



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

July 19, 2019

Mr. Bryan C. Hanson  
Senior Vice President  
Exelon Generation Company, LLC  
President and Chief Nuclear Officer  
Exelon Nuclear  
4300 Winfield Road  
Warrenville, IL 60555

SUBJECT: CALVERT CLIFFS NUCLEAR POWER PLANT, UNITS 1 AND 2 – ISSUANCE  
OF RELIEF REQUEST I5R-04 RE: USE OF ENCODED PHASED ARRAY  
ULTRASONIC EXAMINATION TECHNIQUES (EPID L-2018-LLR-0391)

Dear Mr. Hanson:

By letter dated December 19, 2018 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML18354A431), as supplemented by letter dated April 15, 2019 (ADAMS Accession No. ML19106A003), Exelon Generation Company, LLC (the licensee) submitted a request to the U.S. Nuclear Regulatory Commission (NRC) for the use of alternatives to certain American Society of Mechanical Engineers Boiler & Pressure Vessel Code (ASME Code) Section XI requirements at Calvert Cliffs Nuclear Power Plant, Units 1 and 2 (Calvert Cliffs). The purpose of this letter is to provide the results of the NRC staff's review of the proposed alternative identified as Relief Request (RR) I5R-04, Revision 0. The NRC staff provided separate correspondence regarding the other two requests (i.e., RRs I5R-03 and I5R-05) in the licensee's letter dated December 19, 2018.

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. In RR I5R-04, Revision 0, the licensee proposed to use encoded phased array ultrasonic examination techniques in lieu of the ASME Code-required radiography examinations for inservice inspection Class 1 and 2 ferritic piping repair or replacement welds.

As set forth in the enclosed safety evaluation, the NRC staff concludes that the licensee's proposed alternative to use ultrasonic testing in lieu of radiographic testing using encoded phased array examinations provides reasonable assurance of structural integrity and leaktightness of Class 1 and 2 ferritic piping welds. Thus, ultrasonic testing of the subject welds using the procedure described in the licensee's letters dated December 19, 2018, and April 15, 2019, would provide an adequate level of quality and safety. Accordingly, the NRC staff concludes that the licensee has adequately addressed all the regulatory requirements set forth in 10 CFR 50.55a(z)(1). Therefore, the NRC staff authorizes RR I5R-04 for Calvert Cliffs for the remainder of the fifth 10-year inspection interval, which is scheduled to end on June 30, 2029.

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.

B. Hanson

- 2 -

If you have any questions, please contact the Calvert Cliffs Project Manager, Michael L. Marshall, Jr., at (301) 415-2871 or by e-mail to [Michael.Marshall@nrc.gov](mailto:Michael.Marshall@nrc.gov).

Sincerely,

*/RA/*

James G. Danna, Chief  
Plant Licensing Branch I  
Division of Operating Reactor Licensing  
Office of Nuclear Reactor Regulation

Docket Nos. 50-317 and 50-318

Enclosure:  
Safety Evaluation

cc: Listserv



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

RELIEF REQUEST NO. I5R-04, REVISION 0

EXELON GENERATION COMPANY, LLC

CALVERT CLIFFS NUCLEAR POWER PLANT, UNIT NOS. 1 AND 2

DOCKET NOS. 50-317 AND 50-318

1.0 INTRODUCTION

By letter dated December 19, 2018 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML18354A431), as supplemented by letter dated April 15, 2019 (ADAMS) Accession No. ML19106A003), Exelon Generation Company, LLC (the licensee) submitted an alternative to request relief from the requirements of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (Code) Section XI, paragraph IWA-4221 for Calvert Cliffs Nuclear Plant, Units 1 and 2 (Calvert Cliffs). ASME Code Section XI, paragraph IWA-4221, requires the use of the ASME Code Section III, Subarticles NB-5200, NC-5200, and ND-5200, for repaired and replaced components, which in turn specify the use of radiographic examinations. The licensee is proposing to use phased array ultrasonic testing (UT) as an alternative to the required radiographic testing (RT).

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 REQUIREMENTS

The licensee has proposed an alternative, Relief Request (RR) I5R-04, Revision 0, to the requirements of ASME Code Section XI, paragraph IWA-4221. Section XI, paragraph IWA-4200, covers repair and replacement activities, and paragraph IWA-4221 requires the use of Section III, paragraphs NB-5200, NC-5200, and ND-5200, which require the use of radiographic examinations on Class 2 piping butt welds.

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

Based on the above, and subject to the following technical evaluation, the NRC staff finds that regulatory authority exists for the licensee to request and the Commission to authorize the alternative requested by the licensee.

### 3.0 TECHNICAL EVALUATION

#### 3.1 The Licensee's Relief Request

##### ASME Code Components Affected

All ASME Code Section XI, inservice inspection (ISI) Class 1 and 2 ferritic piping butt welds requiring radiography during repair or replacement activities are affected.

