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U. S. Nuclear Regulatory Commission
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Byron Station, Unit 1
Facility Operating License No. NPF-37
NRC Docket No. STN 50-454

Subject: Byron Station, Unit 1, 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 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.

The purpose of this letter is to provide the results of examinations performed at Byron Station, Unit 1, in accordance with the requirements of the referenced NRC Order.

During the Spring 2005 refueling outage, Byron Station, Unit 1, completed a nonvisual, volumetric nondestructive examination in accordance with Order Section IV. C. (5) (b) (i). 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 Byron Station, Unit 1, Spring 2005 refueling outage ended on March 25, 2005, and therefore the inspection results were required to be submitted by May 24, 2005. It is recognized that this reporting requirement was not met. Upon discovery of the missed requirement, the Byron Station NRC Project Manager and Senior Resident Inspector were notified and the issue was entered into the Byron Station corrective action program.

The volumetric examination was witnessed and evaluated by NRC Region III inspectors during the Spring 2005 refueling outage in accordance with the requirements of Temporary Instruction 2515/150, Revision 3, "Reactor Pressure Vessel Head and Vessel Head Penetration Nozzles (NRC Order EA-03-009)." In addition, upon completion of the examination, the results were discussed with the Byron Station NRC Project Manager and NRC personnel from the Materials and Chemical Engineering Branch.

The detailed report of the examination results is provided in the attachment to this letter. In summary, there were no indications of cracking in any of the reactor pressure vessel (RPV) penetrations and there was no evidence of a leakage path along the RPV head penetration shrink-fit regions. Note that six penetrations (i.e., Nos. 62, 66, 68, 69, 74, and 75) had limited inspection coverage. Exelon Generation Company (EGC) will pursue a relaxation request to address these penetrations. As discussed in a March 15, 2005 telephone conversation between an EGC Licensing representative and the Byron Station NRC Project Manager, this relaxation request was not required to be submitted prior to restart from the Spring 2005 refueling outage. This request will be submitted in the near future.

Also, in accordance with Section IV, paragraph D of the Order, a visual inspection to identify potential boric acid leaks from pressure-retaining components above the RPV head was performed during the Byron Station, Unit 1, Spring 2005 refueling outage. The visual inspection did not identify any boric acid leaks from pressure-retaining components above the RPV head or any boron deposits on the mirror insulation above the RPV head.

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

Respectfully,

Stephen Kuczynski

Stephen E. Kuczynski
Site Vice President
Byron Nuclear Generating Station

Attachment Westinghouse Report WDI-PJF-1302656-FSR-001

SEK/DJS/rah

ATTACHMENT

Westinghouse Report WDI-PJF-1302656-FSR-001

"Byron Generating Station Outage – B1R13 Reactor Vessel Head Penetration Examination"

Byron Generating Station
Outage – B1R13
Reactor Vessel Head
Penetration Examination

February/March 2005

Final NDE Report

WDI-PJF-1302656-FSR-001

Westinghouse Electric Company
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Volume 1

Examination Summary

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1.0 INTRODUCTION

During the Byron Unit B1R13 outage in February/March 2005, Westinghouse performed nondestructive examinations (NDE) of the reactor vessel head CRDM penetration tubes, 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 1 is a Westinghouse design and manufactured by Babcock & Wilcox (B&W). The head contains 78 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 78 penetration tubes, each configuration requiring special consideration for examination. The penetration tubes measure 4.0" on the OD and have an ID dimension of 2.75". The nominal wall thickness is 0.625". 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

