UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

December 23, 2009

Mr. Edward D. Halpin
President and Chief Executive Officer
STP Nuclear Operating Company
South Texas Project
P. O. Box 289
Wadsworth, TX 77483

SUBJECT: SOUTH TEXAS PROJECT, UNITS 1 AND 2 - RE: REQUEST FOR ADDITIONAL INFORMATION FOR GENERIC LETTER 2004-02, "POTENTIAL IMPACT OF DEBRIS BLOCKAGE ON EMERGENCY RECIRCULATION DURING DESIGN BASIS ACCIDENTS AT PRESURIZED-WATER REACTORS" (TAC NOS. MC4719 AND MC4720)

Dear Mr. Halpin:

By electronic mail dated July 16, 2009, to Mr. Wayne Harrison of your staff, the NRC staff forwarded a draft of the enclosed Nuclear Regulatory Commission (NRC) staff's request for additional information (RAI), regarding STP Nuclear Operating Company's (the licensee's) supplemental responses dated February 29 and December 11, 2008 (Agencywide Documents Access and Management System (ADAMS) Accession Nos. ML080700338 and ML083520326, respectively), for NRC Generic Letter 2004-02, "Potential Impact of Debris Blockage on Emergency Recirculation during Design Basis Accidents at Pressurized-Water Reactors."

The NRC staff requested that the licensee verify that the RAI contains no proprietary information or other concerns, so that we can issue the formal RAI without any unintended consequences or concerns. The NRC staff also stated that, if the licensee so wishes, it can request a phone call to clarify any RAI it does not understand or to inform us of any it believes it has already addressed on the docket, and in such a case, to provide specific pages and paragraph references of such information.

By electronic mail dated November 19, 2009, Mr. Jamie Paul of your staff responded to our request, stating that there was no proprietary information, your staff had no concerns in issuing the enclosed RAI, and no clarifications were needed.

Accordingly, the NRC staff is issuing the enclosed final RAI, which is essentially the draft RAI dated July 16, 2009, sent to Mr. Wayne Harrison by electronic mail. When the licensee is prepared to discuss the proposed path forward, NRC will schedule a public agenda-setting teleconference with the NRC staff. The teleconference duration may range from 4 to 6 hours.

The NRC staff will use the results of the above process to develop agenda for an issue resolution public meeting with the licensee.

Please keep me informed on progress on resolution of enclosed final RAI to facilitate scheduling the proposed public agenda-setting teleconference and issue resolution public meeting. If you have any questions, please contact me at (301) 415-1476 or at mohan.thadani@nrc.gov.

Sincerely,

Balwant K. Singal for

Mohan C. Thadani, Senior Project Manager
Plant Licensing Branch IV
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. 50-498 and 50-499

Enclosure:
As stated

cc w/encl: Distribution via Listserv

REQUEST FOR ADDITIONAL INFORMATION

SOUTH TEXAS PROJECT

SUPPLEMENTAL RESPONSES TO GENERIC LETTER (GL) 2004-02

DATED FEBRUARY 29 AND DECEMBER 11, 2008

DOCKET NOS. 50-498 AND 50-499

A. Debris Generation/Zone of Influence (ZOI)

Please respond to the following questions on debris generation testing. Note that the Pressurized-Water Reactor Owners Group (PWROG) is planning to respond to some of these issues generically. The licensee will be expected to respond to all of them. To the extent NRC staff accepts the PWROG's generic resolution, the licensee's request for additional information (RAI) responses may refer to the resolution document as appropriate, while adding site-specific information as needed.

1. Although American National Standards Institute (ANSI)/American Nuclear Society (ANS) standard 58-2-1988, "Design Basis for Protection of Light Water Nuclear Power Plants Against Effects of Postulated Pipe Rupture," predicts higher jet centerline stagnation pressures associated with higher levels of subcooling, it is not intuitive that this would necessarily correspond to a generally conservative debris generation result. Please justify the initial debris generation test temperature and pressure with respect to the plant-specific reactor coolant system (RCS) conditions, specifically the plant hot- and cold-leg operating conditions. If ZOI reductions are also being applied to lines connecting to the pressurizer, then please also discuss the temperature and pressure conditions in these lines. Please describe the results of any tests conducted at alternate temperatures and pressures to assess the variance in the destructiveness of the test jet to the initial test condition specifications.

