Enclosure 1 contains Proprietary Information – Withhold Under 10 CFR 2.390. Upon removal of Enclosure 1, this document is decontrolled.

NEXTera ENERGY SEABROOK

February 28, 2024

L-2024-019
10 CFR 50.55a

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

RE: Seabrook Nuclear Plant Unit 1
Docket No. 50-443
Renewed Facility Operating License NPF-86
Relief Request 4A-01– Request for an Alternative to the Requirements of the ASME Code for Examination of Control Rod Drive Mechanism (ROD) Housing H-4 Canopy Seal Weld

In accordance with the provisions of 10 CFR 50.55a(z)(2), NextEra Energy Seabrook, LLC (NextEra) hereby requests Nuclear Regulatory Commission (NRC) approval of a proposed alternative to the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components," for use at the Seabrook Plant.

NextEra is requesting relief from ASME Code Section III, Subsection NB-5270/NB-5271 to perform a liquid penetrant (PT) surface examination of the repair/replacement of the Seabrook Unit 1 Reactor Vessel Closure Head (RVCH) Control Rod Drive Mechanism (ROD) Housing H-4 Canopy Seal Weld.

As an alternative to the dye penetrant (PT) surface exam, NextEra proposes to perform an enhanced remote visual examination of the weld overlay on the repair/replacement of CRDM H-4 canopy seal weld overlay.

Attachment 1 to this letter contains Relief Request 4A-01. Enclosure 1 contains evaluation NAH-CR020-TR-CF-000001-P, Revision 0, supporting Relief Request 4A-01. Enclosure 1 contains information that Westinghouse Electric Company LLC (Westinghouse) considers to be proprietary in nature. The request is supported by an affidavit signed by Westinghouse, the owner of the information. Pursuant to 10 CFR 2.390(a)(4), NextEra requests the proprietary information be withheld from public disclosure. Enclosure 2 provides a non-proprietary version of the evaluation provided in Enclosure 1. Enclosure 3 provides the Westinghouse Application for Withholding Proprietary Information from Public Disclosure CAW-24-005 affidavit supporting the proprietary withholding request. The affidavit sets forth the basis on which the information may be withheld from public disclosure by the Nuclear Regulatory Commission ("Commission") and addresses with specificity the considerations listed in paragraph (b)(4) of Section 2.390 of the commission's regulations.

NextEra Energy Seabrook, LLC

P.O. Box 300, Lafayette Road, Seabrook, NH 03874

Accordingly, NextEra requests that the information which is proprietary to Westinghouse be withheld from public disclosure in accordance with 10 CFR Section 2.390 of the Commission's regulations. Correspondence with respect to the copyright or proprietary aspects of the items listed above or the supporting Westinghouse affidavit should reference CAW-24-005 and be addressed to Camille Zozula, Manager, Regulatory Compliance & Corporate Licensing, Westinghouse Electric Company, 1000 Westinghouse Drive, Suite 165, Cranberry Township, Pennsylvania, 16066.

NextEra requests approval of the proposed alternative during the month of October 2024.

There are no regulatory commitments contained in this submittal. Should you have any questions regarding this submission, please contact Mr. Kenneth Mack, Fleet Licensing Manager, at 561-904-3635.

Sincerely,

Steve Catron
Licensing and Regulatory Compliance Director – Nuclear Fleet

Attachment 1:	Request for an Alternative to the Requirements of the ASME Code for Examination of Reactor Vessel Head Control Rod Drive Mechanism (ROD) Housing H-4 Canopy Seal Weld
Enclosure 1:	NAH-CR020-TR-CF-000001-P Rev. 0, "Seabrook Unit 1 CRDM Canopy Seal Weld Overlay Repair" (Proprietary)
Enclosure 2:	NAH-CR020-TR-CF-000001-NP Rev. 0, "Seabrook Unit 1 CRDM Canopy Seal Weld Overlay Repair" (Non-Proprietary)
Enclosure 3:	Affidavit CAW-24-005

cc: USNRC Region I Administrator
USNRC Project Manager
USNRC Senior Resident Inspector

Seabrook Unit 1
Fourth Inspection Interval
RELIEF REQUEST NUMBER 4A-01, Rev. 0

Proposed Alternative
In Accordance with 10 CFR 50.55a(z)(2)
Request for an Alternative to the Requirements of the ASME Code for Examination of Reactor Vessel Head Control Rod Drive Mechanism (ROD) Housing H-4 Canopy Seal Weld

1. ASME CODE COMPONENT(S) AFFECTED:

Component:	Replacement Reactor Vessel Closure Head (RVCH) Control Rod Drive Mechanism (ROD) Housing Canopy Seal Weld
Code Class:	Class 1
Reference:	ASME Section XI, IWA-4000, ASME Section III, NB-5270
Exam Category:	NA
Code Item No.:	NA
Description:	Control Rod Drive Mechanism (CRDM) at location H-4 Canopy Seal Weld
Size:	NA
Materials:	Head Adapter: SA-182 Type 304 Rod Travel Housing Lower End Fitting: SA-336 F8 Cap: SA-479 Type 304 Weld Material: ER308/308L

2. APPLICABLE CODE EDITION AND ADDENDA:

The Fourth Ten Year ISI interval Code of record for Seabrook (SEA) Unit 1 is the 2013 Edition (No Addenda) of ASME Boiler and Pressure Vessel Code, Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components" [Ref. 1]. Examination of the reactor vessel CRDM middle canopy seal weld per the original code of construction was a surface examination per NB-5270.

The manufacturing Code for the SEA RVCH Control Rod Drive Mechanisms (CRDM's): ASME Boiler and Pressure Vessel (BPV) Code, Section III, "Rules for Construction of Nuclear Power Plant Components, Division 1," 1974 Edition through and including the Winter 1974 Addenda [Ref. 2].

3. APPLICABLE CODE REQUIREMENT:

IWA-4000 of ASME Code Section XI requires that replacements or repairs be performed in accordance with the owner's original Construction Code of the component or system, or later editions and addenda of the Code.

NB-5270 SPECIAL WELDED JOINTS.
NB-5271 Welded Joints of Specially Designed Seals
Welds of this type shall be examined by either the magnetic particle or liquid penetrant method.

The canopy seal weld is described in ASME Code Section III, and a repair/replacement of this weld would require the following activities:

Machining of a groove to facilitate removal of the CRDM internal motor.
Welding to restore the leak barrier of the original configuration canopy seal weld.
Final surface examination.

