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10 CFR 50 App H

W3F1-2021-0064

November 30, 2021

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

Subject: Proposed Revision to Reactor Vessel Surveillance Capsule Withdrawal Schedule to Support Relocation of Capsules 104° and 284°

Waterford Steam Electric Station, Unit 3
NRC Docket No. 50-382
Renewed Facility Operating License No. NPF-38

The Waterford Steam Electric Station, Unit 3 (Waterford 3) Updated Final Safety Analysis Report (UFSAR) Table 5.3-10 provides the Waterford 3 reactor vessel surveillance capsule withdrawal schedule. In accordance with the provisions of Title 10 of the Code of Federal Regulations (10 CFR) 50, Appendix H, Entergy Operations, Inc. (Entergy) requests Nuclear Regulatory Commission (NRC) approval of a revision to the surveillance capsule withdrawal schedule.

Appendix H Section III.B.3 requires that changes to the withdrawal schedule be submitted in accordance with 10 CFR 50.4 and that the proposed schedule must be approved by the NRC prior to implementation. Per NRC Administrative Letter 97-04, a proposed change to the withdrawal schedule may be approved without a license amendment if the changes conform to the American Society for Testing and Materials (ASTM) Standard Practice E 185-82. The proposed revision complies with ASTM E 185-82 as discussed in the Enclosure.

The reason for the change to the withdrawal schedule is to relocate Capsules 104° and 284° to support the demonstration of reactor vessel integrity through the potential subsequent license renewal(s) at Waterford 3. To meet the requirements for a potential 80-year operating period, at least one capsule must be withdrawn and tested with a neutron fluence higher than that of the peak projected vessel wall. In their current positions, these capsules will not receive fluence greater than the peak vessel fluence. The Enclosure provides the description of and justification for the proposed changes. Attachment 1 to this Enclosure provides the current withdrawal schedule and Attachment 2 to this Enclosure provides a revised withdrawal schedule that incorporates the proposed changes. Details regarding the technical analysis supporting the proposed changes are provided in Attachment 3 to the Enclosure.

To receive the required fluence, it is planned to relocate these capsules during Refueling Outage 24 which is scheduled for Spring 2022. Based on this, Entergy requests approval of the proposed changes by April 1, 2022.

This letter contains no new regulatory commitments.

If you have any questions or require additional information, please contact John Lewis, Regulatory Assurance Manager, at 504-739-6028.

Respectfully,

**Philip
Couture**

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Philip Couture
Date: 2021.11.30
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PC/mmz

Enclosure: Proposed Revision to Waterford 3 Surveillance Capsule Withdrawal Schedule

Attachments to Enclosure:

1. Current Waterford 3 Updated Final Safety Analysis Report Table 5.3-10, Capsule Assembly Removal Schedule
2. Proposed Revision to Waterford 3 Updated Final Safety Analysis Report Table 5.3-10, Capsule Assembly Removal Schedule
3. Westinghouse Letter LTR-SDA-21-061-NP, Rev. 0-A, "Recommendations for Surveillance Capsule Relocation at Waterford Unit 3"

cc: NRC Region IV Regional Administrator
NRC Senior Resident Inspector, Waterford 3
NRC Project Manager, Waterford 3

Enclosure

W3F1-2021-0064

**Proposed Revision to Waterford 3
Surveillance Capsule Withdrawal Schedule**

PROPOSED REVISION TO WATERFORD 3 SURVEILLANCE CAPSULE WITHDRAWAL SCHEDULE

INTRODUCTION

NUREG-2191, "Generic Aging Lessons Learned for Subsequent License Renewal (GALL-SLR) Report" (Reference 1), provides guidance for Subsequent License Renewal (SLR) applicants. The SLR is the renewal of the initial renewed operating license, thereby permitting plants to operate to 80 years. The period of operation between 60 and 80 years is referred to as the subsequent period of extended operation. This guidance states that the Reactor Vessel Material Surveillance Program must meet the requirements of Title 10 of the Code of Federal Regulations (10 CFR) 50, Appendix H (Reference 2), and further states that this program includes withdrawal and testing of at least one surveillance capsule addressing the subsequent period of extended operation.

Appendix H provides the Nuclear Regulatory Commission (NRC) criteria for the design and implementation of the reactor vessel material surveillance programs. This states that the withdrawal schedule must meet the requirements of the edition of the American Society for Testing and Materials (ASTM) E 185 that is current on the issue date of the American Society of Mechanical Engineers (ASME) code to which the reactor vessel was purchased; for reactor vessels purchased after 1982, the design of the surveillance program and the withdrawal schedule must meet the requirements of ASTM E 185-82 (Reference 3). For reactor vessels purchased in or before 1982, later editions of ASTM E 185 may be used, but including only those editions through 1982. The Waterford Steam Electric Station, Unit 3 (Waterford 3) reactor vessel was ordered in March 1971 and the reactor vessel surveillance program for Waterford 3 adheres to the requirements of ASTM E 185-82 (Reference 4).

