findings of the Phase II and Phase III analyses support the usage of a 1/8" debris bed as a strainer failure metric in lieu of head loss correlations, since sensitivity cases that were performed using the 1/8" metric predicted greater values of risk versus other strainer evaluation methods.

Utilization of the 1/8" metric precludes the need for alternative sensitivity cases to study certain potential issues. Namely, potential issues associated with the usage of head loss correlations, chemical effects at the strainer, uncertainties in coatings assessments, ZOI-generated coatings debris, uncertainties in debris characteristics, and near field effect and scaling of empirical analyses (Issues 3, 5, 8, 10, and 11) do not require separate sensitivities because the 1/8" metric is insensitive to the effects of these issues, as discussed in the Phase IV report [4]. For example, the impact of chemical effects (Issue 3) at the ECCS suction strainers became much simpler to evaluate due to the inability of chemicals corrosion products or precipitates to create large head losses without a minimum amount of fibrous debris. Additionally, the outlined methodology and assumptions, including the usage of a 1/8" debris bed failure threshold, cause failures associated with fibrous debris to be accounted for relatively quickly after a LOCA. Thus, any additional contribution of chemical effects to conditional strainer failure probability or time to strainer failure is negligible as the relegation of all beds of a thickness of at least 1/8" to failure captures nearly all of the risk contribution associated with chemical effects. Thus, these issues can be considered well represented in the results of the Phase IV "baseline" CASA Grande evaluation of suction strainer failure probability. The results of this analysis support the conclusion of low generic risk, as all plants are within Regions II or III of Reg. Guide 1.174 ΔCDF guidelines, with or without credit for operator actions.

In addition to the Phase IV baseline analysis, a number of sensitivity cases were utilized as a method to characterize the risk from some of the other potential issues. Sensitivity cases were used to evaluate ZOI adjustments for Air Jet Testing (Issue 7), usage of spherical ZOI (Issue 12), erosion and transport analysis (Issue 9), and latent debris (Issue 6). The sensitivity case runs for three of these issues (7, 9 and 12) easily demonstrate that they represent low or very low risk.

The Issue 6 (Latent Debris) sensitivity case models a source of latent fiber in containment that transports to the suppression pool and ECCS strainers. Since the criterion to determine strainer performance is 1/8" of fibrous debris (including all types of insulation other than Reflective Metallic Insulation (RMI), calculated strainer performance is directly related to the quantity of latent fiber modeled as this amount of fiber is independent of break frequency. Under the simplified, conservative bounds established for this study relative to the strainer performance, this sensitivity became a dominant contributor. In addition to issue-specific sensitivity cases, a cumulative sensitivity case was also analyzed. This case examines the effects of all potential issues by utilizing the modeling assumptions from each individual issue-specific sensitivity case. The risk for all plants with limited credit for operator actions is calculated as Region II or III.

The downstream effect of debris on components (Issue 1) was evaluated separately in Phase IV using the dominant risk contributing case from the Phase II and Phase III pilot plant evaluations. In these evaluations, the baseline reliability and availability of components for the credited ECCS systems were assumed to be representative for the issue phenomenology cases. The risk-informed evaluation of downstream effect of debris focused on evaluating the functionality of those components which ensure an outcome of very low risk significance. Component exposure to debris was evaluated in conjunction with possible failure mechanisms. The impact of debris was determined to be of very low risk significance to these components based on design margin, system configuration or limited mission time. When BWR fleet design variations were considered, there was no discernible change to calculated pilot plant risk due to similarities of BWR safety significant components.

