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December 5, 2008

LTR: BYRON 2008-0119
File: 1.10.0101

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

Byron Station Unit 2
Facility Operating License No. NPF-66
NRC Docket No. STN 50-455

Subject: Byron Station, Unit 2, 60-Day Response to First Revised NRC Order EA-03-009, "Issuance of First Revised NRC Order (EA-03-009) Establishing Interim Inspection Requirements for Reactor Pressure Vessel Heads at Pressurized Water Reactors"

Reference: Letter from R. W. Borchardt (NRC), "Issuance of First Revised NRC Order (EA-03-009) Establishing Interim Inspection Requirements for Reactor Pressure Vessel Heads at Pressurized Water Reactors," dated February 20, 2004

This letter provides the results of examinations performed at Byron Station, Unit 2, in accordance with the requirements of the referenced NRC Order.

During the Fall 2008 refueling outage (i.e., B2R14), Byron Station Unit 2, completed visual, surface, and volumetric nondestructive examinations in accordance with the NRC Order. Section IV. E. of the Order requires that the results of this examination be submitted to the NRC within 60 days after returning the plant to operation.

The summary of the volumetric examination results is provided as an attachment to this letter.

Due to Primary Water Stress Corrosion Cracking (PWSCC) found in Penetration 68 during the B2R13 examination, the Unit 2 Reactor Pressure Vessel (RPV) Head now falls into the "High Susceptibility" category in accordance with the referenced NRC Order, which requires an additional examination in accordance with Section IV.C (1) footnote 3. This additional examination of Penetration 68 was conducted using dye penetrant testing in addition to the examinations required by paragraph IV.C.(5)(a) and paragraph IV.C.(5)(b).

examination of Penetration 68 was conducted using dye penetrant testing in addition to the examinations required by paragraph IV.C.(5)(a) and paragraph IV.C.(5)(b).

<u>60-Day Reporting Required by NRC Order Section IV.E Concerning Section IV.C Examinations</u>

Paragraph C, Item 1 of this Order requires the following inspections:

(1) For those plants in the High category, RPV head and head penetration nozzle inspections shall be performed using the techniques of paragraph IV.C.(5)(a) and paragraph IV.C.(5)(b) every refueling outage.

(a) Bare metal visual examination of 100% of the RPV head surface (including 360° around each RPV head penetration nozzle).

(b) Either:

(i) Ultrasonic testing of each RPV head penetration nozzle (i.e., nozzle base material) from two (2) inches above the J-groove weld to the bottom of the nozzle and an assessment to determine if leakage has occurred into the interference fit zone,

(ii) Eddy current testing or dye penetrant testing of the wetted surface of each J-Groove weld and RPV head penetration nozzle base material to at least two (2) inches above the J-groove weld, or

(iii) A combination of (i) and (ii) to cover equivalent volumes, surfaces and leak paths of the RPV head penetration nozzle base material and j-groove weld as described in (i) and (ii).

A remote/direct bare metal visual inspection of the Unit 2 RPV head was performed during B2R14, to meet the requirements of Item 5(a). The inspection included an examination around the full circumference of each RPV head penetration nozzle (i.e., 78 control rod drive mechanism (CRDM) nozzles and the RPV head vent line) and the RPV head surface to provide 100% coverage of the RPV head. No evidence of CRDM or RPV head vent line boric acid leakage and no evidence of any wastage was observed.

The inspection was performed in accordance with procedure ER-AP-335-1012, "Visual Examination of PWR Reactor Vessel Head Penetrations." The inspection, performed by VT-2 certified personnel, used a pole-mounted camera and a remotely operated crawler with camera, connected to a video recorder/monitor that provided the examiner with immediate access to the examination surfaces. The inspection used remote equipment capable of resolving the appropriate detail (i.e., VT-1/1C character height in accordance with 1992 ASME Boiler and Pressure Vessel Code Section XI, Table IWA-2210-1) at two feet. The actual distances viewed were less than two feet, which gave extremely close views of the nozzle to interface region, thereby ensuring any boric acid leakage would be easily identified.

As previously reported, in B2R13, Penetration 68 had a PWSCC flaw that was required to be repaired. During re-examination in B2R14, in accordance with the requirements of 5(b), no evidence of PWSCC was found in Penetration 68 as well as all other penetrations.

