



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

January 23, 2017

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 NOS. 2 AND 3 – ALTERNATIVE REQUESTS RR-04-23 AND IR-3-28 FOR THE USE OF ENCODED PHASED ARRAY ULTRASONIC EXAMINATION TECHNIQUES IN LIEU OF RADIOGRAPHY (CAC NOS. MF7595 AND MF7596)

Dear Mr. Heacock:

By letter dated April 11, 2016 (Agencywide Documents Access and Management System Accession No. ML16106A105), Dominion Nuclear Connecticut, Inc. (the licensee) submitted Alternative Requests RR-04-23 and IR-3-28 to request relief from the requirements of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (Code), Section XI, paragraph IWA-4221, for the 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 proposed to use phased array ultrasonic testing (UT) 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 provides an acceptable level of quality and safety.

The U.S. Nuclear Regulatory Commission (NRC) staff has reviewed the subject request and concludes, as set forth in the enclosed safety evaluation, that the licensee's proposed alternative to use UT 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, UT 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 Alternative Request RR-04-23 for MPS2 for the remainder of the fourth 10-year ISI that is scheduled to end on March 31, 2020, and IR-3-28 for MPS3 for the remainder of the third 10-year ISI interval that is scheduled to end on April 22, 2019.

D. Heacock

- 2 -

If you have any questions, please contact the Project Manager, Richard Guzman, at 301-415-1030 or by e-mail to [Richard.Guzman@nrc.gov](mailto:Richard.Guzman@nrc.gov).

Sincerely,

A handwritten signature in black ink, appearing to read "Stephen S. Koenick". The signature is fluid and cursive, with a large initial "S" and "K".

Stephen S. Koenick, Acting Chief  
Plant Licensing Branch I  
Division of Operating Reactor Licensing  
Office of Nuclear Reactor Regulation

Docket Nos. 50-336 and 50-423

Enclosure:  
Safety Evaluation

cc w/encl: Distribution via Listserv



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

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

ALTERNATIVE REQUESTS RR-04-23 AND IR-3-28

FOR THE FOURTH AND THIRD INSERVICE INSPECTION INTERVALS

MILLSTONE POWER STATION, UNIT NOS. 2 AND 3

DOMINION NUCLEAR CONNECTICUT, INC.

DOCKET NOS. 50-336 AND 50-423

1.0 INTRODUCTION

By letter dated April 11, 2016 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML16106A105), Dominion Nuclear Connecticut, Inc. (the licensee) submitted Alternative Requests RR-04-23 and IR-3-28 to request relief from the requirements of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (Code), Section XI, paragraph IWA-4221, for the 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 (UT) 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 provides an acceptable level of quality and safety.

2.0 REGULATORY EVALUATION

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

Alternative Requests RR-04-23 and IR-3-28 cite 10 CFR 50.55a(a)(z)(1), which covers requests for alternatives on the basis that the proposed alternative would provide an acceptable level of quality and safety. Section 50.55a(z) of 10 CFR 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 or the Commission) 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 alternatives requested by the licensee.

### 3.0 TECHNICAL EVALUATION

#### 3.1 The Licensee's Relief Request

##### ASME Code Components Affected

Alternative Requests RR-04-23 and IR-3-28 cover circumferential butt welds in ASME Code Class 2 piping with diameters of 3 inches and greater, and thicknesses ranging from 0.280 inch through 2.0 inches 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 ferritic 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 the ASME Code, Section XI.

##### ASME Code Requirement

ASME Code, Section XI, IWA-4221, requires the owner to use the requirements of the construction code for repair/replacement activities. The examination requirements for ASME Code, Section III, Class 2, circumferential butt welds are contained in ASME Code, Section III, 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 an encoded phased array ultrasonic examination technique in lieu of the Code-required radiographic examination for ASME Class 2 ferritic piping replacement welds described above. The licensee is currently authorized to use UT in lieu of radiographic testing (RT) on these components, and this proposed alternative is an update based on experience. The safety evaluation for MPS2 and MPS3 was authorized by letter dated September 21, 2015 (ADAMS Accession No. ML15257A005). The previous alternative used Section III acceptance criteria for flaws and required the inspector to discriminate between planar and volumetric flaws.

Elements of the proposed alternative examination include:

- The ultrasonic examination shall be performed with equipment, procedures, and personnel qualified by performance demonstration.
- The ultrasonic examination shall include 100 percent of the weld volume, which includes the weld-to-base material interface on each side of the weld.

- All flaws will be considered planar, and the acceptance standards for volumetric ultrasonic examination shall be in accordance with ASME Code, Section XI, IWC-3400.
- The ultrasonic examination shall be performed using encoded examination methods.
- A written ultrasonic examination procedure qualified by performance demonstration for flaw detection and sizing shall be used.
- Ultrasonic examination personnel shall be qualified in accordance with ASME Code, Section XI, IWA-2300.
- Examination personnel shall demonstrate their capability to detect and size flaws by performance demonstration

### Basis for Use

The licensee's basis for Alternative Requests RR-04-23 and IR-3-28 is that encoded phased array UT 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-04-23 for the remainder of the fourth 10-year ISI interval that began on April 1, 2010, and is scheduled to end on March 31, 2020. For MPS3, the licensee requests approval of IR-3-28 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 update its use of encoded phased array UT in lieu of RT in Alternative Requests RR-04-23 and IR-3-28. UT, like RT, 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.

