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U.S. Nuclear Regulatory Commission
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Washington, DC 20555-0001

OCONEE NUCLEAR STATION, UNIT NOS. 1, 2 AND 3
DOCKET NOS. 50-269, 50-270, AND 50-287 / RENEWED LICENSE NOS. DPR-38, DPR-47, AND DPR-55

SUBJECT: Response to Second Request for Additional Information (RAI) Regarding Relief Request to Utilize an Alternative Acceptance Criteria for Code Case N-853, "PWR Class 1 Primary Piping Alloy 600 Full Penetration Branch Connection Weld Metal Buildup for Material Susceptible to Primary Water Stress Corrosion Cracking, Section XI, Division 1"

REFERENCES:

1. Duke Energy letter, *Relief Request to Utilize an Alternative Acceptance Criteria for Code Case N-853, "PWR Class 1 Primary Piping Alloy 600 Full Penetration Branch Connection Weld Metal Buildup for Material Susceptible to Primary Water Stress Corrosion Cracking, Section XI, Division 1"*, dated May 4, 2021 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML21124A170)
2. NRC email, *Oconee Nuclear Station, Units 1, 2, and 3 - Request for Additional Information RE: Alternative Request (RA-20-0334) Regarding use of an Alternative to the ASME Code Case N-853 Acceptance Criteria (EPID L-2021-LLR-0032)*, dated August 5, 2021 (ADAMS Accession No. ML21217A191)
3. Duke Energy letter, *Response to Request for Additional Information (RAI) Regarding Relief Request to Utilize an Alternative Acceptance Criteria for Code Case N-853, "PWR Class 1 Primary Piping Alloy 600 Full Penetration Branch Connection Weld Metal Buildup for Material Susceptible to Primary Water Stress Corrosion Cracking, Section XI, Division 1"*, dated August 31, 2021 (ADAMS Accession No. ML21243A515)
4. NRC email, *Oconee Nuclear Station, Units 1, 2, and 3 - Request for Additional Information RE: Alternative Request (RA-20-0334) Regarding use of an Alternative to the ASME Code Case N-853 Acceptance Criteria (EPID L-2021-LLR-0032)*, dated October 1, 2021 (ADAMS Accession No. ML21274A068)

Ladies and Gentlemen:

In Reference 1, Duke Energy Carolinas, LLC (Duke Energy) requested U.S. Nuclear Regulatory Commission (NRC) approval to use an alternative volumetric inspection acceptance criteria for American Society of Mechanical Engineers (ASME) Code Case N-853, "PWR Class 1 Primary Piping Alloy 600 Full Penetration Branch Connection Weld Metal Buildup for Material Susceptible to Primary Water Stress Corrosion Cracking, Section XI, Division 1" at Oconee Nuclear Station Units 1, 2, and 3 (ONS). Specifically, in lieu of the ASME Code, Section III, NB-5330 acceptance criteria for fabrication, Duke Energy proposed to use the preservice examination acceptance criteria of ASME Code, Section XI, IWB-3514. In Reference 2, the NRC staff requested additional information (RAI) regarding Reference 1. Duke Energy provided responses to the Reference 2 RAI in Reference 3. In Reference 4, the NRC staff submitted a second RAI to Duke Energy regarding Reference 1. Enclosure 1 provides Duke Energy's response to the Reference 4 RAI.

No new regulatory commitments have been made in this submittal. If you have additional questions, please contact Mr. Lee Grzeck, Manager (Acting) – Regulatory Affairs, at 980-373-1530.

Sincerely,

Steven M. Snider
Site Vice President
Oconee Nuclear Station

Enclosures:
1. Response to Request for Additional Information

cc:
L. Dudes, Regional Administrator USNRC Region II
J. Nadel, USNRC Senior Resident Inspector – ONS
S. A. Williams, NRR Project Manager – ONS

Enclosure 1
Response to Request for Additional Information

NRC RAI-3

The NRC staff notes that ASME Code Case N-853 requires the weld pad to be ultrasonically examined in accordance with Construction Code or Section III, NB-5330 fabrication acceptance criteria:

- To assure adequate fusion (i.e., adequate bond) with the base material, and
- To detect welding flaws, such as interbead lack of fusion, inclusions, or cracks.

