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U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Mail Stop O-P1-17
Washington, DC 20555-001

Donald C. Cook Nuclear Plant Unit 1
UNIT 1 REACTOR PRESSURE VESSEL UPPER HEAD
INSPECTION RESULTS

References:
1. Revised U. S. Nuclear Regulatory Commission 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," dated February 20, 2004.

2. Letter from John A. Zwolinski, Indiana Michigan Power Company, to Nuclear Regulatory Commission Document Control Desk, "Donald C. Cook Nuclear Plant Unit 1, Unit 1 Vessel Head Inspection Results," AEP:NRC:4054, dated January 26, 2004.

3. Letter from Aby S. Mohseni, Nuclear Regulatory Commission, to Mano K. Nazar, Indiana Michigan Power Company, "Donald C. Cook Nuclear Plant, Unit 1 – Relaxation of the Requirements of First Revised Order (EA-03-009) Regarding Reactor Pressure Vessel Head Inspections Dated February 20, 2004 (TAC No. MC5675)," dated April 14, 2005.

This letter provides information pertaining to reactor pressure vessel (RPV) upper head inspections performed at Donald C. Cook Nuclear Plant during the Unit 1, Cycle 20 refueling outage. Submittal of this information is required by Reference 1, Section IV.E.

The referenced order imposed enhanced requirements for inspection of pressurized water RPV heads and related penetration nozzles. In accordance with Section IV.A of the order, a calculation of the susceptibility category of the Unit 1 RPV upper head as represented by a value of effective degradation years (EDY) was performed. The EDY value at the beginning of the Unit 1, Cycle 20 refueling outage was 8.68. Per Section IV.B of the order, an EDY value of 8.68 places the Unit 1 RPV head in a moderate susceptibility category. In accordance with Paragraph IV.C(2) of the order, a moderate susceptibility category requires that either a visual or a volumetric examination be

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performed in accordance with Paragraph IV.C(5) each refueling outage with the proviso that a visual examination and a volumetric examination are each required to be performed at least once over the course of every two refueling outages. A visual examination was performed during the Unit 1, Cycle 19 refueling outage (Reference 2). Therefore, a volumetric examination was performed during the Unit 1, Cycle 20 refueling outage.

One hundred percent volumetric examinations of 79 control rod drive mechanism penetrations and a single vent penetration in the Unit 1 RPV head was completed in accordance with Paragraphs IV.C(5)(b)(i), (ii) or (iii) of the order using an approved alternative to the requirements of Section IV, Paragraphs C.(5)(b)(i) and C.(5)(b)(ii) (Reference 3). No repairs were required following the volumetric examinations.

The visual inspections performed in accordance with Section IV.D of the order during the Unit 1 refueling outage did not identify any leaks or boron deposits from pressure retaining components on or above the RPV head. Therefore, no report regarding that inspection is required by Section IV.E of the order.

The attachment to this letter provides the report of the non-destructive examination of the RPV upper head nozzles.

This letter contains no new commitments. Should you have any questions, please contact Mr. John A. Zwolinski, Director of Safety Assurance, at (269) 466-2428.

Sincerely,

Daniel P. Fadel
Engineering Vice President

RGV/rdw

Attachment: D.C. Cook Unit 1 – 1C20 Reactor Vessel Head Penetration Examination

c: J. L. Caldwell, NRC Region III
K. D. Curry, Ft. Wayne AEP, w/o attachment
Director, Office of Nuclear Reactor Regulation
J. T. King, MPSC, w/o attachment
C. F. Lyon - NRC Washington, DC
MDEQ – WHMD/RPMWS, w/o attachment
NRC Resident Inspector

Attachment to AEP:NRC:5054-09

Westinghouse Report
D.C. Cook Unit 1 – 1C20
Reactor Vessel Head Penetration Examination

D.C. Cook Unit 1–1C20 Reactor Vessel Head Penetration Examination

April 2005

Final Report

WDI-PJF-1303018-FSR-001

MAY 9, 2005

Westinghouse Electric Company
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1. D.C. Cook Unit 1 Vent Tube ID/J-Groove Weld Disk 3 of 3

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Volume 3

Examination Results

1.0 INTRODUCTION

During the D.C. Cook Unit 1 1C20 outage in the spring of 2005, Westinghouse performed nondestructive examinations (NDE) of the seventy-nine control rod drive mechanism (CRDM) penetration tubes and the vent line in the reactor vessel head.

The purpose of the examination program was to identify evidence of primary water stress corrosion cracking (PWSCC) that might be present on the outside diameter (OD) and inside diameter (ID) surfaces of the head penetration tubes and to assess whether leakage might have occurred into annulus at the tube-to-head interface. Examinations were performed using procedures and techniques demonstrated through the EPRI/MRP protocol [1] and/or Westinghouse internal demonstration programs, and applied consistent with the requirements of the February 20, 2004, First Revision to USNRC Order EA-03-009, "Establishing Interim Inspection Requirements for Reactor Vessel Heads at Pressurized Water Reactors" [2] as amended by the AEP request for relaxation in January 2005 [3].

The D.C. Cook Unit 1 reactor vessel head is a Westinghouse design. The head was manufactured by Combustion Engineering (CE) in Chattanooga, TN. The alloy 600 penetration tubes are shrunk fit into the reactor vessel head and attached with alloy 182/82 partial penetration J-groove welds. The vent line is an alloy 600 tube attached to the reactor vessel head with an alloy 182/82 partial penetration weld.

The penetration tubes in the D.C. Cook Unit 1 reactor vessel head are machined from heats of material supplied by Huntington Alloys. The penetration tubes measure 4.0" on the OD and have an ID dimension of 2.75". The vent line, ¾" schedule 80, has a nominal ID of 0.742" and a nominal OD of 1.05".

A summary of where the various heats of material are located is provided in Table 1-1.