2. Please describe the jacketing/insulation systems used in at South Texas Project (STP), Units 1 and 2, for which ZOI reduction is sought and compare those systems to the jacketing/insulation systems that were tested demonstrating that the tested jacketing/insulation system adequately represent the plant jacketing/insulation system. The description should include differences in the jacketing and banding systems used for piping and other components for which the test results are applied, potentially including steam generators, pressurizers, reactor coolant pumps, etc. At a minimum, the following areas should be addressed:

   a. Please describe how the characteristic failure dimensions of the tested jacketing/ insulation compared with the effective diameter of the jet at the axial placement of the target. The characteristic failure dimensions are based on the primary failure mechanisms of the jacketing system (e.g., for a stainless steel jacket held in place by three latches where all three latches must fail for the jacket to fail, then all three latches must be effectively impacted by the pressure for which the ZOI is calculated). Applying test results to a ZOI based on a centerline pressure for relatively low L/D nozzle to target spacing would be non-conservative with respect to impacting the entire target with the calculated pressure.

b. Please explain whether the insulation and jacketing system used in the testing was of the same general manufacture and manufacturing process as the insulation used in the plant. If not, please explain what steps were taken to ensure that the general strength of the insulation system tested was conservative with respect to the plant insulation. For example, it is known that there were generally two very different processes used to manufacture calcium silicate whereby one type readily dissolved in water but the other type dissolves much more slowly. Such manufacturing differences could also become apparent in debris generation testing, as well.

c. Please provide results of an evaluation of scaling the strength of the jacketing or encapsulation systems to the tests. For example, a latching system on a 30-inch pipe within a ZOI could be stressed much more than a latching system on a 10-inch pipe in a scaled ZOI test. If the latches used in the testing and the plants are the same, the latches in the testing could be significantly under-stressed. If a prototypically sized target were impacted by an undersized jet, it would similarly be under-stressed. Evaluations of banding, jacketing, rivets, screws, etc., should be made. For example, scaling the strength of the jacketing was discussed in the Ontario Power Generation report, "Jet Impact Tests – Preliminary Results and Their Application, N-REP-34320-10000," dated April 18, 2001 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML020290085), on calcium silicate debris generation testing.

3. There are relatively large uncertainties associated with calculating jet stagnation pressures and ZOIs for both the test and the plant conditions based on the models used in the WCAP reports. Please describe the steps taken to ensure that the calculations resulted in conservative estimates of these values. Please provide the inputs for these calculations and describe the sources of the inputs.

4. Please describe the procedure and assumptions for using the ANSI/ANS-58-2-1988 standard to calculate the test jet stagnation pressures at specific locations downrange from the test nozzle. As part of this description, please address the following points.

a. In WCAP-16710-P, "Jet Impingement Testing to Determine the Zone of Influence (ZOI) of Min-K and NUKON Insulation, for Wolf Creek and Callaway Nuclear Operating Plants," please explain why the analysis was based on the initial condition of 530 degrees Fahrenheit (°F) whereas the initial test temperature was specified as 550 °F.

b. Please explain whether the water subcooling used in the analysis was that of the initial tank temperature or the temperature of the water in the pipe next to the rupture disk. Test data indicated that the water in the piping had cooled below that of the test tank.

c. The break mass flow rate is a key input to the ANSI/ANS-58-2-1988 standard. Please explain how the associated debris generation test mass flow rate was determined. If the experimental volumetric flow was used, then explain how the mass flow was calculated from the volumetric flow given the considerations of potential two-phase flow and temperature-dependent water and vapor densities. If the mass flow was analytically determined, then describe the analytical method used to calculate the mass flow rate.

d. Noting the extremely rapid decrease in nozzle pressure and flow rate illustrated in the test plots in the first tenths of a second, please explain how the transient behavior was considered in the application of the ANSI/ANS-58-2-1988 standard. Specifically, please explain whether the inputs to the standard represented the initial conditions or the conditions after the first extremely rapid transient (e.g., say at one tenth of a second).

e. Given the extreme initial transient behavior of the jet, please justify the use of the steady-state ANSI/ANS-58-2-1988 standard jet expansion model to determine the jet centerline stagnation pressures rather than experimentally measuring the pressures.