On September 30, 1997, the NRC issued Administrative Letter (AL) 97-04, "NRC Staff Approval for Changes to 10 CFR 50, Appendix H, Reactor Vessel Surveillance Specimen Withdrawal Schedules" (Reference 5), to all holders of operating licenses for domestic nuclear power plants. In AL 97-04, the NRC staff summarized the Commission's decision promulgated in Commission Memorandum and Order CLI-96-13 (Reference 6). In this Memorandum and Order, the Commission found that, while 10 CFR 50, Appendix H, III.B.3, requires prior NRC approval for all withdrawal schedule changes, only certain changes require the NRC staff to review and approve the changes through the NRC's license amendment process. Specifically, only those changes that are not in conformance with the ASTM standard referenced in 10 CFR 50, Appendix H, are required to be approved through the license amendment process, whereas changes that are determined to conform to the ASTM standard require only staff verification of such conformance.

Entergy Operations, Inc. (Entergy) relocated the Waterford 3 surveillance capsule withdrawal schedule from the Waterford 3 Technical Specifications (TSs) to the Waterford 3 Updated Final Safety Analysis Report (UFSAR) consistent with the provisions of Generic Letter 91-01, "Removal of the Schedule for the Withdrawal of Reactor Vessel Material Specimens from Technical Specifications" (Reference 7) in Amendment 106 to the Facility Operating License (Reference 8). The removal of the withdrawal schedule from the TSs did not result in the loss of any regulatory control because changes to the schedule are controlled by the requirements of 10 CFR 50, Appendix H.

PROPOSED CHANGES TO SCHEDULE

Entergy is proposing to make changes to the schedule to allow relocating surveillance capsules 104° and 284° to the locations at 97° and 263°, respectively, during Refueling Outage 24. Attachment 1 to this Enclosure provides the current withdrawal schedule and Attachment 2 to this Enclosure provides a revised withdrawal schedule that incorporates the proposed changes. [Note: The values in Table 5.3-10 provided in Attachments 1 and 2 to this Enclosure reflect changes that were approved by the NRC in Reference 9 and were incorporated after submittal of the most recent UFSAR update (Reference 4).]

Specific changes to UFSAR Table 5.3-10 are as follows:

1. Note (a) is added to the "Lead Factor" column as follows: "Lead factor is the ratio of the capsule fluence to the peak reactor vessel fluence at the time of withdrawal."
2. (Editorial) The previous single asterisked note (*) for the "Removal Time (EFPY)" column is changed to Note (b).
3. (Editorial) The previous double asterisked note (**), which annotated values that represented actual data on removed capsules, is changed to Note (c).
4. For Capsule 3/W-104, the following changes are made: Azimuthal Location (deg.) is changed to "104 / 97," Lead Factor is changed to "1.02," Removal Time (EFPY) is changed to "Standby (71)," and Target Fluence (n/cm²) is changed to "Standby (5.61E+19)."
5. For Capsule 6/W-284, the following changes are made: Azimuthal Location (deg.) is changed to "284 / 263," Lead Factor is changed to "1.02," Removal Time (EFPY) is changed to "Standby (71)," and Target Fluence (n/cm²) is changed to "Standby (5.61E+19)."
6. Note (d) is added to Capsules 3/W-104 and 6/W-284 as follows: "Capsule was relocated during Refueling Outage 24 in order to experience higher lead factors in support of future operation. The capsules are identified as Standby; thus, there is no requirement to withdraw and test the capsules at the identified EFPY in parentheses. The withdrawal EFPY identifies the time at which the capsule will reach a fluence equivalent to 80 years of operation (72 EFPY)."
7. (Editorial) Format of scientific notation is changed from the standard form to the "E" notation form to be consistent with the format used in source document WCAP-17969-NP, "Analysis of Capsule 83° from the Entergy Operations, Inc. Waterford Unit 3 Reactor Vessel Radiation Surveillance Program" (Reference 10).
8. (Editorial) Information is reformatted into table with gridlines to improve readability.

TECHNICAL ANALYSIS

ASTM E 185-82 recommends that the surveillance capsule lead factors (the ratio of the instantaneous neutron flux density at the specimen location to the maximum calculated neutron flux density at the inside surface of the reactor vessel wall) be in the range of one to three. This range of lead factors will minimize the calculational uncertainties in extrapolating the surveillance measurements from the specimens to the reactor vessel wall and maximize the ability of the program to monitor material property changes throughout the life of the reactor vessel.

Waterford 3 TS Surveillance Requirement 4.4.8.1.2 (Reference 11) states, "The reactor vessel material irradiation surveillance specimens shall be removed and examined, to determine changes in material properties, at the intervals required by 10 CFR Part 50 Appendix H in accordance with the Reactor Vessel material surveillance program – withdrawal schedule in [U]FSAR Table 5.3-10. The results of these examinations shall be used to update [TS] Figures 3.4-2 and 3.4-3." Standby capsules 104° and 284° are available to support the demonstration of reactor vessel integrity into the subsequent period of extended operation. Per the current UFSAR Table 5.3-10 capsule withdrawal schedule, the lead factor for these standby capsules is 0.83. This value is outside of the ASTM E 185-82 recommended range of one to three; therefore, it is concluded that it is necessary to relocate capsules 104° and 284° to support the demonstration of reactor vessel integrity into the subsequent period of extended operation.

