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

February 11, 2016

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

SUBJECT: CALVERT CLIFFS NUCLEAR POWER PLANT, UNIT NO. 1 – RELIEF REQUEST FOR DISSIMILAR METAL BUTT WELD EXAMINATIONS (CAC NO. MF5588)

Dear Mr. Hanson:

By letter dated March 5, 2015 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML15075A018), as supplemented by letter dated November 24, 2015 (ADAMS Accession No. ML15328A513), Exelon Generation Company, LLC (the licensee) submitted a request to the U.S. Nuclear Regulatory Commission (NRC) for authorization of a proposed alternative to the requirements of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code Case N-770-1, as conditioned by Title 10 of the *Code of Federal Regulations* (10 CFR), Part 50, Section 55a(g)(6)(ii)(F), for the Calvert Cliffs Nuclear Power Plant, Unit No. 1 (CCNPP1).

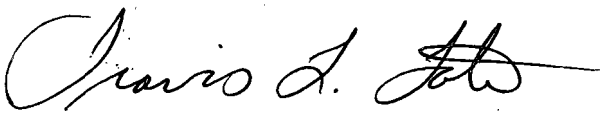
Specifically, the licensee proposed an alternative to the requirements of 10 CFR 50.55a(g)(6)(ii)(F) for 16 dissimilar metal butt welds at CCNPP1. The licensee stated that the previous ultrasonic examinations could not obtain essentially 100 percent coverage of the required examination volume due to weld taper, insulation support obstruction, and the presence of the cast austenitic stainless steel (CASS) safe-ends. Pursuant to 10 CFR 50.55a(z)(2), the licensee requested to use an alternative on the basis that complying with the specified requirement would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

As set forth in the enclosed Safety Evaluation, the NRC staff has concluded that the proposed alternative in Relief Request RR-ISI-04-10 provides reasonable assurance of structural integrity and leak tightness of the subject dissimilar metal butt welds and that complying with the specified requirement would result in hardship or unusual difficulty, without a compensating increase in the level of quality and safety. Accordingly, the NRC staff concludes that the regulatory requirements of 10 CFR 50.55a(z)(2) have been fulfilled and authorizes use of RR-ISI-04-10 at CCNPP1 for the remainder of the fourth 10-year inservice inspection interval.

All other ASME Code, Section XI requirements for which relief was not specifically requested and authorized in the subject proposed alternative remain applicable, including third-party review by the Authorized Nuclear Inservice Inspector.

If you have any questions, please contact the project manager, Alex Chereskin, at 301-415-2549 or Alexander.Chereskin@nrc.gov.

Sincerely,



Travis L. Tate, Chief
Plant Licensing Branch I-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. 50-317

Enclosure:
Safety Evaluation

cc w/enclosure: Distribution via Listserv

UNITED STATES
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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELIEF REQUEST RR-ISI-04-10 REGARDING

DISSIMILAR METAL BUTT WELD EXAMINATIONS

CALVERT CLIFFS NUCLEAR POWER PLANT, LLC

EXELON GENERATION COMPANY, LLC

CALVERT CLIFFS NUCLEAR POWER PLANT, UNIT NO. 1

DOCKET NO. 50-317

1.0 INTRODUCTION

By letter dated March 5, 2015 (Reference 1), as supplemented by letter dated November 24, 2015 (Reference 2), Exelon Generation Company, LLC (the licensee), submitted a request to the U.S. Nuclear Regulatory Commission (NRC) for authorization of a proposed alternative to the requirements of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code Case N-770-1, as conditioned by Title 10 of the *Code of Federal Regulations* (10 CFR), Part 50, Section 55a(g)(6)(ii)(F), for the Calvert Cliffs Nuclear Power Plant, Unit No. 1 (CCNPP1). Specifically, the licensee proposed an alternative to the ultrasonic (UT) examination coverage requirements of 10 CFR 50.55a(g)(6)(ii)(F) for 16 dissimilar metal butt welds (DMBWs) at CCNPP1. The licensee stated that the previous UT examinations could not obtain essentially 100 percent coverage of the required examination volume due to weld taper, insulation support obstruction, and the presence of the cast austenitic stainless steel (CASS) safe-ends. Pursuant to 10 CFR 50.55a(z)(2), the licensee requested to use an alternative on the basis that complying with the specified requirement would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