5. Please describe the procedure used to calculate the isobar volumes used in determining the equivalent spherical ZOI radii using the ANSI/ANS-58-2-1988 standard. Please include discussions of the following points.

    a. Please provide the assumed plant-specific RCS temperatures and pressures and break sizes used in the calculation. Please note that the isobar volumes would be different for a hot-leg break than for a cold-leg break since the degree of subcooling is a direct input to the ANSI/ANS-58-2-1988 standard and which affects the diameter of the jet. Also, please note that an under-calculated isobar volume would result in an under-calculated ZOI radius.

    b. Please describe the calculational method used to estimate the plant-specific and break-specific mass flow rate for the postulated plant loss-of-coolant accident (LOCA), which was used as input to the standard for calculating isobar volumes.

    c. Given that the degree of subcooling is an input parameter to the ANSI/ANS-58-2-1988 standard and that this parameter affects the pressure isobar volumes, please describe the steps taken to ensure that the isobar volumes conservatively match the plant-specific postulated LOCA degree of subcooling for the plant debris generation break selections. Please explain whether multiple break conditions were calculated to ensure a conservative specification of the ZOI radii.

6. Please provide a detailed description of the test apparatus, specifically including the piping from the pressurized test tank to the exit nozzle including the rupture disk system. Please also address the following related points:

a. Based on the temperature traces in the test reports, it is apparent that the fluid near the nozzle was colder than the bulk test temperature. Please explain how the fact that the fluid near the nozzle was colder than the bulk fluid was accounted for in the evaluations.

b. Please explain how the hydraulic resistance of the test piping which affected the test flow characteristics was evaluated with respect to a postulated plant-specific LOCA break flow, where such piping flow resistance would not be present.

c. Please provide the specified rupture differential pressure of the rupture disks.

7. WCAP-16710-P discusses the shock wave resulting from the instantaneous rupture of piping. Please address the following points regarding the shock wave:

   a. Please describe results of analysis or parametric testing conducted to get an idea of the sensitivity of the potential to form a shock wave at different thermal-hydraulic conditions. Please state and justify whether temperatures and pressures prototypical of PWR hot legs were considered.

   b. Please explain whether the initial lower temperature of the fluid near the test nozzle was taken into consideration in the evaluation, and if not, why not. Specifically, please explain and justify whether the damage potential was assessed as a function of the degree of subcooling in the test initial conditions.

   c. Please provide the basis for scaling a shock wave from the reduced-scale nozzle opening area tested to the break opening area for a limiting rupture in the actual plant piping.

   d. Please compare how the effect of a shock wave was scaled with distance for both the test nozzle, and compare that with the expected plant condition.

8. Please provide the basis for concluding that a jet impact on piping insulation with a 45-degree seam orientation is a limiting condition for the destruction of insulation installed on steam generators, pressurizers, reactor coolant pumps, and other non-piping components in the containment. For instance, considering a break near the steam generator nozzle, once insulation panels on the steam generator directly adjacent to the break are destroyed, the LOCA jet could impact additional insulation panels on the steam generator from an exposed end, potentially causing damage at significantly larger distances than for the insulation configuration on piping that was tested. Furthermore, it is not clear that the banding and latching mechanisms of the insulation panels on a steam generator or other RCS components provide the same measure of protection against a LOCA jet as those of the piping insulation that was tested. Although WCAP-16710-P asserts that a jet at Wolf Creek or Callaway cannot directly impact the steam generator, but will flow parallel to it, it seems that some damage to the steam generator insulation could occur near the break, with the parallel flow then jetting under the surviving insulation, perhaps to a much greater extent than predicted by the testing. Similar damage could occur to other component insulation. Please provide a technical basis to demonstrate that the test results for piping insulation are prototypical or

conservative of the degree of damage that would occur to insulation on steam generators and other non-piping components in the containment.

9. Some piping oriented axially with respect to the break location (including the ruptured pipe itself) could have insulation stripped off near the break. Once this insulation is stripped away, succeeding segments of insulation would have one open end exposed directly to the LOCA jet, which appears to be a more vulnerable configuration than the configuration tested by Westinghouse. As a result, damage would seemingly be capable of propagating along an axially-oriented pipe significantly beyond the distances calculated by Westinghouse. Please provide a technical basis to demonstrate that the reduced ZOIs calculated for the piping configuration tested are prototypical or conservative with respect to the degree of damage that could occur to insulation on piping lines oriented axially with respect to the break location.

