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Exelon Nuclear

10 CFR 50.55a

July 25, 2007
BW070053

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Braidwood Station, Units 1 and 2
Facility Operating License Nos. NPF-72 and NPF-77
NRC Docket Nos. 50-456 and 50-457

Subject: Inservice Inspection Program Relief Request I2R-07, Revision 1

References:
(1) Letter from T. J. Tulon (Commonwealth Edison Company) to U.S. NRC Document Control Desk, "Braidwood Nuclear Power Station Units 1 and 2, Second Interval Inservice Inspection Program Plan" dated April 17, 1998.

(2) Letter from A. J. Mendiolla (US NRC) to O. D. Kingsley (Commonwealth Edison Company), "Evaluation of the Second 10-Year Interval Inservice Inspection Program Request for Relief No. I2R-07 for Braidwood Station, Units 1 and 2 (TAC Nos. MA1612 and MA1613)," dated September 10, 1999.

In accordance with 10 CFR 50.55a, "Codes and standards," paragraph (a)(3)(i), Exelon Generation Company, LLC (EGC), is requesting relief from the 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 alternative methods will provide an acceptable level of quality and safety.

Specifically, a revision to previously approved Braidwood Relief Request I2R-07 (submitted under Reference 1 and approved through Reference 2) is requested to make use of American Society of Mechanical Engineers (ASME) Code Case N-706, "Alternative Examination Requirements of Table IWB-2500-1 and Table IWC-2500-1 for PWR Stainless Steel Residual and Regenerative Heat Exchangers, Section XI Division 1." EGC requests the use of Code Case N-706 as an alternative for ASME, Boiler and Pressure Vessel Code, Section XI required inservice inspections on the Residual Heat Removal (RHR) Heat Exchanger. ASME Code Case N-706 allows an alternate

examination method on these vessels. Use of this code case is not currently addressed in either Regulatory Guide 1.147, "Inservice Inspection Code Case Acceptability, ASME Section XI, Division 1," Revision 14 or Regulatory Guide 1.193, "ASME Code Cases Not Approved for Use", Revision 1. The details of the request for relief are enclosed.

EGC requests approval of this request by March 7, 2008 in order to support pre-outage inspections scheduled for the Braidwood Station Unit 2 Spring 2008 refueling outage (i.e., A2R13). If there are any questions or comments, please contact Mr. David Gullott, Regulatory Assurance Manager, at (815) 417-2800.

Respectfully,

Thomas Coutu
Site Vice President
Braidwood Station

Enclosure: Braidwood Station Relief Request I2R-07, Revision 1

Enclosure

Braidwood Station

Relief Request I2R-07, Revision 1

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COMPONENT IDENTIFICATION

Code Class: 2

References: Table IWC-2500-1, IWC-2420, IWC-3000, and Code Case N-706, "Alternative Examination Requirements of Table IWB-2500-1 and Table IWC-2500-1 for PWR Stainless Steel Residual and Regenerative Heat Exchangers, Section XI, Division I"

Examination Categories: C-B

Item Numbers: C2.21, C2.22

Description: Alternative to Volumetric Examination of Residual Heat Removal Heat Exchanger Nozzle-to-Shell Welds and Nozzle Inner Radii

Component Numbers:

Heat Exchanger	Weld Numbers
1RH01AA	RHXN1, RHXN2
1RH01AB	RHXN1, RHXN2
2RH01AA	RHXN1, RHXN2
2RH01AB	RHXN1, RHXN2

Drawing Numbers: 1RHX-01 (Unit 1), 2RHX-01 (Unit 2)

Reference Documents:

1. NUREG/CR 4878, "Analysis of Experiments on Stainless Steel Flux Welds," April 1987.
2. T. W. Simpkin (ComEd) letter to Dr. Thomas E. Murley (USNRC), "Braidwood Station Unit 2 Flaw Evaluation for RHR Heat Exchanger Nozzle to Shell Welds," dated November 13, 1991.
3. Robert M. Pulsifer (USNRC) letter to Thomas J. Kovach (ComEd), "Residual Heat Removal Heat Exchanger Nozzle to Shell Welds (TAC No. M82087)," dated November 21, 1991.
4. Harold D. Pontious, Jr. (ComEd) letter to USNRC Document Control Desk, "Supplemental Information Regarding the Fracture Mechanics Evaluation of Residual Heat Removal System Heat Exchanger Inlet and Outlet Nozzle to Shell Welds," dated November 9, 1994.
5. Denise M. Saccomando (ComEd) letter to USNRC Document Control Desk, "Supplement to Fracture Mechanics Evaluation of Residual Heat Removal System Heat Exchanger Inlet and Outlet Nozzle to Shell Welds," dated December 20, 1994.

