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A Duke Energy Company

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December 23, 2002

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

Subject: Duke Power Company, Oconee Nuclear Station, Unit 2
Docket No. 50-270
Reactor Vessel Head and Penetration Nozzle Condition Report

Enclosure 1 to this letter provides the Duke Energy Corporation report on the condition of the Reactor Vessel Head and Penetration Nozzles for the recently completed Oconee Unit 2 end-of-cycle 19 refueling outage. This report provides the information requested by NRC Bulletin 2001-01, "Circumferential Cracking of Reactor Pressure Vessel Head Penetration Nozzles," dated August 3, 2001, "Requested Action 5," NRC Bulletin 2002-01, "Reactor Pressure Vessel Head Degradation and Reactor Coolant Pressure Boundary Integrity," dated March 18, 2002, items 2.A and 2.B, and NRC Bulletin 2002-02, "Reactor Pressure Vessel Head and Vessel Head Penetration Nozzle Inspection Program," dated August 9, 2002, items 2.A and 2.B.

These bulletins requested that licensees provide information concerning the results of reactor vessel head and head penetration nozzle inspection, repairs and other corrective actions in addition to a description of any leakage.

Enclosure 2 provides ultrasonic examination data sheets for those nozzles with recordable indications or other notable characteristic as listed by Table 1 of Enclosure 1.

If there are any questions, you may contact R. C. Douglas at (864) 885-3073.

Very Truly Yours,

R. A. Jones,
Site Vice President

Enclosures

A088
A095
A096

cc: Mr. L. A. Reyes
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Oconee Unit 2
End-of-Cycle 19 Refueling Outage
Reactor Vessel Head Penetration Nozzle Indication Report

Background

This following provides the Duke Energy Corporation (Duke) response to NRC Bulletin 2001-01, "Requested Action 5", NRC Bulletin 2002-01 "Requested Action 2", and NRC Bulletin 2002-02 "Requested Action 2" for the reactor vessel head inspection and repair activities associated with the above titled refueling outage.

Reactor Vessel Head Design and Fabrication Information

There are 69 Control Rod Drive Mechanism (CRDM) nozzles that penetrate the Reactor Vessel (RV) head. The CRDM nozzles are approximately 5-feet long and are welded to the RV head at various radial locations from the centerline of the RV head. The nozzles are constructed from 4-inch outside diameter (OD) Alloy 600 material. The lower end of the nozzle extends about 6-inches below the inside of the RV head.

The Alloy 600 used in the fabrication of CRDM nozzles was procured in accordance with the requirements of Specification SB-167, Section II to the 1965 Edition including Addenda through Summer 1967 of the ASME B&PV Code. The product form is tubing and the material manufacturer for the Oconee Nuclear Station Unit 2 CRDM nozzles was the Babcock and Wilcox Tubular Products Division.

Each nozzle was machined to final dimensions to assure a match between the RV head bore and the OD of each nozzle. The nozzles were shrunk fit by cooling to at least minus 140 degrees F, inserted into the closure head penetration and then allowed to warm to room temperature (70 degrees F minimum). The CRDM nozzles were tack welded and then permanently welded to the closure head using 182-weld metal. The manual shielded metal arc welding process was used for both the tack weld and the J-groove weld. During weld buildup, the weld was ground, and dye penetrant test (PT) inspected at each 9/32 inch of the weld. The final weld surface was ground and PT inspected.

The weld prep for installation of each nozzle in the RV head was accomplished by machining and buttering the J-groove with 182-weld metal. The RV head was subsequently stress relieved prior to the final completion of the J-grove weld.

Recent RV Head Inspection History

During the previous Oconee Nuclear Station (ONS) Unit 2 refueling outage (end-of-cycle (EOC)18, April-May 2001), a bare metal visual inspection of the top surface of the RV head revealed boric acid deposited on the vessel head surface. The deposits were identified as possibly coming from CRDM nozzles number 4, 6, 18 and 30. Subsequent eddy current testing of the four nozzles revealed shallow axial crack-like indications or clusters on the ID of the nozzles in the vicinity of the partial penetration weld (none indicative of a leak path). PT testing on the weld surface and nozzle OD of the four CRDMs found indications on all four nozzles. Ultrasonic inspections (UT) were performed on the four nozzles using a rotating probe containing multiple transducers. The UT detected 37 OD axial indications and one circumferential indication above the weld. All four nozzles were repaired prior to restart using the Framatome-ANP "ID Temper Bead Repair". Primary Water Stress Corrosion Cracking (PWSCC) was determined to be the root cause.

Report

Note: The following bold text provides the three NRC information requests followed by the Duke response.