Penetration 68 dye penetrant examination was performed in accordance with Westinghouse procedure EXE-ISI-11, Revision 2, and FCN 01. Results found no surface discontinuities (PT White).

<u>60-Day Reporting Required by NRC Order Section IV.E Concerning Section IV.D Examinations</u>

Section IV.D required the following inspections:

D. During each refueling outage, visual inspections shall be performed to identify potential boric acid leaks from pressure-retaining components above the RPV head. For any plant with boron deposits on the surface of the RPV head or related insulation, discovered either during the inspections required by this Order or otherwise and regardless of the source of the deposit, before returning the plant to operation the Licensee shall perform inspections of the affected RPV head surface and penetrations appropriate to the conditions found to verify the integrity of the affected area and penetrations.

VT-2 certified examiners performed a visual inspection to identify potential boric acid leaks from pressure-retaining components above the RPV head. This inspection was performed during the B2R14 shutdown as part of the Mode 3 walkdown. Each of the doors on the integrated RPV head package was opened and the areas of the head insulation around the CRDMs and potential sources of leakage above the head were examined. No evidence of any boric acid leakage from pressure retaining components above the head was found.

During the volumetric examination of Penetration 41, a possible indication was identified. When the data was retrieved from B2R13 for comparison, it became apparent that the two datasets were not of the same penetration. The NDE vendor then determined that Penetration 41 had not been examined in B2R13 and Penetration 48 was examined twice. Penetration 41 was then examined during B2R14 with no evidence of any PWSCC being evident. The missed examination of Penetration 41 was documented in the Corrective Action Program (CAP). Additionally, the NDE vendor has completed an Extent of Condition (EOC) for Byron Unit 1 and Braidwood Units 1 and 2 to determine if a similar situation may have occurred. The EOC determined that no additional nozzle volumetric examinations were missed or same penetration examined twice had occurred.

There are no regulatory commitments contained in this letter.

Should you have any questions or desire additional information regarding this letter, please contact William Grundmann, Regulatory Assurance Manager, at (815) 406-2800.

Respectfully,

David M. Hoots
Site Vice President
Byron Nuclear Generating Station

Attachment Examination Summary from Westinghouse Report WDI-PJF-1303982-FSR-001

ecc: IEMA - Division of Nuclear Safety
Site Vice President - Byron Station
Vice President - Licensing and Regulatory Affairs
Regulatory Assurance Manager - Byron Station
Director - Licensing and Regulatory Affairs
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ATTACHMENT

Examination Summary from Westinghouse Report WDI-PJF-1303982-FSR-001

“Byron Generating Station Outage – B2R14 Reactor Vessel Head Penetration Examination”

Byron Generating Station Outage – B2R14 Reactor Vessel Head Penetration Examination

October 2008

Final NDE Report

WDI-PJF-1303982-FSR-001

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1.0 INTRODUCTION

During the Byron Unit B2R14 outage in October 2008, Westinghouse performed nondestructive examinations (NDE) of the reactor vessel head CRDM penetration nozzles, the reactor vessel head vent tube and the vent line j-weld.

The purpose of the examination program was to identify evidence of primary water stress corrosion cracking (PWSCC) that might be present on the OD and ID surfaces of the head penetration tubes, the ID surface of the vent line tube, and the surface of the vent line J-groove weld. Examinations of the CRDM penetration tubes also included the application of techniques to identify evidence of CRDM leakage in the shrink-fit region at the tube-to-head interface. Examinations were performed using procedures and techniques demonstrated through the EPRI/MRP protocol, and/or Westinghouse internal demonstration programs, and applied in a manner acceptable within the context of the February 20, 2004, USNRC Order EA-03-009, Rev. 1, "Establishing Interim Inspection Requirements for Reactor Vessel Heads at Pressurized Water Reactors".

The reactor vessel head at Byron 2 is a Westinghouse design and manufactured by Babcock & Wilcox (B&W). The head contains seventy eight alloy 600 penetration tubes that are shrunk fit in the reactor vessel head and attached with alloy 182/82 partial penetration J-groove welds. The head also contains one alloy 600 vent tube, attached to the vessel head with an alloy 182/82 partial penetration J-groove weld.

