BWR OWNERS' GROUP

Frederick P. "Ted" Schiffley, II
BWROG Chairman
Tel: (630) 657-3897
Fax: (630) 657-4328
frederick.schiffley@exeloncorp.com

c/o GE Hitachi Nuclear Energy, P.O. Box 780, 3901 Castle Hayne Road, M/C A-70, Wilmington, NC 28402 USA

BWROG-13014
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Project No. 691

Mr. Joe Golla
Project Manager
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

SUBJECT: BWROG ECCS Suction Strainer Program
Closure of Technical Issue 12

REFERENCES:
1. Letter to F.P. Schiffley II, BWROG, from S. Bahadur, NRC, dated May 13, 2011, regarding NRC feedback on BWROG ECCS Suction Strainer Program.
2. Utility Resolution Guide for ECCS Suction Strainer Blockage, NEDO-31686-A, October 1998, BWROG Report.

Dear Mr. Golla:

The Boiling Water Reactor Owners' Group (BWROG) has developed an extensive program to address new technical issues raised during the resolution of Generic Safety Issue #191 (GSI-191), Assessment of Debris Accumulation on PWR Sump Performance, and their impact on previous ECCS suction strainer guidance for BWRs. This plan has been reviewed with the NRC staff and both parties agreed that there are 12 technical issues that warrant further study by the BWROG (Reference 1). The purpose of this letter is to respond and close out one of these technical concerns.

Based on interactions with the Staff and the justification provided, the BWROG considers the Spherical Zone of Influence issue closed with no further action required.

Issue No. 12 – Spherical Zone of Influence – Closure Justification

The concern is that while a spherical ZOI maximizes the quantity of LOCA debris, it may preclude selection of a lesser amount of more problematic debris such as micro-porous or calcium silicate insulation located more remotely from the postulated pipe break. Such materials could be outside the nominal spherical ZOI; however, with the assumption of a smaller, more directed jet flow, these materials could contribute to the debris source term for that postulated break location.

While the BWROG understands the NRC Staff's 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) to specifically exclude or ignore problematic debris sources that could, if destroyed, transport to the ECCS suction strainer.

We agree with the Staff comments in their original SER of the URG on the conservatism inherent in the development and application of the spherical ZOI (e.g., reflection, energy dissipation, etc.). The spherical ZOI developed by the BWROG is the same methodology that the NRC approved in the PWR methodology NEI-04-07. We offer the following additional conservatisms relating to BWR debris sources outside the ZOI sphere but potentially within a directed jet:

1. Regarding calcium silicate 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 theory 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).

We find the Staff's statement regarding a potentially more "realistic" directed jet to not be appropriate in this application.

For this concern, the BWROG does not intend to change the spherical ZOI methodology or requirements associated with debris generation to account for debris sources outside the approved ZOI. We find this concern is adequately considered with the existing methodology. The BWR walkdowns have confirmed the locations of the limited amounts

of these problematic debris materials and some licensees are planning to replace these insulation materials during future planned outages.

In summary we are continuing to make progress in addressing and resolving these NRC concerns. The BWROG intends to use the resolutions documented here to move forward with the remaining project issues. This letter should not be considered a commitment on the part of any specific licensee.

If you have any questions concerning this letter, please do not hesitate to contact me or Ed Asbury, BWROG Project Manager (910-819-7544).

Frederick P. "Ted" Schiffley, II
Chairman
BWR Owners' Group

cc: S. L. Scammon, BWROG ECCS SS Committee Chairman
K. A. McCall, Interim BWROG Program Manager
E. L. Asbury, BWROG ECCS SS Committee Project Manager
BWROG Primary Representatives
BWROG ECCS SS Committee

Attachment:
1. Spherical Zone of Influence Discussion

Attachment 1

Spherical Zone of Influence

Expressed NRC Concerns

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).

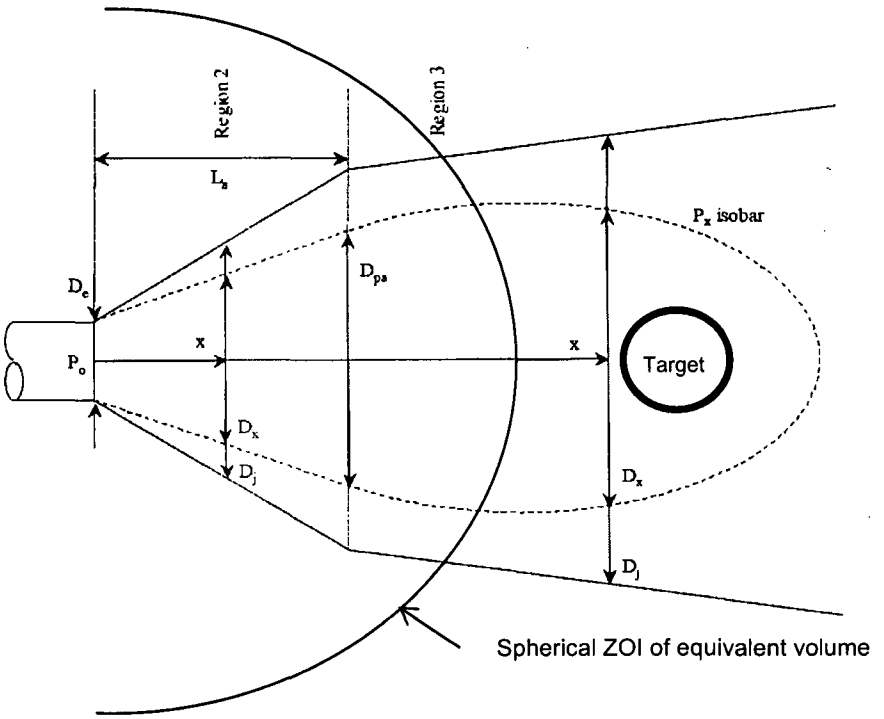

Figure 1: Target Outside Spherical ZOI and Inside Directed Jet

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 3.2.1of 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 this issue since all of 2010. The following is a brief history of the recent interactions

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: Closed. Staff Position on Spherical ZOI: 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.

(The 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.

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, etc.) 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 theory 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).

While the BWROG understands the NRC staff's 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) to specifically exclude or ignore problematic debris sources that could, if destroyed, transport to the ECCS suction strainer. The resolution strategy outlined on the BWROG slide 13 mentioned above was prepared in the event the NRC staff chose to revise its position on the acceptability of the spherical ZOI, which they have not.