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

March 8, 2010

Mr. Charles G. Pardee
President and Chief Nuclear Officer
Exelon Nuclear
4300 Winfield Road
Warrenville, IL 60555

SUBJECT: BRAIDWOOD STATION, UNITS 1 AND 2 - RELIEF REQUEST I2R-50 FOR SECOND 10-YEAR INSERVICE INSPECTION INTERVAL (TAC NOS. ME1038 AND ME1039)

Dear Mr. Pardee:

By letter to the Nuclear Regulatory Commission (NRC) dated March 31, 2009 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML090960468), as supplemented by letter dated October 26, 2009 (ADAMS Accession No. ML093000082), Exelon Generation Company, LLC (the licensee) submitted Relief Request (RR) I2R-50 for Braidwood Station, Units 1 and 2. RR I2R-50 requested approval in accordance with Title 10 of the *Code of Federal Regulations*, Section 50.55a, "Codes and standards," paragraph (g)(5)(iii), to use a proposed alternative to the existing American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components," on the basis that compliance with the specified requirements is impractical due to plant design. The licensee submitted RR I2R-50 for those ASME Section XI weld examinations performed during the second 10-year inservice inspection (ISI) interval where the inspection coverage achieved was less than or equal to 90 percent. The second 10-year ISI interval for Unit 1 began on July 29, 1998, and ended on July 28, 2009. The second 10-year ISI interval for Unit 2 began on October 17, 1998, and ended on October 16, 2008.

The NRC staff has reviewed the licensee's submittals and concludes that ASME Code examination coverage requirements are impractical for the subject welds listed in RR I2R-50 and would create a burden on the licensee. Furthermore, the NRC staff concludes that the examinations performed to the extent practical provide reasonable assurance of structural integrity of the subject welds. Additionally, the NRC staff concludes that granting the requested relief is authorized by law and will not endanger life or property, or the common defense and security, and is otherwise in the public interest given due consideration to the burden upon the licensee that could result if the requirements were imposed on the facility. Therefore, the NRC staff grants relief for the examination coverage for the subject welds listed in RR I2R-50, at Braidwood Station, Units 1 and 2, for the second 10-year ISI interval. All other ASME Code, Section XI requirements, for which relief was not specifically requested and approved in the subject RR, remain applicable, including third-party review by the Authorized Nuclear Inservice Inspector. The NRC staff's safety evaluation is enclosed.

Please contact Mr. Marshall David at (301) 415-1547 if you have any questions on this action.

Sincerely,

Stephen J. Campbell, Chief
Plant Licensing Branch III-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. STN 50-456 and STN 50-457

Enclosure:
Safety Evaluation

cc w/encl: Distribution via Listserv

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

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELIEF REQUEST NO. I2R-50

EXELON GENERATION COMPANY, LLC.

BRAIDWOOD STATION, UNITS 1 AND 2

DOCKET NOS. STN 50-456 AND STN 50-457

1.0 INTRODUCTION

By letter to the Nuclear Regulatory Commission (NRC, the Commission) dated March 31, 2009 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML090960468), as supplemented by letter dated October 26, 2009 (ADAMS Accession No. ML093000082), Exelon Generation Company, LLC (EGC, the licensee) submitted Relief Request (RR) I2R-50 for Braidwood Station, Units 1 and 2. RR I2R-50 requested approval in accordance with Title 10 of the *Code of Federal Regulations*, Section 50.55a, "Codes and standards," paragraph (g)(5)(iii), to use a proposed alternative to the existing American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components," on the basis that compliance with the specified requirements is impractical due to plant design. The licensee submitted RR I2R-50 for those ASME Section XI weld examinations performed during the second 10-year inservice inspection (ISI) interval where the inspection coverage achieved was less than or equal to 90 percent. The second 10-year ISI interval for Unit 1 began on July 29, 1998, and ended on July 28, 2009. The second 10-year ISI interval for Unit 2 began on October 17, 1998, and ended on October 16, 2008.

The NRC staff has reviewed and evaluated the information provided by the licensee in its submittals. The results of the NRC staff's review are presented in the remainder of this safety evaluation.

2.0 REGULATORY EVALUATION

ISI of ASME Code Class 1, 2, and 3 components is to be performed in accordance with Section XI of the ASME Code, and applicable addenda, as required by 10 CFR 50.55a(g), except where specific relief has been granted by the Commission pursuant to 10 CFR 50.55a(g)(6)(i). The regulation at 10 CFR 50.55a(a)(3) states that alternatives to the requirements of paragraph (g) may be used, when authorized by the NRC, if the licensee demonstrates that (i) the proposed alternatives would provide an acceptable level of quality and safety or (ii) compliance with the specified requirements would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

Enclosure

Pursuant to 10 CFR 50.55a(g)(4), ASME Code Class 1, 2, and 3 components (including supports) shall meet the requirements, except the design and access provisions and the preservice examination requirements, set forth in the ASME Code, Section XI, to the extent practical within the limitations of design, geometry, and materials of construction of the components. The regulations require that inservice examination of components and system pressure tests conducted during the first 10-year ISI interval and subsequent intervals comply with the requirements in the latest edition and addenda of Section XI of the ASME Code, which was incorporated by reference in 10 CFR 50.55a(b) 12 months prior to the start of the 120-month ISI interval, subject to the limitations and modifications listed therein. The ASME Section XI Code of record for the Braidwood Station, Units 1 and 2, second 10-year ISI interval, which ended on July 28, 2009, for Unit 1, and on October 16, 2008, for Unit 2, is the 1989 Edition with no Addenda.

