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Dominion®

April 11, 2016

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

Serial No. 16-148
NLOS/WDC R0
Docket Nos. 50-336/423
License Nos. DPR-65
NPF-49

**DOMINION NUCLEAR CONNECTICUT, INC.**
**MILLSTONE POWER STATION UNITS 2 AND 3**
**PROPOSED ALTERNATIVE REQUESTS RR-04-23 and IR-3-28 FOR THE USE OF ENCODED PHASED ARRAY ULTRASONIC EXAMINATION TECHNIQUES IN LIEU OF RADIOGRAPHY**

Pursuant to 10 CFR 50.55a(z)(1), Dominion Nuclear Connecticut, Inc. (DNC) requests Nuclear Regulatory Commission (NRC) approval of Alternative Request RR-04-23, for Millstone Power Station Unit 2 (MPS2) and Alternative Request IR-3-28 for Millstone Power Station Unit 3 (MPS3). ASME Code, Section III requires that ASME Class 2 ferritic circumferential pipe weld joints be examined using radiographic examination techniques to satisfy nondestructive examination requirements. DNC requests approval to use encoded Phased Array Ultrasonic Examination Techniques (PAUT) as an alternative to radiographic examination. DNC considers the proposed alternative would provide an acceptable level of quality and safety. The supporting basis for this request is contained in the attachments to this letter.

DNC requests approval of the proposed alternatives to support anticipated piping repair and replacement activities for the next MPS2 refueling outage currently scheduled to occur during spring 2017 (2R24). The duration of proposed Alternative Request RR-04-23 is for the remainder of the fourth 10-year inservice inspection interval for MPS2 that began on April 1, 2010 and is scheduled to end March 31, 2020. The duration of proposed Alternative Request IR-3-28 is for the remainder of the third 10-year inservice inspection interval for MPS3 that began on April 23, 2009 and is scheduled to end April 22, 2019.

If you have any questions regarding this submittal, please contact Wanda Craft at (804) 273-4687.

Sincerely,

Mark D. Sartain
Vice President – Nuclear Engineering

A047
NRR

Attachments:

1. Alternative Request RR-04-23 Proposed Alternative to ASME Section III.
2. Alternative Request IR-3-28 Proposed Alternative to ASME Section III.

Commitments made in this letter: None

cc: U.S. Nuclear Regulatory Commission
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Serial No. 16-148
Docket No. 50-336

**ATTACHMENT 1**

**ALTERNATIVE REQUEST RR-04-23**
**PROPOSED ALTERNATIVE TO ASME SECTION III**

**MILLSTONE POWER STATION UNIT 2**
**DOMINION NUCLEAR CONNECTICUT, INC.**

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

-- Proposed Alternative Provides an Acceptable Level of Quality and Safety --

## 1. ASME Code Components Affected

| | |
|---|---|
| ASME Code Class: | Code Class 2 |
| References: | ASME Section III, Paragraph NC-5200 and NC-5300 |
| Examination Category: | N/A |
| Item Number: | N/A |
| Description: | Feedwater System, Auxiliary Feedwater System, Main Steam System, Reactor Building Closed Loop Cooling Water System, and Containment Purge System |
| Components: | Circumferential butt welds associated with 3 inches and greater diameter ferritic piping ranging from 0.280 inch through 2.0 inches in thickness |

Use of encoded Phased Array Ultrasonic Examination Techniques (PAUT) is requested as an alternative during repair and replacement activities on the American Society of Mechanical Engineers (ASME) Class 2 piping circumferential butt welds described above. The specific components are limited to carbon steel base and filler material with wall thickness and diameters within the demonstrated procedure ranges in accordance with the process described in Section 5.1. In addition, the geometry must allow 100% examination coverage of the weld volume in accordance with the examination techniques described in Section 5.1(4).

## 2. Applicable Code Edition and Addenda

ASME Section XI, 2004 Edition (No Addenda).

## 3. Applicable Code Requirement

The 2004 Edition of ASME Section XI, paragraph IWA-4221 (Construction Code and Owner's Requirements) requires the owner to use the requirements of the construction code for repair and 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.

## 4. Reason for Request

Replacement of Millstone Power Station Unit 2 (MPS2) piping is periodically performed in support of the Flow Accelerated Corrosion (FAC) program as well as other repair and replacement activities. The use of PAUT in lieu of radiography (RT) to perform the required examinations of the replaced welds would eliminate the safety risk associated with performing RT, which includes the planned exposure and the potential for accidental exposure. It also minimizes the impact on other outage activities normally involved with performing RT. In addition, encoded PAUT is considered equivalent or superior to RT for detecting and sizing critical (planar) flaws.

DNC requests this proposed alternative to support anticipated piping repair and replacement activities during the next MPS2 refueling outage currently scheduled to occur during spring 2017 (2R24). The duration of the proposed alternative request is for the remainder of the fourth 10-year inservice inspection interval for MPS2 that began on April 1, 2010 and is scheduled to end March 31, 2020.

## 5. Proposed Alternative and Basis for Use

DNC is proposing the use of encoded PAUT in lieu of the code-required RT examinations for ASME Class 2 ferritic piping replacement welds. Similar techniques are being used throughout the nuclear industry for examination of dissimilar metal welds, overlaid welds, as well as other applications including B31.1 piping replacements. This proposed alternative request includes requirements that provide an acceptable level of quality and safety that satisfies the requirements of 10 CFR 50.55a(z)(1). The capability of the alternative technique is comparable to the examination methods documented in the ASME Code Sections III, VIII, and IX, and associated code cases (References 1, 3, 5, 6, 8, 9, 10, 11 and 12) related to using ultrasonic examination techniques for weld acceptance.

