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

March 18, 2024

LICENSEE: Southern Nuclear Operating Company, Inc.

FACILITY: Vogtle Electric Generating Plant, Units 3 and 4

SUBJECT: SUMMARY OF MARCH 7, 2024, OBSERVATION PRE-SUBMITTAL MEETING HELD WITH SOUTHERN NUCLEAR OPERATING COMPANY, INC., REGARDING A PROPOSED LICENSE AMENDMENT REQUEST FOR TSTF-577, REVISION 1, "REVISED FREQUENCIES FOR STEAM GENERATOR TUBE INSPECTIONS" FOR VOGTLE ELECTRIC GENERATING PLANT, UNITS 3 AND 4 (EPID NO. L-2024-LRM-0023)

On March 7, 2024, an Observation meeting was held between the U.S. Nuclear Regulatory Commission (NRC) and representatives of Southern Nuclear Operating Company, Inc. (SNC, the licensee). The purpose of the meeting was for SNC to describe its plan to submit a license amendment request (LAR) regarding Technical Specifications Task Force (TSTF) submitted Traveler TSTF-577, Revision 1, "Revised Frequencies for Steam Generator Tube Inspections" (TSTF-577), for Vogtle Electric Generating Plant (Vogtle), Units 3 and 4.

On February 22, 2024 (ML24053A374), the meeting was noticed on the NRC public webpage.

A list of attendees is provided in Enclosure 1.

The NRC staff opened the meeting with introductory remarks and a roll call of the attendees.

MEETING

The SNC representative presented the slides contained in ML24060A273.

SNC discussed (1) background, (2) TSTF-577 topics, (3) Vogtle, Units 3 and 4, and AP1000 operating experience, (4) proposed Vogtle, Units 3 and 4, LAR, and (5) discussions.

BACKGROUND

By letter dated April 14, 2021 (ML21098A242), the NRC staff issued its final safety evaluation (SE) (ML21098A188) and model SE for TSTF-577 (ML21096A274).

The initial incoming TSTF-577 proposed changes to NUREG-2194, "Standard Technical Specifications, Westinghouse Advanced Passive 1000 (AP1000) Plants," Volume 1 "Specifications," and Volume 2, "Bases," Revision 0, dated April 2016 (ADAMS Accession Nos. ML16110A277 and ML16110A369, respectively). During the NRC review, the NRC staff requested additional information regarding AP1000 operating experience that was not available for review. Consequently, industry withdrew applicability of the AP1000 from the TSTF-577 review and stated that the AP1000 design was to be evaluated in a separate safety evaluation (SE). To date, this review has not been done.

TSTF-577 TOPICS

The traveler SE and model SE for TSTF-577 (ML21098A188 and ML21096A274, respectively) did not apply to AP1000 plants.

SNC plans to propose variations from TSTF-577 for NUREG-2194 when it submits the LAR for Vogtle, Units 3 and 4.

VOGTLE, UNITS 3 AND 4, AND AP1000 OPERATING EXPERIENCE

Current Vogtle, Units 3 and 4, Technical Specification (TS) 5.5.4.d.1 and 5.5.4.d.2 state:

1. Inspect 100% of the tubes in each [steam generator] SG during the first refueling outage following installation.

2. Inspect 100% of the tubes at sequential periods of 144, 108, 72, and, thereafter, 60 effective full power months. The first sequential period shall be considered to begin after the first inservice inspection of the SGs. In addition, inspect 50% of the tubes by the refueling outage nearest the midpoint of the period and the remaining 50% by the refueling outage nearest the end of the period. No SG shall operate for more than 72 effective full power months or three refueling outage (Whichever is less) without being inspected.

PROPOSED SG LAR FOR VOGTLE, UNITS 3 AND 4

SNC plans to submit the proposed LAR as a Consolidated Line Item Improvement (CLIIP) LAR based on TSTF-577. SNC plans to identify variations from NUREG-2194 basis in the proposed LAR. SNC plans to request that the NRC complete its review within 6 months. SNC plans to submit the LAR in the second quarter of calendar year 2024.

The TSs (ML14100A106) associated with SG tubes at Vogtle, Units 3 and 3, are (1) TS 3.4.17, “Steam Generator (SG) Tube Integrity,” (2) TS 5.5.4, “Steam Generator (SG) Program,” and (3) TS 5.6.6, “Steam Generator Tube Inspection Report.”

Table 1 below provides the current schedule for the future Vogtle, Unit 3, SG tube inspections in accordance with TS 5.5.4.d.2. Table 2 provides the expected schedule if the proposed LAR is approved.