Details regarding the technical analysis supporting the proposed changes are provided in Attachment 3. As described in Attachment 3, relocation of these capsules to the proposed locations will place the capsules in a higher neutron flux location to have meaningful data in the future and support potential future license renewal periods. The section of Attachment 3 titled "Contingencies" is provided for information only.

This proposed schedule change does not affect the current plans to withdraw or test Waterford 3 capsules and only makes changes to the location of the standby capsules to provide meaningful data in the future, if needed. The NRC determined that the current schedule complies with ASTM E185-82 and 10 CFR 50, Appendix H (Reference 9). Since no changes are being made to any capsule withdrawals or testing, the schedule's compliance with ASTM E185-82 and 10 CFR 50, Appendix H, is unchanged.

REFERENCES

1. NUREG-2191, "Generic Aging Lessons Learned for Subsequent License Renewal (GALL-SLR) Report," Volume 2, (ADAMS Accession No. ML17187A204), July 2017
2. 10 CFR 50, Appendix H, "Reactor Vessel Material Surveillance Program Requirements"
3. ASTM E185-82, "Standard Practice for Conducting Surveillance Tests for Light-Water Cooled Nuclear Power Reactor Vessels," September 1982
4. Waterford Steam Electric Station, Unit 3, Updated Final Safety Analysis Report, Revision 312, Sections 5.2.1.1 and 5.3.1.6, (ADAMS Accession No. ML21273A392), dated September 30, 2021

5. NRC Administrative Letter 97-04, "NRC Staff Approval for Changes to 10 CFR Part 50, Appendix H, Reactor Vessel Surveillance Specimen Withdrawal Schedules," (ADAMS Accession No. ML031210296), dated September 30, 1997
6. NRC Memorandum and Order CLI-96-13, (ADAMS Accession No. ML20135F473), dated December 6, 1996
7. NRC Generic Letter 91-01, "Removal of the Schedule for the Withdrawal of Reactor Vessel Material Specimens from Technical Specifications," (ADAMS Accession No. ML031140127), dated January 4, 1991
8. Nuclear Regulatory Commission (NRC) Letter to Entergy Operations, Inc. (Entergy), "Issuance of Amendment No. 106 to Facility Operating License NPF-38 – Waterford Steam Electric Station, Unit 3 (TAC No. M88434," (ADAMS Accession No. ML021770550), dated May 8, 1995
9. NRC Letter to Entergy, "Waterford Steam Electric Station, Unit 3 – Revision to Reactor Vessel Surveillance Capsule Withdrawal Schedule (EPID L-2019-LLL-0017)," (ADAMS Accession Number ML19282D892), dated October 15, 2019
10. Entergy Letter W3F1-2019-0022 to NRC, "Resubmittal of Reactor Vessel Material Surveillance Program Capsule Test Results" (includes Westinghouse Report WCAP-17969-NP, Revision 2, "Analysis of Capsule 83° from the Entergy Operations, Inc. Waterford Unit 3 Reactor Vessel Radiation Surveillance Program"), (ADAMS Accession Number ML19073A302), dated March 14, 2019
11. Waterford Steam Electric Station, Unit 3, Current Facility Operating License NPF-38, Appendix A, Technical Specifications (ADAMS Accession Number ML053130318)

Enclosure, Attachment 1

W3F1-2021-0064

**Current Waterford 3 Updated Final Safety Analysis Report Table 5.3-10,
Capsule Assembly Removal Schedule**

(1 Page to Follow)

WSES-FSAR-UNIT-3

TABLE 5.3-10

CAPSULE ASSEMBLY REMOVAL SCHEDULE

Capsule No. / ID	Azimuthal Location (deg.)	Lead Factor	Removal Time (EFPY)*	Target Fluence (n/cm²)
1/W-83	83	1.20	24.66**	2.42 x 10 ¹⁹ **
2/W-97	97	1.19	4.41**	6.31 x 10 ¹⁸ **
3/W-104	104	0.83	Standby	--
4/W-263	263	1.19	13.83**	1.45 x 10 ¹⁹ **
5/W-277	277	1.20	48	4.51 x 10 ¹⁹ **
6/W-284	284	0.83	Standby	--

* EFPY - Effective Full Power Years, withdrawal time may be modified to coincide with those refueling outages or plant shutdowns most closely approaching the withdrawal schedule.

** Values represent actual data on removed capsule

NOTE: As required by 10 CFR 50, Appendix H, Section III.B.3, submit a proposed withdrawal schedule with technical justification as specified in 10 CFR 50.4 for NRC approval prior to implementation.