The above requirement provides the basis for allowing only a visual examination for subsequent ISI of the weld pads in ASME Code Case N-853, because using the Section III, NB-5330 acceptance criteria ensures that there are no detrimental flaws (lack of fusion, cracks, etc.) that could propagate and compromise the weld pad. The licensee's proposal to use Section XI, IWB-3514 PSI acceptance criteria for the fabrication inspection could allow welding flaws that could propagate and compromise the structural integrity and leak tightness of the reactor coolant pressure boundary piping. Leaving welding flaws in the weld pads uninspected and unmonitored during service has not been justified.

In addition, the licensee stated that the precedent in reference 8 to letter dated May 4, 2021, approved the use of Section XI, IWB-3514 for full structural weld overlays (ASME Code Case N-638-1) in lieu of the Section III, NB-5330 acceptance criteria and is directly applicable to this proposed alternative RA-20-0334 using ASME Code Case N-853. However, the NRC staff notes that the full structural weld overlays in reference 8 to letter dated May 4, 2021, are volumetrically examined during subsequent ISI intervals to ensure that flaws left in service using the acceptance criteria of Section XI, IWB-3514 would be monitored and evaluated to ensure the flaws would not propagate to compromise the function of the weld overlay. However, there is only a visual examination performed during subsequent ISI interval for the weld pad used in ASME Code Case N-853, and the visual examination cannot monitor the flaws left in service. Therefore, the precedent in reference 8 to letter dated May 4, 2021, is not directly applicable due to the differences in monitoring the flaws left in service.

Provide justification for potentially leaving welding flaws in the weld pads without a periodic inservice volumetric examination. Provide discussion on how it maintains an acceptable level of quality and safety compared to the weld pad with no welding flaws, and how these as-left flaws would not grow during service to compromise the structural integrity and leak tightness of the reactor coolant pressure boundary piping without periodic monitoring by the inservice volumetric examination. In lieu of the above justification, the licensee may also provide the volumetric inspection criteria for monitoring the flaws to be left in service in the weld pad that would form the basis for using Section XI, IWB-3514 acceptance criteria for the weld pad, similar to the inservice examinations that monitor flaws in full structural weld overlays.

Duke Energy Response to NRC RAI-3

Duke Energy provides the following justification and discussion supporting leaving potential flaw(s) in the weld pads without periodic inservice volumetric examination.

Note that Duke Energy intends to use the acceptance criteria of IWB-3514 only. Evaluations using the acceptance criteria of IWB-3600 will not be performed. Any flaws not meeting the IWB-3514 criteria will be repaired/replaced.

The NRC staff noted that ASME Code Case (CC) N-853 requires the weld pad to be ultrasonically examined in accordance with Construction Code or Section III, NB-5330 fabrication acceptance criteria:

- Regarding assurance of adequate fusion (i.e., adequate bond) with the base material:

  Code Case (CC) N-853 requires standard Ultrasonic Testing (UT) of the weld pad/base metal fusion zone. Duke Energy will be applying manual Linear Phased Array (LPA) UT examination of the Alloy 52/152 weld pad and fusion zone, between the Alloy 82/182/Alloy 600 material and the carbon steel piping, which is an enhancement over the CC N-853 UT requirements. The applied LPA volumetric examination technique ensures the presence of an adequate bond between the weld pad and the carbon steel material. In addition, Duke Energy will perform a supplemental (i.e., not required by CC N-853) pre-weld pad installation volumetric manual LPA UT examination of the carbon steel base metal to develop a baseline inspection for use in resolving any features identified during the CC N-853 required final volumetric inspection for potential for lamellar tearing.

- Regarding the ability to detect welding flaws, such as interbead lack of fusion, inclusions, or cracks:

  The application of a manual LPA UT examination will identify all welding flaws, including interbead lack of fusion, inclusions, or cracking. The issue is not that these indications can be detected, manual LPA UT is more than capable of detecting and sizing these types of flaws. Rather, it is what acceptance criteria are to be used if they are detected. The use of IWB-3514 criteria to evaluate indications provides an acceptable level of quality and safety, as detailed below.

- Regarding the allowance of only a visual examination based on no detrimental flaws (lack of fusion, cracks, etc.) that could propagate and compromise the weld pad:

  As discussed in detail below, operating experience and industry reference demonstrate that any indications/flaws accepted using IWB-3514 acceptance criteria will not propagate and compromise the structural integrity and leak tightness of the reactor coolant pressure boundary piping, and thus allowing only a visual examination is justified.