Table 1-1: D.C. Cook Unit 1 RV Head Penetration Material Heats by Location

Heat #	Material Supplier	Penetration Locations
NX7926	Huntington	1, 41 ,42 ,43 ,44 ,45 ,46 ,47, 48, 49, 53, 54, 55, 56, 57
NX7280	Huntington	2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 13, 14, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 50, 51, 52, 58, 59, 61
NX8069	Huntington	12, 15, 16, 17, 18, 19, 20, 21, 38, 39, 40, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79
NX8251	Huntington	22, 60
NX7760	Huntington	62

There are a variety of configurations for the 79 penetration tubes, each configuration requiring special consideration for examination. The penetration tube configurations are as follows:

- 53 penetration tubes with thermal sleeves installed
- 7 penetration tubes with part length drive shafts

- 19 penetration locations without thermal sleeves

The D.C. Cook Unit 1 reactor vessel head is in the "moderate susceptibility" category as defined in the first Revision to USNRC Order EA-03-009.

Paragraph IV.C (5) of the first Revision to USNRC Order EA-03-009 specifies:

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

b) For each penetration, perform a nonvisual NDE in accordance with either i, ii or iii:

i. Ultrasonic testing of each RPV head penetration nozzle volume (i.e., nozzle base material) from two (2) inches above the highest point of the root of the J-groove weld 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 from 2 inches above the highest point of the root of the J-groove weld to 1 inch below the lowest point at the toe of the J-groove weld and including all RPV head penetration nozzle surfaces below the J-groove weld that have an operating stress level 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 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 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 from 2 inches above the highest point of the root of the J-groove weld to 1 inch below the lowest point at the toe of the J-groove weld and including all RPV head penetration nozzle surfaces below the J-groove weld that have an operating stress level 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 welds described in (i) and (ii).

For plants in the moderate category, inspections specified in paragraph IV.C (5) (a) or paragraph IV.C (5) (b) are required each refueling outage. In addition, the inspections specified in paragraph IV.C (5) (a) and paragraph IV.C (5) (b) are required at least once over the course of every two refueling outages.

The examination program selected for D.C. Cook Unit 1 during the 1C20 outage included ultrasonic examinations of the 79 CRDM penetration nozzles with leakage assessment in accordance with paragraph IV.C (5) (b) (i) of the Revised NRC Order. For the vent line the wetted surface examination option using eddy current techniques

was selected in accordance with Section IV.C (5) (b) (ii) of the Revised NRC Order. A bare metal visual examination satisfying paragraph IV.C (5) (a) was performed during the previous outage.

Stress distribution curves were developed in advance of the examination which identified the hoop stress distributions below the attachment welds on the OD surfaces of penetration tubes. A fracture analysis was performed and the results were presented in the form of flaw tolerance charts for both surface and through wall flaws. If indications of PWSCC had been identified, the charts were available to determine the allowable safe operation service life [4].

A contingency plan was in place to address geometric conditions at penetration locations where access of the Trinity blade probes in the penetration/tube annulus might be limited. The contingency plan included equipment and procedures necessary to perform wetted surface examinations in accordance with Section IV.C (5) (b) (ii) of the Revised Order.

The following Westinghouse field service procedures and field change notices (FCNs) were approved for use at D.C. Cook Unit 1.

- WDI-ET-002, Rev. 6 – "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 Inspection of Reactor Vessel Head Penetrations"
- WDI-ET-008, Rev. 5 with FCN 01 – "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"
- WDI-UT-013, Rev. 8 – "CRDM/CI UT Analysis Guidelines"
- WDI-STD-101, Rev. 4 with FCN 01 – "RVHI Vent Tube J-Weld Eddy Current Examination"
- WDI-STD-114, Rev. 3 with FCN 01 – "RVHI Vent Tube ID & CS Wastage Eddy Current Examination"
- WCAL-002, Rev. 5 – "Pulser/Receiver Linearity Procedure"

2.0 SCOPE OF WORK

The reactor vessel head penetration examination scope at D.C. Cook Unit 1 included all seventy-nine CRDM penetration tubes and the vent line.

The examination methodology selected for each penetration was dependent upon the penetration tube configuration and penetration-specific conditions.

1. Nineteen penetration tubes without thermal sleeves were examined from the ID using the Westinghouse 7010 Open Housing Scanner (OHS).

2. Sixty penetration tubes; fifty-three with thermal sleeves and seven part length locations, were examined from the ID using the Westinghouse Gapscanner and Trinity blade probes.

3. The vent line tube eddy current examination was performed with an array of 16 plus-Point probes and a low frequency bobbin coil. The vent line J-groove weld eddy current examination was performed with an array of 28 plus-Point coils.

The delivery system used for the CRDM examinations at D.C. Cook 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 open penetration locations and the Westinghouse Gapscanner end effector for Trinity probe examinations of penetration locations containing thermal sleeves and part length locations.

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 bottom of each penetration. The probe is indexed in the circumferential direction. With the open housing scanner, multiple examination probes are delivered simultaneously. These include time-of-flight diffraction ultrasonic (TOFD-UT) probes oriented in the axial and circumferential directions, 0° ultrasonic probes to identify variations in the penetration tube-to-reactor vessel head shrink fit area that might indicate a leak path in the annulus between the tube and the head, and a supplementary eddy current probe for identification of circumferential and axial degradation on the ID surfaces of the penetration tubes

The Gapscanner end effector delivers Trinity blade probes into the annulus between the ID surface of the head penetration tube and the OD surface of the thermal sleeve or part length drive shaft. The typical annulus size is 0.125". The Trinity blade probes include a

TOFD UT transducer pair for detection of axial and circumferential degradation, and a 0° ultrasonic transducer to identify variations in the penetration tube-to-reactor vessel head shrink fit area that might indicate a leak path in the annulus between the tube and the head, and a supplementary crosswound eddy current coil. 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 bottom of each penetration. The probes are indexed in the circumferential direction.

2.1 CRDM Penetration Tube Ultrasonic and Supplementary Eddy Current Examinations from the Tube ID

All seventy-nine penetration tubes were ultrasonically examined from the tube ID surface in accordance with Section IV.C (5) (b) (i) of the Revised NRC Order. Methods for leakage assessment were incorporated into these examinations.

