



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

April 24, 2015

Mr. David A. Heacock
President and Chief Nuclear Officer
Dominion Nuclear Connecticut, Inc.
Innsbrook Technical Center
5000 Dominion Boulevard
Glen Allen, VA 23060-6711

SUBJECT: MILLSTONE POWER STATION, UNIT NO. 2 – ALTERNATIVE USE OF WELD
OVERLAY AS REPAIR AND MITIGATION TECHNIQUE (TAC NO. MF3918)

Dear Mr. Heacock:

By letter dated April 11, 2014 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML14112A071), as supplemented by letter dated October 14, 2014 (ADAMS Accession Nos. ML14294A453), Dominion Nuclear Connecticut, Inc. (DNC or the licensee), submitted Alternative Request RR-04-20 for Millstone Power Station, Unit No. 2 (MPS2), to allow the application of full structural weld overlay over two dissimilar metal welds (DMWs). The proposed approach is an alternative to the requirements of American Society of Mechanical Engineers *Boiler and Pressure Vessel Code* (ASME Code), Section XI, IWA-4000.

Specifically, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) Section 50.55a(a)(3)(i), the licensee requested to use the proposed alternatives, preemptive full structural weld overlays, on the basis that the alternative examination provides an acceptable level of quality and safety.

As of December 5, 2014, 10 CFR Section 50.55a(a)(3)(i) has been relocated to 10 CFR 50.55a(z)(1). Thus, all requirements associated with 10 CFR 50.55a(a)(3)(i) will be addressed and reflected in 10 CFR 50.55a(z)(1).

The U.S. Nuclear Regulatory Commission (NRC) staff has reviewed the licensee's submittal and determined that Alternative Request RR-04-20 will provide an acceptable level of quality and safety. Accordingly, the NRC staff concludes that the licensee has adequately addressed all of the regulatory requirements set forth in 10 CFR 50.55a(z)(1). Therefore, pursuant to 10 CFR 50.55a(z)(1), the NRC staff authorizes the use of Alternative Request RR-04-20 for the installation of full structural weld overlays on the DMWs and adjacent similar metal welds identified in Table 1 of the attached safety evaluation during 2R23 refueling outage at MPS2. The effective period of Alternative Request RR-04-20 is the Fourth Inservice Inspection Interval which ends on March 31, 2020.

D. Heacock

- 2 -

All other requirements of the ASME Code, Section XI, for which relief was not specifically requested and authorized herein by the NRC staff remain applicable, including the third party review by the Authorized Nuclear Inservice Inspector.

If you have any questions, please contact the Millstone Power Station Project Manager, Richard Guzman, at (301) 415-1030, or email at Richard.Guzman@nrc.gov.

Sincerely,

A handwritten signature in black ink, appearing to read "Michael I. Dudek".

Michael I. Dudek, Acting Chief
Plant Licensing Branch I-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-336

Enclosure:
As stated

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

ALTERNATIVE REQUEST RR-04-20

USE OF WELD OVERLAYS AS AN ALTERNATIVE REPAIR AND MITIGATION TECHNIQUE

MILLSTONE POWER STATION, UNIT NO. 2

DOMINION NUCLEAR CONNECTICUT, INC.

DOCKET NO. 50-336

1.0 INTRODUCTION

By letter dated April 11, 2014 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML14112A071), as supplemented by letter dated October 14, 2014 (ADAMS Accession No. ML14294A453), Dominion Nuclear Connecticut, Inc. (DNC or the licensee), submitted Alternative Request RR-04-20 for Millstone Power Station, Unit No. 2 (MPS2), to allow the application of full structural weld overlay (FSWOL) over two dissimilar metal welds (DMWs). The proposed approach is an alternative to the requirements of American Society of Mechanical Engineers *Boiler and Pressure Vessel Code* (ASME Code), Section XI, IWA-4000.

Specifically, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) Section 50.55a(a)(3)(i), the licensee requested to use the proposed alternatives, preemptive full structural weld overlays, on the basis that the alternative examination provides an acceptable level of quality and safety.

As of December 5, 2014, 10 CFR Section 50.55a(a)(3)(i) has been relocated to 10 CFR 50.55a(z)(1). Thus, all requirements associated with 10 CFR 50.55a(a)(3)(i) will be addressed and reflected in 10 CFR 50.55a(z)(1).