TABLE 1 – Future Vogtle 3 SG Tube Inspections for TS 5.5.4.d.2

REFUELING OUTAGE NUMBER	REFUELING OUTAGE TIME	% SG TUBES INSPECTED	Total EFPM	Sequential Period EFPM
			0	
1	Fall 2024	100	18	0
2	Spring 2026	0	36	18
3	Fall 2027	0	54	36
4	Spring 2029	0	72	54
5	Fall 2030	50	90	72
6	Spring 2032	0	108	90
7	Fall 2033	0	126	108
8	Spring 2035	0	144	126
9	Fall 2036	50	162	144
10	Spring 2038	0	180	18
11	Fall 2039	0	198	36
12	Spring 2041	50	216	54
13	Fall 2042	0	234	72
14	Spring 2044	0	252	90
15	Fall 2045	50	270	108
16	Spring 2047	0	288	18
17	Fall 2048	50	306	36
18	Spring 2050	0	324	54
19	Fall 2051	50	342	72
20	Spring 2053	0	360	18
21	Fall 2054	0	378	36
22	Spring 2056	100	396	54
23	Fall 2057	0	414	18
24	Spring 2059	0	432	36
25	Fall 2060	100	450	54

EFFM = Effective Full Power Months

Below is the table for the proposed future Vogtle, Unit 3, SG tube inspections in accordance with TSTF-577.

TABLE 2 – Proposed Future Vogtle 3 SG Tube Inspections with TSTF-577

REFUELING OUTAGE NUMBER	REFUELING OUTAGE TIME	% SG TUBES INSPECTED	Total EFPM	Sequential Period EFPM
			0	
1	Fall 2024	100	18	0
2	Spring 2026	0	36	18
3	Fall 2027	0	54	36
4	Spring 2029	0	72	54
5	Fall 2030	0	90	72
6	Spring 2032	100	108	90
7	Fall 2033	0	126	18
8	Spring 2035	0	144	36
9	Fall 2036	0	162	54
10	Spring 2038	0	180	72
11	Fall 2039	100	198	90
12	Spring 2041	0	216	18
13	Fall 2042	0	234	36
14	Spring 2044	0	252	54
15	Fall 2045	0	270	72
16	Spring 2047	100	288	90
17	Fall 2048	0	306	18
18	Spring 2050	0	324	36
19	Fall 2051	0	342	54
20	Spring 2053	0	360	72
21	Fall 2054	100	378	90
22	Spring 2056	0	396	18
23	Fall 2057	0	414	36
24	Spring 2059	0	432	54
25	Fall 2060	0	450	72

DISCUSSIONS

SNC plans to submit the proposed LAR as a CLIIP LAR based on TSTF-577 with variations from NUREG-2194 basis, and SNC will request a 6-month review. Because the NRC staff's final traveler SE (ML21098A188) and model SE for TSTF-577 (ML21096A274) does not include AP1000 units, the NRC staff stated that it would be challenging to consider processing the proposed LAR as a CLIIP.

The NRC staff asked the following questions:

- What specific TSs does SNC plan to revise? Does SNC plan to revise TS 5.5.5.d.2?

SNC says its plans to submit changes to TSs 3.4.17, TS 5.5.4, and TS 5.6.6. SNC stated that it would propose a change from TS 5.5.4.d.2 to 96 EFPMs.

- Why does SNC feel that the proposed LAR is a CLIIP? Why does SNC need the proposed LAR completed in 6 months? When is the first refueling outage (RFO) for Vogtle, Unit 3?

SNC stated that the first RFO for Vogtle, Unit 3, is scheduled for fourth quarter of 2024. SNC said that it would consider its need date with the proposed LAR.

- Where does the NRC final TSTF-577 SE and the NRC model SE state that it applies to AP1000 units? Where does the fourth bullet on slide 5 come from?

SNC stated that the fourth bullet on slide 5 is incorrect. SNC said the quote is not from the NRC Model SE, and the quote is in the TSTF-577 Traveler.

- Did the vendor perform baseline eddy current data for the SG tubes in the factory? Were any SG tubes plugged due to the vendor inspections? Does SNC have baseline eddy current data for the SG tubes once the SGs were installed at Vogtle, Units 3 and 4? Were any SG tubes plugged due to the baseline inspection results?

SNC expressed the belief that the vendor did tube inspections in the factory and plugged some tubes due to fabrication issues. SNC said it performed SG tube inspections once the SGs were installed at Vogtle, Units 3 and 4, and did not require any tube plugging.