The proposed examinations will be performed using the encoded PAUT procedure demonstrated in support of previously approved MPS2 Alternative Request RR-04-21 (ADAMS Accession No. ML15257A005). This procedure has been qualified in accordance with a process similar to that defined in Section 5.1 below. The existing procedure will be modified to comply with the requirements of 5.1, as applicable.

The electronic data files for the PAUT examinations will be stored as part of the archival-quality records. In addition, hard copy prints of the data will also be included as part of the PAUT examination records to allow viewing without the use of hardware or software.

5.1 Proposed Alternative

DNC is proposing to perform encoded PAUT examination techniques using demonstrated procedures, equipment and personnel in accordance with the process documented below:

(1) The welds to be examined shall meet the surface conditioning requirements of the demonstrated ultrasonic procedure.

(2) The welds to be examined shall be conditioned such that transducers properly couple with the scanning surface with no more than a 1/32 in. (0.8 mm) gap between the search unit and the scanning surface.

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

(4) The examination volume shall include 100% of the weld volume and the weld-to-base-metal interface.

(a) Angle beam examination of the complete examination volume for fabrication flaws oriented parallel to the weld joint shall be performed.

(b) Angle beam examination for fabrication flaws oriented transverse to the weld joint shall be performed to the extent practical. Scan restrictions that limit complete coverage shall be documented.

(c) A supplemental straight beam examination shall be performed on the volume of base material through which the angle beams will travel to locate any reflectors that can limit the ability of the angle beam to examine the weld. Detected reflectors that may limit the angle beam examination shall be recorded and evaluated for impact on examination coverage. The straight beam examination procedure, or portion of the procedure, is not required to be qualified to these requirements and may be performed using non-encoded techniques.

(5) All detected flaw indications from (4)(a) and (4)(b) above shall be considered planar flaws and compared to the acceptance standards for volumetric examination in accordance with IWC-3400. Preservice acceptance standards shall be applied.

(6) Flaws exceeding the applicable acceptance standards shall be reduced to an acceptable size or removed and repaired, and the location of the repair shall be reexamined using the same ultrasonic examination procedure that detected the flaw.

(7) The ultrasonic examination shall be performed using encoded UT technology that produces an electronic record of the ultrasonic responses indexed to the

probe position, permitting off-line analysis of images built from the combined data.

(a) Where component configuration does not allow for effective examination for transverse flaws, (e.g. pipe-to-valve, tapered weld transition, weld shrinkage, etc.) the use of non-encoded UT technology may be used for transverse flaws. The basis for the non-encoded examination shall be documented.

(8) A written ultrasonic examination procedure qualified by performance demonstration shall be used. The qualification shall be applicable to the scope of the procedure, e.g., flaw detection and/or sizing (length and through-wall height), encoded or non-encoded, single and/or dual side access, etc. The procedure shall:

(a) contain a statement of scope that specifically defines the limits of procedure applicability (e.g. minimum and maximum thickness, minimum and maximum diameter, scanning access);

(b) specify which parameters are considered essential variables, and a single value, a range of values or criteria for selecting each of the essential variables;

(c) list the examination equipment, including manufacturer and model or series;

(d) define the scanning requirements; such as beam angles, scan patterns, beam direction, maximum scan speed, extent of scanning, and access;

(e) contain a description of the calibration method (i.e., actions required to ensure that the sensitivity and accuracy of the signal amplitude and time outputs of the examination system, whether displayed, recorded, or automatically processed, are repeated from examination to examination);

(f) describe the method and criteria for discrimination of indications (e.g., geometric versus flaw indications and surface versus subsurface indications); and

(g) describe the surface preparation requirements.

(9) Performance demonstration specimens shall conform to the following requirements:

(a) The specimens shall be fabricated from ferritic material with the same inside surface cladding process, if applicable, with the following exceptions:

(i) demonstration with shielded metal arc weld (SMAW) single-wire cladding is transferable to multiple-wire or strip-clad processes;

(ii) demonstration with multiple-wire or strip-clad is considered equivalent but is not transferable to SMAW type clad.

(b) The demonstration specimens shall contain a weld representative of the joint to be ultrasonically examined, including the same welding processes.

(c) The demonstration set shall include specimens not thicker than 0.1 in. (2.5 mm) more than the minimum thickness, nor thinner than 0.5 in. (13 mm) less than the maximum thickness for which the examination procedure is applicable. The demonstration set shall include the minimum, within ½ nominal pipe size (NPS), and maximum pipe diameters for which the examination procedure is applicable. If the procedure is applicable to outside diameter (O.D.) piping of 24 in. (600 mm) or larger, the specimen set must include at least one specimen 24 in. O.D. (600 mm) or larger but need not include the maximum diameter.

(d) The demonstration specimen scanning and weld surfaces shall be representative of the surfaces to be examined.

(e) The demonstration specimen set shall include geometric conditions that require discrimination from flaws (e.g., counterbore, weld root conditions, or weld crowns) and limited scanning surface conditions for single-side access, when applicable.

(f) The demonstration specimens shall include both planar and volumetric fabrication flaws (e.g., lack of fusion, crack, incomplete penetration, inclusions) representative of the welding process or processes of the welds to be examined. The flaws shall be distributed throughout the examination volume.

(g) Specimens shall be divided into grading units, flawed and unflawed.

(i) Flawed grading units shall be the actual flaw length, plus a minimum of 0.25 in. (6 mm) on each end of the flaw. Unflawed grading units shall be at least 1 in. (25 mm).

(ii) The number of unflawed grading units shall be at least 1-1/2 times the number of flawed grading units.

