REPORT OF REGULATORY AUDIT
LICENSE AMENDMENT RELATED TO
DEBRIS SCREEN DIMENSIONS
Vogtle Electric Generating Plant, Units 3 and 4 LAR 16-013
Virgil C. Summer Nuclear Station, Units 2 and 3 LAR 14-11

A. Background

By letter dated August 11, 2016, (Agencywide Documents Access and Management System (ADAMS) Accession Number ML16224B122) Southern Nuclear Operating Company (SNC), the licensee for Vogtle Electric Generating Plant (VEGP) Units 3 and 4, requested the United States Nuclear Regulatory Commission (NRC) approval of an amendment and exemption of the combined licenses (COL) for VEGP Units 3 and 4, nuclear power facility (NPF) COL Numbers NPF-91 and NPF-92, respectively. In addition, by letter dated August 12, 2016, (ADAMS Accession Number ML16225A437), South Carolina Electric & Gas Company (SCE&G), the licensee for Virgil C. Summer Nuclear Station (VCSNS) Units 2 and 3, requested the NRC's approval of a technically identical amendment request for NPF COL Numbers NPF-93 and NPF-94, respectively. As part of the LAR, the applicant proposed to change the dimensions of a protective plate over the containment recirculation screens in order to better accommodate pump maintenance. As such, in conjunction with other changes discussed in the LAR, the licensees revised the coating debris settling analysis demonstrating that the protective plate precludes non-safety related coating debris from transporting to the containment recirculation screen. The NRC staff determined that an audit of the SNC/SCE&G's debris settling analysis referenced in the LAR was necessary in order to obtain a full understanding of the impact of the dimension changes.

B. Bases

This regulatory audit is based on the following:

- General Design Criteria (GDC) 4, "Environmental and dynamic effects design bases," of Appendix A to 10 CFR Part 50, which requires in part that the applicant take provisions to accommodate and appropriately protect structures, systems, and components important to safety against the environmental conditions, including dynamic effects, that may result from normal operation, maintenance, testing, equipment failures and postulated accidents.

- GDC 35, "Emergency core cooling," which requires in part that abundant emergency core cooling following a loss of coolant shall be provided.

- Regulatory Guide 1.82, "Water Sources for Long-Term Recirculation Cooling Following a Loss-of-Coolant-Accident"

  The audit plan is available in ADAMS under Accession Number ML16242A175.

C. Audit Location and Dates

Location: The audit was conducted at Westinghouse Electric Company's (the vendor's) local office:

Westinghouse Electric Company, LLC
Washington Operations
11333 Woodglen Drive, Suite 203
Rockville, Maryland 20852
Telephone: (301) 881-7040/7042

Date: September 1, 2016.

D. Audit Team Members

The following NRC staff members participated in substantive discussions during the audit:

Boyce Travis, Reactor Systems Engineer (Containment and Ventilation Branch)

E. Applicant and Industry Staff Participants

Andy Pfister (in person)
Megan (Durse) (via telephone)

F. Documents Audited

- "PXS Recirculation Screen Debris Settling," APP-PXS-M3C-035
- "AP1000 Sump Recirculation RNS Flow Split Calculation with Fathom," APP-GW-M3C-021

G. Description of Audit Activities and Summary of Observations

As part of the audit, NRC staff reviewed two calculations: APP-PXS-M3C-035, "PXS Recirculation Screen Debris Settling," an analysis calculating the settling associated with paint chips on containment screens, and APP-GW-M3C-021, "AP1000 Sump Recirculation RNS Flow Split Calculation with Fathom," an analysis performed to determine the flow provisioning between the containment screens.

The primary focus of APP-PXS-M3C-035, the debris settling analysis, is to demonstrate that coating debris does not reach the containment screens. In the calculation, the vendor applies a debris settling rate based on NUREG/CR-6916, "Hydraulic Transport of Coating Debris," to debris falling at potential locations near the containment recirculation screens. The calculation assesses a number of different flow paths from or around the plate, including flow paths with changes in flow direction, to conservatively determine the shortest distance of approach for paint chip debris to the screens. Once a conservative distance for each screen is assessed, the vendor applies a debris settling rate to a postulated paint chip to determine its settling location. The settling rate is dependent on the size of the paint chip, and the analysis assumes the largest credible paint chip (smaller particulate debris is accounted for at other points in the analysis), roughly equal in size to the diameter of the holes in the containment recirculation screens. The settling rate used in the analysis was based on the minimum settling rate among the three coatings used in NUREG/CR-6916 that are similar in density and composition to the coatings used in the AP1000. The settling rate is also dependent on the velocity of the

approach flow. Due to the somewhat complex geometry around the containment recirculation screens, a detailed calculation was performed to determine the flow provisioning between the two containment screens.