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6. George F. Dick, Jr. (USNRC) letter to D. L. Farrar (ComEd), "Residual Heat Exchanger Nozzle Welds, Byron Station, Units 1 and 2, and Braidwood Station, Units 1 and 2 (TAC Nos. M90894, M80895, M91408 and M90840), " dated February 3, 1995.
7. R. A. Capra (USNRC) letter to D. L. Farrar (ComEd), "Residual Heat Exchanger Nozzle Welds, Byron Station, Units 1 and 2, and Braidwood Station, Units 1 and 2 (TAC Nos. M94393, M94394, M94395 and M94396), " dated February 29, 1996.
8. A. J. Mendiolla (USNRC) letter to O. D. Kingsley (ComEd), "Evaluation of the Second 10-Year Interval Inservice Inspection Program Request for Relief No.I2R-07 for Braidwood Station, Units 1 and 2 (TAC Nos. MA1612 and MA1613)," dated September 10, 1999.
9. LTR-PAFM-03-24, "Technical Basis for Revision of Inspection Requirements for Regenerative and Residual Heat Exchangers," dated August 2003.
10. Pacific Northwest National Laboratory Study PVP2005-71633, "Assessment of ASME Code Examinations on Regenerative, Letdown and Residual Heat Removal Heat Exchangers," dated July 2005.
11. Evangelos S. Marinos (USNRC) letter to David A. Christian (Virginia Electric and Power Company), "Surry Power Station, Unit No. 2 – Fourth 10-Year Inspection Interval Relief Request CMP-007 (TAC No. MD2673)," dated November 29, 2006 (ADAMS Accession Number ML063340294).

CODE REQUIREMENTS

Table IWC-2500-1, Examination Category C-B, Item C2.21 requires volumetric and surface examination of the Nozzle to Shell welds and Item C2.22 requires volumetric examination of the nozzle inner radius of the regions described in Figure IWC 2500-4(a) or (b), for nozzles without reinforcing plate in vessels >½ inch nominal thickness. Examinations shall be conducted on nozzles at terminal ends of piping runs selected for examination under Examination Category C-F each inspection interval.

In cases of multiple vessels of similar design, size, and service, the required examinations may be limited to one vessel or distributed among the vessels.

CODE REQUIREMENTS FROM WHICH RELIEF IS REQUESTED

Relief is requested for the Table IWC-2500-1, Examination Category C-B, Item C2.21 and C2.22 requirement to perform volumetric examination of the Residual Heat Removal Heat Exchanger nozzle-to-shell welds and nozzle inner radii at Braidwood Station Units 1 and 2.

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BASIS FOR RELIEF

Pursuant to 10 CFR 50.55a(a)(3)(i), relief is requested on the basis that the proposed alternative would provide an acceptable level of quality and safety.

Component Description

The Residual Heat Removal (RHR) Heat Exchangers are approximately 7/8-inch nominal wall thickness with nozzles of 14-inch diameter and approximately 3/8 inch in nominal wall thickness. As shown in Figure 1, the subject joint is best characterized as a fillet welded nozzle using an internal reinforcement pad and, as such, is not accurately represented by Figures IWC-2500-4(a) and 4(b), which depict full penetration butt welded nozzles. The inner surface of the nozzle reinforcement pad is representative of the nozzle inner radius requiring Section XI inspection.

Examination Limitations

Due to the inherent geometric constraints of the nozzle design, performance of the Code required ultrasonic examinations (UT) of the nozzle inner radius cannot be accomplished. Outside geometrical constraints also limit the ultrasonic examination of the nozzle-to-vessel welds.

