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10 CFR 50.4
10 CFR Part 54

ATTN: Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Subject: Duke Energy Carolinas, LLC (Duke Energy)
Oconee Nuclear Station (ONS), Units 1, 2, and 3
Docket Numbers 50-269, 50-270, 50-287
Renewed License Numbers DPR-38, DPR-47, DPR-55
Subsequent License Renewal Application
Response to ONS SLRA Second Round RAI 4.6.1-1a

References:

1. Duke Energy Letter (RA-21-0132) dated June 7, 2021, Application for Subsequent Renewed Operating Licenses, (ADAMS Accession Number ML21158A193)
2. NRC Letter dated July 22, 2021, Oconee Nuclear Station, Units 1, 2, and 3 - Determination of Acceptability and Sufficiency for Docketing, Proposed Review Schedule, and Opportunity for a Hearing Regarding Duke Energy Carolinas' Application for Subsequent License Renewal (ADAMS Accession Number ML21194A245)
3. NRC E-mail dated September 22, 2021, Oconee SLRA - Request for Additional Information B2.1.27-1 (ADAMS Accession Number ML21271A586)
4. Duke Energy Letter (RA-21-0281) dated October 22, 2021, Subsequent License Renewal Application, Response to Request for Additional Information B2.1.27-1 (ADAMS Accession Number ML21295A035)
5. NRC E-mail dated November 23, 2021, Oconee SLRA – Request for Additional Information - Set 1 and Second Round Request for Additional Information RAI B2.1.27-1a (ADAMS Accession Number ML21327A277)
6. Duke Energy Letter (RA-21-0332) dated January 7, 2022, Subsequent License Renewal Application Responses to NRC Request for Additional Information Set 1 and Second Round Request for Additional Information B2.1.27-1a (ADAMS Accession Number ML22010A129)
7. NRC E-mail dated January 11, 2022, Oconee SLRA – Request for Additional Information - Set 2 (ADAMS Accession Numbers ML22012A043 and ML22012A042)
8. Duke Energy Letter (RA-22-0036) dated February 14, 2022, Subsequent License Renewal Application Responses to NRC Request for Additional Information Set 2 (ADAMS Accession Number ML22045A021)
9. NRC E-mail dated January 18, 2022, Oconee SLRA – Request for Additional Information Set 3 (ADAMS Accession Numbers ML22019A103 and ML22019A104)

10. Duke Energy Letter (RA-22-0040) dated February 21, 2022, Subsequent License Renewal Application Responses to NRC Request for Additional Information Set 3 (ADAMS Accession Numbers ML22052A002)
11. NRC E-mail dated March 16, 2022, Oconee SLRA – Request for Additional Information Set 4 (ADAMS Accession Numbers ML22080A077 and ML22080A079)
12. NRC E-mail dated March 21, 2022, Oconee SLRA – 2nd Round RAI B4.1-3 (ADAMS Accession Numbers ML22080A077 and ML22080A079)
13. NRC E-mail dated March 29, 2022, Oconee SLRA – 2nd Round RAI 4.6.1-1a (ADAMS Accession Number ML22091A091)
14. Duke Energy Letter (RA-22-0129) dated April 20, 2022, Subsequent License Renewal Application Responses to Oconee SLRA - 2nd Round RAI B4.1-3 (ADAMS Accession Number ML22110A207)
15. Duke Energy Letter (RA-22-0124) dated April 22, 2022, Subsequent License Renewal Application Responses to NRC Request for Additional Information Set 4 (ADAMS Accession Numbers ML22112A016)

By letter dated June 7, 2021 (Reference 1), Duke Energy Carolinas, LLC (Duke Energy) submitted an application for the subsequent license renewal of Renewed Facility Operating License Numbers DPR-38, DPR-47, and DPR-55 for the Oconee Nuclear Station (ONS), Units 1, 2, and 3 to the U.S. Nuclear Regulatory Commission (NRC). On July 22, 2021 (Reference 2), the NRC determined that ONS subsequent license renewal application (SLRA) was acceptable and sufficient for docketing. In emails from NRC to Steve Snider (Duke Energy) dated September 22, 2021, November 23, 2021, January 11, 2022, January 18, 2022, March 16, 2022, and March 21, 2022 (References 3, 5, 7, 9, 11, and 12), the NRC transmitted specific requests for additional information (RAI) to support completion of the Safety Review. The responses were provided to the NRC on October 22, 2021, January 7, 2022, February 14, 2022, February 21, 2022, April 20, 2022, and April 22, 2022 (References 4, 6, 8, 10, 14, and 15).