- What plant-specific operating experience does SNC have for the SG tubes at Vogtle, Units 3 and 4? What is SNC's safety case for 96 effective full power months (EFPMs)? Does SNC have eddy current data for the SG tube inspections at other AP1000 units?

SNC said that the AP1000 SGs are fundamentally the same as other Westinghouse SG designs utilizing Alloy 690TT tubing, and the AP1000 Model Delta-125 SG is similar to an upgraded Model Delta-75 SG that has been used in operation as a replacement SG. SNC stated that the international experience of the AP1000 steam generators is bounded by the degradation identified in operating SGs in the U.S., so the inspection and reporting criteria for Alloy 690TT tubing is equally applicable to the AP1000 SGs. SNC stated that it has seen data from Huang that shows normal wear; however, SNC does not have permission to share the data.

- Would SNC be using a deterministic or Monte-Carlo method or using a maximum depth or 95-percent probability when performing the operating assessment (OA) for the Vogtle, Unit 3, for the SG tube inspections for the first RFO? Will SNC use conservative assumptions when performing the OA for the Vogtle, Unit 3, for the SG tube inspections for the first RFO?

SNC acknowledged these questions and agreed to consider the in its evaluation and submission.

The NRC staff expressed concern that the proposed LAR would be requesting TSTF-577 for units that do not have a single RFO inspection of SG tubes after beginning plant operation.

The NRC also expressed concern about projection of tube degradation after one cycle and noted that one SG inspection for a new plant design has greater uncertainty than units with plant designs or SGs that have been in operation for decades.

The NRC also noted that SGs are complex components and even those with the same design can behave differently depending on fabrication variability.

The NRC staff highlighted operating experience (OE) from two different licensees and suggested the results support a cautious approach. The NRC highlighted the following:

1) One licensee with two identical units. Unit 2 recently had its first inservice inspection (ISI) after installation of replacement SGs. Unit 1 OE has been very good. The NRC staff had a call with the licensee for Unit 2 in fall 2023. The licensee detected unanticipated wear during its first ISI and plugged 57 tubes due to a presumed issue with the preheater lap joints. During the call, the licensee indicated the preliminary operating assessment (OA) would support one outage skip at most before the next tube inspection. The design is identical for Unit 1 and Unit 2.

2) Another licensee replaced its SGs in 2012, did a first ISI after one cycle with no tube support plate (TSP) wear detected. In the second ISI, the licensee detected two low row tubes with aggressive TSP wear. At the third ISI, the licensee did not meet tube integrity for two tubes due to aggressive wear at TSPs.

The NRC staff said it may have challenges making a safety case for the proposed LAR to allow for up to 96 EFPM of operation following an initial inspection with limited OE for Vogtle, Units 3 and 4.

CONCLUDING REMARKS

The NRC staff made no regulatory decisions during the meeting. Once received, the NRC staff will perform a thorough review of the proposed LAR. The NRC staff will make any regulatory decisions in writing in a timely manner. Public Meeting Feedback forms were available, but no comments were received.

The meeting adjourned at 2:43 pm Eastern Standard Time.

Please direct any inquiries to me at John.Lamb@nrc.gov or 301-415-3100.

/RA

John G. Lamb, Senior Project Manager
Plant Licensing Branch, II-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. 52-025 and 52-026

Enclosures: 1. List of Attendees
2. Background Information

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LIST OF ATTENDEES

MARCH 7, 2024, PRE-SUBMITTAL MEETING WITH SOUTHERN NUCLEAR COMPANY

REGARDING A PROPOSED

LICENSE AMENDMENT REQUEST

VOGTLE ELECTRIC GENERATING PLANT, UNITS 3 AND 4

ATTENDEE	**REPRESENTING**
John G. Lamb	U.S. Nuclear Regulatory Commission (NRC)
Mike Markley	NRC
Paul Klein	NRC
Andy Johnson	NRC
Leslie Terry	NRC
Clint Ashley	NRC
Steve Bloom	NRC
Michael Fitzgerald	NRC
Odunayo Ayegbusi	NRC
Cotasha Blackburn	Southern Nuclear Operating Company (SNC)
Ken Lowery	SNC
Ryan Joyce	SNC
Jordan Rice	SNC
DeLisa Pournaras	SNC
Neil Haggerty	SNC
Dan Williamson	
Kyle Caver	SNC
Helen Cothron	Electric Power Research Institute

BACKGROUND INFORMATION

The Vogtle, Units 3 and 4, Steam Generators (SGs) were supplied by Doosan Heavy Industries and Construction of South Korea.