NRC Bulletin 2001-01

5.a A description of the extent of VHP nozzle leakage and cracking detected at your plant, including the number, location, size, and nature of each crack detected.

NRC Bulletin 2002-01

2.A. The inspection scope (if different than that provided in response to item 1.D.[1]) and results, including the location, size, and nature of any degradation detected.

NRC Bulletin 2002-02

2. Within 30 days after plant restart following the next inspection of RPV head and VHP nozzles to identify the presence of any degradation, all PWR addressees are requested to provide:

A. the inspection scope and results, including the location, size, extent, nature of any degradation (e.g., cracking, leakage, and wastage) that was detected; details of the NDE used (i.e., method, number, type, and frequency of transducers or transducer packages, essential variables, equipment, procedure and personnel qualification requirements, including personnel pass/fail criteria); and criteria used to determine whether an indication, "shadow," or "backwall anomaly" is acceptable or rejectable.

Methods Used to Inspect VHP Nozzle and Nozzles Inspected During ONS-2, EOC-19 Refueling Outage:

The methods used to inspect the reactor vessel closure head penetrations during the recently completed outage and the nozzles inspected by each method are given below:

Inspection Method	Nozzles Inspected
"Qualified Bare Metal Visual Inspections" of the top of the RV closure head (one inspection with the head still on the vessel to identify boron deposits and one after the head is on the head stand and deposits removed to identify wastage on masked nozzles).	100% of the RV closure head penetrations, CRDM nozzles #1 through #69.
Ultrasonic Inspection using Framatome-ANP ARAMIS delivery tool from under the head with a circumferential blade probe inspecting for both axial and circumferential indications. The area of coverage was approximately 11" up from the bottom of the nozzle and 370° around the nozzle (10° overlap).	The sixty-five remaining nozzles not previously repaired. (All except nozzles #4, #6, #18, and #30)

[1] Per the Duke response to NRC Bulletin 2002-02, dated April 1, 2002.

Ultrasonic inspection using the Framatome-ANP Top Down Delivery Tool and a rotating probe configured for inspection of the tube material of non-repaired nozzles (to identify indications in the tube material, and to look for leak path in the shrink region). The minimum area of coverage was from the bottom of the nozzle to the top of the head.	Special interest nozzles identified after the initial visual inspection and blade probe UT. Nozzles #8, #9, #11, #15, #21, #28, #33, #36, #38, #42 and #67.
Liquid penetrant inspection of the surface of the J-groove weld and OD surface of the CRDM Nozzle. The area of coverage was the nozzle OD extending below the head and the weld and cladding surface extending 3" radial out from the OD of the nozzle.	Masked or leaking nozzles showing no UT indications or leak path in the shrink fit region, and for remaining nozzles as warranted by NDE results. Nozzles #1, #56, #60, #63 and #67.
Ultrasonic Inspections using the Framatome-ANP Top Down Delivery Tool and a rotating probe configured for inspection of the "ID Temper Bead Repair". The area of coverage was the repair weld, HAZ under the repair weld, and ½" up into the tube.	Previously Repaired CRDM Nozzles #4, #6, #18, and #30.
Liquid Penetrant Inspection using the Framatome-ANP Top Down delivery tool of the ID Temper Bead Repair weld and the roll expanded area. The area of coverage was ½" below the repair weld to approximately 2" above the repair weld.	Previously Repaired CRDM Nozzles that were determined to be masked by the initial visual inspection. Nozzles #4 and #18.

<u>Results of Qualified Bare Metal Visual Inspection of the Top of the RV Closure Head:</u>

On October 15, 2002, during the EOC-19 refueling outage, a visual inspection of the top surface of the Oconee Unit 2 reactor vessel closure head while the head was still on the vessel identified seven nozzles (number 8, 9, 19, 24, 31, 42 and 67) as possibly leaking and five nozzles (number 1, 4, 18, 60 and 63) as being masked. Nozzles were classified as leaking where a flow path was evident. Nozzles were classified as masked where boron deposits were evident but their source inconclusive. Figures 1 through 4 illustrate examples of leaking nozzles with a flow path. Figures 5 and 6 illustrate examples of masked nozzles. This inspection was performed in accordance with Duke's response to NRC Bulletin 2002-02[1] as a "Qualified Visual" inspection looking 360° around each nozzle by an engineer and a QC inspector qualified to perform VT-2 inspections. The individuals who performed the inspection are familiar with the construction of the reactor vessel head/CRD interface and are knowledgeable of and familiar with the symptoms of borated water leakage, as well as the detrimental effects of such leakage. They have reviewed the EPRI guidelines for visual inspection of the RV head and participated in previous inspections at Oconee.