In an email from Angela X. Wu (NRC) to Steve Snider (Duke Energy) dated March 29, 2022 (Reference 13), the NRC transmitted a second round for RAI 4.6.1-1a to support completion of the Safety Review. Enclosure 1 contains the response for RAI 4.6.1-1a. As directed by the NRC Project Manager, the revised due date for this response is May 20, 2022. This submittal contains no new or revised regulatory commitments.

Should you have any questions regarding this submittal, please contact Paul Guill at (704) 382-4753 or by email at paul.guill@duke-energy.com.

I declare under penalty of perjury that the foregoing is true and correct. Executed on May 20, 2022.

Sincerely,

Steven M. Snider
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Enclosure:

1. Response to ONS SLRA Second Round RAI 4.6.1-1a

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ENCLOSURE 1

OCONEE NUCLEAR STATION, UNITS 1, 2, AND 3
SUBSEQUENT LICENSE RENEWAL APPLICATION
RESPONSE TO ONS SLRA 2ND ROUND RAI 4.6.1-1a

Enclosure 1
Response to ONS SLRA 2nd Round RAI 4.6.1-1a

Request for Additional Information (RAI) 4.6.1-1a:

Regulatory Basis:

Title 10 of the *Code of Federal Regulations* (CFR) Section 54.21(a)(3) requires an applicant to demonstrate that the effects of aging for each structure and component identified in 10 CFR 54.21(a)(1) will be adequately managed so that the intended function(s) will be maintained consistent with the current licensing basis for the period of extended operation. One of the findings that the U.S. Nuclear Regulatory Commission (NRC) staff must make to issue a renewed license (10 CFR 54.29(a)) is that actions have been identified and have been or will be taken with respect to managing the effects of aging during the period of extended operation on the functionality of structures and components that have been identified to require review under 10 CFR 54.21, such that there is reasonable assurance that the activities authorized by the renewed license will continue to be conducted in accordance with the current licensing basis.

Per 10 CFR 54.21(c), the applicant is required to evaluate time limited aging analyses (TLAA) and disposition them in accordance with (c)(1)(i), (c)(1)(ii), or (c)(1)(iii). SRP-SLR Section 4.6.1.1 states, in part: “The ASME Code contains explicit requirements for fatigue parameter evaluations (fatigue analyses or fatigue waivers), which are TLAAs.”

In order to complete its review and enable making a finding under 10 CFR 54.29(a), the staff requires additional information in regard to the matters described below.

Background:

SLRA Section 4.6.1, “Containment Liner Plate and Cold Penetrations,” as amended by response to RAI 4.6.1-1 by letter dated February 14, 2022 (ADAMS Accession No. ML22045A021) states, in part:

> For 80-years of operation, the accumulated effects of containment liner and cold penetration loading conditions were evaluated to contemporary standards in accordance with the ASME Code, Section III, Paragraph N-415, to validate that a detailed fatigue analysis would not be warranted. The containment liner plate and cold penetration materials of construction listed in Table 4.6.1-1 above, in particular the carbon steel SA-516 Grade 70 material, meets all six criteria in the ASME Code, Section III, Subsection N-415.1 for the 500 applied design cycles for these components. This evaluation is bounding for the liner plate and cold penetrations, including mechanical, electrical, equipment and personnel-related penetrations.
>
> TLAA Disposition: 10 CFR 54.21(c)(1)(ii)
>
> The fatigue waiver analysis associated with the containment liner plate and cold penetrations meets all six criteria in the ASME Code, Section III, Subsection N-415.1 and will remain valid for the subsequent period of extended operation, in accordance with 10 CFR 54.21(c)(1)(ii).

