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

September 8, 2021

Mr. John A. Krakuszeski
Site Vice President
Brunswick Steam Electric Plant
Duke Energy Progress, LLC
8470 River Rd. SE (M/C BNP001)
Southport, NC 28461

SUBJECT: BRUNSWICK STEAM ELECTRIC PLANT, UNITS 1 AND 2 – REQUEST FOR ADDITIONAL INFORMATION REGARDING PROPOSED ALTERNATIVE TO ASME SECTION XI REQUIREMENTS FOR REPAIR/REPLACEMENT OF BURIED SERVICE WATER PIPING (EPID L-2021-LLR-0014)

Dear Mr. Krakuszeski:

By letter dated February 24, 2021, as supplemented by letters dated May 3, 2021, and June 22, 2021 (Agencywide Documents Access and Management System Accession Nos. ML21055A797, ML21123A293, and ML21173A253), Duke Energy Carolinas, LLC (Duke Energy, or the licensee) submitted a request pursuant to Section 50.55a(z)(1) of Title 10 of the *Code of Federal Regulations* (10 CFR), to use an alternative to certain requirements of the American Society for Mechanical Engineers Boiler & Pressure Vessel Code, Section XI. Specifically, the licensee requested approval to allow the use of Carbon Fiber Reinforced Polymer Composite System for the internal repair of the buried service water piping at Brunswick Steam Electric Plant, Units 1 and 2.

The U.S. Nuclear Regulatory Commission (NRC) staff has determined that additional information is needed as discussed in the Enclosure. During a clarification call on September 7 2021, Mr. Arthur Zaremba of your staff agreed that Duke Energy would respond within 30 days of the date of this letter.

The NRC staff's request for additional information (RAI) contains proprietary information as originally submitted in the letter dated February 24, 2021. Proprietary information withheld under 10 CFR 2.390 is identified by text enclosed within double brackets as shown here **[[   ]]**. A non-proprietary version of the RAI is provided as Enclosure 2.

Enclosure 1 to this letter contains proprietary information. When separated from Enclosure 1, this document is DECONTROLLED.

If you have any questions, please contact me at 301-415-0615 or via e-mail at Zackary.Stone@nrc.gov.

Sincerely,

/RA/

Zackary R. Stone, Project Manager
Plant Licensing Branch II-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. 50-324 and 50-325

Enclosures:
1. Request for Additional Information (Proprietary)
2. Request for Additional Information (Non-Proprietary)

cc: w/o Enclosure 1: Listserv

ENCLOSURE 2

NON-PROPRIETARY VERSION

REQUEST FOR ADDITIONAL INFORMATION

BRUNSWICK STEAM ELECTRIC PLANT, UNITS 1 AND 2

DUKE ENERGY CAROLINAS, LLC

PROPOSED ALTERNATIVE TO ASME SECTION XI REQUIRMENTS FOR

REPAIR/REPLACEMENT OF BURIED SERVICE WATER PIPING

DOCKET NOS. 50-324 AND 50-325

REQUEST FOR ADDITIONAL INFORMATION

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DUKE ENERGY CAROLINAS, LLC

PROPOSED ALTERNATIVE TO ASME SECTION XI REQUIRMENTS FOR

REPAIR/REPLACEMENT OF BURIED SERVICE WATER PIPING

DOCKET NOS. 50-324 AND 50-325

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Regulatory Basis:

Pursuant to 10 CFR 50.55a(z)(1), the applicant shall demonstrate that proposed alternatives to Code requirements would provide an acceptable level of quality and safety.

The U.S. Nuclear Regulatory Commission (NRC) staff's request for additional information (RAI) contains proprietary information as originally submitted in the letter dated February 24, 2021. Proprietary information withheld under 10 CFR 2.390 is identified by text enclosed within double brackets as shown here **[[ ]]**. A non-proprietary version of the RAI is provided as Enclosure 2.