4. REASON FOR REQUEST:

In accordance with 10 CFR 50.55a(z)(2), relief is requested on the basis that compliance with the specified requirements would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

While troubleshooting the reactor control rod assembly at location H-4, SEA determined the middle control rod drive motor required replacement. Removal and restoration of the leak barrier provided by the associated canopy seal weld is required to perform this replacement.

SEA is requesting relief from NB-5270/NB-5271 to perform a liquid penetrant (PT) surface examination of the repair/replacement of the SEA Unit 1 RVCH CRDM H-4 middle canopy seal weld. As an alternative to the PT surface exam, SEA proposes to perform an enhanced remote visual examination of the weld overlay on the repair/replacement of the CRDM H-4 canopy seal weld overlay.

The CRDM drive motor assembly replacement requires cutting of the CRDM middle canopy seal weld between the motor housing and the rod travel housing and unthreading the two housing components to access and replace the internal CRDM drive motor assembly. Following drive motor replacement, the existing rod travel housing will be reinstalled/threaded onto the motor housing and the canopy seal weld will be remade to restore the leak barrier with a root and hot pass, followed by a weld overlay of the canopy seal weld with a multiple layer weld overlay with a minimum 0.16-inch thickness [Ref 3&4] using a compatible austenitic stainless steel filler material.

The CRDM motor housing and the rod travel housing are Class 1 pressure boundary items. The canopy seal weld provides leak prevention barrier only and does not perform a pressure retaining function. Removal and reinstallation of the mid canopy seal weld is a Repair/Replacement activity, under the jurisdiction of ASME Code Section XI, IWA-4000.

To comply with ASME Code Section XI and the original Construction Code, a surface examination must be performed on the completed canopy seal weld overlay. The CRDM canopy seal weld is located above the Reactor Vessel Closure Head (RVCH) multiple rows of penetrations toward the center of the head (Figure 1) and is inside the RVCH cooling shroud, providing extremely limited access for workers to reach the middle canopy seal weld for examination. This highly congested area is also subject to high radiation levels to gain access. To reduce the exposure to personnel involved in the welding process, the repair activities are planned to be performed remotely using machine welding equipment. However, the required dye penetrant (PT) examinations would necessitate hands on access to the middle canopy weld. In addition, equipment disassembly would be required, only to obtain limited access for an individual working from a suspended bosun's chair harness. These additional support activities would result in further exposure and unnecessary industrial safety concerns.

SEA does not have radiological surveys in the exact location of the CRDM H-4 canopy seal, however, recent surveys found that the dose rate near the exterior of the CRDM ventilation ducts was as high as 980 mrem/hr. The dose rate inside the shroud would be expected to be significantly higher than this. Due to the extremely limited access and high dose rates, compliance with this ASME Code requirement would not meet the intent of the site's as low as reasonably achievable (ALARA) radiological control program and presents a hardship to the utility and workers.

As stated in [Ref.3 & 4] the weld overlay repair is designed under the guidance and requirements of ASME Section XI, 2013 Edition [Ref. 1], Paragraph IWB-3640, "Evaluation Procedures and Acceptance Criteria for Flaws in Austenitic and Ferritic Piping," and Appendix C, "Evaluation of Flaws in Piping," as an alternative repair method for this "secondary leak barrier." Guidance is also taken from ASME Code Case N-504-4 [Ref. 5], ASME Section XI Nonmandatory Appendix Q [Ref. 1], and NUREG-0313 [Ref. 6]. The design of the overlay accounts for a postulated through wall flaw in the canopy seal weld, and accounts for crack growth due to both fatigue and stress corrosion mechanisms.

Additionally, visual and/or surface examinations will be performed on the accessible disassembled mating surfaces to ensure they are suitable for performing the weld overlay. In the unlikely event that this NDE detects a rejectable flaw in the canopy seal weld mating surface materials that cannot be removed due to accessibility or tooling limitations, the design accounts for this with the assumption of a pre-existing through wall flaw in the original seal weld secondary leak boundary.

5. PROPOSED ALTERNATIVE AND BASIS FOR USE:

SEA is requesting relief from NB-5270/5271 for a liquid penetrant (PT) surface examination of the repair/replacement of the SEA Unit 1 RVCH penetration CRDM H-4 middle canopy seal weld. As an alternative to the PT surface exam, SEA proposes to perform an enhanced remote visual examination during the repair/replacement of the CRDM H-4 canopy seal weld overlay in lieu of the surface examination required by Code. The new canopy seal weld overlay will be examined for quality of workmanship and discontinuities will be evaluated and dispositioned to ensure the adequacy of the new leakage barrier. The proposed remote enhanced visual examination would be conducted using a video camera with a minimum of 5X magnification. Lighting and acuity will be verified using ASME Code Section XI, Table IWA-2211-1, requirements for VT-1 note (2).

The 0.16" minimum thickness weld overlay is designed to have additional margin over the original canopy seal weld thickness [Ref. 3&4] to account for corrosion and fatigue analyses and will be the new secondary leak barrier. SEA will perform a remote enhanced visual examination on the completed weld, in lieu of the surface examination required by ASME III Code. The seal weld overlay will serve as a full replacement for the secondary leakage barrier, but will not serve any structural function, as the full structural load is still carried by the threaded connection in accordance with the original CRDM housing design.

Basis for Use

The threaded joint between the CRDM rod travel housing and the CRDM motor housing provides the primary reactor coolant system Class 1 pressure boundary and structural support for the CRDM. The canopy seal weld is for secondary leakage prevention only and is not credited in the ASME Code structural analysis. Following replacement of the internal CRDM drive motor, the middle canopy seal weld joint will be welded with a root and hot pass weld, followed by a weld overlay [Ref. 3&4] using weld procedures and personnel qualified in accordance with ASME Code Section IX. These activities will be performed under the control of the ASME Code Section XI Repair/Replacement program.

As demonstrated in multiple similar applications provided in Section 7, Precedents, the proposed alternative enhanced visual examination technique provides higher resolution and consistency than that provided by the requirements of a visually unaided Code VT-1 visual examination and is comparable to relevant indications detectable using PT surface exam technique. Based on the remote enhanced visual examination system's ability to resolve demonstrated graduation, reasonable assurance of the weld integrity is provided by this proposed alternative.

There is no applicable ASME Code Section XI, Examination Category or Item Number associated with this configuration as canopy seal welds are not subject to Table IWB-2500-1 surface or volumetric examinations.

