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

Serial No. 19-112
NRA/SS R0
Docket No. 50-336
License No. DPR-65

DOMINION ENERGY NUCLEAR CONNECTICUT, INC.
MILLSTONE POWER STATION UNIT 2
ALTERNATIVE REQUEST RR-05-03, EXTENSION OF ASME CODE CASE N-770-2 VOLUMETRIC INSPECTION FREQUENCY FOR REACTOR COOLANT PUMP INLET AND OUTLET NOZZLE DISSIMILAR METAL BUTT WELDS

In accordance with 10 CFR 50.55a, "Codes and standards," paragraph (z)(1), Dominion Energy Nuclear Connecticut, Inc. (DENC) requests Nuclear Regulatory Commission (NRC) approval of proposed inservice inspection alternative request RR-05-03 for Millstone Power Station Unit 2 (MPS2). Approval of this alternative request would allow the volumetric examination frequency of American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code Case N-770-2, Inspection Item B for the reactor coolant pump inlet and outlet nozzle dissimilar metal butt welds containing Alloy 82/182 to be extended, on a one time basis, from the required frequency of "not to exceed seven years" to a proposed nominal frequency of 7.5 calendar years.

Deterministic crack growth calculations bounding the subject welds at MPS2, as well as required examinations and existing monitoring practices, provide the basis for extension of the current volumetric examination frequency. Results of crack growth analyses demonstrate that structural integrity of the subject weld joints will be maintained under the proposed alternative reexamination frequency of a nominal 7.5 years and that use of this one-time extension will provide an acceptable level of quality and safety.

The technical basis for this proposed alternative is provided in Attachment 1.

DENC respectfully requests NRC approval of this alternative request by March 31, 2020.

Should you have any questions in regard to this submittal, please contact Shayan Sinha at (804) 273-4687.

Sincerely,

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

A047
NRR

Commitments made in this letter: None

Attachment:

Alternative Request RR-05-03, Extension of ASME Code Case N-770-2, Volumetric Examination Frequency for Reactor Coolant Pump Inlet and Outlet Nozzle Dissimilar Metal Butt Welds

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ATTACHMENT

Alternative Request RR-05-03
Extension of ASME Code Case N-770-2, Volumetric Examination Frequency for Reactor Coolant Pump Inlet and Outlet Nozzle Dissimilar Metal Butt Welds

MILLSTONE POWER STATION UNIT 2
DOMINION ENERGY NUCLEAR CONNECTICUT, INC. (DENC)

Alternative Request RR-05-03

**Proposed Alternative
in Accordance with 10 CFR 50.55a(z)(1)**

--Acceptable Level of Quality and Safety--

1. ASME Code Components Affected

ASME Code Class: Code Class 1

Reference: ASME Code Case – N-770-2, Table 1

Item Number: B

Description: Millstone Power Station Unit 2 (MPS2), dissimilar metal piping butt welds containing Alloy 82/182, unmitigated butt welds at cold leg operating temperature.

Components: Reactor coolant pump (RCP) inlet nozzle safe-end-to-elbow welds and RCP outlet nozzle safe-end-to-pipe welds. See below:

RCP Inlet Nozzle Safe-End-to-Elbow Welds	RCP Outlet Nozzle Safe-End-to-Pipe Welds
Weld No. P-4-C-1	Weld No. P-5-C-3
Weld No. P-8-C-1	Weld No. P-9-C-3
Weld No. P-13-C-1	Weld No. P-14-C-3
Weld No. P-17-C-1	Weld No. P-18-C-3

2. Applicable Code Edition and Addenda

The American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel (BPV) Code, Rules for Inservice Inspection of Nuclear Power Plant Components, Section XI, 2013 Edition [1], as required by 10 CFR 50.55a, is being adopted as the code of record for MPS2's fifth 10-year inservice inspection (ISI) interval.

10 CFR 50.55a(g)(6)(ii)(F)(*1*) requires, "Holders of operating licenses or combined licenses for pressurized-water reactors as of or after August 17, 2017, shall implement the requirements of ASME BPV Code Case N-770-2 [2] instead of ASME BPV Code Case N-770-1, subject to the conditions specified in paragraphs (g)(6)(ii)(F)(*2*) through (*13*) of this section, by the first refueling outage starting after August 17, 2017."

In 2014, NRC approved [3] Relief Request RR-04-15 [4] addressing ultrasonic

testing coverage limitations affecting the subject dissimilar metal welds at MPS2. These modest coverage limitations would not preclude detection of substantial primary water stress corrosion cracking (PWSCC) flaws regardless of flaw location. No indications of PWSCC affecting the subject MPS2 welds have been detected.

