Industry Comments on Proposed Revision to
NRC Safety Evaluation on NEI 04-07

1. The scaling evoked by the NRC staff was developed by the BWROG URG to compensate for the smaller diameter test article used in the air jet tests when applied to larger diameter piping. The scaling is based on the observed failures that were associated with the banding/latching of the jacketing/covers and the assertion that the average target pressure is a better figure of merit than the jet centerline pressure. As noted in the URG SER Appendix B, the simplified URG scaling algorithm is acceptable and is within +/- 25% of the results of a more rigorous algorithm such as the one derived in the URG SER. The following observations are noted:

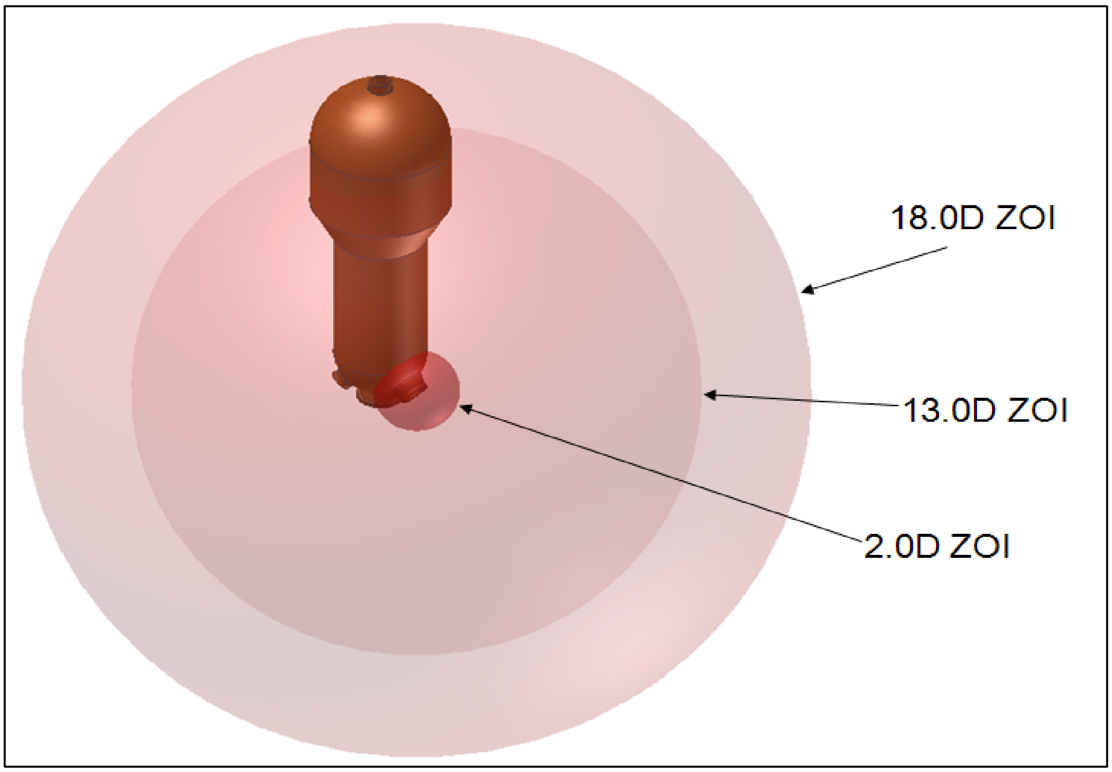
    a. In the last paragraph of page B-5 states that the scaling derivation is appropriate for smaller and larger pipes than tested. Therefore it is appropriate to derive an increased damage pressures for smaller diameter pipes than the tested pipes.

    b. The technical basis for deriving the scaling algorithm is based on comparison of the cross-sectional areas of the tested targets and the plant targets. There are no limitations noted in either the SER or the URG concerning the application of the algorithm for non-piping structures and components. Therefore it is appropriate to derive scaled damage pressures for components such as the steam generator, pressurizer, and reactor coolant pump.

    c. The scaling algorithm modifies the damage pressure to account for differences between the cross-sectional areas of the plant target and the tested target. In neither the URG or the SER to the URG are there specified limitations associated with application of the scaled damage pressure to derive the radius of the ZOI for a specific material/target, i.e. there is no requirement for further considerations of jet direction issues, jacketing material and thickness, jacketing seam orientations, jacketing material overlap, banding material and thickness, types of latches, etc.

