OCONEE NUCLEAR STATION (ONS), UNITS 1, 2, AND 3
SUBSEQUENT LICENSE RENEWAL APPLICATION (SLRA), SLRA SECTION 3.5.2.2.2.6
2nd ROUND OF REQUESTS FOR ADDITIONAL INFORMATION (RAIs)

Regulatory Basis

Title 10 of the Code of Federal Regulations (CFR) Section 54.21(a)(1) requires license renewal applicants to perform an integrated plant assessment (IPA) in their application to identify and list systems, structures, and components (SSCs) that are within the scope of license renewal and subject to aging management review (AMR). Further, 10 CFR 54.21(a)(3) requires for the SSCs identified to be subject to AMR, the applicant demonstrate that the effects of aging will be adequately managed such that their intended functions are maintained consistent with the current licensing basis (CLB) for the subsequent period of extended operation. To complete its review and enable the staff to make a reasonable assurance finding on functionality of reviewed SSCs for the subsequent period of extended operation consistent with 10 CFR 54.21, the staff requires under 10 CFR 54.29(a) additional information be provided regarding the matters described below.

RAI 3.5.2.2.2.6-1A

Background

The applicant in its response to SLRA RAI 3.5.2.2.2.6-1 stated that the "baseline condition of weld WR-36 has been established in part through the absence of bounding degradation detected on the horizontal surface of the RV [reactor vessel] support assembly for Oconee Units 1, 2, and 3." The response also identified loss of material and cumulative fatigue damage to be the aging effects that ONS manages and will continue to do so through ASME Section XI, Subsection IWF, Boric Acid Corrosion, and Fatigue Monitoring AMPs for the subsequent period of extended operation (SPEO). This RAI focuses on "bounding degradation" associated aging effects for loss of material due to boric acid, that could potentially exist at WR-36 weldments.

GALL-SLR AMP XI.S3, "ASME Section XI, Subsection IWF," in its "Acceptance Criteria" program states that "loss of material due to corrosion or wear," is an unacceptable condition for Class 1, 2, 3, and MC component supports. In its "Operating Experience" program element, it states that boric acid corrosion is an aging mechanism that could lead to cracking/SCC of bolts. GALL-SLR AMP XI.M10, "Boric Acid Corrosion," in its "Operating Experience," program element states:

> Boric acid corrosion has been observed in nuclear power plants and references [NRC IN 86-108 (and Supplements 1 through 3), IN 2002-11, IN 2002-13, and IN 2003-02] and has resulted in significant impairment of component-intended functions in areas that are difficult to access/observe (NRC Bulletin 2002-01). Boric acid leakage can become airborne and can cause corrosion in locations other than in the vicinity of the leak [Licensee Event Reports (LER) 250/2010-005, LER 346/2002-008]. Corrosion rates may be inaccurately predicted due to the installation of a different type of material than indicated on the design documents (LER 346/1998-009) or galvanic corrosion caused by wet boric acid crystals bridging between dissimilar metals [Electric Power Research Institute (EPRI) 1000975].

During the regulatory audit, the staff reviewed Action Request (AR) 01809387, which discusses the existence of boron residue on the ONS Unit 2 RV annulus cavity and RV support skirt. It states that although dry boron residue was found on the RV support skirt, the skirt did not exhibit signs of material degradation. Additional AR regulatory audit reviews included AR 02300737, which discusses borated water penetration beneath base plates resulting in potential corrosion under support base plates and anchor bolting, and ARs 01809387 and 01910016, which further address borated water leakage for loss of material and dependency of its rate on temperature and environment (see related audit questions at ADAMS Accession No. ML22024A038).

