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

February 25, 2019

Mr. David B. Hamilton
Site Vice President
FirstEnergy Nuclear Operating Company
Mail Stop A-PY-A290
P.O. Box 97, 10 Center Road
Perry, OH 44081-0097

SUBJECT: PERRY NUCLEAR POWER PLANT, UNIT NO. 1 - REQUEST FOR ALTERNATIVE TO USE ASME CODE CASE N-831 (EPID L-2018-LLR-0119)

Dear Mr. Hamilton:

By letter dated September 7, 2018, FirstEnergy Nuclear Operating Company (FENOC) submitted a request to the U.S. Nuclear Regulatory Commission (NRC) for an alternative to certain requirements in American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), Section XI, "Rules for inservice Inspection of Nuclear Power Plant Components," at Perry Nuclear Power Plant, Unit No. 1. Specifically, FENOC requested to use ASME Code Case N-831, "Ultrasonic Examination in Lieu of Radiography for Welds in Ferritic Pipe, Section XI, Division 1."

Pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) 50.55a(z)(1), FENOC requested to use the proposed alternative on the basis that it provides an acceptable level of quality and safety.

The NRC staff has reviewed the subject request and concludes, as set forth in the enclosed safety evaluation, that FENOC has adequately addressed all of the regulatory requirements set forth in 10 CFR 50.55a(z)(1). Therefore, the NRC staff authorizes the use of Request IR-061 for the remainder of the third 10-year inservice inspection interval and for the entire fourth 10-year inservice inspection interval at Perry Nuclear Power Plant, Unit No. 1.

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.

Sincerely,

David J. Wrona, Branch Chief
Plant Licensing Branch III
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-440

Enclosure: Safety Evaluation

cc: Listserv

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

REQUEST IR-061

ULTRASONIC EXAMINATION IN LIEU OF RADIOGRAPHIC EXAMINATION OF WELDS IN FERRITIC PIPING

FIRSTENERGY NUCLEAR OPERATING COMPANY

PERRY NUCLEAR POWER PLANT, UNIT NO. 1

DOCKET NO. 50-440

1.0 INTRODUCTION

By letter dated September 7, 2018 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML18253A007), FirstEnergy Nuclear Operating Company (FENOC, the licensee), proposed an alternative to the requirements of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components," paragraphs IWA-4221 and IWA-4540(a)(2). As an alternative, the licensee submitted request IR-061, Revision 0, to use phased array ultrasonic testing (PAUT) in lieu of the required radiographic testing (RT) in the examination of welds in ferritic piping as part of repair and replacement activities at Perry Nuclear Power Plant, Unit No. 1 (PNPP).

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 alternative would provide an acceptable level of quality and safety.

2.0 REGULATORY EVALUATION

Adherence to Section XI of the ASME Code is mandated by 10 CFR 50.55a(g)(4), which states, in part, that ASME Code Class 1, 2, and 3 components will meet the requirements, except the design and access provisions and the pre-service examination requirements, set forth in the ASME Code, Section XI.

Paragraph (z) of 10 CFR 50.55a 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 Commission) if: (1) the proposed alternative 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 for the Commission to authorize, the alternative requested by the licensee.

3.0 TECHNICAL EVALUATION

3.1 Request IR-061

3.1.1 ASME Code Components Affected

The affected components are repair and replacement welds in ASME Code Class 1, 2, and 3 ferritic piping.

3.1.2 Applicable Code Edition and Addenda

The applicable codes of record are the ASME Code, Section XI, 2001 Edition through 2003 Addenda, for the third inservice inspection (ISI) interval, and the 2013 Edition for the fourth ISI interval.

3.1.3 Applicable Code Requirements

Paragraph IWA-4221 of the 2001 Edition through 2003 Addenda and the 2013 Edition of the ASME Code, Section XI, requires the owner to meet the applicable owner's requirements and Construction Code requirements when performing repair and replacement activities.

Subsubarticle IWA-4520 of the 2001 Edition through 2003 Addenda and the 2013 Edition of Section XI requires that welding or brazing areas and welded joints made for fabrication or installation of items be examined in accordance with the Construction Code identified in the Repair/Replacement Plan with certain specified exceptions. The examination requirements for the welds are contained in the ASME Code, Section III, subarticles NB-5200, NC-5200, and ND-5200.