After the head was cleaned and placed on the reactor vessel head stand, a visual inspection for wastage was performed and all sixty-nine CRDM flanges were inspected for leakage. The inspection for wastage was able to see 360° around each nozzle at the nozzle to head interface with the aid of a fiberscope when needed: No wastage was identified. The inspection of the CRDM flanges for leakage showed no flange leakage. Figure 7 shows the results of the bare metal visual inspection for this outage (EOC-19) and the location of the repaired nozzles that were found to be leaking in April 2001.

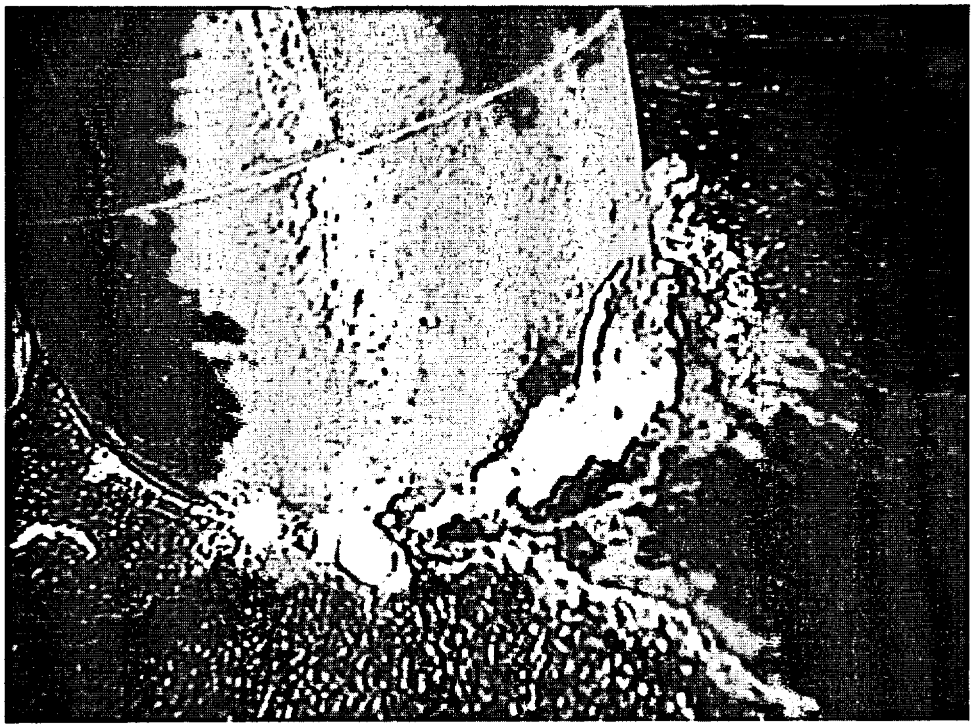


Figure 1 Oconee Unit 2 CRDM Nozzle 19 Identified as Leaking, Top of RV head Inspection for Boric Acid Crystals, 10/15/02