There are a variety of configurations for the seventy eight penetration tubes, each configuration requiring special consideration for examination. The penetration tubes measure 4.04" on the OD and have an ID dimension of 2.75". The nominal wall thickness is 0.645". The penetration tube configurations are as follows:

- 55 penetration tubes with thermal sleeves installed
- 5 open thermocouple column penetration tubes
- 18 open penetration tubes
- One (1) 1.00" - schedule 160, ID vent tube

By virtue of the discovery of a defect during the Spring 2007 Byron B2R13 outage, the Byron Unit 2 reactor vessel head is in the "high susceptibility" category. For a reactor vessel head in the high category, the NRC Order EA 03-009 specifies for each penetration:

"Either

i *Ultrasonic testing of the RPV head penetration nozzle volume (i.e., nozzle base material) from 2 inches above the highest point of the root of the J-groove weld (on a horizontal plane perpendicular to the nozzle axis) to 2 inches below the lowest point at the toe of the J-groove weld on a horizontal plane perpendicular to the nozzle axis (or the bottom of the nozzle if less than 2 inches; OR from 2 inches above the highest point of the root of the J-groove weld (on a horizontal plane perpendicular to the nozzle axis) to 1.0-inch below the lowest point at the toe of the J-groove weld (on a horizontal plane perpendicular to the nozzle axis) and including all RPV head penetration nozzle surfaces below the J-groove weld that have an operating stress level (including all residual and normal operation stresses) of 20 ksi tension and greater. In addition, an assessment shall be made to determine if leakage has occurred into the annulus between the RPV head penetration nozzle and the RPV head low-alloy steel.*

ii *Eddy current testing or dye penetrant testing of the entire wetted surface of the J-groove weld and the wetted surface of the RPV head penetration nozzle base material from at least 2 inches above the highest point of the root of the J-groove weld (on a horizontal plane perpendicular to the nozzle axis) to 2 inches below the lowest point at the toe of the J-groove weld on a horizontal plane perpendicular to the nozzle axis (or the bottom of the nozzle if less than 2 inches OR from 2 inches above the highest point of the root of the J-groove weld (on a horizontal plane perpendicular to the nozzle axis) to 1.0-inch below the lowest point at the toe of the J-groove weld (on a horizontal plane perpendicular to the nozzle axis) and including all RPV head penetration nozzle surfaces below the J-groove weld that have an operating stress level (including all residual and normal operation stresses) of 20 ksi tension and greater.*

iii. *A combination of (i) and (ii) to cover equivalent volumes, surfaces and leak paths of the RPV head penetration nozzle base material and J-groove weld as described in (i) and (ii). Substitution of a portion of a volumetric examination may be performed with the following requirements:*

1. *On nozzle material below the J-groove weld, both the outside diameter and inside diameter surfaces of the nozzle must be examined.*
2. *On nozzle material above the J-groove weld, surface examination of the inside diameter surface of the nozzle is permitted provided a surface examination of the J-groove weld is also performed*

The examination program selected for Byron 2 included ultrasonic examinations of the seventy eight CRDM penetration nozzles with leakage assessment in accordance with Section IV.C.(5) (b) (i) of the Order, and eddy current examinations of the wetted surfaces of the vent tube and vent tube J-groove weld in accordance with Section IV.C.(5) (b) (ii) of the Order.

In anticipation that a combination of volumetric and surface examination techniques might be necessary to complete the reactor vessel head penetration inspection program, the following Westinghouse field service procedures and any associated field change requests (FCRs) were approved for use at Byron 2. With the exception of the vent line examination procedures, WDI-STD-101, Rev. 6 and WDI-STD-114, Rev. 5, all have been demonstrated through the EPRI/MRP protocol. In the absence of an EPRI/MRP protocol for the vent line applications, the examination procedures and techniques are based on processes demonstrated for examinations of steam generator tubes and demonstrated Westinghouse experience with these techniques.

- WDI-ET-003, Rev. 12
  "IntraSpect Eddy Current Imaging Procedure for Inspection of Reactor Vessel Head Penetrations"
- WDI-ET-004, Rev. 12
  "IntraSpect Eddy Current Analysis Guidelines "
- WDI-ET-008, Rev. 9
  "IntraSpect Eddy Current Imaging Procedure for Inspection of Reactor Vessel Head Penetrations With Gap Scanner"
- WDI-UT-010, Rev 15
  "IntraSpect Ultrasonic Procedure for Inspection of Reactor Vessel Head Penetrations, Time of Flight Ultrasonic & Longitudinal Wave & Shear Wave"
- WDI-UT-013, Rev. 13
  "IntraSpect UT Analysis Guidelines"
- WDI-STD-101, Rev. 6
  "RVHI Vent Tube J-Weld Eddy Current Examination"
- WDI-STD-114, Rev. 7
  "RVHI Vent Tube ID & CS Wastage Eddy Current Examination"
- WCAL-002, Rev. 7
  "Pulser/Receiver Linearity Procedure"
- WDI-STD-151, Rev.2
  "Reactor Vessel Head Inspection for Byron Units 1&2 CEA/CBE and Braidwood Units 1&2 CCE/CDE"