3. Applicable Code Requirement

ASME Code Case N-770-2 as Required by 10 CFR 50.55a(g)(6)(ii)(F)		
Class 1 PWR Pressure Retaining Dissimilar Metal Piping and Vessel Nozzle Butt Welds Containing Alloy 82/182		
Inspection Item	Parts Examined	Extent and Frequency of Examination
B	Unmitigated butt weld at cold leg operating temperature (-2410) ≥ 525°F (274°C) and < 580°F (304°C)	Bare metal visual examination once per interval Volumetric examination every second inspection period not to exceed 7 years

4. Reason for Request

DENC requests to extend the frequency to the next RCP inlet and outlet nozzle Alloy 82/182 dissimilar metal weld volumetric examinations by one operating cycle (approximately 18 months) to the fall of 2021 (i.e., refueling outage 27 or 2R27). If approved, the total time between successive examinations would be 7.5 calendar years. These eight RCP nozzle welds were last examined during the spring 2014 refueling outage (2R22) and are due for reexamination during the spring 2020 refueling outage (2R26), per NRC requirement 10 CFR 50.55a(g)(6)(ii)(F) and ASME Code Case N-770-2.

DENC is seeking approval of this one-time extension to allow the volumetric examination of the subject welds to be performed during the fall 2021 refueling outage (2R27). Analyses demonstrate that the proposed alternative reexamination frequency of a nominal 7.5 years will maintain an acceptable level of quality and safety.

5. Proposed Alternative and Basis for Use

Proposed Alternative

Pursuant to 10 CFR 50.55a(z)(1), DENC proposes an alternative to the augmented examination requirements of 10 CFR 50.55a(g)(6)(ii)(F) stated above for the subject components. This alternative is a one-time extension of the volumetric examination frequency of ASME Code Case N-770-2, Table 1, Inspection Item B. The one-time volumetric examination frequency extension would extend the time between successive inspections from the current requirement of 7 years to approximately 7.5 years for MPS2. The most recent volumetric examination of the eight (8) RCP nozzle Alloy 82/182 welds was last performed during the spring 2014 refueling outage (2R22) Reexamination of the subject nozzles is currently due during the spring 2020 refueling outage (2R26).

Basis for Use

The eight Alloy 82/182 dissimilar metal piping butt welds at the RCP inlet and outlet nozzles include the inlet nozzle safe-end-to-elbow weld and outlet nozzle safe-end-to-pipe weld for each RCP. These nozzles are located in the cold leg temperature region of the reactor coolant system (RCS). Although operating at cold leg temperature has a large benefit compared to Alloy 82/182 welds operating at hot leg or pressurizer temperatures, the subject welds are still susceptible to PWSCC.

As discussed below, deterministic crack growth calculations bounding the subject welds at MPS2 and previously submitted to the NRC staff [5], along with other required examinations and existing monitoring practices, constitute the basis for extension of the current volumetric examination frequency for the subject welds. The technical basis provided below demonstrates that the alternative reexamination frequency will maintain an acceptable level of quality and safety.

Cold Leg Alloy 82/182 Dissimilar Metal Butt Weld Operating Experience

Plant experience shows that detectable PWSCC is unlikely to affect the subject welds at MPS2 over the time period of the alternative examination frequency ending in fall 2021. To date, PWSCC indications have not been reported for large-diameter Alloy 82/182 piping butt welds operating at reactor cold leg temperature, including RCP inlet and outlet nozzle Alloy 82/182 welds. This favorable experience for locations NPS 14 and greater, both in domestic and overseas PWRs, is documented in MRP-349 [6] for experience through spring 2012. There remains no service experience involving cracking in these types of welds to date. However, a relatively small number of cases have been reported of PWSCC affecting relatively small diameter (NPS 3 and smaller) Alloy 82/182 piping butt welds at cold leg branch connections. PWSCC has also been detected in other Alloy 600/82/182 components exposed to cold leg temperatures, including CRDM nozzles, reactor vessel bottom mounted nozzles, and steam generator tubing. Thus, the subject welds are conservatively

considered to be susceptible to PWSCC, and axial and circumferential PWSCC flaws are postulated in the assessment below.

Structural Integrity

Flaw evaluations bounding the subject welds at MPS2, and previously submitted to the NRC staff, demonstrate that structural integrity will be maintained assuming PWSCC occurs. Westinghouse report WCAP-17128-NP R1 [5], supplemented by Section 5.3.1 of MRP-349 [6], provide analyses specific to the RCP inlet and outlet nozzles with Alloy 82/182 dissimilar metal welds of Combustion Engineering (CE)-designed PWRs. These evaluations determine the time for a postulated surface flaw that is detectable in the periodic ultrasonic testing (UT) examinations to grow to the allowable flaw size per the margins specified by ASME Section XI. Subcritical growth by both PWSCC and fatigue were considered and results were generated for a range of initial flaw aspect ratios. The crack growth rate equation of MRP-115 [7], which is incorporated in non-mandatory Appendix C of ASME Section XI, was applied for growth by PWSCC, and the fatigue crack growth equations presented in NUREG/CR-6721 [8] were applied. To provide conservatism, residual stresses were calculated assuming no weld repairs and assuming weld repairs on the inside surface of different depths extending 360° around the circumference and, per the recommendations of MRP-287 [9], up to 50% of the weld thickness.