Background

The Braidwood RHR Heat Exchangers were manufactured by Joseph Oats Corporation in 1975 per the requirements of ASME Section III, 1974 Edition, Summer 1975 Addenda, Subarticle NC-3200, Alternate Design Rules for Vessels. The nozzles and shell are fabricated from SA240 type 304 stainless steel material. The RHR heat exchangers' tube side is Code Class 2 and the shell side is Class 3. The nozzle to shell welds were not required to be volumetrically examined during fabrication; only liquid penetrant examinations were performed on the final surfaces of the weld.

During the preservice inspections of the Byron and Braidwood components, relief was requested from performing volumetric examinations of the nozzle to vessel welds due to inherent geometric constraints. The fillet weld located directly above the nozzle-to-vessel weld is an obstruction to the proper movement of the UT inspection transducer. These constraints limit the ability to perform a meaningful UT inspection. These relief requests, NR-14 for Byron Unit 1, NR-13 for Byron Unit 2, 1NR-12 for Braidwood Unit 1, and 2NR-12 for Braidwood Unit 2 were approved by the NRC in NUREG-876, "Safety Evaluation Report Related to the Operation of Byron Station, Units 1 and 2," Supplement 7, Appendix K and NUREG-_1002, "Safety Evaluation Report Related to the Operation of Braidwood Station, Units 1 and 2," Supplement 2, Appendix K.

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BASIS FOR RELIEF (Continued)

Relief Requests NR-12 for Byron and NR-12 for Braidwood were included with the First Ten Year Interval ISI Program Submittal. These relief requests sought the same Code inspection exemptions for the nozzle to shell welds as did the preservice relief requests. Relief for the nozzle to shell weld examination was denied and the NRC requested a best effort UT of the nozzle-to-vessel welds be conducted.

The initial UT inspection performed in 1991 on the Braidwood Unit 2 "A" RHR heat exchanger identified indications which exceeded the ASME Section XI 1983 Edition, Summer 1983 Addenda, Article IWC-3000 allowable limits. The indications, which exceeded the acceptance standards of IWC-3000, were subjected to further evaluation in accordance with ASME Section XI Subarticle IWB-3600. The required Fracture Mechanics Analysis was submitted to the NRC (Reference 2) and the indications were found to be acceptable for continued service (Reference 3). Additional examinations were performed in 1992 for Byron Unit 2 and Braidwood Unit 1 heat exchangers, in 1993 for Byron Unit 1 and Braidwood Unit 2 heat exchangers, in 1994 for Braidwood Unit 2 heat exchangers, and in 1995 for Byron Unit 2 heat exchangers. All welds in this population have been examined at Braidwood Station and all examinations confirmed the existence of fabrication flaws in the nozzle to vessel welds.

The examination results from the inspections performed in 1994 at Braidwood Unit 2 included flaws on the outlet nozzle weld of the 2B RHR vessel that exceeded the 60% acceptance criteria. The size change from previous inspections was attributed to enhancement in the volumetric examination technique. An ASME section XI repair by excavation was completed; the unacceptable flaws were removed and subsequently examined by a best effort UT.

After completion of the best effort UT requested by the NRC, Relief Request NR-23 was submitted, proposing a surface examination in lieu of the Code required volumetric examination for the nozzle-to-vessel welds. Relief was granted (Reference 7), with the provision that a UT examination of one RHR Heat Exchanger nozzle-to-vessel weld per unit will be performed in accordance with IWB-3500 during the next inspection interval.

Safety Significance

The RHR Heat Exchanger welds are within a Class 2 system, on a moderate energy line that operates at a relatively low pressure (approximately 400 psig). This operating pressure is below the design pressure (600 psig) used for allowable flaw size calculations in the Fracture Mechanics Analysis. The actual induced piping loads on the nozzles are less than 60% of the design loads used by the allowable flaw size calculations.

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BASIS FOR RELIEF (Continued)

Observations made of the excavation areas on the Braidwood Unit 2 "B" Outlet RH HX Nozzle (2RHX-01) repair verified that the indications found in the RH HX Nozzles are fabrication flaws: slag, incomplete fusion and excess porosity. No service-induced flaws were found. In addition, the weld bevel groove selected during the original fabrication of these welds (K-bevel groove with fillet weld reinforcement) along with the associated thickness of the nozzle (0.375" nominal wall) make repeatable UT examinations of these welds extremely difficult since the upper envelope of the nozzle examination volume (0.125" from nozzle ID surface) includes the bevel of the groove weld where fabrication flaws are concentrated.