2.0 SCOPE OF WORK

The reactor vessel head penetration nondestructive examination scope at Byron Unit 2 included all seventy eight CRDM penetration tubes and the reactor vessel head vent.

- Examinations of the CRDM penetration tubes were performed from the inside diameter (ID) surfaces using two examination systems. The system selected for each penetration was dependent upon the penetration tube configuration and penetration-specific conditions:

  1) Eighteen (18) open penetration tubes and five (5) open thermocouple column penetration tubes were examined from the ID using the Westinghouse 7010 Open Housing Scanner which perform; 1) TOFD ultrasonic examinations, 2) 0° straight beam examination to identify evidence of a leak path in the shrink fit area, and 3) supplementary eddy current examination.

  2) Fifty-five (55) penetration tubes containing thermal sleeves were inspected from the ID using the Westinghouse Gap Scanner and "Trinity" blade probes which perform 1) TOFD ultrasonic examination, 2) 0° straight beam examination to identify evidence of a leak path in the shrink fit area, and 3) supplementary eddy current examination.

- The vent line tube ID surface and the vent line J-groove weld were examined using eddy current techniques with multiple coil arrays.

- Dye penetrant examination of the weld overlay applied to penetration 68 during the B2R13 outage

2.1 DERI 700 Manipulator

The delivery system used for the CRDM examinations at Byron Unit 2 was the Westinghouse DERI 700 manipulator.

The DERI 700 is a multi-purpose robot that can access all head penetrations and provides a common platform for all CRDM examination end effectors. The manipulator consists of a central leg, mounted on a carriage, which in turn is mounted onto a guide rail. The manipulator arm, with elbow and removable wrist, is mounted onto the carriage, which travels vertically along the manipulator leg.

The DERI 700 was used to deliver 1) the Westinghouse 7010 Open Housing Scanner for ultrasonic and supplementary eddy current examinations of penetration locations without thermal sleeves, 2) the Westinghouse Gap Scanner end effector for ultrasonic and supplementary eddy current examinations of penetration locations containing thermal sleeves.

2.2 7010 Open Housing Scanner Ultrasonic and Eddy Current Examinations

7010 Open Housing Scanner examinations were conducted on eighteen (18) reactor vessel head penetrations without thermal sleeves and five (5) open thermocouple column penetration tubes.

Examinations of these vessel head penetrations included:

1) TOFD ultrasonic techniques demonstrated capable of detecting axial and circumferential reflectors on the penetration tube OD surfaces with PCS24 probes

2) Straight beam ultrasonic techniques at 2.25 MHz to identify possible leak paths in the shrink fit region between the head penetrations and the reactor vessel head, and

3) Supplementary eddy current examinations demonstrated capable of detecting axial and circumferential degradation on the penetration tube ID

The Westinghouse 7010 Open Housing Scanner delivers an examination wand containing ultrasonic and eddy current probes to the ID surface of open reactor vessel head penetrations. The scanning motion is in a vertical direction moving from a specified height above the weld, in this case at least 2.0", to the ID chamfer at the bottom of each penetration. The probe is indexed in the circumferential direction. With the Open Housing Scanner, four examinations are conducted simultaneously. These include:

1) Time-of-flight diffraction ultrasonic examination optimized for identification of axially oriented degradation on the penetration tube OD surfaces
2) Time-of-flight diffraction ultrasonic examination optimized for identification of circumferentially oriented degradation on the penetration tube OD surfaces
3) Straight beam ultrasonic examination to identify variations in the penetration tube-to-reactor vessel head shrink fit area that might indicate a leak path
4) Supplementary eddy current examination for identification of circumferential and axial degradation on the ID surfaces of the penetration tubes

2.3 Gap Scanner Penetration Tube Examinations using Trinity Blade Probe

Examinations were performed with the Gap Scanner end effector from the penetration ID surfaces on fifty five penetration tubes containing thermal sleeves. These fifty five penetration tubes were inspected from the ID using "Trinity" blade probes capable of performing TOFD ultrasonic examinations, leak path assessment, and supplementary eddy current examinations simultaneously.