Confirmation of Leak Integrity

A VT-2 in-service leakage examination is performed on the Class 1 pressure boundary at the conclusion of each refueling outage, as required by ASME Code Section XI, Table IWB-2500-1, Examination Category B-P, "All Pressure Retaining Components." In addition, a leakage examination is performed through the reactor vessel head shroud plexiglass windows at the CRDM penetrations at the beginning of each refueling outage as part of the SEA "Containment Leakage Reduction Program Surveillance" and the Boric Acid Corrosion Control Program. In the unlikely event of leakage from the newly installed seal weld overlay, these examinations are designed to promptly identify and correct the issue. Because the rod travel housing and motor housing are both made from corrosion resistant material, and the structural threaded connection provides a torturous flow path for leakage, this type of minor leakage will not impact the integrity of any safety related carbon steel pressure boundary components.

Conclusion

SEA has concluded that replacement of the CRDM H-4 middle canopy seal weld with a root and hot pass weld followed by a weld overlay has an acceptable design [Ref. 3 & 4] to provide a quality secondary leak barrier for the CRDM H-4 middle canopy seal weld. The design includes a postulated through wall flaw in the existing canopy seal weld, and fatigue and corrosion crack growth analyses that support 60 years of service from the time of installation, well beyond the current license. Further, the use of enhanced visual inspection of the weld overlay will assure a high-quality secondary leak barrier for the CRDM H-4 middle canopy seal weld.

In addition, visual inspections of the reactor vessel head area will continue to confirm the leak integrity of the weld overlay secondary barrier of CRDM H-4.

Based on the discussion and the summary above, it is requested that the NRC authorize this proposed alternative in accordance with 10 CFR 50.55a(z)(2) as the alternative provides an acceptable level of quality and safety

6. <u>DURATION OF PROPOSED ALTERNATIVE:</u>

The proposed alternative is applicable for the 4th ISI interval which began August 19, 2020 and ends on August 18, 2030.

Seabrook Unit 1
Fourth Inspection Interval
RELIEF REQUEST NUMBER 4A-01, Rev. 0

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7. PRECEDENTS:

1) NRC letter regarding approval of Relief Request (21-ISI-1), "Sequoyah Nuclear Plant, Unit 1 and 2-Proposed Alternative to the Requirements of ASME Code (EPID L-2021-LLR-0019), dated May 28, 2021 (ADAMS Accession number ML21131A163)

2) NRC Letter to Exelon Generation Company, LLC, "Braidwood Station, Units 1 and 2 - Relief from the Requirements of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (EPID L-2018-LLR-0033)," dated January 17, 2019 (ML18347B419)

3) NRC Letter to TVA, "Sequoyah Nuclear Plant, Unit 1 - Relief from ASME Code Repair Requirements for Canopy Seal Welds (TAC No. MA9095)," dated September 12, 2000 (ML003749067)

4) NRC Letter to TVA, "Relief from ASME Code Repair Requirements for Canopy Seal Welds at Watts Bar Nuclear Plant (TAC No. MA5051)," dated August 25, 1999 (ML073230305)

5) NRC Letter to TVA, "Relief from ASME Code Repair Requirements for Canopy Seal Welds Sequoyah Nuclear Power Plant, Unit 1 (TAC No. M93835)," dated April 4, 1996 (ML9604290167)

6) NRC letter to Duke Energy Carolinas, LLC, "McGuire Nuclear Station, Unit 1, Relief 08-MN-005, for Control Rod Drive Mechanism (ROD) Canopy Seal Welds (TAC No. MD9875)," dated October 14, 2009 (ML092530620)

7) NRC Letter to Florida Power and Light, "St. Lucie Nuclear Plant, Unit No. 2 – Authorization And Safety Evaluation For Relief Request No. 20, Revision 1 - The Use Of An Alternative To Requirements Of The American Society Of Mechanical Engineers (ASME) Code For Examination Of Reactor Vessel Closure Head Control Element Drive Mechanism (CEDM) Housing #27 Canopy Seal Weld, (EPID L-2022-LLR-0007)," dated June 7, 2022 (ML22151A001)

8. REFERENCES:

1) ASME Boiler and Pressure Vessel Code, Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components," 2013 Edition

2) ASME Boiler and Pressure Vessel Code, Section III, "Rules for Construction of Nuclear Power Plant Components, Division 1," 1974 Edition thru and including Winter 1974 Addendum.

3) Westinghouse Letter, NAH-CR-020-TR-CF-000001-P, Rev 0, "Seabrook Unit 1 CRDM Canopy Seal Weld Overlay Repair," January 22, 2024 (Proprietary)

4) Westinghouse Letter, NAH-CR-020-TR-CF-000001-NP, Rev 0, "Seabrook Unit 1 CRDM Canopy Seal Weld Overlay Repair," January 22, 2024 (Non-Proprietary)

5) ASME Boiler and Pressure Vessel Code, Code Case N-504-4, "Alternative Rules for Repair of Classes 1, 2, and 3 Austenitic Stainless Steel Piping," July 14, 2006.

6) U.S. Nuclear Regulatory Commission NUREG-0313, Revision 2, "Technical Report on Material Selection and Processing Guidelines for BWR Coolant Pressure Boundary Piping, " January 1988.