10. WCAP-16710-P noted damage to the cloth blankets that cover the fiberglass insulation, in some cases resulting in the release of fiberglass. The tears in the cloth covering were attributed to the steel jacket or the test fixture and not the steam/water jet. Please justify the assumption that damage that occurs to the target during the test would not be likely to occur in the plant. Please explain whether the potential for damage to plant insulation from similar conditions was considered. For example, the test fixture could represent a piping component or support, or other nearby structural member. The insulation jacketing is obviously representative of itself. Please provide the basis for the statement in the WCAP that damage similar to that which occurred to the end pieces would not be expected to occur in the plant. It is likely that a break in the plant will result in a much more chaotic condition than that which occurred in testing. Therefore, it would be more likely for the insulation to be damaged by either the jacketing or other objects nearby.

11. Please provide information that justifies that the Marinite® insulation is protected by the plate such that damage outside of 2D is not expected. Please provide information on the failure mode of the insulation and describe whether it is destroyed by the LOCA jet or whether it can be crushed by piping following a break. Alternately, please provide information that shows that all Marinite® that is installed in the general vicinity of the break is considered to be rendered into debris by the transient.

B. Debris Characteristics

12. The analysis assumption of 60 percent small fines and 40 percent large pieces for low-density fiberglass within a 5D ZOI is inconsistent with the Figure II-2 of NRC staff's safety evaluation (SE), dated December 6, 2004 (ADAMS Accession No. ML043280641), on NEI 04-07, which considers past air jet testing and indicates that the fraction of small fines should be assumed to reach 100 percent at jet pressures in the vicinity of 18-19 pounds per square inch (psi). At 5D, the jet pressure is close to 30 psi, which significantly exceeds this threshold. Furthermore, the licensee's assumption that the size distribution for debris in a range of 5D to 7D is 100 percent intact blankets also appears not to be inconsistent with existing destruction testing data. These assumptions for low-density fiberglass debris size distributions appear to be based on the recent Westinghouse/Wyle ZOI testing discussed in WCAP-16710-P. However, that testing was not designed to provide size distribution information. Furthermore, given the

assumption that insulation between 5D and 7D is 100 percent intact pieces that do not transport or erode, the licensee has effectively assumed a 5D ZOI rather than a 7D ZOI for low-density fiberglass. Also, it appears from the testing done by Westinghouse/Wyle for Arkansas Nuclear One (Entergy Operations, Inc. letter dated February 28, 2008, ADAMS Accession No. ML080710544), some damage was seen for Thermal Wrap even at 12D and at 7D. Considering that testing, please explain STP's treatment of Thermal Wrap with a 5D ZOI. Please describe the details of the jacketing and banding that support the same ZOI for both Nukon and Thermal Wrap for STP that is based on the Wolf Creek/Callaway testing. Please provide a detailed summary of the testing that was done, the similarity analysis for the insulation design, and a basis for the testing or other source of the debris distribution percentages that were assumed and why it is representative of the plant condition.

13. Please clarify what percentage of the small fines distribution represents fines and what percentage represents small pieces, and how the split between fines and small pieces was determined when preparing debris for head loss testing. This information is needed because the distribution of debris between the fine and small piece size categories has a significant impact on the measured strainer head loss, particularly for a strainer test that credits debris settlement.

C. Debris Transport

14. The December 11, 2008, supplemental response states on page 14 that 5 percent of small pieces of fiber are assumed to be trapped on wetted surfaces in congested areas due to changes in flow direction during blowdown. Please clarify whether this assumption is still part of the analysis, given that STP is now assuming a three-category size distribution for low-density fiberglass. If so, then please justify any assumption regarding this debris remaining trapped against a wetted vertical surface for any significant period of time.

15. The December 11, 2008, supplemental response states on page 16 that one refinement to the 2004 NRC SE in the transport calculation for STP was that holdup of small pieces of fiberglass was assumed at each level of grating that washdown flow passed through. In addition, zero percent washdown of large pieces of fiberglass was assumed. Please provide the following additional information as a basis for these assumptions:

    a. Please describe the extent and continuity of the grating below the limiting break locations, and provide the percentage of the cross-sectional area below these breaks where grating is installed.

    b. Please provide adequate basis to justify that 40 to 50 percent of small pieces of debris will be held up on grating. Although results from the Drywell Debris Transport Study (DDTS) were cited in the supplemental response, based on the 30-minute duration of the cited tests, the DDTS recommendation was that no retention credit should be allowed for debris fragments that are smaller than openings in floor grating. Based on the information provided in the supplemental response, the NRC staff notes that the duration of spray operation at STP is not certain but could be significantly longer than 30 minutes (e.g., hours or days).