The Gap Scanner end effector delivers "Trinity" blade probes which include a cross-wound eddy current coil, a TOFD UT transducer pair and a 0°ultrasonic transducer into the annulus between the ID surface of the reactor vessel head penetration tube and the OD surface of the thermal sleeve. The typical annulus gap size is 0.125". The blade probe design utilizes a flexible metal "blade" on which ultrasonic and/or eddy current probes are mounted in a spring configuration that enables the probes to ride on the ID surface of the penetration tubes. The scanning motion is in a vertical direction moving from a specified height above the weld, in this case at least 2.0", to the ID chamfer at the bottom of each penetration. The probes are indexed in the circumferential direction. The Gap Scanner end effector also has a probe tilt and drive unit to advance and reverse the probe in the tube/thermal sleeve annulus, a turntable to rotate the probe drive around the axis of the penetration, a lifting cylinder to raise and lower the tilt

and drive unit and a centering device consisting of two clamping arms. With the Gap Scanner, three examinations are conducted simultaneously. These include:

1) Time-of-flight diffraction ultrasonic examination optimized for identification of circumferentially oriented degradation on the penetration tube OD surfaces
2) Straight beam ultrasonic examination to identify variations in the penetration tube-to-reactor vessel head shrink fit area that might indicate a leak path

Supplementary eddy current examination for identification of circumferential and axial degradation on the ID surfaces of the penetration tubes

2.4 Vent Line and Vent Line J-Weld Eddy Current Examination

The vent line tube eddy current examination was performed with and array of 16 plus-Point probes and a low frequency bobbin. The vent line tube scanner is also delivered manually beneath the head and applies an array of plus-Point eddy current coils and a low frequency bobbin probe to the inside diameter surface of the vent tube.

The vent line J-groove weld eddy current examination was performed with an array of 28 plus-Point coils. The vent line weld scanner is delivered manually beneath the head and applies an array of plus-Point eddy current coils to the vent tube J-weld surface. The entire weld is examined with two 360 degree scans.

3.0 EXAMINATION RESULTS

3.1 7010 Open Housing Scanner Ultrasonic and Eddy Current Examinations

The following table provides a summary of all 7010 Open Housing Scanner RVHP nondestructive examinations performed at Byron Unit 2 during the B2R14 fall 2008 refueling outage.

A total of twenty-three (23) open penetrations were inspected from the ID using the Westinghouse Open Housing Scanner. The final disposition of the examination results is provided in the table 3.1 below.

TABLE 3.1
Open Housing Scanner Penetrations

Penetration #	Axial TOFD Channel 1	Circ TOFD Channel 2	0°(2.25 Mhz) Channel 3	Tube ID ECT (Supplement)	Exam Extent	
					Lower	Upper
10	PTI/CBH/NDD	NDD	NDD	NDD	N/A	3.760"
11	NDD	NDD	NDD	NDD	N/A	3.800"
12	NDD	NDD	NDD	NDD	N/A	3.800"
13	NDD	NDD	NDD	NDD	N/A	3.800"
18	NDD	NDD	NDD	NDD	N/A	4.760"
19	NDD	NDD	NDD	NDD	N/A	4.000"
20	NDD	NDD	NDD	NDD	N/A	3.840"
21	NDD	NDD	NDD	NDD	N/A	3.800"
22	NDD	NDD	NDD	NDD	N/A	3.600"
23	NDD	NDD	NDD	NDD	N/A	3.480"
24	NDD	NDD	NDD	NDD	N/A	3.840"
25	NDD	NDD	NDD	NDD	N/A	3.960"
26	NDD	NDD	NDD	NDD	N/A	3.640"
27	NDD	NDD	NDD	NDD	N/A	3.920"
28	PTI/CBH/NDD	NDD	NDD	NDD	N/A	3.680"
29	NDD	NDD	NDD	NDD	N/A	3.680"
62	NDD	NDD	NDD	NDD	N/A	4.200"
64	NDD	NDD	NDD	NDD	N/A	3.840"
74	NDD	NDD	NDD	SGI/CBH/NDD	N/A	3.760"
75	NDD	NDD	NDD	NDD	N/A	3.840"
76	NDD	NDD	NDD	NDD	N/A	4.440"
77	NDD	NDD	NDD	NDD	N/A	4.200"
78	NDD	NDD	NDD	NDD	N/A	4.000"

