CALLAWAY
REQUEST FOR ADDITIONAL INFORMATION
SUPPLEMENTAL RESPONSES TO GENERIC LETTER (GL) 2004-02
DATED 02/29/2008

1. Please provide information that verifies that the break selection process was completed considering the reduced zones of influence (ZOIs) based on WCAP-16710-P, or that the originally selected breaks remain bounding from a debris generation perspective after reducing the ZOIs for Min-K and jacketed Nukon.

2. Please explain whether secondary breaks (main steam or feedwater) could require recirculation to supply containment spray. If one or more secondary breaks require recirculation for containment spray, provide information that shows whether the analysis for any loss-of-coolant accident (LOCA) bounds the secondary break(s). If secondary breaks are not bounded by LOCA analyses, please address the impact of such breaks on ECCS strainer performance, including the method used to determine the limiting MSLB location.

3. Considering that the Callaway debris generation analysis diverged from the approved guidance in NEI 04-07, please provide details on the testing conducted that justified the ZOI reductions for encapsulated Min-K and the jacketed Nukon. The information should include the jacket materials used in the testing, geometries and sizes of the targets and jet nozzle, and materials used for jackets installed in the plant. Provide information that compares the mechanical configuration and sizes of the test targets and jets, and the potential targets and two-phase jets in the plant. Evaluate how any differences in jet/target sizing and jet impingement angle affect the ability of potentially impacted insulation to resist damage from jet impingement. State whether the testing in WCAP-16710-P was bounding for the Callaway insulation systems. If not, provide information that compares the Callaway encapsulation and jacketing systems structure with the system that was used in the testing, showing that the testing conservatively or prototypically bounded potential damage to the insulation materials.

4. The supplemental response showed that the Callaway debris generation/ZOI analysis contained three size categories of fibrous insulation debris: small fines, large pieces and intact. However, as stated in the staff's safety evaluation on NEI 04-07, in order to conduct adequate transport analysis and head loss testing, the small fines should be further broken down into fines (suspended fibers) and small pieces (less than four inches on a side). Using this categorization system (or justifying a different categorization), please provide additional information on the amounts of fibrous debris predicted to be generated from various breaks. Note that reduced ZOIs generally result in increased percentages of small and fine debris.

5. The supplemental response (pg 12 of 81) stated that the Min-K at Callaway is located near the reactor vessel. This raises the question as to whether spherical resizing was done and whether it is appropriate for this location. The staff's audit report for San Onofre discusses a potentially similar issue (Open Item 1 in Section 3.2, ADAMS Accession No. ML071240024) regarding Microtherm insulation that was located on the reactor vessel, for which spherical resizing was considered inappropriate by the staff due to the constraints imposed by the biological shield wall and reactor vessel. Please state whether a spherical ZOI was assumed in this region for which substantial physical

obstructions could result in a significantly non-spherical destruction zone, and, if applicable, provide a technical basis for the use of a spherical ZOI.

6. The WCAP-16710-P ZOI reduction for jacketed Nukon insulation was also taken for Thermal Wrap at Callaway. Please provide information on the jacketing, banding and/or latching, and cloth cover for the Thermal Wrap insulation to provide confidence that it is comparable to the jacketing system for the Nukon insulation system that was tested.

7. The staff has concerns that the size of the nozzle being used for the NUKON destruction testing at Wyle Laboratories may have resulted in non-conservatively exposing only a limited area of the target material to the peak jet pressure, particularly for the tests conducted at the smaller ZOI radii. Since a LOCA jet could be much larger than 3 inches in diameter, the testing may not be representative of an actual LOCA at close ranges where the pressures of the smaller-diameter jet used for the testing would decay significantly more rapidly in the radial direction. This potential non-prototypicality from the debris generation testing affects not only the determination of ZOI size, but also the determination of the size distribution of the debris formed within that ZOI. Appendix II to the safety evaluation on NEI 04-07 indicates that essentially all low-density fiberglass within 7 pipe diameters (7D) of a pipe rupture would become small fines. However, based on the potentially non-conservative NUKON destruction testing performed at Wyle Laboratories discussed above, for Callaway only 60% small fines were assumed to be generated within 5D of a LOCA jet, and 100% intact pieces were assumed to be generated between 5D and 7D of a LOCA jet. Please provide additional information to justify why the quantity of small fines debris assumed for Callaway is conservative or prototypical.