To address the concern of leaving potential flaw(s) in the weld pads without periodic inservice volumetric examination, the NRC staff requested that Duke Energy provide discussion on how it:

1) Maintains an acceptable level of quality and safety as the weld pad with no welding flaws, and
2) How these as-left flaws would not grow during service to compromise the (a) structural integrity and (b) leak tightness of the reactor coolant pressure boundary piping
3) Without periodic monitoring by inservice volumetric examination.

The response to each of these three items is as follows:

1) How does potentially leaving welding flaws in the weld pads maintain an acceptable level of quality and safety as the weld pad with no welding flaws?

The NB-5331 acceptance criteria of CC N-853 do not guarantee zero welding flaws. NB-5331 allows for indications to be left in service (Reference 1). The main difference between the NB-5331 and IWB-3514 acceptance criteria is not necessarily the size of the acceptable indication, but the inspector's characterization (i.e., the reason) for the presence of the indication. NB-5331 requires judgement from the examiner in characterizing and accepting an indication. IWB-3514 does not rely on a similar judgement and evaluates all indications for their acceptability based on their size and orientation, not how they are characterized. The technical basis for the acceptance standards in IWB-3514 is provided in Reference 3. It is based strictly on the size of the indication, not the characterization of the indication. Therefore, meeting the flaw acceptance criteria of IWB-3514 maintains an acceptable level of quality and safety as that obtained by meeting the NB-5331 criteria.

2) What is the basis that these "as-left flaws" would not grow during service to compromise the structural integrity and leak tightness of the reactor coolant pressure boundary piping?

The flaw acceptance standards criteria in Paragraph IWB-3514 of the ASME Section XI Code of Record for the Oconee Nuclear Station (ONS) (i.e., 2007 Edition with 2008 Addenda) are more stringent than those in the more recent NRC endorsed Section XI Codes (i.e., 2015 and later editions). Duke Energy will apply manual LPA UT methods, an enhancement over the CC N-853 UT requirements. LPA UT can resolve indications well below the IWB-3514 acceptance criteria. Any significant welding flaws in the weld pad will be identified, located, and sized. Analytical studies have concluded that fatigue crack growth is insignificant for subsurface flaws that are smaller than the Section XI flaw acceptance standards. These analytical observations are supported by years of inspection results (Reference 2). Operating experience has shown that embedded welding flaws such as lack of fusion or inclusions, even larger than those allowed by IWB-3514, do not generally grow in service. These embedded indications, treated as cracks and evaluated per the rules of Section XI IWB-3600, do not show any significant crack growth. The ASME Code recognizes this, as discussed in the Reference 4, PVP 2008-61412 paper. Therefore, weld pad indications meeting the acceptance criteria of IWB-3514 are not expected to grow. Thus, their presence will not compromise the structural integrity or leak tightness of the reactor coolant pressure boundary components.

3) With the proposed use of IWB-3500 acceptance criteria, why is periodic volumetric monitoring by inservice examination not required?

IWB-3514 does not require periodic volumetric or surface examination of identified, acceptable flaws found in application of Section XI activities. This Section XI requirement is based on quantitative assessments in the development/basis for the IWB-3500 tables, that recognizes that acceptable indications/flaws are sufficiently small that flaw growth during life of plant operation is not a concern (Reference 3). Thus, periodic volumetric monitoring is not required. See response to Item (1) above for a discussion of why this is acceptable for the use of CC N-853.

Additional Supporting Justification

The use of ASME Code, Section XI, IWB-3514 (IWB-3514) acceptance criteria, in lieu of the NB-5330 acceptance criteria, will provide an acceptable level of quality and safety for the weld pads because of the following:

- Both NB-5330 and IWB-3514 allow for flaws to be left in service without compromising the structural integrity and leak tightness of the reactor coolant pressure boundary.

  Using the flaw acceptance criteria of the Construction Code, i.e., 2007/2008 edition/addenda ASME Code, Section III, NB-5331 as required by Code Case N-853, indications are allowed to be left in service. For a weld pad 1.4 inches thick, the allowed NB-5331 indication size (length) is 33% of thickness (Reference 4).