Lastly, it was suggested that non-qualified coating inventories in BWRs may be greater than established at the time the BWR strainer debris source terms were originally defined due to 1) existing programs may not adequately monitor degradation of qualified coatings, and 2) existing programs may not adequately address changes to the unqualified coatings inventory. The BWROG tracked this issue as Issue #5, Coatings Assessments, and developed a survey for BWRs based on queries from the NRC Staff Review Guidance of 2008-03 to 1) establish whether there are programs in place to track qualified and unqualified coatings sources, and 2) validate unqualified coating source terms used in the strainer head loss analyses. The results of the survey were tabulated and circulated to BWROG members for peer comparison. The results of the survey indicate all respondents have a program that routinely monitors the coatings in the drywell and suppression pool. Regarding item 1) above, all respondents have a program and track degraded coatings and remediation in site-specific Corrective Action Programs. Regarding item 2) above, not all of the responses indicated that there is a requirement in the program for comparison to the design basis coatings source term in the strainer performance analysis. These plants were notified through the committee for follow-up. Variability in this source term was considered in the Phase IV report [4].

<u>Summary</u>

A systematic and robust investigation of the ten (10) issues (excluding Downstream Effects on Fuel and Chemical Effects on Fuel, enumerated below) finds them to be of very low potential risk and not in need of further action or consideration.

Our assessment has concluded that none of the ten (10) issues below would necessitate a change to the original design methodology and that all are nonsignificant-risk contributors to increased core damage frequency, as characterized by Regulatory Guide 1.174. Based on our evaluations of these 10 issues, the safety of BWRs is not degraded and no further investigation of these issues is required. Therefore, the BWROG considers the following items as related to the NRC 2008 letter closed with no further action.

1\. Downstream Effects – Components
3\. Head Loss Correlations
5\. Assessment of Coatings
6\. Latent Debris
7\. ZOI Adjustment for Air Jet Testing
8\. ZOI of Protective Coatings
9\. Debris Transport and Erosion
10\. Debris Characteristics
11\. Near Field Effects and Scaling
12\. Spherical Zone of Influence (ZOI)

The BWROG has used this opportunity to reinforce awareness at each BWR plant of the critical importance of ECCS strainer operability and to maintain vigilant programs for controlling containment materials inventory and maintaining coatings quality.

While the viewpoint described above represents the intent of all BWROG members, this letter should not be considered a commitment on the part of any specific licensee.

We look forward to continued cooperation with the Staff regarding ECCS Suction Strainer project scope on the ongoing evaluation of the remaining two (2) issues.

Respectfully,

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REFERENCES

1. NRC Letter, ML080500540 dated April 10, 2008, from Mr. J.A. Grobe to Mr. Richard Anderson, Potential Issues Related to Emergency Core Cooling Systems (ECCS) Strainer Performance at Boiling Water Reactors
2. BWROG Letter, BWROG-09024, Boiling Water Reactor Owners' Group - Potential Issues Related to Emergency Core Cooling Systems (ECCS) Strainer Performance at Boiling Water Reactors, April 13, 2009
3. Regulatory Guide 1.174, An Approach for Using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant Specific Changes to Licensing Basis, Revision 2 (May 2011)
4. BWROG Report 1U004.000.600-RPT-13098, Phase IV ECCS Suction Strainer Risk Informed Analysis, Revision 0
5. NUREG / CR-6224, "Parametric Study of the Potential for BWR ECCS Strainer Blockage Due to LOCA Generated Debris", October 1995
6. NEDO-32686-A (ML092530482), "Utility Resolution Guide for ECCS Suction Strainer Blockage", Volume 1, October 1998
7. NEDO-32686-A (ML092530500), "Utility Resolution Guide for ECCS Suction Strainer Blockage", Volume 2, October 1998
8. NRC Memorandum from Robert B. Elliott to Gary M. Holohan, October 18, 2001
9. 60 FR 42622, "Use of Probabilistic Risk Assessment Methods in Nuclear Activities: Final Policy Statement," Federal Register, Volume 60, Number 158, p. 42622, Washington, DC, August 16, 1995
10. NRC Staff Requirements – SECY-10-0113 – Closure Options for Generic Safety Issue – 191, Assessment of Debris Accumulation on Pressurized Water Reactor Sump Performance, December 23, 2010
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12. Regulatory Guide 1.200, "An Approach for Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk-Informed Activities," U.S. Nuclear Regulatory Commission, Washington, DC
13. NUREG-1855, "Guidance on the Treatment of Uncertainties Associated with PRAs in Risk-Informed Decision Making," Volume 1, March 2009

