NEXTera® ENERGY
POINT BEACH

September 20, 2021

L-2021-172
10 CFR 54.17

U.S. Nuclear Regulatory Commission
Attention: Document Control Desk
11545 Rockville Pike
One White Flint North
Rockville, MD 20852-2746

Point Beach Nuclear Plant Units 1 and 2
Dockets 50-266 and 50-301
Renewed License Nos. DPR-24 and DPR-27

SUBSEQUENT LICENSE RENEWAL APPLICATION - AGING MANAGEMENT REQUEST FOR ADDITIONAL INFORMATION (RAI) SET 7 RESPONSE

References:

1. NextEra Energy Point Beach, LLC (NEPB) Letter NRC 2020-0032 dated November 16, 2020, Application for Subsequent Renewed Facility Operating Licenses (ADAMS Package Accession No. ML20329A292)
2. U.S. Nuclear Regulatory Commission (NRC) Letter dated January 15, 2021, Point Beach Nuclear Plant, Units 1 and 2 - Determination of Acceptability and Sufficiency for Docketing, Proposed Review Schedule, and Notice of Opportunity to Request a Hearing Regarding the NextEra Energy Point Beach, LLC Application for Subsequent License Renewal (EPID No. L-2020-SLR-0002) (ADAMS Accession No. ML21006A417)
3. NRC Letter dated January 15, 2021, Point Beach Nuclear Plant, Units 1 and 2 - Aging Management Audit Plan Regarding the Subsequent License Renewal Application Review (ADAMS Accession No. ML21007A260)
4. US Nuclear Regulatory Commission Meeting with NextEra Energy Concerning the Point Beach Subsequent License Renewal Application Review – June 3, 2021 Public Meeting (ADAMS Accession No. ML21148A116)
5. NRC Email and Attachment dated August 20, 2021, Point Beach SLRA RAI Set 7 Final (ADAMS Accession Nos. ML21242A219, ML21242A220)

NEPB, owner and licensee for Point Beach Nuclear Plant (PBN) Units 1 and 2, has submitted a subsequent license renewal application (SLRA) for the Facility Operating Licenses for PBN Units 1 and 2 (Reference 1). On January 15, 2021, the NRC determined that NEPB's SLRA was acceptable and sufficient for docketing (Reference 2), and on January 15, 2021 issued the regulatory audit plan for the aging management portion of the SLRA review (Reference 3). Based on the information exchanged and discussions held during the public meeting held on June 3, 2021 (Reference 4), the NRC issued its Set 7 RAI to NEPB (Reference 5). The attachment indexed on page 3 of this letter provides the response to this information request.

Should you have any questions regarding this submittal, please contact me at (561) 304-6256 or William.Maher@fpl.com.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on the 20th day of September 2021.

Sincerely,

William Maher

Digitally signed by William Maher
DN: cn=William Maher, o=Nuclear, ou=Nuclear Licensing Projects, email=william.maher@fpl.com, c=US
Date: 2021.09.20 09:18:04 -04'00'

William D. Maher
Licensing Director - Nuclear Licensing Projects

Cc: Administrator, Region III, USNRC
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Resident Inspector, Point Beach Nuclear Plant, USNRC
Public Service Commission Wisconsin

Attachment Index		
Attachment No.	RAI No.	Subject
1	4.7.2-1	Leak-Before-Break of Reactor Coolant System Auxiliary Piping

1. SLRA Section 4.7.2, "Leak-Before-Break of Reactor Coolant System Auxiliary Piping"

RAI 4.7.2-1

Regulatory Basis:

Pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) Section 54.21(c), the SLRA shall include an evaluation of time-limited aging analyses (TLAAs). The applicant shall demonstrate that (i) the analyses remain valid for the subsequent period of extended operation; (ii) the analyses have been projected to the end of the subsequent period of extended operation; or (iii) the effects of aging on the intended function(s) will be adequately managed for the subsequent period of extended operation.