- Indications that may be left in service using the preservice acceptance standards of IWB-3514 are expected to be subsurface indications. Per Table IWB-3514-1 (2007/2008 edition/addenda which is the Code of record at Oconee), the maximum possible flaw depth of a subsurface indication is 9.4% of the pad thickness. It should be noted that most recent editions of ASME Section XI allow much larger flaws under IWB-3514 (up to 15% of thickness). Service experience has shown that subsurface indications (i.e., even those greater than the IWB-3514 acceptance standards) found during inservice examination of vessels and piping welds do not grow during the life of the component (References 2 and 4) since they are not in contact with the reactor coolant environment. As stated in Reference 4:

  > *The studies also concluded that fatigue crack growth is insignificant for subsurface flaws that are smaller than the Section XI flaw acceptance standards. These analytical observations are supported by years of inspection results.*

- The N-853 weld pad is qualified to replace the pressure boundary of a completely cracked Alloy 600 weld boss and its Alloy 82/182 attachment weld to the carbon steel piping and weld pad. Stability against additional cracking is assured by meeting elastic-plastic fracture mechanics (EPFM) criteria for the carbon steel material and Limit Load criteria for the 52/152 weld pad material. The fatigue crack growth analysis for the ONS resistance temperature element (RTE) weld pad demonstrates that it is qualified for an operating period that significantly exceeds the expected operating life of the Oconee Units. This analysis assumes that Alloy 600 nozzle and 82/182 weld material is cracked through the entire component thickness and width. Under the worst-case scenario, when a flaw left in the pad using IWB-3514 acceptance standards is assumed to conservatively align with this large design basis flaw, the depth of the design basis flaw increases less than 3% and then only for the limited indication length (i.e., not across the full 9.0 inch width of the RTE nozzle and 82/182 weld). Therefore, the design life of the pad is not significantly affected.

- The use of preservice and inservice visual examination for CC N-853 is based on, in part, utilizing NB-5330 acceptance criteria because it would assure adequate fusion (i.e., adequate bond) with the base material and to detect welding flaws, such as inter-bead lack of fusion, inclusions, or cracks. As described at the beginning of this RAI response, use of the IWB-3514 acceptance criteria, coupled with the use of LPA UT techniques, in

lieu of NB-5330, would continue to assure adequate fusion and detection of welding flaws.

Post implementation periodic visual examination will also allow leakage to be identified prior to flaw growth that compromises the structural integrity of the pressure boundary components, as described in the following bullet.

- The purpose of the visual examination requirement of Code Case N-853 is to ensure that the as-left structure, with imperfections acceptable per NB-5330 and any subsequent fatigue crack growth, does not cause pressure boundary failure. Periodic visual examinations required by CC N-853, will identify any leakage and require resolution, prior to growth of imperfections/indications that could compromise the structural capacity of the component. It is noted that the use of NB-5331 acceptance criteria allow for indications, and visual examinations alone are used to monitor for leakage.

  Similarly, using the IWB-3514 acceptance standards, any subsurface indication left in service will be monitored through the visual examination requirement in Code Case N-853 to ensure that they do not challenge the structural integrity of the pressure boundary.

  Both acceptance criteria allow the use of visual examinations to identify leakage which would be addressed prior to the growth of the leaking flaws that would compromise the structural integrity of the components.

REFERENCES

1. ASME Code, Section III, Subsection NB, 2007/2008 Edition/Addenda.
2. F. A. Simonen, “Fracture Mechanics Evaluation of Surface Flaws in Reactor Pressure Vessels,” Meeting Minutes from ASME Section XI Task Group on Application of NDE to Operating Criteria, May 1993.
3. R. R. Maccary, “Nondestructive Examination Acceptance Standards – Technical Basis and Development of Boiler and Pressure Vessel Code, ASME Section XI, Division 1,” EPRI NP-1406-SR, May 1980.
4. N. G. Cofie, P. C. Riccardella, J. H. Merkle and H. Do, “Technical Basis for Alternate Successive Inspection Requirements for Vessels and Piping Welds as Prescribed in Code Case N-526 and N-735,” Paper No. PVP2008-61412, Proceedings of PVP2008, 2008 ASME Pressure Vessels and Piping Division Conference, July 27 – 31, 2008, Chicago, Illinois, USA.