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

September 21, 2015

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

SUBJECT: MILLSTONE POWER STATION, UNIT NOS. 2 AND 3 - RELIEF FROM THE REQUIREMENTS OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS BOILER AND PRESSURE VESSEL CODE SECTION XI, REGARDING RADIOGRAPHIC EXAMINATIONS (TAC NOS. MF5014 AND MF5015)

Dear Mr. Heacock:

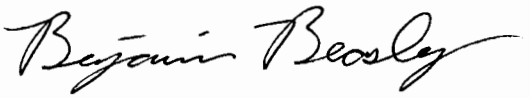
By letter dated October 6, 2014, (Agencywide Documents Access and Management System (ADAMS) Accession No. ML14283A128), Dominion Nuclear Connecticut, Inc. (the licensee) requested relief from the requirements of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (Code) Section XI, Paragraph IWA-4221 for Millstone Power Station Units 2 and 3 (MPS2 and MPS3). ASME Code Section XI, paragraph IWA-4221 requires the use of Section III paragraph NC-5200 for repaired and replaced components, which in turn specifies the use of radiographic examinations. The licensee proposed to use phased array ultrasonic testing as an alternative to the required radiographic testing at MPS2 and MPS3 for the fourth and third 10-year inservice inspection (ISI) intervals, respectively.

Specifically, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) 50.55a(z)(1), the licensee requested to use the proposed alternative on the basis that the encoded phased array ultrasonic examination alternative would provide an acceptable level of quality and safety.

The NRC staff has reviewed the subject requests and concludes, as set forth in the enclosed safety evaluation, that the licensee's proposed alternative to use ultrasonic testing with encoded phased array examinations in lieu of radiographic testing provides reasonable assurance of structural integrity and leak tightness of Class 2 ferritic piping welds. Thus, ultrasonic testing using the procedure described in the submittals of the subject welds would provide an adequate 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, the NRC staff authorizes relief request RR-04-21 for MPS2 for the remainder of the fourth 10-year ISI interval that is scheduled to end on March 31, 2020 and IR-3-25 for MPS3 for the remainder of the third 10-year ISI that is scheduled to end on April 22, 2019.

If you have any questions, please contact, Richard Guzman, senior project manager assigned to the Millstone Power Station, at (301) 415-1030.

Sincerely,



Benjamin Beasley, Chief
Plant Licensing Branch I-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. 50-336 and 50-423

Enclosure:
As stated

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UNITED STATES
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WASHINGTON, D.C. 20555-0001

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELIEF REQUEST NOS. RR-04-21 AND IR-3-25 RELATED TO THE USE OF PHASED ARRAY ULTRASONIC TESTING AS AN ALTERNATIVE TO RADIOGRAPHIC TESTING FOR THE UNIT 2 FOURTH AND UNIT 3 THIRD 10-YEAR INTERVALS

DOMINION NUCLEAR CONNECTICUT, INC.

MILLSTONE POWER STATION, UNIT NOS. 2 & 3

DOCKET NOS. 50-336 & 50-423

1.0 INTRODUCTION

By letter dated October 6, 2014, (Agencywide Documents Access and Management System (ADAMS) Accession No. ML14283A128), Dominion Nuclear Connecticut, Inc. (the licensee) requested relief from the requirements of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (Code) Section XI, Paragraph IWA-4221 for Millstone Power Station, Unit Nos. 2 and 3 (MPS2 and MPS3). ASME Code Section XI, paragraph IWA-4221 requires the use of Section III paragraph NC-5200 for repaired and replaced components, which in turn specifies the use of radiographic examinations. The licensee is proposing to use phased array ultrasonic testing as an alternative to the required radiographic testing.

Specifically, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) 50.55a(z)(1), the licensee requested to use the proposed alternative on the basis that the encoded phased array ultrasonic examination alternative would provide an acceptable level of quality and safety.

2.0 REGULATORY EVALUATION

The licensee has requested relief from the requirements of ASME Code Section XI paragraph IWA-4221. Section XI section IWA-4200 covers repair and replacement activities, and paragraph IWA-4221 requires the use of Section III paragraph NC-5200, which requires the use of radiographic examinations on Class 2 piping butt welds.