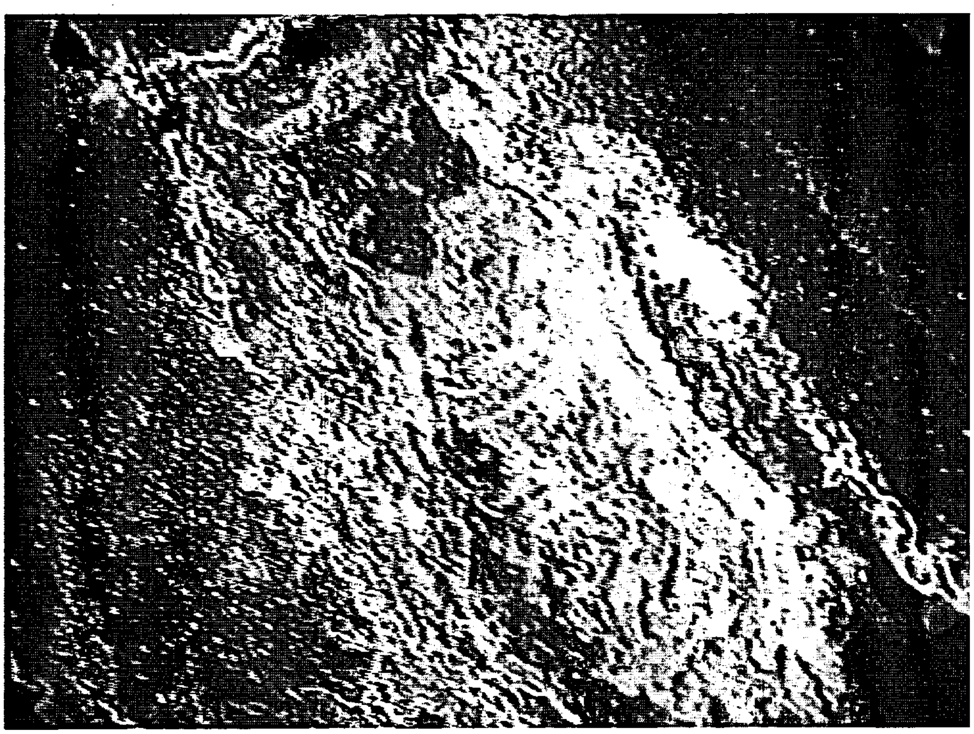


Figure 2 Oconee Unit 2 CRDM Nozzle 31 Identified as Leaking, Top of RV head Inspection for Boric Acid Crystals, 10/15/02

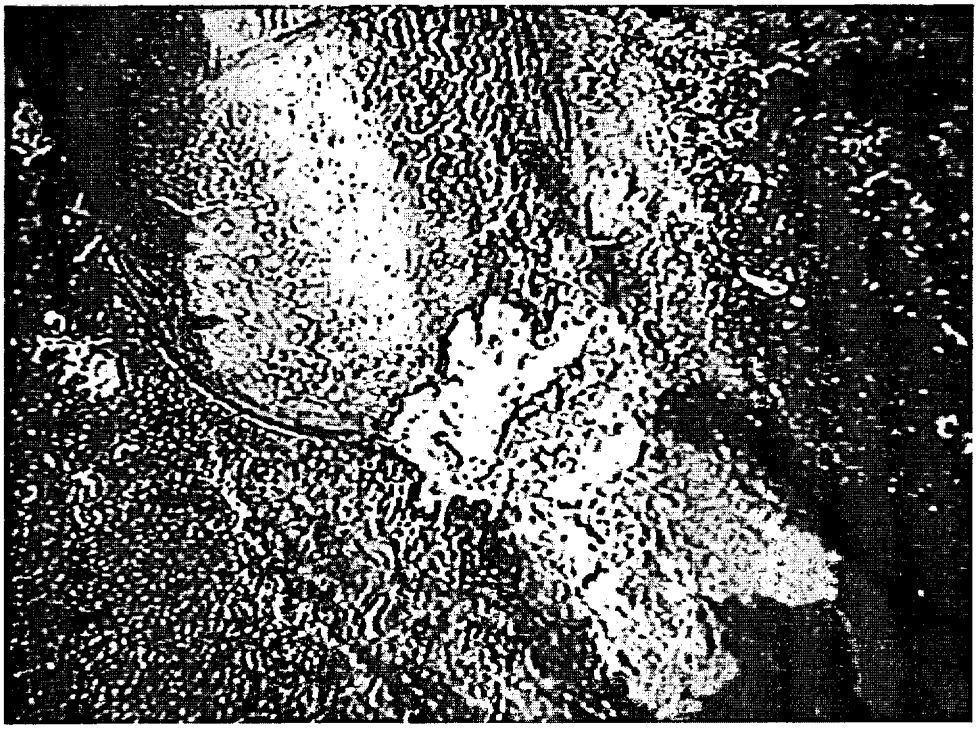


Figure 3 Oconee Unit 2 CRDM Nozzle 42 Identified as Leaking, Top of RV head Inspection for Boric Acid Crystals, 10/15/02