Enclosure, Attachment 2

W3F1-2021-0064

**Proposed Revision to Waterford 3 Updated Final Safety Analysis Report Table 5.3-10,
Capsule Assembly Removal Schedule**

(1 Page to Follow)

TABLE 5.3-10

CAPSULE ASSEMBLY REMOVAL SCHEDULE

Capsule No. / ID	Azimuthal Location (deg.)	Lead Factor ^(a)	Removal Time (EFPY) ^(b)	Target Fluence (n/cm ²)
1/W-83 ^(c)	83	1.20	24.66	2.42E+19
2/W-97 ^(c)	97	1.19	4.41	6.31E+18
3/W-104 ^(d)	104 / 97	1.02	Standby (71)	Standby (5.61E+19)
4/W-263 ^(c)	263	1.19	13.83	1.45E+19
5/W-277	277	1.20	48	4.51E+19
6/W-284 ^(d)	284 / 263	1.02	Standby (71)	Standby (5.61E+19)

Notes:

- (a) Lead factor is the ratio of the capsule fluence to the peak reactor vessel fluence at the time of withdrawal.
- (b) EFPY - Effective Full Power Years, withdrawal time may be modified to coincide with those refueling outages or plant shutdowns most closely approaching the withdrawal schedule.
- (c) Values represent actual data on removed capsule.
- (d) Capsule was relocated during Refueling Outage 24 in order to experience higher lead factors in support of future operation. The capsules are identified as Standby; thus, there is no requirement to withdraw and test the capsules at the identified EFPY in parentheses. The withdrawal EFPY identifies the time at which the capsule will reach a fluence equivalent to 80 years of operation (72 EFPY).

NOTE: As required by 10 CFR 50, Appendix H, Section III.B.3, submit a proposed withdrawal schedule with technical justification as specified in 10 CFR 50.4 for NRC approval prior to implementation.

Attachment 3

W3F1-2021-0064

**Westinghouse Letter LTR-SDA-21-061-NP, Rev. 0-A,
"Recommendations for Surveillance Capsule Relocation
at Waterford Unit 3"**

(11 Pages to Follow)



Westinghouse Electric Company
302 Building
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To: Michael Francis

Date: October 4, 2021

From: RV/CV Design & Analysis
Phone: (412) 342-1788

Our ref: LTR-SDA-21-061-NP, Rev. 0

Subject: **Recommendations for Surveillance Capsule Relocation at Waterford Unit 3**

Attachment: A. Recommendations for Surveillance Capsule Relocation at Waterford Unit 3

Reference: 1. LTR-AMER-MKG-21-84, Revision 0, "Westinghouse Offer for Surveillance Capsule Relocation at Waterford Unit 3," March 26, 2021.

Entergy contracted Westinghouse to provide a letter report justifying a surveillance capsule withdrawal schedule update applicable to Waterford Unit 3 as described in Reference 1. The attachment to this letter provides the recommendation for relocating surveillance capsules at Waterford 3 to support the demonstration of reactor vessel integrity through the potential subsequent license renewal(s). The justification for relocation of Capsule 104° and/or 284° and a revised surveillance capsule withdrawal schedule are provided in Attachment A. This letter report provides justification appropriate for submittal to the United States Nuclear Regulatory Commission (U.S. NRC).

Please transmit this document and the following attachments to the customer.

If you have any questions, please contact the undersigned.

Electronically Approved*

Author: D. Brett Lynch
Reactor Vessel/Containment Vessel
(RV/CV) Design & Analysis

Electronically Approved*

Reviewed: Benjamin E. Mays
License Renewal, Radiation Analysis, and
Nuclear Operations

Electronically Approved*

Approved: Lynn A. Patterson, Manager
RV/CV Design & Analysis

****Electronically approved records are authenticated in the electronic document management system.***

Attachment A
Recommendations for Surveillance Capsule
Relocation at Waterford Unit 3

Recommendations for Surveillance Capsule Relocation at Waterford Unit 3

BACKGROUND

Appendix H, “Reactor Vessel Material Surveillance Program Requirements,” to Title 10 of the Code of Federal Regulations (10 CFR), Part 50 [Ref. 1], describes reactor vessel (RV) material surveillance program requirements. Paragraph III.B.3 of 10 CFR Part 50, Appendix H states that a proposed withdrawal schedule must be submitted with a technical justification per 10CFR50.4 and approved prior to implementation.

NRC Administrative Letter 97-04 [Ref. 2] clarified the submittal requirements of 10 CFR Part 50, Appendix H. As stated in Administrative Letter 97-04, “[A]s long as the plant’s withdrawal schedule change meets the applicable ASTM [American Society for Testing and Materials] standard, the plant will not be exceeding the operating authority already granted in its license. Therefore, a license amendment would not be required, although prior NRC approval to verify conformance with the ASTM standard is required by [10 CFR Part 50,] Appendix H.”

CURRENT PROGRAM / WITHDRAWAL SCHEDULE

A pressure vessel steel irradiation surveillance program was developed for the RV of Waterford Unit 3 in TR-C-MCS-001 [Ref. 3], TR-C-MCS-002 [Ref. 4], and C-NLM-003 [Ref. 5]. The program comprises the evaluation of radiation effects on sample materials based on comparison pre-irradiation testing of a selected group of specimens to determine toughness properties of the reactor pressure vessel. Continuous monitoring of these specimens within the reactor pressure vessel provides data on the integrity of the vessel in terms of adequate toughness properties. TR-C-MCS-001, TR-C-MCS-002, and C-NLM-003 provide a description of the surveillance capsules and pre-irradiated test results.

