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

January 11, 2018

Mr. James J. Hutto
Regulatory Affairs Director
Southern Nuclear Operating Co., Inc.
P.O. Box 1295, Bin 038
Birmingham, AL 35201-1295

SUBJECT: VOGTLE ELECTRIC GENERATING PLANT, UNITS 1 AND 2 – REQUEST FOR ADDITIONAL INFORMATION (CAC NOS. MF9685 AND MF9686; EPID L-2017-TOP-0038)

Dear Mr. Hutto:

By letter dated April 21, 2017 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML17116A096) as supplemented by letters dated July 11, 2017 (ADAMS Accession No. ML17192A245), November 9, 2017 (ADAMS Accession No. ML17314A014) and January 2, 2018 (ADAMS Accession No. ML18004A070), Southern Nuclear Operating Company, Inc. submitted a plant-specific technical report (TR) for Vogtle Electric Generating Plant, Units 1 and 2 , and requested U.S. Nuclear Regulatory Commission (NRC) approval. The plant-specific TR describes a risk-informed methodology to evaluate debris effects with the exception of in-vessel fiber limits.

The NRC staff has reviewed the submittal and has determined that additional information is needed to complete its review. Enclosed is the NRC staff's request for additional information (RAI). The RAIs were discussed with your staff on January 4, 2018, and it was agreed that your response would be provided within 30 days from the date of this letter.

If you have any questions regarding this request, please contact me at (301) 415-2871 or Michael.Marshall@nrc.gov.

Sincerely,

Michael L. Marshall /

Michael L. Marshall, Jr., Senior Project Manager
Plant Licensing Branch I
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. 50-424 and 50-425

Enclosure:
Request for Additional Information

REQUEST FOR ADDITIONAL INFORMATION

REGARDING SYSTEMATIC RISK-INFORMED ASSESSMENT OF

DEBRIS TECHNICAL REPORT

SOUTHERN NUCLEAR OPERATING COMPANY, INC.

VOGTLE ELECTRIC GENERATING PLANT, UNITS 1 AND 2

SOUTHERN NUCLEAR OPERATING COMPANY

DOCKET NOS. 50-424 AND 50-425

By letter dated April 21, 2017 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML17116A096) as supplemented by letters dated July 11, 2017 (ADAMS Accession No. ML17192A245), November 9, 2017 (ADAMS Accession No. ML17314A014), and January 2, 2018 (ADAMS Accession No. ML18004A070), Southern Nuclear Operating Company, Inc. (SNC) submitted a plant-specific technical report (TR) for Vogtle Electric Generating Plant, Units 1 and 2, (VEGP) and requested U.S. Nuclear Regulatory Commission (NRC) approval. The plant-specific TR describes a risk-informed methodology to evaluate debris effects with the exception of in-vessel fiber limits.

The NRC staff reviewed the submittal and has determined that the enclosed additional information is needed to complete its review. The requests for additional information (RAIs) listed below are not a complete listing of the additional information needed to complete the NRC staff's review. Additional RAIs were provided via separate correspondence. RAIs number 1 through 3 were sent in a separate letter dated October 12, 2017 (ADAMS Accession No. ML17264A282). RAIs number 4 through 10 were sent in a separate letter dated November 15, 2017 (ADAMS Accession No. ML17275A026). RAIs number 11 through 15 were sent in a separate letter dated November 22, 2017 (ADAMS Accession No. ML17318A035).

Unless stated otherwise, all references to enclosures, sections, and page numbers in the RAIs are concerning the letter dated April 21, 2017.

RAIs

(16) Enclosure 3, Section 9.0 states that debris is assumed to arrive at the strainers as a function of pool turnover time that changes the relative accumulation of debris on strainers, depending on the operating alignments and run time of pumps taking suction from the pool. Section 10.1 states that head losses are applied using a rule-based approach based on the amount of fiber on the strainer. Please confirm that head loss is applied at each time step as follows:

a. If there is any debris on the strainer, but it is less than 0.45 inches theoretical thickness, the thin bed head loss is applied.

b. If the debris bed has a theoretical thickness of greater than 0.45 inches, the calcium phosphate head loss is added to the total.