On March 16, 2022, the NRC staff held a closed public meeting with ONS, in part to clarify loss of material due to boric acid corrosion on the RV support skirt, summarized in a letter dated April 4, 2022, to Duke Energy (ADAMS Accession No. ML22084A614). ONS in its clarifying proprietary presentation (ADAMS Accession No. ML22084A109) stated:

> [[[redacted]

[redacted]]]

Issue

In the revised SLRA Table 3.1.2-1 regarding the "support skirt" AMR line items, the applicant proposes to manage the effects of aging for loss of material with SLRA AMPs B2.1.4 (Boric Acid Corrosion) and B2.1.30 (Section XI, Subsection IWF) during the SPEO. These SLRA AMPs have no discussion on "bounding degradation" for loss of material aging effect. The applicant's response to SLRA RAI 3.5.2.2.2.6-3 (designated by ONS as 3.5.2.2.2.2-3, ADAMS Accession No. ML22010A130) and discussion of TRP 76 RAI 3.5.2.2.2.2-3 during the March 7, 2022, (partially closed) and March 16, 2022, (closed) public meetings (documented in meeting summaries at ADAMS Accession Nos. ML22075A204 and ML22084A614, respectively) indicate that the RV lower skirt areas and RV anchorage experience temperatures close to the EPRI-referenced temperatures of 212–220°F (included in the EPRI "Boric Acid Corrosion: Revision to BAC Guidebook (ADAMS Accession No. ML120690185)) that result in a concentrated boric acid, maximizing its effects for corrosion/loss of material in areas where borated water leakage exists. Additionally, as noted above in the "Background," evaporating borated water could contribute to loss of material of the RV support skirt assembly that could include the W36 welds as well.

It is not clear whether the "bounding degradation" for loss of material refers to a specific amount (e.g., mills) or to a general corrosion that could affect the structural integrity or reduce the load bearing capacity of the RV support skirt assembly, and hence those of the W-36 weldments. It is also not clear how much boric acid could accumulate in the lower part of the RV support skirt/ RV anchorage and whether the accumulation would lead to a specific amount of loss of material that could be used as an indicator for the W-36 weldments integrity. Furthermore, it is not clear to what extent if any the evaporated off/airborne boric acid may have affected or potentially could affect difficult to access or uninspectable areas of the RV support skirt assembly, such as the W36 weldments, through the SPEO.

Finally, it is not clear what steps the applicant takes and will continue to do so to the end of the SPEO to ensure that difficult to access or uninspectable areas of the RV support skirt assembly, such as the W36 weldments at the transition forging to support skirt, are not affected by boric acid leakage or airborne boric acid that could cause loss of material. It is also not clear how ONS plans to use the "bounding degradation" for loss of material to establish a baseline for the condition of the W36 weldments before entering the SPEO and thereafter to its end to ensure the integrity of the W36 weldments.

Request

a) Describe the term "bounding degradation" in the context of loss of material aging effect. Include in the discussion numerical values considered in the "bounding degradation" for loss of material and how these values are used to evaluate the integrity of difficult to access or uninspectable areas, such as the W36 weldments, of the ONS units.
b) Clarify what steps ONS has taken and continues to do so for the subsequent period of extended operation to ensure that difficult to access or uninspectable areas of the RV support skirt assembly are not affected by airborne boric acid so that the structural integrity and bearing capacity of the support structure remains intact.
c) Identify necessary updates of pertinent areas of relevant procedures and of the SLRA reflecting the ONS response to this RAI clarifying the ONS position on "bounding degradation" associated with loss of material aging effect input or justify the ONS position for not updating.

RAI 3.5.2.2.2.6-1B

Background

The applicant's response to ONS SLRA RAI 3.5.2.2.2.6-1 stated that the "baseline condition of weld WR-36 has been established in part through the absence of bounding degradation detected on the horizontal surface of the RV support assembly for Oconee Units 1, 2, and 3." The response also identifies loss of material and cumulative fatigue damage to be the aging effects that ONS manages and will continue to do so through SLRA AMPs B2.1.4, B2.1.30, and B3.1, (ASME Section XI, Subsection IWF, Boric Acid Corrosion, and Fatigue Monitoring AMPs) respectively, during the SPEO. This RAI focuses on "bounding degradation" associated with the aging effect for cumulative fatigue damage of the WR-36 weldments.

SLRA Section 4.3.2.1 as amended by SLRA Supplement 2 dated November 11, 2021 (ADAMS Accession No. ML21315A012), states that “[t]he effects of fatigue on the intended functions of the reactor vessels, including the reactor vessel support skirts, will be adequately managed by the Fatigue Monitoring AMP (B3.1) for the Subsequent Period of Extended Operation (SPEO).”