8. The staff's safety evaluation (SE) for NEI 04-07 stated that a maximum of 15% holdup of debris should be assumed in inactive holdup regions during pool fill up. For the case of single-train sump operation for Callaway, a two-sump plant, the sump that is not operating essentially becomes an inactive holdup region. From this point of view, the staff observed that Callaway appeared to credit a 15% inactive holdup volume in the containment pool, plus 14% holdup in the inactive recirculation sump for single-train cases, for a total of 29% of debris held up in inactive volumes for these single-train cases (e.g., the Loop D cross-over break). The staff considers this credit a deviation from the approved guidance in the SE, which stated that the limit for inactive hold up should be 15% unless a computational fluid dynamics (CFD) analysis was performed that considered the time-dependent containment pool flows during pool fill up. Please provide additional basis for the assumed total inactive holdup fraction of 29% or revise this value to within the accepted SE range.

9. The supplemental response discusses Stokes' Law, but does not specifically quantify the credit taken for application of this methodology. Please state the quantities of fine debris assumed to settle onto the containment floor by applying the Stokes' Law methodology. If credit is taken for such settling, technical justification is needed regarding the following points: (1) (lack of) experimental benchmarking of analytically derived TKE (turbulent kinetic energy) metrics; (2) uncertainties in the predictive capabilities of TKE models in CFD codes, particularly at the low TKE levels necessary to suspend individual fibers and 10-micron particulate; (3) the basis for analytical prediction of settling velocities in quiescent water due to the specification of shape factors and drag coefficients for irregularly shaped debris; and (4) the basis for theoretical correlation of the terminal settling velocity to turbulent kinetic energy that underlies the Alion

methodology for fine debris settling. Please address these points to demonstrate that the credit taken for fine debris settling is technically justified.

10. Please identify the source of the erosion testing used to justify 10% erosion of fiberglass in the containment pool for Callaway and specify the velocity, turbulence and chemical conditions for which the testing is applicable, and the velocity, turbulence and chemical conditions present in the Callaway containment pool.

11. The licensee's submittal indicated that their analyses and/or testing were substantially incomplete in the head loss and vortexing area. The staff will review the remaining information when the licensee submits it, and as a result of such review the staff could request additional information in this subject area. Among items that should be addressed are:

    a. At the beginning of recirculation for a small-break LOCA, the strainer stacks are not submerged by about six inches. This condition should be evaluated for vortexing, air ingestion, and failure of the strainer to pass adequate flow.

    b. The PCI clean strainer head loss calculation is founded on a correlation based on prototype BWR strainer testing. The BWR strainers have a significantly different geometry than PWR strainers. The staff has stated that the applicability of the BWR prototype correlation to PWR strainers has not been shown to be valid.

    c. The Callaway strainer testing was witnessed by the staff. The staff observed that significant agglomeration of debris occurred during testing. The staff also noted that the amount of fine debris predicted to reach the strainer was extremely low compared to other plant evaluations that used test methods the staff has found to be generally acceptable. Because the testing was designed to credit near-field settling, these issues could have significantly affected the results of the testing in a non-conservative manner. It was noted in the debris characteristics section of the supplemental response that the small debris contained about 30% fines. However, if the fines were not separated from the smalls prior to addition, it is likely that they would become entangled or agglomerated with the larger debris. This would reduce fine debris transport and the ability of the fibrous debris to create a thin bed. In fact, in PCI testing witnessed by the staff after the Callaway testing, high head losses occurred with the addition of only particulate and fine fibrous debris.

    d. The supplemental response states that no containment accident pressure is credited with regard to head loss, vortexing, air ingestion, or void fraction determination. Considering the small strainer submergence for a large-break LOCA (relative to the head loss across the strainer screen) and lack of submergence for a small-break LOCA, it is not clear to the staff what pressure prevents flashing across the debris bed and strainer.