As discussed in WCAP-17128-NP R1 [5], the flaw growth and tolerance results bound the weld geometry and loads specific to the subject RCP inlet and outlet nozzle Alloy 82/182 welds at MPS2. Piping stresses for CE-designed plants, including MPS2, were calculated using the corresponding RCP nozzle weld geometries. Overall maximum values were applied in the flaw evaluations by bounding the stresses first within each plant and then across the fleet of CE-designed plants. Per Section 6.2 of WCAP-17128-NP R1 [5], the PWSCC crack growth rate was calculated using a metal temperature of 550°F (288°C), which is conservatively greater than the normal cold leg operating temperature at MPS2.

The results demonstrate that structural integrity of the subject weld joints will be maintained under the proposed alternative reexamination frequency of a nominal 7.5 years. For circumferentially oriented cracking, the results show that flaws with an initial total-length-to-depth aspect ratio as large as 10 and an initial through-wall depth of 20% will be acceptable for at least 10 years. WCAP-17128-NP R1 [5] and Section 5.3.1 of MRP-349 [6] also present the results of advanced finite-element analysis (FEA) crack growth studies that model flaw shape development based on the stress intensity factor calculated at each point along the crack front. Consistent with the results of the standard flaw evaluation approach, these results show crack growth times, from a detectable flaw to the allowable flaw size limit per ASME Section XI, exceeding the length of the proposed reexamination frequency.

The results for some axially oriented flaws show shorter crack growth times than both the N-770-2 [2] and alternative reexamination frequencies. However, axial cracks affecting the subject welds are not a credible concern for producing a pipe rupture and loss-of-coolant-accident because the limited width of PWSCC-susceptible material (i.e., of the Alloy 82/182 weld metal) limits the credible length of axial cracking that could be produced. For the subject RCP nozzle Alloy 82/182 welds, the width (i.e., axial extent) of Alloy 82/182 weld metal is nominally 2.20 inches at the inlet nozzle and 1.88 inches at the outlet nozzle [4]. These widths are much smaller than the critical through-wall axial flaw length of 38.2 inches documented in MRP-349 [6] for the limiting RCP nozzle case for CE-designed plants. Hence, structural integrity will be maintained through the end of the alternative reexamination frequency postulating both circumferential and axial cracks.

Leak Tightness Considerations

The crack growth calculations show that there is the potential for leakage to occur if axial PWSCC is postulated under both the N-770-2 [2] and alternative volumetric reexamination frequencies. The frequent visual examinations performed from the exterior of the welds, in accordance with ASME Section XI and ASME Code Cases N-770-2 [2] and N-722-1 [10], provide defense-in-depth to address the possibility of through-wall axial cracking and consequent boric acid corrosion. Additionally, DENC trends daily RCS leak rate values in accordance with procedures [12] consistent with the guidance of WCAP-16465-NP [11]. These guidelines for enhanced leak rate monitoring would require a response in the case where the seven-day rolling average of daily RCS unidentified leak rates exceeded 0.1 gpm. Finally, the additional risk of leakage occurring under the proposed frequency is relatively small as the alternative nominal volumetric reexamination frequency represents only about a 7% increase over the maximum frequency permitted by N-770-2. The visual examinations for leakage and enhanced leak rate monitoring are concluded to maintain defense-in-depth and address the concern for leakage occurring due to postulated axially oriented PWSCC.

Conclusions

In summary, deterministic crack growth calculations bounding the subject welds at MPS2 and previously submitted to the NRC staff [5], along with other required examinations and existing monitoring practices, constitute the basis for extension of the current volumetric examination frequency for the subject welds. The evaluation of circumferential flaws demonstrates that structural integrity is maintained by showing that the time for growth from a flaw with detectable depth to a flaw size at the limit of acceptability per ASME Section XI is much longer than the requested frequency. Axial PWSCC flaws at the subject welds do not represent a credible concern for unstable rupture, while other required examinations and existing monitoring practices address the concern for axial cracking affecting leak tightness. Defense-in-depth is maintained through the

frequent visual examinations for evidence of leakage in combination with enhanced online leak detection capabilities.

These analyses demonstrate that the alternative reexamination frequency of a nominal 7.5 years will maintain an acceptable level of quality and safety. Therefore, DENC requests that the NRC authorize this proposed alternative in accordance with 10 CFR 50.55a(z)(1).