14. NUREG-1829, "Estimating Loss-of-Coolant Accident (LOCA) Frequencies Through the Elicitation Process, Volume 1-2, April 2008

15. ML16126A303, "Boiling Water Reactor Owners' Group Phase III Emergency Core Cooling System Suction Strainer Risk-Informed Analysis," Project No. 691, General Comments and Clarifying Questions

Table 1
Description of ECCS Suction Strainer Potential Issues

Issue No.	NRC / BWROG Concern	Risk Evaluation
1. Downstream Effects (Components & Systems)	BWROG should consider a more rigorous evaluation of erosion, abrasion and blockage of downstream components due to debris penetrating suction strainer	Explicitly addressed as part of a supplemental Phase IV evaluations BWROG-ECCS-TP-1-1 and BWROG-ECCS-TP-1-2. This issue is addressed in a risk-based approach in conjunction with deterministic methodology.
2. Downstream Effects (Fuel / In-vessel)	NRC has not seen a written evaluation of the potential for downstream effects of debris on BWR fuel	Currently not in scope. Downstream Effects (Fuel / In-vessel) are to be addressed in a risk-informed framework as part of a separate project in 2017.
3. Debris Head-Loss Correlations	NRC has concerns on the reliability of the head loss predictions using correlations in the: Treatment of microporous debris and calcium silicate insulations that may result in high head losses The treatment of thin fibrous / particulate debris beds (thin-bed effect)	All CASA Grande evaluations model any accumulation of at least 1/8" of fibrous debris as an ECCS suction strainer failure in lieu of NPSH or structural limits calculated using debris head-loss correlations. This evaluation precludes any reliance on correlations for predicting head loss. The basis for the 1/8" of fibrous debris is taken from test report, Zigler, G, "Test Evaluation Report for Test TPP-VL0400-005: LaSalle Strainer Fiber and RMI Debris Tests, ITS Corporation, June 1998. This report was reviewed by the NRC (see Section 3.1.7 of LA-UR-01-1595, BWR ECCS Strainer Blockage Issue: Summary of Research and Resolution Actions, March 21, 2001). Test 1 in this report is Minimum Fiber Bed Threshold Test involved investigating the fiber loading needed to completely coat the strainer with a uniform nominal 1/8" to 1/4" fiber bed. Results of the test concluded that the assumption of a fiber volume equivalent to a 1/8" uniform bed thickness is sufficient to cover all the strainer surface areas homogenously and is very conservative with the actual value closer to 1/4".

Table 1
Description of ECCS Suction Strainer Potential Issues

Issue No.	NRC / BWROG Concern	Risk Evaluation
4. Chemical Effects	BWROG should consider the chemical environment, including corrosion products, may impact the debris head loss at the strainer or downstream component (e.g., fuel)	Chemical effects impact on debris head loss is greatly simplified based on the Debris Head Loss Correlation criteria developed above (Issue #3). Since the chemical impact on head loss is negligible or zero prior to the accumulation of at least 1/8" debris bed and debris beds at or greater than 1/8" is assumed a failure in terms of loss of NPSH, chemical effects are essentially included or bounded by the risk evaluation. Chemical effects on the downstream fuel are not in scope. Downstream Effects (Chemical / In-vessel) are to be addressed in a risk-informed framework as part of a separate project in 2017.
5. Coatings Assessments	NRC is concerned that non-qualified coating inventories in BWRs may be greater than established at the time the BWR strainer debris source terms were defined: Existing programs may not adequately monitor degradation or qualified coatings Existing programs may not adequately address changes to the unqualified coatings inventory	The evaluation of a 1/8" fiber debris bed as the only criterion for ECCS strainer failure is designed to capture strainer failures caused by large loadings of particulate debris types, which may include debris captured in coatings assessments. This issue is more directly assessed in the BWROG survey response regarding programmatic controls.
6. Latent Debris	NRC noted that the BWROG methodology assumed that latent debris is made up solely of particulate with a generic quantity of 150 lbm. PWRs validated the quantity and size characteristics of latent debris through source term walkdowns and determined the source term may contain a fibrous component. Neglecting this fibrous component can be potentially non-conservative for plants with little or no fiber.	CASA Grande evaluations analyze the effects of latent fibrous debris. The sensitivity case models 15% of latent debris as fibrous (similar to PWRs) and fully transports this amount to the ECCS suction strainers along with the ZOI-generated debris for evaluation of debris bed formation on the ECCS strainers. The value of latent debris is taken as either the plant-specific value or 150 lbm.