As per, Section IV.C. (5) of the USNRC Order EA-03-009 revision 1 ,The Byron Unit 1 reactor vessel head is in the "low susceptibility" category. For a reactor vessel head in the low category, the requirements of paragraph IV.C. (5)(b), specify 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 1 included ultrasonic examinations of the 78 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 1. With the exception of the vent line examination procedures, WDI-STD-101, Rev. 4 and WDI-STD-114, Rev. 3, FCR 001, 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-002, Rev. 6
  "IntraSpect Eddy Current Inspection of J-Groove Welds in Vessel Head Penetrations"
- WDI-ET-003, Rev. 8
  "IntraSpect Eddy Current Imaging Procedure for Inspection of Reactor Vessel Head Penetrations"
- WDI-ET-004, Rev. 8
  "IntraSpect Eddy Current Analysis Guidelines "
- WDI-ET-008, Rev. 5
  "IntraSpect Eddy Current Imaging Procedure for Inspection of Reactor Vessel Head Penetrations With Gap Scanner"
- WDI-UT-010, Rev 10
  "IntraSpect Ultrasonic Procedure for Inspection of Reactor Vessel Head Penetrations, Time of Flight Ultrasonic & Longitudinal Wave & Shear Wave"
- WDI-UT-013, Rev. 8
  "IntraSpect UT Analysis Guidelines"
- WDI-STD-101, Rev. 4
  "RVHI Vent Tube J-Weld Eddy Current Examination"
- WDI-STD-114, Rev. 3, FCR-001
  "RVHI Vent Tube ID & CS Wastage Eddy Current Examination"
- WCAL-002, Rev. 5
  "Pulser/Receiver Linearity Procedure"
- WDI-STD-151, Rev.0.
  "Reactor Vessel Head Inspection for Byron Units 1&2 CEA/CBE and Braidwood Units 1&2 CCE/CDE"
- WDI-UT -011, Rev.7
  "IntraSpect NDE Procedure for Inspection of Reactor Vessel Head Vent Tubes"

The vessel head penetrations data results were dispositioned based on an assessment of results from the nondestructive examinations presented herein.

2.0 SCOPE OF WORK

The reactor vessel head penetration nondestructive examination scope at Byron Unit 1 included all 78 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 performs; 1) TOFD ultrasonic examinations, 2) 0° straight beam examinations to identify evidence of a leak path in the shrink fit area, and 3) supplementary eddy current examinations.

  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 examinations, 2) 0° straight beam examinations to identify evidence of a leak path in the shrink fit area, and 3) supplementary eddy current examinations.
- The vent line tube ID surface and the vent line J-groove weld were examined using eddy current techniques with multiple coil arrays.
- Grooveman inspection was performed on the O.D. of penetration #68. Due to the limited scan length value (Lower Exam Extent) obtained with the Gap Scanner, we attempted to get additional data on the OD with our Grooveman tool.

The delivery system used for the CRDM examinations at Byron Unit 1 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, and 3) the Westinghouse Grooveman for a special interest eddy current examination.

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 circumferentially oriented degradation on the penetration tube OD surfaces

2) Time-of-flight diffraction ultrasonic examination optimized for identification of axially 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

The Gap Scanner end effector delivers "Trinity" blade probes which include a crosswound 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

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

The Grooveman scanner has modified heads that can perform separate eddy current examinations on the J-groove weld surface and the penetration tube OD base material. This is reserved for the penetrations that require supplemental exam.

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.

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.

2.1 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 in accordance with WDI-UT-010, Rev. 10 – "IntraSpect Ultrasonic Procedure for Inspection of Reactor Vessel Head Penetrations, Time of Flight Ultrasonic, Longitudinal Wave & Shear Wave.

2) Straight beam ultrasonic techniques at 2.25 MHz and 5.0 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 surfaces in accordance with and WDI-ET-003, Rev. 8 - "IntraSpect Eddy Current Imaging Procedure for Inspection of Reactor Vessel Head Penetrations".

2.2 Gap Scanner Penetration Tube Examinations using Trinity Blade Probe

Examinations were performed with the Gap Scanner end effector from the penetration ID surfaces on 55 penetration tubes containing thermal sleeves. These 55 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. These examinations were performed in accordance with:

1) WDI-UT-010, Rev. 10 – "IntraSpect Ultrasonic Procedure for Inspection of Reactor Vessel Head Penetrations, Time of Flight Ultrasonic Longitudinal Wave & Shear Wave

2) WDI-ET-008, Rev. 5 – "Intraspect Eddy Current Imaging Procedure for Inspection of Reactor Vessel Head Penetrations With Gap Scanner".