Paragraph 10 CFR 50.55a(b)(2)(xx)(B), "System leakage tests: Second provision," requires that the nondestructive examination (NDE) provision in IWA-4540(a)(2) of the 2002 Addenda of Section XI be applied when performing system leakage tests after repair and replacement activities performed by welding or brazing on a pressure retaining boundary using the 2003 Addenda through the latest edition and addenda incorporated by reference in subparagraph IWA-4540(a)(1)(ii).

Subparagraph IWA-4540(a)(2) of the 2002 Addenda of the ASME Code, Section XI, requires, in part, that the NDE method and acceptance criteria of the 1992 Edition or later of the ASME Code, Section III, be met prior to return to service.

3.1.4 Reason for Request

The licensee stated that it periodically replaces piping in support of the Flow Accelerated Corrosion program and other repair and replacement activities. The use of encoded PAUT in lieu of 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 personnel exposure. The PAUT minimizes the impact on other outage activities normally involved with performing RT such as limited access to work locations and the need to

control system fluid fill status. The licensee explained that RT requires piping to remain fluid empty for adequate examination sensitivity and resolution. According to the licensee, encoded PAUT is equivalent or superior to the code-required RT for ASME ferritic piping repair and replacement welds for detecting and sizing critical (planar) flaws, such as cracks and lack of fusion. The PAUT provides sizing capabilities for both depth and length dimensions of a flaw, which are required to apply the acceptance criteria of the applicable code case. The licensee indicated that RT does not provide depth sizing capabilities.

The licensee further stated that the provisions in the ASME Code, Section XI, IWA-4520(b)(2) and IWA-4521 of the 2008 Addenda through the latest edition allowing the substitution of UT for RT specified in the Construction Code are not approved per 10 CFR 50.55a(b)(2)(xix).

3.1.5 Proposed Alternative

The licensee proposed to perform encoded PAUT in accordance with ASME Code Case N-831 "Ultrasonic Examination in Lieu of Radiography for Welds in Ferritic Pipe, Section XI, Division 1," in lieu of the ASME Code-required RT when it repairs or replaces welds in Class 1, 2, and 3 ferritic piping in accordance with the ASME Code, Section XI, paragraphs IWA-4221, IWA-4520, and IWA-4540(a)(2), and ASME Code, Section III, subarticles NB-5200, NC-5200, and ND-5200.

3.1.6 Basis for Use

The licensee stated that similar PAUT techniques are being used throughout the nuclear industry for examination of dissimilar metal welds, overlaid welds, and other applications including ASME B31.1 piping replacements. The licensee further stated that the NRC has recognized that PAUT provides an equally effective examination for identifying the presence of fabrication flaws in carbon steel welds to that of radiography. Encoded PAUT is equivalent or superior to RT for detecting and sizing critical (planar) flaws. The industry developed the basis for the proposed alternative from numerous codes, code cases, associated industry experience, articles, and the results of RT and encoded PAUT examinations. The examination procedure and personnel performing examinations are qualified using representative piping conditions and flaws that demonstrate the ability to detect and size flaws that are both acceptable and unacceptable to the defined acceptance standards. The licensee stated that the demonstrated ability of the examination procedure and personnel to appropriately detect and size flaws provides an acceptable level of quality and safety.

3.1.7 Duration of Proposed Alternative

The licensee requested the proposed alternative for the third and fourth 10-year ISI intervals. The third ISI interval began on May 18, 2009, and is scheduled to end on May 17, 2019. The fourth ISI interval is scheduled to begin on May 18, 2019, and end on May 17, 2029.

3.2 NRC Staff Evaluation

3.2.1 Background

The NRC staff notes that ASME Code, Section XI, subarticle IWA-4200, provides provisions for repair/replacement activities. Paragraph IWA-4221 requires that when an existing piping item such as a weld is repaired or replaced, the repair and replacement shall satisfy the requirements of the Construction Code to which the original item was constructed. As part of

repair and replacement activities, the ASME Code, Section XI, paragraphs IWA-4221 and IWA-4540(a)(2), require the use of ASME Code, Section III subarticles, which specify the use of RT to examine the repaired or replaced welds.

The licensee proposed to use encoded PAUT in lieu of RT for repair and replacement activities. Ultrasonic testing (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 in the welds. These differences in physical mechanisms result in several key differences in sensitivity and discrimination capability between UT and RT.

The NRC staff has assessed the differences between UT and RT to determine the effectiveness of the use of UT in lieu of RT since 2009. The NRC staff, with the assistance from the Pacific Northwest National Laboratory (PNNL), has reviewed literature, evaluated the technical bases in previous relief requests and proposed alternatives, and performed confirmatory experimental tests to validate the findings.