6. Duration of Proposed Alternative

The provisions of this alternative are applicable to MPS2's fifth 10-year ISI interval, which will commence on April 1, 2020 and end on March 31, 2030.

7. Precedents

As documented in the table below, there are several cases in which NRC has approved alternatives extending the volumetric examination frequency for large-diameter Alloy 82/182 piping butt welds susceptible to PWSCC. The reactor vessel inlet nozzle welds addressed by these relief requests are similar to the RCP inlet and outlet dissimilar metal welds at MPS2. These previous relief requests are based on deterministic crack growth calculations of assumed flaws performed using the same approach as applied for the circumferential flaw evaluation cited as part of the basis for this relief request.

Plant	NRC ADAMS Accession No.		Approval Date
	Relief Request	NRC Safety Evaluation	
Comanche Peak Unit 1	ML15300A013	ML16074A001	03/14/2016
Farley Units 1 and 2	ML14084A203	ML14262A317	12/05/2014
Indian Point Unit 2	ML13064A299	ML13310A575	11/14/2013
Indian Point Unit 3	ML14017A054	ML14199A444	08/04/2014
McGuire Unit 1	ML15083A045	ML15232A543	08/27/2015
South Texas Project Unit 1	ML15133A130	ML15218A367	08/21/2015
South Texas Project Unit 2	ML16076A319	ML16174A091	06/30/2016

8. References

1. ASME Boiler and Pressure Vessel Code, Section XI, 2013 Edition.
2. ASME Code Case N-770-2, "Alternative Examination Requirements and Acceptance Standards for Class 1 PWR Piping and Vessel Nozzle Butt Welds Fabricated With UNS N06082 or UNS W86182 Weld Filler Material With or Without Application of Listed Mitigation Activities," Section XI, Division 1, American Society of Mechanical Engineers, New York, Approval Date: June 9, 2011.
3. Letter from B. G. Beasley (U.S. NRC) to D. A. Heacock (Dominion), "Millstone Power Station, Unit No. 2 – Issuance of Relief Request RR-04-15 Regarding Limited One-Sided Ultrasonic Examination Technique (TAC No. MF1405)," dated March 31, 2014. [NRC ADAMS Accession No.: ML14063A578]
4. Letter from E. S. Grecheck (Dominion) to U.S. NRC, "Dominion Nuclear Connecticut, Inc. Millstone Power Station Unit 2 ASME Section XI Inservice Inspection Program Alternative Request RR-04-15, Limited One-Sided Ultrasonic Examination Technique," Serial No. 13-210, dated April 9, 2013. [NRC ADAMS Accession No.: ML13108A008]
5. *Flaw Evaluation of CE Design RCP Suction and Discharge Nozzle Dissimilar Metal Welds, Phase III Study*, WCAP-17128-NP, Revision 1, Westinghouse, May 2010. [NRC ADAMS Accession No.: ML12306A291]
6. *Materials Reliability Program: PWR Reactor Coolant System Cold-Loop Dissimilar Metal Butt Weld Reexamination Interval Extension (MRP-349): A Basis for Revision to the Requirements of MRP-139 and American Society of Mechanical Engineers Code Case N-770 for Large-Diameter Welds at Cold-Leg Temperatures*. EPRI, Palo Alto, CA. 2012. 1025852. [Freely downloadable at www.epri.com; NRC ADAMS Accession No.: ML12276A110]
7. *Materials Reliability Program Crack Growth Rates for Evaluating Primary Water Stress Corrosion Cracking (PWSCC) of Alloy 82, 182, and 132 Welds (MRP-115)*. EPRI, Palo Alto, CA: 2004. 1006696. [Freely downloadable at www.epri.com]
8 *Effects of Alloy Chemistry, Cold Work, and Water Chemistry on Corrosion Fatigue and Stress Corrosion Cracking of Nickel Alloys and Welds*. NUREG/CR-6721, ANL-01/07. 2001.
9. *Materials Reliability Program: Primary Water Stress Corrosion Cracking (PWSCC) Flaw Evaluation Guidance (MRP-287)*. EPRI, Palo Alto, CA: 2010. 1021023. [Freely downloadable at www.epri.com]
10. ASME Code Case N-722-1, "Additional Examinations for PWR Pressure Retaining Welds in Class 1 Components Fabricated With Alloy 600/82/182 Materials," Section XI, Division 1, American Society of Mechanical Engineers, New York, Approval Date: January 26, 2009.

11. *Pressurized Water Reactor Owners Group Standard RCS Leakage Action Levels and Response Guidelines for Pressurized Water Reactors,* WCAP-16465-NP, Revision 0, Westinghouse, September 2006. [NRC ADAMS Accession No.: ML070310082]

12. Millstone Power Station Common Operating Procedure C OP 200.15, Revision 4, RCS Leakage Trending and Investigation.