Furthermore, the staff also notes that a fraction of the debris held up on gratings could be exposed to concentrated streams of run-off flow (as opposed to fine spray droplets), which could further increase the tendency for erosion and washdown beyond what was observed in the DDTS results for the spray cases.

c. Please state whether and how the assumptions concerning capture of small pieces of fiberglass on gratings during washdown are currently credited in the STP transport analysis that consider a three-category size distribution for low-density fiberglass debris.

16. The December 11, 2008, supplemental response states on page 8 that a three-category size distribution is used for low-density fiberglass debris including small fines, large pieces and intact blankets. However, the discussion of debris transport refers in a number of places to small pieces of fiberglass (e.g., page 14, page 16, table 14, etc.). Please clarify whether these statements have been updated to reflect the revised debris size distribution on page 8.

17. Please provide the basis for considering a transport case with two sumps operating as the limiting condition for debris transport. Although debris would be distributed to an extra strainer, the staff observed that a design-basis case with three sumps operating would likely experience increased debris transport to the strainers in the analysis, and also in the head loss testing that credited substantial debris settlement using a flow rate based on the operation of two sumps. The increased debris transport associated with this condition may be more significant than the offsetting potential for additional debris sharing with a third strainer.

18. Please provide a description of any testing performed to support the assumption of 10 percent erosion of fibrous debris pieces in the containment pool. Please specifically include the following information:

a. Please describe the test facility used and demonstrate the similarity of the flow conditions (velocity and turbulence), chemical conditions, and fibrous material present in the erosion tests to the analogous conditions applicable to the plant condition.

b. Please provide specific justification for any erosion tests conducted at a minimum tumbling velocity if debris settling was credited in the test flume for velocities in excess of this value.

c. Please identify the length of the erosion tests and how the results were extrapolated to the sump mission time.

19. The supplemental response, dated December 11, 2008, indicates that a significant percentage of small fines of low-density fiberglass were assumed to transport to the strainers (i.e., 95 percent). In addition, no large debris pieces were assumed to enter the containment pool. These analytical assumptions minimized the quantity of settled small and large pieces of fiberglass that were analytically assumed to erode in the containment pool. However, for the strainer head loss testing conducted by

Performance Contracting, Inc. (PCI), the NRC staff considers it likely that a significant fraction of small pieces that were analytically considered transportable actually settled in the test flume, rather than transporting to the test strainer. The head loss testing did not model the erosion of this debris. The licensee's consideration of debris erosion, therefore, appears to be non-conservative, because neither the analysis nor the head loss testing accounted for the erosion of debris that settled during the head loss testing. Please estimate the quantity of eroded fines from small pieces of fiberglass debris that would result had erosion of the settled debris in the head loss test flume been accounted for and justify the neglect of this material in the head loss testing program.

20. For a number of cases, the supplemental response stated that 17 percent of the latent debris was assumed to be captured in inactive holdup volumes in containment (i.e., inactive cavities and the inactive sump). For an additional case (i.e., Case 2), a similar treatment was applied to Marinite® and coatings debris. The NRC staff's SE on NEI 04-07 recommended that no more than 15 percent holdup in inactive volumes be assumed unless a pool-fill transport analysis was performed similar to the staff's sample calculation in Appendix IV to the SE. Please provide adequate justification for the assumption concerning the holdup of latent debris in inactive sump pool volumes.

21. Please provide the technical basis for concluding that no large debris pieces will be blown into upper containment. Please include a description of the extent and continuity of the grating above the limiting break locations, and provide a fraction of the cross-sectional area above these breaks where grating is installed.

22. Please provide additional information concerning the following debris transport assumptions regarding failed coatings debris:

    a. A basis for the zero percent transport fraction for epoxy coating debris inside the reactor cavity for breaks that do not occur within the reactor cavity.

    b. A description of the methodology for determining the transport fraction for failed epoxy coatings outside the reactor cavity, for which transport percentages from 41 to 48 percent were calculated for various scenarios.

