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Project No. 691

Mr. Victor Cusumano
Safety Issues Resolution Branch Chief
Division of Safety Systems
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20555

SUBJECT: Revised BWROG Request for Closure of ECCS Suction Strainer Issues: Latent Debris Issue #6; Zone of Influence (ZOI) Adjustment for Air Jet Testing (AJT) Issue #7; and Spherical Zone of Influence (ZOI) Issue #12

REFERENCES:

1. Letter BWROG-09024 to J. Grobe, NRC, from R. Anderson, BWROG, "Potential Issues Related to Emergency Core Cooling Systems (ECCS) Strainer Performance at Boiling Water Reactors," dated April 13, 2009 [ADAMS ML092160139]

2. Letter BWROG-14006 "BWROG Request for Closure of ECCS Suction Strainer Issues: Latent Debris Issue #6; Zone of Influence (ZOI) Adjustment for Air Jet Testing (AJT) Issue #7; and Spherical Zone of Influence (ZOI) Issue #12," dated February 14, 2014 [ADAMS ML14065A063]

3. BWROG document, "Utility Resolution Guide for ECCS Suction Strainer Blockage," NEDO-32686-A, dated October 1998. [ADAMS ML092530482]

4. Letter BWROG-13014 to Joe Golla, NRC, from F.P. Schiffley, BWROG, "BWROG ECCS Suction Strainer Program Closure of Technical Issue 12," dated February 19, 2013 (ML13051A383)

5. Summary of September 22, 2010 Public Meeting with the Boiling Water Reactor Owners' Group (BWROG), October 20, 2010 (ML102800152)

6. Summary of October 20, 2010 Public Meeting with the Boiling Water Reactor Owners' Group (BWROG), November 4, 2010 (ML103010393)

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Dear Mr. Cusumano:

This letter provides the BWROG positions on three ECCS Suction Strainer technical issues: Latent Debris Issue #6; Zone of Influence (ZOI) Adjustment for Air Jet Testing (AJT) Issue #7; and Spherical Zone of Influence (ZOI) Issue #12, as described in the BWROG plan (Reference 1). The original request for closure was submitted on February 14, 2014 within letter, BWROG-14006 (Reference 2). This letter incorporates discussions between the BWROG and NRC Staff that occurred during a teleconference on September 24, 2014, and a public meeting held on December 4, 2014. Provided our positions are acceptable to NRC Staff, please provide written NRC agreement that these issues are closed.

Latent Debris Issue #6

Background

The latent debris issue is related to the quantity and composition of latent debris in the containment that might be transported to the ECCS suction strainers. The BWROG Utility Resolution Guidance (URG) (Reference 3, Attachment 1, page 53) for ECCS strainers states:

> *"It is the judgment of the BWROG that the use of 150 lbm of dirt/dust in the strainer head loss evaluation will conservatively address the debris from dirt/dust in the drywell, dirt/dust in the suppression chamber above the level of the suppression pool which could be washed into the pool as a result of a LOCA induced pool swell, and the debris which would result should the LOCA jet impact a concrete wall."*
>
> *"Alternatively, licensees may use a value lower than the conservative value recommended by the BWROG. Should licensees choose to use such an approach, they should document the basis for the value and assure the inspection criteria in their FME/housekeeping programs are adequate to assure the value assumed would not be exceeded."*

As part of the resolution of GSI-191, the NRC had LANL perform a study of the dirt and dust from four PWR containments (NUREG/CR-6877) and found that fiber debris constituted 5% to 16% by weight, of the dirt/dust debris observed. LANL recommended that a generic value of 15%-by-weight fiber be used for PWR containment dirt/dust debris (more fiber is considered to be conservative). The NRC accepted this recommendation and it was widely used by PWR licensees.

BWROG Project Plan Issue #6 involves reviewing the current method used by PWRs to address latent debris (dirt/dust), and to determine if the BWROG URG should be revised.

BWROG Issue 6 Activities

Most of the BWR licensees have completed drywell and wetwell walkdowns in a manner similar to the PWR licensees to determine plant-specific quantities of dirt/dust debris. Results indicated that the actual quantity of dirt/dust debris found was less than the URG generic assumption of 150 lbm.

BWROG Position

The BWROG will provide guidance on latent debris to include the assumption that 15% by weight of the latent debris will be fiber, and 85% will be particulate unless plant-specific debris sampling and analysis indicates a different fraction.