2.1.1 CRDM Penetration Tube 7010 Open Housing Scanner Examinations

7010 Open Housing Scanner examinations were conducted on nineteen reactor vessel head penetrations without thermal sleeves.

Examinations of these vessel head penetrations included:

1. TOFD ultrasonic techniques 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 to identify possible leak paths in the shrink fit region between the head penetrations and the reactor vessel head, also in accordance with WDI-UT-010, Rev. 10, and

3. supplementary eddy current examinations 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".

2.1.2 CRDM Penetration Tube Gapscanner Trinity Probe Examinations

Examinations were performed with the Gapscanner end effector and Trinity probes on sixty penetration tubes; fifty-three with thermal sleeves and seven part length locations, from the penetration ID surfaces.

Examinations of these vessel head penetrations included:

1. TOFD ultrasonic techniques 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 to identify possible leak paths in the shrink fit region between the head penetrations and the reactor vessel head, also in accordance with WDI-UT-010, Rev. 10, and

3. supplementary eddy current examinations in accordance with and WDI-ET-008, Rev. 5 - "IntraSpect Eddy Current Imaging Procedure for Inspection of Reactor Vessel Head Penetrations".

2.2 Eddy Current Wetted Surface Examinations

Wetted surface examinations were conducted on the vent line and the vent line weld using eddy current techniques in accordance with Section IV.C (5) (b) (ii) of the Revised NRC Order.

2.2.1 Vent Line Tube ID and J-Weld Eddy Current Examinations

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 - "Head Vent ID Eddy Current Inspection". 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, "RVHI Vent Tube J-Weld Eddy Current Examination".

3.0 EXAMINATION RESULTS

3.1 CRDM Penetration Tube Ultrasonic and Supplementary Eddy Current Examinations from the Tube ID

Table 3-1 provides a summary of results from the 7010 Open Housing Scanner reactor vessel head penetration nondestructive examinations.

Table 3-1: Open Housing Scanner Examination Results

Penetration #	Axial TOFD	Circ TOFD	Leak Path Assessment	Supplementary Tube ID ECT
2	NDD	NDD	NDD	NDD
3	NDD	NDD	NDD	NDD
4	NDD	NDD	NDD	NDD
5	NDD	NDD	NDD	NDD
15	NDD	NDD	NDD	NDD
17	NDD	NDD	NDD	NDD
19	NDD	NDD	NDD	NDD
21	NDD	NDD	NDD	NDD
26	NDD	NDD	NDD	NDD
27	NDD	NDD	NDD	NDD
28	NDD	NDD	NDD	NDD
29	NDD	NDD	NDD	NDD
32	NDD	NDD	NDD	NDD
74 T/C	NDD	NDD	NDD	NDD
75 T/C	NDD	NDD	NDD	NDD
76 T/C	NDD	NDD	NDD	NDD
77 T/C	NDD	NDD	NDD	NDD
78 T/C	NDD	NDD	NDD	NDD
79 T/C	NDD	NDD	NDD	NDD

T/C: Thermocouple Column Location

Legend

NDD: No Detectable Degradation

No detectable degradation characteristic of PWSCC was reported in any of the penetrations examined with the 7010 Open Housing Scanner. There was no evidence of leakage in the annulus between the penetration nozzles and the reactor vessel head.

Table 3-2 provides a summary of results from Gapscanner examinations performed with Trinity Probes.

Table 3-2: Trinity Probe Examination Results

Penetration #	PCS24 TOFD	0° Leak Path	Supplementary Tube ID ECT
1	NDD	NDD	NDD
2			
3			
4			
5			
6	NDD	NDD	NDD
7	NDD	NDD	NDD
8	NDD	NDD	NDD
9	NDD	NDD	NDD
10	NDD	NDD	NDD
11	NDD	NDD	NDD
12	NDD	NDD	NDD
13	NDD	NDD	NDD
14	NDD	NDD	NDD
15			
16	NDD	NDD	NDD
17			
18	NDD	NDD	NDD
19			
20	NDD	NDD	NDD
21			
22	NDD	NDD	NDD
23	NDD	NDD	NDD
24	NDD	NDD	NDD
25	NDD	NDD	NDD
26			
27			
28			
29			
30 P/L	NDD	NDD	NDD
31 P/L	NDD	NDD	NDD
32			
33 P/L	NDD	NDD	NDD
34 P/L	NDD	NDD	NDD
35 P/L	NDD	NDD	NDD
36 P/L	NDD	NDD	NDD
37 P/L	NDD	NDD	NDD
38	NDD	NDD	NDD
39	NDD	NDD	NDD
40	NDD	NDD	NDD
41	NDD	NDD	NDD
42	NDD	NDD	NDD
43	NDD	NDD	NDD
44	NDD	NDD	NDD
45	NDD	NDD	NDD

Penetration #	PCS24 TOFD	0° Leak Path	Supplementary Tube ID ECT
46	NDD	NDD	NDD
47	NDD	NDD	NDD
48	NDD	NDD	NDD
49	NDD	NDD	NDD
50	NDD	NDD	NDD
51	NDD	NDD	NDD
52	NDD	NDD	NDD
53	NDD	NDD	NDD
54	NDD	NDD	NDD
55	NDD	NDD	NDD
56	NDD	NDD	NDD
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64	NDD	NDD	NDD
65	NDD	NDD	NDD
66	NDD	NDD	NDD
67	NDD	NDD	NDD
68	NDD	NDD	NDD
69	NDD	NDD	NDD
70	NDD	NDD	NDD
71	NDD	NDD	NDD
72	NDD	NDD	NDD
73	NDD	NDD	NDD
74			
75			
76			
77			
78			
79			

P/L: Part Length Location

No detectable degradation characteristic of PWSCC was reported in any of the penetration tubes examined with the Trinity Probes. There was no evidence of leakage in the annulus between the penetration nozzles and the reactor vessel head.