23. No transport of small or large pieces of debris was assumed to occur during the pool fill phase of the event, but justification for this assumption was not provided. The NRC staff expects that velocities in some parts of typical containment pools could well exceed the transport metric for debris in these categories during the pool-fill phase of transport. Flow conditions during the pool-fill phase of the LOCA were not considered by the testing, nor was the potential for some types of debris to enter a non-quiescent containment pool closer than 45 feet from the strainer due to the effects of blowdown, washdown, and pool-fill transport. The lack of modeling of these transport aspects of the head loss testing appeared to result in a non-prototypical reduction in the quantity of debris reaching the test strainer. Please provide the technical basis for not explicitly modeling transport modes other than recirculation transport, considering the following points:

a. As shown in Appendix III of the NRC staff's SE on NEI 04-07, containment pool velocity and turbulence values during fill up may exceed those during recirculation, due to the shallowness of the pool.

b. The pool-fill phase will tend to move debris from inside the secondary shield wall into the outer annulus away from the break location and nearer to the recirculation sump strainers.

c. Representatively modeling the washdown of some fraction of the debris nearer the strainer than 45 feet would be expected to increase the quantity of debris transported to the strainer and the measured head loss.

d. If credit was taken for the four openings in the secondary shield wall being raised above the containment pool floor level in making this determination, then please provide a description of any other flow paths through the secondary shield wall through which these debris types might transport during the pool fill phase.

24. Please provide plots of velocity and turbulence contours in the containment pool that include the entire pool and which are based on the computational fluid dynamics model used in the debris transport analysis. Please also provide close-up plots of the velocity and turbulence contours in the region of the strainer and its immediate surroundings from the computational fluid dynamics model that was used to determine the flume velocities and turbulence levels for head loss testing. In addition, please provide a table of the head loss test flume (average) velocity as a function of distance from the test strainer. Please indicate which plant strainer is being modeled in the head loss test.

25. Please discuss any sources of drainage that enter the containment pool near the containment sump strainers (i.e., within the range of distances modeled in the head loss test flume, e.g., 45 feet). Please identify whether the drainage would occur in a dispersed form (e.g., droplets) or a concentrated form (e.g., streams of water running off of surfaces). Please discuss how these sources of drainage are modeled in the test flume to create a prototypical level of turbulence in the test flume.

26. Please identify any debris quantities added to the test flume prior to starting the test pump for the head loss tests and provide a technical basis for adding this debris prior to starting the test pump.

D. Head Loss and Vortexing

27. Please provide the vortex test conditions and observations. Page 50 of the supplemental response dated December 11, 2008, stated that the Froude (Fr) number was limited to < 0.25, but on page 38 it was stated that the Fr # = 0.459. Please explain this apparent discrepancy.

28. Please provide debris sizing, amount of each debris size for each size category, and basis for the distribution chosen for the debris surrogates added to the head loss testing (similar to what was provided in the February 29, 2008, submittal that referred to an earlier test protocol no longer credited by the licensee). As discussed in the "NRC Staff

Review Guidance Regarding Generic Letter 2004-02 Closure in the Area of Strainer Head Loss and Vortexing," dated March 2008 (ADAMS Accession No. ML080230038), and in Appendix II of the NRC staff's SE on NEI 04-07, the debris should be categorized into distinct sizes including fine debris in order to ensure that the test was conducted in a manner that realistically modeled transport of the debris. Please state what categorization was used and justify any method chosen that is not consistent with the NRC staff's SE and guidance.

29. Please justify that the debris addition sequence did not non-conservatively affect the ability of more transportable debris to reach the strainer. The supplemental response dated December 11, 2008, indicated that some fine fibrous debris was added after less transportable debris and that coating chips were added in the first debris addition batch. The addition of less transportable debris prior to more transportable debris is likely to result in the entrapment of some debris that might otherwise reach the strainer.

30. Please provide the head loss plots for the testing including annotation of significant events during the test. Please include the portion of the plot that shows the flow sweeps that were performed to determine whether boreholes were present in the debris bed.

31. Please provide the design maximum head loss and the basis for the maximum. It appeared that the structural limit may provide the maximum allowable head loss. Verify that the structural pressure limit of 5.71 feet is not exceeded during any phase of the LOCA response. Please provide head loss at lowest postulated sump temperature and compare it to the structural limit. State whether clean strainer head loss counts against the structural limit, or if only debris head loss needs to be considered. Page 51 of the supplemental response dated December 11, 2008, states that the total strainer head loss is 6.504 feet at 171 °F. It is unclear whether this includes the clean strainer head loss. The debris head loss will increase as temperature decreases. Please provide the outcome of extrapolations of the head loss test results to various temperatures required for head loss considerations.

32. Please provide information on whether the strainer is vented. The supplemental response dated December 11, 2008, states that the strainer will be fully submerged, but the response did not address whether there are vent paths above the submerged water level. If the strainer is vented, please justify that the strainer will function adequately in the vented configuration considering that the available driving head across the strainer is caused only by the elevation difference between the water upstream and downstream of the strainer.

33. The supplemental response dated December 11, 2008, stated on page 53 that containment accident pressure was not credited to prevent flashing across the strainer. However, the tested head loss is much greater than the stated strainer submergence (10 inches for large break LOCA and 0.5 inches for a small break LOCA). The sump temperature is greater than 212 °F at switchover to recirculation. Therefore, some containment pressure is likely required to prevent flashing. Please provide the margin to flashing and the assumptions for the calculation.

34. In addition to flashing, the potential for deaeration of the coolant as it passes through the debris bed should be considered. Please provide an evaluation of the potential for deaeration of the fluid as it passes through the debris bed and strainer and whether any entrained gasses could reach the pump suction. If entrained gasses can reach the pump suction, please evaluate how the net positive suction head required (NPSHr) for the pump could be affected as described in NRC Regulatory Guide 1.82, Revision 3, "Water Sources for Long-Term Recirculation Cooling Following a Loss-of-Coolant Accident," Appendix A (ADAMS Accession No. ML03314034).

35. Please address the potential for floating debris to collect on top of strainer during a small break LOCA and thus provide a potential air-entrainment pathway to the interior of the strainer.

36. On page 21 of the December 11, 2008, supplemental response, one of the strainers (Strainer A) appears to be located near a region where runoff from spray drainage enters the containment pool. Given that the submergence of the strainers is minimal for the small break LOCA case (0.5 inches), please provide a technical basis for concluding that drainage of spray water near the strainer surface will not result in splashing and surface disturbances that would cause unacceptable air entrainment into the strainers and emergency core cooling system (ECCS) and containment spray pumps.

E. Net Positive Suction Head (NPSH)

37. Please provide NPSH margin results for low head safety injection, high head safety injection and containment spray pumps, for the large break LOCA and small break LOCA cases, under conditions of hot-leg recirculation.

38. As requested in NRC's November 2007 content guide, please describe the methodology and assumptions used to compute the limiting pump flow rates for all pumps taking suction from the ECCS sumps.

39. As requested in the NRC's content guide, please provide the volumes of the water sources that contribute to the formation of the containment pool for the limiting minimum containment water level. Please include a specific discussion of both the large and small break LOCA cases. In particular, for small break LOCA cases, the accumulators and RCS volumes may not contribute to containment pool formation because the RCS pressure may remain too high for accumulator injection and because ECCS injection may result in the refill of the RCS with cooler water, even including the pressurizer steam space for a limiting break near the top of the pressurizer.

40. As requested in the NRC's content guide, please identify the methodology and any computer codes used to perform the suction piping friction loss calculations to determine the loss coefficients.

41. As requested in the NRC's content guide, please state the criterion and methodology used by the pump vendor to determine the NPSHr for all pumps taking suction from the ECCS sumps.

42. Please provide the basis for considering the two-train NPSH results (based on the failure of one diesel generator) to be the limiting single failure. The NRC staff noted that other cases exist, such as the operation of three trains (no single failure), or the operation of a single train (which is permitted by the emergency operating procedures through operator actions to shut off redundant pumps). Please provide the NPSH results for these other cases and the basis for considering the two-sump case as limiting with respect to NPSH margin.

43. Please state whether the NPSH results on page 58 of the December 11, 2008, supplementary response include debris bed and clean strainer head loss. If these additional loss terms are included in the results, then please provide NPSH margin results that do not include these terms, per the definition of NPSH margin in Regulatory Guide 1.82.

44. Please identify the volume of holdup assumed for the refueling canal and provide further information that justifies that the refueling canal drains cannot become fully or partially blocked such that additional hold up could occur, or the extent to which hold up could occur. STP has the potential to generate hundreds of cubic feet of fiber, as well as miscellaneous debris and other materials. It is not clear from the information provided in the supplemental responses that the existing design of the drains is sufficient to keep small and large pieces of debris from plugging the drains for the refueling canal. In particular, it is not clear why large pieces of debris (e.g., fibrous, miscellaneous, etc.) cannot be transported to the upper containment through blowdown or other transport processes. If debris larger than or similar to the size of the drain line ends up in the refueling cavity, it is not clear that temporary floatation and transport by surface currents to the drains would not provide a credible mechanism for blocking the drain lines. In a like manner, several small pieces of debris may be capable of causing partial or complete blockage of the drain lines as well.