A hydrostatic test was performed by the manufacturer, after fabrication, for all vessels at a pressure of 803 psig. Another hydrostatic test was performed in the field, after installation, at a pressure of 750 psig for Braidwood Unit 1 and 800 psig for Braidwood Unit 2 with no leakage noted from these regions. Pressure is the dominant load on the nozzle weld. The hydro tests have demonstrated that these nozzle welds can withstand almost double the operating pressure, without structural failure, despite the presence of the fabrication flaws in the weld.

The Fracture Mechanics Analysis shows that these nozzles have a large flaw tolerance because of material ductility, flexibility (thin walled), and the reinforcement provided by the fillet weld. It has also been shown (Reference 1) that the fracture toughness of flux welds is higher than that used in the allowable flaw size calculation performed as part of the fracture mechanics evaluation.

A finite element analysis was performed and submitted to the NRC for review (Reference 4). The analysis was subsequently supplemented (Reference 5). The results of this analysis show that the inside diameter of the nozzle is in compression and the outside diameter (O.D.) is in tension. Consequently, any service-induced flaw would be expected to initiate at the O.D. of the nozzle where the weld membrane stresses are in tension. All the fabrication flaws exist within the areas shown in the analysis to be in compressive or negligible stress and are not subject to propagation. The NRC review of the finite element analysis is documented in Reference 6.

The objective of the Inservice Inspection Program is to detect "service-induced flaws" before they become safety significant. As discussed above, a service-induced flaw would initiate as a surface flaw at the nozzle O.D., so a Penetrant Test would be more appropriate for detecting an O.D. located service-induced flaw than a volumetric exam. Also, due to the low stresses present and given the fracture toughness of stainless steel, leakage from the joint would likely be detected before a major leak would occur. A VT-2 examination is conducted on all RHR Heat Exchangers once per inspection period as required by ASME Section XI Category C-H.

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BASIS FOR RELIEF (Continued)

Performance of surface examinations each inspection period will provide the best means for detection of service-induced flaws and provide assurance that a service-induced defect will be identified prior to component failure. Ultrasonic examinations for the RHR nozzle-to-vessel weld will not provide detection capabilities of service-induced flaws beyond that provided by surface examination. Additionally, performance of the ultrasonic examinations requires extensive labor resources, unnecessary radiation exposure to the examiners and significant cost without a commensurate increase in quality or public safety.

Justification

Based on the volumetric examinations and the repair completed at Braidwood Unit 2 these flaws were characterized as fabrication defects, and not service-induced cracks. Additionally, the Fracture Mechanics Analysis of the indications predicts negligible crack growth. The Fracture Mechanics Analysis also revealed that the inside nozzle surface is in compression and the outside surface is in tension. Therefore, a Section XI surface examination is a more appropriate test to verify the structural integrity of these welds.

In the Safety Evaluation (Reference 8) approving Revision 0 of Relief Request I2R-07, NRC staff concluded ***"performance of PT examinations each inspection each period as proposed by the licensee will provide and acceptable means for detection of the service induced flaws on the surface of the nozzles and should identify any significant service induced crack growth. Performance of the Code required UT examinations for the RHR nozzle-to-vessel weld would provide additional monitoring capabilities for service induced flaw growth beyond that provided by the PT examination. However, because the licensee has UT examined all the nozzles at least once, has removed and/or analyzed existing indications, has concluded that the indications are fabrication flaws, and because crack growth would be expected to be slow due to the compressive stresses on the inside surface of the nozzles, additional UT examinations in this service period will not add significant assurance that the indications are not growing in service."***

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PROPOSED ALTERNATE PROVISIONS

Code Case N-706, "Alternative Examination Requirements of Table IWB-2500-1 and Table IWC-2500-1 for PWR Stainless Steel Residual and Regenerative Heat Exchangers, Section XI Division 1" allows substituting the volumetric examination required by Table IWC-2500-1 (and Table IWB-2500-1) by a VT-2 visual examination, provided no previous through-wall leaks have been experienced on the subject welds and at least one volumetric examination has been completed on these welds. Tables 1 and 2 provide the surface and volumetric examination history of these welds at Braidwood Station. Previous VT-2 examination results are not included in these tables, but review of previous results confirmed that through-wall leakage has not been identified on any of these welds at Braidwood Station.