Proposed BWROG URG Revision Narrative Related to Issue 6

The BWROG recommends the generic use of 150 lbm of dirt/dust in the strainer head loss evaluation to conservatively address the debris from dirt/dust in the drywell, dirt/dust in the suppression chamber above the level of the suppression pool which could be washed into the pool as a result of a LOCA induced pool swell, and the debris which would result should the LOCA jet impact a concrete wall. Alternatively, licensees may use a different value than this generic value provided that value has been substantiated with a plant walkdown and FME/housekeeping procedures have been implemented to maintain plant cleanliness. Should licensees choose to use such an approach, they should document the basis for the value and assure the inspection criteria in their FME/housekeeping programs are adequate to assure the value assumed would not be exceeded.

The dirt and dust shall be assumed to be 85% particulate and 15% fiber by weight. Alternatively, licensees may use a different composition provided that they have substantiated this composition with an analysis of the dirt/dust in their plant or in a similar BWR with similar FME/housekeeping procedures. Should licensees choose such an approach, they should document the basis for the identified dirt/dust composition.

Integration with BWROG Program

Content and guidance associated with Issue #6 as addressed in this letter will be captured in the BWROG URG revision occurring at the end of the ECCS Suction Strainer Program should a revision become necessary.

Zone of Influence (ZOI) Adjustment for Air Jet Testing (AJT) Issue #7 and Spherical Zone of Influence (ZOI) Issue #12

Narrative contained below describing the BWROG position associated with Issue 12, is a revised restatement of the original February 19, 2013 submittal (Reference 4).

NRC Position Summary

The NRC's concern is that, while a spherical ZOI may have maximized the quantity of debris, it may have precluded selection of a lesser amount of more problematic debris, such as micro-porous or calcium silicate insulation. Such problematic debris materials could be outside the spherical ZOI, but within the ZOI of a directed jet (see Figure 1).