Relief requests RR-04-21 and IR-3-25, dated October 6, 2014, cited 10 CFR 50.55a(a)(3)(i), which covers requests for alternatives on the basis that the proposed alternative would provide an acceptable level of quality and safety. On December 5, 2015, the NRC reorganized 10 CFR 50.55a (*Federal Register* Volume 79 Number 214), and RRs that had been previously covered by 10 CFR 50.55a(a)(3)(i) are now covered under the equivalent 10 CFR 50.55a(z)(1).

Pursuant to 10 CFR 50.55a(g)(4), ASME Code Class 1, 2, and 3 components (including supports) shall meet the requirements, except the design and access provisions and the pre-service examination requirements, set forth in the ASME Code, Section XI, "Rules for Inservice Inspection 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 repair and replacement activities 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(a) 12 months prior to the start of the 120-month inspection interval, subject to the conditions listed therein.

Paragraph 50.55a(z) of 10 CFR 50 states, in part, that alternatives to the requirements of 10 CFR 50.55a(b)-(h) may be used, when authorized by the U.S. Nuclear Regulatory Commission (NRC), if: (1) the proposed alternatives would 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 finds that regulatory authority exists for the licensee to request, and the Commission to authorize, the alternative requested by the licensee.

3.0 TECHNICAL EVALUATION

3.1 Licensee's Relief Requests

ASME Code Components Affected

Relief requests RR-04-21 and IR-3-25 cover circumferential butt welds of 3 inches and greater diameter in ferritic piping ranging from 0.280 inch through 2.0 inches in thickness on ASME Code Class 2 welds in the Feedwater System, Auxiliary Feedwater System, Main Steam System, Reactor Building Closed Loop Cooling Water System, and Containment Purge System. The specific components are limited to carbon steel base and filler material.

ASME Code of Record

The code of record for the fourth 10-year inservice inspection (ISI) interval (MPS2) and the third 10-year ISI interval (MPS3) is the 2004 Edition of ASME Section XI.

ASME Code Requirement

ASME Section XI, paragraph IWA-4221 requires the owner to use the requirements of the construction code for repair/replacement activities. The examination requirements for ASME Section III, Class 2 circumferential butt welds are contained in the ASME Code, Section III, paragraph NC-5200. The requirement is to perform radiographic examinations of these welds using the acceptance standards specified in paragraph NC-5300.

Proposed Alternative

The licensee is proposing the use of encoded phased array ultrasonic examination technique in lieu of the ASME Code-required radiographic examination for the feedwater piping. The proposed alternative is the same as described in a previous relief request, RR-04-16, dated August 1, 2013 (ADAMS Accession No. ML13220A019), and amended by letters dated November 22, 2013, February 27, 2014, and March 14, 2014 (ADAMS Accession Nos. ML13338A284, ML14063A206, and ML14084A383, respectively).

Elements of the proposed alternative examination include:

- The surface shall be conditioned such that transducers may properly couple with the scanning surface with no more than a 1/32-inch gap between the search unit and the scanning surface.

- The ultrasonic examination shall be performed with equipment, procedures, and personnel qualified by performance demonstration.

- The ultrasonic examination shall include 100% of the weld volume, which includes the weld-to-base material interface on each side of the weld.

- The acceptance standards for volumetric ultrasonic examination shall be in accordance with ASME Section III, NC-5330 "Ultrasonic Acceptance Standards" with evaluation of flaw indications in accordance with the procedure rather than using a 20% amplitude reference level threshold.

- The ultrasonic examination shall be performed using encoded examination methods.

- A written ultrasonic examination procedure qualified by performance demonstration for flaw detection, characterization, and sizing shall be used.

- Personnel performing ultrasonic examinations shall be qualified in accordance with ASME Section XI, IWA-2300 and shall demonstrate their capability to detect, characterize and size flaws by performance demonstration.

Basis for Use

The basis for RR-04-21 and IR-3-25 is that the licensee is proposing that encoded phased array ultrasonic testing is equivalent to, or superior for, detecting and sizing critical (planar) flaws as compared to the required radiographic examination.

Duration of Proposed Alternative

For MPS2, the licensee requests approval of RR-04-21 for the remainder of the fourth 10-year Inspection interval that began on April 1, 2010 and is scheduled to end on March 31, 2020. For MPS3, the licensee requests approval of IR-3-25 for the remainder of the third 10-year ISI interval that began on April 23, 2009 and is scheduled to end on April 22, 2019.