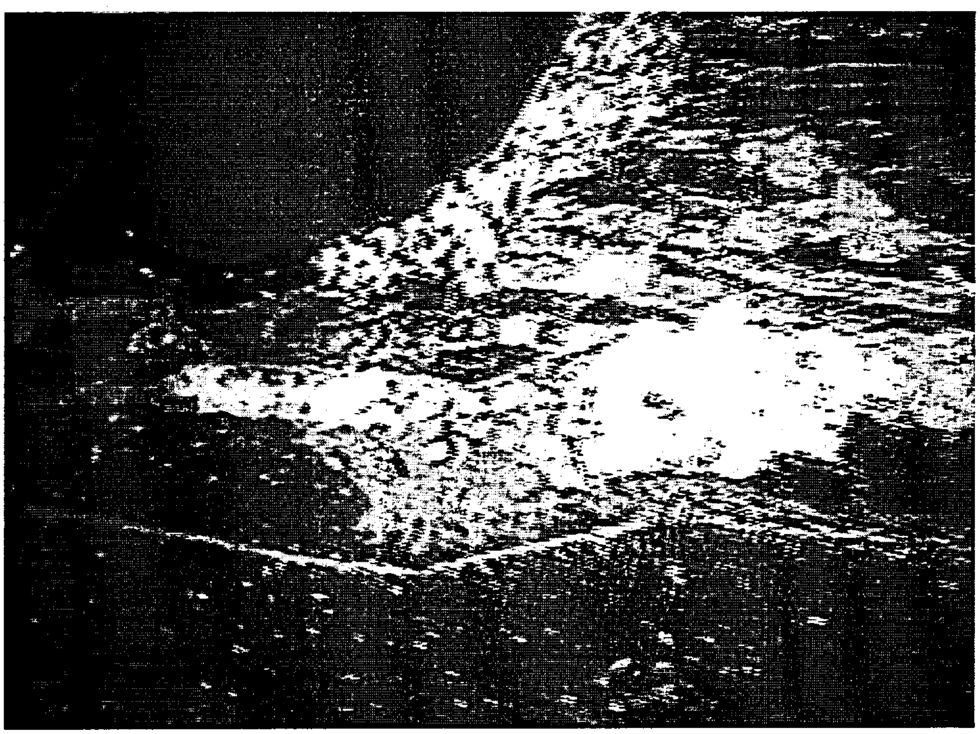


Figure 4 Oconee Unit 2 CRDM Nozzle 67 Identified as Leaking, Top of RV head Inspection for Boric Acid Crystals, 10/15/02

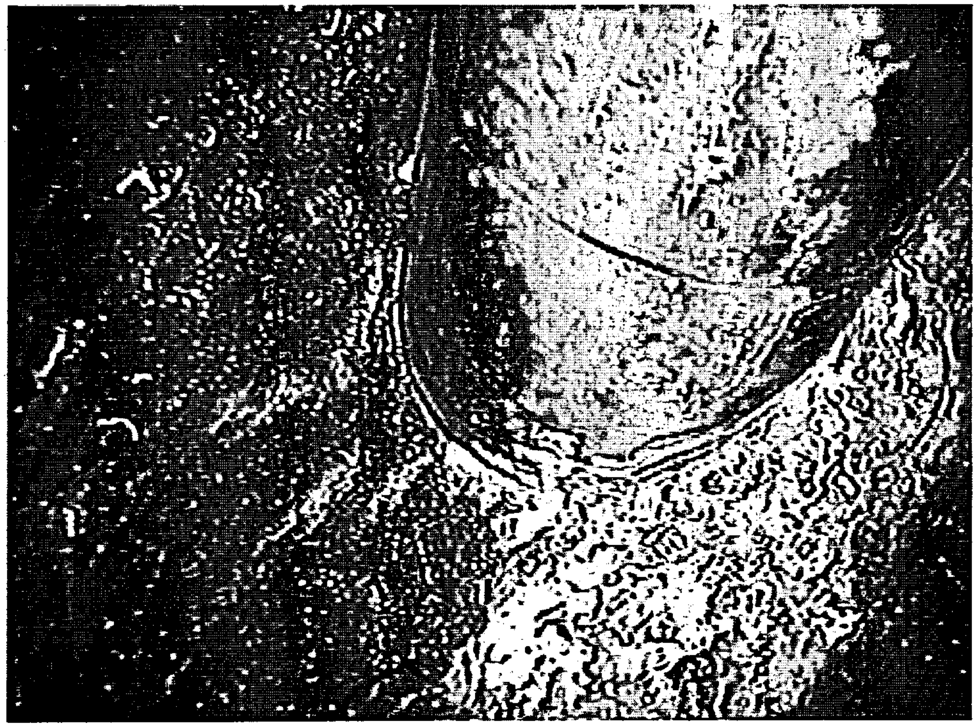
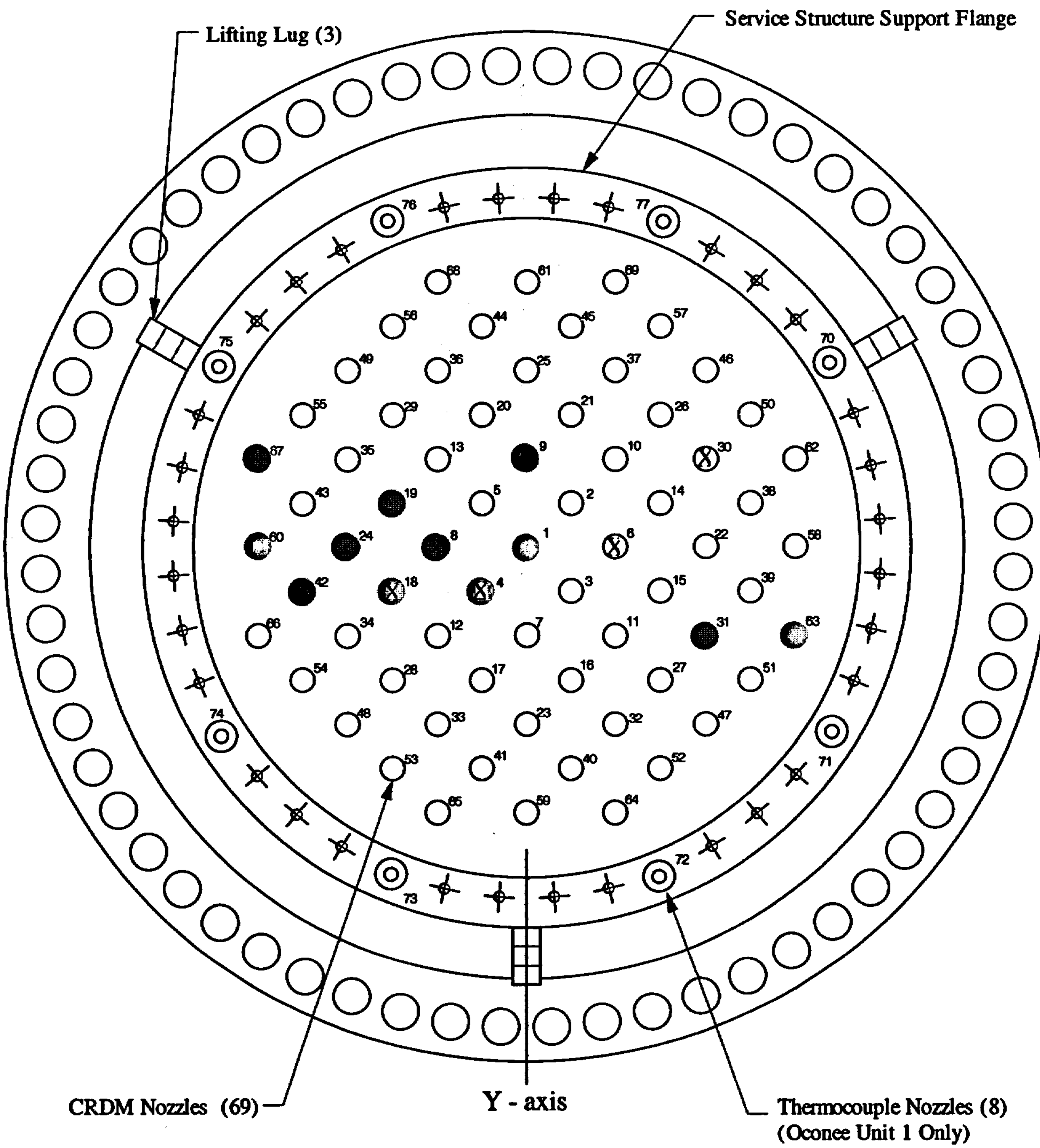