3.2 Eddy Current Wetted Surface Examinations

3.2.2 Vent Line Tube and J-Weld Eddy Current Examinations

Results of the eddy current examinations of the vent line and vent line J-groove weld are summarized in Table 3-4.

Table 3-4 Vent Tube and J-Groove Weld Eddy Current Results

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

No detectable degradation characteristic of PWSCC was identified during the eddy current examinations of the vent line J-groove weld and the vent line tube ID surface.

4.0 EXAMINATION COVERAGE

4.1 Penetration Tube Configuration and Examination Summary

The configuration of a sleeved D.C. Cook Unit 1 CRDM penetration tube is illustrated in Figure 4-1. This figure represents the tube-to-head geometry at the penetration 0° azimuth, or "downhill" side of the tube. The bottom ends of all penetration tubes are threaded on the OD surface and have a chamfer on the ID surface. The threads extend from the bottom of the tube to an elevation of approximately 0.62" where a thread relief is machined. The top of the thread relief is 0.75" 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", varies based on location of the penetration in the head. These distances are generally longer for penetrations at "inboard" locations and become progressively shorter for penetrations located further away from the center of the head. The ID surface chamfers are machined at a 15^0 angle from the bottom of the tube to an elevation of 0.23".

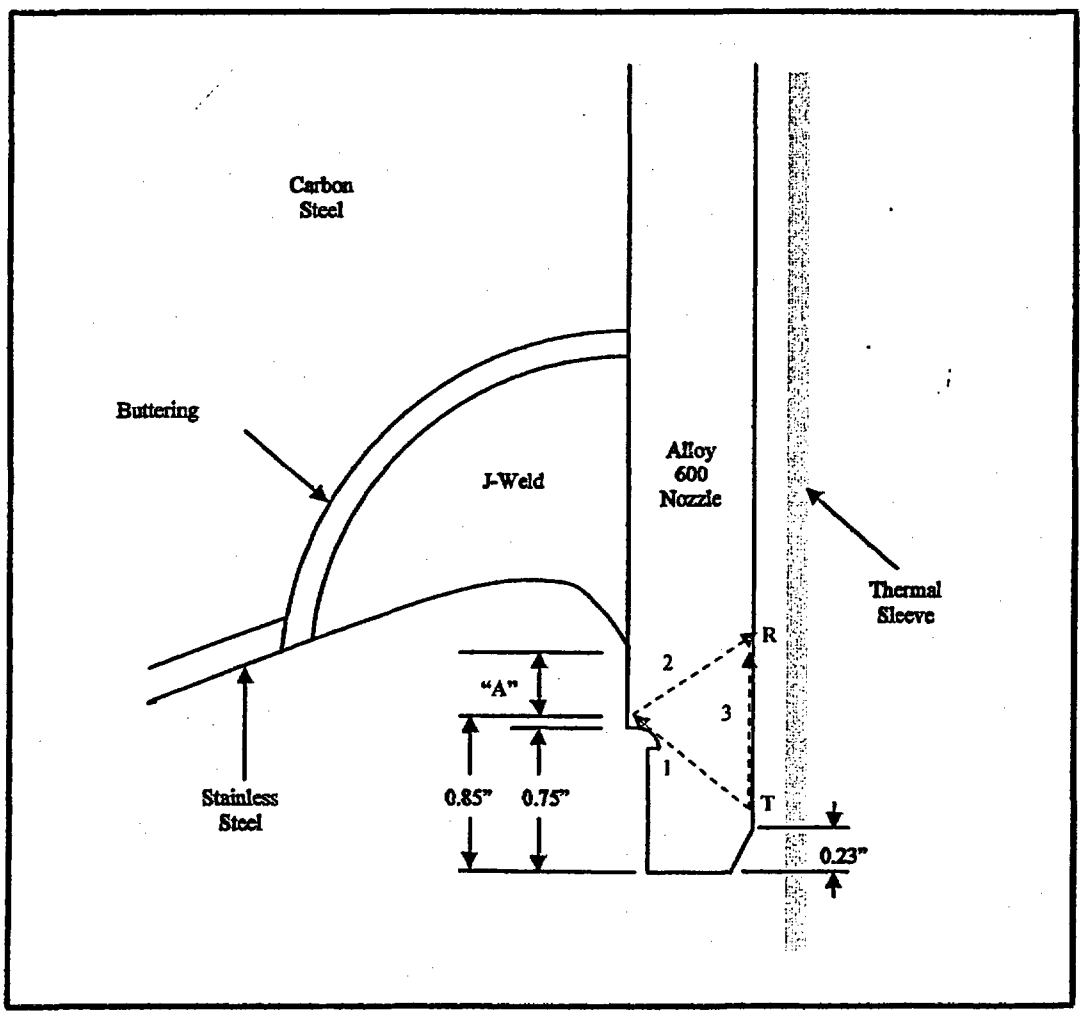


Figure 4-1: Illustration of Axially Oriented TOFD Examination Coverage on D.C. Cook Unit 1 Penetration Geometry at 0° (Downhill Side)

4.2 Ultrasonic Testing Coverage in Accordance With Section IV.C (5) (b) (i) of the Revised NRC Order

The ultrasonic method demonstrated through the EPRI/MRP Protocol for detection of circumferential and axial degradation on the OD and ID surfaces of CRDM penetration tubes is the time-of-flight diffraction (TOFD) technique. The TOFD technique is a "pitch/catch" ultrasonic method, where longitudinal waves are transmitted into the tube at an angle by a transmitter (T) and reflects off of the backside of the tube to a receiver (R), as shown in path "1-2" in Figure 4-1. A lateral wave also travels on the tube ID surface between the transmitter and receiver as shown in path "3". The transmitting and receiving elements are mounted on a "shoe" with a probe center spacing of 0.925". ID TOFD coverage is provided by the lateral wave to the elevation of the chamfer the tube on the ID surface. With an axially oriented TOFD transducer pair, OD coverage becomes completely effective at an elevation just above the top of the thread relief. The presence of the thread relief results in a slight masking of the ultrasound to the OD surface to an elevation conservatively estimated at 0.10" above the thread relief. In this area, however, OD initiated degradation would be detected once the depth of the degradation exceeded the depth of the masked area. With a circumferentially oriented TOFD transducer pair, OD coverage is extended to the elevation of the top of the chamfer, approximately 0.23" above the bottom of the tube. In the threaded region, cracks extending deeper than the threads will be detected.