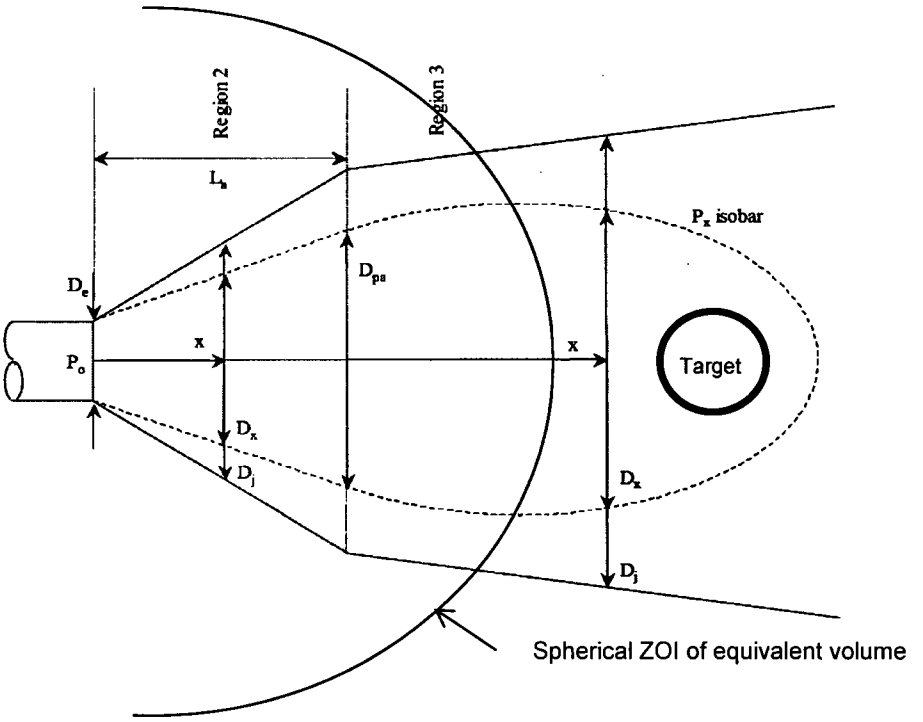

Figure 1: Target Outside Spherical ZOI and Inside Directed Jet

Current BWR Methodology

NRC SER on URG, Section 3.2.1.2,

"The BWROG choice of mapping a spherical ZOI with a volume equal to the volume of the doubled-ended conical ZOI for a freely expanding jet is unsupported either by analytical modeling or experimental evidence. The BWROG's rationale, however, appears logical (although qualitative). As a result, the staff conducted a confirmatory analysis using a limited CFD model to demonstrate the effect of the jet interaction with structure and piping in the drywell. This analysis demonstrated the diffusion of the break jet as it interacts with structures and piping. On the basis of this analysis, the staff concludes that the spherical ZOIs developed using methods 2 or 3 in Section 3.2.1.2 of the URG are conservative and acceptable. The basis for the staff's conclusion is that the jet emanating from a broken pipe will lose energy and diffuse with distance and its interaction with surrounding pipes and structures, and the URG methodology does not account for this piping/structural interaction which conservatively increases the calculated size of the ZOI. The staff concurs with the URG's recommended use of a spherical model as the best means to account for the impact of drywell congestion, drywell structural interactions, and the dynamic effects of pipe separation."

NRC SER on NEI-04-07, ES.2

"The staff has reviewed the use of a spherical model sized in accordance with the ANSI/ANS standard and finds this approach acceptable. The spherical geometry proposed encompasses a zone which considers multiple jet reflections at targets, offset between broken ends of a guillotine break, and pipe whip. The staff's confirmatory analysis (see Appendix I to this SE) verifies the applicability of the ANSI/ANS standard for determining the size of this zone. The staff found the use of a ZOI model to be an acceptable approach for analyzing debris generation in accordance with RG 1.82, Revision 3 (The staff also used and approved this approach in the boiling-water reactor (BWR) sump performance SE). The GR recommendation to truncate the spherical ZOI when a robust barrier or large piece of equipment is encountered is acceptable to the staff. The refinement offered in the GR to apply spherical ZOIs that correspond to material-specific destruction pressures for each material that may be affected in the vicinity of a break, is also acceptable."

Background

While this concern was not identified in RG 1.82 Revision 3 or the SER on NEI-04-07, it is now included in RG 1.82 Revision 4. Section 1.3.3.1 issued in March 2012.

> *"If the evaluation uses simplified ZOI models, such as the spherical ZOI models that are discussed in Section 3.2.1 of NEDO-32686-A (Ref. 15) and Section 3.4.2 of NEI 04-07 (Ref. 26 and 27), licensees should apply sufficient conservatism to account for simplifications and uncertainties in the model. For example, a spherical ZOI model assumes that the blowdown from a LOCA is evenly distributed in all directions radiating from the break location. Although, with sufficiently conservative inputs, a spherical model may be appropriate for estimating the loadings of debris within a ZOI, such a model does not account for non-uniform blowdown that could create damage in a particular direction at much greater distances from the break. Therefore, such a spherical model would likely be non-conservative when specifying an exclusion zone for particularly problematic materials (e.g., calcium silicate insulation for a PWR with a trisodium phosphate buffer or fibrous debris for a plant with a limited strainer area that intends to demonstrate that a fibrous debris bed cannot be formed)."*

The BWROG and the NRC Staff have had several discussions regarding these issues since 2010. The following is a summary of recent interactions (Reference 5; Reference 6):

Issue No. 12, Spherical ZOI Presentation (September 22, 2010) - The second presentation was on Issue No. 12, Spherical ZOI (see ADAMS Accession No. ML102800091). This presentation provided discussions on the technical concern, issue history, resolution strategy, and next steps and milestones. The overall technical concern is that, while a spherical ZOI (accepted by the staff) may have maximized the quantity of debris, it may have precluded the selection of a lesser amount of more problematic debris, such as microporous or calcium silicate insulation.

The staff stated that its current position, as documented in the 2004 Safety Evaluation of NEI 2004-07 for PWRs, and the URG SE for BWRs, and in NUREG/CR-7011, "Evaluation of Treatment of Effects of Debris in Coolant on ECCS and CSS Performance in Pressurized Water Reactors and Boiling Water Reactors," is that spherical ZOIs are acceptable. The staff is considering whether a change in that position is appropriate for BWRs. In doing this, the staff will consider information provided by the BWROG.

Action 11 - The staff stated that it would provide, by the November 2010 meeting with the BWROG, a clear statement of intention on whether it plans to revise its position on spherical ZOI.

The BWROG will decide on its path forward for guidance on problematic debris outside of the spherical ZOI after the staff dispositions its concerns.