The surveillance program was originally planned to cover the 40-year design life of the reactor pressure vessel and was based on ASTM E185-73 [Ref. 6]. Six surveillance capsules for monitoring the effects of neutron exposure on the Waterford Unit 3 reactor pressure vessel core region (beltline) materials were inserted in the RV prior to initial plant startup. The six capsules were positioned in the RV, as shown in Figure 1, between the core barrel and the vessel wall, at various azimuthal locations. The vertical center of the capsules is opposite the vertical center of the core. The capsules contain specimens made from the following:

- Lower Shell Plate M-1004-2 (longitudinal orientation)
- Lower Shell Plate M-1004-2 (transverse orientation)
- Weld metal fabricated with weld wire Heat Number 88114, Linde Type 0091 flux, which is equivalent to the heat number and flux type used in the actual fabrication of the intermediate shell to lower shell circumferential weld seam
- Weld heat affected zone (HAZ) material of Lower Shell Plate M-1004-2
- Standard Reference Material (SRM) Heavy-Section Steel Technology (HSST)-01MY Plate

FSAR Table 5.3-10 presents the current capsule withdrawal schedule. Since the initial reactor vessel surveillance program was developed, Waterford Unit 3 was approved for a 60-year operating license [Ref. 7]. In order to satisfy commitments associated with the renewed operating license, a revision to the

capsule withdrawal schedule was requested and approved [Refs. 8 and 9]. The capsule withdrawal schedule which supports the 60-year operating license is reconstructed in Table 1.

The reactor vessel irradiation surveillance program, including the withdrawal schedule, is in compliance with ASTM E185-82 [Ref. 10] and 10 CFR Part 50, Appendix H [Ref. 1]. Currently, Waterford Unit 3 has withdrawn and tested three (3) of its six (6) original surveillance capsules, with the remaining three (3) capsules remaining in the RV undergoing neutron irradiation. The test results of the last capsule tested (3rd overall) are presented in WCAP-17969-NP [Ref. 11]. The fluence results presented within this letter are based on the fluence analysis within WCAP-17969-NP. One additional capsule, located at 277°, is scheduled to be withdrawn and tested at 48 effective full-power years (EFPY) of operation, which is when the surveillance capsule is projected to have a neutron fluence equal to the peak RV wall fluence at 55 EFPY (60 years of total operation). Withdrawal and testing of Capsule 277° satisfies the regulatory requirements of 10CFR50, Appendix H and NUREG-1801 [Ref. 12], Section XI.M31 for a 60-year license.

Two additional capsules, 104° and 284°, remain in the vessel as standby capsules. They are located such that the ratio of their fluence to the maximum fluence of the vessel wall (termed a lead factor) is less than 1. Therefore, the exposure of these capsules in their current locations will always trail the peak RV wall fluence.

PROPOSED REVISION TO THE WITHDRAWAL SCHEDULE

It is anticipated that for a second license extension, at least one of the remaining two (2) capsules would need to be withdrawn and tested. In order to meet the requirements of ASTM E185-82 and NUREG-2191 [Ref. 13] for a potential 80-year operating period, at least one capsule must be withdrawn and tested with a neutron fluence higher than that of the peak projected vessel wall. In their current positions, Capsules 104° and 284° will not receive fluence greater than the peak vessel fluence.

Waterford Unit 3 will relocate the surveillance capsules at 104° and 284° to the locations at 97° and 263°, respectively, during Refueling 24 outage. The objective of this relocation is to place surveillance capsules in a higher neutron flux location in order to have meaningful data in the future and support potential future license renewal periods.

Table 2 provides the proposed revised capsule removal schedule which complies with the requirements of ASTM E185-82 and considers guidance from NUREG-2191 [Ref. 13] for a potential 80-year (72 EFPY) period of operation.

JUSTIFICATION

This proposed schedule change does not affect the current plans to withdraw or test Waterford Unit 3 capsules and only makes changes to the location of the standby capsules in order to provide meaningful data in the future, if needed. The NRC determined that the current schedule complies with ASTM E185-82 and 10CFR50, Appendix H per Reference 9. Since no changes are being made to any capsule withdrawals or testing, the schedule's compliance with ASTM E185-82 and 10CFR50, Appendix H is unchanged.

As can be seen in Table 3 and Table 4, capsules residing at the 14° location of the octagonally symmetric model, which includes both Capsules 104° and 284°, will experience the lowest fluence rate of all capsule

locations, and, in fact, trail the peak fluence experienced by the RV wall. All vacant locations, which are located at a 7° location of the octagonally symmetric model, experience the same higher fluence rate. Therefore, the location closest to the current location was chosen as the destination for the relocated capsules.

Table 5 indicates that the maximum RV fluence at 72 EFPY is projected to be 5.61E+19 n/cm² (E>1.0 MeV). In accordance with the requirements of ASTM E185-82, Section 7.6 and NUREG-2191, Section XI.M31 for a potential 80-year life, the surveillance capsules should be removed when their neutron fluence exceeds the peak vessel fluence at the end of life, which is estimated to be 72 EFPY for an 80-year life. At the start of Refueling Outage 24, Waterford 3 is projected to have experienced approximately 32 EFPY of operation, at which time the capsules currently residing at 104° and 284° will have experienced an irradiation of 2.15E+19 n/cm² per Table 3. In order for these capsules to reach the peak RV fluence at 72 EFPY, an additional fluence of 3.46E+19 n/cm² must be experienced. It will take approximately an additional 39 EFPY of operation at the 7° location to reach the 72 EFPY peak RV fluence of 5.61E+19 n/cm² based on the fluence rate of the 7° location. This additional 39 EFPY will be reached at 71 EFPY of total operation. It should be noted that since Waterford Unit 3 is only licensed for 60 years of operation, these relocated capsules are classified as standby capsules and are not required to be withdrawn and tested at this time. The relocations are being undertaken to provide meaningful data in the future, if needed.

CONTINGENCIES

In order to account for potential issues with relocating the capsules, contingency plans are proposed in this section. As stated above, all vacant locations, which are each located at a 7°-equivalent location, experience the same fluence rate. Therefore, if either the 97° or 263° vacant locations are unable to be utilized, the vacant 83° location provides an acceptable and radiologically equivalent alternative.

If one, or both, of the capsules is removed but cannot be relocated to any of the vacant locations, then the capsule(s) will be returned to its original location, if possible, or stored in the spent fuel pool (SFP) for potential future reinsertion. Additionally, if the first capsule intended to be relocated cannot successfully be relocated, then plans to relocate the second capsule will be re-evaluated by Entergy prior to proceeding, with contingency that relocation of the second capsule will not take place during RF24.

If any of these contingency plans are required to be utilized, an updated surveillance capsule withdrawal schedule will be provided to the NRC to reflect the status of the Waterford Unit 3 surveillance capsules.

REFERENCES

1. Code of Federal Regulations 10CFR50, Appendix H, "Reactor Vessel Material Surveillance Program Requirements," U.S. Nuclear Regulatory Commission, Federal Register, October 2, 2020.
2. Nuclear Regulatory Commission (NRC) Administrative Letter 97-04, "NRC Staff Approval for Changes to 10 CFR Part 50, Appendix H, Reactor Vessel Surveillance Specimen Withdrawal Schedules," dated September 30, 1997. (Agencywide Documents Access and Management System (ADAMS) Accession No. ML031210296)
3. TR-C-MCS-001, Revision 0, "Summary Report on Manufacture of Test Specimens and Assembly of Capsules for Irradiation Surveillance of Waterford-Unit 3 Reactor Vessel Materials," December 1977.

4. TR-C-MCS-002, Revision 0, "Louisiana Power & Light Waterford Steam Electric Station Unit No. 3 Evaluation of Baseline Specimens Reactor Vessel Materials Irradiation Surveillance Program," October 1977.
5. C-NLM-003, Revision 1, "Program for Irradiation Surveillance of Waterford Unit Three Reactor Vessel Materials," October 1974.
6. ASTM E185-73, "Standard Recommended Practice for Surveillance Tests for Nuclear Reactor Vessels," American Society for Testing and Materials, 1973.
7. NRC Safety Evaluation Report (SER), "Safety Evaluation Report Related to the License Renewal of Waterford Steam Electric Station Unit 3," August 2018. [*ADAMS Accession Number ML18228A668*]
8. Letter to NRC, "Proposed Revision to Reactor Vessel Surveillance Capsule Withdrawal Schedule Waterford Steam Electric Station, Unit 3 Docket No. 50-382 Renewed Facility Operating License No. NPF-38," April 2019. [*ADAMS Accession Number ML19115A417*]
9. NRC Letter, "Waterford Steam Electric Station, Unit 3 – Revision to Reactor Vessel Surveillance Capsule Withdrawal Schedule (EPID L-2019-LLL-0017)," October 2019. [*ADAMS Accession Number ML19282D892*]
10. ASTM E185-82, "Standard Practice for Conducting Surveillance Tests for Light-Water Cooled Nuclear Power Reactor Vessels," American Society for Testing and Materials, 1982.
11. Westinghouse Report WCAP-17969-NP, Revision 2, "Analysis of Capsule 83° from the Entergy Operations, Inc. Waterford Unit 3 Reactor Vessel Radiation Surveillance Program," November 2017.
12. NUREG-1801, Revision 2, "Generic Aging Lessons Learned (GALL) Report," U.S. Nuclear Regulatory Commission, December 2010. [*ADAMS Accession Number ML103490041*]
13. NUREG-2191, Volume 2, "Generic Aging Lessons Learned for Subsequent License Renewal (GALL-SLR) Report," U.S. Nuclear Regulatory Commission, July 2017. [*ADAMS Accession Number ML17187A204*]
14. Westinghouse Report WCAP-18002-NP, Revision 0, "Waterford Unit 3 Time-Limiting Aging Analysis on Reactor Vessel Integrity," July 2015.

Table 1
Current Surveillance Capsule Withdrawal Schedule

Capsule No. / ID	Azimuthal Location (deg.)	Lead Factor	Removal Time (EFPY)*	Target Fluence (n/cm²)
1/W-83	83	1.20	24.66**	2.42E+19**
2/W-97	97	1.19	4.41**	6.31E+18**
3/W-104	104	0.83	Standby	–
4/W-263	263	1.19	13.83**	1.45E+19**
5/W-277	277	1.20	48	4.51E+19
6/W-284	284	0.83	Standby	–

* EFPY – Effective Full Power Years, withdrawal time may be modified to coincide with those refueling outages or plant shutdowns most closely approaching the withdrawal schedule.

** Values represent actual data on removed capsule.

Table 2
Recommended Revised Surveillance Capsule Withdrawal Schedule

Capsule No. / ID	Azimuthal Location (deg.)	Lead Factor^(a)	Removal Time (EFPY)^(b)	Target Fluence (n/cm²)
1/W-83 ^(c)	83	1.20	24.66	2.42E+19
2/W-97 ^(c)	97	1.19	4.41	6.31E+18
3/W-104 ^(d)	104 / 97	1.02	Standby (71)	Standby (5.61E+19)
4/W-263 ^(c)	263	1.19	13.83	1.45E+19
5/W-277	277	1.20	48	4.51E+19
6/W-284 ^(d)	284 / 263	1.02	Standby (71)	Standby (5.61E+19)

Notes:

- (a) Lead factor is the ratio of the capsule fluence to the peak reactor vessel fluence at the time of withdrawal.
- (b) EFPY – Effective Full Power Years, withdrawal time may be modified to coincide with those refueling outages or plant shutdowns most closely approaching the withdrawal schedule.
- (c) Values represent actual data on removed capsule.
- (d) Capsule was relocated during Refueling Outage 24 in order to experience higher lead factors in support of future operation. The capsules are identified as Standby; thus, there is no requirement to withdraw and test the capsules at the identified EFPY in parentheses. The withdrawal EFPY identifies the time at which the capsule will reach a fluence equivalent to 80 years of operation (72 EFPY).

Table 3
Fluence (E > 1.0 MeV) at the Geometric Center of the
Surveillance Capsules at Core Midplane

End of Cycle	Cycle Length (EFPY)	Total Time (EFPY)	Fluence (n/cm ²)		Fluence Rate (n/cm ² - EFPY)	
			7-Degree	14-Degree	7-Degree	14-Degree
1	1.04	1.04	1.85E+18	1.28E+18	–	–
2	1.01	2.05	3.25E+18	2.25E+18	–	–
3	1.15	3.20	4.84E+18	3.31E+18	–	–
4	1.21	4.41	6.31E+18	4.32E+18	–	–
5	1.25	5.66	7.87E+18	5.40E+18	–	–
6	1.30	6.95	9.47E+18	6.35E+18	–	–
7	1.35	8.30	1.04E+19	7.05E+18	–	–
8	1.35	9.66	1.15E+19	7.83E+18	–	–
9	1.44	11.10	1.27E+19	8.68E+18	–	–
10	1.40	12.50	1.37E+19	9.47E+18	–	–
11	1.33	13.83	1.45E+19	1.00E+19	–	–
12	1.48	15.31	1.56E+19	1.08E+19	–	–
13	1.40	16.70	1.68E+19	1.17E+19	–	–
14	1.40	18.10	1.82E+19	1.26E+19	–	–
15	1.29	19.39	1.95E+19	1.35E+19	–	–
16	1.35	20.74	2.08E+19	1.44E+19	–	–
17	1.31	22.05	2.19E+19	1.52E+19	–	–
18	1.40	23.46	2.33E+19	1.61E+19	–	–
19	1.20	24.66	2.42E+19	1.68E+19	–	–
23 ^(b)	–	32 ^(b)	3.08E+19	2.15E+19 ^(b)	8.98E+17	6.38E+17
Future	–	36	3.44E+19	2.40E+19		
Future	–	40	3.80E+19	2.66E+19		
Future	–	48	4.51E+19	3.16E+19		
Future	–	55	5.14E+19	3.61E+19		
Future	–	60	5.59E+19	3.93E+19		
Future	–	66	6.13E+19	4.31E+19		
Future	–	72	6.67E+19	4.70E+19		

Notes:

- (a) Values through 60 EFPY are taken from WCAP-17969-NP and consistent with WCAP-18002-NP. Values beyond 60 EFPY are based on linear extrapolation.
- (b) End-of-cycle 23 is projected to occur at approximately 32 EFPY. Thus, the projected fluence on Capsule 104° and 284° at the time of relocation is approximately 2.15×10^{19} n/cm².