2.0 REGULATORY EVALUATION

Section 50.55a(g)(6)(ii)(F) of 10 CFR requires that licensees of existing operating pressurized-water reactors (PWRs) implement the requirements of ASME Code Case N-770-1, "Alternative Examination Requirements and Acceptance Standards for Class 1 PWR Piping and Vessel Nozzle Butt Welds Fabricated With UNS N06082 or UNS W86182 Weld Filler Material With or Without Application of Listed Mitigation Activities," subject to the conditions specified in paragraphs (g)(6)(ii)(F)(2) through (g)(6)(ii)(F)(10), by the first refueling outage after August 22, 2011. Paragraph 55a(g)(6)(ii)(F)(4) of 10 CFR 50 states, "The axial examination coverage

requirements of Paragraph –2500(c) may not be considered to be satisfied unless essentially 100 percent coverage is achieved."

Section 50.55a(z) of 10 CFR states, in part, that alternatives to the requirements of 10 CFR 50.55a(g) may be used when authorized by the NRC if the applicant demonstrates that: (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 analysis of the regulatory requirements, the NRC staff concludes that regulatory authority exists to authorize the proposed alternative Relief Request RR-ISI-04-10 pursuant to 10 CFR 50.55a(z)(2).

3.0 TECHNICAL EVALUATION

3.1 Components Affected

ASME Code Class 1 PWR Pressure Retaining Dissimilar Metal Piping Welds Containing Alloy 82/182, ASME Code Case N-770-1, inspection items as shown below:

- Inspection Item B, Unmitigated Butt Welds at Cold Leg Operating Temperature:

Weld ID	Nominal Pipe Size
102300 / 30-RC-11A-7	30"
102450 / 30-RC-11A-10	30"
104550 / 30-RC-11B-7	30"
104700 / 30-RC-11B-10	30"
107450 / 30-RC-12A-7	30"
107600 / 30-RC-12A-10	30"
109600 / 30-RC-12B-7	30"
109750 / 30-RC-12B-10	30"
114350 / 12-SI-1009-16	12"
115200 / 12-SI-1010-14	12"
116000 / 12-SI-1011-13	12"
116750 / 12-SI-1012-13	12"

- Inspection Item D, Uncracked Butt Welds Mitigated with Stress Improvement:

Weld ID	Nominal Pipe Size
110450 / 12-PSL-1	12"
113150 / 12-SC-1004-1	12"
118500 / 4-PS-1003-6	4"

- Inspection Item E, Cracked Butt Welds Mitigated with Stress Improvement:

Weld ID	Nominal Pipe Size
111100 / 12-PSL-13	12"

3.2 Inservice Inspection Interval

The proposed duration for CCNPP1 is for the remainder of the fourth 10-year inservice inspection (ISI) interval which started on October 10, 2009, and concludes on June 30, 2019.

3.3 ASME Code of Record

The ASME Section XI Code of Record for the fourth 10-year ISI interval is the 2004 Edition with no Addenda.

3.4 ASME Code and/or Regulatory Requirements

- ASME Code Case N-770-1, Paragraph –2420 states successive examinations are specified in Table 1 of ASME Code Case N-770-1. Table 1, Inspection Item B, requires examination every second inspection period not to exceed 7 years. Inspection Items D and E also require successive examinations based on defined criteria.

- ASME Code Case N-770-1, Paragraph –2500(c) states, in part, that:

  > If 100% coverage of the required volume for axial and circumferential flaws cannot be met, but essentially 100% coverage for circumferential flaws (100% of the susceptible material volume) can be achieved, the examination for axial flaws shall be completed to achieve the maximum coverage practical.

- 10 CFR 50.55a(g)(6)(ii)(F)(4) states that, "The axial examination coverage requirements of Paragraph –2500(c) may not be considered to be satisfied unless essentially 100 percent coverage is achieved."