In anticipation of the approval of Code Case N-706, the NRC staff contracted Pacific Northwest National Laboratory (PNNL) to perform a study regarding the issues of inspection and the value of continued volumetric and/or surface examinations of pressure-retaining shell welds from the exterior surface of RHR (and regenerative) heat exchangers. The PNNL study (Reference 10) concluded that failure frequencies of these heat exchanger welds are very low (no documented failure events within industry databases), elimination of volumetric and/or surface examinations on these heat exchangers has little impact on core damage or large early release frequencies, and the results of the study support the technical basis for possible changes to ASME Section XI rules for examination of these heat exchangers.

Braidwood Station will perform a VT-2 of the nozzle-to-vessel welds on the A and B RHR Heat Exchangers each during Examination Category C-H pressure testing periodic test for the remainder of the second inspection interval as specified by Code Case N-706 Item 1.15.

In addition to the periodic VT-2 examination, the nozzle-to-vessel welds on the A and B RHR Heat Exchangers for Braidwood Units 1 and 2 will receive a Section XI surface examination during the remaining inspection period and a Visual (VT-1) examination of the nozzle inner radii in one heat exchanger will be performed either directly or remotely, to the extent practical, if disassembly of a heat exchanger is required for maintenance purposes as originally committed under Revision 0 of Relief Request I2R-07. The VT-1 examinations will only be performed once per inspection interval.

PERIOD FOR WHICH RELIEF IS REQUESTED

Relief is requested for the remainder of the second ten-year inspection interval of the Inservice Inspection Program for Braidwood Units 1 and 2.

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PRECEDENTS

A similar relief request was recently approved for Dominion (Virginia Electric and Power Company) Surry Power Station, Unit 2 (Reference 11).

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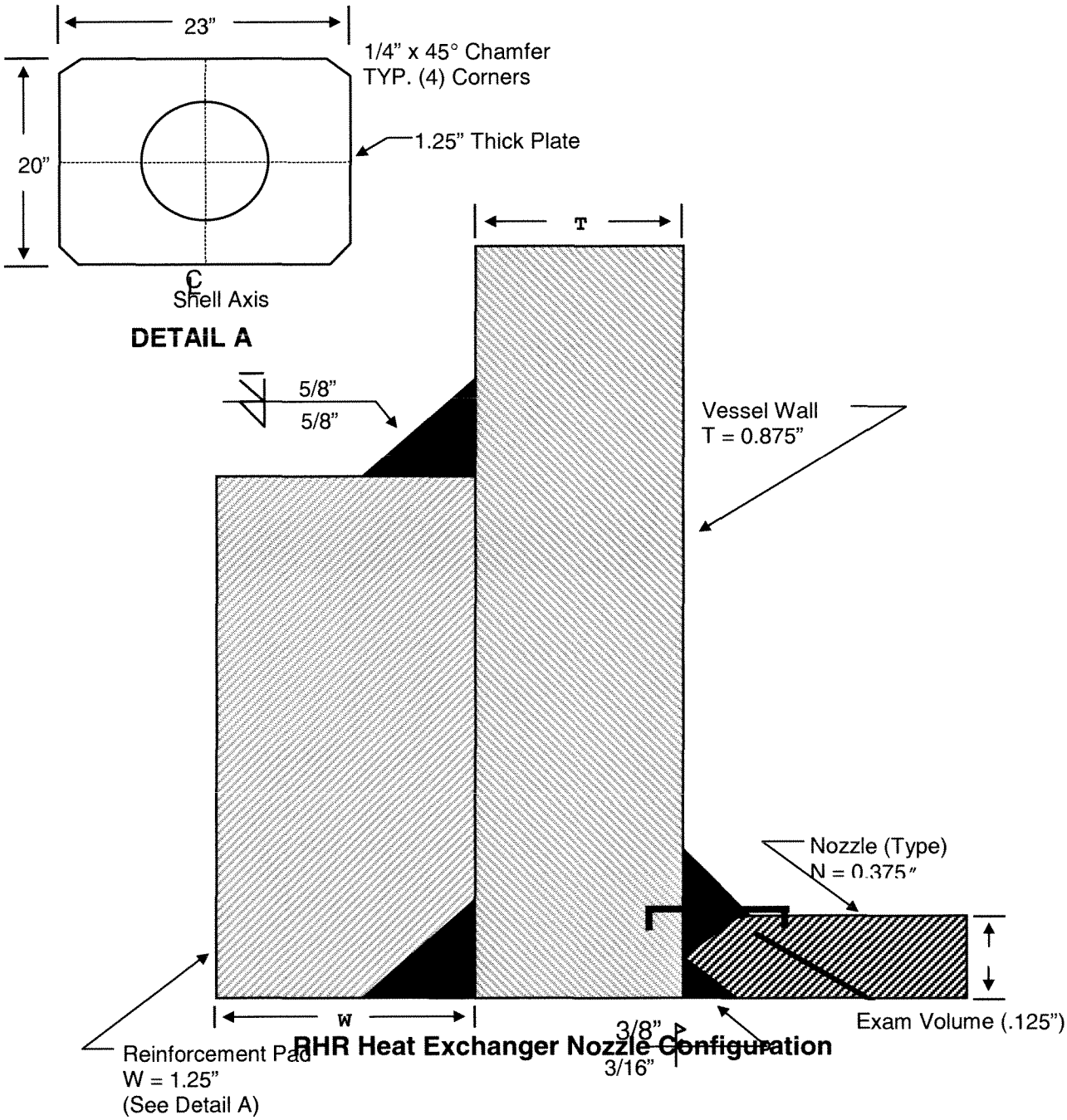
Figure 1
(Not to Scale)