Legend: (for Table 3.1.1)

NDD	No Detectable Defect	LOL	Loss of Lateral Wave
PTI	Penetration Tube Indication	WVI	Weld Volume Indication
IPA	Indication Profile Analysis	SGI	Surface Geometry Indication
BBP	B and B Prime	PCI	Probe Chatter Indication
SSS	Shallow Surface Scratch	SI	Special Interest

There was no detectable degradation in the twenty-three penetrations inspected with the 7010 Open Housing Scanner System.

There were no indications of leak paths identified in the shrink fit areas with the 0° UT probes.

Of the twenty-three penetrations inspected with the 7010 Open Housing Scanner System, none showed indications characteristic of primary water stress corrosion cracking on the ID surface and no penetrations showed any detectable degradation. Although some of the Eddy Current indications were detectable with the TOFD inspection, all indicated a depth less or equal to 0.040".

All penetrations were inspected from 2 inches above the highest point of the root of the J-groove weld (on a horizontal plane perpendicular to the nozzle axis) to the chamfer at the bottom end of the tube. All penetrations have UT data collected at least 1 inch below the lowest point at the toe of the J-groove weld to the chamfer.

3.2 Gap Scanner Penetration Tube Trinity Blade Probe Examinations

The following table provides a summary of all Gap Scanner examinations performed at Byron Unit 2 during the B2R14 Spring 2008 refueling outage.

Fifty-five penetration tubes containing thermal sleeves; penetrations #1 through #9, #14 through #17, #30 through #61, #63, #65, and #66 through #73 were inspected from the ID using the Westinghouse Gap Scanner and "Trinity" blade probes.

The final disposition of the examination results is provided in the table 3.2 below.

TABLE 3.2
Thermal Sleeve Penetrations

Penetration #	PCS 23.5 TOFD	0° Leak Path	Supplementary ECT Tube ID	Exam Extent	
				Lower	Upper
1	NDD	NDD	NDD	N/A	2.760"
2	NDD	NDD	NDD	N/A	3.240"
3	NDD	NDD	NDD	N/A	3.200"
4	SGI/CBH/NDD	NDD	NDD	N/A	3.400"
5	SGI/CBH/NDD	NDD	NDD	N/A	3.080"
6	SSS/CBH/NDD PTI/CBH/NDD	NDD	SGI/NDD	N/A	3.640"
7	SGI/CBH/NDD PTI/CBH/NDD	NDD	NDD	N/A	3.720"
8	SGI/CBH/NDD	NDD	SGI/NDD	N/A	2.960"
9	SGI/CBH/NDD PTI/CBH/NDD	NDD	SGI/NDD	N/A	3.320"
14	PTI/CBH/NDD	NDD	NDD	N/A	3.600"

Penetration #	PCS 23.5 TOFD	0° Leak Path	Supplementary ECT Tube ID	Exam Extent	
				Lower	Upper
15	NDD	NDD	NDD	N/A	4.160"
16	NDD	NDD	NDD	N/A	3.520"
17	PTI/CBH/NDD	NDD	NDD	N/A	3.120"
30	NDD	NDD	NDD	N/A	3.800"
31	PTI/CBH/NDD	NDD	NDD	N/A	3.520"
32	PTI/CBH/NDD	NDD	NDD	N/A	3.840"
33	NDD	NDD	NDD	N/A	2.840"
34	NDD	NDD	NDD	N/A	2.720"
35	PTI/CBH/NDD	NDD	NDD	N/A	2.800"
36	PTI/CBH/NDD	NDD	NDD	N/A	3.680"
37	PTI/CBH/NDD	NDD	NDD	N/A	3.360"
38	PTI/CBH/NDD	NDD	NDD	N/A	3.120"
39	PTI/CBH/NDD	NDD	NDD	N/A	3.680"
40	NDD	NDD	NDD	N/A	2.560"
41	NDD	NDD	NDD	1.200'	3.840"
42	PTI/CBH/NDD	NDD	NDD	N/A	3.920"
43	NDD	NDD	NDD	N/A	3.560"
44	PTI/CBH/NDD PTI/IPA/NDD	NDD	NDD	N/A	3.920"
45	NDD	NDD	NDD	N/A	3.680"
46	NDD	NDD	NDD	N/A	2.600"
47	NDD	NDD	NDD	N/A	2.800"
48	PTI/CBH/NDD	NDD	NDD	N/A	3.720"
49	PTI/CBH/NDD	NDD	SGI/CBH/NDD	N/A	3.360"
50	PTI/CBH/NDD	NDD	NDD	N/A	3.400"
51	PTI/CBH/NDD	NDD	NDD	N/A	3.840"
52	NDD	NDD	NDD	N/A	3.280"
53	PTI/CBH/NDD	NDD	NDD	N/A	3.880"
54	PTI/CBH/NDD	NDD	NDD	N/A	3.880"
55	PTI/CBH/NDD	NDD	NDD	N/A	3.960"
56	PTI/CBH/NDD	NDD	NDD	N/A	4.320"
57	NDD	NDD	NDD	N/A	3.640"
58	PTI/CBH/NDD	NDD	NDD	N/A	2.640"
59	VOL/CBH/NDD PTI/CBH/NDD	NDD	NDD	N/A	2.680"
60	NDD	NDD	NDD	N/A	3.480"
61	PTI/CBH/NDD	NDD	NDD	N/A	3.080"
63	NDD	NDD	NDD	N/A	4.000"
65	NDD	NDD	NDD	N/A	3.440"
66	NDD	NDD	NDD	N/A	4.000"
67	PTI/CBH/NDD	NDD	NDD	N/A	3.680"
68	PTI/CBH/NDD	NDD	NDD	0.000"	4.000"
69	NDD	NDD	NDD	N/A	4.040"
70	NDD	NDD	NDD	N/A	2.560"

Penetration #	PCS 23.5 TOFD	0° Leak Path	Supplementary ECT Tube ID	Exam Extent	
				Lower	Upper
71	PTI/CBH/NDD	NDD	SGI/CBH/NDD	N/A	2.760"
72	NDD	NDD	NDD	N/A	3.960"
73	NDD	NDD	NDD	N/A	3.960"

Legend for Table 3.2.1:

NDD No Detectable Defect
PTI Penetration Tube Indication
IPA Indication Profile Analysis
BBP B and B Prime
VOL Volumetric
SGI Surface Geometry Indication
SSS Shallow Surface Scratch

There was no detectable degradation in the 55 penetrations inspected with the Gap Scanner System

All penetrations were inspected from 2 inches above the highest point of the root of the J-groove weld (on a horizontal plane perpendicular to the nozzle axis) to the start of the thread relief shadow effect at the bottom end of the tube. All penetrations, except #33, #34, #39, #42, #44, #45, #51, #52, #53, #55, #56, #58, #63, #69 and #71, have UT data collected at least 1 inch below the lowest point at the toe of the J-groove weld to the chamfer. The shortest coverage measured was penetration 56 measuring 0.640".

It should be noted that as part of the repair performed on Penetration #68 during the B2R13 outage, approximately 3 inches of tube was removed below the toe of the J-groove weld. In its current configuration the tube ends at the toe of the J-groove weld on the down hill side of the penetration. Therefore, measured coverage at 0° is 0 inches.

3.3 Vent Line ID and Vent Line J-Weld Eddy Current Examination

Eddy current examinations were conducted on the vent line J-groove weld and on the ID of the vent line tube. These examinations are designed to identify the presence of primary water stress corrosion cracking on the surfaces of the weld and tube that are exposed to primary coolant. Results of these examinations are summarized in the table below.

Table 3.3
Vent Line Examination

Penetration #	Array ECT Results
Vent Line Weld	**NDD**
Vent Line Tube	**NDD**

Legend:

NDD No detectable Defect

No detectable degradation was identified during the eddy current examination of the vent line J-groove vent line weld or the vent line tube.

3.4 Dye Penetrant Examination

A dye penetrant examination of the weld overlay applied to penetration 68 during the B2R13 outage was performed using solvent removable dye penetrant. No detectable degradation was identified from this examination.

3.5 Penetration Tube Thickness Variations

During the B2R13 outage, wall thickness variations in the chamfer region were noted on 20 tubes. The B2R13 NDE report states "The variation of wall thickness originates from changes in the ID, however the cause is unknown. It shall be noted that the changes only appear in sleeved penetrations." Variations in wall thickness were observed on these same 20 penetrations during the B2R14 outage. The tubes exhibiting variations in wall thickness are tabulated in Table 3.4.