3.0 TECHNICAL EVALUATION

A discussion of the NRC staff's evaluation of the information submitted by the licensee in support of RR I2R-50 follows. The NRC staff's evaluation is provided in five parts according to the applicable Examination Category of ASME Code, Section XI.

In RR I2R-50, the licensee requested relief from the ASME Code, Section XI examination requirements for the ASME Code Class 1 and 2 component welds listed below for Braidwood Station, Units 1 and 2:

Braidwood Station, Unit 1		
Weld Number	ASME Code Category/Item Number	Weld Configuration
1RV-03-001	B-A/B1.40	Reactor Pressure Vessel (RPV) Head-to-Flange Weld
1PZR-01-N2	B-D/B3.110	Pressurizer Spray Nozzle-to-Vessel Weld
1PZR-01-N3	B-D/B3.110	Pressurizer Relief Nozzle-to-Vessel Weld
1RC-17-13	R-A/R1.20	Pipe-to-Valve Circumferential Weld
1SG-05-SGSE-02	R-A/R1.20	Steam Generator Auxiliary Feedwater Safe End-to-Nozzle Weld

Braidwood Station, Unit 2		
Weld Number	ASME Code Category/Item Number	Weld Configuration
2RV-03-001	B-A/B1.40	RPV Head-to-Flange Weld
2PZR-01-N2	B-D/B3.110	Pressurizer Spray Nozzle-to-Vessel Weld
2PZR-01-N3	B-D/B3.110	Pressurizer Relief Nozzle-to-Vessel Weld
2SG-01-SGC-02	C-A/C1.30	Steam Generator Tube Sheet-to-Stub Barrel Weld

3.1 ASME Code, Section XI, Examination Category B-A, Item B1.40, RPV Head-to-Flange Weld 1RV-03-001 (Unit 1) and Weld 2RV-03-001 (Unit 2)

ASME Code Requirement

ASME Code, Section XI, Table IWB-2500-1, Examination Category B-A, Item Number B1.40 requires essentially 100 percent volumetric and surface examinations for the RPV head-to-flange weld. The required examination region for the volumetric and surface exams is specified in ASME Code, Section XI, Figure IWB-2500-5. "Essentially 100 percent," as clarified by ASME Code Case N-460, "Alternative Examination Coverage for Class 1 and Class 2 Welds," is greater than 90 percent coverage of the examination volume or surface area as applicable. ASME Code Case N-460 has been approved for use by the NRC staff in Regulatory Guide (RG) 1.147, Revision 15, "Inservice Inspection Code Case Acceptability."

Licensee's ASME Code Relief Request

In accordance with 10 CFR 50.55a(g)(5)(iii), the licensee requested relief from the ASME Code, Section XI requirements for performing a full (essentially 100 percent) volumetric examination of the region specified in Figure IWB-2500-5 of the ASME Code, Section XI, for the RPV head-to-flange welds at Braidwood, Units 1 and 2. Relief was requested for the second 10-year ISI interval at Braidwood, Units 1 and 2. As discussed next, geometry and the presence of cladding on the inside diameter surface of the RPV head-to-flange welds result in limited access to the entire examination volume.

Licensee's Basis for Relief Request (as stated)

> The reactor vessel head-to-flange weld has a nominal thickness of 7.0" and is clad with stainless steel on the inside diameter surface. The surface geometry of the flange obstructs the ultrasonic transducer movement that is needed to examine the [ASME] Code required volume from the flange side. The propagation for the ultrasonic beam was in the shear mode. Normally this mode would allow the ultrasonic beam to reflect off the inside surfaces and create a two-beam axis at right angles to each other; however, the presence of the stainless steel cladding precludes the ultrasound beams from reflecting at the inside diameter from the head/cladding interface. In addition to the examination limitations encountered due to the

flange configuration and inside diameter cladding, additional examination restrictions are caused by the presence of three lifting lugs located on the reactor vessel head. These limitations preclude complete coverage of the full volume for the required scanning directions mandated by ASME [Code,] Section V and Section XI. These limitations are inherent to the original design of the reactor vessel head. Conformance with the ASME [Code,] Section XI requirements for essentially 100 [percent] of the volumetric coverage would require extensive structural modifications to the reactor vessel head.

No additional examinations were completed during the inspection interval; however, the aggregate examination coverage achieved [88.65 percent / 87.64 percent] along with the results of the completed surface examination, system pressure tests, and bare metal visual inspections performed throughout the inspection interval provide reasonable assurance that pressure boundary integrity has been maintained for this component. There were no recordable indications (other than geometric conditions) noted during any of the examinations (surface, volumetric, and visual) performed during the course of the interval.

Licensee's Proposed Alternative Examination (as stated)

In addition to performing the 0, 45, and 60 degree ultrasonic scans required by [ASME Code,] Appendix I, additional 30 and 40 degree ultrasonic scans were performed in lieu of the 70 degree scan as permitted by [ASME Code,] Section V, Article 4, T-441.3.2.1, to supplement coverage. The calculated volumetric coverage achieved for all combined scans was documented as [88.65 percent / 87.64 percent].

The [ASME] Code required surface examination area (B-E as depicted in [ASME Code,] Figure IWB-2500-5) was fully achieved (100 [percent] coverage) utilizing the magnetic particle method. In addition to the required surface examination, numerous system leakage tests (ASME [Code,] Section XI Category B-P and Generic Letter 88-05) at nominal system operating pressure (2235 psig [pounds per square inch gauge]) and temperature (557°F) as well as bare metal visual examinations of the upper reactor head associated with the First Revised Order EA-03-009 have been completed with no evidence of leakage associated with the [RPV] head-to-flange weld noted during the course of the interval.

Radiography (RT) is not a desired option because RT is limited in the ability to detect expected degradation mechanisms such as service induced cracking. Additionally, RT has not been qualified through performance demonstration.

NRC Staff Evaluation

The ASME Code, Section XI, requires essentially 100 percent volumetric coverage of the examination volume specified in ASME Code, Section XI, Figure IWB-2500-5 for the RPV head-to-flange welds at Braidwood Station, Units 1 and 2. This examination volume includes the actual weld, as well as the adjacent base metal on either side of the weld extending to a distance of one-half the thickness of the vessel wall from the extremities of the weld crown. The ASME Code, Section XI, also requires essentially 100 percent surface examination coverage of the examination area specified in ASME Code, Section XI, Figure IWB-2500-5. The licensee has requested relief from the requirements for full volumetric examination coverage. This RR does not apply to the requirements for full surface examination coverage. Information supplied by the licensee demonstrates that the surface geometry of the flange, in conjunction with access

restrictions caused by the lifting lugs located on the RPV head, preclude complete coverage of the full examination volume in the four required scan directions mandated by the ASME Code, Section V. Therefore, the limitation in the examination coverage was inherent in the design of RPV head and flange. Conformance with the ASME Code, Section XI requirements for essentially 100 percent volumetric examination coverage would require extensive structural modifications to the RPV head and flange. Therefore, the NRC staff determined that the ASME Code-required examinations are impractical to perform.

The licensee calculated the overall examination coverage that was achieved for both the weld and the adjacent base metal for each of the subject RPV head-to-flange welds. This overall examination coverage was calculated by averaging the examination coverage percentages for each of the ASME Code-required scan directions at each beam angle. The licensee conducted a total of nine scans covering each of the scan directions and beam angles required by the ASME Code, Section V, for the weld portion of the examination volume and a total of seven scans for the base metal portion of the examination volume. The table below shows the volumetric examination coverage that was achieved for each of the subject RPV head-to-flange welds.

Weld Number	Percentage Examined Weld / Base Metal	Aggregate Examination Coverage
1RV-03-001 (Unit 1)	92.27 percent / 85.03 percent	88.65 percent
2RV-03-001 (Unit 2)	90.31 percent / 84.97 percent	87.64 percent

The licensee's limited scope volumetric examination was able to achieve 88.65 percent and 87.64 percent coverage for welds 1RV-03-001 (Unit 1) and 2RV-03-001 (Unit 2), respectively, for the RPV head-to-flange welds. In addition to performing the 0, 45, and 60 degree ultrasonic scans required by ASME Code, Appendix I, the licensee performed additional 30 and 40 degree ultrasonic scans in lieu of the 70 degree scan as permitted by ASME Code, Section V, Article 4, T-441.3.2.1 to supplement coverage. The licensee's surface examination achieved 100 percent coverage of the examination area specified in ASME Code, Section XI, Figure IWB-2500-5 for the subject welds. In addition to the required surface examination, the licensee performed numerous system leakage tests (ASME Code, Section XI, Category B-P and Generic Letter 88-05) at nominal system operating pressure (2235 psig) and temperature (557°F) as well as bare metal visual examinations of the upper RPV head associated with the First Revised Order EA-03-009 with no evidence of leakage or recordable indications (other than geometric conditions) associated with the RPV head-to-flange welds noted during the course of the second 10-year ISI interval.

The licensee has shown that examining 100 percent of the ASME Code-required volumes of the subject welds is impractical. The NRC staff determined that, based on the volumetric coverage obtained, it is reasonable to conclude that if significant service-induced degradation had occurred in the subject welds, evidence of it would have been detected. Furthermore, the NRC staff determined that the examinations performed provide reasonable assurance of structural integrity of the subject welds for Braidwood Station, Units 1 and 2.

3.2 ASME Code, Section XI, Examination Category B-D, Item B3.110, Pressurizer Nozzle-to-Vessel Welds

Braidwood Station, Units 1 and 2, Pressurizer Nozzle-to-Vessel Weld Coverage

Weld Number	Percentage Examined Weld / Base Metal	Aggregate Examination Coverage
1PZR-01-N2 (Spray-Unit 1)	73.03 percent / 66.65 percent	69.84 percent
1PZR-01-N3 (Relief-Unit 1)	81.0 percent / 66.2 percent	73.6 percent
2PZR-01-N2 (Spray-Unit 2)	90.41 percent / 76.86 percent	83.64 percent
2PZR-01-N3 (Relief-Unit 2)	88.13 percent / 73.67 percent	80.90 percent

ASME Code Requirement

ASME Code, Section XI, Table IWB-2500-1, Examination Category B-D, Item Number B3.110 requires essentially 100 percent volumetric and surface examinations for this weld. The required examination region for the volumetric and surface exams is specified in ASME Code, Section XI, Figure IWB-2500-7(b). "Essentially 100 percent," as clarified by ASME Code Case N-460, is greater than 90 percent coverage of the examination volume, or surface area, as applicable. ASME Code Case N-460 has been approved for use by the NRC staff in RG 1.147, Revision 15.

Licensee's ASME Code Relief Request

In accordance with 10 CFR 50.55a(g)(5)(iii), the licensee requested relief from the ASME Code, Section XI requirements for performing a full volumetric examination of the region specified in ASME Code, Section XI, Figure IWB-2500-7(b) for the subject pressurizer nozzle-to-vessel welds for the second 10-year ISI interval at Braidwood Station, Units 1 and 2. As discussed next, the geometry of the subject nozzles along with the presence of cladding on the inside diameter of the pressurizer nozzle and vessel result in limited access to the entire examination volume.

Licensee's Basis for Relief Request (as stated)

> The pressurizer vessel [spray / relief / spray / relief] nozzle-to-vessel weld is approximately [2.7" / 2.7" / 2.7" / 2.8"] thick. The pressurizer nozzle and vessel are clad with stainless steel on the inside diameter surface. The geometry of the nozzle along with the presence of the cladding on the inside diameter of the pressurizer result in limited access to the entire examination volume. The propagation for the ultrasonic beam was in the shear mode. Normally this mode would allow the ultrasonic beam to reflect off the inside surfaces and create a two-beam axis at right angles to each other; however, the presence of the stainless steel cladding precludes the ultrasonic beams from reflecting at the inside diameter from the shell/cladding interface. The nozzle geometry tapers away from the weld resulting in limited scanning surfaces available for transducer coupling on the nozzle side of the weld resulting in additional examination limitations. These factors result in limited examination coverage from the scan directions required by ASME [Code,] Section V and Section XI. These limitations are

inherent to the original design of the pressurizer vessel. Conformance with the ASME [Code,] Section XI requirements for essentially 100 [percent] of the volumetric coverage would require extensive structural modifications to the pressurizer vessel.

No additional examinations were completed during the inspection interval; however, the examination coverage [shown in the table above] along with the results of the pressure test and bare metal visual inspections provide reasonable assurance that pressure boundary integrity has been maintained for this component throughout the interval.

Licensee's Proposed Alternative Examination (as stated)

In addition to performing the 0, 45 (recorded as 46 degrees in coverage calculation data [for 2PZR-01-N2 and 2PZR-01-N3]), 60, and 70 degree scans to the extent practical as required by [ASME Code,] Appendix I, additional 30 and 40 degree scans were performed to supplement coverage. The aggregate examination coverage achieved was [69.84 percent / 73.6 percent / 83.64 percent / 80.9 percent]. In addition to completing the required volumetric examination to the extent practical, numerous system leakage tests (ASME [Code,] Section XI, Category B-P and Generic Letter 88-05) at nominal system operating pressure (2235 psig) and temperature (557°F) as well as the bare metal visual examinations associated with NRC Bulletin 2004-01 of the upper pressurizer vessel head were completed with no evidence of leakage associated with the pressurizer spray nozzle-to-vessel weld noted during the course of the interval.

Radiography as an alternative is not feasible because access is not available for film placement. No alternative examinations are planned for the weld during the current inspection interval.

NRC Staff Evaluation

The ASME Code, Section XI requires essentially 100 percent volumetric coverage of the examination volume specified in Figure IWB-2500-7(b) for the pressurizer nozzle-to-vessel welds. This examination volume includes the actual weld, as well as the adjacent base metal on either side of the weld extending to a distance of one-half the thickness of the wall from the extremities of the weld crown. The geometry of the subject pressurizer nozzles and the presence of vessel cladding resulted in limited access to the entire examination volume. Ultrasonic testing (UT) scans of the examination volume from the nozzle side of the weld were limited due to the geometry of the nozzle relative to the available transducer sizes. Specifically, the nozzle geometry tapers away from the weld resulting in limited scanning surfaces available for transducer coupling on the nozzle side of the weld resulting in additional examination limitations. Furthermore, the stainless steel cladding at the inner surface of the pressurizer vessel resulted in significant scattering of reflected ultrasonic energy from the clad-weld interface. These two factors resulted in limited examination coverage from the four orthogonal scan directions that are required by the ASME Code, Section V for UT scans of these welds and the two orthogonal scan directions required for the adjacent base metal. Conformance with the ASME Code, Section XI requirements for essentially 100 percent volumetric examination coverage would require extensive structural modifications to the pressurizer vessel.

The licensee calculated the overall examination coverage that was achieved for both the weld and the adjacent base metal for each of the subject nozzle-to-vessel welds. This overall examination coverage was calculated by averaging the examination coverage percentages for

each of the ASME Code-required scan directions at each beam angle. The table above shows the volumetric examination coverage that was achieved for each of the subject nozzle-to-vessel welds.

The licensee's limited scope volumetric examination was able to achieve 69.84 and 73.6 percent coverage for Braidwood Station, Unit 1 (for 1PZR-01-N2 and 1PZR-01-N3, respectively), and 83.64 and 80.9 percent coverage for Braidwood Station, Unit 2 (for 2PZR-01-N2 and 2PZR-01-N3, respectively), of the ASME Code-required examination volume specified in ASME Code, Figure IWB-2500-7(b) for the nozzle-to-vessel welds at Braidwood Station, Units 1 and 2. In addition to performing the 0, 45, 60 and 70 degree ultrasonic scans required by ASME Code, Appendix I, the licensee performed additional 30 and 40 degree ultrasonic scans to supplement coverage. In addition, the licensee performed numerous system leakage tests (ASME Code, Section XI, Category B-P at nominal system operating pressure and temperature) with no evidence of leakage. No unacceptable indications, other than geometric conditions associated with the pressurizer spray and relief nozzle-to-vessel welds, were noted during the course of the interval.

Based on the above considerations, the NRC staff determined that the ASME Code, Section XI requirement to perform volumetric examinations of the pressurizer nozzle-to-vessel welds with essentially 100 percent coverage of the examination volume is impractical. The NRC staff determined that, based on the volumetric coverage obtained, it is reasonable to conclude that if significant service-induced degradation had occurred in the subject welds, evidence of it would have been detected. Furthermore, the NRC staff determined that the examinations performed provide reasonable assurance of structural integrity of the subject welds for Braidwood Station, Units 1 and 2.

3.3 ASME Code, Section XI, Examination Category R-A, Item R1.20, Pipe-to-Valve Circumferential Weld 1RC-17-13 (Unit 1)

ASME Code Requirement

The examination requirements for the subject weld at Braidwood Station, Unit 1, are governed by a Risk-Informed Inservice Inspection (RI-ISI) program that was approved by the NRC staff on February 20, 2002 (ADAMS ML020350153). The RI-ISI program was developed in accordance with Electric Power Research Institute (EPRI) Topical Report TR-112657, Rev. B-A, "Revised RI-Inservice Inspection Evaluation Procedure" (January 2000). As part of the NRC-approved program, the licensee has implemented inspection requirements listed in ASME Code Case N-578-1[1], "Risk-Informed Requirements for ASME Code, Class 1, 2 or 3 Piping, Method B," along with the more detailed provisions contained in EPRI TR-112657. Table 1 of ASME Code Case N-578-1 assigns the Examination Category R-A, Item R1.20, to piping inspection elements not subject to a known damage mechanism. EPRI TR-112657 includes guidance for requesting relief from volumetric examinations if 100 percent of the required volumes cannot be examined.

Circumferential weld 1RC-17-13 is subject to the examination requirements of ASME Code, Section XI, Table IWB-2500-1, Examination Category B-J, Figure IWB-2500-8(c), as supplemented by Figure 4-2 of EPRI TR-112657. Figure 4-2 depicts the required examination

1 Although ASME Code Case N-578-1 has not been approved for use in RG 1.147, Revision 15, licensees base their RI-ISI inspection sample size and examination methodology on Table 1 of ASME Code Case N-578-1 with NRC approval.

volume (A-B-C-D), which includes the lower 1/3 thickness of the circumferential weld. There was no counterbore detected, so the volume1/2" each side of the weld toes (shown in Figure 4-1 of EPRI TR-112657) was used by the licensee to define the required examination volume.

ASME Code Case N-460, approved for use by NRC in RG 1.147, Revision 15, states that a reduction in examination coverage due to geometry or interference for any ASME Code Class 1 and 2 weld is acceptable provided that the reduction is less than 10 percent (i.e., greater than 90 percent examination coverage is obtained).

As required by 10 CFR 50.55a, the 1995 Edition with 1996 Addenda of the ASME Code, Section XI, Appendix VIII, "Performance Demonstration for Ultrasonic Examination System," was used for examination procedures, equipment, and personnel.

Licensee's ASME Code Relief Request

In accordance with 10 CFR 50.55a(g)(5)(iii), the licensee requested relief from the ASME Code, Section XI examination requirements for the pipe-to-valve circumferential weld 1RV-17-13 at Braidwood Station, Unit 1. Relief was requested for the second 10-year ISI interval at Braidwood Station, Unit 1. As discussed next, geometry results in limited access to the entire examination volume.

Licensee's Basis for Relief Request (as stated)

> This austenitic stainless steel pipe-to-valve weld and associated base materials are 4" NPS [nominal pipe size] with a nominal wall thickness of 0.531" (Schedule 160) and forms the break between the "RC" [reactor coolant] and "RY" [pressurizer] subsystem for the pressurizer spray line. Under the Braidwood Risk-Informed ISI Program, the welds associated with this particular piping segment are considered Category R-A, Item R1.20 which are not subject to any specific degradation mechanisms. This weld had been examined during the first [10-year] ISI inspection interval as a "structural discontinuity" and was reselected again in the second [10-year ISI] interval under the Risk-Informed ISI Program. These examinations were performed using examination procedures and personnel qualified under the Performance Demonstration Initiative (PDI) program administered through the EPRI NDE Center, specifically, PDI-UT-2 which is qualified for manual IGSCC [intergranular stress corrosion cracking] detection and length sizing for austenitic stainless steel welds. The PDI procedure is not qualified for the detection of flaws on the far side of single sided access examinations on austenitic stainless steel piping welds. The valve geometry tapers away from the weld resulting in limited scanning surface available on the valve side. Volumetric examinations were also completed on five additional Category R-A, Item R1.20 welds upstream of this weld during the same refuel outage. The limited access of some welds or the presence of component supports adjacent to other welds on the line limited the population of welds for this particular segment.
>
> No additional examinations were completed during the inspection interval; however, the examination coverage of 50 [percent] along with the results of volumetric examinations performed on the other five welds in the population, as well as the numerous pressure tests completed over the course of the interval provide reasonable assurance that pressure boundary integrity has been maintained for this component.