Seabrook Unit 1
Fourth Inspection Interval
RELIEF REQUEST NUMBER 4A-01, Rev. 0

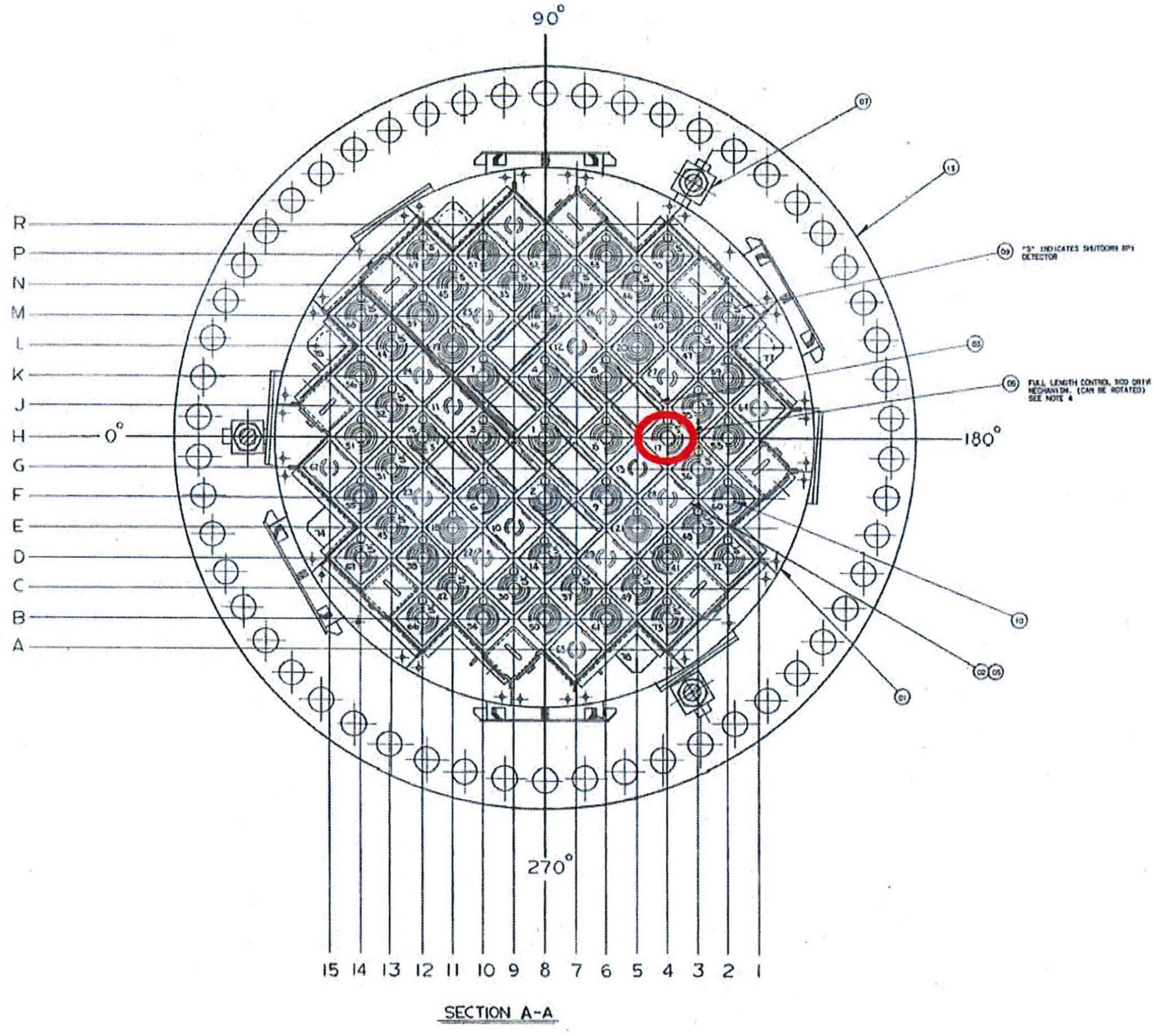

Figure 1: Seabrook RVCH Penetration/CRDM Layout with CRDM at location H-4 Identified

Enclosure 2

DOCUMENT COVER SHEET

DOCUMENT NO.	REVISION	PAGE 1 of 16
NAH-CR020-TR-CF-000001-NP	**0**	

PE SEAL (If required)

ALTERNATE DOCUMENT NUMBER: None

TITLE: **Seabrook Unit 1 CRDM Canopy Seal Weld Overlay Repair**

ATTACHMENTS:
None

Signature Responsibility	Name	SIGNATURE / DATE **(If processing electronic approval select option)**
Author	Matthew A. Correia	**Electronically Approved*****
Verifier	Gordon Z. Hall	**Electronically Approved*****
Responsible Manager	Justin D. Webb for Stephen P. Rigby	**Electronically Approved*****

**Approval signifies that the document and all required reviews are complete, the appropriate proprietary class has been assigned, electronic file has been provided to PRIME, and the document is released for use.*

*** This record was final approved on 01/26/2024 12:40:03. (This statement was added by the PRIME system upon its validation)

FOREWORD

This document contains Westinghouse Electric Company LLC proprietary information and data which has been identified by brackets. Coding [(a,c,e)] associated with the brackets sets forth the basis on which the information is considered proprietary.

The proprietary information and data contained within the brackets in this report were obtained at considerable Westinghouse expense and its release could seriously affect our competitive position. This information is to be withheld from public disclosure with the Rules of Practice 10 CFR 2.390 and the information presented herein is safeguarded in accordance with 10 CFR 2.390. Withholding of this information does not adversely affect the public interest.

This information has been provided for your internal use only and should not be released to persons or organizations outside the Directorate of Regulation and the Advisory Committee on Reactor Safeguards (ACRS) without the express written approval of Westinghouse Electric Company LLC. Should it become necessary to release this information to such persons as part of the review procedure, please contact Westinghouse Electric Company LLC, which will make the necessary arrangements required to protect the Company’s proprietary interests.

Several locations in this topical report contain proprietary information. Proprietary information is identified and bracketed. For each of the bracketed locations, the reason for the proprietary classification is provided using a standardized system. The proprietary brackets are labeled with three (3) different letters, “a”, “c”, and “e” which stand for:

(a) The information reveals the distinguished aspects of a process (or component, structure, tool, method, etc.) where prevention of its use by any of Westinghouse’s competitors without license from Westinghouse constitutes a competitive economic advantage over other companies.

(c) The information, if used by a competitor, would reduce their expenditure of resources or improve their competitive position in the design, manufacture, shipment, installation, assurance of quality, or licensing a similar product.

(e) The information reveals aspects of past, present, or future Westinghouse or customer funded development plans and programs of potential commercial value to Westinghouse.

1.0 Background and Purpose

Dating back to 2000, Seabrook has experienced control rod slipping at location H-04 attributed to crud mis-stepping as the likely cause. Since its initial discovery in the industry in 1977, crud related control rod mis-stepping has been a consistent concern for operating nuclear plants. Crud particulates build up in the dashpot region of the Control Rod Drive Mechanisms (CRDM), held in place by the strong magnetic fields used to actuate CRDMs, binding against the control rod drive mechanism latch arm assemblies, and causing sluggish CRDM movement. Rod slipping occurs when sluggish latch arm movement leads to a failure of the Rod Control System to properly cycle between each step of inserting or withdrawing a control rod, causing one of the CRDM latches to not engage fully at its required time.

Seabrook has experienced rod slipping at H-04 on a consistent basis during quarterly Rod Operability Surveillances, most recently in December 2022, and is seeking to correct this issue through replacement of the control rod drive mechanism latch assembly at location H-04 with a Unit 2 spare in the Fall 2024 outage.