Action 11: Staff Position on Spherical ZOI [Closed] - NRC Staff to provide a clear statement of intent on whether it plans to revise its position on ZOI. The

technical concern is that, while spherical ZOI (accepted by the NRC staff) may have maximized the quantity of debris, it may have precluded the selection of a lesser amount of more problematic debris, such as microporous or calcium silicate insulation.

[NRC staff has stated] This Action is closed but the technical issue remains. The NRC staff decided that spherical ZOIs, as applied, contain adequate conservatism such that localized concentrations of debris outside of the spherical ZOI, but potentially within a more realistic directed jet ZOI would usually be adequately accounted for in the spherical ZOI. However, plants should review the potential debris sources within the containment for materials that are known to be particularly problematic. If these materials are present in containment and are not accounted for in the debris generation calculation due to spherical resizing of the ZOI, the plant should evaluate whether destruction of these materials and others within a directed jet would result in a more limiting debris generation scenario than that calculated by the spherical method and adjust their source term accordingly. The resolution strategy outlined by the BWROG on slide 13 of their presentation on this issue (Spherical ZOI, ADAMS Accession No. ML102800091) at the September 22, 2010, public meeting (meeting summary at ML102800152) is found to be acceptable (Reference 5).

BWROG Position

We agree with the NRC Staff on the conservatism inherent in the development and application of the spherical ZOI (e.g., reflection, energy dissipation) and also offer the following additional conservatisms relating to debris sources outside the sphere but within a directed jet:

1. Regarding calcium silicate problematic insulation, the radius of the BWR spherical ZOI is 6.4D (D is expressed in pipe diameter) and larger than the PWR ZOI of 5.45D with higher operating pressures and temperatures.

2. The directed jet assumes the break is fully offset with no interference from either the opposing jet or any structures with the effluent hitting a line of site target greater than 24 feet away (12D or 24 feet is the radius of the spherical ZOI associated with Min-K and Microtherm, and assuming a 24 inch pipe break).

3. Although the spherical ZOI remains conservative, the BWROG will address this issue by providing enhanced guidance in the area of debris generation, specifically looking at problematic targets:

    a) Identify all "problematic" debris that was excluded from calculated, design-basis source terms. Problematic debris is defined as any debris that could have significant head loss implications at the strainer.

b) Either include the debris source term or justify its exclusion. Justification can include:

   i. Assessment of the target's distance from any possible break
   ii. Identifying shadowing/obstructions between break and problematic debris source

While the BWROG understands NRC staff concern over these potentially problematic materials, there is no intent by the BWROG to 1) Develop new guidance on the size and shape of a directed jet ZOI, or 2) Specifically exclude or ignore problematic debris sources that could, if destroyed, transport to the ECCS suction strainer.

Integration with BWROG Program

Content and guidance associated with Issues #7 and #12 as addressed in this letter will be captured in the BWROG URG revision occurring at the end of the ECCS Suction Strainer program should this become necessary. The proposed changes would be as follows:

Section 3.2.1.2.3.2, Method 2 – Target Based Analysis using Limiting Size Zones of Influence, will be amended as follows:

7. *Identify all "problematic" debris that was excluded from calculated, design-basis source terms. Problematic debris is defined as any debris that could have significant head loss implications at the strainer. Either include the debris source term or justify its exclusion. Justification can include:*
   - *Assessment of the target's distance from any possible break*
   - *Identifying shadowing/obstructions between break and problematic debris source*

Section 3.2.1.2.3.3, Method 3 – Break Specific Analysis using Break-Dependent Zones of Influence will be amended to include the following guidance:

4. *Identify all "problematic" debris that was excluded from calculated, design-basis source terms. Problematic debris is defined as any debris that could have significant head loss implications at the strainer. Either include the debris source term or justify its exclusion. Justification can include:*
   - *Assessment of the target's distance from any possible break*
   - *Identifying shadowing/obstructions between break and problematic debris source*

Requested Action

The BWROG requests the Nuclear Regulatory Commission (NRC) Staff's written feedback regarding the content of this letter within seven weeks (35 working days) following receipt.

This is an interval agreed upon during the public meeting held on October 20, 2010 (Reference 6). Future tasks depend upon receiving timely feedback from the Staff.

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 regarding ECCS Suction Strainer project scope.

Respectfully,

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Commitments: None