2. The NRC staff stated that the scaling equation identified in the BWROG URG was inadvertently excluded from the SER. On Page 2 of the NRC letter, the staff stated that this scaling equation does not need to be applied to all types of insulation that were specified in the URG. Specifically for Transco stainless steel RMI or Darchem DARMET RMI, the staff determined that the existing 2D ZOI size is acceptable because RMI is not a significant contributor to strainer head loss. RMI, however, can be a significant contributor to water holdup within containment. Crumpled RMI debris can be retained by grating and meshed doors (such as personnel control doors) that are in the water flow pathway to the sump. The water flows in these constrictions can be significant and cause a decrease in the water level downstream of the RMI holdup. Additionally, crumpled RMI debris can cause partial blockage of drains causing increased water holdup and a reduced water level in the post-LOCA pool. Lower pool water level leads to higher velocities, and therefore higher propensity for debris transport to the sump. Also, the water level could be sufficiently reduced to allow air ingestion and vortexing to occur at the sump strainer.

Note that using the scaling equation could result in significantly more RMI debris than has currently been analyzed under the existing methodology. For example, if the destruction pressure is scaled for the diameter of the lower and upper portions of a steam generator, the ZOI size would increase from 2D to 13D on the lower portion of the steam generator (11.3 ft diameter) and 18D on the upper portion of the steam generator (14.6 ft diameter). As shown in the following figure, applying this equation for RMI would result in the entire steam generator being enveloped within the ZOI. This would increase the quantity of RMI debris from approximately 2,500 ft^2 (38 ft^3) to over 60,000 ft^2 (900 ft^3). Nine Hundred cubic feet of crumpled RMI foils could cause a significant impact on ECCS performance as noted above. Selective dismissal of the application of scaling to certain types of RMI was not recommended by the URG and the associated SER for BWRs. Selective dismissal of the application of the



scaling to certain types of RMI as recommended by the NRC staff in the draft revision to the NEI 04-07 SER is not appropriate, and would be in direct contradiction to the previous NRC position.

Figure 1: Increase in ZOI size for Transco RMI due to application of URG scaling equation

3. The draft revision to the ZOI guidance in the SER dismisses the application of the scaling algorithm to Cal-Sil because the staff determined that "the existing ZOI value is sufficient without additional scaling because the ZOI value is based on a different test using a two-phase jet for which the damage mechanism observed during testing was related to tearing of the jacketing rather than failure of the jacketing bands." The scaling algorithm is based on scaling the jet centerline pressure by the ratio of the cross-sectional area of the test target and the plant target to develop the same force on the jacketing, i.e., the larger the cross section the lower the pressure required to generate the same force on the jacketing. The insulation is considered to fail when either the force on the jacketing exceeds the band strength and the band fails, or if the tearing strength is low, when the jacketing tears. Therefore the insulation failure mechanism should not impact the applicability of the scaling algorithm.

4. As noted by the staff in the proposed revisions to the SER ZOIs, "the (Cal-Sil) ZOI (damage pressure) value is based on a different test using a two-phase jet". The tests referred by the staff are the OPG two phase tests. The OPG Cal-Sil test series were performed with a 2" target pipe diameter in contrast to the BWROG air jet tests performed with a 12" target diameter pipe. Scaling of the Cal-Sil destruction pressure should therefore be based on the 2" target diameter from which the damage pressure was derived.