Background:

SLRA Section 4.7.2, "Leak-Before-Break [LBB] of Reactor Coolant System Auxiliary Piping," identifies the potential for thermal aging of the auxiliary line piping components and fatigue crack growth as the aging effects that must be addressed for subsequent license renewal (SLR). SLRA Section 4.7.2 states that thermal aging of the stainless steel weld material was considered in the evaluations of the pressurizer surge line, the residual heat removal (RHR) system, and the accumulator line (see WCAP-15065-P-A, Revision 1, "Technical Justification for Eliminating Pressurizer Surge Line Rupture as the Structural Design Basis for Point Beach Units 1 and 2 Nuclear Plants," June 2001; WCAP-15105-P-A, Revision 1, "Technical Justification for Eliminating Residual Heat Removal (RHR) Rupture as the Structural Design Basis for Point Beach Units 1 and 2 Nuclear Plants," June 2001; and WCAP-15107-P-A, Revision 1, "Technical Justification for Eliminating Accumulator Rupture as the Structural Design Basis for Point Beach Units 1 and 2 Nuclear Plants," June 2001) by assuming saturated conditions (fully aged).

In addition, SLRA Section 4.7.1, "Leak-Before-Break of Reactor Coolant System Loop Piping," and WCAP-14439-P, Revision 4, "Technical Justification for Eliminating Large Primary Loop Pipe Rupture as the Structural Design Basis for the Point Beach Nuclear Plant Units 1 and 2 for the Subsequent License Renewal Program (80 Years)," June 2020, address thermal aging effects on the cast austenitic stainless steel components for the LBB analyses of the Point Beach reactor coolant loop piping.

Issue:

SLRA Enclosure 4, Attachment 17, Westinghouse LTR-SDA-II-20-06, Revision 1, "Leak-Before-Break Reconciliation of the Point Beach Units 1 and 2 Pressurizer Surge Line, Residual Heat Removal Line, and Accumulator Line Piping Systems for the Subsequent License Renewal Program," May 4, 2020, does not discuss the disposition of thermal aging of the stainless steel welds as described in SLRA Section 4.7.2 and does not provide a basis for that disposition in the SLRA.

In addition, the equation used to implement the assumption of "saturated conditions (fully aged)" in the calculations is Eq. 3

$$J\ (kJ/\mathrm{m}^2) = 73.4 + 83.5\ \Delta a\ (mm)^{0.643}$$

in NUREG/CR-6428, "Effects of Thermal Aging on Fracture Toughness and Charpy-Impact Strength of Stainless Steel Pipe Welds," May 1996 ("Revision 0"), which is described as "the lower–bound J–R curve for both SAWs [submerged arc welds] and SMAWs [shielded metal arc welds]." A more recent report, NUREG/CR-6428, Revision 1, "Effects of Thermal Aging on Fracture Toughness and Charpy-Impact Strength of Stainless Steel Pipe Welds," August 2018 ("Revision 1"), identifies Eq. 22

$$J\ (kJ/\mathrm{m}^2) = 117\ \Delta a\ (mm)^{0.45}$$

as the recommended lower bound J-R curve for thermally aged SAWs and SMAWs. Eq. 22 of Revision 1 is approximately 25% lower than Eq. 3 of Revision 0 at a crack growth (Δa) value of 1 mm.

Request:

1. What is the basis for the disposition of 10 CFR 54.21(c)(1)(i) in SLRA Section 4.7.2 as it pertains to thermal aging of stainless steel welds?
2. In its consideration of the TLAA related to LBB analyses for the reactor coolant system auxiliary piping, did the applicant consider the updated analysis on lower bound thermal aging of stainless steel welds from NUREG/CR-6428, Revision 1, relative to the assumptions made in WCAP-15065-P-A, Revision 1, WCAP-15105-P-A, Revision 1, and WCAP-15107-P-A, Revision 1?
3. Would the use of the updated lower bound thermal aging curves for stainless steel welds from NUREG/CR-6428, Revision 1 affect the conclusions in SLRA Section 4.7.2?
4. As cited in SLRA Section 4.7.1, WCAP-14439-P, Revision 4 addresses thermal aging effects on the cast austenitic stainless steel components for the LBB analyses of the Point Beach reactor coolant loop piping. Was thermal aging of the stainless steel welds considered in this report, and would use of the updated lower bound thermal aging curves for stainless steel welds from NUREG/CR-6428, Revision 1 affect the conclusions in SLRA Section 4.7.1?

