PROPRIETARY INFORMATION – WITHHOLD UNDER 10 CFR 2.390

VIRGINIA ELECTRIC AND POWER COMPANY
RICHMOND, VIRGINIA 23261

September 15, 2021

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D. C. 20555

Serial No.: 21-042B
NRA/GDM R0
Docket Nos.: 50-336/423
50-338/339
50-280/281
License Nos.: DPR-65/NPF-49
NPF-4/7
DPR-32/37

VIRGINIA ELECTRIC AND POWER COMPANY (DOMINION ENERGY VIRGINIA)
NORTH ANNA AND SURRY POWER STATIONS UNITS 1 AND 2
DOMINION ENERGY NUCLEAR CONNECTICUT, INC. (DENC)
MILLSTONE POWER STATION UNITS 2 AND 3
REQUEST FOR APPROVAL OF APPENDIX E OF FLEET REPORT DOM-NAF-2-A
QUALIFICATION OF THE FRAMATOME BWU-I CHF CORRELATION IN THE DOMINION ENERGY VIPRE-D COMPUTER CODE
RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

By letter dated February 11, 2021 [Serial No. 21-042 (ADAMS Accession No. ML21042B321)], Dominion Energy Virginia and DENC (collectively, Dominion Energy) submitted Appendix E, "Qualification of the Framatome BWU-I CHF Correlation in the Dominion Energy VIPRE-D Computer Code," to Fleet Report DOM-NAF-2-A for NRC review and approval. By letter dated August 13, 2021, the NRC requested additional information to facilitate their review. Dominion Energy's response to the NRC request is provided in Attachment 1.

Attachment 1 contains information proprietary to Framatome Inc. and is supported by an affidavit (Attachment 3) signed by Framatome, the owner of the information. The affidavit sets forth the basis on which the information may be withheld from public disclosure by the Commission and addresses with specificity the considerations listed in paragraph (b)(4) of Section 2.390 of the Commission's regulations. Accordingly, it is respectfully requested the proprietary information be withheld from public disclosure in accordance with 10 CFR 2.390. A redacted, non-proprietary response to the NRC request for additional information is provided in Attachment 2.

Attachment 1 contains information that is being withheld from public disclosure under 10 CFR 2.390. Upon separation from Attachment 1, this page is decontrolled.

If you have questions or require additional information, please contact Mr. Gary D. Miller at (804) 273-2771.

Respectfully,

Mark D. Sartain
Vice President – Nuclear Engineering and Fleet Support

Commitments made in this letter: None

Attachment: Response to NRC Request for Additional Information

1. Response to NRC Request for Additional Information, Appendix E to Fleet Report DOM-NAF-2, "Qualification of the Framatome BWU-I CHF Correlation in the Dominion Energy VIPRE-D Computer Code." **[PROPRIETARY]**
2. Response to NRC Request for Additional Information, Appendix E to Fleet Report DOM-NAF-2, "Qualification of the Framatome BWU-I CHF Correlation in the Dominion Energy VIPRE-D Computer Code." [Non-Proprietary]
3. Framatome Affidavit for Withholding Proprietary Information from Public Disclosure

cc: U. S. Nuclear Regulatory Commission - Region I
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NRC Senior Resident Inspector
Millstone Power Station

NRC Senior Resident Inspector
North Anna Power Station

NRC Senior Resident Inspector
Surry Power Station

[Non-Proprietary]

ATTACHMENT 2

Response to NRC Request for Additional Information:

Appendix E to Fleet Report DOM-NAF-2-A, "Qualification of the Framatome BWU-I CHF Correlation in the Dominion Energy VIPRE-D Computer Code"

Dominion Energy Nuclear Connecticut, Inc. (DENC)
Millstone Power Station Units 2 and 3
Virginia Electric and Power Company (Dominion Energy Virginia)
North Anna and Surry Power Stations Units 1 and 2

RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION:

APPENDIX E TO FLEET REPORT DOM-NAF-2-A, "QUALIFICATION OF THE FRAMATOME BWU-I CHF CORRELATION IN THE DOMINION ENERGY VIPRE-D COMPUTER CODE"

Background

By letter dated February 11, 2021 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML21042B321), as supplemented by letter dated May 13, 2021 (ADAMS Accession No ML21133A285), Dominion Energy requested approval of Appendix E of fleet report DOM-NAF-2, "Qualification of the Framatome BWU-I CHF [Critical Heat Flux] Correlation in the Dominion Energy VIPRE-D Computer Code." By letter dated August 13, 2021, the NRC staff requested additional information to complete their review. The NRC request and Dominion Energy's responses are provided below.