5. In the basis for the proposed revisions to the SER ZOIs, the staff noted that "the (Cal-Sil) damage mechanism observed during testing was related to tearing of the jacketing rather than failure of the jacketing bands." In page 29 of the SER to NEI-04-07, the staff concluded that "… comparison with OPG data on greater than 40 percent reduction in damage pressure for calcium silicate insulation … the NRC staff position is that damage pressures for all material types characterized with air jet testing should be reduced by 40 percent to account for potentially enhanced debris generation in a two-phase PWR jet." It appears that the reason for the reduction in damage pressure was the different failure mechanism of the OPG Cal-Sil, i.e. the jacketing in the OPG test, as opposed to the banding failure observed in other testing and not in the "potentially enhanced debris generation in a two phase PWR jet". The postulated "potentially enhanced debris generation in a two phase PWR jet" noted in the SER to NEI 04-07 is also currently not supported by the NRC as noted in the April 10, 2008 letter from John Grobe to Richard Anderson entitled "POTENTIAL ISSUES RELATED TO EMERGENCY CORE COOLING SYSTEMS (ECCS) STRAINER PERFORMANCE AT BOILING WATER REACTORS". This NRC letter notes that "Large-scale jet impact testing, such as that conducted by Swedish utilities at the Siemens - KWU facilities in Karlstein, Germany in 1994-95, has clearly demonstrated that saturated water jets are far less destructive than steam jets. This suggests that single-phase air jet tests would be conservative relative to two-phase saturated water tests (e.g., similar to steam)."

The NRC should consider taking this opportunity in revising the SER ZOIs to account for target scaling to also revise upwards all the damage pressures listed in the proposed revision to the SER ZOIs to account for the different failure mechanism in the OPG Cal-Sil that formed a large portion of the basis for reduction in the damage pressures and take in to consideration the staff's recent statement that "suggests that single-phase air jet tests would be conservative relative to two-phase saturated water tests".

6. The draft revision to the SER has additional selective application of the scaling algorithm to other materials (e.g. Koolphen-K) in contradiction to the recommendations of the URG and its associated SER. The NRC should either determine that the scaling algorithm is appropriate and apply it to all jacketed/banded insulation systems or determine that the scaling algorithm is flawed and should not be used. To selectively impose the scaling algorithm on certain types of insulation systems while dismissing it for others in not technically justifiable.

7. What is the basis for concluding that a 4D ZOI is appropriate for Transco RMI with Aluminum foils? To be consistent with the revised guidance for Nukon with Sure Hold Bands, shouldn't this ZOI size be based on the target diameter using the URG scaling equation rather than a specific ZOI size?

8. If it is necessary to consider the partial destruction of Aluminum RMI beyond the RMI ZOI due to the potential contribution to chemical effects, shouldn't it also be necessary to consider partial destruction of fiberglass blankets and other insulation materials outside of the ZOI since additional debris in the containment pool will also affect the chemical debris load? Selective application of the concept of partially destroyed insulation systems is not technically justifiable and could lead to non-conservative conclusions.

9. Pages 3 and 4 of the NRC letter states that the staff considers 4D to be an acceptable ZOI for epoxy coatings with reference to acceptable test reports. In the revised Table 3-2, however, the SER simply provides the 4D ZOI as an acceptable ZOI without any requirement for licensees to reference the test report directly. Please clarify whether it is acceptable for licensees to reference the SER for the appropriate ZOI size for epoxy coatings and the various insulation types, or whether the NRC expects licensees to reference the original test documents.

10. Page 4 of the NRC letter states that Nukon with Sure Hold Bands should be considered to be 100% small fines. For licensees performing refined analyses, does the staff expect plants to assume that the small fines will be treated as fine debris, or is it appropriate to use a refined size distribution consisting of both fines and small pieces similar to what many licensees have done with other fiberglass debris?

11. Draft SER Table 3-2, Footnote 3 concerning Sure-Hold bands states that the equation should be used for scaling down the destruction pressure for pipes with a larger diameter. As noted previously, in the URG, the equation was provided for use in scaling the destruction pressures down for larger diameter pipes and up for smaller diameter pipes. If this scaling equation is

valid, shouldn't it be equally appropriate to scale up the destruction pressure for Nukon with Sure Hold Bands on smaller diameter pipes?