EMIB RAI-1:

The scope section of Attachment A in Enclosure 2 of the submittal mentions that it has not been determined whether the cement mortar lining will be removed or remain in place for upgrade of Brunswick service water piping using CFRP composite lining. Attachment B, Table 1 of Enclosure 4 provides a minimum average requirement for shear bond strength between CFRP and steel of **[[ ]]**. Section 5A.3.1 of Attachment A in Enclosure 5 lists shear bond strength of CFRP on host pipe of **[[ ]]**, which is also used in calculations in Attachment C of Enclosure 5.

(a) Discuss the applicability of the above noted shear bond strength values for the following situations:
    a. Between CFRP and host steel pipe when the cement lining is removed, and
    b. Between CFRP and host steel pipe when cement lining remains in place.

(b) Discuss the acceptability of shear bond strength of **[[ ]]**.

EMIB RAI-2:

Figures S-7 and S-8 in Attachment D to Enclosure 5 of the submittal provide illustrations of CFRP composite system termination detail at straight ends, and repair terminations, where a certain length of host pipe is required to act compositely with the CFRP system. At the ends of the repair, a good bond with host pipe substrate is critical to maintain structural integrity so that the CFRP composite system can transfer loads to the host pipe. Provide additional discussion to address the following related to the intact or non-repaired side of the terminations.

(a) Whether the intact piping on the non-repaired side of terminations is buried, or whether all non-repaired side is above ground.

(b) The distance from the termination end to the end of buried portion of pipe or to the beginning of aboveground piping in the building penetrations or valve pits.

(c) The distance from termination end to the piping supports or anchors in the vicinity for the aboveground piping.

(d) Repair terminations interface with the repaired and the non-repaired sides of the piping. It appears that the loads from the repaired side are considered. Provide a discussion on structural integrity of the repair terminations from consideration of any dead weight, thermal, seismic, and any other applicable loadings from the non-repaired side for the terminations at Reactor Building wall, radwaste tunnel, and service water pumphouse. Address the structural integrity of the terminations for combined loads from repaired side and non-repaired or above ground continuation piping.

(e) Attachment C of Enclosure 5 lists a stress of **[[ ]]** of maximum longitudinal demand from non-repair side. Discuss if this stress represents the effect from all loadings from nonrepaired side combined with the effects from loads from repaired side to verify the structural integrity of the termination interfaces.

EMIB RAI-3:

Attachment F in Enclosure 5 discusses seismic analysis for the design basis earthquake (DBE) combined with emergency operating conditions for service water piping. The seismic analysis of the piping is performed using the analytical software ABAQUS. Attachment F to Enclosure 5 states that seismic ground strain analysis is based on 100-40-40 combination rule described in American Society of Civil Engineers, ASCE/SEI 4-16, “Seismic Analysis of Safety-Related Nuclear Structures”. Discuss how this seismic analysis compares with the original design criteria. 100-40-40 combination refers to three orthogonal directions. Eight load cases were considered but included only two horizontal directions. The third orthogonal direction (vertical) appears to be not considered. Please provide rationale to justify the approach used.

EMIB RAI-4:

Some recent limited testing data indicates that the glass transition temperature (T_g) is also dependent on the cure temperature. If the actual cure temperature in the field is not-high enough, the glass transition temperature, as listed in Enclosure 4, Attachment B, Table 3, of $T_g \geq$ max **[[ ]]** may not be achieved. When T_g is very close to T_{max} with no **[[ ]]**, the epoxy may become rubbery and the CFRP system may lose its structural integrity and therefore capability to support the applied loads.

(a) Provide discussion and any test data on field cure temperature effect, and realistic glass transition temperature achievable with curing temperatures attainable during actual CFRP repair field installation conditions at Brunswick.

(b) Include a detailed discussion to provide assurance that the epoxy will not become rubbery, and the CFRP system will be capable of supporting the applied loading at the maximum operating temperature of **[[ ]]**. Provide a discussion on how much will be the margin between realistic T_g achievable for curing and installation at Brunswick and maximum operating temperature of **[[ ]]**.

(c) It appears that Enclosure 6 Attachment C and Enclosure 7 address tension testing and degree of cure testing of witness panels. However, the submittal does not discuss testing for glass transition temperature of the as-installed field cured CFRP repair. The licensee is requested to address testing of witness panels representing the as installed field cured conditions for T_g to demonstrate that $T_g \geq T_{max}$ + margin.