The CRDM mid-canopy seal weld is cut in order to replace the existing CRDM latch assembly. A like-for-like mid-canopy seal weld will be performed after the latch assembly replacement. Based on lessons learned, Westinghouse proposed to pursue an NRC relief request for performing a weld overlay (WOL) process in place of a like-for-like seal weld.

Although no leak or flaw was detected in the canopy seal weld, a postulated through-wall flaw is assumed in the existing canopy seal weld for the design of the WOL. The WOL repair designed under the requirements of ASME Section XI, 2013 Edition [5], Paragraph IWB-3640, "Evaluation Procedures and Acceptance Criteria for Flaws in Austenitic and Ferritic Piping," and Appendix C, "Evaluation of Flaws in Piping," will be used as an alternative repair method. Guidance is also taken from ASME Code Case N-504-4 [7] which was incorporated into 2007 with 2008 Addendum and later editions of ASME Section XI Article Q [5], and NUREG-0313 [8].

2.0 Method Discussion

Analyses of Record (AOR) for the type L-106A1 CRDMs installed at Seabrook Unit 1 is contained in Engineering Memorandum EM-5889 Revision 1 [1] including addenda. The CRDM canopy seal weld stresses from the AOR are scaled for the post-WOL canopy seal geometry and used for the stress and fracture mechanics evaluation. Both stress corrosion cracking (SCC) and fatigue crack growth mechanisms are considered.

3.0 Acceptance Criteria

IWB-3640 and Appendix C of the 2013 Edition of ASME Section XI [5] will be used to perform the required fracture mechanics evaluation and to design a weld overlay repair of the postulated flawed canopy seal weld. Portions of Code Case N-504-4 [7] are also used for guidance. Code Case N- 504-4 allows repair by addition of weld material without removal of the underlying defect to be considered as a code repair. The Code Case N-504-4 is endorsed by the NRC in Regulatory Guide 1.147, [9] and incorporated into Article Q of ASME Section XI [5].

IWB-3640 provides criteria for acceptance of flaws without repair in ductile, austenitic materials. The basis for such acceptance is the evaluation of the structural adequacy of the flawed component after considering the predicted flaw growth over the evaluation period. The acceptance criteria are based upon the net section collapse (limit load) criteria which are defined in detail in Appendix C of Section XI. Also, NUREG-0313 [8] is used for guidance. The use of NUREG-0313 will result in the repair design of the canopy seal weld to be based upon conservative treatment of applied stresses, and includes allowance for continued flaw growth, as required by Section XI.

4.0 Input

Geometric Input

The Seabrook 1 CRDM drawings are listed in [2]. This canopy seal, referenced in the AOR as the mid-level canopy seal, represents the joining of the rod travel housing and the latch housing. A diagram of the canopy seal is included in drawing [2.a] and shown in Figure 4-1.

(a,c,e)

Figure 4-1: Canopy Seal Diagram

The weld overlay that will be installed over the rod travel housing and latch housing canopy seal is illustrated in Figure 4-2. The minimum WOL thickness is 0.16 inches.

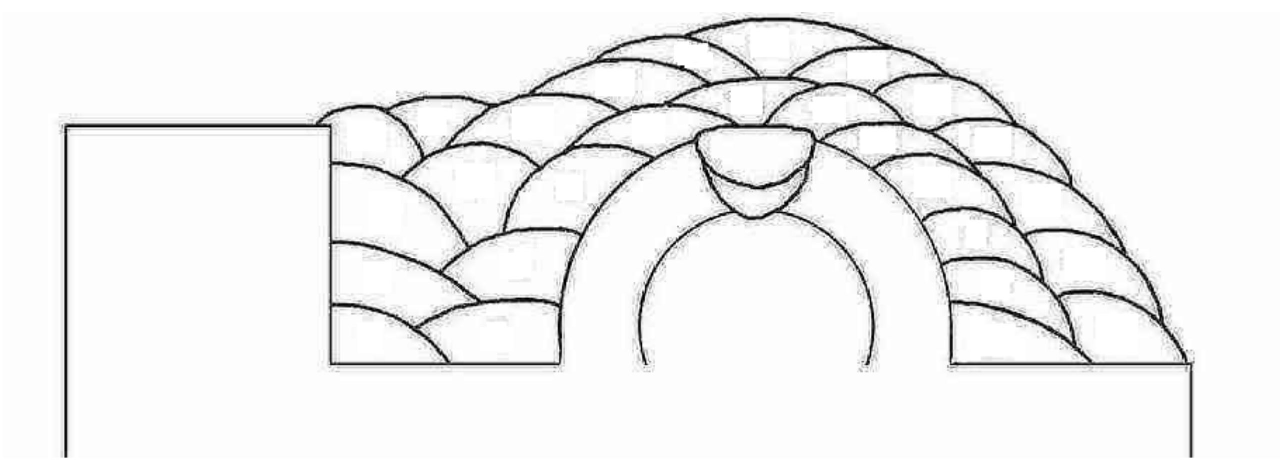

Figure 4-2: Canopy Seal Weld Overlay Design Sketch

The dimensions of the canopy seal are included as part of the rod travel [2.b] and latch [2.c] housings final machined drawings, as shown below in Figure 4-3 and Figure 4-4.

(a,c,e)

Figure 4-3: Rod Travel Housing Final Machining Drawing

(a,c,e)

Figure 4-4: Latch Housing Final Machining Drawing [2.c]

Note, the thickness of the canopy seal on the rod travel and latch housings are listed in these drawings as having a nominal value of [ ](a,c,e,). However, in drawing 9752D60 [2.d], included in EM-5889 Addendum 1, Rev. 1 [1.a], a spare L-106A1 CRDM is shown to have a rod travel housing with a nominal inner radius of [ ](a,c,e), as shown below in Figure 4-5. The difference is due to the number of significant digits between Latch Housing drawing [2.c] and the Rod Travel Housing drawing [2.d]. The limiting value of [ ](a,c,e) is conservatively used in this evaluation.

(a,c,e)

Figure 4-5: Spare L-106A1 CRDM Rod Travel Housing Drawing [2.d]

5.0 Canopy Seal Stress Calculations

As discussed in the AOR of the CRDM [1], per ASME Section III, NB-3227.7, welded seals such as the CRDM canopy seals are only subjected to general primary membrane stress (P_m) requirements due to internal pressure loading. All other membrane and bending stress intensity developed in the welded seal may be considered as secondary stress intensity. Therefore, only pressure induced P_m is considered for the canopy seal weld and WOL section. The primary membrane stresses are calculated using the formulas from Table 32, Case 1b of [6], which are applicable to a thick-walled pressure vessel. This simplified method does not necessarily yield accurate stresses in the canopy seal and weld overlay but is reasonable for the purpose of comparing the strength of the weld overlay to the strength of the canopy seal.