The Vogtle, Units 3 and 4, Updated Final Safety Analysis Report (UFSAR) (ML14100A106), Section 5.1.3.2, “AP1000 Steam Generator,” states:

> Design enhancements include nickel-chromium-iron Alloy 690 thermally treated tubes on a triangular pitch, improved antivibration bars, single-tier separators, enhanced maintenance features, and a primary-side channel head design that allows for easy access and maintenance by robotic tooling. The AP1000 steam generator employs tube supports utilizing a broached hole support plate design. All tubes in the steam generator are accessible for sleeving, if necessary. The design enhancements are based on proven technology.
>
> The basic function of the AP1000 steam generator is to transfer heat from the single-phase reactor coolant water through the U-shaped heat exchanger tubes to the boiling, two-phase steam mixture in the secondary side of the steam generator. The steam generator separates dry, saturated steam from the boiling mixture, and delivers the steam to a nozzle from which it is delivered to the turbine. Water from the feedwater system replenishes the steam generator water inventory by entering the steam generator through a feedwater inlet nozzle and feedring.

The Vogtle, Units 3 and 4, UFSAR, Section 5.2.5.2.1, “Steam Generator Tubes,” states:

> An important potential identified leakage path for reactor coolant is through the steam generator tubes into the secondary side of the steam generator. Identified leakage from the steam generator primary side is detected by one, or a combination, of the following:
>
> - High condenser air removal discharge radioactivity, as monitored and alarmed by the turbine island vent discharge radiation monitor,
> - Steam generator secondary side radioactivity, as monitored and alarmed by the steam generator blowdown radiation monitor,
> - Secondary side radioactivity, as monitored and alarmed by the main steam line radiation monitors,
> - Radioactivity, boric acid, or conductivity in condensate as indicated by laboratory analysis.

The Vogtle, Units 3 and 4, UFSAR, Section 5.4.2.2, “[Steam Generator] Design Description,” states:

> The AP1000 steam generator is a vertical-shell U-tube evaporator with integral moisture separating equipment. Figure 5.4-2 shows the steam generator, indicating several of its design features.
>
> The design of the Model Delta-125 steam generator, except for the configuration of the channel head, is similar to an upgraded Model Delta-75 steam generator.

The Delta-75 steam generator has been placed in operation as a replacement steam generator.

Steam generator design features are described in the following paragraphs.

On the primary side, the reactor coolant flow enters the primary chamber via the hot leg nozzle. The lower portion of the primary chamber is elliptical and merges into a cylindrical portion, which mates to the tubesheet. This arrangement provides enhanced access to all tubes, including those at the periphery of the bundle, with robotics equipment. This feature enhances the ability to inspect, replace and repair portions of the AP1000 unit compared to the more spherical primary chamber of earlier designs. The head is divided into inlet and outlet chambers by a vertical divider plate extending from the apex of the head to the tubesheet.

The reactor coolant flow enters the inverted U-tubes, transferring heat to the secondary side during its traverse, and returns to the cold leg side of the primary chamber. The flow exits the steam generator via two cold leg nozzles to which the reactor coolant pumps are directly attached. A high integrity, nickel-chromium-iron (Alloy 690) weld is made to the nickel-chromium-iron alloy buttered ends of these nozzles.

A passive residual heat removal (PRHR) nozzle attaches to the bottom of the channel head of the loop 1 steam generator on the cold leg portion of the head. This nozzle provides recirculated flow from the passive residual heat removal heat exchanger to cool the primary side under emergency conditions. A separate nozzle on one of the steam generator channel heads is connected to a line from the chemical and volume control system. The nozzle provides for purification flow and makeup flow from the chemical and volume control system to the reactor coolant system.

The AP1000 steam generator channel head has provisions to drain the head. To minimize deposits of radioactive corrosion products on the channel head surfaces and to enhance the decontamination of these surfaces, the channel head cladding is machined or electropolished for a smooth surface. The primary manways provide enhanced primary chamber access compared to previous model steam generators.

Should steam generator replacement using a channel head cut be required, the arrangement of the AP1000 steam generator channel head facilitates steam generator replacement in two ways. It is completely unobstructed around its circumference for mounting cutting equipment. And is long enough to permit post-weld heat treatment with minimal effect of tubesheet acting as a heat sink.