Examination coverage on the ID surfaces of the sixty penetration tubes examined with Trinity Probes and nineteen penetration tubes examined with the Open Housing Scanner extended from the top of the chamfer in each tube to at least 2.0" above the uppermost elevation of the weld. The extent of coverage was verified for each penetration by 1) confirmation that tube entry signals at the elevation of the chamfer were evident in the eddy current and ultrasonic data, and 2) direct measurements from the TOFD UT C-scans which demonstrated scan coverage elevations were in excess of 2.0" above the uppermost elevation of each weld. In all cases, ID coverage included at least 1.0" below the lowest elevation of the J-groove welds.

Examination coverage on the OD surfaces of the nineteen penetration tubes examined with the Open Housing Scanner extended from the top of the chamfer in each tube to at least 2.0" above the uppermost elevation of the weld. For those tubes examined with Trinity Probes OD coverage extended just above the elevation of the thread relief to at least 2.0" above the welds. The extent of coverage was verified for each examination of each penetration by 1) confirmation that TOFD responses were evident from the thread relief and 2) direct measurements from the TOFD UT C-scans which demonstrated scan coverage elevations were in excess of 2.0" above the uppermost elevation of each weld. This coverage is illustrated in Figure 4-2.

OD and ID examination coverage measured for each penetration location during the spring 2005 examination program is provided in Appendix A. Results in this Appendix differ somewhat from those provided in the prior D.C. Cook Unit 1 reactor vessel head

penetration J-groove weld elevation study [5] because examinations in the spring of 2002 at D.C. Cook Unit 1 were 1) performed prior to the NRC Order, 2) focused primarily on the detection of circumferential cracking above the J-groove welds, and 3) did not take into account the additional coverage provided by the circumferentially oriented TOFD transducer pair in the Open Housing Scanner.

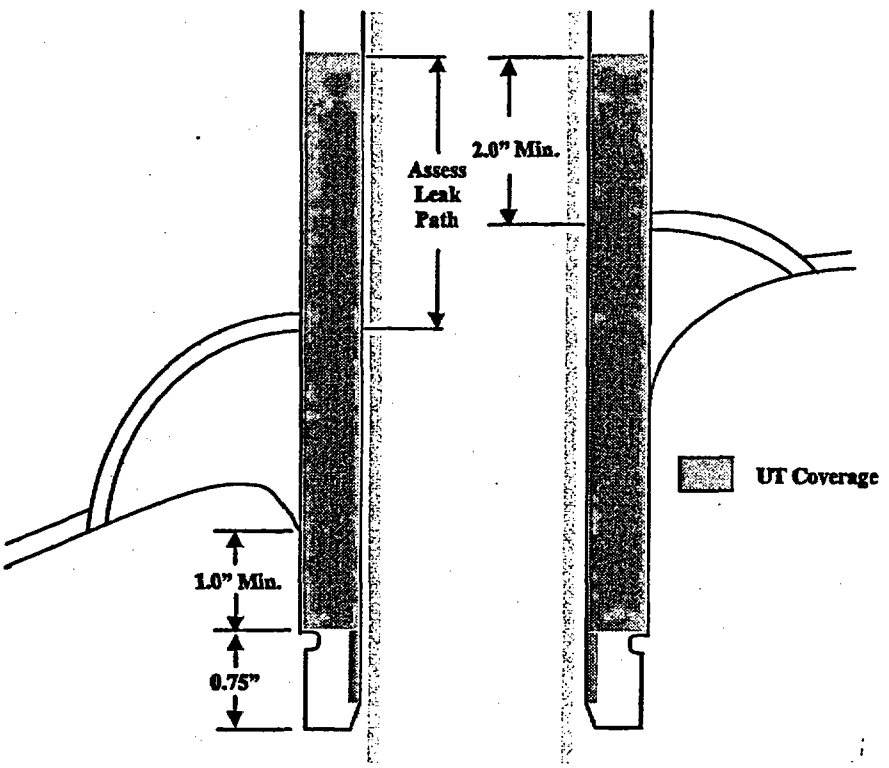


Figure 4-2: UT Coverage In Accordance With Section IV.C (5) (b) (i) of the Revised NRC Order - Illustrative

5.0 DISCUSSION OF RESULTS

Penetration tube ultrasonic examination data were analyzed in accordance with WDI-UT-013, Rev. 8 – "CRDM/ICI UT Analysis Guidelines". 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 1R15 examinations were loaded on the analysis workstations to allow comparison of the current results with history. The screening and resolution process for ID indications is summarized in the logic chart in Figure 5-1 and the process for OD indications is summarized in the logic charts in Figures 5-2 and 5.3.

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

Results from the TOFD ultrasonic and eddy current examinations of the seventy-nine CRDM penetrations and head vent line identified no indications characteristic of PWSCC.