3.5 Proposed Alternative

The licensee proposed to use the previously obtained UT examination coverage (as shown in the March 5, 2015, submittal) of the DM butt welds identified above to satisfy the examination requirements of ASME Code Case N-770-1 and 10 CFR 50.55a(g)(6)(ii)(F)(4).

3.6 Licensee's Basis for Use of the Proposed Alternative

The licensee proposed to use weld examination coverage achieved during the ASME Code Case N-770-1 baseline examinations for the components listed above as an alternative to the N-770-1 and 10 CFR 50.55a(g)(6)(ii)(F)(4) required examination coverage of "essentially 100 percent" or "100 percent of the susceptible material volume," because the required coverage is unattainable without enduring significant hardship. These welds have been examined in the past (i.e., 2010) using examination techniques qualified to meet the requirements of ASME Code Section XI, Appendix VIII, as required in 10 CFR 50.55a(g)(6). The weld examinations achieved the maximum practical amount of examination coverage obtainable within the limitations imposed by the design, geometry, and materials of construction

for the components. The examination coverage achieved for these components during the 2010 examinations is shown in Table 1A of the March 5, 2015, submittal.

The 12 unmitigated welds, listed above (Inspection Item B welds) and in Table 1A of the licensee's submittal, are found in lower temperature regions of the reactor coolant system (RCS) (at temperatures near the RCS cold leg temperature). Therefore, there is a lower probability of crack initiation and a slower crack growth rate. These welds are also highly flaw tolerant, as demonstrated in Electric Power Research Institute, Inc. Materials Reliability Program Technical Report MRP-109, "Materials Reliability Program: Alloy 82/182 Pipe Butt Weld Safety Assessment for US PWR Plant Designs: Westinghouse and CE Design Plants (MRP-109)," dated July 2004 (Reference 3).

The licensee ground the welds (contoured) to ensure maximum UT coverage by eliminating areas of poor UT probe contact and ensuring the best angles of incidence of the UT sound used to examine the weld. The licensee stated that:

> Where appropriate, contouring has already been completed on the examination surface. Further actions are limited by the design minimum wall calculations for the piping. Additional axial flaw coverage would require a weld build-up of the dissimilar metal (DM) weld followed by additional contouring and a Construction Code required radiography examination. These additional steps to improve axial coverage constitute a hardship that does not result in an increase to health and safety of the public.

The licensee also stated that:

> Additionally, bare metal visual examinations in accordance with ASME Code Cases N-722-1 and N-770-1 will continue to be performed. During refueling outages, qualified examiners perform walkdowns of the Class 1 components at both pressurized and cold shutdown conditions. These walkdowns satisfy the ASME Section XI pressure testing and the station Boric Acid Corrosion Control Program requirements.
>
> Therefore, the UT examination coverages, which include a large percentage of the susceptible material for the circumferential and axial flaws, combined with the periodic system pressure tests and outage walkdowns, provide an acceptable level of quality and safety for identifying degradation from primary water stress corrosion cracking (PWSCC) prior to the development of a safety-significant flaw.

3.7 NRC Staff Evaluation

PWSCC of nickel-based pressure boundary materials is a safety concern. Operational experience has shown that PWSCC can occur as a result of the combination of susceptible material, corrosive environment, and tensile stresses, resulting in leakage and the potential for loss of structural integrity. The subject DMBWs meet these conditions, and therefore, may be susceptible to PWSCC. The examination requirements of ASME Code Case N-770-1, as conditioned by 10 CFR 50.55a(g)(6)(ii)(F), are intended to ensure the structural integrity and leak tightness, and thus, an acceptable level of quality and safety, of DMBWs through nondestructive examination.

The NRC staff notes that the generic rules for the frequency of volumetric examination of DMBWs were established to provide reasonable assurance of the structural integrity of the reactor coolant pressure boundary. Therefore, the staff finds that plant-specific analysis could be used to provide a basis for inspection relief if the inspection requirement presents a significant hardship. Accordingly, the staff reviewed the licensee's proposed alternative under the requirements of 10 CFR 50.55a(a)(z)(2) such that, "Compliance with the specified requirements would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety."