2.3 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 coil in accordance with WDI-STD-114, Rev. 3 - "RVHI Vent Tube ID & CS Wastage Eddy Current Examination". The vent line J-groove weld eddy current examination was performed with an array of 28 plus-Point coils in accordance with WDI-STD-101, Rev. 4, and "RVHI Vent Tube J-Weld Eddy Current Examination".

2.4 Grooveman Eddy Current Examination (Supplemental)

The Grooveman tube scan was performed as a supplemental examination, in accordance with procedure WDI-ET-002, Rev.6. Penetration #68 needed additional scanning on the O.D. because the lower exam extent at that 0 degree location measured only 0.48".

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 1 during the 1R 13 Spring 2005 refueling outage.

A total of twenty-three (23) open penetrations; #10, #11, #12, #13, #18, #19, #20, #21, #22, #23, #24, #25, #26, #27, #28, #29, #62, #64, #74, #75, #76, #77 and #78, were inspected from the ID using the Westinghouse Open Housing Scanner. The final disposition of the examination results is provided in the table 3.1.1 below.

Table 3.1.1 Open Housing Scanner Penetrations

Penetration #	Axial TOFD Channel 1	Circ TOFD Channel 2	0°(2.25 Mhz) Channel 3	0°(5.0 Mhz) Channel 4	Tube ID ECT Supplement)	Exam Extent	
						Lower	Upper
10	WII / NDD	WII / NDD	NDD	NDD	NDD	1.52"	4.08"
11	WII / NDD	WII / NDD	NDD	NDD	NDD	1.52"	5.04"
12	WII / NDD	WII / NDD	NDD	NDD	NDD	1.76"	4.28"
13	NDD	PTI / IPA / VOL / NDD	NDD	NDD	NDD	1.76"	4.36"
18	NDD	WII / NDD	NDD	NDD	NDD	1.68"	4.28"
19	PTI / BBP / NDD	PTI / BBP / NDD	NDD	NDD	NDD	1.84"	5.24"
20	NDD	PTI / BBP / WII / NDD	NDD	NDD	NDD	1.68"	3.92"
21	PTI / BBP / VOL / NDD	PTI / BBP / VOL / NDD	NDD	NDD	NDD	1.70"	4.00"
22	NDD	WII / NDD	NDD	NDD	PCI / NDD	1.68"	3.72"
23	NDD	PTI / BBP / WII / NDD	NDD	NDD	NDD	1.52"	4.20"
24	WII / NDD	WII / NDD	NDD	NDD	NDD	1.68"	5.52"
25	WII / NDD	WII / NDD	NDD	NDD	NDD	1.84"	5.28"

Penetration #	Axial TOFD Channel 1	Circ TOFD Channel 2	0°(2.25 Mhz) Channel 3	0°(5.0 Mhz) Channel 4	Tube ID ECT Supplement)	Exam Extent	
						Lower	Upper
26	NDD	PTI / BBP / WII / NDD	NDD	NDD	NDD	1.80"	4.12"
27	NDD	NDD	NDD	NDD	CCG / SSI / NDD	1.84"	3.20"
28	NDD	NDD	NDD	NDD	NDD	1.84"	3.48"
29	NDD	NDD	NDD	NDD	NDD	1.76"	4.04"
62	WII / NDD	WII / NDD	NDD	NDD	CCG / NDD	0.84"	4.16"
64	NDD	PTI / IPA / WII / NDD	NDD	NDD	CCG / NDD	1.20"	5.40"
74	WII / NDD	WII / NDD	NDD	NDD	SGI / NDD	0.72"	3.40"
75	PTI / IPA/ WII / NDD	PTI / IPA/ WII / NDD	NDD	NDD	CCG / NDD	0.56"	3.56"
76	NDD	PTI / IPA / NDD	NDD	NDD	CCG / NDD	1.32"	3.24"
77	WII / NDD	PTI/ IPA/ WII/NDD SSS/NDD	NDD	NDD	SGI/NDD CCG/NDD	1.00"	2.92"
78	WII / NDD	NDD	NDD	NDD	CCG / NDD	1.08"	3.36"