Licensee's Proposed Alternative Examination (as stated)

> In accordance with PDI-UT-2 requirements, axial and circumferential 45 degree shear wave scans and axial 60 degree refracted longitudinal wave (RL) scans of this weld were performed to the extent practical. The aggregate examination coverage achieved was 50 [percent].
>
> In addition to completing the required volumetric examination scans to the extent practical, numerous system leakage tests (ASME [Code,] Section XI, Category B-P and Generic Letter 88-05) at nominal system operating pressure (2235 psig) and temperature (557°F) were completed with no evidence of leakage associated with this weld noted during the course of the interval.
>
> The required 100 [percent] coverage was attained for the remaining five welds with no recordable indications noted in any of the welds. Since all six of these welds experience the same system conditions without any known degradation mechanism, reasonable assurance exists that there is no adverse condition associated with population of welds including the weld where limited inspection coverage was achieved.
>
> Radiography (RT) is not a desired option because RT is limited in the ability to detect expected degradation mechanisms such as thermal fatigue cracking and stress corrosion cracking initiating at the pipe inside surface. Additionally, RT has not been qualified through the performance demonstration process.

NRC Staff Evaluation

The licensee was unable to perform a full examination from both sides of the subject weld because the examination can only be performed from one side (pipe side) of the weld. This access limitation is due to the presence of unfavorable geometry at the valve side of the weld. To comply with the ASME Code-required volumetric examination coverage, the licensee would have to redesign and reinstall the subject component which is a burden to the licensee. The NRC staff notes that at the time of this RR, PDI has not been able to qualify a single-side examination procedure that is capable of demonstrating equivalency for a two-sided examination procedure for austenitic stainless steel welds.

The volumetric examination was performed during the first 10-year ISI interval and was reselected again in the second 10-year ISI interval under the RI-ISI Program. These examinations were performed using PDI-UT-2; however, the procedure used is not qualified for the detection of flaws on the far side of single-sided (the valve side) access examinations on austenitic stainless steel piping welds. The licensee stated in its October 26, 2009, supplement that, during development of the RI-ISI program weld screening and selection, a number of single-sided welds downstream of the subject weld were recognized as single-sided examinations and removed from further consideration for the RI-ISI program; however, the subject weld was overlooked as a single-sided examination. Furthermore, the licensee stated that the subject weld has been flagged as a limited examination and alternate weld selections (pipe-to-elbow circumferential welds) on the line have been identified for consideration for the third 10-year ISI interval. (The licensee noted that the error has been entered into its corrective action program.)

Based on the PDI-UT-2 ultrasonic examinations performed, limited axial and circumferential 45 degree shear wave scans, and axial 60 degree RL scans of this weld, were performed to the extent practical. The licensee was only able to obtain coverage of 50 percent of the required examination volume. Therefore, the NRC staff finds that compliance with the ASME Code coverage requirements in the inspection of the subject weld is impractical. Furthermore, no recordable flaw indications were observed during these examinations, and no evidence of leakage was noted during the system leakage tests performed during the interval. Based on the volumetric coverage obtained and the leakage test tests performed, it is reasonable to conclude that, if significant service-induced degradation had occurred in the subject weld, evidence of it would have been detected by the examinations that were performed. Furthermore, the NRC staff determined that the examinations performed provide reasonable assurance of structural integrity of the subject weld for Braidwood Station, Unit 1.

3.4 ASME Code, Section XI, Examination Category R-A, Item R1.20, Steam Generator Auxiliary Feedwater Safe End-to-Nozzle Weld 1SG-05-SGSE-02 (Unit 1)

ASME Code Requirement

The examination requirements for the subject welds at Braidwood Station, Unit 1, are governed by a RI-ISI program that was approved by the NRC staff on February 20, 2002. The RI-ISI program was developed in accordance with EPRI Topical Report TR-112657, Rev. B-A. As part of the NRC-approved program, the licensee has implemented inspection requirements listed in ASME Code Case N-578-1, along with the more detailed provisions contained in TR-112657. Table 1 of ASME Code Case N-578-1 assigns the Examination Category R-A, Item R1.20, to piping inspection elements not subject to a known damage mechanism. EPRI TR-112657 includes guidance for requesting relief from volumetric examinations if 100 percent of the required volumes cannot be examined.

Safe end-to-nozzle weld 1SG-05-SGSE-02 is subject to the examination requirements of ASME Code, Section XI, Table IWC-2500-1, Examination Category C-F-1, Figure IWC-2500-7, as supplemented by Figure 4-2 of EPRI TR-112657. Figure 4-2 depicts the required examination volume (A-B-C-D), which includes the lower 1/3 thickness of the circumferential weld. There was no counterbore detected, so the volume 1/2" each side of the weld toes (shown in Figure 4-1 of EPRI TR-112657) was used by the licensee to define the required examination volume.

ASME Code Case N-460, approved for use by NRC in RG 1.147, Revision 15, states that a reduction in examination coverage due to geometry or interference for any ASME Code Class 1 and 2 weld is acceptable provided that the reduction is less than 10 percent (i.e., greater than 90 percent examination coverage is obtained).

As required by 10 CFR 50.55a, the 1995 Edition with 1996 Addenda of the ASME Code, Section XI, Appendix VIII, "Performance Demonstration for Ultrasonic Examination System," was used for examination procedures, equipment, and personnel.

Licensee's ASME Code Relief Request

In accordance with 10 CFR 50.55a(g)(5)(iii), the licensee requested relief from the ASME Code, Section XI examination requirements for the steam generator auxiliary feedwater safe end-to-nozzle weld 1SG-05-SGSE-02 at Braidwood Station, Unit 1. Relief was requested for the

second 10-year ISI interval at Braidwood Station, Unit 1. As discussed next, geometry limits scanning the entire examination volume.

Licensee's Basis for Relief Request (as stated)

> The auxiliary feedwater safe end-to-nozzle weld and associated adjacent base materials are approximately 1.1" thick. This full penetration weld is Inconel 690 material but is not in contact with reactor coolant. This weld was shop fabricated and installed during the [Braidwood Station,] Unit 1 steam generator replacement during the A1R07 refuel outage (fall 1998). Under the Braidwood Risk-Informed ISI Program, the welds associated with this particular segment are considered Category R-A, Item R1.20, which are not subject to any specific degradation mechanisms. Due to the physical configuration of the carbon steel nozzle, which includes an adjacent taper running away from the circumferential weld, limitations preventing scanning (limitation calculated to be 35.5 [percent] for nozzle side circumferential scans) to attain coverage of 90 [percent] exist. In accordance with PDI-UT-10 requirements, 35, 40, 45, and 60 degree shear and 45 and 60 degree refracted longitudinal wave (RL) scans of this weld were performed to the extent practical. The aggregate examination coverage achieved was 79 [percent].
>
> No additional examinations were completed during the inspection interval; however, the examination coverage of 79 [percent] along with the results of the pressure tests assure boundary integrity has been maintained for this component.

Licensee's Proposed Alternative Examination (as stated)

> These examinations were performed using examination procedures and personnel qualified under the Performance Demonstration Initiative (PDI) program administered through the EPRI NDE Center, specifically, PDI-UT-10 which is qualified for single or dual sided manual detection and circumferential length sizing for dissimilar metal welds. In addition to performing the required volumetric examination to the extent practical, numerous system leakage tests performed at system nominal operating pressure (1005 psig) and temperature (443^{0}F) have been completed with no evidence of leakage associated with the auxiliary feedwater nozzle-to-safe end weld noted.
>
> Radiography as an alternative is not feasible because access is not available for film placement. No alternative examinations are planned for the weld during the current inspection interval.

NRC Staff Evaluation

The licensee conducted a volumetric examination of the safe end-to-nozzle weld 1SG-05-SGSE-02 by conducting 35, 40, 45, and 60 degree shear and 45 and 60 degree RL scans of this weld of the accessible regions using procedures and personnel qualified in accordance with the PDI-UT-10 requirements. The physical configuration of this carbon steel nozzle, which includes an adjacent taper running away from the circumferential weld, prevented the scanning (limitation calculated to be 35.5 percent for nozzle side circumferential scans) to attain coverage of 90 percent of the subject weld. The aggregate examination coverage achieved was 79 percent. In addition to completing the required volumetric examination to the extent practical, the licensee performed numerous system leakage tests at nominal system operating pressure and

temperature with no evidence of leakage associated with the auxiliary feedwater safe end-to-nozzle weld noted during the course of the interval, nor did the licensee find any recordable indications during the second 10-year ISI interval limited volumetric examinations for weld 1SG-05-SGSE-02.

The NRC staff determined that the ASME Code, Section XI, requirement to perform the volumetric examination of the auxiliary feedwater safe end-to-nozzle weld, with essentially 100 percent coverage of the examination volume specified in ASME Code, Section XI, Figure IWC-2500-7 is impractical. Based on the volumetric coverage obtained and the leakage test tests performed, it is reasonable to conclude that, if significant service-induced degradation had occurred in the subject weld, evidence of it would have been detected by the examinations that were performed. Furthermore, the NRC staff determined that the examinations performed provide reasonable assurance of structural integrity of the subject weld for Braidwood Station, Unit 1.

3.5 ASME Code, Section XI, Examination Category C-A, Item C1.30, Steam Generator Tube Sheet-to-Stub Barrel Weld 2SG-01-SGC-02 (Unit 2)

ASME Code Requirement

ASME Code, Section XI, Table IWC-2500-1, Examination Category C-A requires volumetric examination of Item C1.30 (Tube Sheet-to-Shell welds). Table IWC-2500-1 Note (1) states essentially 100 percent of the weld length shall be examined. ASME Code, Section XI, Figure IWC-2500-2 depicts the required examination volume (E-F-G-H), which includes the actual circumferential weld and adjacent base metal 1/2" on either side of the weld from the extremities of the weld crown. ASME Code, Section XI, Mandatory Appendix I requires UT examination of vessel welds greater than 2" thick to be conducted in accordance with ASME Section V, Article 4.