##### ASME Code of Record

The fifth 10-year interval of the Calvert Cliffs, Units 1 and 2, ISI program is based on the ASME Code Section XI, 2013 Edition.

##### ASME Code Requirement

The ASME Code Section XI, IWA-4221, requires that items used for repair or replacement activities meet the applicable owner's requirements and construction code requirements when performing repair/replacement activities. IWA-4520 requires that welded joints made for installation of items be examined in accordance with the construction code identified in the repair and replacement plan.

Section 50.55a(b)(2)(xx)(B) of 10 CFR states that:

The NDE [nondestructive examination] provision in IWA-4540(a)(2) of the 2002 Addenda of Section XI must 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 paragraph (a)(I)(ii) of this section.

IWA-4540(a)(2) of the 2002 Addenda of the ASME Code Section XI requires that the NDE and acceptance criteria of the 1992 Edition or later of the ASME Code Section III be met prior to return to service in order to perform a system leakage test in lieu of a system hydrostatic test. The examination requirements for the ASME Code Section III circumferential butt welds are contained in the ASME Code Section III, Subarticles NB-5200, NC-5200, and ND-5200. The acceptance standards for radiographic examination are specified in the ASME Code Section III, Subarticles NB-5300, NC-5300, and ND-5300.

##### Reason for Request

The licensee requested approval of this proposed alternative to support anticipated piping repair and replacement activities at Calvert Cliffs during the fifth ISI interval. Replacement of piping is periodically performed in support of the flow accelerated corrosion program, as well as other repair and replacement activities. The use of encoded phased array ultrasonic examination techniques (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 personnel exposure. 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 fill status because RT would require a line to remain empty of fluid to obtain adequate examination sensitivity and resolution. In addition, encoded PAUT has been demonstrated to be adequate for detecting and sizing critical flaws.

### Proposed Alternative

The licensee is proposing the use of encoded PAUT in lieu of the ASME Code-required RT examinations for ISI Class 1 and 2 ferritic piping repair and replacement welds at Calvert Cliffs. Similar techniques are being used throughout the nuclear industry for examination of dissimilar metal welds and overlaid welds, as well as other applications, including ASME B31.1 piping replacements. This proposed alternative request includes requirements that provide an acceptable level of quality and safety that satisfy the requirements of 10 CFR 50.55a(z)(l). The examinations will be performed using personnel and procedures qualified with the requirements listed below.

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.

Elements of the proposed alternative examination include:

- The welds to be examined shall meet the surface conditioning requirements of the demonstrated ultrasonic procedure.
- The welds to be examined shall be conditioned such that transducers properly couple with the scanning surface with no more than a 1/32 inch (0.8 millimeter) gap between the search unit and the scanning surface.
- The ultrasonic examination shall be performed with equipment, procedures, and personnel qualified by performance demonstration.
- The examination volume shall include 100 percent of the weld volume and the weld-to-base metal interface.
- All detected fabrication flaw indications listed below shall be considered planar flaws and compared to the preservice acceptance standards for volumetric examination in accordance with IWB-3000, IWC-3000, or IWD-3000. Preservice acceptance standards shall be applied. 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.
  - Angle beam examination of the complete examination volume for fabrication flaws oriented parallel to the weld joint shall be performed.
  - 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.

- Flaws exceeding the applicable acceptance standards, and when 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 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 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 or through-wall height), encoded or non-encoded, single and/or dual side access, etc.).
- Performance demonstration specimens shall conform to a list of requirements related to fabrication, geometry, flaw direction, size, and distribution.
- Ultrasonic examination procedures shall be qualified by performance demonstration in accordance with the specific requirements.
- Ultrasonic examination personnel shall be qualified in accordance with ASME Code Section XI, IWA-2300.
- 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.
- The preservice examinations will be performed per ASME Section XI.

#### Basis for Use

The licensee is proposing that encoded phased array UT is equivalent to or superior for detecting and sizing critical (planar) flaws, as compared to the required radiographic examination. 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. It has been shown that PAUT provides an equally effective examination for identifying the presence of fabrication flaws in carbon steel welds compared to RT. 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 demonstrated ability of the examination procedure and personnel to appropriately detect and size flaws provides an acceptable level of quality and safety alternative as allowed by 10 CFR 50.55a(z)(1).

The requirements in the RR are based upon ASME Section XI, Code Case N-831 (N-831), and will apply to ISI ferritic piping butt welds requiring radiography during repair or replacement activities. N-831 was approved by the ASME Board on Nuclear Codes and Standards on October 20, 2016; however, it has not been incorporated into NRC Regulatory Guide 1.147, "Inservice Inspection Code Case Applicability, ASME Section XI, Division 1."