c. If the debris bed is greater than 32.04 cubic feet (0.57 inches) per residual heat removal (RHR) strainer, the full load head loss is applied in place of the thin bed head loss, and appropriate chemical effects adders are applied.

d. If the amount of aluminum in solution reaches the calculated saturation limit or at 24 hours, whichever occurs first, the sodium aluminum silicate head loss is added to the total.

e. The extrapolation value is added to the head loss at 7.5 hours.

f. The head loss is corrected for flow and temperature (difference from test flow velocity and temperature) at each time step. The head loss correction used is the greater of that derived from the thin bed or full load test for the conditions that exist at the time step being evaluated.

g. When there is flow through the strainer, the clean strainer head loss is added at every time step.

Please confirm that this description of the head loss model is correct. If the description is not correct, please provide a revised description, including a graphical representation of the head loss response to changes in the various model parameters.

(17) Enclosure 3, Table 3-9 indicates that a 12.814 inch break results in a failure. This location produces and transports less fiber than other locations that do not fail. Please explain why this debris generation location with less fiber transported results in a failure.

(18) In Enclosure 5, Section 3.a.1 the licensee states that pipe welds were used as the location of debris generation locations. Please describe how the potential for the failure of piping at locations other than welds (e.g., highly stressed locations, branch connections, and elbows) was considered. If the potential for the failure of piping at locations other than welds was not considered, please provide a basis for not considering locations other than welds.

(19) In Enclosure 1, Section 5.3 is a list of hazards, initiating events, and plant operating modes that were included in the evaluation of debris effects. In this section, the licensee states that initiating events and plant modes that have low potential for any significant risk impact were not evaluated explicitly. Please explain whether breaks postulated to occur outside the first isolation valve are in sections of piping that are normally isolated from the reactor coolant system (RCS) and confirm that the failures of these pipes would not result in RCS leakage rates greater than normal makeup capabilities.

(20) The licensee describes the flow model and debris mass balance approach in Section 3.e of Enclosure 5. In Section 13.1 of Enclosure 3, the licensee describes the implementation of the flow model and mass balance approach in the NARWHAL software. The NARWHAL flow model and the debris mass balance approach (i.e., algorithm for distributing debris on strainers, pool, core, and debris retained on structures or not transported to strainers) is not described in sufficient detail (e.g., the use of pool debris transport fractions derived from the computational fluid dynamics

(CFD) model) regarding the factors leading to strainer failure. Tables 3.e.6-7 through 3.e.6-14 are stated to be overall transport fractions for various pump operating states and break locations. These tables sometimes have different amounts being transported to each pump, but the staff understands that the debris is allocated to each pump based on its flow rate. Please describe how RHR pumps with the same flow rate appear to accumulate different amounts of debris. Please clarify how the transport values are calculated in NARWHAL. In particular,

a. Please provide a simplified high-level description of the NARWHAL debris transport and distribution models, including a description of how the debris transport fractions from the CFD model, blowdown analysis, and other portions of the transport analysis are incorporated into the final transport values for debris to each strainer. Please describe of which values are inputs to the transport logic trees, which tables are outputs of the transport logic trees, and how the "overall" transport values are treated based on the pump operating states.

b. Is some of the small and large debris predicted to transport to the strainer actually fine debris that was eroded from the small and large pieces of debris?

c. Please provide a description of the methodology used within NARWAHL that keeps track of the fine debris that originates from small and large pieces of debris so that strainer failures are tracked accurately in terms of debris accumulation.

(21) For the fiber mass balance, please confirm the adequacy of the penetration model from the information provided in the submittal. Also, please confirm that the filtration and shedding functions included in the mass balance model were compared to the test data using the final set of parameters for NARWHAL calculations.

a. Is the penetration amount based on the total amount of fiber or only the fine fiber arriving at the strainer?

b. Please provide a comparison of the equation predictions with the test data using the parameters for NARWHAL calculations.