Figure 5 Oconee Unit 2 CRDM Nozzle 60 Identified as Masked, Top of RV head Inspection for Boric Acid Crystals, 10/15/02

Figure 6 Oconee Unit 2 CRDM Nozzle 63 Identified as Masked, Top of RV head Inspection for Boric Acid Crystals, 10/15/02



● Nozzles 8, 9, 19, 24, 31, 42 and 67 identified as leaking during EOC-19

◐ Nozzles 1, 4, 18, 60 and 63 identified as being masked during EOC-19

X Nozzles 4, 6, 18 and 30 were repaired (ID Temper Bead) during EOC-18

Figure 7 Bare metal visual inspections of RV head, Oconee Unit 2 CRDM nozzles identified as suspect, during EOC-19 refueling outage, October 15, 2002

<u>Results of Ultrasonic Inspection of CRDM Nozzles Using the Framatome-ANP "ARAMIS" tool from Under the RV Head to Deliver a UT Blade Probe to the ID of the CRDM Nozzles:</u>

UT from the Inside Diameter (ID) of the sixty-five CRDM nozzles that had not been previously repaired (all except nozzles 4, 6, 18 and 30) was performed using the Framatome-ANP "ARAMIS" tool to deliver a circumferentail blade probe to the ID of the CRDM nozzles from under the RV head. This blade probe contains a nominal 5.0 MHz, 50 degree TOFD transducer set that provides flaw detection for axial, circumferential, and off–axis flaws within the nozzle wall. The examination techniques also include some capability for the detection of a leak path associated with a leak through the shrink fit area between the nozzle outside surface and the vessel head. The area of coverage was approximately 11 inches up from the bottom of the nozzle and 370 degrees around the nozzle (i.e., with 10 degrees overlap). Each nozzle was cleaned by running sand paper affixed to a metal strip up into the gap and then using a water jet to wash out any loose debris. The cleaning has been shown to improve the inspection quality and to extend probe life and prevent probe lift off.