(h) Demonstration specimen set flaw distribution shall be as follows:

(i) For thickness greater than 0.50 in. (13mm); at least 20% of the flaws shall be distributed in the outer third of the specimen through-wall thickness, at least 20% of the flaws shall be distributed in the middle third of the specimen through-wall thickness and at least 40% of the flaws shall be distributed in the inner third of the specimen through-wall thickness. For thickness 0.50 in. (13mm) and less, at least 20% of the flaws shall be distributed in the outer half of the specimen

through-wall thickness and at least 40% of the flaws shall be distributed in the inner half of the specimen through-wall thickness.

(ii) At least 30% of the flaws shall be classified as surface planar flaws in accordance with IWA-3310. At least 40% of the flaws shall be classified as subsurface planar flaws in accordance with IWA-3320.

(iii) At least 50% of the flaws shall be planar type flaws, such as lack of fusion, incomplete penetration, or cracks. At least 20% of the flaws shall be volumetric type flaws, such as slag inclusions.

(iv) The flaw through-wall heights shall be based on the applicable acceptance standards for volumetric examination in accordance with IWC-3400. At least 30% of the flaws shall be classified as acceptable planar flaws, with the smallest flaws being at least 50% of the maximum allowable size based on the applicable a/l aspect ratio for the flaw. Additional smaller flaws may be included in the specimens to assist in establishing a detection threshold, but shall not be counted as a missed detection if not detected. At least 30% of the flaws shall be classified as unacceptable in accordance with the applicable acceptance standards. Welding fabrication flaws are typically confined to a height of a single weld pass. Flaw through-wall height distribution shall range from approximately 1 to 4 weld pass thicknesses, based on the welding process used.

(v) When applicable, at least two flaws, but no more than 30% of the flaws, shall be oriented perpendicular to the weld fusion line and the remaining flaws shall be circumferentially oriented.

(vi) For demonstration of single-side-access capabilities, at least 30% of the flaws shall be located on the far side of the weld centerline and at least 30% of the planar flaws shall be located on the near side of the weld centerline. The remaining flaws shall be distributed on either side of the weld.

(10) Ultrasonic procedures shall be qualified by performance demonstration in accordance with the following requirements.

(a) The procedure shall be demonstrated using either a blind or a non-blind demonstration.

(b) The use of the non-blind performance demonstration is used to assist in optimizing the examination procedure. When applying the non-blind demonstration process, personnel have access to limited knowledge of specimen flaw information during the demonstration process. The non-blind demonstration process consists of an initial demonstration without any flaw information, an assessment of the results and feedback on the performance provided to the qualifying candidate. After an assessment of

the initial demonstration results, limited flaw information may be shared with the candidate as part of the feedback process to assist in enhancing the examination procedure to improve the procedure performance. In order to maintain the integrity of the specimens for blind personnel demonstrations, only generalities of the flaw information may be provided to the candidate. Procedure modifications or enhancements made to the procedure, based on the feedback process, shall be applied to all applicable specimens based on the scope of the changes.

(c) Objective evidence of a flaw's detection, length and through-wall height sizing, in accordance with the procedure requirements, must be provided to the organization administering the performance demonstration.

(d) The procedure demonstration specimen set shall be representative of the procedure scope and limitations (e.g., thickness range, diameter range, material, access, surface condition).

(e) As a minimum, the demonstration set shall include specimens to represent the minimum and maximum diameter and thickness covered by the procedure. When the procedure spans a range of diameters and thicknesses, additional specimens shall be included in the set to demonstrate the effectiveness of the procedure throughout the entire range.

(f) The procedure demonstration specimen set shall include at least 30 flaws and shall meet the requirements of (9) above.

(g) Procedure performance demonstration acceptance criteria

(i) To be qualified for flaw detection, all flaws in the demonstration set that are ≥ 50% of the maximum allowable size, based on the applicable a/l aspect ratio for the flaw, shall be detected. In addition, when performing blind procedure demonstrations, no more than 20% of the non-flawed grading units shall contain a false call. Any non-flaw condition (geometry, etc.) reported as a flaw shall be considered a false call.

(ii) To be qualified for flaw length sizing, the root mean square (RMS) error of the flaw lengths estimated by ultrasonics, as compared with the true lengths, shall not exceed 0.25 in. (6 mm) for NPS diameters of 6.0 in. (152 mm) and less, and 0.75 in. (18 mm) for diameters greater than 6.0 in. (152 mm) NPS.

(iii) To be qualified for flaw through-wall height sizing, the RMS error of the flaw through-wall heights estimated by ultrasonics, as compared with the true through-wall heights, shall not exceed 0.125 in. (3 mm).

(iv) RMS error shall be calculated as follows:

$$RMS = \left[ \frac{\sum_{i-1}^{n} (m_i - t_i)^2}{n} \right]^{1/2}$$

Where

$m_i$ = measured flaw size

$t_i$ = true flaw size

$n$ = number of flaws measured

(h) Changing essential variables may be accomplished during successive personnel performance demonstrations. Each examiner need not demonstrate qualification over the entire range of every essential variable.

(11) Ultrasonic examination personnel shall be qualified in accordance with IWA-2300. In addition, examination personnel shall demonstrate their capability to detect and size flaws by performance demonstration using the qualified procedure in accordance with the following requirements:

(a) The personnel demonstration shall be conducted in a blind fashion (flaw information is not provided).

(i) The demonstration specimen set shall contain at least 10 flaws and shall meet the flaw distribution requirements of (9)(h) above, with the exception of (9)(h)(v). When applicable, at least one flaw, but no more than 20% of the flaws, shall be oriented perpendicular to the weld fusion line and the remaining flaws shall be circumferentially oriented.