TABLE 3.4
Penetration Tubes with Thickness Variations

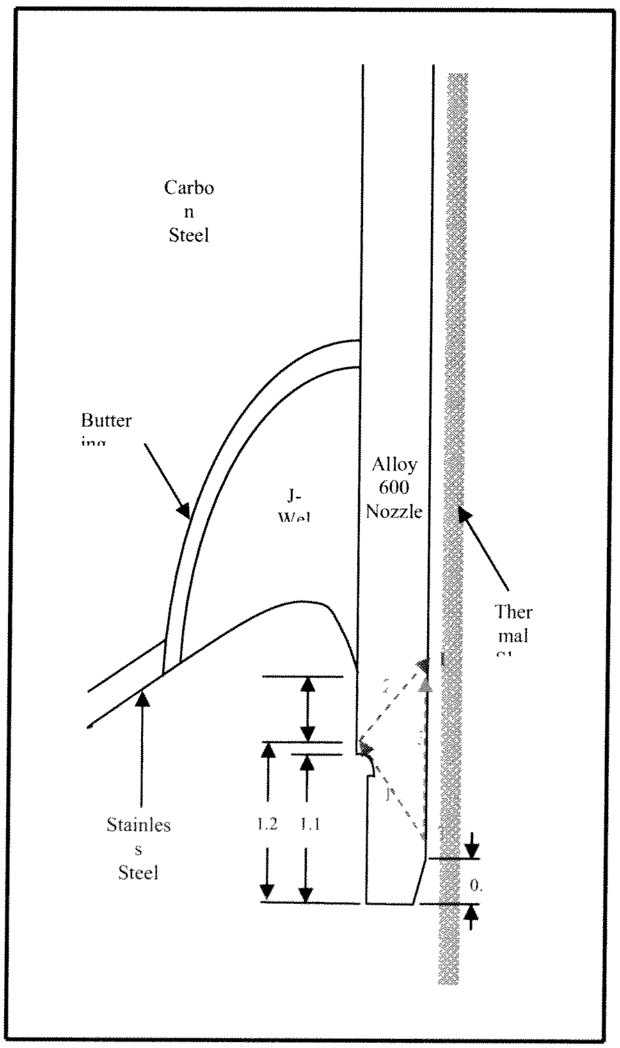
Penetration Number	Penetration Type
33	Sleeved
36	Sleeved
37	Sleeved
39	Sleeved
43	Sleeved
47	Sleeved
49	Sleeved
51	Sleeved
52	Sleeved
53	Sleeved
54	Sleeved
57	Sleeved
58	Sleeved
61	Sleeved
63	Sleeved
66	Sleeved
67	Sleeved
71	Sleeved
72	Sleeved
73	Sleeved

4.0 EXAMINATION COVERAGE

The configuration of the Byron Unit 2 CRDM penetration tubes is shown in the figure 4.1 below. This figure represents the tube-to-head geometry on the "downhill" side of the tube (0° location of the penetration). The bottom ends of all seventy-eight penetration tubes are threaded on the OD surface and have a 20° chamfer on the ID surface. The threads on the tube OD surfaces and chamfer on the ID surfaces represent geometric conditions which limit examination coverage near the bottoms of the tubes.

The coverage below the weld that was obtained during the B2R13 outage was measured and documented in WesDyne report PJF-1303451-FSR-001. The coverage below the weld obtained for each tube during the B2R14 outage was the same as the coverage below the weld obtained during the B2R13 outage.

Figure 4.1
Byron Unit 2 Tube End Geometry



5.0 DISCUSSION OF RESULTS

Eddy Current tube ID surface examinations showed no penetration tubes with indications characteristic of cracking. Some of the ID surface examinations did show shallow surface indications that were detectable with the TOFD inspection; however, all indicated a depth equal to or less than 0.040".

Eddy current examinations of the vent line tube and vent line weld showed no evidence of cracking.

The straight beam ultrasonic examinations of the shrink-fit regions of the seventy-eight penetration tubes showed no evidence of leak paths.

Results from the TOFD ultrasonic examinations of the seventy-eight reactor vessel head penetrations showed no penetration tubes with indications characteristic of cracking.

Data sheets and printouts of the results of each examination performed on each penetration are found in Volume 2.