NRC RAI-1

Please confirm that Dominion will use a process to generate the predicted CHF [Critical Heat Flux] value that is consistent with the process used when determining the predicted CHF value of the validation data.

Dominion Energy Response:

Yes, Dominion Energy uses a process to qualify CHF correlations which is consistent with the approach used by the vendor during the development of the correlation as documented in Section 4.9 and 4.10 of Reference 7.

NRC RAI- 2:

Please identify which fuel types have been validated using the BWU-I CHF model. For application to previously unanalyzed fuel types, such as AFA fuel, please demonstrate that the number of data points used for validation of that fuel type is sufficient for ensuring the accuracy of the DNBR [Departure from Nucleate Boiling Ratio] limit. Specifically,

[[[redacted] *]]*

Dominion Energy Response:

The response to this RAI is addressed by separating the requested information into three sections:

1. *Please identify which fuel types have been validated using the BWU-I CHF model.*

   Dominion Energy is not aware of any fuel designs that have been licensed for reactor operations with the BWU-I CHF correlation; however, the BWU Critical Heat Flux Correlations Topical Report (Reference 1, Section 4.2) contains information on the fuel assemblies for which the BWU-I CHF correlation is applicable:

   > *"In this report, then, the Inconel mixing vane design correlation (BWU-I) is established as the basic correlation for fuel assemblies with mixing vane grids. The enhanced mixing vane correlation (BWU-Z) is presently only valid for the Mark-BW17 design. Fuel assemblies with any other type of mixing vane spacer grid would require analysis with BWU-I unless an enhancement could be demonstrated from CHF data for that specific design."*

   Note that the term "Inconel" is described by Framatome to be a "convenient term for use in describing the original mixing vane concept – not the material itself" (Reference 1, Section 4.2).

2. *For application to previously unanalyzed fuel types, such as AFA fuel, please demonstrate that the number of data points used for validation of that fuel type is sufficient for ensuring the accuracy of the DNBR [Departure from Nucleate Boiling Ratio] limit.*

   Historically, the testing and development of older CHF correlations has consisted of a wide array of grid types, operating conditions, axial power distributions, array sizes, and grid spacings. More recently, CHF correlations tend to be developed for specific fuel or grid designs which produce more accurate DNBRs, leading to lower DNBR limits for the correlations which provide more margin in DNB analyses.

   For example, the Westinghouse WRB-2 CHF correlation was developed using tests with various heated lengths, axial power profiles, both unit and guide tube cells, as well as different mixing vane grid designs (Reference 5, Section A.2.3). As such, the WRB-2 CHF correlation database contains a wide variety of test data for 17x17 nuclear fuel products.

Elaborating on this example, the WRB-2M CHF correlation was later introduced for fuel assemblies with the Modified Low Pressure Drop (LPD) mixing vane grid and Modified Intermediate Flow Mixer (IFM) grid (Reference 6, Section 1). Westinghouse conducted additional CHF tests with the Modified LPD and IFM grids. The WRB-2M CHF correlation is a modification to the WRB-2 CHF correlation developed to optimize the CHF predictions to provide more accurate DNB predictions, as it was determined during testing that WRB-2 significantly underpredicted the CHF performance (Reference 6, Section 3.1). The tests conducted for the development of the WRB-2M CHF correlation are documented in Reference 6, Section 2.

As such, the WRB-2M CHF correlation is a more fine-tuned correlation than WRB-2 and is specifically intended for more accurate DNB analysis of fuel assemblies with the Modified LPD and IFM grid designs.

Westinghouse determined a minimum DNBR (95/95) limit of 1.17 for the WRB-2 CHF correlation (Reference 5, Section A.2.3.4) and a limit of 1.14 for the WRB-2M CHF correlation (Reference 6, Section 3.4). The reduction in the limit clearly demonstrates that the WRB-2M CHF correlation, which was correlated and optimized especially for those fuels with Modified LPD and IFM grids, offers an improved predictive capability of the thermal performance compared to the WRB-2 CHF correlation. Reference 6, Section 1 also states that the WRB-2 correlation DNBR limit of 1.17 may be conservatively applied to fuels with the Modified LPD and IFM grids; however, it was desired to develop a correlation which will more accurately predict DNB for fuels with Modified LPD and IFM grids.

Similarly, Framatome has established the BWU-I CHF correlation as the basic correlation for fuel assemblies with mixing vane grids (Reference 1, Section 4.2). The thermal-hydraulic tests upon which the BWU-I CHF correlation constants were developed (herein referred to as the BWU-I Experimental Database), consider a wide variety of test geometries such as rod diameters, pin pitches, axial flux shapes, heated lengths, and mixing vane grid spacings. As such, the BWU-I correlation is a generic correlation and therefore applicable to the different types of fuel assemblies that are represented by the constituent test sections and approved by the NRC (Reference 2).

Framatome has determined a DNBR limit of 1.21 for the BWU-I CHF correlation using LYNX2 (Reference 1, Section 4.1). Dominion Energy's benchmark to LYNX2/BWU-I (Reference 3, Section E.5.1) using VIPRE-D/BWU-I (Experimental Database) results in a DNBR limit of 1.23.

Recall that Westinghouse stated that the WRB-2 DNBR limit (1.17) may be conservatively applied to those fuel assemblies with Modified LPD and IFM grids. Once the WRB-2M correlation was optimized for these grid designs, the applicable DNBR limit decreased (1.14), thereby allowing more margin for DNB analyses. It is expected that, should a CHF correlation be developed solely upon the AFA-type mixing vane and mid-span mixing grid data collected at the Columbia University Heat Transfer Research Facility (HTRF)[1] (referred to as the CU Tests) the resulting 95/95 DNBR limit would be lower than that determined for VIPRE-D/BWU-I Combined Database in Reference 3 (1.23). In other words, applying the DNBR limit derived using the generic VIPRE-D/BWU-I Combined Database is conservative.

The BWU-I CHF correlation was not developed using the CU Tests. As mentioned previously, the BWU-I CHF correlation is a generic correlation intended for fuel assemblies with mixing vane grids. Therefore, a statistical analysis of the two data sets (the BWU-I CHF correlation Experimental Database and the CU Tests) is performed to determine if the data are similar enough to combine and conservatively apply one-sided tolerance theory for the determination of a 95/95 DNBR limit. Section E.5.2 of Reference 3 documents this statistical analysis of the VIPRE-D/BWU-I Experimental Database and the CU Tests, which demonstrates that the two data groups are of similar populations and therefore may be combined for further analysis. This total database is referred to as the VIPRE-D/BWU-I Combined Database. The DNBR limits for both the VIPRE-D/BWU-I Experimental and Combined Databases were determined to be 1.23. Additionally, the CHF results of the two databases are indistinguishable in Figures E.5.2-1 through E.5.2-4 of Reference 3, demonstrating that the BWU-I CHF correlation accurately predicts CHF for assemblies which employ AFA-type mixing vane and mid-span mixing grids.

In summary, the historical experience of generic versus optimized correlations, the generic applicability of the BWU-I CHF correlation to a wide variety of fuel assembly configurations, the extensive history of the Columbia HTRF with the development of NRC-approved CHF correlations, and the results of the aforementioned statistical and visual analysis provide confidence that the DNBR limits for the VIPRE-D/BWU-I code/correlation pair documented in Reference 3 provide adequate protection at a 95/95 confidence level. Therefore, the limit of

[1] The Columbia HTRF has an extensive history with the testing and development of various NRC-approved CHF correlations, such as the Framatome BWU-Z and the Westinghouse WRB-2M CHF correlations.

1.23 as documented in Reference 3 is conservative for application to fuel assemblies with AFA-type mixing vane and mid-span mixing grids.

3. *Specifically, [[* [redacted] *]]*

[redacted]

TABLE REDACTED

Figures RAI 2-1 through 2-4 [redacted]

Figure RAI 2-1: [redacted]

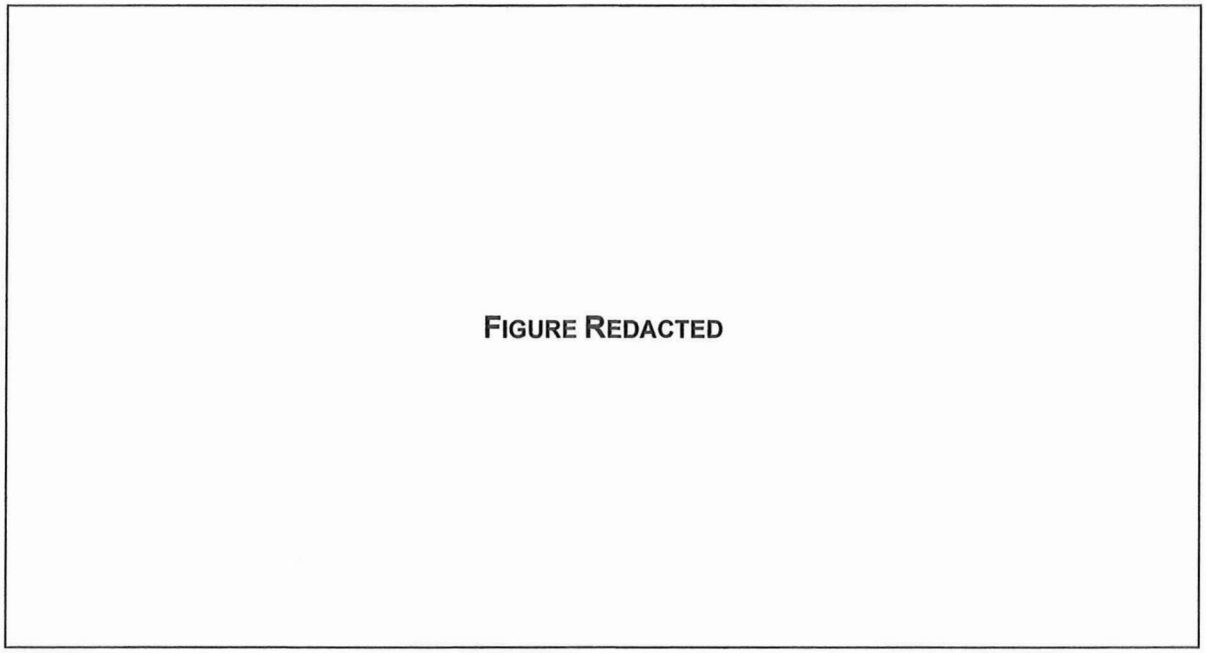


Figure RAI 2-2: [redacted]

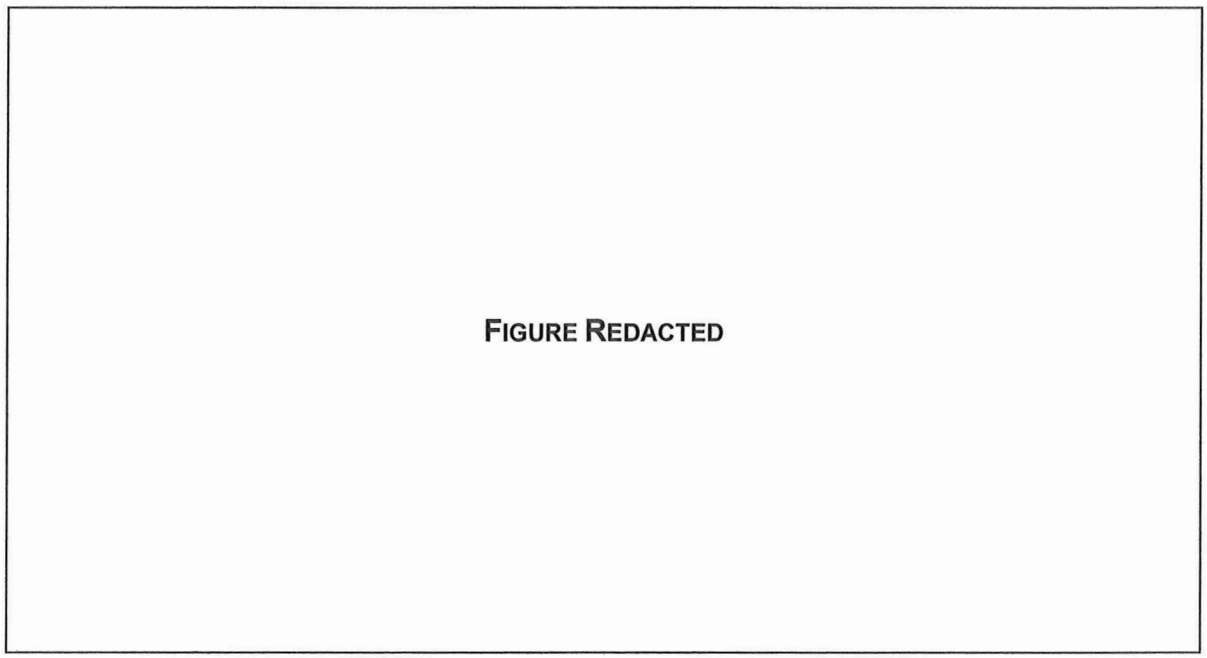


Figure RAI 2-3: [redacted]

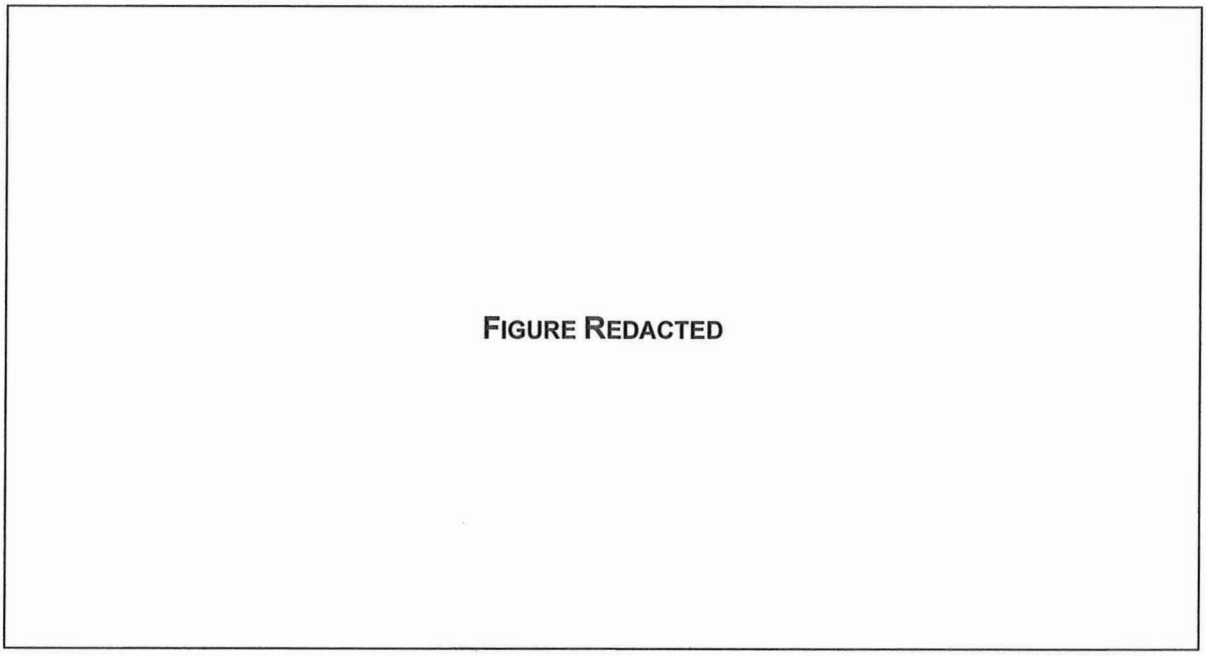
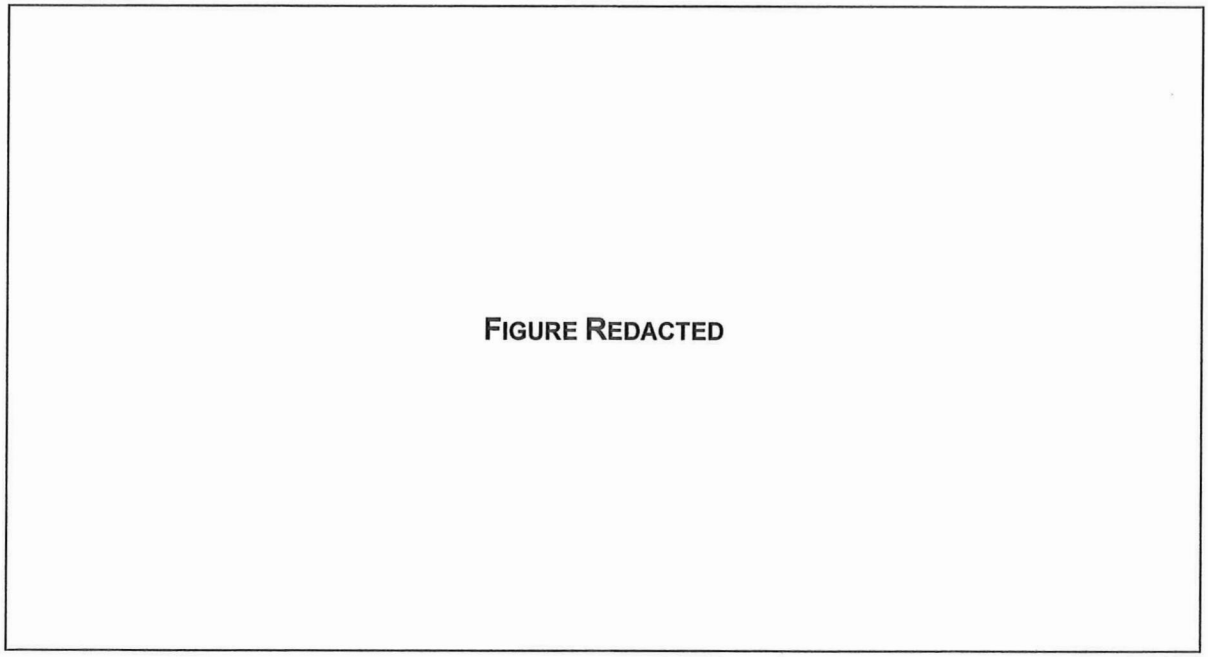


Figure RAI 2-4: [redacted]



As noted in the RAI, [redacted]

Mass Velocity

[redacted]

Dominion Energy thermal-hydraulic analyses using the VIPRE-D code are not conducted at [redacted]

Thermal-hydraulic analyses performed in VIPRE-D are conducted at conservative initial flow conditions. For example, the minimum measured flow rate used in VIPRE-D for Surry Power Station for current and intended future operation is 273,000 gpm, which translates to approximately 2.37 Mlbm/hr-ft^2. Similarly, for North Anna Power Station, the minimum measured flow rate is 295,000 gpm, which translates to approximately 2.51 Mlbm/hr-ft^2. For Millstone Unit 3, the minimum measured flow rate is 379,200 gpm, which translates to approximately 2.55 Mlbm/hr-ft^2. [redacted]

As such, the flow rates used in VIPRE-D analyses shall [redacted] As Dominion Energy thermal-hydraulic analyses do not utilize [redacted] the BWU-I CHF correlation [redacted]

Thermodynamic Quality

[redacted]

[redacted]

From Figures RAI 2-3 and 2-4, it appears that [redacted] by very conservative points in the tests considered. These conservative points have [redacted]

Points with [redacted] (Figure RAI 2-3) are [redacted] and appear to be [redacted] As such, [redacted] Similarly, points with [redacted] (Figure RAI 2-4) are [redacted] and appear to be [redacted] These points [redacted] Figures RAI 2-5 and 2-6 are identical to Figures RAI 2-3 and 2-4, respectively, [redacted]

[redacted]

Figure RAI 2-5: [redacted]

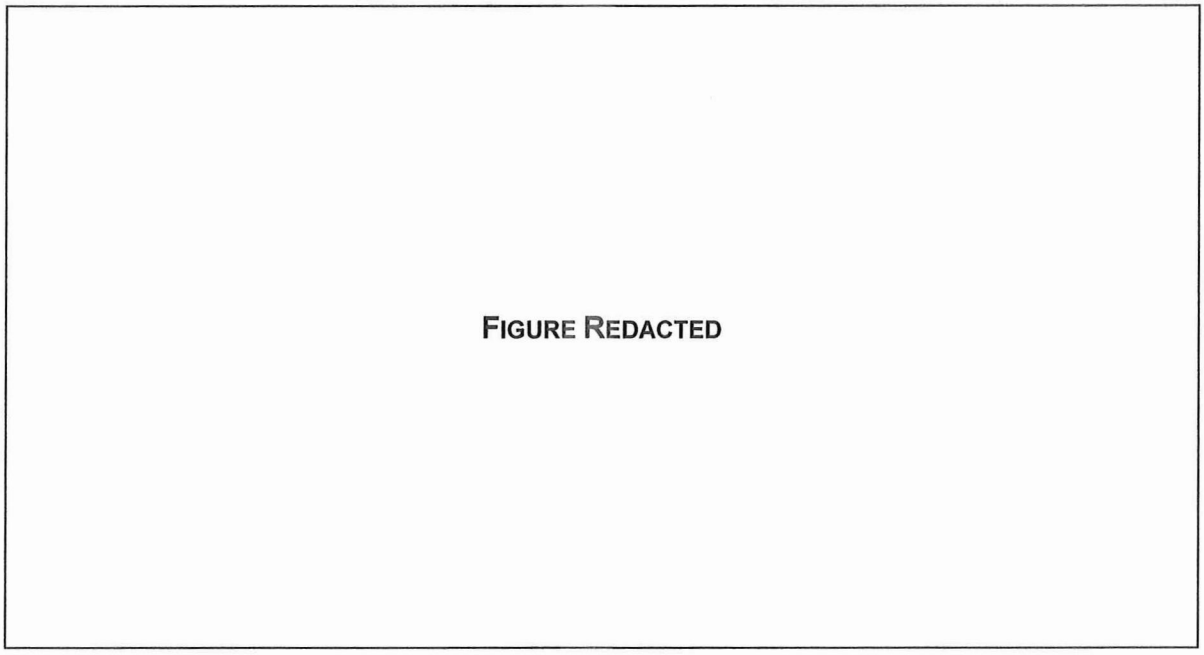
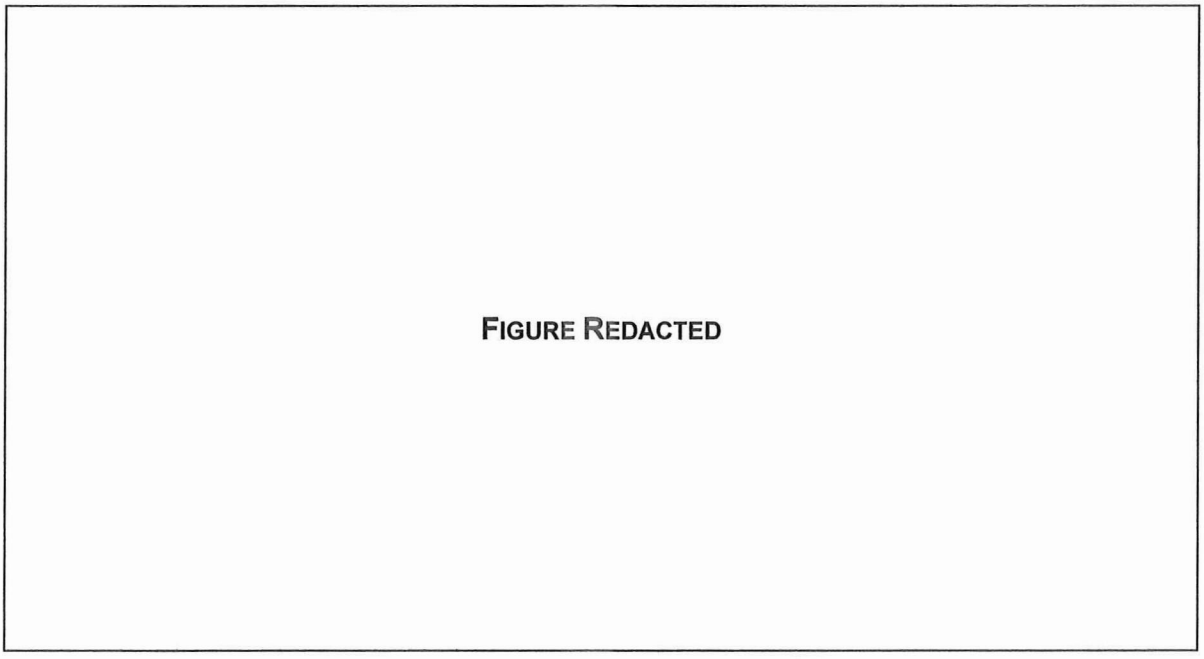


