VIRGINIA ELECTRIC AND POWER COMPANY
RICHMOND, VIRGINIA 23261

March 19, 2018

10 CFR 50 Appendix H

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

Serial No.: 18-098
NRA/GDM: R2
Docket Nos.: 50-280/281
License Nos.: DPR-32/37

VIRGINIA ELECTRIC AND POWER COMPANY (DOMINION ENERGY VIRGINIA)
SURRY POWER STATION UNITS 1 AND 2
REVISED REACTOR VESSEL MATERIALS SURVEILLANCE CAPSULE WITHDRAWAL SCHEDULES
RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

By letter dated July 28, 2017, Serial No. 17-243, (Agencywide Documents Access and Management System (ADAMS) Accession No. ML17213A080), Dominion Energy Virginia submitted a request for NRC review and approval of proposed reactor vessel material surveillance capsule withdrawal schedules for Surry Power Station (Surry) Units 1 and 2 in accordance with Title 10 of the Code of Federal Regulations (10 CFR) Part 50, Appendix H, *Reactor Vessel Material Surveillance Program Requirements*. The proposed withdrawal schedules address revisions to the surveillance capsule withdrawal schedules approved for the 40 to 60-year period of extended operation (PEO).

On February 2, 2018, the NRC Surry Project Manager provided a request for additional information (RAI) to facilitate staff review of the submittal. Dominion Energy Virginia's response to the RAI is provided in the attachment.

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

Sincerely,

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

Commitments made in this letter:

1. Should the NRC not approve Subsequent License Renewal (SLR) for Surry, Dominion Energy Virginia will revise the capsule withdrawal schedule for Capsule U in Surry Unit 2 back to the existing date in the current version of the UFSAR capsule withdrawal schedule to ensure the one year reporting requirement outlined in 10 CFR 50, Appendix H is met.

A008
NRR

Attachments:

1. Response to NRC Request for Additional Information, "Revised Reactor Vessel Materials Surveillance Capsule Withdrawal Schedules," Surry Power Station Units 1 and 2

2. WCAP-18028-NP, Rev. 0, "Extended Beltline Pressure Vessel Fluence Evaluations Applicable to Surry Units 1 & 2," September 2015

3. WCAP-18242-NP, Rev. 0, "Surry Units 1 and 2 Time-Limited Aging Analysis on Reactor Vessel Integrity for Subsequent License Renewal," October 2017

4. WCAP-18243-NP, Rev. 0, "Surry Units 1 and 2 Heatup and Cooldown Limit Curves for Normal Operation," October 2017

cc: U.S. Nuclear Regulatory Commission
Region II
Marquis One Tower
245 Peachtree Center Ave., NE Suite 1200
Atlanta, Georgia 30303-1257

NRC Senior Resident Inspector
Surry Power Station

Ms. K. R. Cotton Gross
NRC Project Manager
U. S. Nuclear Regulatory Commission
One White Flint North
Mail Stop 08 G9A
11555 Rockville Pike
Rockville, Maryland 20852-2738

Mr. J. R. Hall
NRC Senior Project Manager
U. S. Nuclear Regulatory Commission
One White Flint North
Mail Stop 08 B1A
11555 Rockville Pike
Rockville, MD 20852-2738

Attachment 1

RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION REVISED REACTOR VESSEL MATERIALS SURVEILLANCE CAPSULE WITHDRAWAL SCHEDULES

SURRY POWER STATION UNITS 1 AND 2

VIRGINIA ELECTRIC AND POWER COMPANY
(DOMINION ENERGY VIRGINIA)

Response to NRC Request for Additional Information (RAI)
Revised Reactor Vessel Materials Surveillance Capsule Withdrawal Schedules

Surry Power Station Units 1 and 2

By letter dated July 28, 2017 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML17213A080), Dominion Energy Virginia submitted a request for NRC review and approval of proposed reactor vessel material surveillance capsule withdrawal schedules for Surry Power Station (Surry) Units 1 and 2 in accordance with *Title 10 of the Code of Federal Regulations* (10 CFR) Part 50, Appendix H, *Reactor Vessel Material Surveillance Program Requirements.* The proposed withdrawal schedules address revisions to the surveillance capsule withdrawal schedules approved for the 40 to 60-year period of extended operation (PEO). NRC staff has reviewed the submittal and determined that additional information is needed to complete their review of the submittal.

NRC COMMENT

BACKGROUND

The objective of the reactor vessel material surveillance program is to provide sufficient material data and dosimetry to monitor changes in fracture toughness of the ferritic materials in the reactor vessel beltline due to neutron irradiation. Appendix H to 10 CFR Part 50 requires that if peak neutron fluence at the end of the design life of the vessel will exceed 1 x 10^{17} n/cm^2 (E >1MeV), then reactor vessel beltline materials must be monitored by a surveillance program to meet the American Society for Testing and Materials (ASTM) E 185 Standard. *However, the surveillance program withdrawal schedule in ASTM E 185-82 is based on plant operation during the original (40-year) license term, and additional surveillance capsules may be needed for the period of extended operation. As stated in* NUREG-1801, Revision 2, Generic Aging Lessons Learned (GALL) Report Final Report, Aging Management Program (AMP) XI.M31, Reactor Vessel Surveillance*:*

> *"The plant-specific or integrated surveillance program shall have at least one capsule with a projected neutron fluence equal to or exceeding the 60-year peak reactor vessel wall neutron fluence prior to the end of the period of extended operation. The program withdraws one capsule at an outage in which the capsule receives a neutron fluence of between one and two times the peak reactor vessel wall neutron fluence at the end of the period of extended operation and tests the capsule in accordance with the requirements of ASTM E 185-82."*