Of the sixty-five nozzles ultrasonically tested with the blade probe, ten nozzles (11, 15, 19, 21, 24, 31, 33, 36, 38 and 42) contained one or more axial indications located on the OD of the nozzle. UT results for seven nozzles (8, 9, 15, 19, 24, 31 and 36) revealed indications of a possible leak path in the shrink fit region of the annulus. The UT test for leak path was deemed indeterminate on two nozzles (21 and 56). Only partial coverage was obtained on three nozzles (nozzle 28 with 20% coverage, nozzle 61 with 90% coverage and nozzle 68 with 95% coverage). No circumferential indications were found. Table 1 provides a summary of the UT results giving the indications location within the nozzle with respect to the J-groove weld and its circumferential location with respect to downhill, along with estimated through nozzle wall dimension and indication length within the nozzle. An adjustment was made to the circumferential location such that the downhill location is at 0° and the positive direction is clockwise looking down from the flange.

<u>Results of Ultrasonic Inspection of CRDM Nozzles Using the Framatome-ANP "Top Down" Delivery Tool and a Rotating Probe Configured for Inspecting Non-Repaired Nozzles:</u>

UT was performed using the Framatome-ANP "Top Down" delivery tool and a rotating probe configured for inspection of the tube material on eleven special interest CRDM nozzles (8, 9, 11, 15, 21, 28, 33, 36, 38, 42 and 67). The rotating probe for nozzle examination consists of a transducer head that holds eight search units. These search units were divided into two sets, one for the axial beam direction and one for the circumferential beam direction. The axial beam direction set of search units consisted of 5.0 MHz, longitudinal wave forward scatter time of flight search units with angles of 30° and 45°; backward scatter pulse echo, 2.25 MHz 60° shear units. The circumferential beam direction set of search units consisted of 5.0 MHz, longitudinal wave forward scatter time of flight search units with angles of 45°, 55°, and 65°; backward scatter pulse echo, 2.25 MHz 60° shear wave search units. The rotating probe also contains a 5.0 MHz 0° longitudinal wave search unit. This probe provides the ability to detect and characterize axial, circumferential and off axis flaws in the tube material of the CRDM nozzles. The examination techniques also include some capability for the detection of a leak path associated with a leak between the nozzle outside surface and the vessel head in the shrink fit area. The area of coverage of this UT inspection was from the top of the nozzle to the top of the head, and 370° around the nozzle (10° overlap).

The special interest nozzles were selected after completion of both the initial visual inspection for leakage and the blade probe UT inspection. Nozzles 8, 9 and 67 were chosen because the visual inspection identified them as leaking and blade probe UT found no indications in the nozzle material. Nozzles 11, 15, 21, 33, 36 and 38 were chosen because the visual inspection did not identify them as leaking or masked, and the blade probe inspection showed axial indications. Nozzle 42 was chosen because the visual inspection identified it as leaking and blade probe UT inspection identified it as containing axial indications, but no leak path was seen in the shrink fit area. Nozzle 28 was inspected because only 20% coverage could be obtained with the blade probe.

Six of the special interest nozzles (11, 15, 21, 36, 38 and 42) contained one or more axial indications located on the OD of the nozzle. Four nozzles (8, 9, 15, and 36) were called as having indications of a possible leak path in the shrink fit region of the annulus. Table 1 provides a summary of the rotating UT inspection results along with the blade probe UT inspection results. As requested, the Framatome-ANP UT data sheets for nozzles with UT indications are included as Enclosure 2 to the submittal.