(22) The licensee describes the fibrous debris transport in Enclosures 3 and 5. The fine debris was assumed to transport, during blowdown, based on the volumes of lower and upper containment. "Appendix VI: Detailed Blowdown/Washdown Transport Analysis for Pressurized-Water Reactor Volunteer Plant," of the safety evaluation (SE) (ADAMS Accession No. ML050550156) for NEI 04-07, Revision 0, "Pressurized Water Reactor Sump Performance Evaluation Methodology," (ADAMS Accession No. ML050550138) which indicates that a significant amount of small and fine debris would remain in the break compartment due to various capture mechanisms.

a. Please discuss whether the potential for the holdup was considered in the fine and small debris transport analysis and provide the basis for the assumptions used in the fine debris transport analysis.

b. Please discuss the basis for acceptability of assumptions used to simplify the blowdown transport evaluation. For example, holdup in compartments was not modeled, but debris blown to lower containment was placed directly in the pool to account for uncertainties regarding holdup.

(23) Please explain whether all debris that transports to lower containment is assumed to be in the pool. If it is not, please provide the amounts held up above the pool for each debris type, and the basis for the assumed holdup quantities.

(24) In Section 3.h.2 of the submittal, the licensee states:

> It was assumed that 100 percent of unqualified coatings were in the containment pool at the start of recirculation. This is a conservative assumption since no credit is taken for retention of unqualified coatings in upper containment regardless of the failure time or if containment sprays [CSs] are initiated.
>
> It was assumed that the unqualified and degraded qualified coatings in VEGP have a recirculation transport fraction of 100%. This is consistent with the debris transport calculation, and is conservative since settling of this debris is not credited.

In Section 3.h.6 of the submittal, the licensee states:

> In accordance with the guidance provided in NEI 04-07 (Reference 2 [ADAMS Accession No. ML050550138]) and the associated NRC SE (Reference 3 [ADAMS Accession No. ML050550156]), all coating debris was treated as particulate and therefore transported entirely to the sump strainer.

a. Please provide the basis for the transport fractions for the various types of unqualified coating debris listed in Tables 3.e.6-7 through 3.e.6-14 of Enclosure 5. Alternately, provide revised transport values for unqualified coatings in the tables based on the information provided in other sections of the submittal as discussed above.

b. Please explain why the transport fractions vary among the types of unqualified coatings for different break locations and equipment operating states.

(25) Please provide the bases for the overall latent debris transport fractions for the non-spray cases in Tables 3.e.6-8 through 3.e.6-12.

(26) Section 3.e.1 of Enclosure 5 states that the location of each type and size of debris at the beginning of recirculation was determined based on the location of the break. Larger debris may remain closer to the break location. Section 3.e.6 describes recirculation transport cases that were applied to various break locations.

a. Please describe how debris locations at the start of recirculation were determined, including the effects of blowdown, pool fill, and washdown. If the some of the effects are not accounted for in the model, please describe how the evaluation ensures that the model is conservative. Alternatively, pleaseconfirm that risk is not underestimated.

b. Please describe which recirculation transport cases from Tables 3.e.6-4 through 3.e.6-6 were applied to corresponding break location cases.

c. Please clarify whether the CFD results used in the transport analysis were steady state values input at the start of the recirculation transport or if the values were changing based on stagnant conditions at the start of recirculation.

d. Please describe the difference between recirculation transport cases 1 and 5.

(27) In Enclosure 5, the licensee describes debris capture on and debris penetration through the sumps. Please confirm that the Vogtle testing used to develop the penetration model was biased to increase penetration amounts. The staff has reviewed the submittal including the sensitivity studies and uncertainty analyses related to in-vessel downstream effects. It is not apparent that the licensee has determined the final methodology it will use to evaluate the effects of debris that may enter the reactor vessel.

Please describe how SNC will ensure that there is no significant increase in uncertainty, that sensitivity studies remain applicable and bounding for the methods and assumptions used to evaluate in-vessel effects, or that no significant increase in risk is apparent.

(28) Please confirm that the clean strainer head loss is 4.40 inches of water as described in on Page E5-75 in Section 3.f.9 of Enclosure 5. On page E5-81 in Section 3.f.10, the bounding clean strainer head loss is listed as 4.40 ft.

(29) In Sections 3.g.1, 3.g.2, 3.g.8, and 3.o.2 of Enclosure 5, the licensee states that sump levels were calculated using the NARWHAL software and hand calculations. In addition, hand calculations were used for the vortex analysis and chemical effects evaluation.

a. Please describe how did the NARWHAL level calculations compare to the hand calculations.

b. Does Vogtle have a containment analysis code (e.g., GOTHIC) that can be used to calculate sump level? If so, please provide a comparison of the containment analysis results to those used in the risk analyses. Alternately, provide a comparison to design basis level values.