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" (ADAMS Accession No. ML15253A674). 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 PA-UT [phased-array ultrasonic testing],

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 PA-UT parameters applied were shown to be more effective for planar flaws, but slightly less effective for small volumetric flaws, than RT.

Based on the conclusions of NUREG/CR-7204, the NRC staff finds that there is a sufficient technical basis for the use of UT in lieu of RT for ferritic steel welds. Given that UT in lieu of RT is apparently possible, the NRC staff worked to determine if the proposed alternatives apply UT in a way that provides reasonable assurance of finding structurally-significant flaws.

This is the third proposed alternative submitted by the licensee with respect to UT in lieu of RT. During the first review of the use of UT in lieu of RT for the earlier proposed Alternative Relief (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. The NRC staff authorized the original proposed alternative in the safety evaluation dated April 4, 2014 (ADAMS Accession No. ML14091A973). The second set of alternatives allowing the use of UT in lieu of RT for MPS2 and MPS3 (RR-04-21 and IR-3-25) was authorized by letter dated September 21, 2015.

Important aspects of this proposed alternative include:

- The examination volume shall include 100 percent of the weld volume and the weld-to-base-metal interface
- The electronic data files for the PA-UT examinations will be stored as archival-quality records. In addition, hard copy prints of the data will also be included as part of the PA-UT examination records to allow viewing, without the use of hardware or software.
- Ultrasonic procedures shall be qualified by using either a blind or a non-blind performance demonstration using a minimum of 30 flaws covering a range of sizes, positions, orientations, and types of fabrication flaws. The demonstration set shall include specimens to represent the minimum and maximum diameter and thickness covered by the procedure. Relevant flaws for the demonstration set are those that are 50 percent or more of the acceptable flaw size, as defined by ASME Code, Section XI, IWC-3400. All relevant flaws in the demonstration set need to be detected for the procedure to be qualified.
- Ultrasonic examination personnel shall demonstrate their capability to detect and size flaws by performance demonstration using the qualified procedure. The demonstration specimen set shall contain at least 10 flaws covering a range of sizes, positions, orientations, and types of fabrication flaws.

The current proposed alternative is very similar to the previous authorized alternatives in the qualification processes for procedures and personnel. The difference in the two alternatives is how the current proposed alternative handles flaw characterization and the acceptance criteria for flaws. In the previous alternatives, the procedure and inspector had to be able to distinguish between the various types of fabrication flaws and the flaw evaluations were handled under

ASME Code, Section III, NC-5330, acceptance criteria for the weld inspections. The ASME Code, Section III, NC-5330, acceptance criteria describe two classes of flaws, cracks, lack of fusion, and incomplete penetration flaws, often referred to as planar flaws, and all other flaws, often referred to as volumetric flaws. Volumetric flaws include phenomena such as slag and porosity. Cracks, lack of fusion, and incomplete penetration flaws are not acceptable at any length. The volumetric-type flaws are acceptable if their length is below certain thresholds defined in ASME Code, Section III, NC-5330. The previous alternatives require the procedure and inspector to distinguish between the planar and volumetric fabrication flaws to properly assess them versus the requirements of ASME Code, Section III, NC-5330.

In the current proposed alternatives, all flaws are treated as planar, and the flaws will be evaluated against ASME Code, Section XI, IWC-3400, which is based on calculations to determine if the component is acceptable for service, not workmanship standards. ASME Code, Section XI, IWC-3400, allows larger flaws than Section III, NC-5330, with the flaw sizes conservatively-sized to assure that the component will maintain structural integrity and leak-tightness. The use of ASME Code, Section XI, IWC-3400, has proven effective for piping welds for ISIs. The NRC staff finds that the use of ASME Code, Section XI, IWC-3400, acceptance standards are appropriate for the proposed alternatives, as the proposed alternatives are for repair/replacement activities, not new plant construction, and have favorable industry experience with ASME Code, Section XI, IWC-3400.

Based on the results of NUREG/CR-7204, and the work evaluated in the review of Alternative Request RR-04-16, there is reasonable assurance that the encoded phased array UT qualified as proposed by the licensee will 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 with encoded phased array examinations in lieu of RT provides reasonable assurance of structural integrity and leak-tightness of Class 2 ferritic piping welds. Thus, UT 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 Alternative Request RR-04-23 for MPS2 for the remainder of the fourth 10-year ISI that is scheduled to end on March 31, 2020, and IR-3-28 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: January 23, 2017

D. Heacock

- 2 -

If you have any questions, please contact the Project Manager, Richard Guzman, at 301-415-1030 or by e-mail to [Richard.Guzman@nrc.gov](mailto:Richard.Guzman@nrc.gov).

Sincerely,

*/RA/*

Stephen S. Koenick, Acting Chief  
Plant Licensing Branch I  
Division of Operating Reactor Licensing  
Office of Nuclear Reactor Regulation

Docket Nos. 50-336 and 50-423

Enclosure:  
Safety Evaluation

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