12. The equation in Footnote 3 mentioned above, is defined in both the URG and the SER to NEI 04-07 as:

$$P_{dest}\,(D) = P_{dest}\,(12'') \times R\,(12'')\,/\,R\,(D)$$

Where: P_{dest} (D) = Destruction pressure for target material installed on a pipe of diameter D
P_{dest} (12″) = Destruction pressure for target material installed on a pipe of 12-inch nominal diameter

Note that this equation includes the insulation thickness in addition to the pipe diameter. However, in the SER to the URG, the equation was interpreted to be:

$$P_{dest}\,(D) = P_{dest}\,(12'') \times 12''\,/\,D$$

This form of the equation does not take into consideration the insulation thickness, and results in a larger scaling factor. Please clarify which form of the equation should be used, and whether the original NRC acceptance of the equation (in the SER to the URG) would have changed if the equation had been interpreted as originally written.

13. On Page 30a of the draft SER revision, the staff states:
"In applying the ZOI and destruction pressure values from Table 3-2, care should be taken to ensure that plant insulation installations to which these values are applied are at least as robust as the configuration that was tested. This guidance applies not only to the physical properties of the insulation or other target material (e.g., base material, jacketing, bands, latches, etc.), but also to the particular means of installation and attachment of jacketed insulations (e.g., ensuring
band and jacket stresses for the installed configuration are bounded by testing, ensuring that more-limiting failure modes would not occur due to configuration or orientation differences, etc.). Scaling from the test condition to the plant condition should be applied where appropriate and justified. Specifically, as noted in Table 3-2 for certain types of insulation where excess band or latch stress was observed to be the failure mode, the reference destruction pressure should be scaled according to pipe diameter for insulation installed on larger plant pipe sizes. A reference that describes the testing that supports each of the values in Table 3-2 is provided in the final column of the table."

How much rigor is the NRC staff expecting licensees to apply when analyzing whether a specific ZOI size is applicable to their insulation configuration? When performing their debris generation analyses, most licensees simply used the ZOI size corresponding to their insulation type without a detailed review of the band spacing, jacket strength, and other factors in the test configuration compared to the plant configuration. In many cases, these details may not be fully reported in the test reports or readily available for all of the insulation installed at the plants. Does the NRC expect licensees who have not performed this comparison to reevaluate the ZOI used for each insulation type, even if their analysis has been previously accepted by the NRC?

14. On Page 4 of the draft guidance for installing Sure Hold Bands, the staff states: "'Sure-Hold' bands, fasteners, and associated components were designed and tested to support installation on piping insulation. The staff would not consider it acceptable for licensees to apply destruction pressure values approved for 'Sure-Hold' bands on piping to insulation installed on non-piping components such as steam generators, pressurizers, reactor coolant pumps, etc." For the CEESI air jet destruction testing as well as the OPG two phase jet destruction testing, all insulation materials were tested in a configuration consistent with insulation installed on piping. However, the destruction pressures and corresponding ZOI sizes determined from this testing have been widely used by licensees for insulation destruction on both piping and non-piping components including fiberglass and RMI on steam generators, pressurizers, and reactor coolant pumps. The NRC staff has frequently accepted the use of the pipe based ZOI sizes for large equipment without requiring additional testing or analysis. Since the testing for Nukon with Sure Hold Bands was conducted at CEESI in the same manner as the other Nukon and RMI tests, what is the staff's basis for not considering it acceptable to apply the ZOI for Nukon with Sure Hold Bands to non-piping components? Is the staff reconsidering their acceptance of using other ZOIs for non-piping components?

15. The basis for the proposed 4D ZOI for Transco RMI with aluminum foils is not specified.

16. What is the proposed applicability of any revised SE to current applications that have used NEI 04-07? Has an evaluation of backfit implications been performed and will the results of this evaluation be made publicly available?

17. Table 3-2, the ZOI entry for Protective Coatings should be listed as "4.0" not "4D", in order to be consistent with the rest of the table.