Full coverage of the welds in their current configurations is unattainable due to the presence of CASS material; physical obstructions; and the limitations imposed by design, geometry, and/or materials of construction. The staff is not aware of other reasonable options for attaining the required examination coverage and, therefore, finds that attaining the required ASME Code Case N-770-1 examination coverage would present a hardship.

The licensee stated that CCNPP1 has examined these welds in the past (i.e., 2010). The UT examination performed in spring 2010 was a manually-delivered, phased-array, single-sided UT examination performed in both the circumferential and axial directions from the outside diameter. The personnel and UT procedure, SI-UT-130, "Procedure for the Phased Array Ultrasonic Examination of Dissimilar Metal Welds," were qualified to the requirements of ASME Code, Section XI, Appendix VIII, Supplement 10, for detection and characterization of PWSCC. The SI-UT-130 procedure is also qualified to scan DMBWs with single-sided access. This qualification allows for interrogation of DMBWs that have CASS safe-ends or restricted scanning conditions from the opposite side. The licensee indicated that these previous UT examinations could not obtain essentially 100 percent coverage of the required examination volume due to weld taper, insulation support obstruction, and the presence of the CASS safe-ends.

In the licensee's November 24, 2015, response to NRC's request for additional information (RAI), the licensee stated that Exelon Generation Company, LLC nondestructive examination procedures have adopted the industry Nondestructive Evaluation Improvement Focus Group guidance for examination of DMBWs based on operating experience with these examinations. The licensee stated these procedures will be in effect during the CCNPP1 DMBW examinations.

As identified in MRP-109 and WCAP-17128-NP (Reference 4), the axial flaws that could result from a PWSCC mechanism in the susceptible Alloy 82/182 butt weld are not structurally significant. The axial critical flaw length for an reactor coolant pump (RCP) inlet and outlet Alloy 82/182 butt weld is 38.2" (MRP-109 Table 5-2), which exceeds the width of the CCNPP1 RCP inlet and outlet Alloy 82/182 butt weld material width of 1.75"-2.5". Therefore, the NRC staff finds that a critical axial flaw in an RCP inlet or outlet Alloy 82/182 butt resulting from a PWSCC mechanism is not credible, and improving the axial flaw examination volume coverage would not result in an increase in safety.

All of the welds identified in this request received essentially 100 percent examination coverage for circumferential flaws in the susceptible material that alleviates any structural integrity concerns, because an axial PWSCC flaw will be arrested in the adjacent non-susceptible material. Flaw tolerance was further documented in a February 18, 2013, letter to the NRC (Reference 5), which summarized a flaw tolerance evaluation that is bounding for all the RCP

inlet and outlet DMWs. In addition, all DMWs operating a hot leg temperature or greater have been mitigated with stress improvement.

The staff determined that initiation or growth of a safety-significant flaw in a cold leg or mitigated Alloy 82/182 DM butt weld is extremely unlikely. However, as an added measure of safety, the industry has developed guidelines to improve its RCS leak detection capability, in part, due to the concern with PWSCC. CCNPP1 procedures for reactor coolant inventory analysis use the recommendations and guidance of WCAP-16423-NP (Reference 6) and WCAP-16465-NP (Reference 7). The enhanced leak rate monitoring and detection procedure monitors specific values of unidentified leakage, 7-day rolling average, and baseline means. Action levels are initiated as low as when the unidentified leak rate exceeds 0.1 gallons per minute. The staff finds that the enhanced leak detection capability provides an increased level of safety so that if a flaw were to grow through-wall, although unlikely, it would be detected prior to its growing to a safety-significant size.

The licensee states that contouring has already been completed on the examination surface, and further actions are limited by the design minimum wall calculations for the piping. Obtaining additional circumferential scan coverage would require a weld build-up of the DMBW followed by contouring, and an ASME Code, Section III, required radiographic examination. The NRC staff has examined the drawings submitted by the licensee and finds that fulfilling the essentially 100 percent examination coverage requirement is not possible using currently available UT technology and procedures. The NRC staff finds that the lack of ASME Code, Section XI, Appendix VIII, compliant examination of the CASS and carbon steel materials is not a structural integrity concern, since they are not known to be susceptible to PWSCC or other service-related cracking in the RCS environment. Therefore, the NRC staff accepts the UT examination coverage achieved for these materials. The NRC staff further finds that the efforts needed to obtain essentially 100 percent scan coverage of the susceptible material would present a hardship.