Input for Stress Calculations

Design Temperature:	$T_{design} := 650\,°F$	Per Section 3.1 of [1]
Design Pressure	$q := 2500\,psi$	Per Section 3.1 of [1] 2500 psia (2485 psig)

Original Canopy Seal Dimensions:

Inner Radius: $[\qquad]^{(a,c,e)}$

Thickness: $[\qquad]^{(a,c,e)}$

Outer Radius: $[\qquad]^{(a,c,e)}$

Weld Overlay Dimensions:

Inner Radius: $[\qquad]^{(a,c,e)}$

Thickness: $[\qquad]^{(a,c,e)}$

Outer Radius: $[\qquad]^{(a,c,e)}$

Per the AOR [1], the rod travel housing and latch housing are both made of SA-336 Gr. F8. However, in the AOR the limiting stress allowable, S_m, of the cap and head adapter were used for the stress evaluation. The cap and head adapter are made of SA-479 304 and SA-182 F304, respectively. The limiting value of S_m is conservatively used for the canopy seal weld.

Design Stress Intensity value of canopy seal:

$S_{m,canopy} = [\qquad]^{(a,c,e)}\,psi$ Per Table 8-2 of [1]

Primary Stresses for the Original Canopy Seal:

[ ]$^{(a,c,e)}$

Primary Stresses for Weld Overlay Only:

(a,c,e)

The primary stresses in the weld overlay, conservatively calculated without any support from the original canopy seal, are less than the primary stresses calculated in the original canopy seal. Therefore, the primary stresses in Engineering Memorandum, EM-5889 [1] can be conservatively applied to the weld overlay.

Primary Stresses for the combined Canopy Seal and Weld Overlay:

(a,c,e)

Weld Overlay Thermal Stress

Historically, analyses have shown insignificant temperature variation across the thickness of the canopy seals. The water inside the canopy seal is stagnant, any change of the reactor coolant temperature is transmitted by means of conduction through the rod travel and latch housings to the canopy seal. Therefore, the through-wall temperature of the canopy is quite uniform and the thermal stress at the canopy seal and overlay is negligible.

Weld Overlay Filler Material

The filler metal originally used for construction to join the two SA-336 F8 components was ER316L. The filler metal which will be used for the overlay and weld metal support in the seal weld groove is ER308/308L. Using ER308/308L filler metal compositionally is similar to ER316L. Both filler metals are nominally in the same family of alloys, 20Cr – 10Ni alloys, which result in an austenitic weld metal with comparable ferrite values. The resultant weld using either ER308/308L or ER316L when joining the SA-479 316 to SA-182 F348 base metal will produce ferrite levels of approximately 8 to 11 Ferrite. The resultant weld will produce similar corrosion resistance in the presence of reactor water and resistance to stress corrosion cracking.

The CRDM materials are identified in the AOR [1]. The ASME design stresses for these materials are listed in Table 5-1. The original limiting S_m = 16.1 ksi was used as allowable in the AOR [1]. This was the S_m value for both SA-479 type 304 and SA-182 type F304 that made up the cap and head adapter, respectively. The S_m for ER308/308L weld filler is slightly higher than the AOR. Therefore, using the AOR limiting S_m is conservative for this evaluation.

Table 5-1: ASME Material Design Stresses at 650°F

S_y (ksi)	S_m (ksi)	Material	Component	Code
17.9	17.8	SA-336 F8	Rod Travel/Latch Housing	[3]
17.9	16.1	SA-479 304	Cap	[3]
17.9	16.1	SA-182 F304	Head Adapter	[3]
18.0	16.2	ER308/308L	WOL Weld Filler	[4]

6.0 Stress Corrosion Crack Growth Analysis

An assessment of the repaired canopy seal weld following the WOL is carried out assuming all the original seal wall thickness has cracked. A hypothetical flaw depth equivalent to this original seal wall thickness as the initial flaw depth is used to estimate the remaining life of the repaired weld under stress corrosion cracking (SCC) followed by fatigue crack growth.

For the estimation of the crack propagation rate, the following equation is used:

$$\frac{da}{dt} = 2.825(10^{-11})K^{3.43}$$

Where: da/dt is the crack growth rate with time (in/hr), and

K is the stress intensity factor (ksi√in)

This equation was developed for 316 stainless steels in a BWR normal water chemistry using [8] and [11]. Note that the ER308/308L weld filler metal that is selected for this application has a similar level of chrome and nickel content compared to type 316 stainless steel. The aforementioned SCC rate is appropriate for the filler metal. Note also that the BWR environment is more aggressive than the PWR environment. Cracking in austenitic stainless steels have been by far more frequently observed in BWRs than in PWRs. The SCC growth estimates below are thus conservative.

The stress intensity factor for a crack in the intermediate canopy seal is conservatively estimated based on a circumferential internal surface crack in a cylinder (see Article IV.3.4.5 in R6 Code manual [10]) considering a crack width/depth ratio of 2:

$$K = 0.682\,\sigma\sqrt{\pi a}$$

Where: a is the crack depth (in), and

σ is the stress (ksi)

Here, the hypothetical initial crack depth is through the entire wall of the original seal weld which is 0.09 inch deep which is considered to be conservative. The driving force in stress corrosion cracking is the sustained stress during normal operation, plus the residual stress due to the weld overlay process. The weld residual stresses in the canopy are conservatively taken as equal to the yield strength of the CRDM material. Per engineering memorandum, EM-5889 [1], the rod travel housing and the latch housing are both SA-336 Gr. F8. The maximum yield strength of this material at 650°F is 17.9 ksi per ASME Section III, Table I-2.2 [3]. See Table 5-1. The weld residual stress will be conservatively assumed to be 17.9 ksi.

The stresses in the canopy under design conditions are taken from [1]: P_m = [ ]$^{(a,c,e)}$. This primary stress level has to be factored down to account for the overlay. The Section 5.0 closed-form solutions for the pre- and post-WOL canopy seal weld pressure stresses are used to scale the P_m. For the longitudinal stress, the scale factor is [ ]$^{(a,c,e)}$ = 0.243. For the maximum circumferential stress, the scale factor is [ ]$^{(a,c,e)}$ = 0.627. The limiting factor of 0.627 is used to scale the post-WOL stress. The total stress (that includes yield stress at 650°F) is [ ]$^{(a,c,e)}$. Considering design conditions in place of normal operating condition is a conservative assumption. Hence, the stress intensity factor is:

[ ]$^{(a,c,e)}$

The initial crack propagation rate is then:

[ ]$^{(a,c,e)}$

This rate is equal to [ ]$^{(a,c,e)}$, which is not significant with respect to the weld overlay thickness of 0.16 inches.