3.2 NRC Staff Evaluation

The licensee is proposing to use encoded phased array ultrasonic testing in lieu of radiographic testing in RR-04-21 and IR-3-25. Ultrasonic testing, like radiographic testing, is a volumetric inspection technique that is commonly used to inspect welds in nuclear power plants and in other industries. Ultrasonic examinations are not equivalent to radiographic examinations as they use different physical mechanisms to detect and characterize discontinuities. These differences in physical mechanisms result in several key differences in sensitivity and discrimination capability. The NRC has examined the differences between ultrasonic test (UT) and radiographic test (RT) in a technical letter report, "Replacement of Radiography with Ultrasonics for the Nondestructive Inspection of Welds – Evaluation of Technical Gaps – An Interim Report" (ADAMS Accession No. ML101031254). More recent information, including work performed at the Pacific Northwest National Laboratory on the application of UT in lieu of RT was presented in a public meeting on August 30, 2012 (ADAMS Accession No. ML12243A447).

An assessment of the use of UT in lieu of RT by the NRC is described in NUREG/CR-7204 "Applying Ultrasonic Testing In Lieu of Radiography for Volumetric Examination of Carbon Steel Piping." The assessment concluded that UT has the potential to replace RT for ferritic welds if done to a sufficient level of rigor. This report included evaluation on the use of UT in lieu of RT for welded pipes and plates with thicknesses ranging from 0.844 inches to 2.2 inches thick.

One conclusion from NUREG/CR-7204 was "considering overall detections/non-detections for the piping specimens, as well as the Navy plates, it appears that phased array ultrasonic inspection (PAUT), based on the techniques applied in this study, provides an equally effective examination for identifying the presence of fabrication flaws in carbon steel welds. The PAUT parameters applied were shown to be more effective for planar flaws, but slightly less effective for small volumetric flaws, than RT."

RR-04-21 and IR-3-25 are technically very similar to a previous relief request, RR-04-16, dated August 1 2013. The primary difference is that RR-04-16 was a one-time request to use UT in lieu of RT for a specific set of components and RR-04-21 and IR-3-25 are more open ended, allowing UT in lieu of RT for a wider array of ferritic feedwater system welds for the duration of the 10-year ISI intervals. RR-04-16 covered components from 6 inches to 18 inches in diameter, with thicknesses ranging from 0.28 to 0.75 inches. Both RR-04-21 and IR-3-25 cover components 3 inches and greater in diameter with thickness ranging from 0.28 to 2 inches. In each relief request, the pipes, components, and weld filler material are limited to ferritic steel. The proposed examinations will be performed using the encoded PAUT procedure demonstrated in support of previously approved Alternative Request RR-04-16.

Single Sided Ultrasonic Examinations

The alternative proposed use of single-sided ultrasonic examinations for eight components in RR-04-21 and IR-3-25. One of the conclusions of NUREG/CR-7204 was that single-sided examinations should be expected to have a lower probability of detection than an examination from both sides of a weld.

The licensee addressed this concern in the letter dated February 27, 2014 (ADAMS Accession No. ML14063A206) by showing successful detections of lack of fusion defects from either side

of the welds. The proposed procedure addresses the difficulties in detecting lack of fusion defects on the near side of the weld by using the "second leg" of the ultrasonic beam. As shown in the letter dated February 27, 2014, the use of the second leg enables the procedure to detect lack of fusion defects from either side of the weld. The amplitudes of the responses from the defects are lower from the near side of the weld, but the lack-of-fusion defects are still clearly detectable.

Additionally, the licensee also compared the results of the proposed ultrasonic procedure to the results of the ASME Code-required RT examination of the welds. The licensee provided examples of cracks and lack of fusion flaws that were detected by ultrasonic testing from either side of the weld but were not detected by radiographic testing.

Permanent Records

As stated in RR-04-21 and IR-3-25, the electronic data files for the UT examinations will be stored as part of the archival quality record. In addition to the electronic data, hard copy prints of the data will also be included as part of the record that allows viewing without the use of hardware or software.

