Staff Evaluation of BWROG Position of Reduced Destruction Pressure

The Boiling Water Reactor Owners Group (BWROG) position (included below) provides the Utility Resolution Guidance (URG) values for debris assumed to transport to the strainer as approved by the staff safety evaluation (SE). The position provides the methodology for the calculation, but does not provide the basis for the assumptions in the URG. Therefore, the staff reviewed the URG SE and selected sections of the URG to determine whether it is reasonable to assume that a 30% larger zone of influence (ZOI) resulting from increasing the spherical ZOI from 10.4D (10 psi) to 11.4D (6 psi) could cause significant additional fibrous debris to reach the strainer. The BWROG position assumes that all destruction between 10.4D and 11.4D occurs at 6 psi. The BWROG position lists conservatisms that were noted in the staff SE on the URG.

The air jet impact test (AJIT) referenced in the BWROG position was conducted at a target pressure of about 6 psi. At this pressure the destruction was about 2% small fines, 2% large pieces, and the cloth cover was completely removed from the internal fiberglass blanket. The test that provides the basis for the 10 psi destruction threshold was conducted at a target pressure of about 10 psi and resulted in about 6% of the fiber being fragmented into small fines and 63% large fiber pieces. During this test, the cloth cover was also completely removed from the fiberglass blanket. Based on the spherical ZOI model, the pressure through the added ZOI volume would decrease from about 10 psi at 10.4D to 6 psi at 11.4D. Therefore small and fine debris generation would decrease from 6% at the smaller diameter to 2% at the larger diameter. The BWROG assumption that all destruction occurs at the lowest pressure is non-conservative. Based on the limited test results, the generation of small fines between 10.4D and 11.4D would be between 6% and 2%. For this evaluation the staff assumes that 4% fragmentation into small fines will occur. The URG assumes that blankets that are substantially intact are not transportable. Although the AJIT description considered most of the debris to be blankets and covering material, the staff does not agree that exposed fiberglass blankets can be considered to be substantially intact or "canvassed debris." With the cloth covering removed even very large pieces of exposed fiberglass blanket would potentially be further fragmented. If generated below the lowest grating in containment these pieces should be assumed to transport per the URG guidance. Additionally, any exposed blanket should be assumed to erode at the normal rate if generated either above or below the grating. The URG assumed erosion rate is 6.25%.

The staff considers it reasonable, for fibrous debris with the cloth cover removed above the grating in the volume between 10.4D and 11.4D, to assume 6% erosion and transport of the 4% fine and small pieces generated by the break. That is, 10% of the fiber between 10.4D and 11.4D would be transportable to the strainer. This would be added to the assumed 28% of the debris reaching the strainer from other sources (inside 10.4D) above the grating. For debris generated below the grating in the volume between 10.4D and 11.4D the normal URG combined debris generation and transport value of 78% is appropriate.

The staff agrees that the SE on the URG recognized that there were potential conservatisms in the URG methodology. However, the conservatisms were not quantified. Additionally, there are significant uncertainties in debris generation and transport evaluations which may reduce or negate the potential effects of conservatisms listed in the position.

Based on the above, the staff does not agree with the BWROG position that transportable debris generated between 10.4 and 11.4D would have a negligible contribution to debris reaching the strainer, especially for debris generated below the lowest grating in containment. The actual impact on debris to be considered in the strainer evaluation depends on the location of insulation in containment with respect to the postulated break.