Licensee management of Appendix H surveillance programs may also include planning for subsequent license renewal (SLR). Information for this consideration is provided in AMP XI.M31 of NUREG-2191, Volume 2, Generic Aging Lessons Learned for Subsequent License Renewal (GALL-SLR) Report, *which includes the following:*

This program includes withdrawal and testing of at least one surveillance capsule addressing the subsequent period of extended operation, with a neutron fluence of the surveillance capsule between one and two times the peak neutron fluence of interest projected at the end of the subsequent period of extended operation. The peak reactor vessel neutron fluence of interest at the end of the subsequent period of extended operation should address the time-limited aging analyses (TLAAs) described in the following sections of the Standard Review Plan for Review of Subsequent License Renewal Applications for Nuclear Power Plants (SRP-SLR), *as applicable: Sections 4.2.2.1.2 (Upper-Shelf Energy), 4.2.3.1.3 (Pressurized Thermal Shock) and 4.2.3.1.4 (Pressure-Temperature Limits) for pressurized water reactors (PWRs); and Sections 4.2.2.1.2 (Upper-Shelf Energy), 4.2.3.1.4 (Pressure Temperature Limits), 4.2.3.1.5 (Elimination of Boiling Water Reactor Circumferential Weld Inspection) and 4.2.3.1.6 (Boiling Water Reactor Axial Welds) for boiling water reactors (BWRs).*

For PWRs, such as Surry, the neutron fluence of interest is defined by the pressurized thermal shock (PTS) analyses as the best-estimate neutron fluence projected for a specific vessel beltline material at the clad-base-metal interface on the inside surface of the vessel at the location where the material receives the highest fluence on the expiration date of the operating license.

Surry Unit 1 received its renewed license on March 20, 2003, which expires on May 25, 2032; Surry Unit 2 received its renewed license on March 20, 2003, which expires on January 29, 2033. The currently approved surveillance capsule withdrawal schedules for the period of extended operation include the withdrawal of Capsule Z in 2025 at an estimated capsule neutron fluence of 6.31 x 10^{19} n/cm^2 for Surry, Unit 1, and the withdrawal of Capsule U in 2027 at an estimated capsule neutron fluence of 5.95 x 10^{19} n/cm^2 for Surry, Unit 2. The submittal proposes delaying the withdrawal of Capsule Z from 2025 to 2027 at an estimated capsule neutron fluence of 6.35 x 10^{19} n/cm^2 for Surry Unit 1. For Surry, Unit 2, the submittal proposes delaying the withdrawal of Capsule U from 2027 to 2032 at an estimated capsule neutron fluence of 7.26 x 10^{19} n/cm^2.

Data from surveillance capsule specimen testing are analyzed, in addition to prior results from the surveillance program, to determine the adequacy of the fracture toughness of the reactor vessel materials. Non-conservative results may require a change in the Technical Specifications (TS), either in the pressure-temperature (P-T) limits or in the operating procedures required to meet the limits.

NRC RAI #1

The last capsules tested for Surry, Units 1 and 2, were withdrawn in 1997 and 2002, respectively. For Surry, Unit 1, the tested capsule with the highest neutron fluence was withdrawn in 1986. Staff notes that there are 3 and 2 standby capsules remaining for Surry, Units 1 and 2, respectively. Provide a detailed technical basis for assurance of reactor vessel integrity including consideration of the very long time intervals and low neutron fluence levels of the last surveillance capsules withdrawn and tested.

Dominion Energy Virginia Response

Reactor vessel integrity is assured through compliance with applicable regulatory requirements including 10 CFR 50.61 and 10 CFR 50 Appendix G, as well as the guidance of Regulatory Guide 1.99, Revision 2, and Regulatory Guide 1.190.

The technical basis assuring reactor vessel integrity for Surry Units 1 and 2 is documented in the two most recent Surry TS amendments that revised the heatup and cooldown pressure-temperature (P-T) limit curves. The technical bases included in the two amendments are summarized as follows:

1. Surry TS Amendment Nos. 274/274 dated May 31, 2011 (ADAMS Accession Number ML11110A111): These amendments extended the core burnup applicability limit for the Surry Units 1 and 2 TS P-T limit curves from 28.8 Effective Full Power Years (EFPY) and 29.4 EFPY, respectively, to 48 EFPY for both units. The associated analysis validated the technical basis for reactor vessel integrity through 48 EFPY.

2. Surry TS Amendment Nos. 285/285 dated June 26, 2015 (ADAMS Accession Number ML15173A102): These amendments revised the Surry Units 1 and 2 TS P-T limit curves to be fully representative of the allowable operating conditions during Reactor Coolant System (RCS) startup and cooldown evolutions. The amendments did not modify the 48 EFPY beltline materials properties or the 48 EFPY beltline fluence values. However, in response to an NRC request for additional information that requested fluence values for the reactor vessel extended beltline nozzle materials, Dominion provided the NRC with updated extended beltline material properties and fluence values. (Reference Dominion letters dated February 4, 2015, July 30, 2015 and October 26, 2015 [ADAMS Accession Numbers ML15041A720, ML15216A366, and ML15302A340, respectively]). The reactor vessel integrity assessment remains conservative and demonstrates significant margins through 60 years of plant operation.

The fluence assessments for the Surry reactor vessels that were prepared in response to the NRC request for additional information noted above were documented in WCAP-18028-NP, Rev. 0, "Extended Beltline Pressure Vessel Fluence Evaluations Applicable to Surry Units 1 & 2," September 2015. Following completion of the fluence

assessment in WCAP-18028-NP, the Surry reactor vessels have been assessed for operation through 60 years and 80 years of plant operation.

The most recent assessment of reactor vessel integrity through 80 years of plant operation is documented in WCAP-18028-NP, Rev. 0; WCAP-18242-NP, Rev. 0, "Surry Units 1 and 2 Time-Limited Aging Analysis on Reactor Vessel Integrity for Subsequent License Renewal," October 2017; and WCAP-18243-NP, Rev. 0, "Surry Units 1 and 2 Heatup and Cooldown Limit Curves for Normal Operation," October 2017, which are provided in Attachments 2, 3 and 4, respectively. The assessment demonstrates that reactor vessel integrity concerns, including pressurized thermal shock (PTS), heatup and cooldown limitations, low temperature overpressure protection (LTOP), upper shelf energy (USE), and equivalent margins assessments (EMA), continue to be satisfied through the subsequent license renewal period. It is acknowledged that certain materials are projected to fall below the 50 ft-lb USE limitation; however, EMAs have been prepared that address these materials.

Reactor vessel integrity through the SLR period is ensured as follows:

- WCAP-18242-NP, Tables 4-1 and 4-2 verify the RT_{PTS} values for Surry Units 1 and 2 remain below the RT_{PTS} screening criteria through 68 EFPY.
    - WCAP-18242-NP, Tables 5-1 and 5-2 verify most Surry Unit 1 and 2 reactor vessel materials remain above the USE screening criteria through 68 EFPY. For those materials that do not, EMAs were completed in BAW-2192-P, Supplement 1, Revision 0, "Low Upper-Shelf Toughness Fracture Mechanics Analysis of Reactor Vessels of B&W Owners Reactor Vessel Working Group for Levels A & B Service Loads," and BAW-2178-P, Supplement 1, Revision 0, "Low Upper-Shelf Toughness Fracture Mechanics Analysis of Reactor Vessels of B&W Owners Reactor Vessel Working Group for Levels C & D Service Loads." The PWROG submitted these reports to the NRC for review and approval on December 15, 2017. (ADAMS Accession Number ML17354A011)
    - WCAP-18243-NP, Section 7 verifies the Surry Units 1 and 2 TS heatup and cooldown P-T limit curves remain conservative for use through 68 EFPY.

The Surry Units 1 and 2 reactor vessels are operated with a single set of heatup and cooldown P-T limit curves. The P-T limit curves included in the Surry TS are based upon the most limiting material properties from both the Unit 1 and Unit 2 reactor vessels. WCAP-18243-NP assesses the TS P-T limit curves through the SLR period of 68 EFPY. Per WCAP-18243-NP, the most limiting adjusted reference temperature (ART) values were those for the following welds: 1) the Surry Unit 1 Lower Shell Longitudinal Weld L2 (Heat # 299L44, using Position 2.1) at both the 1/4 thickness (1/4T) and 3/4 thickness (3/4T) locations for "axial flaw" materials, 2) the Surry Unit 1 Intermediate to Lower Shell Circumferential Weld (Heat # 72445, using Position 1.1 or Position 2.2) at the 1/4T location, and 3) the Surry Unit 2 Intermediate to Lower Shell Circumferential Weld (Heat # 0227, using Position 2.1) at the 3/4T location for "circumferential flaw" materials. These three weld materials are discussed below.

- **Heat #299L44**: Capsules X and A5 containing weld material Heat #299L44 were previously removed and tested with fluence values higher than the fluence value this weld is predicted to experience after 68 EFPY. Table 3-9 of WCAP-18242-NP shows surveillance capsules at fluence values of 2.11E19 n/cm^2 and 2.75E19 n/cm^2. Table 4-1 of WCAP-18242-NP shows that Heat #299L44 in the Surry Unit 1 reactor vessel is predicted to receive a surface fluence of 1.26E19 n/cm^2 at 68 EFPY. It is noted that this material is a limiting material for RT_{PTS} (see WCAP-18242-NP Section 4, "PTS Conclusion") and P-T limit curves (see Table 6.1-13 of WCAP-18242-NP). The existing P-T limit curves were developed based upon bounding information relative to fluence and adjusted reference temperature (ART) values for Heat #299L44. Therefore, deferring the withdrawal of Capsule Z from 2025 to 2027 has no impact on the assessment of reactor vessel integrity for the Unit 1 reactor vessel or the existing P-T limit curves. Since Capsule Z is the only remaining capsule containing Heat #299L44 material, it is important that withdrawal of this capsule be deferred until it reaches a fluence value that will bound 80 years of plant operation.

- **Heat #72445**: Weld material Heat #72445 is not included in the Surry reactor vessel surveillance capsule program. Material property data have been obtained from sister plants and have been incorporated into the reactor vessel integrity assessment for the Surry reactor vessels. The sister plant data for Heat #72445 meets the credibility criteria of Regulatory Guide 1.99, Revision 2; therefore, deferring withdrawal of Capsule Z from 2025 to 2027 has no impact on the assessment of reactor vessel integrity for the Unit 1 reactor vessel or the existing P-T limit curves.

- **Heat #0227**: Weld material Heat #0227 is not included in the reactor vessel surveillance programs of other plants. Capsules X, V, and Y containing Heat #0227 were previously removed and tested. The data for these capsules meet the credibility criteria outlined in Regulatory Guide 1.99, Revision 2. This information has been used to verify the acceptability of using the existing P-T limit curves for operation through 68 EFPY. Deferring withdrawal of Capsule U from 2027 to 2032 is necessary to obtain bounding fluence values for further assessment of Heat #0227 for operation through 68 EFPY. Review of the remaining capsules indicate that deferral of Capsule U from 2027 to 2032 is the quickest way to obtain fluence values that bound operation through the SLR period of 68 EFPY for Heat #0227.

In summary, the technical basis provided above provides assurance of reactor vessel integrity for operation through the existing PEO (48 EFPY), as well as the SLR PEO (68 EFPY).

NRC RAI #2

By letter dated November 5, 2015 (ADAMS Accession No. ML15314A078), notification was given of the licensee's intention to submit an application for the second renewed operating licenses for Surry, Units 1 and 2. AMP XI.M31 in the GALL-SLR Report states:

> *"If a surveillance capsule was previously identified for withdrawal and testing to address the initial period of extended operation, it is not acceptable to redirect or postpone the withdrawal and testing of that capsule to achieve a higher neutron fluence that meets the neutron fluence criterion for the subsequent period of extended operation."*

Provide a basis to address the letter intent to pursue SLR with consideration and consistency of the information from AMP XI.M31 in the GALL-SLR stated above.

Dominion Energy Virginia Response

Dominion Energy Virginia's approach for addressing RAI #2 involves three aspects. The first aspect pertains to details for Surry Unit 1, the second aspect pertains to details for Surry Unit 2, and the third aspect addresses the safety of the Surry reactor vessels, as well as responsible asset management.

1. Surry Unit 1: For Surry Unit 1, deferral of withdrawal and testing of Capsule Z is requested from 2025 to 2027 to coincide with our refueling outage schedule. This will ensure the fluence of the Heat #299L44 weld material specimen will have reached a value in excess of the reactor vessel fluence corresponding to 68 EFPY. Capsule Z is the only remaining capsule that contains Heat #299L44, so it is important that withdrawal of this capsule be deferred until it reaches a fluence value that will bound 80 years of plant operation. Dominion Energy Virginia does not consider deferral of withdrawing Capsule Z from 2025 to 2027 as an encroachment on the provisions of AMP XI.M31, rather we consider it an acceptable change under 10 CFR 50 Appendix H that requires approval by the NRC prior to implementation.

   Four capsules currently remain for Surry Unit 1: Capsules Z, U, S, and Y. WCAP-18242-NP, Section 7, provides guidance for management related to the remaining surveillance capsules. Specifically, Westinghouse has recommended that Capsule Z be withdrawn and tested at approximately 44 EFPY (projected to occur in 2027), which is when the fluence value of the capsule is projected to reach the projected 80-year (68 EFPY) peak vessel fluence (6.35×10^{19} n/cm^2). This fluence value is also below twice the 60-year reactor vessel peak fluence to support the current 60-year license (48 EFPY); therefore, it also satisfies the existing license requirement for surveillance capsule withdrawal and testing. Standby Capsules U, S, and Y should remain in the reactor. For asset management considerations, if additional metallurgical data or dosimetry measurements are desired, withdrawal and testing of one of these capsules would be considered. Also, Westinghouse

recommends removal of these capsules from the Surry Unit 1 reactor before fluence values exceed 1.25 times the 80-year peak reactor vessel fluence. It is noted that 1.25 times the 80-year fluence is equal to 100 years of plant operation. Capsules U and S may remain in the reactor vessel through 68 EFPY, but Capsule Y should be removed prior to 58 EFPY (projected to occur in 2041).

As noted above, Capsule Z is the only remaining capsule that contains our limiting weld material Heat #299L44; consequently, it is important that withdrawal of this capsule be deferred until it reaches a fluence value that will bound 80 years of plant operation. The basis for this conclusion is as follows:

- Per WCAP-18242-NP, the Surry Units 1 and 2 limiting RT_{PTS} value for base metal or longitudinal weld materials at 68 EFPY is 253.2°F (see Table 4-1 and Table 4-2), which corresponds to Surry Unit 1 Lower Shell Longitudinal Weld L2 Heat #299L44 (using credible surveillance data). The Surry Units 1 and 2 limiting RT_{PTS} value for circumferentially oriented welds at 68 EFPY is 229.8°F (see Table 4-1 and Table 4-2), which corresponds to Surry Unit 1 Intermediate to Lower Shell Circumferential Weld Heat #72445. The Surry Units 1 and 2 limiting RT_{PTS} material for base metal or longitudinal weld materials under the previous 48 EFPY analysis is the Surry Unit 1 Lower Shell Longitudinal Weld L2 Heat #299L44.

- Per WCAP-18243-NP the most limiting ART values that pertain to "axial flaw" materials were those of the Surry Unit 1 Lower Shell Longitudinal Weld L2 (Heat #299L44, using Position 2.1) at both the 1/4T and 3/4T locations. The Surry Units 1 and 2 limiting RT_{PTS} value for base metal or longitudinal weld materials at 68 EFPY is 253.2°F (see Table 4-1 and Table 4-2), which corresponds to Surry Unit 1 Lower Shell Longitudinal Weld L2 Heat #299L44 (using credible surveillance data).

2. Surry Unit 2: For Surry Unit 2, deferral of withdrawal and testing of Capsule U from 2027 to 2032 is requested to ensure that Heat #0227 receives fluence in excess of 68 EFPY. For the SLR period, Dominion Energy Virginia has already identified another Surry Unit 2 capsule to be tested, i.e., either Capsule T or Z. The request to defer Capsule U from 2027 to 2032 is proposed to ensure that fluence information is obtained for Heat #0227 as soon as possible to confirm 68 EFPY projections. Since another capsule is proposed for removal and testing during the SLR period, we believe the intent of AMP XI.M31 in the GALL-SLR is being met.

   Three Surry Unit 2 capsules currently remain that contain Heat #0227: Capsules U, T, and Z. WCAP-18242-NP, Section 7, provides guidance for management of the remaining surveillance capsules. Specifically, Westinghouse recommends that Capsule U be withdrawn and tested at approximately 49 EFPY (projected to occur in 2032), which is when the fluence value of the capsule is projected to reach the projected 80-year (68 EFPY) peak vessel fluence (7.26×10^{19} n/cm^2).

This fluence value is also below twice the 60-year reactor vessel peak fluence value to support the current 60-year license (48 EFPY); therefore, it also satisfies the existing license requirement for surveillance capsule withdrawal and testing. Standby Capsules T and Z should remain in the reactor. For asset management considerations, if additional metallurgical data or dosimetry measurements are desired, withdrawal and testing of one of these capsules would be considered. Removal of these capsules from the Surry Unit 2 reactor is recommended before fluence values exceed 1.25 times the 80-year peak reactor vessel fluence value. It is noted that 1.25 times the 80-year fluence value is equal to 100 years of plant operation. Capsule Z may remain in the reactor vessel through 68 EFPY, but Capsule T should be removed prior to 60 EFPY (projected to occur in 2044).

Note the limiting ART values that pertain to "circumferential flaw" materials were those of the Surry Unit 1 Intermediate to Lower Shell Circumferential Weld (Heat #72445, using Position 1.1 or Position 2.2) at the 1/4T location and the Surry Unit 2 Intermediate to Lower Shell Circumferential Weld (Heat # 0227, using Position 2.1) at the 3/4T location.

As noted above, either Capsule T or Z will be tested during the SLR period, thereby satisfying AMP XI.M31.

3. Safety of the Surry Reactor Vessels and Responsible Asset Management: As noted in the response to RAI #1 above, the most recent assessment of reactor vessel integrity through 80 years of plant operation is documented in WCAP-18028-NP, WCAP-18242-NP, and WCAP-18243-NP. This assessment demonstrates that reactor vessel integrity concerns including PTS, heatup and cooldown limitations, LTOP, USE, and EMAs continue to be satisfied through the SLR period. It is acknowledged that some of the materials are projected to fall below the 50 ft-lb upper shelf energy limitation; however, an EMA has been prepared for these materials.

   Reactor vessel integrity through the SLR period is ensured as follows:

- WCAP-18242-NP, Tables 4-1 and 4-2 verify the RT_{PTS} values for Surry Units 1 and 2 remain below the RT_{PTS} screening criteria through 68 EFPY.
  - WCAP-18242-NP, Tables 5-1 and 5-2 verify most Surry Unit 1 and 2 reactor vessel materials remain above the USE screening criteria through 68 EFPY. For those materials that do not, EMAs were completed in BAW-2192-P, Supplement 1, Revision 0, "Low Upper-Shelf Toughness Fracture Mechanics Analysis of Reactor Vessels of B&W Owners Reactor Vessel Working Group for Levels A & B Service Loads," and BAW-2178-P, Supplement 1, Revision 0, "Low Upper-Shelf Toughness Fracture Mechanics Analysis of Reactor Vessels of B&W Owners Reactor Vessel Working Group for Levels C & D Service Loads." The PWROG submitted these reports to the NRC for review and approval on December 15, 2017 (ADAMS Accession Number ML17354A011).

- WCAP-18243-NP, Section 7 verifies the Surry Units 1 and 2 TS heatup and cooldown P-T limit curves remain conservative for use through 68 EFPY.

The Virginia State Corporation Commission has authorized Dominion Energy Virginia to pursue SLR and to maintain Surry in a manner such that it will be operated safely and economically. Dominion Energy Virginia is proposing to optimize the surveillance withdrawal capsule schedule as soon as practical to provide documented evidence that the Surry Units 1 and 2 reactor vessels can be operated safely through their 80-year life. We do not believe it is prudent to remove and test surveillance capsules prior to them reaching 80 years of fluence because it would not conservatively bound plant operation through 80 years.

Dominion Energy Virginia has proposed to remove and test a different capsule in Unit 1 (Capsule S, U or Y) and a different capsule in Unit 2 (Capsule T or Z) during the SLR period. Dominion Energy Virginia has more standby capsules than most operating sites. Therefore, withdrawal and testing of these remaining capsules is intended since the corresponding fluence values at the time of withdrawal can be used to support future Dominion Energy Virginia objectives.

Further, we believe the intent of AMP XI.M31 in the GALL-SLR is to ensure that adequate testing is performed or additional capsules be fabricated from reconstituted materials. For Surry Units 1 and 2, there are adequate capsules to bound operation through 80 years.

Dominion Energy Virginia's objective of operating the Surry units for 80 years necessitates early verification of the fluence and material properties that bound proposed plant operation. Consequently, we have proposed to remove Capsule Z in Unit 1 in 2027 and Capsule U for Unit 2 in 2032 to verify fluence and materials properties to support operation of the Surry reactor vessels during the SLR period.

NRC RAI #3

The neutron fluence values projected to the end of the PEO have varied in different submittals for Surry. Identify the highest beltline best-estimate neutron fluence at the clad-base-metal interface on the inside surface of the vessel that is projected on the expiration date of the renewed license for each unit, including identification of the safety evaluation approving those values. Neutron fluence projections must use an NRC-approved methodology and be consistent with Regulatory Guide 1.190, Calculational and Dosimetry Methods for Determining Pressure Vessel Neutron Fluence.

Dominion Energy Virginia Response

Dominion Energy Virginia has revised the Surry Units 1 and 2 TS P-T limits curves on two separate occasions in the last eight years as noted in the response to RAI #1 above. Surry TS Amendment Nos. 274/274 (including the associated NRC Safety Evaluation) dated May 31, 2011 revised the P-T limits curves by increasing the core burnup applicability limit from 28.8 EFPY and 29.4 EFPY for Surry Units 1 and 2, respectively, to 48 EFPY for both units and validated the technical basis for reactor vessel integrity through 48 EFPY. Surry TS Amendment Nos. 285/285 dated June 26, 2015 revised the Surry TS P-T curves for clarification and to be fully representative of the allowable operating conditions during RCS startup and cooldown evolutions. These amendments did not revise the 48 EFPY beltline materials properties or the 48 EFPY beltline fluence values.

By letter dated May 6, 2010 (Serial No. 10-199) [ADAMS Accession Number ML101310604], Dominion Energy Virginia provided reactor vessel neutron fluence projections and the associated technical basis. An excerpt from that letter containing this fluence information is provided below. (The identified references are listed in the May 6, 2010 letter.) The fluence values shown are the highest beltline best-estimate neutron fluence at the clad-base-metal interface on the inside surface of the vessel that is projected on the expiration date of the renewed license for each unit. The information provided in Tables 3.1 and 3.2 below are the analysis of record through 48 EFPY.

3.1 RPV Neutron Fluence Projections

The reactor vessel beltline fluence values used for material properties calculations are unchanged from those utilized in the Reference [3] RVID update and exemption request submittal approved by the NRC in Reference [4]. The reactor vessel fast neutron fluence calculations were performed by Framatome ANP, and are applicable to the license renewal period (60-year operation) at Surry Power Station. The fluence calculations assumed removal of Flux Suppression Inserts (FSIs) from peripheral locations in Surry Unit 1, use of Integral Fuel Burnable Absorber (IFBA), rather than discreet burnable poison rods, and a 95% capacity factor. The fast neutron fluence predictions were prepared in accordance with the requirements of US NRC Regulatory Guide (RG) 1.190 [10], as described in Framatome ANP Topical Report BAW-2241-P-A [9]. BAW-2241 was approved by NRC in Reference [5].

More recently, Westinghouse performed revised reactor vessel fast neutron fluence analyses that considered planned implementation of a Measurement Uncertainty Recapture (MUR) core power uprating at Surry Units 1 and 2 [18]. The acceptance criteria for a Light Water Reactor (LWR) exposure evaluation is derived from RG 1.190, Section 1.4.3 [10]. This section of the RG states that "a vessel fluence uncertainty of 20% (1σ) is acceptable for RT_{PTS} and RT_{NDT} determination." The NRC approved methodology used for the Surry Units 1 and 2 fluence evaluations has been demonstrated to satisfy this criterion. The particular requirements of the RG that are incorporated into this methodology are as follows:

1. *The calculations use neutron transport cross-sections from the latest version of the Evaluated Nuclear Data File (ENDF/B-VI).*

2. *A P5 expansion of the scattering cross-sections is used in the discrete ordinates calculations. This exceeds the minimum requirement of RG 1.190.*

3. *An S16 order of angular quadrature is used in the discrete ordinates calculations. This exceeds the minimum requirement of RG 1.190.*

4. *An uncertainty analysis that includes comparisons of calculations with test and power reactor benchmarks and an analytical uncertainty study has been completed and documented in NRC approved topical reports [6 and 7]. The overall uncertainty in the transport calculations was demonstrated to be 13% (1σ). This level of uncertainty meets the 20% (1σ) requirement of RG 1.190.*

The reactor vessel fast neutron fluence values utilized in the Reference [3] RVID update and exemption request submittal approved by the NRC in Reference [4] conservatively bound those calculated by Westinghouse, even after consideration of the MUR uprate. Therefore, the more conservative Framatome ANP fluence analysis results continue to be used herein.

For convenience, the previously submitted [3] fluence values prepared by Framatome ANP are presented in Tables 3.1 and 3.2 for Surry Units 1 and 2, respectively, below.

Table 3.1
RPV Fluence Projections for Surry Unit 1

Surry Unit 1		***Neutron Fluence (E > 1.0 MeV)***	
Location	***Material***	***Fluence at 32 EFPY (n/cm^2)***	***Fluence at 48 EFPY (n/cm^2)***
Vessel Wall Inner Surface (0°)	*Intermediate and Lower Plates*	*3.80E+19*	*5.66E+19*
Lower Shell Longitudinal Weld, L1 & L2	*SA-1494/8T1554 SA-1526/299L44*	*6.40E+18*	*1.04E+19*
Intermediate Shell Longitudinal Weld, L3 & L4	*SA-1494/8T1554*	*6.78E+18*	*1.08E+19*
Intermediate to Lower Shell Circumferential Weld, W05	*SA-1585/72445 SA-1650/72445*	*3.74E+19*	*5.61E+19*
Nozzle to Intermediate Shell Circumferential Weld, W06	*J726/25017*	*5.27E+18*	*7.75E+18*

Table 3.2
RPV Fluence Projections for Surry Unit 2

Surry Unit 2		***Neutron Fluence (E > 1.0 MeV)***	
Location	***Material***	***Fluence at 32 EFPY (n/cm^2)***	***Fluence at 48 EFPY (n/cm^2)***
Vessel Wall Inner Surface (0°)	*Intermediate and Lower Plates*	*3.64E+19*	*5.38E+19*
Lower Shell Longitudinal Weld, L1 & L2	*WF-4/8T1762 WF-8/8T1762*	*7.62E+18*	*1.14E+19*
Intermediate Shell Longitudinal Weld, L3 & L4	*SA-1585/72445 WF-4/8T1762*	*7.63E+18*	*1.14E+19*
Intermediate to Lower Shell Circumferential Weld, W05	*R3008/0227*	*3.62E+19*	*5.37E+19*
Nozzle to Intermediate Shell Circumferential Weld, W06	*J737/4275*	*4.00E+18*	*6.32E+18*

By letter dated June 3, 2014 (Serial No 14-262) [ADAMS Accession Number ML14160A607], Dominion Energy Virginia submitted a License Amendment Request (LAR) proposing revision of the Surry TS P-T limits curves for clarification and to be fully representative of the allowable operating conditions during RCS startup and cooldown evolutions. The NRC approved the LAR in Surry TS Amendment Nos. 285/285 dated June 26, 2015. As noted above, that license amendment did not revise the beltline material 48 EFPY fluence values for the beltline materials. However, an NRC request for additional information (RAI) pertaining to this submittal requested fluence projections for the extended beltline nozzle materials.

The Surry reactor vessel fluence projections were updated in WCAP-18028-NP (Attachment 2) in response to the NRC RAI for the extended beltline nozzle materials received on January 9, 2015. To date, only the fluence projections in WCAP-18028-NP for the extended beltline materials have been considered by the NRC in response to their RAI. Dominion Energy Virginia provided the extended beltline materials fluence data to the NRC by letters dated February 4, 2015 (Serial No. 15-023) [ADAMS Accession Number ML15041A720]; July 30, 2015 (Serial No. 15-023A) [ADAMS Accession Number ML15216A366]; and October 26, 2015 (Serial No. 15-023B) [ADAMS Accession Number ML15302A340].

In preparation for SLR, Dominion Energy Virginia has used the fluence values in WCAP-18028-NP for assessment of both the beltline and extended beltline materials through 68 EFPY. The most up to date fluence values through 68 EFPY are reported in Table 2-2 and Table 2-3 of WCAP-18028-NP for Units 1 and 2, respectively. These fluence values were derived by Westinghouse in accordance with RG 1.190. The fluence values from Table 2-2 and Table 2-3 of WCAP-18028-NP are reproduced below and have been amended to include 48 EFPY data determined by linear interpolation.

Table 2-2 Surry Unit 1 - Maximum Fast Neutron (E > 1.0 MeV) Fluence Experienced by Pressure Vessel Materials in the Extended Beltline

Material	Neutron Fluence [n/cm^2]				
	32.5 EFPY	48 EFPY	54 EFPY	68 EFPY*	72 EFPY
1/4 T Flaw in Outlet Nozzle					
Nozzle 1	1.53E+16	2.37E+16	2.69E+16	3.45E+16	3.67E+16
Nozzle 2	1.08E+16	1.70E+16	1.93E+16	2.49E+16	2.65E+16
Nozzle 3***	4.48E+16	6.72E+16	7.59E+16	9.62E+16	1.02E+17
1/4 T Flaw in Inlet Nozzle					
Nozzle 1***	5.80E+16	8.70E+16	9.82E+16	1.24E+17	1.32E+17
Nozzle 2	1.40E+16	2.19E+16	2.50E+16	3.22E+16	3.42E+16
Nozzle 3	1.98E+16	3.06E+16	3.48E+16	4.46E+16	4.74E+16
Outlet Nozzle Forging to Vessel Shell Welds – Lowest Extent					
Nozzle 1	3.62E+16	5.59E+16	6.35E+16	8.13E+16	8.63E+16
Nozzle 2	2.55E+16	4.00E+16	4.55E+16	5.86E+16	6.23E+16
Nozzle 3**	1.06E+17	1.59E+17	1.79E+17	2.27E+17	2.40E+17
Inlet Nozzle Forging to Vessel Shell Welds – Lowest Extent					
Nozzle 1**	1.42E+17	2.13E+17	2.40E+17	3.04E+17	3.22E+17
Nozzle 2	3.43E+16	5.35E+16	6.10E+16	7.84E+16	8.34E+16
Nozzle 3**	4.85E+16	7.49E+16	8.51E+16	1.09E+17	1.16E+17
Nozzle Shell	3.64E+18	5.34E+18	6.00E+18	7.54E+18	7.98E+18
Nozzle Shell to Intermediate Shell Circumferential Weld	3.64E+18	5.34E+18	6.00E+18	7.54E+18	7.98E+18
Intermediate Shell					
Plate 1	3.17E+19	4.53E+19	5.06E+19	6.29E+19	6.65E+19
Plate 2	3.17E+19	4.53E+19	5.06E+19	6.29E+19	6.65E+19
Intermediate Shell Longitudinal Welds					
Weld 1	5.75E+18	8.71E+18	9.85E+18	1.25E+19	1.33E+19
Weld 2	5.75E+18	8.71E+18	9.85E+18	1.25E+19	1.33E+19
Intermediate Shell to Lower Shell Circumferential Weld	3.18E+19	4.55E+19	5.08E+19	6.31E+19	6.67E+19
Lower Shell					
Plate 1	3.20E+19	4.57E+19	5.11E+19	6.35E+19	6.70E+19
Plate 2	3.20E+19	4.57E+19	5.11E+19	6.35E+19	6.70E+19
Lower Shell Longitudinal Welds					
Weld 1	5.80E+18	8.78E+18	9.94E+18	1.26E+19	1.34E+19
Weld 2	5.80E+18	8.78E+18	9.94E+18	1.26E+19	1.34E+19
Lower Shell to Lower Vessel Head Circumferential Weld	<1E+17	<1E+17	<1E+17	<1E+17	<1E+17

* Corresponds to 80 years of life.

** Outlet Nozzle 3 reached 1.0E+17 n/cm^2 at approximately 30.8 EFPY.
Inlet Nozzle 1 reached 1.0E+17 n/cm^2 at approximately 23.2 EFPY.
Inlet Nozzle 3 is projected to reach 1.0E+17 n/cm^2 at approximately 62.8 EFPY.

*** 1/4T flaw in Outlet Nozzle 3 is projected to reach 1.0E+17 n/cm2 at approximately 70.7 EFPY, which corresponds to June 10, 2055.
1/4T flaw in Inlet Nozzle 1 is projected to reach 1.0E+17 n/cm2 at approximately 55.0 EFPY, which corresponds to December 21, 2038.

Table 2-3 Surry Unit 2 - Maximum Fast Neutron (E > 1.0 MeV) Fluence Experienced by Pressure Vessel Materials in the Extended Beltline

Material	Neutron Fluence [n/cm^2]				
	31.3 EFPY	48 EFPY	54 EFPY	68 EFPY*	72 EFPY
1/4 T Flaw in Outlet Nozzle					
Nozzle 1	1.49E+16	2.35E+16	2.66E+16	3.38E+16	3.58E+16
Nozzle 2	1.09E+16	1.72E+16	1.95E+16	2.48E+16	2.63E+16
Nozzle 3***	4.29E+16	7.23E+16	8.28E+16	1.07E+17	1.15E+17
1/4 T Flaw in Inlet Nozzle					
Nozzle 1***	5.55E+16	9.35E+16	1.07E+17	1.39E+17	1.48E+17
Nozzle 2	1.41E+16	2.23E+16	2.52E+16	3.21E+16	3.40E+16
Nozzle 3	1.93E+16	3.04E+16	3.44E+16	4.37E+16	4.63E+16
Outlet Nozzle Forging to Vessel Shell Welds – Lowest Extent					
Nozzle 1	3.52E+16	5.55E+16	6.27E+16	7.96E+16	8.45E+16
Nozzle 2	2.57E+16	4.06E+16	4.60E+16	5.85E+16	6.20E+16
Nozzle 3**	1.01E+17	1.71E+17	1.95E+17	2.53E+17	2.70E+17
Inlet Nozzle Forging to Vessel Shell Welds – Lowest Extent					
Nozzle 1**	1.36E+17	2.29E+17	2.62E+17	3.40E+17	3.62E+17
Nozzle 2	3.45E+16	5.45E+16	6.17E+16	7.84E+16	8.32E+16
Nozzle 3**	4.73E+16	7.44E+16	8.41E+16	1.07E+17	1.13E+17
Nozzle Shell	3.52E+18	5.86E+18	6.70E+18	8.65E+18	9.21E+18
Nozzle Shell to Intermediate Shell Circumferential Weld	3.52E+18	5.86E+18	6.70E+18	8.65E+18	9.21E+18
Intermediate Shell					
Plate 1	3.10E+19	4.97E+19	5.64E+19	7.20E+19	7.65E+19
Plate 2	3.10E+19	4.97E+19	5.64E+19	7.20E+19	7.65E+19
Intermediate Shell Longitudinal Welds					
Weld 1	5.98E+18	9.13E+18	1.03E+19	1.29E+19	1.36E+19
Weld 2	5.98E+18	9.13E+18	1.03E+19	1.29E+19	1.36E+19
Intermediate Shell to Lower Shell Circumferential Weld	3.11E+19	4.98E+19	5.66E+19	7.22E+19	7.67E+19
Lower Shell					
Plate 1	3.12E+19	5.01E+19	5.68E+19	7.26E+19	7.71E+19
Plate 2	3.12E+19	5.01E+19	5.68E+19	7.26E+19	7.71E+19
Lower Shell Longitudinal Welds					
Weld 1	6.03E+18	9.19E+18	1.03E+19	1.30E+19	1.37E+19
Weld 2	6.03E+18	9.19E+18	1.03E+19	1.30E+19	1.37E+19
Lower Shell to Lower Vessel Head Circumferential Weld	<1E+17	<1E+17	<1E+17	<1E+17	<1E+17

* Corresponds to 80 years of life.

** Outlet Nozzle 3 reached 1.0E+17 n/cm^2 at approximately 31.0 EFPY.
Inlet Nozzle 1 reached 1.0E+17 n/cm^2 at approximately 23.5 EFPY.
Inlet Nozzle 3 is projected to reach 1.0E+17 n/cm^2 at approximately 63.9 EFPY.

*** 1/4T flaw in Outlet Nozzle 3 is projected to reach 1.0E+17 n/cm2 at approximately 63.8 EFPY, which corresponds to July 6, 2048.
1/4T flaw in Inlet Nozzle 1 is projected to reach 1.0E+17 n/cm2 at approximately 50.9 EFPY, which corresponds to December 25, 2034.

NRC RAI #4

AMP XI.M31 in the GALL Reports includes the withdrawal and testing of a capsule during the period of extended operation to provide assurance of reactor vessel integrity for the license renewal period. The submittal requests a change to the withdrawal year for Capsule U in Surry, Unit 2, to 2032. Appendix H requires that each capsule withdrawal and the test results must be the subject of a summary technical report to be submitted within one year of the date of capsule withdrawal, unless an extension is granted by the Director, Office of Nuclear Reactor Regulation. The end of the renewed license period is January 29, 2033.

Provide an explanation of the plan for meeting the reporting period requirements. If changes are needed to the Technical Specifications, include how these would be incorporated considering the proposed withdrawal year of 2032 and expiration of the renewed license period on January 29, 2033.

Dominion Energy Virginia Response

On November 5, 2015 (ADAMS Accession No. ML15314A078), Dominion notified the NRC of our intent to submit an application to NRC to amend the operating license for Surry to 80 years of plant operation. Submittal of the SLR application for NRC review and approval is currently planned for the first quarter of 2019. If NRC approves SLR for Surry Units 1 and 2, adequate time will exist for meeting the reporting period requirements for deferral, withdrawal and testing of Capsule U in Surry Unit 2 to 2032. Should the NRC not approve SLR for Surry, Dominion Energy Virginia will revise the capsule withdrawal schedule for Capsule U in Surry Unit 2 back to the existing date in the current version of the UFSAR capsule withdrawal schedule to ensure the one year reporting requirement outlined in 10 CFR 50, Appendix H is met.