### Duration of Proposed Alternative

The licensee requested relief for the fifth ISI interval. Additionally, the licensee asked for relief for the remainder of the plant life for Calvert Cliffs, Units 1 and 2 or until the NRC approves ASME Code Case N-831, or a later revision, in Regulatory Guide 1.147 or another document during the interval. The NRC staff evaluation is limited to the fifth ISI interval.

### 3.2 Staff Evaluation

The licensee is proposing to update its use of encoded phased array UT in lieu of RT in RR I5R-04. UT, like RT, is a volumetric inspection technique that is commonly used to inspect welds in nuclear power plants and in other industries. Ultrasonic examinations are not equivalent to radiographic examinations, as they use different physical mechanisms to detect and characterize discontinuities. These differences in physical mechanisms result in several key differences in sensitivity and discrimination capability.

Code Case N-831 discusses ultrasonic examination in lieu of radiography for welds in ferritic piping; however, it has yet to be approved by the NRC and incorporated into the latest revision of Regulatory Guide 1.147. An assessment of the use of UT in lieu of RT by the NRC has been described in NUREG/CR-7204, "Applying Ultrasonic Testing In Lieu of Radiography for Volumetric Examination of Carbon Steel Piping" (ADAMS Accession No. ML15253A674), concluding that UT has the potential to replace RT for ferritic welds if done to a sufficient level of rigor. This report included evaluation on the use of UT in lieu of RT for welded pipes and plates with thicknesses ranging from 0.844 inches to 2.2 inches.

One conclusion from NUREG/CR-7204 is:

Considering overall detections/non-detections for the piping specimens, as well as the Navy plates, it appears that 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.

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

Some of the primary aspects of this proposed alternative include:

- The examination volume shall include 100 percent of the weld volume and the weld to-base metal interface.
- The electronic data files for the 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.
- Ultrasonic procedures shall be qualified by using either a blind or a non-blind performance demonstration using a minimum of 30 flaws covering a range of sizes, positions,

orientations, and types of fabrication flaws. The demonstration set shall include specimens to represent the minimum and maximum diameter and thickness covered by the procedure.

- The flaw through-wall heights shall be based on the applicable acceptance standards for volumetric examination in accordance with the ASME Code Section XI, IWB-3400, IWC-3400, or IWD-3400. At least 30 percent of the flaws shall be classified as acceptable planar flaws, with the smallest flaws being at least 50 percent of the maximum allowable size based on the applicable all aspect ratio for the flaw.
- Ultrasonic examination personnel shall demonstrate their capability to detect and size flaws by performance demonstration using the qualified procedure. The demonstration specimen set shall contain at least 10 flaws covering a range of sizes, positions, orientations, and types of fabrication flaws, particularly those covered in Section 9(h) of the licensee's submittal dated December 19, 2018.

The remaining aspects of the proposal are listed in Section 5.1, "Proposed Alternative," of the licensee's submittal dated December 19, 2018.

All flaws detected using angle-beam ultrasonic inspections will be treated as planar, and the flaws will be evaluated against the preservice acceptance standards of the ASME Code Section XI, IWB-3400, IWC-3400, or IWD-3400 for ASME Code Class 1, 2, or 3 welds, respectively, which are based on calculations to determine if the component is acceptable for service, not workmanship standards. The use of the ASME Code Section XI, IWB-3400, IWC-3400, and IWD-3400, has proven effective for piping welds for ISI. The NRC staff finds that the use of these acceptance standards is appropriate for the proposed alternatives, considering they are for repair and replacement activities. Based on the results of NUEG/CR-7204 and the work evaluated in the review of RR I5R-04, there is reasonable assurance that the encoded phased array UT qualified as proposed by the licensee will provide an adequate level of quality and safety.

#### 4.0 CONCLUSION

As set forth above, the NRC staff concludes that the licensee's proposed alternative to use UT in lieu of RT using encoded phased array examinations provides reasonable assurance of structural integrity and leaktightness of Class 1 and 2 ferritic piping welds. Thus, UT using the procedure described in the submittals of the subject welds would provide an adequate level of quality and safety. Accordingly, the NRC staff concludes that the licensee has adequately addressed all the regulatory requirements set forth in 10 CFR 50.55a(z)(1). Therefore, the NRC staff authorizes RR I5R-04 for Calvert Cliffs, Units 1 and 2 for, the remainder of the fifth 10-year ISI that is scheduled to end on June 30, 2029.

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

Principal Contributors: Austin Young

Date: July 19, 2019



SUBJECT: CALVERT CLIFFS NUCLEAR POWER PLANT, UNITS 1 AND 2 – ISSUANCE OF RELIEF REQUEST I5R-04 RE: USE OF ENCODED PHASED ARRAY ULTRASONIC EXAMINATION TECHNIQUE (EPID L-2018-LLR-0391) DATED JULY 19, 2019

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