Legend: (for Table 3.1.1)
NDD No Detectable Defect
SAI Single Axial Indication
PTI Penetration Tube Indication
IPA Indication Profile Analysis
BBP B and B Prime
SSS Shallow Surface Scratch
WII Weld Interface Indication
VOL Volumetric
CCG Craze Crack Geometry
PCI Probe Chatter Indication

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, except #62, #74 and #75, 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 1 during the B1R13 Spring 2005 refueling outage.

55 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 3.2.1 below.

Table 3.2.1 Thermal Sleeve Penetrations

Penetration #	PCS24 TOFD	0^o Leak Path	Supplementary ECT Tube ID	Exam Extent	
				Lower	Upper
1	PTI / BBP/ WII / NDD	NDD	NDD	1.36"	3.76"
2	WII / NDD	NDD	SGI / NDD	1.48"	4.16"
3	WII / NDD	NDD	SGI / NDD	1.32"	3.80"
4	PTI / IPA / NDD	NDD	SGI / NDD	1.40"	3.52"
5	PTI / IPA / NDD	NDD	SGI / NDD	1.52"	3.96"
6	WII / NDD	NDD	SGI / NDD	1.40"	3.64"
7	WII / NDD	NDD	SGI / NDD	1.40"	3.68"
8	WII / NDD	NDD	SGI / NDD	1.48"	3.68"
9	PTI / IPA / WII / NDD	PTI / IPA / WII / NDD	SGI / NDD	1.56"	4.00"
10	-----	-----	-----	-----	-----
11	-----	-----	-----	-----	-----
12	-----	-----	-----	-----	-----
13	-----	-----	-----	-----	-----
14	WII / NDD	NDD	NDD	1.68"	3.64"
15	PTI / IPA / WII / NDD	NDD	NDD	1.40"	3.60"
16	PTI / IPA / WII / NDD	NDD	NDD	1.60"	3.40"
17	PTI / IPA / WII / NDD	NDD	NDD	1.48"	3.80"
18	-----	-----	-----	-----	-----
19	-----	-----	-----	-----	-----
20	-----	-----	-----	-----	-----
21	-----	-----	-----	-----	-----
22	-----	-----	-----	-----	-----
23	-----	-----	-----	-----	-----
24	-----	-----	-----	-----	-----
25	-----	-----	-----	-----	-----
26	-----	-----	-----	-----	-----
27	-----	-----	-----	-----	-----
28	-----	-----	-----	-----	-----
29	-----	-----	-----	-----	-----
30	WII / NDD	NDD	NDD	1.36"	3.36"
31	PTI / IPA / WII / NDD	NDD	NDD	1.36"	3.72"
32	SSS / WII / NDD	SSS / NDD	SSI / NDD	1.44"	3.48"

Penetration #	PCS24 TOFD	0° Leak Path	Supplementary ECT Tube ID	Exam Extent Lower	Exam Extent Upper
33	PTI / IPA / WII / NDD	NDD	NDD	1.44”	3.84”
34	PTI / IPA / WII / NDD	NDD	NDD	1.36”	3.76”
35	PTI / IPA / WII / NDD	NDD	NDD	1.40”	3.48”
36	PTI / IPA / WII / NDD	NDD	NDD	1.56”	3.44”
37	PTI / IPA / NDD	NDD	NDD	1.48”	3.56”
38	PTI / IPA / WII / NDD	NDD	NDD	1.32”	3.52”
39	PTI / IPA / WII / NDD	NDD	NDD	1.00”	3.84”
40	WII / NDD	NDD	NDD	1.20”	3.64”
41	PTI / IPA / WII / NDD	NDD	NDD	1.16”	3.40”
42	PTI / IPA / WII / NDD	NDD	NDD	1.20”	3.60”
43	PTI / IPA / WII / NDD	NDD	NDD	1.32”	3.68”
44	PTI / IPA / WII / NDD SSS / NDD	NDD	SSS / NDD	1.08”	3.00”
45	WII / NDD	NDD	NDD	1.24”	3.92”
46	NDD	NDD	NDD	1.12”	3.84”
47	PTI / IPA / WII / NDD	NDD	NDD	1.24”	3.68”
48	PTI / IPA / WII / NDD	NDD	NDD	1.36”	3.48”
49	PTI / IPA / WII / NDD	NDD	NDD	1.32”	3.72”
50	PTI / IPA / WII / NDD	NDD	SGI / NDD	1.20”	3.60”
51	PTI / IPA / NDD	NDD	NDD	1.16”	3.72”
52	PTI / IPA / WII / NDD	NDD	NDD	1.40”	4.00”
53	PTI / IPA / WII / NDD	NDD	NDD	1.16”	3.52”
54	NDD	NDD	NDD	1.24”	3.60”
55	PTI / IPA / WII / NDD	NDD	NDD	1.20”	3.72”
56	PTI / IPA / WII / NDD	NDD	NDD	1.12”	3.72”
57	PTI / IPA / NDD	NDD	NDD	1.16”	3.88”
58	PTI / IPA / WII / NDD	NDD	NDD	1.28”	3.24”
59	PTI / IPA / WII / NDD	NDD	NDD	1.00”	3.88”
60	PTI / IPA / WII / NDD	NDD	NDD	1.12”	3.28”
61	PTI / IPA / WII / NDD	NDD	NDD	1.16”	3.84”
62	-----	-----	-----	-----	-----
63	PTI / IPA / NDD	NDD	NDD	1.20”	3.84”
64	-----	-----	-----	-----	-----
65	PTI / IPA / WII / NDD SSS/NDD	NDD	SSS/NDD	1.12”	3.12”
66	PTI / IPA / WII / NDD	NDD	NDD	0.96”	3.92”
67	PTI / IPA / WII / NDD	NDD	NDD	1.12”	4.08”
68	PTI / IPA / WII / NDD SSS/NDD	NDD	SAI / NDD	0.50”	4.08”
69	PTI / IPA / WII / NDD	NDD	NDD	0.68”	3.72”
70	PTI / IPA / WII / NDD	NDD	NDD	1.00”	3.84”
71	PTI / IPA / WII / NDD	NDD	NDD	1.08”	3.12”
72	PTI / IPA / WII / NDD	NDD	NDD	1.00”	3.76”
73	PTI / IPA / WII / NDD	NDD	NDD	1.00”	3.72”
74	-----	-----	-----	-----	-----

Penetration #	PCS24 TOFD	0° Leak Path	Supplementary ECT Tube ID	Exam Extent	
				Lower	Upper
75	-----	-----	-----	-----	-----
76	-----	-----	-----	-----	-----
77	-----	-----	-----	-----	-----
78	-----	-----	-----	-----	-----

Legend for Table 3.2.1:

NDD No Detectable Defect
SAI Single Axial Indication
PTI Penetration Tube Indication
IPA Indication Profile Analysis
BBP B and B Prime
SSS Shallow Surface Scratch
WII Weld Interface Indication
VOL Volumetric
CCG Craze Crack Geometry
PCI Probe Chatter Indication

There was no detectable degradation in the fifty-five penetrations inspected with the 7010 Open Housing Scanner System. There were no indications of leak paths in the shrink fit areas examined with the 0° UT probe.

Of the fifty-five penetrations inspected with the Gap Scanner Eddy Current System, none showed indications characteristic of primary water stress corrosion cracking on the ID surface and no penetrations showed any detectable degradation. Many of the Eddy Current indications were detectable with the TOFD inspection; however, all had depths less than or equal to 0.040". Most of these were related to the manufacturing deformation in the "Press Fit" region. Other ID surface eddy current indications were noted as Shallow Surface Scratches (SSS).

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, but #66, #68 and #69, have UT data collected at least 1 inch below the lowest point at the toe of the J-groove weld to the chamfer.

3.3 Vent Line 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 3.3.1

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 Grooveman Eddy Current Examinations (Supplemental)

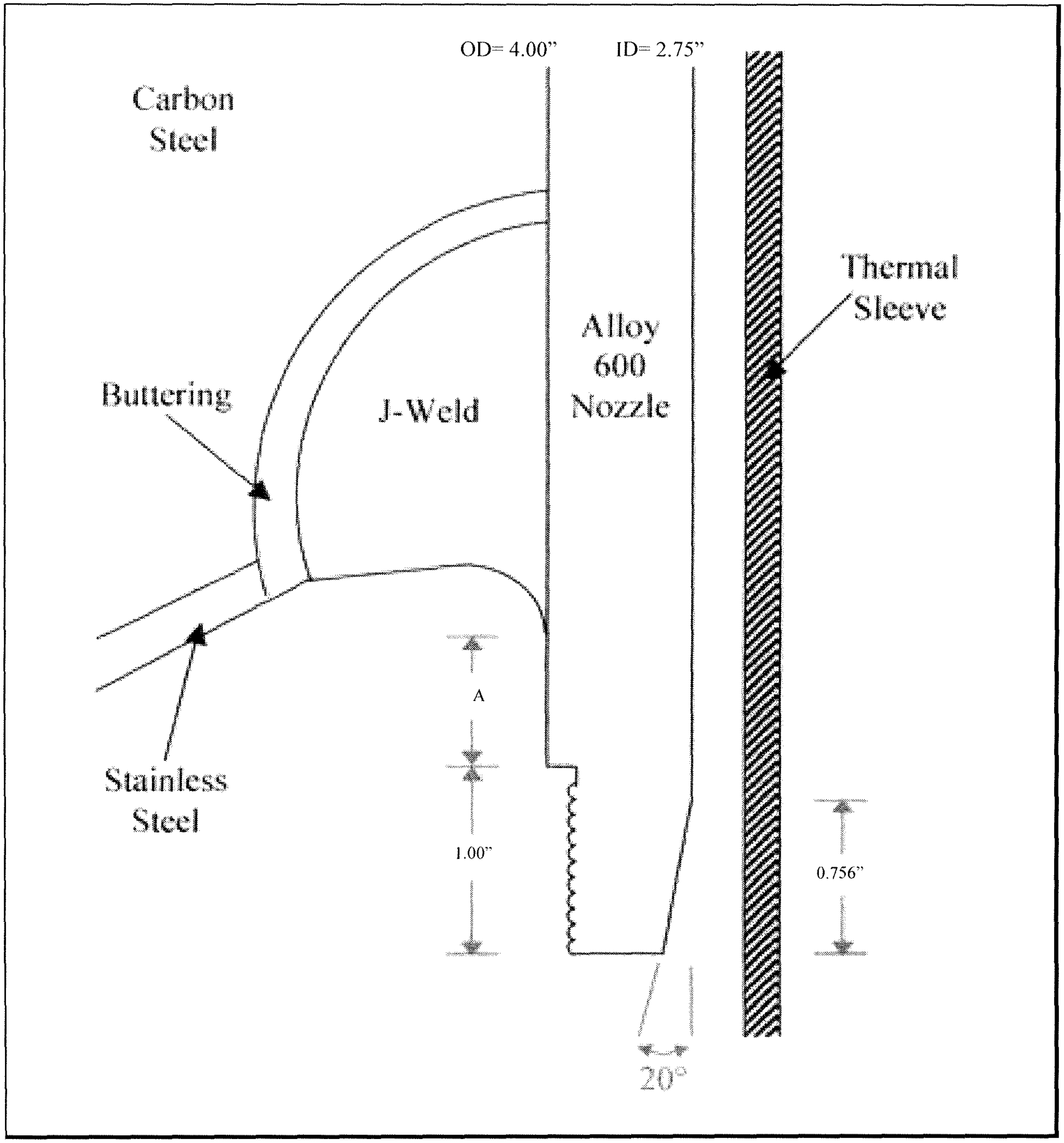
Table 3.4.1

Penetration #	Roof Scan	Tube Scan
# 68	N/A	NDD

No detectable degredation was identified during the eddy current examination in Penetration # 68 after the OD scan of the tube

4.0 EXAMINATION COVERAGE

The configuration of the Byron Unit 1 CRDM penetration tubes is shown in the figure 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.



OD= 4.00"
ID= 2.75"
Carbon Steel
Thermal Sleeve
Alloy 600 Nozzle
Buttering
J-Weld
A
Stainless Steel
1.00"
0.756"
20°

Figure 4.1

The threads on the OD surfaces extend from the bottom of the tube to an elevation of approximately 1.0" where a thread relief is machined. The top of the thread relief is 1.188" above the bottom of the tube. The distance from the top of the thread relief to the bottom of the fillet of the J-groove weld (identified as "A" in the figure 4.1) varies based on location of the penetration in the head and the amount of weld material applied during the welding process. These distances are longer for penetrations at inner locations and become progressively shorter for penetrations located further away from the center of the head.

The ID surfaces of the penetration tubes are chamfered at a 20° angle from the bottom of the tube to an elevation of 0.756". 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.