The related review procedures in SRP-SLR Section 4.6.3.1.1.2 states, in part: “The revised fatigue parameter evaluations [fatigue analyses or fatigue waivers] based on the projected number of occurrences and severities of cyclic loads are reviewed to ensure that the calculated fatigue parameters remain less than the allowed values at the end of the subsequent period of extended operation.”

Issue:

The fatigue waiver evaluation that the applicant stated, in the response to RAI 4.6.1-1, to have performed for the containment liner plate and cold penetrations (including mechanical, electrical, and equipment and personnel-related penetrations) in accordance with the ASME Code, Section III, paragraph N-415.1 was not available for required staff verification during the audit (see audit report section for SLRA TLAA Section 4.6.1, “Containment Liner Plate” in ADAMS Accession No. ML22045A053). Therefore, the staff was unable to verify the claimed fatigue waiver analysis during the audit. Further, SLRA Section 4.6.1, as amended by the response to RAI 4.6.1-1, does not appear to provide sufficient technical detail that demonstrates how the fatigue waiver analyses satisfied all the six acceptance criteria in the ASME Code, Section III, paragraph N415.1, for the containment liner plate and each of the cold penetrations for which it is credited. The staff needs additional information to verify the applicant’s fatigue waiver analyses to make its regulatory finding for the TLAA.

Request:

Provide the fatigue waiver analyses of record (calculation that includes material and cyclic inputs and fatigue parameter evaluations) that demonstrates how the six criteria in the ASME Code, Section III, paragraph N415.1 (1965 edition code of record) were shown to be met for the containment liner plate and each of the cold penetrations for which it is credited.

Alternatively, describe in sufficient technical detail (providing reference to the analysis of record, including material and cyclic inputs and fatigue parameter evaluations) how each of the six acceptance criteria in the ASME Code, Section III, paragraph N415.1 (1965 edition code of record) were satisfied for the containment liner plate and each of the cold penetrations for which the fatigue waiver analysis is credited.

Response to RAI 4.6.1-1a:

As part of subsequent license renewal (SLR), a fatigue exemption evaluation was performed for the containment liner plate and cold penetrations and is documented in Oconee plant calculation OSC-2077-03-SLR-1009, “Supporting Analysis for Subsequent License Renewal (SLR) – Reactor Building Liner Plate and Penetration Design & Licensing Bases Review to Support a Fatigue Exemption Evaluation for ONS SLR Application.” Cold penetrations are defined as mechanical, electrical, equipment and personnel hatches, and fuel transfer tube, excluding the main steam and main feedwater penetrations. As described in Oconee UFSAR Section 3.8.1.5.3, the containment liner plate and penetrations are designed in accordance with the 1965 Edition of the ASME Boiler and Pressure Vessel Code, Section III, Nuclear Vessels. The fatigue exemption evaluation for the Oconee containment liner plate and cold penetrations was performed in accordance with 1965 ASME Section III, Article 4, Paragraph 415.1 (ASME Code). The evaluation demonstrates that the Oconee containment liner plate and cold penetrations meet the six criteria for fatigue exemption, and therefore these components do not require an explicit Code fatigue analysis.

The design conditions for the Oconee containment liner plate and penetrations are described in the Oconee UFSAR Section 3.1.49 and include a design pressure of 60 pounds per square inch gauge (psig) and a design temperature of 300 degrees Fahrenheit (300°F). The operating pressure for the containment liner and penetrations is 5 psig as shown in Technical Specification 3.6.4. As determined from operational data, the maximum average reactor building operating temperature for Oconee Units 1, 2, and 3 is 140°F. Oconee UFSAR Section 3.8.1.5.3 describes the fatigue loads that are considered in the design of the containment liner plate and penetrations. The bounding full range temperature and pressure cycles for the Oconee Units is 500 cycles, which includes Type A integrated leak rate tests required by 10 CFR 50, Appendix J. The materials of construction for the Oconee containment liner plates and penetrations are described in Table 4.6.1-1 below. Each material was considered for the evaluation, and it was determined that SA-516 Grade 70 was the limiting material based on design stress intensities. All material values used in the fatigue exemption evaluation are taken from Tables N-421, N-426, and N-427 of the 1965 Edition of the ASME Code, Section III.