SLRA AMP B3.1 (Fatigue Monitoring) in its “Program Description,” states it “monitors and tracks the number of occurrences and severity of design basis transients assessed in the applicable fatigue or cyclic loading analyses” and that “each analyzed component does not exceed the applicable limit through the SPEO.” SLRA Section B3.1 describes the AMP as consistent with enhancements and no exceptions to GALL-SLR AMP X.M1, which states that “[f]atigue of components is managed by monitoring one or more relevant fatigue parameters … established by the applicable fatigue analysis.” The GALL-SLR AMP X.M1 also states that the program “verifies the continued acceptability of existing analyses through cycle counting” and periodically updates “the fatigue analyses to demonstrate that they continue to meet the appropriate limits.”

<u>Issue</u>

SLRA AMP B3.1 has no discussion on “bounding degradation” for cumulative fatigue damage aging effect on the RV support skirt WR36 welds of the RV transition forging (i.e., dutchman). It is not clear what fatigue parameter(s) is (are) monitored for the relevant fatigue analysis (e.g., transient cycle limits/cyclic loading) for cumulative usage factor or reviewed for fatigue evaluation needed for ASME Section III fatigue waiver evaluation specific to the RV steel support skirt WR36 welds and used to define the “bounding degradation” for cumulative fatigue damage aging effect. It is also not clear whether such a fatigue analysis (or fatigue evaluation) considered the effects of the boric acid corrosion, if any, for the definition of “bounding degradation” aging effect for the WR-36 support skit welds.

<u>Request</u>

a) Describe the term “bounding degradation” as it relates to the cumulative fatigue damage aging effect. Include in the “bounding degradation” discussion for cumulative fatigue damage numerical values used in the relevant fatigue analysis (e.g., loading limit cycles) or considered in fatigue waiver evaluation.

b) Clarify whether loss of material aging effect (e.g., due to boric acid corrosion), if it occurs, has been considered in the fatigue life evaluation of the support skirt and in particular at the WR-36 weldments.

c) Identify necessary updates of pertinent areas of relevant procedures and of the SLRA reflecting the ONS response to this RAI clarifying the ONS position on “bounding degradation” for cumulative fatigue damage aging effect or justify the ONS position for not updating.

RAI 3.5.2.2.2.6-3A

Background

ONS in its response to RAI 3.5.2.2.2.6-3 (designated by ONS as 3.5.2.2.2.2-3, ADAMS Accession No. ML22010A130) described the methodology used to estimate the temperature at the RV concrete pedestal. It stated that its methodology is based on a two-dimensional (2D) model used in an analysis to calculate temperature contours at two representative **[[**[redacted]**]]**. The methodology **[[**[redacted]**]]**. Through this approach ONS concluded that “[a]ll primary shield wall concrete temperatures are less than 200°F in SLRA section 3.5.2.2.2.2.

Issue

The staff noted that Figures 3.5.2.2.2.2-3-1 and 3.5.2.2.2.2-3-2 presented in the response to RAI 3.5.2.2.2.6-3 (designated by ONS as 3.5.2.2.2.2-3) and Figures 9-5 and 9-6 in ANP-3898P (ADAMS Accession No. 21158A201) **[[**[redacted]**]]** During the March 7, 2022, (partially closed) and March 16, 2022, (closed) public meetings (documented in meeting summaries at ADAMS Accession Nos. ML22075A204 and ML22084A614, respectively), ONS stated that its methodology was based on **[[**[redacted]**]]**.

The **[[**[redacted]**]]**.

The staff notes that **[[**[redacted]**]]** provides a unique temperature estimate for the bolt or pin azimuth at the RV support skirt plate interfacing the concrete pedestal. What it is not clear in the SLRA and in the response to RAI 3.5.2.2.2.6-3 is the conservatism in the methodology used that led ONS conclude that "[a]ll primary shield wall concrete temperatures are less than 200° F."

<u>Request</u>

a) Clarify the conservatism used in the **[[** [redacted] **]]**.
b) Identify necessary updates of pertinent areas of the SLRA reflecting this RAI input or justify the ONS position for not updating.