Figure 5-1 - Penetration Tube ID Indication Screening

ET/UT: ID INDICATION SCREENING

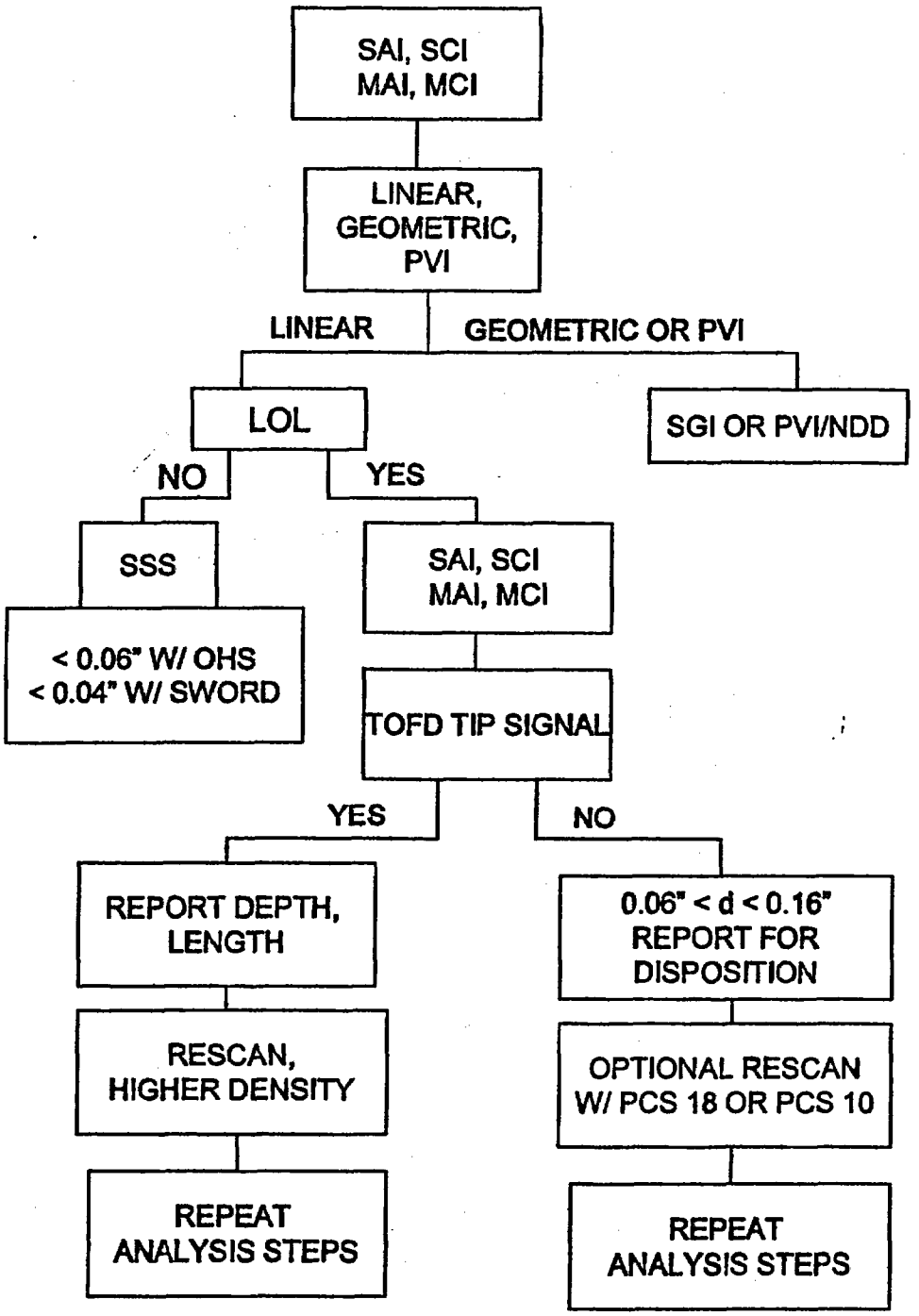


Figure 6-2 - Penetration Tube OD Indication Screening Within Weld Zone

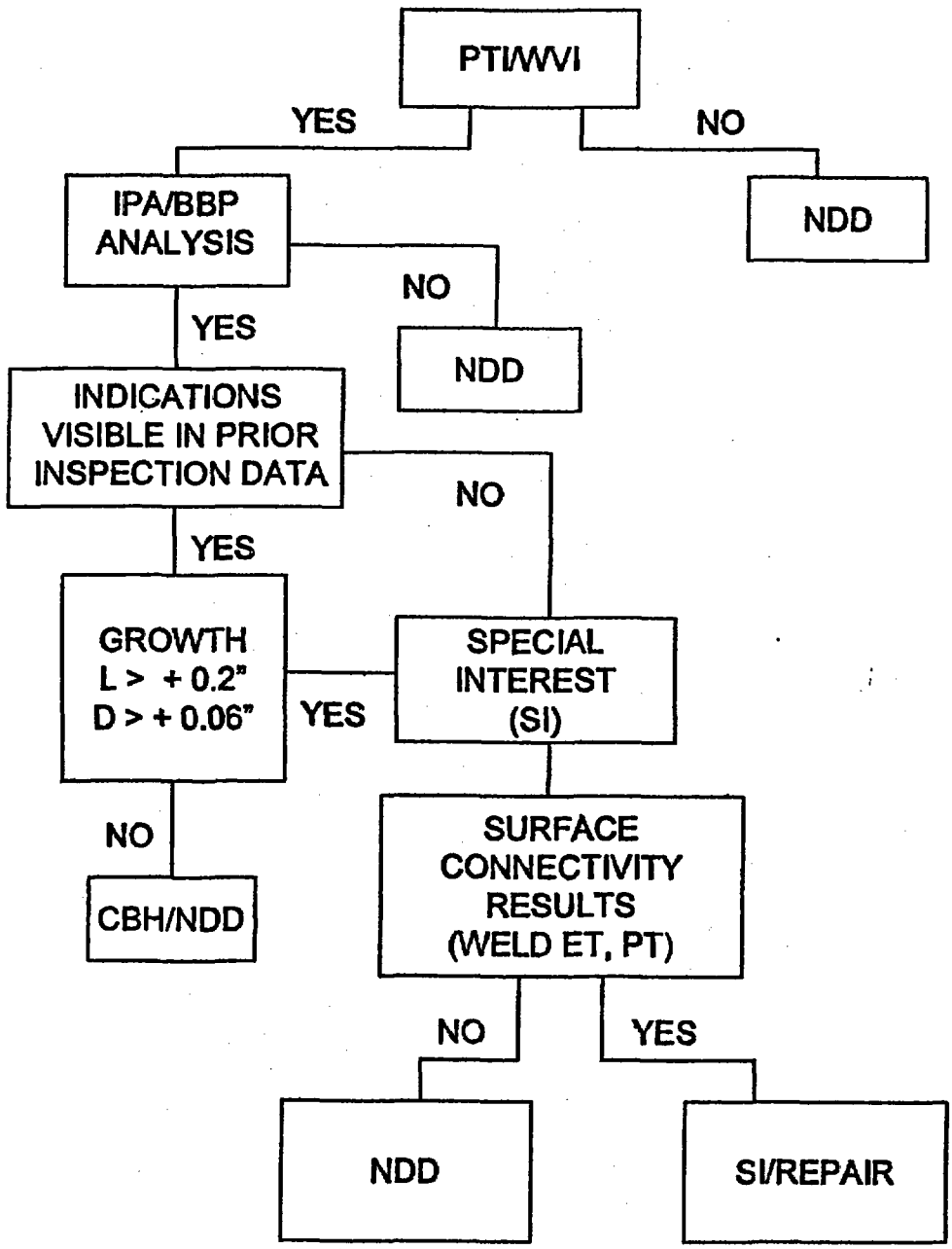
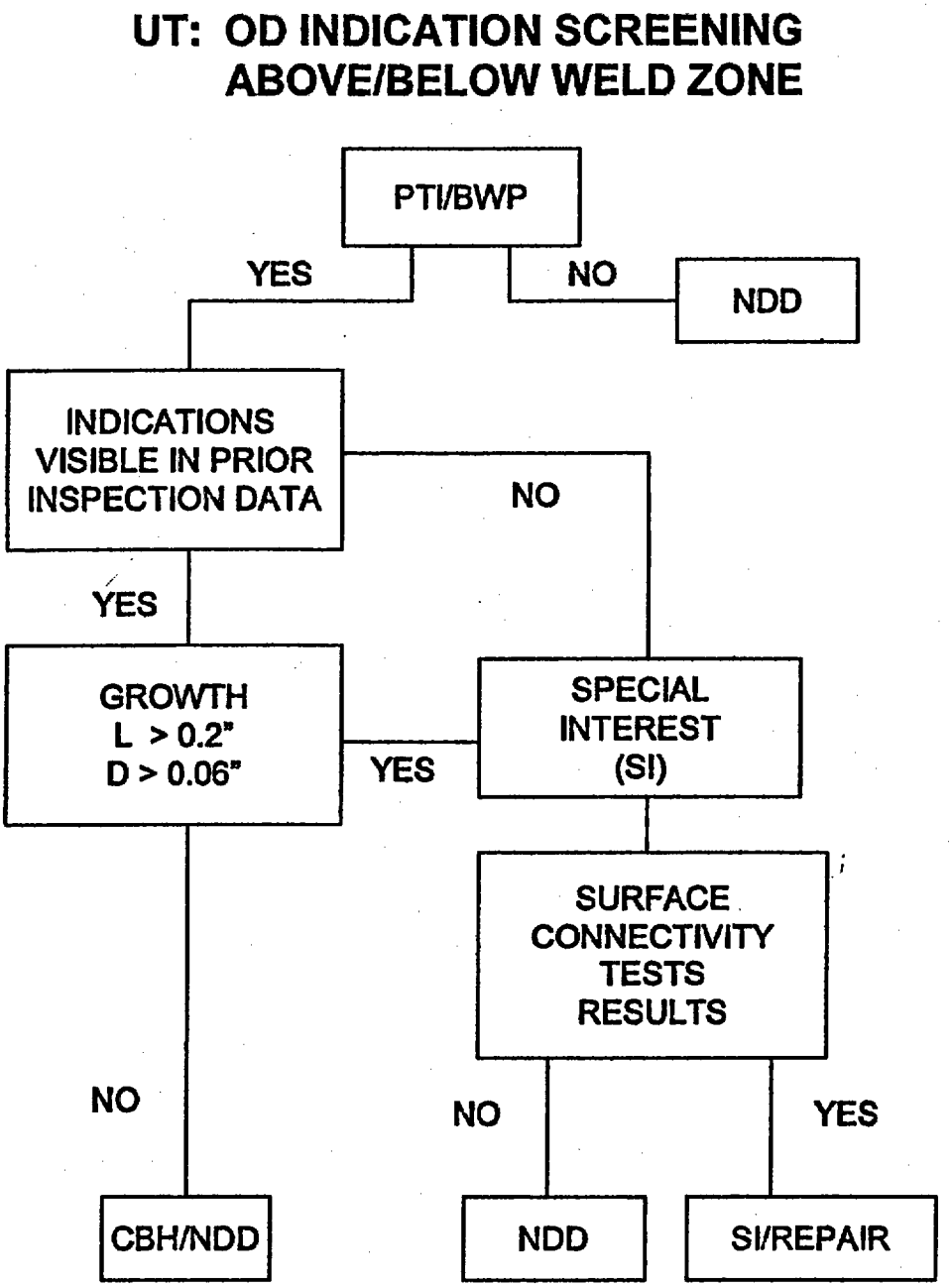


Figure 5-3 - Penetration Tube OD Indication Screening Above or Below Weld Zone



6.0 REFERENCES

[1] EPRI/MRP89 Technical Report, "Materials Reliability Program: Demonstrations of Vendor Equipment and Procedures for the Inspection of Control Rod Drive Mechanism Head Penetrations (MRP-89)", EPRI, Palo Alto, CA: July, 2003.

[2] USNRC Letter EA-03-009, "Issuance of First Revised NRC Order (EA-03-009) Establishing Interim Inspection Requirements for Reactor Vessel Heads at Pressurized Water Reactors", February 20, 2004.

[3] AEP Letter Number AEP:NRC:5054-03, Docket No. 50-135, "Request for Relaxation From Nuclear Regulatory Commission Revised Order Establishing Interim Inspection Requirements for Reactor Pressure Vessel Heads at Pressurized Water Reactors", dated January 20, 2005.

[4] WCAP-14118-P, Rev. 7, "Structural Integrity Evaluation of Reactor Vessel Head Penetrations to Support Continued Operation: D.C. Cook Units 1 and 2", Westinghouse Electric Company LLC, May 2004.