(30) One assumption of the analysis is that the CSs actuate only for hot-leg breaks greater than 15 inches. The staff reviewed the model uncertainty study summarized in Tables 3-16 and 3-17 and observed that the effects of CS operation following small-break loss-of-coolant accident (i.e., less than 2 inches) does not appear to have been evaluated.

Please confirm that the CSs are not started by operator action in response to loss-of-coolant accident scenarios not covered by the uncertainty analysis (breaks less than 2 inches), including for the control of fission products. Alternatively, please demonstrate that operation of sprays under these scenarios does not significantly affect risk.

(31) Enclosure 5, Section 3.i.3, does not state whether aluminum and calcium sources within containment are controlled. Are the source terms for potential chemical effects in the sump pool evaluated within the design change process?

(32) Enclosure 5, Section 3.I.4 states that the Vogtle limiting break with respect to upstream flow blockage occurs under the operating deck and inside the secondary shield wall. For breaks within these bounds, the analysis shows that debris large enough to potentially block the refueling cavity drains cannot credibly reach the refueling cavity. Are there breaks in other locations that could allow debris to transport to and block the refueling cavity drains? If yes, please describe how the potential for sump inventory holdup in the refueling cavity is addressed for these cases.

(33) In Section 3.n.1 of Enclosure 5, the licensee describes fiber penetration testing performed for Vogtle's strainers. The section states that the first two batches consisted of fiber equal to 1/16 inch bed thicknesses, the third through seventh batches consisted of fiber equal to 1/8 inch bed thicknesses, and the final batch consisted of fiber equal to a 1/4 inch bed thickness. Considering the skewed distribution of fiber on the strainer observed during head loss testing, please justify that the batches added after the initial two batches did not result in bypass results less than the bypass that may have occurred with smaller batches.

(34) In Section 3.f.3 of Enclosure 5, the licensee discusses vortexing of plant strainers (i.e., air ingestion). In Section 4 of Enclosure 5, the licensee provides responses to previous RAIs. Is the issue of the potential for air ingestion as discussed in RAI 22 on page E5-183 addressed by limiting the volume of debris to that included in the testing and assigning all cases with larger debris loads to failure, combined with decreasing the strainer height?

(35) In Section 3.f.4 of Enclosure 5, the licensee states that green silicon carbide powder was used as a surrogate for coatings during head loss testing. The licensee further states that the mass of the surrogate was adjusted based on the difference in density between the surrogate and plant coatings so that the volumes of the coatings in the plant were modeled in the test. The NRC staff also reviewed the Calculation No. ALION-CAL-SNC-7410-005, Revision 1 "Head Loss Testing of a Prototypical Vogtle 1 and 2 Strainer Assembly," August 13, 2015 (ADAMS Accession No. ML15293A187), and noted that the plant coatings were described as having a density of about 200 pounds per cubic foot (Table 2.2.2-2 in the calculation). According to Section 3.h of Enclosure 5, there is a significant amount of epoxy coatings in the plant. In general, epoxy has a density of about 100 pounds per cubic foot (see Table 3.c.1-1 in Enclosure 5).

Please describe how the mass of coatings surrogates used in head loss testing was adjusted to account for the difference in density between the plant coatings and the surrogate material such that the volume of particulate debris was conserved in the testing. If the difference in density was not accounted for in the testing, please describe how the analysis is adjusted to accommodate additional plant debris.

(36) Enclosure 5, Section 3.g.16 states that the CS pumps are expected to have greater net positive suction head (NPSH) margins than the RHR pumps due to lower flow rates and lower debris loads. Please describe the assumptions used in the NPSH margin calculations that determined that the CS margins are bounded by the RHR margins or explain how the CS pump operation is evaluated in the analysis.

SUBJECT: VOGTLE ELECTRIC GENERATING PLANT, UNITS 1 AND 2 – REQUEST FOR ADDITIONAL INFORMATION (CAC NOS. MF9685 AND MF9686; EPID L-2017-TOP-0038) DATED JANUARY 11, 2018

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