(d) The following cautionary note is provided in in Section 401-VIII-4 CURE of ASME PCC-2-2018 standard.

> Caution: Each polymer in the repair system can be cured to a range of glass transition temperatures. Repair systems will not achieve the ultimate glass transition temperature determined by the qualification testing specified in this Standard unless they experience the same temperature for the same period of time as the sample tested. Repairs designed for elevated temperature service will not meet the requirements of this Article unless they are subject to a post-cure (heating) cycle that matches the thermal history of the sample tested during qualification.

Please provide a discussion on whether the Brunswick CFRP piping repair installation will satisfy the above cautionary note.

EMIB RAI-5:

Attachment A to Enclosure 9 discusses operating experience and provides a list of successful applications of CFRP composite systems in piping.

(a) Clarify if any of those listed in Enclosure 9 include similar cure at elevated temperatures, and whether the epoxy used is the same as that planned for use at Brunswick.
(b) Also, clarify if any of those in Enclosure 9 include CFRP repair of steel piping with cement mortar lining.

EMIB RAI-6:

Attachment C to Enclosure 5 summarizes that the CFRP system design for Brunswick consists of the **[[**

]].

EMIB-RAI 7:

In Enclosure 5 it is mentioned that the minimum expected **[[**

]].

[[

]]

EMIB RAI-8:

Attachment C in Enclosure 5 of the submittal provides a summary table of computed **[[** **]]** and for 3 separate soil covers of 12.25 ft, 19.5 ft, and 6.75 ft. The table also provides factor of safety limits for the 9 limit states. Unlike metallic materials, there are many unknown uncertainties associated with CFRP composite materials which are non-isotropic, and the analytical methods. Further, CFRP materials have significant variation in material properties. A-Basis properties are more appropriate for use in safety related ASME Section III design. A review of the table indicates that **[[** **]]**. Discuss design improvements or modifications required to satisfy the required factor of safety.

NPHP RAI-1:

Enclosure 4, Attachment B, Table 2 discusses the **[[** **]]** Enclosure 5, Attachment B provided the **[[** **]]**

Clarify whether the **[[** **]]**

NPHP RAI-2:

Enclosure 8, Attachment A, Section 17, page 15 of 36 stated, in part, that:

> **[[** **]]**

Discuss how the CFRP composite system that **[** .**]]**

NPHP RAI-3:

Enclosure 4, Attachment B, page 16 of 17 stated, in part, that:

> **[[** **]]**

Clarify whether the **[[**

]]

NPHP RAI-4:

Enclosure 2, Attachment A, page 3 of 11 stated, in part, that:

> It has not been determined whether the cement mortar lining will be removed or remain in place. Hydraulic and structural analysis will be performed to justify either condition, (1) cement mortar lining removed or (2) cement mortar lining remains.

Furthermore, Enclosure 5, Attachment D, page 83 of 122 stated, in part, that:

> **[[**
>
> **]]**

(a) For terminal ends, clarify whether the CFRP will be installed on host pipe's bare metal or on the concrete mortar lining. If the answer is on the concrete mortar lining, provide justification.
(b) **[[**
]
(c) **[[**
]]
(d) Clarify whether the pipe metallic substate is catholically protected to minimize the corrosion and loss of metal from outside of the pipe.
(e) RA-20-0353 referenced ASME Code Case N-871, "Repair of Class 2 & 3 Piping Using Carbon Fiber Reinforced Polymer Composites," that was approved by the ASME Code. Clarify why the CFRP composite system and the terminal ends of metallic substrate will not be inspected (e.g., visually, acoustically, or both) following installation at the second period of the current 10-year ISI interval to monitor the soundness of the installed CFRP composite system.

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NAME	ZStone	RButler	ITseng (Acting)
DATE	08/31/2021	08/31/2021	08/25/2021
OFFICE	NRR/DNRL/NPHP/BC	NRR/DORL/LPL2-2/BC	NRR/DORL/LPL2-1/PM
NAME	MMitchell	DWrona	ZStone
DATE	08/26/2021	08/31/2021	09/08/2021

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