BWROG Position on Effect of Reduced Nukon Destruction Pressure

The BWROG method is slightly different than the PWROG method in that the BWROG method uses a combined debris generation/transport fraction that is applied based on the containment type. The volume averaged destruction/transport factor suggested and used by the BWROG for NUKON fines is 0.23 for Mark I's and Mark III's. This value was evaluated by the NRC as conservative in Appendix G of the NRC SER on the URG (see discussion on page G-5). The methodology for the destruction factor is provided in a technical reference located in Volume 3 of the URG. The debris generation/transport to the suppression pool is calculated as follows:

For jacketed and unjacketed NUKON debris generated above the lowest drywell grating, 23% of the damaged insulation is fine debris that subsequently transports directly to the suppression pool. Then, 6.25% of the remaining 77% (blanket material) is eroded away and also transported for a total of 28% of the ZOI insulation transported into the suppression pool (i.e., 0.23 + 0.0625 x 0.77 = 0.28). For NUKON insulation below the lowest grating, the total debris transported to the suppression pool would consist of the 23% fines, 70% of the 77% blanket material, and 6.25% of the non-transported blanket-material that subsequently is eroded (i.e., 0.23 + 0.70 x 0.77 + 0.0625 x 0.30 x 0.77 = 0.78). These values are conservatively applied to Mark II containments as well.

During the staff review of the URG, the staff noted the following conservatisms in the BWROG methods:

- The blanket arrangement used in the BWROG testing is highly conservative, and in the NRC sponsored testing, the amount of debris generation was substantially less. NRC-sponsored testing required artificial means to hold the blankets in place to maximize debris generation, otherwise no more that 25 to 30% of the insulation was destroyed.
- The targets and structures located in the jet pathway would provide considerable protection to the blankets.
- Not all the targets in the BWR drywell are normal to the jet centerline (JCL) as tested by the BWROG. In fact, the staff's survey suggests that a majority of the piping (> 65%) would be located parallel to the jet flow. In this case only a small portion of the blanket would be subjected to the high dynamic pressures.

In the NRC Drywell Debris Transport Study (DDTS), the NRC interpretation of the AJIT test report is that 40% of the NUKON insulation within the ZOI is "canvassed debris" which is not transportable. Hence, the NRC position is that the maximum amount of debris which can be transported to the suppression pool from the lower portion of the drywell is 60% of the initial insulation within the ZOI, a lower number than the corresponding 78% presented by the URG – acknowledging that canvassed debris does not erode due to the protective nature of the canvas.

I hope this helps with a little background. Once again, I'm not convinced that this concern about reducing the damage pressure for NUKON is worth pursuing since we're talking about debris in the spherical region between 10.4D and 11.4D (roughly 2 feet), which, from the AJIT test below, is 1.9% fines and 1.8% large fiber pieces at the 11.4D ZOI. Plants have already evaluated the 10.4D ZOI and adding a negligible amount of fiber to their analysis would not change the results. Applying these normally oriented target results to congested BWR containment piping arrangements has already been established as very conservative and does not warrant the additional analysis.

TEST 6-2

Date of Test:	August 1, 1996 (test #36)
Insulation Material:	Unjacketed PCI NUKON® blanket with Velcro® band closures. The NUKON® blanket seam was located at the 9 o'clock position.
Test Distance:	80 L/D (240.5 inches)
Test Pressure:	1123 psig stagnation pressure at the nozzle (maximum)
Test Duration:	6 seconds
Insulation Surface Pressure:	6 psig (approximate)
Test Results:	The blanket remained on the target pipe for several seconds before the strap connections to the blanket's cloth cover were pulled out. The cloth cover of the blanket was completely removed, with most of the internal fiberglass wool and scrim intact. 99% of the total insulation mass was recovered.

Test Debris:

Debris	Fines, Small Fibers, and Dust	Large Fiber pieces	Blankets and Covering Material	Total
Total Mass	0.0904 lbm	0.6592 lbm	9.7338 lbm	10.4834 lbm
% Mass	1.9% (0.9% recovered)	6.3%	91.8%	100% (99% recovered)
Debris Comments	Large fiber pieces consists of 4.5% (0.4712 lbm) of straps and connecting metal parts and 1.8% (0.1880 lbm) of large fiber pieces. Fines, small fibers and dust consists of 0.9% recovered and 1.0% unrecovered debris.			

Observations: