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

July 31, 2023

MILLSTONE POWER STATION, UNIT NO. 3 – AUTHORIZATION AND SAFETY EVALUATION FOR ALTERNATIVE REQUEST NO. IR-4-11 (EPID L-2022-LLR-0067)

LICENSEE INFORMATION

Recipient's Name and Address: Mr. Eric S. Carr
President – Nuclear Operations and
Chief Nuclear Officer
Dominion Energy Nuclear Connecticut, Inc.
Millstone Power Station
Innsbrook Technical Center
5000 Dominion Blvd.
Glen Allen, VA 23060-6711

Licensee: Dominion Energy Nuclear Connecticut, Inc.

Plant Name and Unit: Millstone Power Station, Unit No. 3

Docket No.: 50-423

APPLICATION INFORMATION

Application Date: September 28, 2022

Application Agencywide Documents Access and Management System (ADAMS) Accession No.: ML22271A913

Applicable Inservice Inspection (ISI) Program Interval and Interval Start/End Dates: The fourth inspection interval for Millstone Power Station, Unit 3 (Millstone 3), began on February 23, 2019, and is scheduled to end February 22, 2029.

Alternative Provision: The applicant requested an alternative under Title 10 of the *Code of Federal Regulations* (10 CFR), paragraph 50.55a(z)(2).

ISI Requirement: 10 CFR 50.55a(g)(6)(ii)(D)(5)

Applicable Code Edition and Addenda: American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components," 2013 Edition.
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Brief Description of the Proposed Alternative:

Dominion Energy Nuclear Connecticut, Inc. (licensee) implemented an Ultra High Pressure Cavitation Peening (UHPCP) process at Millstone 3 during the fall 2020 refueling outage (RFO) for all of the unit's reactor pressure vessel head penetration nozzles (RPVHPNs). In accordance with MRP-335, Revision 3-A, the follow-up volumetric examination of the RPVHPNs is currently scheduled for fall 2023 RFO at Millstone 3. However, the warranty from the licensee's vendor that performed the UHPCP application specifies that a follow-up volumetric examination be conducted in the third RFO after peening.

To eliminate performance of equivalent examinations in two sequential RFOs, the licensee is requesting deferral of the Millstone 3 RPVHPNs post-peening follow-up volumetric examination scheduled for the unit's fall 2023 RFO until the unit's spring 2025 RFO. The licensee confirms there will be no deviation in visual examination requirements, as bare metal visual examinations will be performed each RFO in accordance with MRP-335, Revision 3-A, Section 4.3.4.

For additional details on the licensee's request, please refer to the documents located at the ADAMS Accession No. identified above.

STAFF EVALUATION

The U.S. Nuclear Regulatory Commission (NRC) staff reviewed and evaluated the licensee's request on the basis of 10 CFR 50.55a(z)(2), such that compliance with the specified requirements would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety. The specified requirement under 10 CFR 50.55a(g)(6)(ii)(D) was performance of a follow-up volumetric examination after two operating cycles following the application of peening on the RPVHPNs. The licensee noted that the vendor for the peening process requires a volumetric examination after three operating cycles to support the warranty for the peening process. The purpose of the licensee's proposed alternative is to defer the regulatory required volumetric examination to be in conjunction with the vendor's warranty required volumetric examination.

The licensee noted the hardship in performing the examination in two sequential RFOs would add unnecessary radiological dose. The nozzles to be examined are in a locked high radiation area and estimated personnel radiological exposure to perform a volumetric examination of all nozzles would be approximately 545 mRem. The NRC staff recognized the licensee's concerns and found the licensee has identified a hardship meeting the requirement of 10 CFR 50.55a(z)(2).

The NRC staff reviewed the level of quality and safety of the licensee's proposed alternative that the volumetric examinations of the subject RPVHPNs be delayed for one cycle of operation. The licensee provided supporting basis though a flaw analysis, prior volumetric and bare metal visual examination results and defense-in-depth actions. The NRC staff reviewed each of these factors in evaluating the level of quality and safety in the licensee's proposed alternative.

The licensee utilized a flaw analysis performed by Dominion Engineering, Inc. Technical Note TN-4069-00-01, Revision 0 (ML18248A060), which was previously submitted to support a proposed alternative for Byron Station, Unit 2, to defer some volumetric examinations. The licensee reviewed the flaw analysis and concluded that it was also applicable to Millstone 3,

which uses a nominal 18-month fuel cycle, and operates its reactor pressure vessel upper head at similar cold loop temperature conditions.

The NRC staff notes that the degradation mechanism of concern is leakage of primary coolant containing boric acid from the RPVHPNs and/or associated J-groove weld. This leakage can cause two issues to challenge the structural integrity of the reactor coolant pressure boundary of the reactor pressure vessel (RPV) head or nozzles. The first challenge is circumferential cracking, and thereby ejection, of a penetration nozzle from the RPV head. This could cause a small break loss-of-coolant-accident or control rod misalignment. The second challenge is that the leakage could cause boric acid corrosion of the low alloy steel material that comprises the bulk thickness of the RPV head. Boric acid corrosion rates of low alloy steel could be up to 6 inches/year under very severe conditions as discussed in NRC report, NUREG/CR-6875, "Boric Acid Corrosion of Light Water Reactor Pressure Vessel Materials," J.-H. Park, O. K. Chopra, K. Natesan, and W. J. Shack; July 2005 (ML052360563). After sufficient corrosion, a small or medium break loss of coolant accident could occur. To prevent significant degradation in RPV heads and penetration nozzles, 10 CFR 50.55a(g)(6)(ii)(D) requires an inspection program for these components, including volumetric examinations and bare metal visual examinations. The NRC staff further notes that the licensee applied peening on the subject nozzles and associated J-groove weld surfaces, in accordance with MRP-335, Revision 3-A, to mitigate against primary water stress corrosion cracking (PWSCC) initiation in the components.

The NRC staff reviewed TN-4069-00-01, Revision 0, and determined that the crack growth analyses were based on conservative assumptions and industry-wide crack size measurement data applicable for Millstone 3. The analysis included a matrix of deterministic PWSCC crack growth calculations. The matrix considered various crack growth cases that involve different initial crack sizes, crack aspect ratios, operating temperatures, and severity levels of stress profiles. The crack growth analysis discussed the effectiveness of follow-up volumetric examination to monitor pressure boundary leakage of the nozzles. The analysis further estimates the growth of hypothetical, shallow PWSCC cracks that may have been missed in previous examinations. The report evaluation indicated that extending the currently approved examination schedule by one cycle of operation would result in a very low fraction of cases that could cause nozzle leakage. Further the report concluded the possibility of leaking nozzles after the follow-up volumetric examination would be the same for examinations performed after two or three cycles of operation.

The NRC staff reviewed the licensee's assessment of TN-4069-00-01, Revision 0, and determined that it is representative for MPS3. The NRC staff notes that leakage is required to establish the necessary environmental conditions for circumferential cracking of the nozzle above the J-groove weld or boric acid corrosion of the low alloy steel RPV head. Therefore, additional time would be required to initiate and grow a circumferential crack in the nozzle material above the J-groove weld or produce sufficient boric acid corrosion of the upper head material to challenge the structural integrity of the RPV head. The NRC staff notes that while the possibility of leakage from a nozzle or J-groove weld cannot be completely discounted, the time necessary for any such hypothetical leakage was evaluated to determine the potential to challenge structural integrity of the RPV head or nozzle.

The NRC staff performed a series of independent evaluations to verify the licensee's assessment. Based on MRP-335, Revision 3-A, the NRC staff determined that there is reasonable assurance that peening of the MPS3 nozzles will mitigate new crack initiation. The NRC staff also determined that the bare metal visual examination of the RPV head to be performed during each refueling outage ensures there is currently no active indication of nozzle

leakage, and any potential leakage will be identified. The NRC staff's independent evaluations found some cases of crack growth and specific weld residual stress profiles where leakage could result if the examination frequency was increased by one cycle of operation. However, the NRC staff evaluations showed insufficient time for these cases, either in the nozzle or J-groove weld, to allow leakage to challenge the structural integrity of the RPV head. The NRC staff bases this conclusion on the need for additional circumferential crack growth for nozzle ejection or the leaking flaw to grow to allow leakage rates to cause boric acid corrosion rates identified in NUREG/CR-6875. Therefore, the NRC staff determined that the conclusions of the licensee's assessment are acceptable.

The NRC staff reviewed the operating experience available for MPS3 and other peened RPVHPNs. The NRC staff noted that no previous indications of PWSCC have been identified in the MSP3 RPVHPNs or associated J-groove welds. Additionally, during follow-up volumetric examinations of RPVHPNs of similar operating temperature conditions, no new indications of PWSCC were identified in the peened areas of RPVHPNs at four other plants. Further, no indications of leakage were found at these plants through the J-groove weld by the volumetric leak path examination. The NRC staff determined that these examination results provide additional assurance that indicates the margin of the postulated flaw analyses utilized by the licensee and NRC are conservative.

The NRC staff further assessed the adequacy of the defense-in-depth of the licensee's examination and monitoring requirements to evaluate the structural integrity of the upper head and nozzles. The NRC staff notes the licensee confirmed that a bare metal visual examination was and will be performed on each nozzle for evidence of pressure boundary leakage every refueling outage in accordance with MRP-335, Revision 3-A. The NRC staff finds that the visual examination is an effective defense-in-depth inspection. The NRC staff also notes that technical specifications of MPS3 require operational leakage monitoring. Further, the NRC notes the licensee also implements a lower 0.1 gallon-per-minute leakage action level on unidentified reactor coolant pressure boundary leakage, consistent with WCAP-16465-NP, "Pressurized Water Reactor Owners Group Standard RCS Leakage Action Levels and Response Guidelines for Pressurized Water Reactors," (ML070310082). The NRC staff finds the ongoing leakage monitoring program at Millstone 3, during the additional cycle of operation, provides an effective defense-in-depth basis to ensure the structural integrity of the RPV head and nozzles at Millstone 3 for the period of the licensee's proposed alternative. The NRC staff also notes that if any leakage is identified, it would be required to be repaired and the examination requirements of 10 CFR 50.55a(g)(6)(ii)(D) would be implemented.

Given the licensee's identified hardship, the NRC staff finds that the licensee has provided an adequate technical basis to extend the follow-up volumetric examination of the subject RPVHPNs for one operating cycle. The NRC staff also finds that the defense-in-depth bare metal visual examination, along with operational leakage monitoring, provides reasonable assurance that the structural integrity of the RPV upper head and nozzles are maintained. Therefore, the NRC staff finds that complying with the current volumetric examination requirement in the fall 2023 RFO along with the licensee's warranty obligation in spring 2025 RFO would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

CONCLUSION

The NRC staff has determined that complying with the specified requirements described in the licensee's request referenced above would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

The proposed alternative provides reasonable assurance of structural integrity of the reactor pressure vessel head. The NRC staff concludes that the licensee has adequately addressed the regulatory requirements set forth in 10 CFR 50.55a(z)(2).

The NRC staff authorizes the use of proposed alternative IR-4-11 at Millstone 3, until the spring 2025 RFO.

All other ASME BPV Code, Section XI, requirements for which an alternative was not specifically requested and authorized remain applicable, including third-party review by the Authorized Nuclear Inservice Inspector.

Principal Contributor: J. Collins, NRR

Date: July 31, 2023

Hipolito J. Gonzalez

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Plant Licensing Branch I
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

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SUBJECT: MILLSTONE POWER STATION, UNIT NO. 3 - AUTHORIZATION AND SAFETY EVALUATION FOR ALTERNATIVE REQUEST NO. IR-4-11 (EPID L-2022-LLR-0067) DATED JULY 31, 2023

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