(b) Personnel performance demonstration acceptance criteria:

(i) To be qualified for flaw detection, personnel demonstration shall meet the requirements of the following table for both detection and false calls. Any non-flaw condition (geometry, etc.) reported as a flaw shall be considered a false call.

(ii)

| Performance Demonstration Detection Test Acceptance Criteria | | | |
|---|---|---|---|
| **Detection Test Acceptance Criteria** | | **False Call Test Acceptance Criteria** | |
| **No. of Flawed Grading Units[1]** | **Minimum Detection Criteria** | **No. of Unflawed Grading Units** | **Maximum Number of False Calls** |
| 10 | 8 | 15 | 2 |
| 11 | 9 | 17 | 3 |
| 12 | 9 | 18 | 3 |
| 13 | 10 | 20 | 3 |
| 14 | 10 | 21 | 3 |
| 15 | 11 | 23 | 3 |
| 16 | 12 | 24 | 4 |
| 17 | 12 | 26 | 4 |
| 18 | 13 | 27 | 4 |
| 19 | 13 | 29 | 4 |
| 20 | 14 | 30 | 5 |
| **Note 1**: Flaws ≥ 50% of the maximum allowable size, based on the applicable a/l aspect ratio for the flaw. | | | |

(iii) To be qualified for flaw length sizing, the RMS error of the flaw lengths estimated by ultrasonics, as compared with the true lengths, shall not exceed 0.25 in. (6 mm) for NPS diameters of 6.0 in. (152 mm) and less, and 0.75 in. (18 mm) for diameters greater than 6.0 in. (152 mm) NPS.

(iv) To be qualified for flaw through-wall height sizing, the RMS error of the flaw through-wall heights estimated by ultrasonics, as compared with the true through-wall heights, shall not exceed 0.125 in. (3 mm).

(12) Documentation of the qualifications of procedures and personnel shall be maintained. Documentation shall include identification of personnel, NDE procedures, equipment and specimens used during qualification, and results of the performance demonstration.

(13) The pre-service examinations will be performed per ASME Section XI (Reference 4)

5.2 Basis for Use

The overall basis for this proposed alternative is that encoded PAUT is equivalent or superior to RT for detecting and sizing critical (planar) flaws. In this regard, the

basis for the proposed alternative was developed from numerous codes, code cases, associated industry experience, articles, and the results of RT and encoded PAUT examinations.

## 6. Duration of Proposed Alternative

DNC requests approval of this relief for the remainder of the fourth 10-year inservice inspection interval for MPS2 that began on April 1, 2010 and is scheduled to end on March 31, 2020.

## 7. Conclusion

10 CFR 50.55a(z) states:

"Alternatives to the requirements of paragraphs (b) through (h) of this section or portions thereof may be used when authorized by the Director of the Office of Nuclear Reactor Regulation, or Director, Office of New Reactors, as appropriate. A proposed alternative must be submitted and authorized prior to implementation. The applicant or licensee must demonstrate that:

(1) The proposed alternatives would provide an acceptable level of quality and safety, or

(2) Compliance with the specified requirements of this section would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety."

The proposed alternative discussed in this alternative request is in accordance with 10 CFR 50.55a(z)(1), in that the proposed alternative would provide an acceptable level of quality and safety.

## 8. Precedents

8.1 Oconee Request for Relief No. 2006-ON-001, dated June 20, 2006, requested an alternative for examination of butt welds between the Pressurizer Level and Sample Tap nozzles and their respective Safe Ends. The reason for the request was based on the difficulty to perform the code required radiography. The alternative was to perform ultrasonic examination per similar requirements to Code Case N- 659-0. (ML061210495)

8.2 Wolf Creek 10 CFR 50.55a Request ET 06-0029, dated September 1, 2006, requested an alternative for examination of main steam and feedwater piping welds being replaced due to flow assisted corrosion. The reason for the

request was based on the acceptability of the proposed ultrasonic examination alternative process, radiation exposure reduction, outage costs and duration, and radiography exposure risk. (ML062500093)

8.3 Palo Verde Nuclear Generating Station Relief Request 48, dated August 1, 2012 (ML12229A046). NRC approval dated April 12, 2013 (ML13091A177).

8.4 Millstone Power Station Unit 2 Alternative Request RR-04-16, dated August 1, 2013 (ML13220A019). NRC approval dated April 4, 2014 (ML14091A973).

8.5 Millstone Power Station Unit 2 Alternative Request RR-04-21, dated October 6, 2014 (ML14283A128). NRC approval dated September 21, 2015 (ML15257A005).

8.6 Millstone Power Station Unit 3 Alternative Request IR-3-25, dated October 6, 2014 (ML14283A128). NRC approval dated September 21, 2015 (ML15257A005).

## 9. References

1. ASME Section III Code Case N-659-2, "Use of Ultrasonic Examination in Lieu of Radiography for Weld Examination Section III, Divisions 1 and 3," dated June 9, 2008
2. Pacific Northwest National Laboratory Report PNNL-19086, "Replacement of Radiography with Ultrasonics for the Nondestructive Inspection of Welds - Evaluation of Technical Gaps - An Interim Report," dated April 2010
3. ASME B31.1, Case 168, "Use of Ultrasonic Examination in Lieu of Radiography for B31. 1 Application," dated June 1997
4. ASME Section III and XI 2004 Edition, No Addenda
5. ASME Section III, Code Case N-818, "Use of Analytical Evaluation approach for Acceptance of Full Penetration Butt Welds in Lieu of Weld Repair," dated December 6, 2011
6. ASME Code Case 2235-9, 2005; "Use of Ultrasonic Examination in Lieu of Radiography Section I, Section VIII, Divisions 1 and 2, and Section XII," dated October 11
7. Journal of Pressure Vessel Technology, "Technical Basis for ASME Section VIII Code Case 2235 on Ultrasonic Examination of Welds in Lieu of Radiography;" Rana, Hedden, Cowfer and Boyce, Volume 123, dated August 2001
8. ASME Code Case 2326, "Ultrasonic Examination in Lieu of Radiographic Examination for Welder Qualification Test Coupons Section IX," dated January 20, 2000
9. ASME Code Case 2541, "Use of Manual Phased Array Ultrasonic Examination Section V," dated January 19, 2006
10. ASME Code Case 2558, "Use of Manual Phased Array E-Scan Ultrasonic Examination Per Article 4 Section V," dated December 30, 2006

11 ASME Code Case 2599, "Use of Linear Phased Array E-Scan Ultrasonic Examination Per Article 4 Section V," dated January 29, 2008
12. ASME Code Case 2600, "Use of Linear Phased Array S-Scan Ultrasonic Examination Per Article 4 Section V," dated January 29, 2008
13. ASME Section XI, Code Case N-713, "Ultrasonic Examination in Lieu of Radiography," dated November 10, 2008
14. EPRI presentation, "Ultrasonic Capability Study for Reduction of Weld Repair During the Construction-UT Technical Presentation," dated May 2010

# ATTACHMENT 2

## ALTERNATIVE REQUEST IR-3-28
## PROPOSED ALTERNATIVE TO ASME SECTION III

**MILLSTONE POWER STATION UNIT 3**
**DOMINION NUCLEAR CONNECTICUT, INC.**

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

-- Proposed Alternative Provides an Acceptable Level of Quality and Safety --

## 1. ASME Code Components Affected

| | |
|---|---|
| ASME Code Class: | Code Class 2 |
| References: | ASME Section III, Paragraph NC-5200 and NC-5300 |
| Examination Category: | N/A |
| Item Number: | N/A |
| Description: | Feedwater System, Auxiliary Feedwater System, and the Main Steam System |
| Components: | Circumferential butt welds associated with 3 inches and greater diameter ferritic piping ranging from 0.280 inch through 2.0 inches in thickness |

Use of encoded Phased Array Ultrasonic Examination Techniques (PAUT) is requested as an alternative during repair and replacement activities on the American Society of Mechanical Engineers (ASME) Class 2 piping circumferential butt welds described above. The specific components are limited to carbon steel base and filler material with wall thickness and diameters within the demonstrated procedure ranges in accordance with the process described in Section 5.1. In addition, the geometry must allow 100% examination coverage of the weld volume in accordance with the examination techniques described in Section 5.1(4).

## 2. Applicable Code Edition and Addenda

ASME Section XI, 2004 Edition (No Addenda).

## 3. Applicable Code Requirement

The 2004 Edition of ASME Section XI, paragraph IWA-4221 (Construction Code and Owner's Requirements) requires the owner to use the requirements of the construction code for repair and 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.

## 4. Reason for Request

Replacement of the Millstone Power Station Unit 3 (MPS3) piping is periodically performed in support of the Flow Accelerated Corrosion (FAC) program as well as other repair and replacement activities. The use of PAUT in lieu of radiography (RT) to perform the required examinations of the replaced welds would eliminate the safety risk associated with performing RT, which includes the planned exposure and the potential for accidental exposure. It also minimizes the impact on other outage activities normally involved with performing RT. In addition, encoded PAUT is considered equivalent or superior to RT for detecting and sizing critical (planar) flaws.

DNC requests this proposed alternative to support anticipated piping repair and replacement activities for the next MPS3 refueling outage currently scheduled to occur during fall 2017. The duration of the proposed alternative request is for the remainder of the third 10-year inservice inspection interval for MPS3 that began on April, 23, 2009 and is scheduled to end April 22, 2019.

## 5. Proposed Alternative and Basis for Use

DNC is proposing the use of encoded PAUT in lieu of the code-required RT examinations for ASME Class 2 ferritic piping replacement welds. Similar techniques are being used throughout the nuclear industry for examination of dissimilar metal welds, overlaid welds, as well as other applications including B31.1 piping replacements. This proposed alternative request includes requirements that provide an acceptable level of quality and safety that satisfies the requirements of 10 CFR 50.55a(z)(1). The capability of the alternative technique is comparable to the examination methods documented in the ASME Code Sections III, VIII, and IX, and associated code cases (References 1, 3, 5, 6, 8, 9, 10, 11 and 12) related to using ultrasonic examination techniques for weld acceptance.

The proposed examinations will be performed using the encoded PAUT procedure demonstrated in support of previously approved MPS3 Alternative Request IR-3-25 (ADAMS Accession No. ML15257A005). This procedure has been qualified in accordance with a process similar to that defined in Section 5.1 below. The existing procedure will be modified to comply with the requirements of Section 5.1, as applicable.

The electronic data files for the PAUT examinations will be stored as archival-quality records. In addition, hard copy prints of the data will also be included as part of the PAUT examination records to allow viewing without the use of hardware or software.

5.1 Proposed Alternative

DNC is proposing to perform encoded PAUT examination techniques using demonstrated procedures, equipment and personnel in accordance with the process documented below:

(1) The welds to be examined shall meet the surface conditioning requirements of the demonstrated ultrasonic procedure.

(2) The welds to be examined shall be conditioned such that transducers properly couple with the scanning surface with no more than a 1/32 in. (0.8 mm) gap between the search unit and the scanning surface.

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

(4) The examination volume shall include 100% of the weld volume and the weld-to-base-metal interface.

(a) Angle beam examination of the complete examination volume for fabrication flaws oriented parallel to the weld joint shall be performed.

(b) Angle beam examination for fabrication flaws oriented transverse to the weld joint shall be performed to the extent practical. Scan restrictions that limit complete coverage shall be documented.

(c) A supplemental straight beam examination shall be performed on the volume of base material through which the angle beams will travel to locate any reflectors that can limit the ability of the angle beam to examine the weld. Detected reflectors that may limit the angle beam examination shall be recorded and evaluated for impact on examination coverage. The straight beam examination procedure, or portion of the procedure, is not required to be qualified to these requirements and may be performed using non-encoded techniques.

(5) All detected flaw indications from (4)(a) and (4)(b) above shall be considered planar flaws and compared to the acceptance standards for volumetric examination in accordance with IWC-3400. Preservice acceptance standards shall be applied.

(6) Flaws exceeding the applicable acceptance standards shall be reduced to an acceptable size or removed and repaired, and the location of the repair shall be reexamined using the same ultrasonic examination procedure that detected the flaw.

(7) The ultrasonic examination shall be performed using encoded UT technology that produces an electronic record of the ultrasonic responses indexed to the

probe position, permitting off-line analysis of images built from the combined data.

(a) Where component configuration does not allow for effective examination for transverse flaws, (e.g. pipe-to-valve, tapered weld transition, weld shrinkage, etc.) the use of non-encoded UT technology may be used for transverse flaws. The basis for the non-encoded examination shall be documented.

(8) A written ultrasonic examination procedure qualified by performance demonstration shall be used. The qualification shall be applicable to the scope of the procedure, e.g., flaw detection and/or sizing (length and through-wall height), encoded or non-encoded, single and/or dual side access, etc. The procedure shall:

(a) contain a statement of scope that specifically defines the limits of procedure applicability (e.g. minimum and maximum thickness, minimum and maximum diameter, scanning access);

(b) specify which parameters are considered essential variables, and a single value, a range of values or criteria for selecting each of the essential variables;

(c) list the examination equipment, including manufacturer and model or series;

(d) define the scanning requirements, such as beam angles, scan patterns, beam direction, maximum scan speed, extent of scanning, and access;

(e) contain a description of the calibration method (i.e., actions required to ensure that the sensitivity and accuracy of the signal amplitude and time outputs of the examination system, whether displayed, recorded, or automatically processed, are repeated from examination to examination);

(f) describe the method and criteria for discrimination of indications (e.g., geometric versus flaw indications and surface versus subsurface indications); and

(g) describe the surface preparation requirements.

(9) Performance demonstration specimens shall conform to the following requirements:

(a) The specimens shall be fabricated from ferritic material with the same inside surface cladding process, if applicable, with the following exceptions:

(i) demonstration with shielded metal arc weld (SMAW) single-wire cladding is transferable to multiple-wire or strip-clad processes;

(ii) demonstration with multiple-wire or strip-clad is considered equivalent but is not transferable to SMAW type clad.

(b) The demonstration specimens shall contain a weld representative of the joint to be ultrasonically examined, including the same welding processes.

(c) The demonstration set shall include specimens not thicker than 0.1 in. (2.5 mm) more than the minimum thickness, nor thinner than 0.5 in. (13 mm) less than the maximum thickness for which the examination procedure is applicable. The demonstration set shall include the minimum, within ½ nominal pipe size (NPS), and maximum pipe diameters for which the examination procedure is applicable. If the procedure is applicable to outside diameter (O.D.) piping of 24 in. (600 mm) or larger, the specimen set must include at least one specimen 24 in. O.D. (600 mm) or larger but need not include the maximum diameter.

(d) The demonstration specimen scanning and weld surfaces shall be representative of the surfaces to be examined.

(e) The demonstration specimen set shall include geometric conditions that require discrimination from flaws (e.g., counterbore, weld root conditions, or weld crowns) and limited scanning surface conditions for single-side access, when applicable.

(f) The demonstration specimens shall include both planar and volumetric fabrication flaws (e.g., lack of fusion, crack, incomplete penetration, inclusions) representative of the welding process or processes of the welds to be examined. The flaws shall be distributed throughout the examination volume.

(g) Specimens shall be divided into grading units, flawed and unflawed.

(i) Flawed grading units shall be the actual flaw length, plus a minimum of 0.25 in. (6 mm) on each end of the flaw. Unflawed grading units shall be at least 1 in. (25 mm).

(ii) The number of unflawed grading units shall be at least 1-1/2 times the number of flawed grading units.

(h) Demonstration specimen set flaw distribution shall be as follows:

(i) For thickness greater than 0.50 in. (13mm); at least 20% of the flaws shall be distributed in the outer third of the specimen through-wall thickness, at least 20% of the flaws shall be distributed in the middle third of the specimen through-wall thickness and at least 40% of the flaws shall be distributed in the inner third of the specimen through-wall thickness. For thickness 0.50 in. (13mm) and less, at least 20% of the flaws shall be distributed in the outer half of the specimen

through-wall thickness and at least 40% of the flaws shall be distributed in the inner half of the specimen through wall thickness.

(ii) At least 30% of the flaws shall be classified as surface planar flaws in accordance with IWA-3310. At least 40% of the flaws shall be classified as subsurface planar flaws in accordance with IWA-3320.

(iii) At least 50% of the flaws shall be planar type flaws, such as lack of fusion, incomplete penetration, or cracks. At least 20% of the flaws shall be volumetric type flaws, such as slag inclusions.

(iv) The flaw through-wall heights shall be based on the applicable acceptance standards for volumetric examination in accordance with IWC-3400. At least 30% of the flaws shall be classified as acceptable planar flaws, with the smallest flaws being at least 50% of the maximum allowable size based on the applicable a/l aspect ratio for the flaw. Additional smaller flaws may be included in the specimens to assist in establishing a detection threshold, but shall not be counted as a missed detection if not detected. At least 30% of the flaws shall be classified as unacceptable in accordance with the applicable acceptance standards. Welding fabrication flaws are typically confined to a height of a single weld pass. Flaw through-wall height distribution shall range from approximately 1 to 4 weld pass thicknesses, based on the welding process used.

(v) When applicable, at least two flaws but no more than 30% of the flaws shall be oriented perpendicular to the weld fusion line and the remaining flaws shall be circumferentially oriented.

(vi) For demonstration of single-side-access capabilities, at least 30% of the flaws shall be located on the far side of the weld centerline and at least 30% of the planar flaws shall be located on the near side of the weld centerline. The remaining flaws shall be distributed on either side of the weld.

(10) Ultrasonic procedures shall be qualified by performance demonstration in accordance with the following requirements.

(a) The procedure shall be demonstrated using either a blind or a non-blind demonstration.

(b) The use of the non-blind performance demonstration is used to assist in optimizing the examination procedure. When applying the non-blind demonstration process, personnel have access to limited knowledge of specimen flaw information during the demonstration process. The non-blind demonstration process consists of an initial demonstration without any flaw information, an assessment of the results and feedback of the performance provided to the qualifying candidate. After an assessment of

the initial demonstration results, limited flaw information may be shared with the candidate, as part of the feedback process, to assist in enhancing the examination procedure to improve the procedure performance. In order to maintain the integrity of the specimens for blind personnel demonstrations, only generalities of the flaw information may be provided to the candidate. Procedure modifications or enhancements made to the procedure, based on the feedback process, shall be applied to all applicable specimens based on the scope of the changes.

(c) Objective evidence of a flaw's detection, length and through-wall height sizing, in accordance with the procedure requirements, must be provided to the organization administering the performance demonstration.

(d) The procedure demonstration specimen set shall be representative of the procedure scope and limitations (e.g., thickness range, diameter range, material, access, surface condition).

(e) As a minimum, the demonstration set shall include specimens to represent the minimum and maximum diameter and thickness covered by the procedure. When the procedure spans a range of diameters and thicknesses, additional specimens shall be included in the set to demonstrate the effectiveness of the procedure throughout the entire range.

(f) The procedure demonstration specimen set shall include at least 30 flaws and shall meet the requirements of (9) above.

(g) Procedure performance demonstration acceptance criteria

(i) To be qualified for flaw detection, all flaws in the demonstration set that are ≥ 50% of the maximum allowable size, based on the applicable a/l aspect ratio for the flaw, shall be detected. In addition, when performing blind procedure demonstrations, no more than 20% of the non-flawed grading units shall contain a false call. Any non-flaw condition (geometry, etc.) reported as a flaw shall be considered a false call.

(ii) To be qualified for flaw length sizing, the root mean square (RMS) error of the flaw lengths estimated by ultrasonics, as compared with the true lengths, shall not exceed 0.25 in. (6 mm) for NPS diameters of 6.0 in. (152 mm) and less, and 0.75 in. (18 mm) for diameters greater than 6.0 in. (152 mm) NPS.

(iii) To be qualified for flaw through-wall height sizing, the RMS error of the flaw through-wall heights estimated by ultrasonics, as compared with the true through-wall heights, shall not exceed 0.125 in. (3 mm).

(iv) RMS error shall be calculated as follows:

$$RMS = \left[ \frac{\sum_{i-1}^{n} (m_i - t_i)^2}{n} \right]^{1/2}$$

Where

$m_i$ = measured flaw size

$t_i$ = true flaw size

$n$ = number of flaws measured

(h) Changing essential variables may be accomplished during successive personnel performance demonstrations. Each examiner need not demonstrate qualification over the entire range of every essential variable.

(11) Ultrasonic examination personnel shall be qualified in accordance with IWA-2300. In addition, examination personnel shall demonstrate their capability to detect and size flaws by performance demonstration using the qualified procedure in accordance with the following requirements:

(a) The personnel demonstration shall be conducted in a blind fashion (flaw information is not provided).

(i) The demonstration specimen set shall contain at least 10 flaws and shall meet the flaw distribution requirements of (9)(h) above, with the exception of (9)(h)(v). When applicable, at least one flaw but no more than 20% of the flaws shall be oriented perpendicular to the weld fusion line and the remaining flaws shall be circumferentially oriented.

(b) Personnel performance demonstration acceptance criteria:

(i) To be qualified for flaw detection, personnel demonstration shall meet the requirements of the following table for both detection and false calls. Any non-flaw condition (geometry, etc.) reported as a flaw shall be considered a false call.

(ii)

| Performance Demonstration Detection Test Acceptance Criteria | | | |
|---|---|---|---|
| **Detection Test Acceptance Criteria** | | **False Call Test Acceptance Criteria** | |
| **No. of Flawed Grading Units[1]** | **Minimum Detection Criteria** | **No. of Unflawed Grading Units** | **Maximum Number of False Calls** |
| 10 | 8 | 15 | 2 |
| 11 | 9 | 17 | 3 |
| 12 | 9 | 18 | 3 |
| 13 | 10 | 20 | 3 |
| 14 | 10 | 21 | 3 |
| 15 | 11 | 23 | 3 |
| 16 | 12 | 24 | 4 |
| 17 | 12 | 26 | 4 |
| 18 | 13 | 27 | 4 |
| 19 | 13 | 29 | 4 |
| 20 | 14 | 30 | 5 |
| **Note 1**: Flaws ≥ 50% of the maximum allowable size, based on the applicable a/l aspect ratio for the flaw. | | | |

(iii) To be qualified for flaw length sizing, the RMS error of the flaw lengths estimated by ultrasonics, as compared with the true lengths, shall not exceed 0.25 in. (6 mm) for NPS diameters of 6.0 in. (152 mm) and less, and 0.75 in. (18 mm) for diameters greater than 6.0 in. (152 mm) NPS.

(iv) To be qualified for flaw through-wall height sizing, the RMS error of the flaw through-wall heights estimated by ultrasonics, as compared with the true through-wall heights, shall not exceed 0.125 in. (3 mm).

(12) Documentation of the qualifications of procedures and personnel shall be maintained. Documentation shall include identification of personnel, NDE procedures, equipment and specimens used during qualification, and results of the performance demonstration.

(13) The pre-service examinations will be performed per ASME Section XI (Reference 4)

5.2 Basis for Use

The overall basis for this proposed alternative is that encoded PAUT is equivalent or

superior to RT for detecting and sizing critical (planar) flaws. In this regard, the basis for the proposed alternative was developed from numerous codes, code cases, associated industry experience, articles, and the results of RT and encoded PAUT examinations.

## 6. Duration of Proposed Alternative

DNC requests approval of this alternative request for the remainder of the third 10-year inservice inspection interval for MPS3 that began on April 23, 2009 and is scheduled to end on April 22, 2019.

## 7. Conclusion

10 CFR 50.55a(z) states:

"Alternatives to the requirements of paragraphs (b) through (h) of this section or portions thereof may be used when authorized by the Director of the Office of Nuclear Reactor Regulation, or Director, Office of New Reactors, as appropriate. A proposed alternative must be submitted and authorized prior to implementation. The applicant or licensee must demonstrate that:

(1) The proposed alternatives would provide an acceptable level of quality and safety, or

(2) Compliance with the specified requirements of this section would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety."

The proposed alternative discussed in this alternative request is in accordance with 10 CFR 50.55a(z)(1), in that the proposed alternative would provide an acceptable level of quality and safety.

## 8. Precedents

8.1 Oconee Request for Relief No. 2006-ON-001, dated June 20, 2006; requested an alternative for examination of butt welds between the Pressurizer Level and Sample Tap nozzles and their respective Safe Ends. The reason for the request was based on the difficulty to perform the code required radiography. The alternative was to perform ultrasonic examination per similar requirements to Code Case N- 659-0.

8.2 Wolf Creek 10 CFR 50.55a Request ET 06-0029, dated September 1, 2006; requested an alternative for examination of main steam and feedwater piping welds being replaced due to flow assisted corrosion. The reason for the

request was based on the acceptability of the proposed ultrasonic examination alternative process, radiation exposure reduction, outage costs and duration, and radiography exposure risk. (ML062500093)

8.3 Palo Verde Nuclear Generating Station Relief Request 48, dated August 1, 2012 (ML12229A046). NRC approval dated April 12, 2013 (ML13091A177).

8.4 Millstone Power Station Unit 2 Alternative Request RR-04-16, dated August 1, 2013 (ML13220A019). NRC approval dated April 4, 2014 (ML14091A973).

8.5 Millstone Power Station Unit 2 Alternative Request RR-04-21, dated October 6, 2014 (ML14283A128). NRC approval dated September 21, 2015 (ML 15257A005).

8.6 Millstone Power Station Unit 3 Alternative Request IR-3-25, dated October 6, 2014, (ML14283A128). NRC approval dated September 21, 2015 (ML 15257A005).

## 9. References

1. ASME Section III Code Case N-659-2, "Use of Ultrasonic Examination in Lieu of Radiography for Weld Examination Section III, Divisions 1 and 3," dated June 9, 2008
2. Pacific Northwest National Laboratory Report PNNL-19086, "Replacement of Radiography with Ultrasonics for the Nondestructive Inspection of Welds - Evaluation of Technical Gaps - An Interim Report," dated April 2010
3. ASME B31.1, Case 168, "Use of Ultrasonic Examination in Lieu of Radiography for B31. 1 Application," dated June 1997
4. ASME Section III and XI 2004 Edition, No Addenda
5. ASME Section III Code Case N-818, "Use of Analytical Evaluation approach for Acceptance of Full Penetration Butt Welds in Lieu of Weld Repair," dated December 6, 2011
6. ASME Code Case 2235-9, 2005; "Use of Ultrasonic Examination in Lieu of Radiography Section I, Section VIII, Divisions 1 and 2, and Section XII," dated October 11
7. Journal of Pressure Vessel Technology, "Technical Basis for ASME Section VIII Code Case 2235 on Ultrasonic Examination of Welds in Lieu of Radiography;" Rana, Hedden, Cowfer and Boyce, Volume 123, dated August 2001
8. ASME Code Case 2326, "Ultrasonic Examination in Lieu of Radiographic Examination for Welder Qualification Test Coupons Section IX," dated January 20, 2000
9. ASME Code Case 2541, "Use of Manual Phased Array Ultrasonic Examination Section V," dated January 19, 2006
10. ASME Code Case 2558, "Use of Manual Phased Array E-Scan Ultrasonic Examination Per Article 4 Section V," dated December 30, 2006

11. ASME Code Case 2599, "Use of Linear Phased Array E-Scan Ultrasonic Examination Per Article 4 Section V," dated January 29, 2008
12. ASME Code Case 2600, "Use of Linear Phased Array S-Scan Ultrasonic Examination Per Article 4 Section V," dated January 29, 2008
13. ASME Section XI, Code Case N-713, "Ultrasonic Examination in Lieu of Radiography," dated November 10, 2008
14. EPRI presentation, "Ultrasonic Capability Study for Reduction of Weld Repair During the Construction-UT Technical Presentation," dated May 2010