Table 4.6.1-1: ONS Liner Plate and Cold Penetrations Materials of Construction

ASTM	Material	Type	Components
A36	Carbon Steel	Containment Liner	Plate
SA-516 Grade 70	Carbon Steel	Containment Liner Mech. Penetrations Elec. Penetrations	Plate
A-333 Grade 6	Carbon Steel	Mech. Penetrations Elec. Penetrations	Pipe
A-155	Carbon Steel	Mech. Penetrations Elec. Penetrations	Pipe
A36	Carbon Steel	Elec. Penetrations	Rod
SA-516 Grade 70	Carbon Steel	Mech. Penetrations Elec. Penetrations	Pipe Cap/Dished Head
SA-106 Grade C	Carbon Steel	Mech. Penetrations	Pipe
A-350 Grade LF2	Carbon Steel	Elec. Penetrations	Forging
A-234 Grade WPB	Carbon Steel	Elec. Penetrations	Fittings
SA-182 F304	Stainless Steel	Elec. Penetrations	Flange
SA-316	Stainless Steel	Mech. Penetrations	Plate

Criteria (a) from Paragraph N-415.1 of the 1965 Edition of the ASME Code, Section III, describes the specified number of times (including startup and shutdown) that the pressure will be cycled from atmospheric pressure to operating pressure and back to atmospheric pressure. The allowed number of cycles is calculated as 3 times the design stress intensity, S_m, at the operating temperature and is compared to the applied cycles. The material used for the fatigue exemption evaluation is SA-516, Grade 70 (Table N-421, SA-212, Grade B, 70 kips per square inch (ksi) minimum tensile). At the specified operating temperature for the containment liner plate and penetrations, this results in an S_m value of 23.22 ksi. Figure N-415(A) of the 1965 Edition of the ASME Code, Section III, provides the allowable amplitude of alternating stress intensity, S_a, for carbon and alloy steels. At a value of 3 times S_m, the allowed number of cycles is 1600. This value is greater than the 500 full range temperature and pressure cycles for the containment liner plate and penetrations and therefore Criteria (a) is met.

Criteria (b) from Paragraph 415.1 of the 1965 Edition of the ASME Code, Section III, describes that the full range of pressure fluctuations during normal operation shall not exceed the quantity (1/3) x design pressure x (S_a/S_m). S_a is the value obtained from the applicable fatigue curve for the total specified number of significant pressure fluctuations and is 105 ksi. S_m is taken from Table N-421 from ASME Code, Section III and is 23.22 ksi as described in Criteria (a). The quantity of the full range of pressure fluctuations during normal operation is calculated as 90 psig. Therefore, the normal pressure fluctuations would have to be greater than 90 psig to be fatigue significant. Normal service conditions for the containment liner plate and penetrations are -2.45 to 1.2 psig, and Type A integrated leak rate tests are 60 psig. Both normal service conditions and Type A integrated leak rate tests are less than 90 psig, which is the pressure fluctuation to be considered fatigue significant. Therefore, neither the normal pressure fluctuations or the Type A integrated leak rate tests are fatigue significant and Criteria (b) is met.

Criteria (c) from Paragraph N-415.1 of the 1965 Edition of the ASME Code, Section III, describes the allowable temperature difference during normal operation startup and shutdown and is based on mean operating temperature and S_a. The minimum operating temperature for the Oconee Units is 70°F and the maximum operating temperature is 140°F. This results in a mean operating temperature of 105°F. S_a was determined in Criteria (b) and is 105 ksi at the maximum operating temperature of 140°F. The modulus of elasticity and the coefficient of thermal expansion were extracted from Tables N-426 and N-427 of the 1965 Edition of the ASME Code, Section III at a mean operating temperature of 105°F. This resulted in an allowable temperature difference of 301°F for 500 cycles, which is less than the temperature difference of 70°F during normal operation and Criteria (c) is met.