RHR Heat Exchanger Nozzle Configuration

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Table 1
Braidwood Station Unit 1RHR Heat Exchanger Inspection History
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Weld Number	Inspection Month/Year	Exam Type		Exam Results / Comments
		PT	UT	
1RHX-01-1RHXN1 (A HX)	3/1991	X	X	No Recordable Indications (NRI)
	9/1992	X	X	Liquid Penetrant (PT) 7/32" linear indication (L/I) at 1.0" counterclockwise (CCW), 3/16" L/I at 7.5" CCW and 5/32" L/I at 22" CCW. Indications were removed, removal verified by PT examination. Ultrasonic (UT) Numerous indications noted, evaluated and accepted by System Materials Analysis Department (SMAD).
	4/1997	X		NRI
	9/1998		X	Examination performed to fulfill First Interval NRC SER (dated February 22, 1996) requirement to volumetrically inspect one nozzle, per unit, during the Second Interval to verify no flaw growth. No appreciable flaw growth was noted.
	3/2000	X		NRI
	4/2003	X		NRI

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Table 1
Braidwood Station Unit 1RHR Heat Exchanger Inspection History
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Weld Number	Inspection Month/Year	Exam Type		Exam Results / Comments
		PT	UT	
1RHX-01-1RHXN2 (A HX)	9/1992	X	X	(PT) NRI (UT) Numerous indications noted, evaluated and accepted by SMAD.
	4/1997	X		NRI
	3/2000	X		NRI
	4/2003	X		NRI

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Table 1
Braidwood Station Unit 1RHR Heat Exchanger Inspection History
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Weld Number	Inspection Month/Year	Exam Type		Exam Results / Comments
		PT	UT	
1RHX-01-1RHXN1 (B HX)	9/1992	X	X	(PT) NRI (UT) Numerous indications noted, evaluated and accepted by SMAD.
	4/1997	X		NRI
	3/2000	X		NRI
	4/2003	X		NRI

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Table 1
Braidwood Station Unit 1RHR Heat Exchanger Inspection History
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Weld Number	Inspection Month/Year	Exam Type		Exam Results / Comments
		PT	UT	
1RHX-01-1RHXN2 (B HX)	9/1992	X	X	(PT) 3/32" recordable indication (R/I) at 0.5" CCW and 1/8" R/I at 16.5" CCW. Indications were removed, removal verified by PT examination. (UT) Numerous indications noted, evaluated and accepted by SMAD
	4/1997	X		NRI
	3/2000	X		NRI
	4/2003	X		NRI