Table 1
Description of ECCS Suction Strainer Potential Issues

Issue No.	NRC / BWROG Concern	Risk Evaluation
7. Zone of Influence (ZOI) Adjustment for Air Jet Testing (AJT)	The BWROG Zone of Influence (ZOI) is based on debris generation tests conducted with air as the test fluid. The NRC is concerned that steam may be more destructive than air, requiring an increase in the size of the ZOIs.	The issue of steam may be more destructive than air has been resolved with the Staff and no reduction factor on the damage pressure need be applied (ML15062A365). However, CASA Grande sensitivity case increases the ZOI by 10% to address Issue #7 and Issue #12. This 10% increase in ZOI diameter increases the ZOI volume by 33% and is designed to capture problematic insulation sources outside the spherical ZOI.
8. Coatings Zone of Influence (ZOI)	The destruction of qualified coatings due to HELB is ZOI-based for PWRs and the BWRs use a generic value of 85 lbm. NRC is concerned that the BWR method is not sufficiently conservative.	BWROG calculated new damage pressures and ZOIs for BWR coatings in BWROG-ECCS-TA08-001. The NRC reviewed and determined that the ZOI used by the BWROG is appropriate (ML13280A347). CASA sensitivity cases calculates the quantity of destroyed qualified coatings based on material specific damage pressures and zones of influence for comparison to the baseline generic value of 85 lbm. However, the evaluation of a 1/8" fiber debris bed as the only criterion for ECCS strainer failure is designed to capture strainer failures caused by large loadings of particulate debris types, including coatings debris produced by a ZOI.
9. Debris Transport and Erosion	The NRC is concerned that: Differences in debris size distributions used between PWRs and BWRs may not have a substantial technical basis Differences in erosion of debris should be reconciled	CASA sensitivity case considers an increase of fibrous debris erosion. The full 25% of the low-density fiberglass (LDFG) not initially transported is eroded over a 3-hour period. CASA sensitivity case considers debris to transport to suppression pool in first 60 seconds vs 10 minutes. CASA Grande sensitivity case utilizes larger transport fractions to assess the effects of increased debris erosion. This sensitivity case also models transport to the suppression pool in first 60 seconds of the accident, as opposed to 10 minutes.

Table 1
Description of ECCS Suction Strainer Potential Issues

Issue No.	NRC / BWROG Concern	Risk Evaluation
10. Debris Characteristics	NRC is concerned that: Blockage potential of calcium silicate insulation and other problematic materials such as microporous insulation may not have been treated conservatively. Recent testing for PWRs has identified potential for significant head loss increases.	The evaluation of a 1/8" fiber debris bed as the only criterion for ECCS strainer failure is simplified from previous methods of head-loss estimation, which rely more heavily on debris characteristics.
11. Near Field Effect / Scaling	Assurance is needed that any debris settling during BWR strainer testing was similar or less than would occur following a LOCA in the plant, or consistent with the analyses.	The evaluation of a 1/8" homogenized fiber debris bed as the only criterion for ECCS strainer failure removes reliance on experimental models and does not credit settling in the suppression pool.
12. Spherical Zone of Influence (ZOI)	NRC noted that while a spherical Zone of Influence (ZOI) may have maximized the quantity of debris, it may have precluded selection of a lesser amount of more problematic debris targets such as microporous or calcium silicate insulation. Such a target could be outside the nominal spherical ZOI but be within a more realistic direct jet flow.	CASA Grande sensitivity case increases the ZOI by 10% to address Issue #7 and Issue #12. This 10% increase in ZOI diameter increases the ZOI volume by 33%.