NEPB Response:

1. The statement from Section 4.7.2 of the SLRA, regarding thermal aging of stainless steel weld material, is based on the original NRC Staff Safety Evaluation Reports (SERs), which are now archived within the auxiliary line LBB reports for Point Beach Units 1 and 2:
   - Pressurizer Surge Line WCAP-15065-P-A, Revision 1 (Reference 1); SER dated 12/15/2000 *(ADAM Accession Number ML003777863)*
   - RHR Line WCAP-15105-P-A, Revision 1 (Reference 2); SER dated 12/18/2000 *(ADAM Accession Number ML003777964)*

- Accumulator Line WCAP-15107-P-A, Revision 1 (Reference 3); SER dated 11/7/2000 *(ADAM Accession Number ML003767681)*

Section 4.1 in each of these SERs includes a discussion related to thermal aging of stainless steel welds and summarizes evaluations performed by the NRC Staff.

It is noted that the evaluation considering the effects of thermal aging on stainless steel welds was not performed by Westinghouse and is not typical of any Westinghouse LBB analyses (past or current) that have been submitted to the NRC. Therefore, Westinghouse is not cognizant of the specific details of the Staff's independent evaluations discussed in Section 4.1 of the SERs.

For notable precedents, the Subsequent License Renewal Application for Turkey Point Units 3 and 4 was issued in 2019. This application included LBB evaluations for reactor coolant loop (RCL) and auxiliary piping systems, with no evaluation related to NUREG-6428 or the thermal aging of stainless steel weld materials. Specifically, the SER for the Turkey Point SLRA (updated in December of 2019) includes the following statement regarding thermal embrittlement on auxiliary piping systems (page 4-65 of Reference 4):

> *"The staff also finds that, because the subject piping does not contain CASS, thermal embrittlement is not an issue; therefore, a TLAA is not necessary to address material property changes due to thermal aging embrittlement."*

It should be noted that the materials for the Turkey Point Units 3 and 4 auxiliary piping components (i.e. surge, RHR, and accumulator) and welds are the same as Point Beach Units 1 and 2, as such there are no CASS components in the piping systems.

Furthermore, as part of the Surry RCL LBB evaluations (see Section 4.7.3.2.2 of Surry SLR SER; Reference 5), the Staff accepted that the aged fracture toughness of the wrought and cast stainless steel base metal is more limiting than that of the stainless steel weld metal. Therefore, no additional thermal aging analysis was needed for the stainless steel weld metal in the LBB evaluations for the Surry RCL. The Surry auxiliary lines (accumulator, surge, RHR, safety injection, and loop bypass) were also evaluated for LBB. Similar to the Point Beach auxiliary lines, the Surry lines are also made of non-CASS stainless steel base metal and SMAW or SAW welds. For these non-CASS materials, no thermal aging was necessary for the Surry auxiliary lines. The Staff has accepted the Surry auxiliary lines LBB evaluation on August 20, 2021 based on the understanding that there is no additional thermal aging embrittlement for the non-CASS base and weld metals (see Section 3.3.1 of Reference 6).

Similarly, the NRC SER for the License Renewal for Vogtle Units 1 and 2 was issued in April of 2009 (Reference 7). Again, the LBB evaluations and SER for the RCL and auxiliary piping do not include any content specific to NUREG-6428 or the thermal aging of stainless steel weld materials.

Therefore, the Westinghouse LBB evaluations performed in WCAP-15065-P-A, Revision 1, WCAP-15105-P-A, Revision 1, and WCAP-15107-P-A, Revision 1 have been evaluated and determined to remain valid for the Subsequent Period of Extended Operation (SPEO) in accordance with 10CFR54.21(c)(1)(i).

2. Thermal aging of stainless steel welds is not considered in the Westinghouse LBB evaluations of the Point Beach Units 1 and 2 pressurizer surge line (WCAP-15065-P-A, Reference 1), RHR line (WCAP-15105-P-A, Reference 2), nor accumulator line (WCAP-15107-P-A, Reference 3). These evaluations are consistent with guidance from the Generic Aging Lessons Learned (GALL) Report (Reference 8) and the GALL Subsequent License Renewal (SLR) Report (Reference 9). NUREG-1801 and NUREG-2191 endorse addressing thermal aging of cast austenitic stainless steel (CASS) base metals for piping systems. NUREG-1801 and NUREG-2191 do not mention NUREG-6428, nor recognize thermal aging of stainless steel welds as an aging effect necessitating management for the PEO and SPEO, respectively.