This equation has been integrated for a 60-year evaluation period, giving an increase in K from [ ]$^{(a,c,e)}$. The final crack depth due to 60 years of SCC, starting from the WOL installation, is 0.1316 inches. Results are summarized in Table 6-1.

Table 6-1: Stress Corrosion Crack Growth Results

{ }(a,c,e)

7.0 Fatigue Crack Growth Performance

Fatigue crack growth is conservatively estimated using a stress intensity range $3*S_m$ for P_m+P_b+Q, maximum allowed by the ASME code.

The results from EM-5889, Rev. 1, Table 8-2 [1] shows that in the initial configuration, the calculated P_m+P_b+Q stress in the canopy seal weld is [ ](a,c,e) during normal conditions. The ASME code allowable of $3*S_m$ is 48.3 ksi. This stress range is applicable to the transients with the largest pressure and temperature variations and is likely related to an event with a limited number of occurrences. The weld overlay repair will significantly decrease this stress, therefore, the assumption is conservative. The detailed design analyses performed for similar canopy seal WOL analyses for other plants confirm this assumption.

The stress intensity factor is calculated as discussed in the previous section.

[ ](a.c.e)

Using Figure C-8410-1 of [5] (see Figure 7-1), the fatigue crack growth rate for austenitic stainless steel in air environments is taken conservatively at $2.0*10^{-5}$ in/cycle for R=0.9 (assuming a high mean stress to account for the weld residual stresses) and at 550°F. A factor of 2 is then used to account for the water environment. For the sake of this evaluation, it is assumed that 200 occurrences of this stress range occur over a life of 60 years of the plant. The assumed occurrences is conservative to cover the remaining licensed operating period, after the weld overlay installation.

The total propagation of the crack is: [ ](a,c,e), which is not significant in comparison with the thickness of the weld overlay thickness of 0.16 in.

FIG. C-8410-1 REFERENCE FATIGUE CRACK GROWTH CURVES FOR AUSTENITIC STAINLESS STEELS IN AIR ENVIRONMENTS

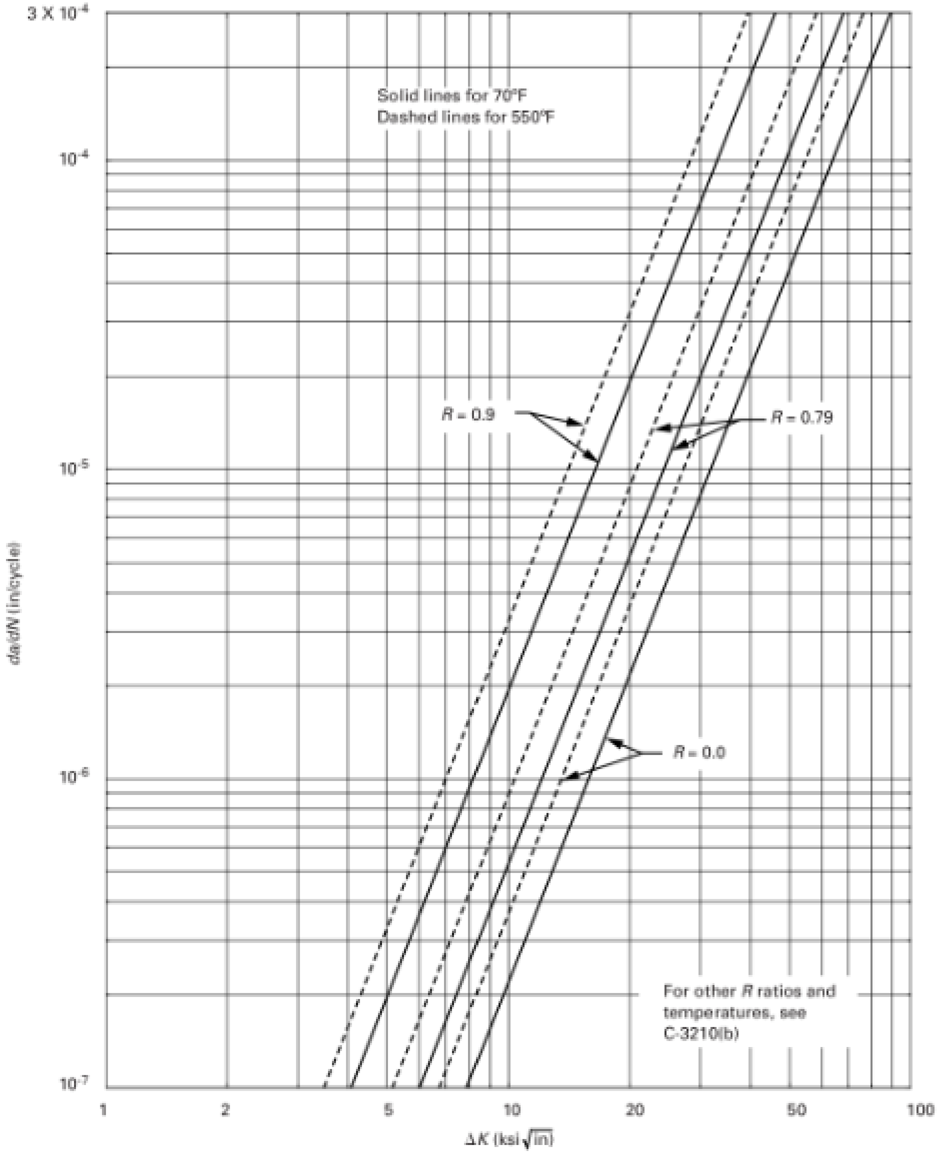

Figure 7-1: ASME Section XI Fatigue Curve [5]

8.0 Summary and Conclusion

In this report, the impact of the mid-canopy seal weld overlay has been assessed. The following topics have been addressed:

- Primary and thermal stresses in a weld overlay with a minimum thickness of 0.16 inch are less than the primary and thermal stresses in a canopy seal. Therefore, the stresses calculated in Engineering Memorandum No. 5889 [1] are conservatively applicable to a minimum 0.16-inch-thick weld overlay, and thus the Section III ASME Code [4] criteria are met by the weld overlay.
- A stress corrosion performance evaluation has been carried out. An initial propagation rate of [ ](a,c,e) in/year for an initial flaw depth of [ ](a,c,e) has been calculated, which is not significant in comparison with the weld overlay thickness of 0.16 inch. The crack depth after 60 years has been evaluated to be [ ](a,c,e).
- A fatigue crack growth evaluation has been carried out. A propagation of [ ](a,c,e) has been calculated assuming an initial flaw depth of [ ](a,c,e) and 200 full thermal cycles of a stress range equal to $3*S_m$, which is not significant in comparison with the weld overlay thickness of 0.16 inch.