Licensee's ASME Code Relief Request

In accordance with 10 CFR 50.55a(g)(5)(iii), the licensee requested relief from the ASME Code, Section XI requirements for performing a full (essentially 100 percent) volumetric examination of the region specified in ASME Code, Section XI, Figure IWC-2500-2 for the steam generator tube sheet-to-stub barrel weld at Braidwood Station, Unit 2. Relief was requested for the second 10-year ISI interval at Braidwood Station, Unit 2. As discussed next, geometry and interferences result in limited access to the entire examination volume.

Licensee's Basis for Relief Request (as stated)

> The steam generator tube sheet-to-stub barrel weld is approximately 3.3" thick. Access to scanning the complete circumference of this weld in all required directions is limited by a number of inspection covers, branch connections, a weld pad, and a vessel identification plate. These factors result in limited examination coverage from the scan directions required by ASME [Code,] Section V and Section XI. These limitations are inherent to the original design of the steam generator vessel. Conformance with the ASME [Code,] Section XI requirements for essentially 100 [percent] of the volumetric coverage would require extensive structural modifications to the steam generator vessel.

No additional examinations were completed during the inspection interval; however, the examination coverage of 88.4 [percent] along with the results of the completed pressure tests provide reasonable assurance that pressure boundary integrity has been maintained for this component throughout the interval.

Licensee's Proposed Alternative Examination (as stated)

The required 0, 45, and 60 degree scans required by Appendix I, were completed to the extent practical. The location and extent of the noted limitations precludes any additional scanning angles increasing examination coverage. The aggregate examination coverage achieved was 88.4 [percent].

In addition to completing the required volumetric examination to the extent practical, numerous system leakage tests (ASME Section XI Category B-P and Generic Letter 88-05) at nominal system operating pressure (885 psig) and temperature (445°F) were completed with no evidence of leakage associated with the tube sheet-to-shell weld noted during the course of the interval.

Radiography as an alternative is not feasible because access is not available for film placement.

NRC Staff Evaluation

The ASME Code, Section XI requires essentially 100 percent volumetric coverage of the examination volume specified in ASME Code, Section XI, Figure IWC-2500-2 steam generator tube sheet-to-stub barrel weld at Braidwood Station, Unit 2. This examination volume includes the actual weld, as well as the adjacent base metal on either side of the weld extending to a distance of 1/2" from the extremities of the weld crown. The licensee conducted a volumetric examination of the tube sheet-to-stub barrel weld by conducting the required 0, 45, and 60 degree UT scans of the accessible regions using procedures and personnel qualified in accordance with the ASME Code, Section XI, Appendix III. The location and extent of the design limitations precluded any additional scanning angles increasing examination coverage. The aggregate examination coverage achieved was 88.4 percent. Access to scanning the complete circumference of this weld in all required directions was limited by a number of inspection covers, branch connections, a weld pad, and a vessel identification plate. Conformance with the ASME Code, Section XI requirements for essentially 100 percent volumetric examination coverage would require extensive structural modifications around the steam generator tube sheet-to-stub barrel weld. This would impose a burden on the licensee. These examinations are, therefore, impractical to perform to the extent required by the ASME Code, Section XI. In addition to completing the required volumetric examination to the extent practical, the licensee performed numerous system leakage tests (ASME Code, Section XI Category B-P and Generic Letter 88-05) at nominal system operating pressure and temperature with no evidence of leakage associated with the tube sheet-to-shell weld noted during the course of the interval.

The NRC staff determined that the ASME Code, Section XI, requirement to perform the volumetric examination of the generator tube sheet-to-stub barrel weld, with essentially 100 percent coverage of the examination volume specified in ASME Code, Section XI, Figure IWC-2500-2 is impractical. Based on the volumetric coverage obtained and the leakage tests

performed, it is reasonable to conclude that if significant service-induced degradation had occurred in the subject welds, evidence of it would have been detected by the examinations that were performed. Furthermore, the NRC staff determined that the examinations performed provide reasonable assurance of structural integrity of the subject weld for Braidwood Station, Unit 2.

4.0 CONCLUSION

The NRC staff has reviewed the licensee's submittals and concluded that the ASME Code examination coverage requirements are impractical for the subject welds listed in RR I2R-50 and that imposition of the ASME Code requirements would create a burden on the licensee. The NRC staff further determined that, based on the volumetric and surface coverage, if applicable, obtained on the subject welds, it is reasonable to conclude that if significant service-induced degradation had occurred, evidence of it would have been detected by the examinations that were performed. Therefore, the NRC staff concluded that the examinations performed to the extent practical provide reasonable assurance of structural integrity of the subject welds.

Additionally, the NRC staff concluded that granting relief pursuant to 10 CFR 50.55a(g)(6)(i) is authorized by law and will not endanger life or property, or the common defense and security, and is otherwise in the public interest given due consideration to the burden upon the licensee that could result if the requirements were imposed on the facility.

The NRC staff concluded that the licensee has adequately addressed all of the regulatory requirements set forth in 10 CFR 50.55a(g)(6)(i), and is in compliance with 10 CFR 50.50.55a with the granting of this relief. Therefore, the NRC staff grants relief for the examination coverage for the subject welds listed in RR I2R-50 for Braidwood Station, Units 1 and 2, for the second 10-year ISI interval.

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

Principal Contributor: T. McLellan, NRR

Date: March 8, 2010

Please contact Mr. Marshall David at (301) 415-1547 if you have any questions on this action.

Sincerely,

/RA/

Stephen J. Campbell, Chief
Plant Licensing Branch III-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. STN 50-456 and STN 50-457

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