[5] WDI-PJF-1302955-FSR-001, Rev. 1, "D.C. Cook Unit 1 May 2002 Reactor Vessel Head Penetration J-Groove Weld Elevation Study", Westinghouse Electric Company LLC, August 6, 2004.

Appendix A: D.C. Cook Unit 1 RVHP Examination Coverage Summary

Pen #	OD Coverage Below Weld	ID Coverage Below Weld	1.0" Below Weld on OD	OD Coverage Above Weld	ID Coverage Above Weld	2.0" Above Weld on OD
	Measured	Measured	Y or N	Measured	Measured	Y or N
1	1.84	2.29	Y	3.44	3.89	Y
2	2.20	2.65	Y	3.68	4.13	Y
3	2.12	2.57	Y	4.08	4.53	Y
4	2.24	2.69	Y	3.40	3.85	Y
5	1.94	2.39	Y	3.80	4.25	Y
6	1.40	1.85	Y	3.36	3.81	Y
7	1.56	2.01	Y	3.24	3.69	Y
8	1.48	1.93	Y	3.40	3.85	Y
9	1.84	2.29	Y	3.36	3.81	Y
10	1.64	2.09	Y	3.40	3.85	Y
11	1.68	2.13	Y	3.48	3.93	Y
12	1.68	2.13	Y	3.32	3.77	Y
13	1.24	1.69	Y	3.37	3.82	Y
14	1.32	1.77	Y	3.52	3.97	Y
15	2.04	2.49	Y	4.04	4.49	Y
16	1.68	2.13	Y	3.56	4.01	Y
17	2.04	2.49	Y	3.96	4.41	Y
18	1.64	2.09	Y	3.48	3.93	Y
19	2.08	2.53	Y	3.60	4.05	Y
20	1.60	2.05	Y	3.68	4.13	Y
21	1.68	2.13	Y	3.88	4.33	Y
22	1.16	1.61	Y	3.28	3.73	Y
23	1.24	1.69	Y	3.52	3.97	Y
24	1.00	1.45	Y	3.16	3.61	Y
25	1.16	1.61	Y	3.12	3.57	Y
26	1.64	2.09	Y	4.12	4.57	Y
27	1.72	2.17	Y	4.04	4.49	Y
28	1.88	2.33	Y	3.32	3.77	Y
29	1.44	1.89	Y	4.00	4.45	Y
30	0.88	1.33	N	3.12	3.57	Y
31	1.08	1.53	Y	3.04	3.49	Y
32	1.64	2.09	Y	4.08	4.53	Y
33	0.88	1.33	N	3.44	3.89	Y
34	1.34	1.79	Y	3.48	3.93	Y
35	1.16	1.61	Y	3.60	4.05	Y
36	1.28	1.73	Y	3.28	3.73	Y
37	0.96	1.41	N	3.48	3.93	Y
38	0.94	1.39	N	3.72	4.17	Y
39	1.08	1.53	Y	2.76	3.21	Y
40	0.96	1.41	N	2.84	3.29	Y

Pen #	OD Coverage Below Weld	ID Coverage Below Weld	1.0" Below Weld on OD	OD Coverage Above Weld	ID Coverage Above Weld	2.0" Above Weld on OD
	Measured	Measured	Y or N	Measured	Measured	Y or N
41	1.12	1.57	Y	2.88	3.33	Y
42	1.08	1.53	Y	3.92	4.37	Y
43	1.24	1.69	Y	2.80	3.25	Y
44	0.88	1.33	N	2.76	3.21	Y
45	0.92	1.37	N	3.92	4.37	Y
46	0.84	1.29	N	3.20	3.65	Y
47	0.96	1.41	N	3.28	3.73	Y
48	1.08	1.53	Y	2.86	3.31	Y
49	0.96	1.41	N	4.04	4.49	Y
50	0.76	1.21	N	3.24	3.69	Y
51	0.90	1.35	N	3.24	3.69	Y
52	0.76	1.21	N	2.60	3.05	Y
53	0.76	1.21	N	2.84	3.29	Y
54	0.96	1.41	N	2.72	3.17	Y
55	1.14	1.59	Y	2.64	3.09	Y
56	0.84	1.29	N	4.08	4.53	Y
57	0.96	1.41	N	4.08	4.53	Y
58	0.72	1.17	N	3.16	3.61	Y
59	0.84	1.29	N	3.68	4.13	Y
60	1.12	1.57	Y	3.12	3.57	Y
61	1.08	1.53	Y	3.67	4.12	Y
62	1.04	1.49	Y	3.32	3.77	Y
63	0.72	1.17	N	3.72	4.17	Y
64	0.96	1.41	N	3.88	4.33	Y
65	0.92	1.37	N	3.40	3.85	Y
66	0.68	1.13	N	3.60	4.05	Y
67	1.16	1.61	Y	2.96	3.41	Y
68	0.72	1.17	N	3.68	4.13	Y
69	1.04	1.49	Y	4.00	4.45	Y
70	0.68	1.13	N	2.28	2.73	Y
71	0.68	1.13	N	2.72	3.17	Y
72	1.12	1.57	Y	2.24	2.69	Y
73	0.92	1.37	N	2.56	3.01	Y
74	1.16	1.61	Y	4.28	4.73	Y
75	1.24	1.69	Y	4.00	4.45	Y
76	1.20	1.65	Y	3.96	4.41	Y
77	1.20	1.65	Y	3.64	4.09	Y
78	1.24	1.69	Y	4.96	5.41	Y
79	1.44	1.89	Y	4.20	4.65	Y

Notes:

1. ID coverage extends to at least 2.0" above highest weld elevation at all penetration locations

2. OD coverage extends to at least 2.0" above highest weld elevation at all penetration locations

3. ID coverage extends at least 1.0" below the lowest weld elevation at all penetration locations

4. OD coverage extends to at least 1.0" below the lowest weld elevation at 52 penetration locations. The minimum coverage achieved below the weld elevation on the remaining 27 locations is 0.68"