2.0 REGULATORY REQUIREMENTS

In the relief request, the licensee requests authorization of an alternative pursuant to 10 CFR 50.55a(a)(3)(i). As stated above, as of December 5, 2014, 10 CFR Section 50.55a(a)(3)(i) has been relocated to 10 CFR 50.55a(z)(1). Thus, all requirements associated with 10 CFR 50.55a(a)(3)(i) will be addressed and reflected in 10 CFR 50.55a(z)(1).

Pursuant to 10 CFR, Part 50, Section 50.55a(g)(4), ASME Code Class 1, 2, and 3 components (including supports) must meet the requirements, except design and access provisions and the preservice examination requirements, set forth in the ASME Code, Section XI, "Rules for Inservice Inspection (ISI) of Nuclear Power Plant Components," to the extent practical within the limitations of design, geometry, and materials of construction of the components.

The regulations require that inservice examination of components and system pressure tests conducted during the first 10-Year Interval and subsequent intervals comply with the requirements in the latest edition and addenda of Section XI of the ASME Code incorporated by reference in 10 CFR 50.55a(b), 12 months prior to the start of the 120-month interval, subject to the limitations and modifications listed therein.

Pursuant to 10 CFR 50.55a(z), alternatives to requirements may be authorized by the U.S. Nuclear Regulatory Commission (NRC), if the licensee demonstrates that: (1) the proposed alternatives provide an acceptable level of quality and safety, or (2) compliance with the specified requirements would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

Based on the above, and subject to the following technical evaluation, the NRC staff concludes that it has the regulatory authority to authorize an alternative proposed by the licensee.

3.0 TECHNICAL EVALUATION

3.1 LICENSEE'S PROPOSED ALTERNATIVE REQUEST RR-04-20

The licensee has requested approval to use an alternative to the relevant requirements of the ASME Code, Section XI, related to weld overlay repairs and preemptive type weld overlay applications for mitigation of primary water stress corrosion cracking (PWSCC).

3.2 ASME Code Components Affected

The licensee proposes to install a preemptive full structural weld overlay on the two DMWs and similar metal welds identified in Table 1, "Welds Affected by Request for Alternative RR-04-20."

TABLE 1: Welds Affected by Request for Alternative RR-04-20

Nozzle Type	Material Identification				
	Nozzle (carbon steel)	DMW weld (Nickel Alloy)	Safe end (stainless steel)	ISI Weld (stainless steel)	Pipe/fitting (stainless steel)
Hot Leg drain line, 2 inch NPS	A-105, Gr.2 (P1)	BPD-C-1001	SA-182, TP-316 (P8)	BPD-C-1003	A-376, 316 (P8)
RCS Cold Leg Letdown Line, 2 inch NPS	A-105, Gr.2 (P1)	BPD-C-4000	SA-182, TP-316 (P8)	BPD-C-4002	A-376, 316 (P8)

NPS = nominal pipe size

3.3 Code Requirements

The code of record for MPS2 repair/replacement activities for the current fourth ISI interval is the 2004 Edition with No Addenda of the ASME Code, Section XI. In addition, as required by 10 CFR 50.55a, the licensee will use Appendix VIII, "Performance Demonstration for Ultrasonic Examinations," of the 2001 Edition of the ASME Code, Section XI, for ultrasonic testing (UT) examination of the weld overlay.

The ASME Code, Section XI, 2004 Edition, no Addenda, IWA-4000 is used for the MPS2 repair/replacement program, which does not include the needed requirements for the weld overlay repair.

The ASME Code requirements for which relief is requested are contained in the following: (1) 2004 Edition of the ASME Code, Section XI, IWA-4000; and (2) 2001 Edition of the ASME Code, Section XI, Appendix VIII, Supplement 11.

The ASME Code, Section XI, Table IWB-2500, Categories B-F and B-J, prescribes ISI requirements for Class 1 butt welds.

Appendix VIII, Supplement 11 of the ASME Code, Section XI, specifies performance demonstration requirements for UT examination of weld overlays.

3.4 Proposed Alternative

Pursuant to 10 CFR 50.55a(z)(1), in lieu of performing ASME Code repairs in accordance with IWA-4000, the licensee proposes the following as alternatives to the Code requirements specified above. The proposed alternatives are applicable to the two DMWs and adjacent stainless steel welds identified in Table 1 of this safety evaluation. The MPS2 tentative schedule calls for the FSWOLs to be installed during fall 2015 refueling outage.