Both crack propagation assessments ensure the compliance with the provisions from ASME Section XI, IWB-3640, i.e., the final flaw depth of 0.140 in, 56% of the 0.25 inch post-WOL canopy seal thickness, which is less than the 75% wall thickness limit. The results are summarized in Table 8-1. In conclusion the design of the weld overlay is acceptable.

Table 8-1: Summary of Flaw Evaluation

[ ](a,c,e)

9.0 References

1. Westinghouse Engineering Memorandum, EM-5889, Rev. 1, "Public Service Company of New Hampshire, Seabrook No. 1, L-106A1 Full Length Control Rod Drive Mechanism Pressure Boundary Component Summary Report," December 9, 1985, as modified by:
   a. Westinghouse Engineering Memorandum Addendum, EM-5889 Addendum 1, Rev. 1, "Public Service Company of New Hampshire, Seabrook No. 1, Spare L106A-1 Full-Length Control Rod Drive Mechanism Assembly Pressure Boundary Component Summary Report," November 28, 1984
2. Westinghouse Drawings:
   a. 8380D62, Rev. 5, "General Assembly – CRDM – L106A1-412"
   b. 5060D70, Rev. 5, "Rod Travel Housing – L106A1"
   c. 5061D14, Rev. 7, "Latch Housing – Final Mach."
   d. 9752D60, Rev. 1, "Rod Travel Hsg. L106A1"
3. ASME Boiler and Pressure Vessel Code, Section III-1, "Rules for Construction of Nuclear Power Plant Components Subsection NA – General Requirements," 1974 Edition including Winter 1974 Addendum.
4. ASME Boiler and Pressure Vessel Code, Section II and III, 1998 Edition through 2000 Addenda.
5. ASME Boiler and Pressure Vessel Code, Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components," 2013 Edition.
6. Roark, Raymond J. and Young, Warren C., "Formulas for Stress and Strain," Fifth Edition, McGraw-Hill Inc. New York, NY, 1975.
7. ASME Boiler and Pressure Vessel Code, Code Case N-504-4, "Alternative Rules for Repair of Class 1, 2, and 3 Austenitic Stainless Steel Piping," July 14, 2006.
8. NUREG-0313, Rev. 2, "Technical Report on Material Selection and Processing Guidelines for BWR Coolant Pressure Boundary Piping, Final Report," January 1988.
9. Regulatory Guide 1.147, Rev. 19, "Inservice Inspection Code Case Acceptability ASME Section XI Division 1," October 2019.
10. R6 Procedure, Rev. 4, "Assessment of the integrity of structures containing defects", 2000.
11. Westinghouse Report, WCAP-16357-P, Evaluation of CRDM Lower Canopy Seal Weld Overlay Repair: Seabrook Nuclear Power Station Unit 1, October 2004.

Commonwealth of Pennsylvania:
County of Butler:

(1) I, Camille Zozula,Manager, Global Nuclear Regulatory Affairs, have been specifically delegated and authorized to apply for withholding and execute this Affidavit on behalf of Westinghouse Electric Company LLC (Westinghouse).

(2) I am requesting the proprietary portions of NAH-CR020-TR-CF-000001-P Revision 0 be withheld from public disclosure under 10 CFR 2.390.

(3) I have personal knowledge of the criteria and procedures utilized by Westinghouse in designating information as a trade secret, privileged, or as confidential commercial or financial information.

(4) Pursuant to 10 CFR 2.390, the following is furnished for consideration by the Commission in determining whether the information sought to be withheld from public disclosure should be withheld.

(i) The information sought to be withheld from public disclosure is owned and has been held in confidence by Westinghouse and is not customarily disclosed to the public.

(ii) The information sought to be withheld is being transmitted to the Commission in confidence and, to Westinghouse's knowledge, is not available in public sources.

(iii) Westinghouse notes that a showing of substantial harm is no longer an applicable criterion for analyzing whether a document should be withheld from public disclosure. Nevertheless, public disclosure of this proprietary information is likely to cause substantial harm to the competitive position of Westinghouse because it would enhance the ability of competitors to provide similar technical evaluation justifications and licensing defense services for commercial power reactors without commensurate expenses. Also, public disclosure of the information would enable others to use the information to meet NRC requirements for licensing documentation without purchasing the right to use the information.

(5) Westinghouse has policies in place to identify proprietary information. Under that system, information is held in confidence if it falls in one or more of several types, the release of which might result in the loss of an existing or potential competitive advantage, as follows:

(a) The information reveals the distinguishing aspects of a process (or component, structure, tool, method, etc.) where prevention of its use by any of Westinghouse's competitors without license from Westinghouse constitutes a competitive economic advantage over other companies.

(b) It consists of supporting data, including test data, relative to a process (or component, structure, tool, method, etc.), the application of which data secures a competitive economic advantage (e.g., by optimization or improved marketability).

(c) Its use by a competitor would reduce his expenditure of resources or improve his competitive position in the design, manufacture, shipment, installation, assurance of quality, or licensing a similar product.

(d) It reveals cost or price information, production capacities, budget levels, or commercial strategies of Westinghouse, its customers or suppliers.

(e) It reveals aspects of past, present, or future Westinghouse or customer funded development plans and programs of potential commercial value to Westinghouse.

(f) It contains patentable ideas, for which patent protection may be desirable.

(6) The attached documents are bracketed and marked to indicate the bases for withholding. The justification for withholding is indicated in both versions by means of lower-case letters (a) through (f) located as a superscript immediately following the brackets enclosing each item of information being identified as proprietary or in the margin opposite such information. These lower-case letters refer to the types of information Westinghouse customarily holds in confidence identified in Sections (5)(a) through (f) of this Affidavit.

I declare that the averments of fact set forth in this Affidavit are true and correct to the best of my knowledge, information, and belief. I declare under penalty of perjury that the foregoing is true and correct.

Executed on: 1/25/2024

Signed electronically by
Camille Zozula