The NRC staff also audited the flow split calculation, APP-GW-M3C-021. Because of the non-uniform nature of the region around the containment recirculation screens, combined with the large flow resistances associated with the divider plate between the two screens, the calculation performed in Fathom shows that flow is preferentially distributed to one screen at nearly a 2:1 ratio. In the calculation, the vendor performed a detailed accounting of the flow resistances in each path that were used to determine the final flow split values. Notably, no sensitivity analyses were performed on flow resistances for the divider plate, which was by far the largest flow resistance encountered and had a profound impact on the flow split. NRC staff believes, however, that the calculation represents a reasonable representation of the flow between the two recirculation screens and that further conservative assumptions made in the debris settling analysis accommodate some of the uncertainty that might be associated with the flow resistances.

The debris settling analysis then uses the flow rate obtained from the flow split calculation and biases it slightly more conservatively (so that more of the flow passes through one screen). In addition, the flow rate is conservatively biased with a reduced screen area due to obstructions from surrounding equipment by 10 percent. Based on the flow rate through each screen, the vendor calculates an approach velocity. In order to apply the settling rate, calculating the approach distance (horizontal and vertical) is required to apply the settling rate from NUREG/CR-6916. The calculation explores a number of different approaches to the screens, both from chip debris falling from the protective plate as well as more torturous paths involving turns. Upon determining the shortest approach, the vendor then applied the calculated settling rate, applying a further factor of 1.4 (so that debris effectively travels 1.4 times further horizontally than the rate from the NUREG would suggest) for margin. There is some uncertainty inherent in using the values from NUREG/CR-6916, as the coatings used in the AP1000 are not identical to those used in the NUREG; in addition, the lowest flow rate tested in NUREG/CR-6916 is somewhat higher than the expected maximum flow rate for the paint chips in the AP1000. These differences, in conjunction with the potential uncertainties associated with the as-built flow resistances, make the use of a margin factor of 1.4 a practical measure to provide confidence that the screen meets its licensing basis design criteria of no debris blocking the screen. The vendor also performed sensitivity studies evaluating an increased margin factor ranging from 2 to 10; each of the increased sensitivity cases showed varying levels of debris reaching the screen. Additionally, the vendor noted that use of no margin (rather than 1.4) resulted in the screen being capable of a 19:1 flow split with no debris reaching the screen.

The calculation tracks the projected location of coating debris for the cases in a spreadsheet, showing when (if applicable) the debris reaches the “floor” level, or reaches the screens in the sensitivity cases. For the licensing basis case, the limiting case is the minimum horizontal approach to the screen with the higher flow rate. Using the safety factor of 1.4 resulted in debris settling out on the “floor” just below the screen (which is elevated slightly from the “floor”).

In summary, the NRC staff audited both the debris settling analysis and the flow split calculation that informed the settling analysis. Staff determined that the analyses are appropriately conservative and reasonably reflect the purposes described in the LAR.

H. Exit Briefing

The NRC staff's audit was conducted on the afternoon of September 1, 2016. The vendor and NRC staff discussed the staff's takeaways from the audit, and the staff indicated the necessary information within the scope of the audit was provided to assist the staff in their review.

I. Requests for Additional Information (RAI) Resulting from Audit

No RAIs were asked as a result of this audit.

J. Open Items and Proposed Closure Paths

No open items were identified as a result of the audit.

K. Deviations from the Audit Plan

NRC staff requested access to a calculation referenced in the settling analysis, APP-GW-M3C-021, as listed above in Section F.

L. References

1. Request for License Amendment and Exemption 16-013: Debris Screen Related Dimensions, letter from SNC, dated August 11, 2016 (ADAMS Accession Number ML16224B122).

2. Request for License Amendment and Exemption 14-11: Debris Screen Related Dimensions, letter from SCE&G, dated August 12, 2016 (ADAMS Accession Number ML16225A437).

3. Regulatory Audit Plan for the Review of Request for License Amendment and Exemption (LAR 16-013) Debris Screen Related Dimensions for the Vogtle Electric Generating Plant Units 3 and 4 dated September 2, 2016 (ADAMS Accession Number ML16242A175).

4. NRO-REG-108, "Regulatory Audits," dated April 2, 2009 (ADAMS Accession Number ML081910260).