By letter dated April 17, 2008 (ADAMS Accession No. ML081140078), the licensee submitted Westinghouse reports entitled, "Millstone Unit 2 RCS [reactor coolant system] Surge, Spray, Shutdown Cooling, Safety Injection, Charging Inlet, and Letdown/Drain Nozzles Structural Weld Overlay Qualification (Proprietary and non-Proprietary)." The reports describe the geometries of the FSWOLs, provide the technical basis for the application of the FSWOLs, summarize the associated analyses, and provide the methodology used to demonstrate the acceptability of the FSWOLs design qualifications.

The licensee's proposed alternative is designed to mitigate PWSCC on DMWs using full structural weld overlays at MPS2. The weld overlay will also be installed on the similar metal welds that are located adjacent to the DMWs to facilitate ultrasonic testing (UT) examination of the DMWs.

A DMW is a weld that joins two pieces of metal that are not of the same material. In the proposed alternative, the dissimilar metal weld joins the ferritic (i.e., low alloy carbon steel) nozzle to the safe end that is fabricated with austenitic stainless steel. The DMW itself is made of nickel-based Alloy 82/182. The proposed preemptive weld overlay is a process by which weld filler metal that is resistant to stress corrosion cracking is deposited on the outside surface of the degraded pipe including the original pipe weld. The licensee will install preemptive full structural

weld overlays in accordance with the proposed requirements specified in Enclosure 1 of the licensee's proposed alternative. The licensee stated that these requirements are consistent with the methodology of ASME Code, Section XI, Code Case N-740-2, "Dissimilar Metal Weld Overlay for Repair of Class 1, 2, and 3 Items, Section XI, Division 1." The requirements for design, fabrication, examination, pressure testing, and ISI of preemptive full structural weld overlays are described in Enclosure 1 of the licensee's proposed alternative.

The licensee stated that UT examinations of the proposed preemptive full structural weld overlays will be conducted in accordance with Appendix VIII, Supplement 11, of the 2001 Edition of ASME Code, Section XI, utilizing alternatives to the Performance Demonstration Initiative (PDI) Program. The proposed PDI alternatives to Appendix VIII, Supplement 11, are specified in Enclosure 2 of the licensee's proposed alternative.

3.5 Duration of Alternative

The licensee's proposed alternative is applicable to the fourth 10-Year Interval at MPS2. The licensee states that MPS2 is currently in the fourth 10-year ISI interval which began on April 1, 2010, and will end on March 31, 2020.

4.0 NRC STAFF EVALUATION

The licensee states that Alternative Request RR-04-20 is based on Code Case N-740 and N-740-1. As stated above, the licensee's weld overlay design is also consistent with Code Case N-740-2. Code Cases N-740 and N-740-1 combine the requirements in Code Case N-504-4, "Alternative Rules for Repair of Class 1, 2, and 3 Austenitic Stainless Steel Piping, Section XI, Division 1," and Code Case N-638-1, "Similar and Dissimilar Metal Welding Using Ambient Temperature Machine GTAW [gas tungsten arc welding] Temper Bead Technique, Section XI, Division 1." The NRC staff has endorsed Code Cases N-504-4 and N-638-1 in Regulatory Guide (RG) 1.147, Revision 16, but not Code Cases N-740, N-740-1, or N-740-2. RG 1.147, as incorporated by reference into 10 CFR 50.55a(3)(b), identifies Code Cases with any identified limitations or modifications that the NRC has determined to be acceptable alternatives to applicable parts of Section XI. As identified in RG 1.147, Code Case N-504-4 is conditionally accepted stating that the provisions of Section XI, Appendix Q to the ASME Code must also be met. Accordingly, the NRC staff evaluated the acceptability of Request for Alternative RR-04-20 based on the requirements of Code Cases N-504-4 and N-638-1, as well as Appendix Q to the ASME Code, Section XI.

In a letter dated October 14, 2014 (ADAMS Accession No. ML14294A453), the licensee responded to an NRC request for additional information regarding the scheduled, Spring 2014, reexamination of the welds for which relief was requested. During this reexamination the subject welds were examined using the latest industry guidance and encoded phased array ultrasonic technology. The licensee stated that no unacceptable flaws were detected.

4.1 General Requirements

Section 1.0, "General Requirements," of Attachment 1, Enclosure 1, of the licensee's proposed alternative provides requirements for the specification of the base metal (carbon steel, stainless steel, and Alloy 82/182) and weld overlay filler metal (Alloy 52M), surface condition of the base metal, and chromium content of the weld overlay deposits. The proposed alternative is consistent with Codes Cases N-504-4 and N-638-1, and Appendix Q to the ASME Code, Section XI.