Additionally, in the licensee's November 24, 2015, response to NRC's RAI, the licensee confirmed it would continue to evaluate new technologies that offer improvements, nondestructive examination performance, and examination coverage.

Therefore, the NRC staff finds the examination coverage meeting that which was achieved previously and described in the March 5, 2015, submittal, provides an acceptable level of quality and safety for identifying degradation from PWSCC prior to a safety-significant flaw developing. The examination coverage includes essentially 100 percent of the susceptible material for the safety-significant circumferential flaw and a significant percentage of the susceptible material for the less safety-significant axial flaw, combined with the periodic system pressure tests, outage walkdowns, and leakage monitoring.

In summary, the NRC staff finds that performing the actions needed to achieve the UT examination coverage required by 10 CFR 50.55a(g)(6)(ii)(F)(4) would constitute a hardship. The NRC staff also finds that there is reasonable assurance of structural integrity and leak tightness of the subject welds.

4.0 CONCLUSION

As set forth above, the NRC staff has concluded that proposed alternative Relief Request RR-ISI-04-10 provides reasonable assurance of structural integrity and leak tightness of the subject DMBWs, and that complying with the specified requirement would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety. Accordingly, the NRC staff concludes that the regulatory requirements of 10 CFR 50.55a(z)(2) have been fulfilled and authorizes use of RR-ISI-04-10 at CCNPP1 for the remainder of the fourth 10-year ISI interval.

All other ASME Code, Section XI requirements for which relief was not specifically requested and authorized in the subject proposed alternative remain applicable, including third-party review by the Authorized Nuclear Inservice Inspector.

5.0 REFERENCES

1. Letter from David Gudger, Exelon Generation Company, LLC to NRC, "Relief Request for Dissimilar Metal Butt Weld Examinations," March 5, 2015 (ADAMS Accession No. ML15075A018).

2. Letter from David Gudger, Exelon Generation Company, LLC to NRC, "Relief Request for Dissimilar Metal Butt Weld Examinations," November 24, 2015 (ADAMS Accesion No. ML15328A513).

3. Electric Power Research Institute, Inc. Materials Reliability Program Technical Report, "Materials Reliability Program: Alloy 82/182 Pipe Butt Weld Safety Assessment for US PWR Plant Designs: Westinghouse and CE Design Plants (MRP-109)," July 2004 (ADAMS Accession No. ML042080193).

4. Westinghouse Topical Report WCAP-17128-NP, Revision 1, "Flaw Evaluation of CE Design RCP Suction and Discharge Nozzle Dissimilar Metal Welds, Phase III Study," May 2010 (ADAMS Accession No. ML12306A291).

5. Letter from James Stanley, CENG to NRC, "Response to Request for Additional Information – Relief Request RR-ISI-04-07A, Dissimilar Metal Butt Welds Baseline Examinations," February 18, 2013 (ADAMS Accession No. ML13051A740).

6. Westinghouse Topical Report WCAP-16423-NP, Revision 0, "Pressurized Water Reactor Owners Group Standard Process and Methods for Calculating RCS Leak Rate for Pressurized Water Reactors," September 2006 (ADAMS Accession No. ML070310084).

7. Westinghouse Topical Report WCAP-16465-NP, Revision 0, September 2006, "Pressurized Water Reactor Owners Group Standard RCS Leakage Action Levels and Response Guidelines for Pressurized Water Reactors," September 2006 (ADAMS Accession No. ML070310082).

Principal Contributor: Keith Hoffman

Date: February 11, 2016

If you have any questions, please contact the project manager, Alex Chereskin, at 301-415-2549 or Alexander.Chereskin@nrc.gov.

Sincerely,

/RA/

Travis L. Tate, Chief
Plant Licensing Branch I-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-317

Enclosure:
Safety Evaluation

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