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Table 2
Braidwood Station Unit 2 RHR Heat Exchanger Inspection History
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Weld Number	Inspection Month/Year	Exam Type		Exam Results / Comments
		PT	UT	
2RHX-01-1RHXN1 (A HX)	10/1991 11/1991	X	X X	(PT) NRI (UT) Recordable Indications 10" CCW, 16.5" CCW & 23" CCW; 0.5", 1.5", 5.75", 6.5", 7.375", 16.125", 16.5", 17.5", 18.5", 21.125", 23.25", 24.5", 31", 35.25", 36.5" and 39.625" (All CCW facing vessel).
	3/1993		X	Resized indications using P-Scan, evaluated and accepted per SMAD.
	9/1994		X	Indications at 18.4" to 18.9", 19.8" to 23.1" and 30.4" to 30.5". Acceptable size per Westinghouse evaluation.
	3/1996	X		NRI
	4/1999	X		NRI
	4/2002	X		NRI
	10/2006	X		NRI

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Table 2
Braidwood Station Unit 2 RHR Heat Exchanger Inspection History
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Weld Number	Inspection Month/Year	Exam Type		Exam Results / Comments
		PT	UT	
2RHX-01-1RHXN2 (A HX)	10/1991 11/1991	X	X X	(PT) NRI (UT) Sample expansion. Numerous indications noted. Reference reports for details.
	3/1993		X	Resized indications using P-Scan, accepted per SMAD.
	9/1994		X	Indications noted at 9.3" to 10.5", 23.7" to 24.4" and 41.1" to 41.7". Acceptable per Westinghouse evaluation.
	3/1996	X		NRI
	4/1999	X		NRI
	4/2002	X		NRI
	10/2006	X		NRI

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Table 2
Braidwood Station Unit 2 RHR Heat Exchanger Inspection History
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Weld Number	Inspection Month/Year	Exam Type		Exam Results / Comments
		PT	UT	
2RHX-01-1RHXN1 (B HX)	11/1991		X	Sample expansion. Numerous indications noted. Reference reports for details.
	3/1993		X	Resized indications using P-Scan, evaluated and accepted per SMAD.
	10/1994 11/1994	X	X X	(PT) NRI, baseline examination after weld repairs. (UT) RECORDABLE INDICATIONS: Indications noted from 0" to 1.9", 2.5" to 2.8", 3.2" to 3.25", 4" to 4.2", 5" to 9.9", 13.1" to 13.5", 21.6" to 23.6", 24.6" to 25", 26.3" to 26.4", 27" to 27.1", 28.3" to 28.4", 30.1" to 30.2", 32.3" to 32.9", 35.3" to 38.7", 41.5" to 41.6" and 42.2" to 44.6". Some indications did not meet Westinghouse evaluation. Weld repairs were performed. All indications met the Westinghouse evaluation after repair was completed.
	3/1996	X		NRI
	4/1999	X		NRI
	4/2005	X		NRI
	10/2006	X		NRI

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Table 2
Braidwood Station Unit 2 RHR Heat Exchanger Inspection History
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Weld Number	Inspection Month/Year	Exam Type		Exam Results / Comments
		PT	UT	
2RHX-01-1RHXN2 (B HX)	11/1991		X	Sample expansion. Numerous indications noted. Reference reports for details.
	3/1993		X	Resized indications using P-Scan, evaluated and accepted per SMAD.
	10/1994		X	Indications noted at 0" to .32", .76" to 1.2", 4.9" to 5.7", 8.4" to 9.9", 8.4" to 9.8", 13.2" to 14.6", 15" to 15.1", 16.2" to 16.3", 23" to 23.2", 25.4" to 25.5", 29.1" 29.5", 36" to 36.3", 41.7" to 41.75", 42.3" to 42.2" and 44.6" to 44.7". Acceptable per Westinghouse evaluation.
	3/1996	X		NRI
	4/1999	X		NRI
	4/2005	X		NRI
	10/2006	X		NRI