4.2 Crack Growth Considerations and Design

Section 2, "Crack Growth Considerations and Design," of Attachment 1, Enclosure 1, of the licensee's proposed alternative provides the requirements for weld overlay design, design-basis flaw size, and the crack-growth calculation. The result of the crack-growth calculation assures that the growth of the crack in the base metal will be mitigated or minimized by the installation of the weld overlay. The Section 2 requirements are consistent with Code Case N-504-4 and Appendix Q to the ASME Code, Section XI. The NRC staff considered the significant issues as discussed below.

The licensee stated that the design basis for full structural weld overlays is to maintain the original design margins with no credit taken for the underlying PWSCC-susceptible weldments. The assumed design-basis flaw for the purpose of sizing the weld overlays is 360 degrees and 100 percent through the original wall thickness of the DMWs. Regarding the crack-growth analysis for the preemptive full structural weld overlay, the licensee stated that a 100 percent through-wall flaw has been postulated for the crack growth calculations.

As part of the weld overlay design, the licensee will perform nozzle-specific stress analyses to establish a residual stress profile in each subject nozzle. Post-weld overlay residual stresses at normal operating conditions will be shown to result in beneficial compressive stresses on the inside surface of the components, assuring that further crack initiation due to PWSCC is highly unlikely.

The licensee will also perform fracture mechanics analyses to predict crack growth for postulated flaws. Crack growth due to PWSCC and fatigue will be analyzed for the original DMW. The analyses will demonstrate that the postulated cracks will not grow beyond the design basis for the weld overlays. The licensee will demonstrate that applying the weld overlay does not impact the conclusions of the existing stress reports. The stress and fatigue criteria of ASME Code, Section III, will be met for regions of the overlays remote from the assumed cracks.

The licensee will measure shrinkage during the overlay application. Shrinkage stresses at other locations in the piping systems arising from the weld overlays will be demonstrated not to have an adverse effect on the systems. Clearances of affected supports and restraints will be checked after the overlay repair, and will be reset within the design ranges as required. The licensee will evaluate the total added weight on the piping systems due to the overlays for potential impact on piping system stresses and dynamic characteristics. The as-built dimensions of the weld overlays will be measured and evaluated to demonstrate that they meet or exceed the minimum design dimensions of the overlays.

The NRC staff concludes that the crack growth considerations and design of the licensee's proposed alternative provide an acceptable level of quality and safety as the proposed analyses and shrinkage measurement are consistent with paragraph (g) of Code Case N-504-4 and are, therefore, acceptable.

4.3 Examination and Inspection

Section 3, "Examination and Inspection," of Attachment 1, Enclosure 1, of the licensee's proposed alternative provides requirements for the acceptance examination, pre-service examination, and inservice examination after the weld overlay is installed. The length, surface finish, and flatness requirements of the weld overlay are specified in the weld overlay design to provide the required examination volume of the weld overlay as shown in Figure 1 of Attachment 1 of the licensee's proposed alternative.

4.3.1 Acceptance Examination

Section 3(a), "Acceptance Examination," of Attachment 1, Enclosure 1, of the licensee's proposed alternative requires a surface and UT examination of an installed weld overlay. The NRC staff concludes that the requirements of the acceptance examination are acceptable because they are consistent with Code Case N-504-4 and Appendix Q to the ASME Code, Section XI.

4.3.2 Preservice and Inservice Inspection

Section 4(b), "Preservice and Inservice Examination," of Enclosure 1, Attachment 1, of the licensee's proposed alternative requires an UT examination of the installed weld overlay and the upper (outer) 25 percent of the original pipe-wall thickness. The required examination volume is defined in Figure 1 of Attachment 1 of the proposed alternative. The examinations shall comply with ASME Code Case N-770-1, subject to the conditions specified in paragraphs (g)(6)(ii)(F)(2) through (g)(6)(ii)(F)(10) of 10CFR50.55a. The NRC staff concludes the preservice and inservice examination requirements are acceptable because they are consistent with Code Cases N-504-4, N-770-1 and Appendix Q to the ASME Code, Section XI.