In 2015, the NRC, in cooperation with PNNL, published the study in NUREG/CR-7204, "Applying Ultrasonic Testing In Lieu of Radiography for Volumetric Examination of Carbon Steel Piping" (ADAMS Accession No. ML15253A674). This report evaluated the use of UT in lieu of RT for welded pipes and plates with thicknesses ranging from 0.844 inches to 2.2 inches.

In NUREG/CR-7204, the NRC staff stated that:

> Considering overall detections/non-detections for the piping specimens, as well as the Navy plates, it appears that [phased array ultrasonic inspection] PA-UT, 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.

NUREG/CR-7204 explained that the PA-UT parameters were slightly less effective to detect small volumetric flaws than RT because the amplitude threshold in the study was set to eliminate the need to analyze many very small reflectors. This does not mean that PA-UT performed in the field is less effective than RT in detecting small volumetric flaws.

Based on this study, the NRC staff finds that there is a sufficient technical basis for the use of UT in lieu of RT for welds in ferritic steel piping. Given that UT in lieu of RT can be effective, the NRC staff considered whether the proposed alternative (i.e., use of Code Case N-831) in Request IR-061 applies UT in a way that provides reasonable assurance of finding structurally significant flaws.

The ASME Code committees approved ASME Code Case N-831 on October 20, 2016. However, the NRC has not yet approved this Code Case for generic use. Code Case N-831 includes requirements for personnel and procedure qualification, specimen description, and requirements for demonstrating the effectiveness of the ultrasonic examination procedure.

3.2.2 Evaluation

To evaluate the alternative request (i.e., ASME Code Case N-831), the NRC staff used NUREG/CR-7204, the 2013 Edition of the ASME Code, Section XI, Appendix VIII, and industry's Performance Demonstration Initiative (PDI).

The NRC staff notes that the U.S. nuclear utilities created the PDI program to implement performance demonstration requirements of the ASME Code, Section XI, Appendix VIII. The industry's PDI program qualifies equipment, procedures, and personnel in accordance with the UT criteria of Appendix VIII. The Electric Power Research Institute (EPRI) maintained a performance demonstration program (the precursor to the PDI program) under the Tri-party Agreement with the NRC, Boiling Water Reactor Owner's Group, and EPRI, as discussed in the NRC letter dated July 3, 1984 (ADAMS Legacy Library Accession No. 8407090122). The NRC staff recognizes that the PDI program does not fully comport with the requirements of the ASME Code, Section XI, Appendix VIII. However, through various public meetings between the industry and NRC, the staff has determined that the PDI program provides an acceptable level of quality and safety. The staff routinely assesses the PDI program for consistency with the current ASME Code and proposed changes. The NRC staff and industry hold periodic meetings to discuss the adequacy of the PDI program because the PDI program is continuously evolving and improving based on operating experience from nuclear power plants.

The NRC staff notes that Appendix VIII of the 2013 Edition of the ASME Code, Section XI, does not have provisions for the performance demonstration of UT in lieu of RT. Supplement 3 of Appendix VIII of the 2013 Edition of the ASME Code, Section XI, does provide provisions for qualification requirements of ferritic piping welds.

The provisions in ASME Code Case N-831 are divided into paragraphs from (a) to (k). As part of its evaluation, the NRC staff grouped the paragraphs of the Code Case in various categories as shown below, such as general requirements, examination coverage, disposition of flaws, equipment qualification, procedure qualification, specimen requirements, conduct of performance demonstration, acceptance criteria, and personnel qualification. These categories represent the significant aspects of the UT examinations and mimic the categories in various supplements in the ASME Code, Section XI, Appendix VIII.

3.2.2.1 General Requirements

Paragraph (a) of ASME Code Case N-831 states, "Use of this [Code] Case is limited to welds made as part of a repair/replacement activity and is subject to review by the Authorized Inspection Agency."

Paragraph (b) states, "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 [millimeter] mm) gap between the search unit and the scanning surface."

Paragraph (c) states, "Ultrasonic examination shall be performed using equipment, procedures, and personnel qualified by performance demonstration as described in this Case."

The NRC finds that the proposed paragraph (a) is acceptable because: (1) RR IR-061 and ASME Code Case N-831 clearly identify the scope of application, i.e., the proposed alternative is applicable to the repaired or replaced welds, and (2) the licensee has submitted RR IR-061 for NRC review and approval. In addition, RR IR-061 states that the affected components are

repair and replacement welds of ASME Code, Class 1, 2, and 3 ferritic piping. The NRC staff notes that Request IR-061 is not applicable to ASME/ANSI [American National Standards Institute] B31.1 and B31.7 piping even though some of them are ferritic piping. Also, the request is not applicable to stainless steel piping.

Regarding paragraph (b), the NRC staff notes that NUREG/CR-7204 recommends that all weld crowns be ground flush with surfaces of adjacent parent materials allowing UT scans to be performed over the weld. This approach will increase the probability of detecting flaws along all fusion zones and throughout the weld volume by enabling scanning to be accomplished from opposing parallel and perpendicular directions to the weld, and allowing zero-degree data to be collected for assisting flaw characterization. The NRC staff finds that paragraph (b) is acceptable because it requires the weld surface to be smooth such that the transducers have proper contact to obtain appropriate examination results.

The NRC staff finds that paragraph (c) is acceptable because it requires that the UT be qualified by performance demonstration which provides rigor and enhancement in the UT to improve detection and sizing of flaws.

3.2.2.2 Examination Coverage

Paragraph (d) of ASME Code Case N-831 states:

> The examination volume shall include 100% of the weld volume and the weld-to-base metal interface.
>
> (1) Angle beam examination of the complete examination volume for fabrication flaws oriented parallel to the weld joint shall be performed.
>
> (2) 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.
>
> (3) A supplemental straight beam examination shall be performed on the volume of base metal 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 the straight-beam portion of the procedure, is required to be qualified in accordance with Section V, Article 4.

For the routine weld examinations during inservice inspection, the NRC has accepted examination coverage of "essentially" 100 percent, which permits examination coverage volume to be less than 100 percent but be greater than 90 percent. However, paragraph (d) requires that the examination coverage volume be 100 percent. The NRC staff finds that 100 percent examination coverage is acceptable because it is more stringent than the essentially 100 percent. The NRC staff finds that the requirements for the angel beam examination are acceptable because they are consistent with the requirements of the ASME Code, Section V. Based on its evaluation, the NRC staff finds paragraph (d) and associated subparagraphs are acceptable.

3.2.2.3 Disposition of Flaws

Paragraph (e) of ASME Code Case N-831 states:

> All detected flaws from (d)(1) and (d)(2) above shall be considered planar flaws and shall be compared to the preservice acceptance standards for volumetric examination in accordance with Article IWB-3000, IWC-3000, or IWD-3000, as applicable. Analytical evaluation for acceptance of flaws in accordance with IWB-3600, IWC-3600, or IWD-3600 is permitted for flaws that exceed the applicable acceptance standards and are confirmed by surface or volumetric examination to be non-surface-connected.

Paragraph (f) states:

> Flaws exceeding the applicable acceptance standards, and analytical evaluation has not been performed for acceptance, 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.

The NRC staff finds that paragraphs (e) and (f) are acceptable because the provisions in these two subparagraphs are consistent with the requirements of dispositioning flaws in the ASME Code, Section XI, Articles IWB-3000, IWC-3000, and IWD-3000.

3.2.2.4 Equipment Qualification

Paragraph (g) of ASME Code Case N-831 states:

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

The NRC staff finds that paragraph (g) is acceptable because it requires encoded UT to be performed, which has the advantage of having an electronic record of the inspection results for off-line analysis. The NRC staff finds it acceptable that if UT cannot be performed for transverse flaws, non-encoded UT may be used because the non-encoded UT could still provide relevant information on potential flaws.

3.2.2.5 Procedure Qualification

Paragraph (h) of ASME Code Case N-831 states:

> 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 or sizing (length or through-wall height), encoded or non-encoded, single- or dual-side access.

Paragraph (h) includes seven subparagraphs (h)(1) through (h)(7) regarding procedure qualifications.

The NRC staff finds that paragraph (h) and associated subparagraphs (h)(1) through (h)(7) are acceptable because: (1) they are consistent with the ASME Code, Section XI, Appendix VIII, VIII-1100(b), which requires the owner to have a written procedure in accordance with the performance demonstration program for the ultrasonic examination, and (2) they require specific contents be included in the written procedure which are similar to the information as discussed in various Supplements of the ASME Code, Section XI, Appendix VIII.

3.2.2.6 Specimen Requirements

Paragraph (i) of ASME Code Case N-831 states:

> Performance demonstration specimens shall conform to the following requirements:
>
> (1) The specimens shall be fabricated from ferritic material with the same inside surface cladding process, if applicable, with the following exceptions:
>
> (a) Demonstration with shielded metal arc weld (SMAW) single-wire cladding is transferable to multiple-wire or strip-clad processes.
>
> (b) Demonstration with a multiple-wire or strip-clad process is considered equivalent but is not transferable to SMAW type cladding processes.

The NRC staff finds that subparagraphs (i)(1)(a) and (i)(1)(b) are acceptable because they are consistent with subarticles 2.1(c)(1) and 2.1(c)(2) of Supplement 4 of the ASME Code, Section XI, Appendix VIII. The NRC staff notes that Supplement 4 is related to the UT examination of welds in reactor vessels, not piping. However, ferritic piping is fabricated with similar low alloy steel as that of the reactor vessels. The provisions on the SMAW used in fabricating the reactor vessel are applicable to the ferritic piping. Therefore, the NRC staff finds that the provisions on fabricating the specimens used in Supplement 4 are applicable to the ferritic piping and to subparagraphs (i)(1)(a) and (b) of the Code Case.

Subparagraph (i)(2) states, "The demonstration specimens shall contain a weld representative of the joint to be ultrasonically examined, including the same welding processes."

Subparagraph (i)(3) states:

> The demonstration set shall include specimens not thicker than 0.1 inches (2.5 mm) more than the minimum thickness, nor thinner than 0.5 inches (13 mm) less than the maximum thickness for which the examination procedure is applicable. The demonstration set shall include the minimum, within $^1/_2$ of the nominal outside diameter, and maximum pipe diameters for which the examination procedure is applicable. If the procedure is applicable to piping of 24 inches (600 mm) O.D. [outer diameter] or larger, the specimen set must include at least one specimen 24 inches (600 mm) O.D. or larger but need not include the maximum diameter.

The NRC staff finds that subparagraph (i)(2) is acceptable because it requires the specimen be representative of the weld joint to be ultrasonically examined, including the same welding processes, in the demonstration specimen set.

The NRC staff notes that Supplement 3, "Qualification Requirements for Ferritic Piping Welds," of Appendix VIII to the ASME Code, Section XI, is applicable to ASME Code Case N-831. However, Supplement 3 specifies that Supplement 2 provisions shall be used with certain exception. Supplement 2 provides qualification requirements for wrought austenitic piping welds. Supplement 3 requires that the pipe specimen not be thinner than 1.0 inch less than the maximum thickness for which the examination procedure is applicable, whereas subparagraph (i)(3) of Code Case N-831 requires that the specimen not be thinner than 0.5 inch less than the maximum thickness. The NRC staff finds this difference is acceptable because subparagraph (i)(3) is more stringent than Supplement 3 of Appendix VIII. In addition, the staff finds that subparagraph (i)(3) is similar to paragraph 1.1(b) of Supplement 2 of Appendix VIII. Therefore, the NRC staff finds that subparagraph (i)(3) is acceptable.

Subparagraph (i)(4) states, "The demonstration specimen scanning and weld surfaces shall be representative of the surfaces to be examined."

Subparagraph (i)(5) states, "The demonstration specimen set shall include geometric conditions that require discrimination from flaws (e.g., counterbore, weld root conditions, weld crowns) and limited scanning surface conditions for single-side access, when applicable."

Subparagraph (i)(6) states, "The demonstration specimens shall include both planar and volumetric fabrication flaws (e.g., lack of fusion, crack, incomplete penetration, slag inclusions) representative welding process or processes of the welds to be examined. The flaws shall be distributed throughout the examination volume."

The NRC staff finds that subparagraph (i)(4) is acceptable because the demonstration specimen scanning and weld surface must be representative of the weld condition in the field to demonstrate the capability of the examination procedure and personnel.

The NRC staff finds that subparagraph (i)(5) is acceptable because its provision is similar to paragraph 1.1(c)(4) of Supplement 2 of Appendix VIII to the ASME Code, Section XI.

The NRC staff finds that subparagraph (i)(6) is acceptable because it requires fabrication flaws to be included in the specimens. The NRC staff notes that the proposed alternative is applicable to UT examination conducted right after the weld is repaired or replaced. Therefore, fabrication defects, not service-induced flaws, should be included in the specimens.

Specimen Grading Units

Subparagraph (i)(7) of ASME Code Case N-831 states:

> Specimens shall be divided into flawed and unflawed grading units as follows:
>
> (a) 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).

(b) The number of unflawed grading units shall be at least $1^1/_2$ times the number of flawed grading units.

The NRC staff finds that subparagraphs (i)(7), (i)(7)(a), and (i)(7)(b), are acceptable because: (1) the provision of unflawed grading units be at least 1 inch is the same as that of paragraph 1.2(a) of Supplement 2 of Appendix VIII to the ASME Code, Section XI, and (2) it is reasonable for the unflawed grading units be more than the flawed grading units in the sample because the repaired or replaced weld should not have many fabrication defects.

Distribution of Flaws in Specimens

Subparagraph (i)(8) of ASME Code Case N-831 states:

Demonstration specimen set flaw distribution shall be as follows:

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

(b) At least 30% of the flaws shall be classified as surface planar flaws in accordance with the ASME Code, Section XI, IWA-3310. At least 40% of the flaws shall be classified as subsurface planar flaws in accordance with IWA-3320.

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

(d) The flaw through-wall heights shall be based on the applicable acceptance standards for volumetric examination in accordance with IWB-3400, IWC-3400, or Article IWD-3000, as applicable. 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 [a = crack depth and ℓ = crack length] 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 one to four weld pass thicknesses, based on the welding process used.

(e) If 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.

(f) 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.

The NRC staff finds subparagraph (i)(8)(a) is acceptable because the flaw distribution required is similar to the flaw distribution in subarticles 1.2 and 1.3 of Supplement 2 to the ASME Code, Section XI, Appendix VIII.

The NRC staff notes that the percentage of flaws required in subparagraphs (i)(8)(b) and (i)(8)(c) are not consistent, but are in the range of percentage of flaws, with those in Supplements 2, 4, 10, and 14, of Appendix VIII to the ASME Code, Section XI. The NRC staff determines that the percentage of flaws in subparagraphs (i)(8)(b) and (i)(8)(c) are reasonable and suitable to be contained in the specimen sets. Therefore, the NRC staff finds that subparagraphs (i)(8)(b) and (i)(8)(c) are acceptable.

The NRC staff finds that subparagraph (i)(8)(d) is acceptable because the percentages of flaws are based on acceptable and unacceptable flaws, the flaw height is based on acceptance standards of subarticles IWB-3400, IWC-3400, and IWD-3400 of the ASME Code, Section XI, and the flaw height is also based on weld passes.

The NRC staff notes that subarticle 1.2(c)(2) of Supplement of Appendix VIII to the ASME Code, Section XI, requires that "At least one and a maximum of 10% of the flaws, rounded to the next higher whole number, shall be oriented axially. The remainder of the flaws shall be oriented circumferentially." Subparagraph (i)(8)(e) of the Code Case requires that at least two flaws, but no more than 30% of the flaws, be oriented perpendicular to the weld fusion line (axially), and the remaining flaws be circumferentially-oriented. The NRC staff finds subparagraph (i)(8)(e) requires more axial flaws in the specimen set than that of Supplement 2 of Appendix VIII. The NRC staff notes that axial flaws are harder to detect than circumferential flaws. Thus, more axial flaws in the specimen set will provide rigor to the UT procedure qualification. Based on its evaluation, the NRC staff finds that subparagraph (i)(8)(e) is acceptable.

The NRC staff notes that Supplement 4 of Appendix VIII provides provisions for single side access examinations without providing the flaw distribution in the specimen. The NRC staff finds that subparagraph (i)(8)(f) is acceptable because the flaws are distributed evenly in the weld, i.e., 30 percent of the flaws are distributed in the far side of the weld centerline, 30 percent of the flaws are distributed in the near side of the weld centerline, and the remaining 40 percent of the flaws are distributed in either side of the weld volume.

3.2.2.7 Conduct of Performance Demonstration

Paragraph (j) of ASME Code Case N-831 states:

> Ultrasonic examination procedures shall be qualified by performance demonstration in accordance with the following requirements.
>
> (1) The procedure shall be demonstrated using either a blind or a non-blind demonstration.

(2) The non-blind performance demonstration is used to assist in optimizing the examination procedure. When applying the non-blind performance demonstration process, personnel have access to limited knowledge of specimen flaw information during the demonstration process. The non-blind performance 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. 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.

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

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

(5) The demonstration set shall include specimens to represent the minimum and maximum diameter and thickness covered by the procedure. If 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.

(6) The procedure demonstration specimen set shall include at least 30 flaws.

The NRC staff notes that ASME Code, Section XI, Appendix VIII, and PDI program provide provisions for conducting performance demonstration. The NRC staff finds that subparagraph (j)(1) is acceptable in that the procedure qualification is demonstrated by either a blind or a non-blind demonstration because subparagraph (j)(2) provides specific requirements in conducting blind and non-blind demonstration. The NRC staff notes that the personnel qualification should be conducted by a blind demonstration as discuss in subparagraph (k)(1), which is evaluated in Section 3.2.2.9 below. The NRC staff finds that the proposed blind and non-blind demonstrations are similar to that of the PDI program.

The NRC staff finds that subparagraphs (j)(3), (j)(4), and (j)(5) are acceptable because the reporting requirements in these three subparagraphs are either similar to or consistent with those in various supplements in the ASME Code, Section XI, Appendix VIII.

The NRC staff finds that subparagraph (j)(6) is acceptable because it requires at least 30 flaws in the specimen set in the procedure demonstration. As a comparison, Supplement 10 of the ASME Code, Section XI, Appendix VIII, requires only 10 flaws. More flaws in the specimen set provide more rigor on the procedure demonstration.

3.2.2.8 Acceptance Criteria

Subparagraph (j)(7) of ASME Code Case N-831 states:

> Procedure performance demonstration acceptance criteria:
>
> (a) To be qualified for flaw detection, all flaws in the demonstration set that are not less than 50% of the maximum allowable size, based on the applicable a/ℓ [a = flaw depth; ℓ = flaw length] 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 may contain a false call. Any non-flaw condition (e.g., geometry) reported as a flaw shall be considered a false call.
>
> (b) To be qualified for flaw length sizing, the root mean square (RMS) error of the flaw lengths estimated by ultrasonic examinations, as compared with the true lengths, shall not exceed 0.25 in. (6 mm) for [nominal pipe size] NPS 6 (DN 150) and smaller, and 0.75 in. (18 mm) for larger than NPS 6 (DN 150).
>
> (c) To be qualified for flaw through-wall height sizing, the RMS error of the flaw through-wall heights estimated by ultrasonic examinations, as compared with the true through-wall heights, shall not exceed 0.125 in. (3 mm).
>
> (d) RMS error shall be calculated as follows:

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

where
m_i=measured flaw size
n=number of flaws measured
t_i=true flaw size

The NRC staff finds that subparagraph (j)(7)(a) is acceptable because it provides a requirement on the number of flaws that must be detected and it limits no more than 20 percent of the non-flawed grading units may contain a false call.

The NRC staff finds that subparagraph (j)(7)(b) is acceptable because the 0.75 inch RMS error for the length sizing for pipe greater than NPS 6 is consistent with paragraph 3.2(a) of Supplement 2 to Appendix VIII of the ASME Code, Section XI. In addition, subparagraph (j)(7)(b) is more stringent and restrictive than paragraph 3.2(a) of Supplement 2 because it requires a RMS of 0.25 inches for NPS 6 and smaller pipe.

The NRC staff finds that subparagraph (j)(7)(c) is acceptable because it is consistent with paragraph 3.2(b) of Supplement 2 to Appendix VIII of the ASME Code, Section XI, which requires an RMS error of 0.125 inches for the depth sizing.

The NRC staff finds that subparagraph (j)(7)(d) is acceptable because the RMS error equation in ASME Code Case N-831 is the same as that in Appendix VIII, subarticle VIII-3120, of the ASME Code, Section XI.

Subparagraph (j)(8) states, "Essential variables may be changed during successive personnel performance demonstrations. Each examiner need not demonstrate qualification over the entire range of every essential variable."

The NRC staff finds that subparagraph (j)(8) is acceptable because it is reasonable to expect that the essential variables of the UT are changed from time to time during successive personnel performance demonstration tests so that the examinees will not memorize the test setup for successive tests. However, each examiner may not need to be qualified over the entire range of every essential variable. This gives flexibility to the examiner when essential variables are changed often.

3.2.2.9 Personnel Qualification

Paragraph (k) of ASME Code Case N-831 states:

> Ultrasonic examination personnel shall be qualified in accordance with the ASME Code, Section XI, 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:
>
> (1) The personnel performance demonstration shall be conducted in a blind fashion (flaw information is not provided). The demonstration specimen set shall contain at least 10 flaws and shall meet the above flaw distribution requirements in paragraph (i)(8), with the exception of (i)(8)(e). 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.
>
> (2) Personnel performance demonstration acceptance criteria:
>
> (a) To be qualified for flaw detection, personnel performance demonstration shall meet the requirements of Table 1 [in ASME Code Case N-831] for both detection and false calls. Any non-flaw condition (e.g., geometry) reported as a flaw shall be considered a false call.
>
> (b) 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 6 (DN 150) and smaller, and 0.75 in. (18 mm) for larger than NPS 6 (DN 150).

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

The NRC staff finds that paragraph (k) and associated subparagraphs (k)(1), (k)(2), and (k)(2)(a) are acceptable because they are consistent with either the PDI program or the ASME Code, Section XI, Appendix VIII. Specifically, the NRC staff notes that the acceptance criteria for personnel qualification for detection and false calls in Table 1 of ASME Code Case N-831, as specified in subparagraph (k)(2)(a), are consistent with Table VIII-S10-1 of the ASME Code, Section XI, Appendix VIII, which provides acceptance criteria for personnel qualification for the UT examination of dissimilar metal piping welds. The NRC staff finds the personnel qualification for the UT examination of dissimilar metal piping welds is appropriate for the UT examination in ferritic piping because in both cases the qualification is to test the skills of the personnel in UT examination.

The NRC staff finds that paragraph (k)(2)(b) is acceptable because the RMS error of 0.75 inches for the flaw length is consistent with that of ASME Code Cases N-695 and N-696, which the NRC approved for use in Regulatory Guide 1.147, Revision 18 (ADAMS Accession No. ML16321A336). In addition, the NRC staff has previously accepted the RMS error of 0.25 inches for the pipe size NPS 6 inch and smaller in the review of a relief request for Millstone, North Anna, and Surry, dated January 24, 2018 (ADAMS Accession No. ML18019A195).

The NRC staff finds that paragraph (k)(2)(c) is acceptable because the RMS error for the through-wall height is consistent with that of ASME Code Cases N-695 and N-696, which the NRC approved for use in Regulatory Guide 1.147, Revision 18.

3.2.2.10 Demonstration Results

Paragraph (l) of ASME Code Case N-831 states:

> The owner is responsible for reviewing the procedures and demonstration results to validate that the ranges of the essential variables in the procedure were included in the demonstation.

The NRC staff finds that paragraph (l) is acceptable because the licensee is required to validate the range of the essential variables for the PA-UT to ensure the reliability of the volumetric examinations.

3.2.2.11 Documentation

Paragraph (m) of ASME Code Case N-831 states:

> Documentation of the qualifications of procedures and personnel shall be maintained by the Owner. Documentation shall include identification of personnel, NDE procedures, equipment, and specimens used during qualification, and results of the performance demonstration.

The NRC staff finds that paragraph (m) is acceptable because the documentation satisfies the documentation requirements of the ASME Code, Sections V and XI.

3.2.2.12 Summary

The NRC staff determines that based on PNNL's study, the latest UT technology is capable of and effective in detecting fabrication flaws in ferritic piping. As to performing the UT in the field, the NRC staff finds that ASME Code Case N-831 includes acceptable requirements for various qualifications such as equipment, procedure, and personnel, and performance demonstration. The Code Case requires 100-percent examination coverage of the weld volume and the weld-to-base metal interface. In addition, the use of the Code Case requires review by the NRC. Based on the provisions of ASME Code Case N-831, the NRC staff concludes that there is reasonable assurance that the encoded PAUT, applied and qualified as proposed by the licensee, will provide an acceptable level of quality and safety in the examinations of ASME Code Class 1, 2, and 3 piping welds as part of repair and replacement activities.

4.0 CONCLUSION

As set forth above, the NRC staff concludes that the licensee's proposed alternative to use UT in lieu of RT provides reasonable assurance of structural integrity and leak tightness of Class 1, 2, and 3 ferritic piping welds. Thus, ultrasonic examination using the procedure described in Request IR-061 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, the NRC staff authorizes the use of Request IR-061 for the remainder of the third 10-year ISI interval and for the entire fourth 10-year ISI interval at PNPP.

The NRC staff notes that the approval of Request IR-061 does not imply or infer the NRC approval of ASME Code Case N-831 for generic use.

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.

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SUBJECT: PERRY NUCLEAR POWER PLANT, UNIT NO. 1 - REQUEST FOR ALTERNATIVE TO USE ASME CODE CASE N-831 (EPID L-2018-LLR-0119) DATED FEBRUARY 25, 2019

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