Table 4
Surveillance Capsule Lead Factors

Cycle ID	Cycle Length (EFPY)	Total Time (EFPY)	Lead Factor	
			7-Degree	14-Degree
1	1.04	1.04	1.25	0.87
2	1.01	2.05	1.22	0.84
3	1.15	3.20	1.20	0.82
4	1.21	4.41	1.19 (Capsule 97°)	0.81
5	1.25	5.66	1.18	0.81
6	1.30	6.95	1.17	0.78
7	1.35	8.30	1.18	0.80
8	1.35	9.66	1.18	0.80
9	1.44	11.10	1.18	0.81
10	1.40	12.50	1.19	0.82
11	1.33	13.83	1.19 (Capsule 263°)	0.82
12	1.48	15.31	1.19	0.83
13	1.40	16.70	1.20	0.83
14	1.40	18.10	1.20	0.83
15	1.29	19.39	1.20	0.83
16	1.35	20.74	1.20	0.83
17	1.31	22.05	1.19	0.83
18	1.40	23.46	1.19	0.82
19	1.20	24.66	1.20 (Capsule 83°)	0.83
Future	–	32.00	1.20	0.84
Future	–	36.00	1.20	0.84
Future	–	40.00	1.20	0.84
Future	–	48.00	1.19	0.84
Future	–	55.00	1.19	0.84
Future	–	60.00	1.19	0.84
Future	–	66.00	1.19	0.84
Future	–	72.00	1.19	0.84

Table 5
Peak Projected RV Fluence at the Clad/Base Metal Interface^(a)

Total Time (EFPY)	Peak Beltline Fluence (n/cm ²)	Peak Extended Beltline Fluence (n/cm ²)
32.00	2.57E+19	3.28E+17
36.00	2.86E+19	3.72E+17
40.00	3.16E+19	4.16E+17
48.00	3.78E+19	5.05E+17
55.00	4.32E+19	5.82E+17
60.00	4.70E+19	6.38E+17
66.00	5.16E+19	7.05E+17
72.00	5.61E+19	7.72E+17

Note:

- (a) Fluence values through 60 EFPY are taken from WCAP-17969-NP and consistent with WCAP-18002-NP. Fluence values beyond 60 EFPY are based on linear extrapolation.

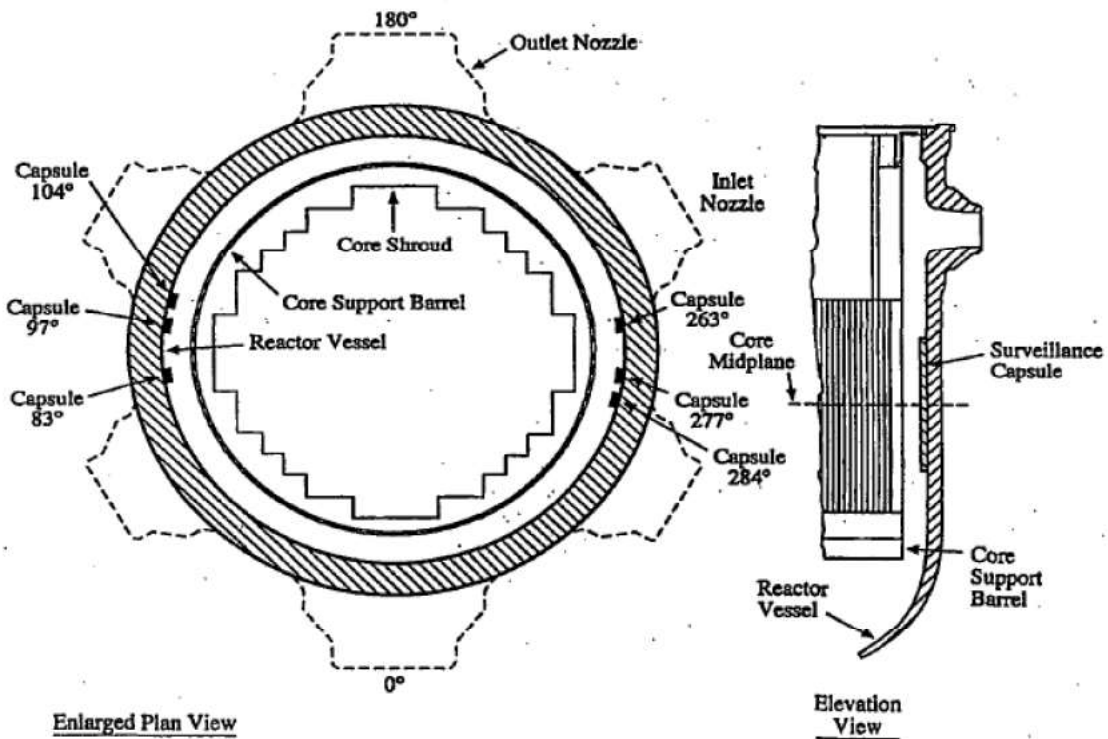


Figure 1 Arrangement of Surveillance Capsules in the Waterford Unit 3 Reactor Vessel

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