4.4 PDI Program

Appendix VIII, Supplement 11, of the 2001 Edition of ASME Code, Section XI, specifies requirements for performance demonstration of UT examination procedures, equipment, and personnel used to detect and size flaws in full structural overlays of wrought austenitic piping welds. The current UT examination technology cannot meet the requirements of Appendix VIII, Supplement 11. Therefore, the industry initiated the PDI Program as an alternative to satisfy the requirements of ASME Code, Section XI, Appendix VIII. To this end, Electric Power Resource Institute (EPRI) has developed a program for qualifying equipment, procedures, and personnel in accordance with the UT criteria of Appendix VIII, Supplement 11. The PDI program is assessed semi-annually by the NRC staff for consistency with the current ASME Code and proposed changes.

The licensee has proposed to use the PDI program, as indicated in Enclosure 2 of the licensee's proposed alternative, to satisfy the Appendix VIII, Supplement 11, qualification requirements. The PDI initiatives will be used for qualification of UT examinations to detect and size flaws

in the preemptive full structural weld overlays of this request. The NRC staff evaluated the differences between the PDI program and Supplement 11 as shown in Enclosure 2 of the licensee's proposed alternative. The NRC staff concludes that the justifications for the differences are acceptable and the PDI program provides an acceptable level of quality and safety. Therefore, the proposed MPS2 PDI program is acceptable for use in lieu of Supplement 11 of Appendix VIII to the ASME Code, Section XI.

4.5 Reporting Requirements

In Attachment 2, Enclosure 2, of the licensee's proposed alternative, the licensee agreed to submit the following information:

- (1) The licensee will submit the following information to the NRC within 14 days from completing the final UT examinations of the completed weld overlays:
 - (a) Weld overlay examination results including a listing of indications detected and coverage limitations;
 - (b) Disposition of all indications using the standards of ASME Code, Section XI, IWB-3514-2 and/or IWB-3514-3 criteria and, if possible, the type and nature of the indications; and
 - (c) A discussion of any repairs to the weld overlay material and/or base metal and the reason for the repairs.
- (2) Prior to entry into Mode 4 start-up from MPS2's 2R23 outage, the licensee will submit a preliminary stress analysis summary to the NRC as described in Paragraphs g(2) and g(3) of ASME Code Case N-504-4 demonstrating that the RCS piping nozzles will perform their intended design functions after the weld overlay installation. The stress analysis report will include results showing that the requirements of NB-3200 and NB-3600 of the ASME Code, Section III, are satisfied. The stress analysis will also include results showing that the requirements of IWB-3000 of the ASME Code, Section XI, are satisfied. The results will show that the postulated crack, including its growth in the nozzles, will not adversely affect the integrity of the overlaid welds.
- (3) The final evaluation shall be submitted within 60 days of plant restart from the outage in which the FSWOLs were installed.

The NRC staff concludes that the above reporting requirements are acceptable because the weld overlay examination results and stress analysis will provide verification of the condition of the weld overlays after installation. The NRC staff concludes that the requirements of Alternative Request RR-04-20 with the associated Enclosure 1 and 2 are consistent with the intent of the provisions of ASME Code Cases N-504-4, N-638-1, and Appendices VIII and Q of ASME Code, Section XI. Therefore, the licensee's proposed alternative is acceptable.

5.0 CONCLUSION

The NRC staff has reviewed the licensee's submittal and determined that Alternative Request RR-04-20 will provide an acceptable level of quality and safety. Accordingly, the NRC staff concludes that the licensee has adequately addressed all of the regulatory requirements set forth in 10 CFR 50.55a(z)(1). Therefore, pursuant to 10 CFR 50.55a(z)(1), the NRC staff authorizes the use of Alternative Request RR-04-20 for the installation of full structural weld overlays on the DMWs and adjacent similar metal welds identified in Table 1 of this safety evaluation during 2R23 refueling outage at MPS2. The effective period of Alternative Request RR-04-20 is the fourth ISI interval which ends on March 31, 2020.

All other requirements of the ASME Code, Section XI, for which relief was not specifically requested and authorized herein by the NRC staff remain applicable, including the third party review by the Authorized Nuclear Inservice Inspector.

Principal Contributor: Steven Vitto

Date: April 24, 2015

D. Heacock

- 2 -

All other requirements of the ASME Code, Section XI, for which relief was not specifically requested and authorized herein by the NRC staff remain applicable, including the third party review by the Authorized Nuclear Inservice Inspector.

If you have any questions, please contact the Millstone Power Station Project Manager, Richard Guzman, at (301) 415-1030, or email at Richard.Guzman@nrc.gov.

Sincerely,

/RA/

Michael I. Dudek, Acting Chief
Plant Licensing Branch I-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-336

Enclosure:

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NAME	MThadani	KGoldstein	JTsao*	RGuzman	MDudek
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