Procedure Demonstration

The procedure demonstration described in RR-04-21 and IR-3-25 is an open demonstration using a minimum of 30 flaws. The inspection procedures would be qualified by examining a set of open test specimens to determine if the procedure can detect and characterize the flaws in the specimens. The specimens will contain a variety of fabrication-style flaws, including incomplete fusion, incomplete penetration, slag inclusions, porosity, and cracking. Additionally, as described in the letter dated August 1, 2013 (ADAMS Accession No. ML13220A019), the personnel performing the examination must pass a blind demonstration prior to analyzing data from the welds. The combination of the limitation of RR-04-21 and IR-3-25 to Class 2 ferritic welds and the use of the blind personnel performance demonstration qualification (described below) addresses the NRC staff concerns.

Personnel Demonstration

As stated in RR-04-21 and IR-3-25, personnel conducting the examinations would need to pass a blind performance demonstration examination. The analyst would have to examine a minimum of ten flaws. To pass the demonstration, the personnel would need to detect 80 percent or greater of the intended flaws, and no more than 20 percent of the grading units shall contain a false call.

To be qualified for flaw characterization, 80 percent or greater of the intended flaws within the demonstration set shall be correctly characterized as planar (which includes cracks, lack of fusion and incomplete penetration) or volumetric (which includes slag and porosity). Any non-flaw condition (geometry, etc.) reported as a flaw shall be considered a false call.

Acceptance Criteria

The proposed alternatives in RR-04-21 and IR-3-25 use the acceptance criteria in ASME Code, Section III NC-5330 acceptance criteria for the weld inspections. The NC-5330 acceptance

criteria describe two classes of flaws. Planar-type flaws that are defined as cracks, lack of fusion, and incomplete penetration are not acceptable at any length. Other volumetric-type flaws, such as slag and porosity, are acceptable if their length is below certain thresholds defined in NC-5330. The two classes of flaws require that the inspector be able to discriminate between the flaw types. While it makes little difference if the inspector cannot distinguish between slag and porosity, as they have the same acceptance criteria, it is important that the inspector be able to properly characterize cracks, lack of fusion, and incomplete penetration, as these types of flaws are always unacceptable in ASME Code Section III NC-5330. The licensee will not use the 20 percent amplitude threshold in ASME Code Section III NC-5330. Additionally, as described above, the equipment, procedure and personnel must be able to discern between volumetric and planar flaws to pass the performance demonstration testing.

The NRC staff finds that the use of ASME Code Section III NC-5330 acceptance criteria without the 20 percent amplitude threshold is acceptable for the UT techniques described in RR-04-21 and IR-3-25.

During the review of the use of UT in lieu of RT for the earlier RR-04-16, the NRC staff evaluated the qualification process and the results obtained by the proposed phased-array procedure on a series of representative flawed specimens. Following its detailed review, the NRC staff authorized the original proposed alternative in the safety evaluation dated April 4, 2014 (ADAMS Accession No. ML14091A973).

Based on the results of NUEG/CR-7204 and the work evaluated in the review of RR-04-16, there is reasonable assurance that the encoded phased array UT qualified as in RR-04-21 and IR-3-25 would provide an adequate level of quality and safety.

4.0 CONCLUSION

As set forth above, the NRC staff concludes that the licensee's proposed alternative to use UT in lieu of RT using encoded phased array examinations provides reasonable assurance of structural integrity and leak tightness of Class 2 ferritic piping welds. Thus, ultrasonic testing using the procedure described in the submittals of the subject welds would provide an adequate 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, the NRC staff authorizes relief request RR-04-21 for MPS2 for the remainder of the fourth 10-year Inspection that is scheduled to end on March 31, 2020, and IR-3-25 for MPS3 for the remainder of the third 10-year ISI interval that is scheduled to end on April 22, 2019.

All other requirements of the ASME Code for which relief has not been specifically requested remain applicable, including third-party review by the Authorized Nuclear Inservice Inspector.

Principal Contributor: S. Cumblidge

Date: September 21, 2015

If you have any questions, please contact, Richard Guzman, senior project manager assigned to the Millstone Power Station, at (301) 415-1030.

Sincerely,

/RA/

Benjamin Beasley, Chief
Plant Licensing Branch I-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. 50-336 and 50-423

Enclosure:
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