Figure RAI 2-6: [redacted]



ATTACHMENT 3

Framatome Affidavit:

Withholding Proprietary Information from Public Disclosure

Dominion Energy Nuclear Connecticut, Inc. (DENC)
Millstone Power Station Units 2 and 3

Virginia Electric and Power Company (Dominion Energy Virginia)
North Anna and Surry Power Stations Units 1 and 2

AFFIDAVIT

1. My name is Gayle Elliott. I am Deputy Director, Licensing and Regulatory Affairs, for Framatome Inc. (Framatome) and as such I am authorized to execute this Affidavit.

2. I am familiar with the criteria applied by Framatome to determine whether certain Framatome information is proprietary. I am familiar with the policies established by Framatome to ensure the proper application of these criteria.

3. I am familiar with the Framatome information contained in Attachment 1, "Response to NRC Request for Additional Information: Appendix E to Fleet Report DOM-NAF-2-A, 'Qualification of the Framatome BWU-I CHF Correlation in the Dominion Energy VIPRE-D Computer Code'," of a Letter from Mr. Mark Sartain (Virginia Electric and Power Company) to Document Control Desk (NRC), Serial No. 21-042B, Docket Nos. 50-336/423, 50-338/339, 50-280/281, dated September 13, 2021 and referred herein as "Document." Information contained in this Document has been classified by Framatome as proprietary in accordance with the policies established by Framatome for the control and protection of proprietary and confidential information.

4. This Document contains information of a proprietary and confidential nature and is of the type customarily held in confidence by Framatome and not made available to the public. Based on my experience, I am aware that other companies regard information of the kind contained in this Document as proprietary and confidential.

5. This Document has been made available to the U.S. Nuclear Regulatory Commission in confidence with the request that the information contained in this Document be withheld from public disclosure. The request for withholding of proprietary information is made in accordance with 10 CFR 2.390. The information for which withholding from disclosure is

requested qualifies under 10 CFR 2.390(a)(4) "Trade secrets and commercial or financial information."

6. The following criteria are customarily applied by Framatome to determine whether information should be classified as proprietary:

(a) The information reveals details of Framatome's research and development plans and programs or their results.

(b) Use of the information by a competitor would permit the competitor to significantly reduce its expenditures, in time or resources, to design, produce, or market a similar product or service.

(c) The information includes test data or analytical techniques concerning a process, methodology, or component, the application of which results in a competitive advantage for Framatome.

(d) The information reveals certain distinguishing aspects of a process, methodology, or component, the exclusive use of which provides a competitive advantage for Framatome in product optimization or marketability.

(e) The information is vital to a competitive advantage held by Framatome, would be helpful to competitors to Framatome, and would likely cause substantial harm to the competitive position of Framatome.

The information in this Document is considered proprietary for the reasons set forth in paragraphs 6(d) and 6(e) above.

7. In accordance with Framatome's policies governing the protection and control of information, proprietary information contained in this Document has been made available, on a limited basis, to others outside Framatome only as required and under suitable agreement providing for nondisclosure and limited use of the information.

8. Framatome policy requires that proprietary information be kept in a secured file or area and distributed on a need-to-know basis.

9. The foregoing statements 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: September 13, 2021

ELLIOTT Gayle Digitally signed by ELLIOTT Gayle
Date: 2021.09.13 11:29:11 -04'00'

Gayle Elliott