   Additionally, there are no known NRC Interim Staff Guidance (ISG) documents pertaining to thermal aging of stainless steel welds. The response to Request 1 (above) details recent LBB precedents for Turkey Point, Surry, and Vogtle (References 4 through 7), which demonstrate acceptance of LBB evaluations without thermal aging of stainless steel welds. See also response to Request 3 (below) regarding Revision 0 versus Revision 1 of NUREG-6428. The Westinghouse LBB methodology for Point Beach Units 1 and 2, with respect to thermal aging of piping and weld materials, is consistent with recent license renewal applications (References 4, 5, and 7, as discussed in response to Request 1).

3. As noted in response to Request 1, the stainless steel weld thermal aging evaluations for the Point Beach Units 1 and 2 auxiliary piping systems were performed by the NRC Staff during the initial review in 2000 for WCAP-15065-P (Reference 1), WCAP-15105-P (Reference 2), and WCAP-15107-P (Reference 3).

   Per Section 4.1 of the SERs attached to each LBB report, the Staff justifies the use of the unaged lower-bound J-R curve from NUREG-6428 as appropriate for evaluating thermal aging:

   > "*...lower bound J-R curve used by the staff was actually developed by Wilkowski and Ghadiali at Battelle Columbus Laboratory as a fit to* ***unaged*** [emphasis added] *SS weld data, but the conclusions of Reference 3* [NUREG-6428, Revision 0] *noted that there was little observed change in the fracture toughness behavior with thermal aging for those welds that began with inferior fracture toughness properties.*"

   The unaged and aged lower-bound J-R curve equations are not updated between Revision 0 and Revision 1 of NUREG-6428 (see equations below). The only update in Revision 1 of NUREG-6428 is to provide the standard power law curve fit equations for both unaged and aged J-R curves (see discussion in Section 3.2.3

and Figure 3-13 and Figure 3-14 of NUREG-6428, Revision 1). As discussed above, only the unaged lower-bound fracture toughness curve was used per the justification given above for the NRC Staff review and approval of the LBB lines.

Unaged lower bound fracture toughness:

$$J\left(\frac{kJ}{m^2}\right) = 73.4 + 83.5\,\Delta a(mm)^{0.643}$$

Equation (3) in NUREG-6428 Revision 0, Equation (18) in NUREG-6428 Revision 1

$$J(kJ/m^2) = 138\,\Delta a(mm)^{0.45}$$

Equation (19) in NUREG-6428 Revision 1

Aged fracture toughness:

$$J(kJ/m^2) = 40 + 83.5\,\Delta a(mm)^{0.643}$$

Equation (4) in NUREG-6428 Revision 0, Equation (21) in NUREG-6428 Revision 1

$$J(kJ/m^2) = 117\,\Delta a(mm)^{0.45}$$

Equation (22) in NUREG-6428 Revision 1

As discussed in Section 3.2.3 and Figure 3-13 and Figure 3-14 of NUREG-6428, Revision 1, the thermal aging correlations in NUREG-6428 Revision 1 remain the same as Revision 0. Thus, the conclusions in the original SERs of WCAP-15065-P-A (Reference 1), WCAP-15105-P-A (Reference 2), and WCAP-15107-P-A (Reference 3) are still applicable to the SLR LBB evaluations. The NRC Staff review for the current 80-year application should be consistent and remain unchanged from the original review of these LBB lines since the NUREG-6428 Revision 0 had already provided both the unaged and aged correlations for stainless steel welds.

As justified in WCAP-15065-P-A (Reference 1), WCAP-15105-P-A (Reference 2), and WCAP-15107-P-A (Reference 3), fracture mechanics evaluations for LBB are primarily based on a limit load evaluation methodology (with applied Z-factor to account for reduced toughness of SMAW/SAW welds), considering the tensile properties of the base metal, which are more limiting than the tensile properties of the weld material.

4. Thermal aging of stainless steel welds was not considered for the RCL piping of Point Beach Units 1 and 2 in WCAP-14439-P, Revision 4. This is consistent with all past (and current) Westinghouse LBB evaluations for RCL piping. As noted in the response to Request item 1, SERs for Turkey Point Units 3 and 4 (Reference 4), Surry Units 1 and 2 (Reference 5), and Vogtle Units 1 and 2 (Reference 7) provide examples of prior approvals that do not evaluate thermal aging of stainless steel weld materials for the RCL piping systems. Specifically, for the Surry SER (Section 4.7.3.2.2 of Reference 5), the Staff accepted that the aged fracture

toughness of the wrought and cast stainless steel base metal is more limiting than that of the stainless steel weld metal. Likewise, the SER for first License Renewal for Point Beach Units 1 and 2 (Reference 10, Section 4.4.4 for RCL piping LBB) does not consider thermal aging of stainless steel weld materials.