The tubes are fabricated of nickel-chromium-iron Alloy 690. The tubes undergo thermal treatment following tube-forming operations. The tubes are tack-expanded, welded, and expanded over the full depth of the tubesheet. Full depth expansion was selected because of its capability to minimize secondary water access to the tube-to-tube-sheet crevice. The method by which the tubes are expanded into the tubesheet is determined based on consideration of the residual stresses and the resultant susceptibility of the tube to degradation.

Residual stresses (and the expanded tube's susceptibility to degradation) are limited, in part, through tight control of the pre-expansion clearance between the tube and tubesheet hole.

Support of the tubes is provided by ferritic stainless steel tube support plates. The holes in the tube support plates are broached with a hole geometry to promote flow along the tube and to provide an appropriate interface between the tube support plate and the tube. Figure 5.4-3 shows the support plate hole geometry. Anti-vibration bars installed in the U-bend portion of the tube bundle minimize the potential for excessive vibration.

Steam is generated on the shell side, flows upward, and exits through the outlet nozzle at the top of the vessel. Feedwater enters the steam generator at an elevation above the top of the U-tubes through a feedwater nozzle. The feedwater enters a feedring via a welded thermal sleeve connection and leaves it through nozzles attached to the top of the feedring. The nozzles are fabricated of an alloy that is very resistant to erosion and corrosion with the expected secondary water chemistry and flow rate through the nozzles. After exiting the nozzles, the feedwater flow mixes with saturated water removed by the moisture separators. The flow then enters the downcomer annulus between the wrapper and the shell.

Fluid instabilities and water hammer phenomena are important considerations in the design of steam generators. Water level instabilities can occur from density wave instabilities which could affect steam generator performance. Density wave instability is avoided in the AP1000 steam generator by including appropriate pressure losses in the downcomer and the risers that lead to negative damping factors.

Steam generator bubble collapse water hammer has occurred in certain early pressurized water reactor steam generator designs having feedrings equipped with bottom discharge holes. Prevention and mitigation of feedline-related water hammer has been accomplished through an improved design and operation of the feedwater delivery system. The AP1000 steam generator and feedwater system incorporate features designed to eliminate the conditions linked to the occurrence of steam generator water hammer. The steam generator features include introducing feedwater into the steam generator at an elevation above the top of the tube bundle and below the normal water level by a top discharge feedring. The top discharge of the feedring helps to reduce the potential for vapor formation in the feedring. This minimizes the potential for conditions that can result in water hammer in the feedwater piping. The feedwater system features (Subsection 10.4.7 discusses in more detail) designed to prevent and mitigate water hammer include a short, horizontal or downward sloping feedwater pipe at steam generator inlet.

These features minimize the potential for trapping pockets of steam which could lead to water hammer events.

Stratification and striping are reduced by an upturning elbow inside the steam generator which raises the feedring relative to the feedwater nozzle. The elevated feedring reduces the potential for stratified flow by allowing the cooler, more dense feedwater to fill the nozzle/elbow arrangement before rising into the feedring.

The potential for water hammer, stratification, and striping is additionally reduced by the use of a separate startup feedwater nozzle. The startup feedwater nozzle is located at an elevation that is the same as the main feedwater nozzle and is rotated circumferentially away from the main feedwater nozzle. A startup feedwater spray system independent of the main feedwater feedring is used to introduce startup feedwater into the steam generator. The layout of the startup feedwater piping includes the same features as the main feedwater line to minimize the potential for water hammer.

The startup feedwater system is used to introduce water into the secondary side of the steam generator as described in Subsection 10.4.7.2.3.

At the bottom of the wrapper, the water is directed toward the center of the tube bundle by the lowest tube support plate. This recirculation arrangement serves to minimize the low-velocity zones having the potential for sludge deposition.

As the water passes the tube bundle, it is converted to a steam-water mixture. Subsequently, the steam-water mixture from the tube bundle rises into the steam drum section, where centrifugal moisture separators remove most of the entrained water from the steam. The steam continues to the secondary separators, or dryers, for further moisture removal, increasing its quality to a designed minimum of 99.75 percent (0.25 percent by weight maximum moisture). Water separated from the steam combines with entering feedwater and recirculates through the steam generator. A sludge collector located amidst the inner primary separator risers provides a preferred region for sludge settling away, from the tubesheet and tube support plates. The dry, saturated steam exits the steam generator through the outlet nozzle, which has a steam-flow restrictor. (See Subsection 5.4.4.)

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Docket Nos. 52-025 and 52-026

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NAME	JLamb	KGoldstein	SBloom	MMarkley	JLamb
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