18. Cover letter page 2, last full paragraph states;

    The NRC staff determined that sufficient conservatism did not exist in the ZOI values for "Sure-Hold" banded insulations to allow the NRC staff to disregard applying the scaling equation to these insulations. The quantity of damaged fiberglass that could be generated when a scaled up ZOI is considered is potentially greater than fibrous debris quantity computed using the existing ZOI. For example, after accounting for this scaling, the quantity of small fines generated during the "Sure-Hold"-banded air jet tests of jacketed Nukon would potentially result in more small fine debris than assuming 60 percent small fines per the baseline assumption in NEI 04-07 for the existing ZOI. In addition, given the observations of fibrous insulation testing without "Sure-Hold" bands as referenced in Appendix II of the SE, the staff determined that failure of the bands at some point as the target moves closer to *the jet would likely result in the fibrous insulation being fragmented into predominantly fine debris. Lastly, due to the 8-ft length of the jacketed Nukon targets secured with "Sure-Hold" bands relative to the nozzle diameter of 3 inches, at the distances tested, the outer regions of the target would not have been exposed to the full jet centerline pressure. This may have resulted in an underestimation of the potential for debris generation when using "Sure-Hold" bands.*

Comment: The highlighted sections in the paragraph above indicate supposition. Is there a technical basis for predicting a higher quantity of fine debris?

19. Cover letter page 4, 1st full paragraph states:–

The NRC staff further plans to revise Table 3-3 of the SE to specify a debris size distribution for jacketed Nukon with "Sure-Hold" bands that is consistent with the analysis presented in Appendix II to the SE. Appendix II documents that the staff's acceptance of the baseline size distribution of 60% small pieces and 40% large pieces for Nukon fiber blankets was based on a ZOI size of 17D. As demonstrated in Figure II-2 from this appendix, the degree of insulation fragmentation is not constant with jet pressure, but increases as the jet pressure impacting the target is increased, approaching 100% fragmentation into small fines at impingement pressures of approximately 20 psig. Although jacketing secured with "Sure-Hold" bands would provide the underlying Nukon fiberglass greater protection than was afforded the targets in the tests shown in Figure II-2, much larger impingement pressures ranging from greater than 20 psig potentially up to the reactor coolant system pressure for targets near the break opening would be experienced. Air jet testing of jacketed Nukon secured with "Sure-Hold" bands did not result in the failure of the jacketing system; however, based on the dimensional scaling of the jet nozzle to the target, the target would not have been fully impacted by the peak jet centerline pressure. Furthermore, the jet centerline pressures tested were intended to establish the threshold of destruction and are not sufficient to characterize the resulting debris size distribution within the ZOI. Therefore, the NRC staff is planning to revise Table 3-3 of the SE to indicate that jacketed Nukon with "Sure-Hold" bands destroyed within a ZOI should be considered to be 100% small fines.

Comment: What is the basis or source of the statement highlighted above? The basis for this statement could not be found within the CEESI testing report.

The referenced Figure II-2 describes NUKON, Transco and Knauf. The NUKON product is not 100% destroyed to small fines at 20 psig. The curve shown is a best-fit curve for all manufacturers' data. If you are describing using Sure Hold Bands and it can only be used for NUKON, then only the data for NUKON should be considered. Looking at the CEESI test data, the worst case reported for NUKON was 60% fines at 17 psig. In fact, testing at pressures higher than 20 psig yielded less than 10% fines and at 190 psig 25% fines. From reading this it appears other manufacturers data is being used to describe NUKON because it shows worse jet impingement destruction and it subsequently supports elimination of fibrous insulation.

20. Guidance for Installation: Page 4, 4th bullet – *"An axial overlap of at least 2 inches should be maintained between adjacent segments of jacketing. A "Sure-Hold" band should be centered on the overlap between adjacent segments of jacketing"*.

    Comment - The standard NUKON Jacket that is installed at all of the plants has a one-inch longitudinal overlap and that is what was tested with the "Sure-Hold" Bands. What is the basis, or test report, that supports a 2 inch axial offset?

21. Guidance for Installation document: Page 4, 5th bullet – "*A circumferential overlap of at least 2 inches should be maintained along radial seams of the jacketing."*

    Comment - This is the standard instruction for NUKON; does this mean every joint must be inspected for the overlap?

    These two bulleted items may be essentially trying to say the same thing. One statement is regarding the two-inch overlap between adjacent segments covered with a Sure-Hold band the second then stating a circumferential overlap of two inches along radial seams. The two bulleted statements could be read as one and the same regarding the overlap. Is it the NRC's intent to dictate an overlap for the longitudinal seam that runs the jacket length but have failed to adequately describe their meaning?