F. Coatings Evaluation

45. In accordance with the NRC staff's "Revised Content Guide for Generic Letter 2004-02 Supplemental Responses," dated November 21, 2007 (ADAMS Accession No. ML073110389), please provide the specific types of qualified coatings used in containment and the substrates on which they were applied. Also, please justify how the WCAP-16568-P testing is applicable to the qualified coatings at STP.

46. The Keeler and Long report 06-0413, "Design Basis Accident Testing of Coating Samples from Unit 1 Containment, TXU Comanche Peak SES," dated April 13, 2006 (ADAMS Accession No. ML070230390), referenced in the licensee's supplemental response, only applies to degraded qualified epoxies and not original equipment manufacturer epoxy coatings. Please clarify the definition of unqualified epoxy coatings at STP, since unqualified epoxy coatings may be considered to be degraded qualified coatings and/or original equipment manufacturer coatings, and that the unqualified epoxies used at STP are similar to the coating systems tested by Keeler and Long.

47. Please clarify/justify the use of unqualified epoxy coating debris in chip form in head loss testing given that a continuous debris bed appears to form during testing. From the

NRC review guidance and SE, if there is a bed present, all coating debris should be treated as particulate and assume to transport to the sump, unless proper justification and/or data are provided.

G. Debris Source Term

48. The supplemental response dated December 11, 2008, provides a three-sentence summary of how the containment is kept clean. Please provide a more detailed description of the containment foreign material control programs for STP, including reference to procedural requirements and brief description of methods used to clean or maintain cleanliness.

H. Structural Analysis

49. The supplemental responses contain very limited information detailing the results of the structural analyses performed to demonstrate the structural integrity of the replacement sump strainers at STP. The responses provide only a brief qualitative statement of the results without any supporting quantitative data summarizing the results of the analyses as requested in the second portion of item 3.k of the NRC staff's March 2008 revised content guide for the GL 2004-02 supplemental responses. Please provide the actual and allowable stresses and show the design margins for the strainers and all associated welds and components.

50. Item 3.k.3 of the revised content guide for the GL 2004-02 supplemental responses requests that the licensee "Summarize the evaluations performed for dynamic effects such as pipe whip, jet impingement, and missile impacts associated with high-energy line breaks (as applicable)." The STP initial and final supplemental responses state that no evaluations were performed with regards to the effects that high energy line breaks may have on the strainers. They also state that while the high head safety injection lines are within the vicinity of the strainers, there is no need to perform an evaluation on these lines since the lines are "used for accident mitigation and are not assumed to be the accident initiator." The NRC staff considers that this is not an adequate justification for exempting the lines from an evaluation. Please provide a more detailed synopsis of where the lines are located with respect to the replacement strainers, whether breaks are postulated on these lines in accordance with the licensing basis, or justify technically why no breaks need to be postulated (e.g., are there normally closed isolation valves or is the piping otherwise only pressurized during accident mitigation?).

I. Downstream Effects/In-vessel

51. The NRC staff does not consider in-vessel downstream effects to be fully addressed at STP as well as at other pressurized-water reactors. STP's 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 STP 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 NRC staff SE that in-vessel downstream effects have been addressed at STP. In any event, the licensee should report how it has addressed the in-vessel downstream effects issue within 90 days of issuance of the final NRC staff SE on WCAP-16793.

J. Chemical Effects

52. The licensee performed integrated head loss testing in a flume by adding chemical precipitates after other non-chemical debris. The NRC staff questions the transport of the calcium phosphate precipitate during the test since the plant's trisodium phosphate basket location relative to the sump strainers varies and in some cases may be less than the distance from the precipitate introduction point to the strainer section in the test flume. The staff also questions if fibrous debris settlement within the narrow cross section of the test flume may create a pile of fiber that filters the calcium phosphate precipitate in a non-conservative manner since this precipitate settles more rapidly than the aluminum based precipitate. Given this concern, please justify why the head loss testing was appropriate in terms of calcium phosphate precipitate transport to the test strainer.

Please keep me informed on progress on resolution of enclosed final RAI to facilitate scheduling the proposed public agenda-setting teleconference and issue resolution public meeting. If you have any questions, please contact me at (301) 415-1476 or at mohan.thadani@nrc.gov.

Sincerely,

/RA by Balwant K. Singal for/

Mohan C. Thadani, Senior Project Manager
Plant Licensing Branch IV
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. 50-498 and 50-499

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