12. The licensee's submittal indicated that its analyses and/or testing were substantially incomplete in the net positive suction head (NPSH) area. The staff will review the remaining information when the licensee submits it, and as a result of such review the staff could request additional information in this subject area. Among items that should be addressed are:

a. the completed NPSH analyses with the quantitative results for the NPSH margins,

b. both cold-leg and hot-leg recirculation scenario NPSH margins for all pumps taking suction from the recirculation sump,

c. the NPSH margin values for the small- and large-break LOCAs,

d. the pump vendor's criteria for determining the NPSH required (NPSHr) data for the pumps taking suction from the recirculation sump,

e. the specific methodology used for computing friction head loss in suction piping, and

f. a summary of the single failure analysis for the NPSH calculation (single failure scenarios considered should be identified, and NPSH margin results should be presented).

13. For degraded qualified coatings, the Keeler and Long Report and industry testing are cited as justification of epoxy chip sizes. The NRC Revised Content Guide has accepted use of the Keeler and Long Report, which results in smaller chip sizes than those described in table 3h-2. Please provide justification for using chips larger than those determined in the Keeler and Long report. In addition, please summarize methods and results of the industry testing reference used to determine the size distribution of degraded qualified coatings.

14. Please describe how the quantity of curled chips is determined. In addition, please justify the simplification of the size distribution of the curled chips to a 1.5 inch chip size.

15. Please clarify the weight distribution of coating debris surrogates used in head loss testing. Please explain whether it is consistent with table 3h-2 in the submittal. If so, please explain the basis for the distribution in table 3h-2.

16. Please provide the quantities of each type of coatings surrogate material used in head loss testing.

17. The licensee's submittal indicated that their analyses and/or testing were substantially incomplete in the downstream effects, components and systems, fuel and vessel area. The staff will review the remaining information when the licensee submits it, and as a result of such review the staff could request additional information in this subject area. When submitted, please provide the information requested under item (n) in the Revised Content Guide for Generic Letter 2004-02 Supplemental Response dated November 2007. The NRC staff considers in-vessel downstream effects to be not fully addressed at Callaway as well as at other PWRs. The Callaway GL 2004-02 submittal refers to draft WCAP-16793-NP, "Evaluation of Long-Term Cooling Considering Particulate, Fibrous, and Chemical Debris in the Recirculating Fluid." The NRC staff has not issued a final safety evaluation (SE) for WCAP-16793-NP. The licensee may demonstrate that in-vessel downstream effects issues are resolved for Callaway by showing that the licensee's plant conditions are bounded by the final WCAP-16793-NP and the corresponding final NRC staff SE,

and by addressing the conditions and limitations in the final SE. The licensee may also resolve this item by demonstrating without reference to WCAP-16793 or the staff SE that in-vessel downstream effects have been addressed at Callaway.

18. Please provide the basis that demonstrates that chemicals leaching from insulations and other containment materials that are sprayed but not submerged (i.e., located above the flood plane following a LOCA) are not significant to chemical precipitate formation.

19. Please identify and justify the assumptions related to phosphate inhibition of aluminum corrosion. For example: (1) what is the threshold concentration of phosphate assumed to passivate aluminum? (2) what time is assumed to reach that phosphate concentration in the pool? and (3) if phosphate inhibition is credited for aluminum in the spray zone, what amount of containment spray time is assumed (after the pool reaches an inhibition threshold of phosphate) before the aluminum is passivated?