Criteria (d) from Paragraph N-415.1 of the 1965 Edition of the ASME Code, Section III, describes that the allowable temperature difference during normal operation does not exceed the quantity $S_a/(2E\alpha)$, where S_a is the allowed stress for 10^6 cycles, E is the modulus of elasticity, and α is the coefficient of thermal expansion. As defined previously, the S_a for 500 cycles is 105 ksi and the S_a for 10^6 cycles is 12.5 ksi as shown in Figure N-415(A) of the ASME Code. The values for the modulus of elasticity and the coefficient of thermal expansion are taken from Tables N-426 and N-427 of the 1965 Edition of the ASME Code, Section III at a mean operating temperature of 105°F. The allowed temperature difference for 10^6 cycles is 36°F and the allowed temperature difference at 500 cycles is 301°F. To be significant, a temperature difference greater than 36°F would be required, thus all 500 cycles are significant. Since the actual temperature difference is 70°F (from 70°F to 140°F) and the allowed temperature difference is 301°F, Criteria (d) is met.

Criteria (e) from Paragraph N-415.1 of the 1965 Edition of the ASME Code, Section III, describes the allowable temperature difference during normal operation for dissimilar materials. A significant temperature difference is defined as a value greater than $S_a/[2(E_1\alpha_1 - E_2\alpha_2)]$, where S_a is the allowed stress for the weaker material. The dissimilar metals in the Oconee containment liner plate and penetrations are carbon steel and stainless steel. The values of S_a for carbon steel are taken from Figure N-415(A) of the ASME Code, and the values of S_a for stainless steel are taken from Figure N-415(B) of the ASME Code. For each material the values of S_a are considered for 500 cycles and 10^6 cycles. For carbon steel these values are 105 ksi and 12.5 ksi. For stainless steel the values are 136 ksi and 26 ksi. The values for the modulus of elasticity and coefficient of thermal expansion of each material were taken from Tables N-426 and N-427 of the 1965 Edition of the ASME Code, Section III at a mean operating temperature of 105°F. Using the S_a for the weaker material, the resulting allowed temperature difference at 10^6 cycles is 79°F. To be significant, a temperature difference greater than

79°F would be required, thus all 500 cycles are not fatigue significant. Since the actual temperature difference value is 70°F and the 500 cycles are not fatigue significant, Criteria (e) is met.

Criteria (f) from Paragraph N-415.1 of the 1965 Edition of the ASME Code, Section III, describes that the specified full range of mechanical loads, excluding pressure but including pipe reactions, does not result in load stresses whose range exceeds S_a. The cycles considered for this evaluation were 10^6 cycles and 7000 cycles. The S_a value was taken from Figure N-415(A) for each number of cycles and resulted in values of 12.5 ksi and 42.85 ksi. For comparison, the S_a value for stainless steel was taken from Figure N-415(B) and resulted in a value of 64.425 ksi. Therefore, the carbon steel is the limiting fatigue material.

Reactor building penetrations were designed primarily for faulted loads and their associated allowable stress values. Normal loads were not considered to be design limiting. Initially, the imposed penetration faulted loads were conservatively compared to their resultant normal stress allowable values of 18.7 ksi. In specific cases where the faulted loads exceeded normal allowable values, (Penetrations 7 and 9, specifically) additional analyses were performed. In these cases, normal loads were compared to resultant normal allowable stresses (19.25 ksi) and faulted loads to faulted allowable stress values (25.3 ksi).

Oconee now qualifies the reactor building penetrations within the various piping analysis calculations. The current penetration qualification process compares faulted loads to faulted load allowable values. In some cases, as in the 1980s, normal loads are compared to normal allowable loads. Those penetration loads are not 'converted' into normal penetration stresses, as the allowable loads reflect the allowable normal and faulted stresses (19.25 and 25.3 ksi, respectively) developed in the 1980s. Maintaining penetration loads below their load allowable values keeps the resulting normal penetration stresses below 19.25 ksi, well below the S_a value for the penetration material. Thus, the moment loads meet the S_a allowable for the piping materials, and Criteria (f) is met.

In summary, the fatigue exemption evaluation described above meets all six criteria defined in the 1965 Edition of the ASME Code, Section III, Nuclear Vessels. The evaluation bounds the containment liner plate and cold penetrations that are part of the Oconee Units. The information provided herein supports the response to RAI 4.6.1-1, included in RAI Set 2 (ML22045A021), that updated the Oconee SLRA Sections 4.6.1 and A4.6.1 to describe the fatigue exemption evaluation for the containment liner plate and cold penetrations.