Consistent with the response for Request item 2, the evaluation of LBB for the RCL piping is based on guidance from NUREG-1801 (Reference 8) and NUREG-2191 (Reference 9). Again, these references endorse addressing thermal aging of CASS base metals for piping systems, but do not recognize thermal aging of stainless steel welds nor do these references mention NUREG-6428.

The RCL fracture mechanics evaluations, supporting LBB, are based on either a limit load evaluation methodology (with welding process Z-factors) considering the limiting tensile properties of the base metal, or an Elastic Plastic Fracture Mechanics (EPFM) evaluation considering the thermally aged CASS base metal properties.

Summary and Conclusions

The subject of this RAI is specific to the thermal aging of stainless steel welds. The responses, herein, show that the Westinghouse analyses for Leak-Before-Break of the Point Beach RCL and auxiliary piping systems do not consider thermal aging of stainless steel weld materials. Precedents for LBB applications at Turkey Point, Surry, and Vogtle (References 4 through 7) demonstrate recent acceptance of LBB evaluations without thermal aging of stainless steel welds. Furthermore, basis documents; GALL (Reference 8), GALL-SLR (Reference 9), and current ISGs do not specifically recognize thermal aging of stainless steel welds.

The research into thermal aging of stainless steel welds, documented in NUREG-6428, has not changed significantly. Material testing data and lower bound fracture toughness J-R curves are consistent between Revision 0 (1996) and Revision 1 (2018) of NUREG-6428. With no change to the lower bound fracture toughness, the original Staff review and approval of the Point Beach auxiliary line LBB evaluations remains applicable for the 80-year SPEO.

The Point Beach LBB analyses of the RCL and auxiliary piping systems are consistent with industry guidance and recent precedents. These evaluations remain applicable for the 80-year SPEO.

References:

1. Westinghouse Report, WCAP-15065-P-A Revision 1, "Technical Justification for Eliminating Pressurizer Surge Line Rupture as the Structural Design Basis for Point Beach Units 1 and 2 Nuclear Plants," June 2001
2. Westinghouse Report, WCAP-15105-P-A Revision 1, "Technical Justification for Eliminating Residual Heat Removal (RHR) Rupture as the Structural Design Basis for Point Beach Units 1 and 2 Nuclear Plants," June 2001

3. Westinghouse Report, WCAP-15107-P-A Revision 1, "Technical Justification for Eliminating Accumulator Rupture as the Structural Design Basis for Point Beach Units 1 and 2 Nuclear Plants," June 2001
4. U.S. NRC, "Safety Evaluation Report Related to the Subsequent License Renewal of Turkey Point Generating Units 3 and 4," December 2019 *(ADAM Accession Number ML19191A057)*
5. U.S. NRC, "Safety Evaluation Report Related to the Subsequent License Renewal of Surry Power Station, Units 1 and 2," March 2020 *(ADAM Accession Number ML20052F520)*
6. U.S. NRC, "Surry Power Station, Units 1 and 2 – Issuance of Amendment Nos. 304 and 304 Re: Leak-Before-Break for Pressurizer Surge, Residual Heat Removal, Safety Injection Accumulator, Reactor Coolant System Bypass and Safety Injection Lines," August 20, 2021 *(ADAMS Accession Number ML21175A185)*
7. U.S. NRC, "Safety Evaluation Report Related to the License Renewal of Vogtle Electric Generating Plant, Units 1 and 2," Volume 2, April 2009 *(ADAMS Accession Number ML091320236)*
8. U.S. NRC, NUREG-1801, Revision 2, "Generic Aging Lessons Learned (GALL) Report – Final Report," December 2010 *(ADAMS Accession Number ML103490041)*
9. U.S. NRC, NUREG-2191, Volume 2, "Generic Aging Lessons Learned for Subsequent License Renewal (GALL-SLR) Report – Final Report," July 2017*(ADAMS Accession Number ML17187A204)*
10. U.S. NRC, NUREG-1839, "Safety Evaluation Report Related to the License Renewal of the Point Beach Nuclear Plant, Units 1 and 2," December 2005 *(ADAMS Accession Number ML053420137)*

Associated SLRA Revisions:

None.

Associated Enclosures:

None.