RAI 3.5.2.2.2.6-7A

<u>Background</u>

In its nonproprietary response to RAI 3.5.2.2.2.6-7 (ADAMS Accession No. ML22045A021), the applicant determined that the nelson studs may be susceptible to irradiation embrittlement, which was based, in part, on the determination of the lowest service temperature (LST) value for the nelson studs. In proprietary report ANP-3898P, Revision 0 (Enclosure 5, Attachment 1 to the SLRA), the applicant explained that temperature contours of the reactor vessel (RV) support skirt assemblies of the ONS units were developed using models **[[** [redacted] **]]**. The applicant also explained these temperature contours during a closed, proprietary meeting on March 16, 2022 (ADAMS Accession No. ML22084A614 for meeting summary). The applicant stated that it used the temperature contour at the **[[** [redacted] **]].** However, the applicant's statement did not indicate that the nelson studs were included in the ANP-3898P evaluation, therefore the temperature contour used for the nelson studs is not clear.

<u>Issue</u>

Because the ANP-3898P evaluation did not include the nelson studs, the staff is not clear whether the LST value determined in the response to RAI 3.5.2.2.2.6-7 for the nelson studs was based on the temperature contour **[[** [redacted] **]]**.

Request

a) Clarify whether the LST value determined in the response to RAI 3.5.2.2.2.6-7 for the nelson studs was based on the temperature contour at the **[[** [redacted] **]]**.

b) Identify necessary updates of pertinent areas of the SLRA to reflect this clarification or justify the ONS position for not updating.

RAI 3.5.2.2.2.6-9

Background

In Section 9.4.3 of nonproprietary report ANP-3898NP, Revision 0 (Enclosure 4, Attachment 1 to the SLRA, ADAMS Accession No. ML21158A200), the applicant determined a minimum LST value of 139.05°F for the RV support skirt and steel components of the embedment assemblies. During a closed, proprietary meeting on March 16, 2022 (ADAMS Accession No. ML22084A614 for meeting summary), the applicant explained two conservatisms in the determination of the minimum LST value of 139.05°F.

Issue

To make its safety findings, the staff needs the explanation of the conservatisms applied to determine the minimum LST value of 139.05°F for the RV support skirt and steel components of the embedment assemblies submitted into the NRC docket.

Request

a) Discuss and submit the explanation(s) of conservatism(s) used in the determination of the minimum LST value of 139.05°F for the RV support skirt and steel components of the embedment assemblies submitted into the NRC docket.

b) Identify necessary updates of pertinent areas of the SLRA to reflect this explanation or justify the ONS position for not updating.

RAI 3.5.2.2.2.6-10

Background

In Section 9.4.4.3 of ANP-3898NP, Revision 0, the applicant discussed the initial nil-ductility temperature (NDT) values of the RV support skirt assembly components. In RCIs 3.5.2.2.2.6-H and 3.5.2.2.2.6-I, included in the letter dated December 2, 2021 (ADAMS Accession No. ML21336A001), the applicant confirmed that there were no plant-specific measured values of initial NDT (or Charpy V-Notch absorbed energy values from which initial NDT values can be derived) of the RV support skirt assembly components, and that the initial NDT values and corresponding margins came from NUREG-1509, "Radiation Effects on Reactor Pressure Vessel Supports," May 1996 and BAW-10046A, "Methods of Compliance With Fracture Toughness and Operational Requirements of 10 CFR 50, Appendix G," Revision 2 (ADAMS Accession No. ML20207G642).

Issue

Reporting of initial NDT values (or Charpy V-Notch absorbed energy values from which initial NDT values can be derived) for steel components are typically required by the design code of record, such as Section III of the ASME Code. It is not clear why plant-specific measured values of initial NDT values (or Charpy V-Notch absorbed energy values from which initial NDT values can be derived) were not available for the ONS RV support skirt assembly components. The NRC staff noted that plant-specific measured values of initial NDT values were also not available for the sole plate, vertical bearing plate, and nelson studs of the embedment assembly that the applicant evaluated in its response to RAI 3.5.2.2.2.6-7.

Request

a) Explain why plant-specific records of measured values of initial NDT (or Charpy V-Notch absorbed energy values from which initial NDT values can be derived) are/were not available for use in the ONS RV support skirt assembly and embedment assembly components (which includes the sole plate, vertical bearing plate, and nelson studs) for the transition temperature evaluation.
b) Identify necessary updates of pertinent areas of the SLRA to reflect this clarification or justify the ONS position for not updating.