For ID examinations of all 78 penetration tubes, the supplementary eddy current and the TOFD PCS24 examination coverage extended from the uppermost elevation of the chamfer, 0.756" from the bottom of the tube, to elevations at least 2.0" above the welds. The extent of coverage was verified for each examination of each penetration by confirmation that 1) tube entry signals were evident and 2) scan coverage elevations were in excess of 2.0" above the uppermost elevation of each weld.

For OD examinations of all 78 penetration tubes, the TOFD PCS24 transducer coverage extended from the thread relief, 1.00" from the bottom of the tube, to elevations at least 2.0" above the welds. The extent of coverage was verified for each examination of each penetration by confirmation that 1) TOFD ultrasonic signals from the thread relief were evident and 2) scan coverage elevations were in excess of 2.0" above the uppermost elevation of each weld.

Note: The values of examination extent in table 3.1.1 and 3.2.1 is the value from the weld toe to the loss of TOFD lateral wave signal approximately 0.16 inches above the thread relief.

5.0 DISCUSSION OF RESULTS

All penetration tube ultrasonic examination data were analyzed in accordance with WDI-UT-013, Rev. 8 – "IntraSpect UT Analysis Guidelines". The penetration tube eddy current data were analyzed in accordance with WDI-ET-004, Rev. 8 – "IntraSpect Eddy Current Analysis Guidelines Inspection of Reactor Vessel Head Penetrations".

Data from the eddy current examinations of the vent line and vent line weld were analyzed in accordance with WDI-STD-114, Rev. 3,FCR 001 – "RVHI Vent Tube ID & CS Wastage Eddy Current Examination" and WDI-STD-101, Rev. 4 – "RVHI Vent Tube J-Weld Eddy Current Examination", respectively.

Data sheets and printouts of the results of each examination performed on each penetration are found in Volume 2 and Volume 3.

Results from the TOFD ultrasonic of the seventy-eight reactor vessel head penetrations, and the eddy current examinations of the vent line tube and vent line weld identified no indications characteristic of PWSCC.

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

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