Table 1 Oconee Unit 2 CRDM Nozzle UT[1] Inspection Results, October 2002

Noz #[2]	Ind #	Type	Circumferential Extent[3] (0° = downhill side) Min.	Max.	Flaw Through Nozzle Wall Thickness (in.)	Surface (ID/OD)	Location (B/W/A)[4]	Axial Length (in.)	Circum. Length (in.)	Leak Path Shrink Fit (Yes/No)
8b		NRI								Yes
8r		NRI								Yes
9b		NRI								Yes
9r		NRI								Yes
11b	1	Axial	228.0°	232.0°	0.13"	OD	B/W	1.24"	0.14"	No
11b	2	Axial	249.0°	250.0°	0.41"	OD	B/W	1.13"	0.03"	No
11r	1	Axial	221.0°	226.0°	0.32"	OD	B/W	1.47"	0.17"	No
11r	2	Axial	239.0°	249.0°	0.35"	OD	B/W	1.28"	0.35"	No
15b	1	Axial	15.0°	15.0°	0.53"	OD	B/W/A	2.37"	0.00"	Yes
15b	2	Axial	54.2°	61.0°	0.36"	OD	B/W	0.94"	0.24"	Yes
15b	3	Axial	215.0°	216.0°	0.06"	OD	B/W	0.58"	0.03	Yes
15b	4	Axial	228.0°	228.0°	0.05"	OD	B/W	0.41"	0.00"	Yes
15b	5	Axial	359.0°	359.0°	0.22"	OD	B/W	1.42"	0.00"	Yes
15r	1	Axial	1.0°	1.0°	0.53"	OD	B/W/A	2.39"	0.00"	Yes
15r	2	Axial	46.0°	48.9°	0.28"	OD	B/W	0.60"	0.10"	Yes
15r	3	Axial	206.0°	206.0°	0.15"	OD	B/W	0.55"	0.00"	Yes
15r	4	Axial	245.0°	245.0°	0.17"	OD	B/W	1.44"	0.00"	Yes
15r	5	Axial	349.0°	349.0°	0.24"	OD	B/W	1.27"	0.00"	Yes
19b	1	Axial	14.3°	14.5°	0.43"	OD	B/W/A	1.92"	0.01"	Yes
19b	2	Axial	106.0°	108.0°	0.15"	OD	B/W	1.17"	0.07"	Yes
19b	3	Axial	205.0°	208.0°	0.16"	OD	B/W	1.31"	0.10"	Yes
19b	4	Axial	218.0°	219.0°	0.28"	OD	B/W	1.21"	0.03"	Yes

Noz #[2]	Ind #	Type	Circumferential Extent[3] (0° = downhill side) Min.	Max.	Flaw Through Nozzle Wall Thickness (in.)	Surface (ID/OD)	Location (B/W/A)[4]	Axial Length (in.)	Circum. Length (in.)	Leak Path Shrink Fit (Yes/No)
19b	5	Axial	239.0°	244.0°	0.13"	OD	B/W/R	2.22"	0.17"	Yes
19b	6	Axial	265.0°	265.0°	0.11"	OD	B/W	0.54"	0.00"	Yes
19b	7	Axial	304.0°	308.7°	0.10"	OD	B/W	1.27"	0.16"	Yes
19b	8	Axial	331.0°	332.0°	0.34"	OD	B/W	1.48"	0.03"	Yes
19b	9	Axial	350.0°	352.0°	0.12"	OD	B/W	0.44"	0.07"	Yes
21b	1	Axial	126.0°	127.0°	0.23"	OD	B/W	0.53"	0.03"	N/A
21b	2	Axial	138.0°	145.0°	0.24"	OD	B/W	0.96"	0.24"	N/A
21b	3	Axial	181.0°	190.0°	0.25"	OD	B/W	1.75"	0.31"	N/A
21b	4	Axial	205.0°	210.0°	0.25"	OD	B/W	1.20"	0.17"	N/A
21b	5	Axial	226.0°	235.0°	0.34"	OD	B/W	1.05"	0.31"	N/A
21b	6	Axial	237.0°	247.0°	0.37"	OD	B/W	1.39"	0.35"	N/A
21b	7	Axial	259.0°	262.0°	0.11"	OD	B/W	0.88"	0.10"	N/A
21r	1	Axial	127.0°	127.0°	0.21"	OD	B/W	0.82"	0.00"	No
21r	2	Axial	139.9°	145.9°	0.35"	OD	B/W	1.41"	0.21"	No
21r	3	Axial	181.5°	181.5°	0.23"	OD	B/W	1.01"	0.30"	No
21r	4	Axial	205.0°	208.5°	0.22"	OD	B/W	0.65"	0.12"	No
21r	5	Axial	220.0°	223.0°	0.29"	OD	B/W	1.49"	0.10"	No
21r	6	Axial	237.9°	247.0°	0.25"	OD	B/W	1.02"	0.32"	No
21r	7	Axial	255.0°	264.0°	0.32"	OD	B/W/A	1.35"	0.31"	No
24b	1	Axial	9.0°	9.0°	0.15"	OD	B/W	1.00"	0.00"	Yes
24b	2	Axial	40.2°	42.0°	0.22"	OD	B/W	1.14"	0.06"	Yes
24b	3	Axial	231.0°	257.0°	0.40"	OD	B/W	1.17"	0.91"	Yes
24b	4	Axial	291.0°	292.0°	0.19"	OD	B/W	1.12"	0.03"	Yes
24b	5	Axial	315.0°	316.0°	0.11"	OD	B/W	0.88"	0.03"	Yes
31b	1	Axial	181.0°	181.0°	0.46"	OD	B/W	1.26"	0.00"	Yes
31b	2	Axial	219.0°	244.0°	0.45"	OD	B/W/A	2.30"	0.87"	Yes
31b	3	Axial	246.0°	259.0°	0.31"	OD	B/W	1.33"	0.45"	Yes
31b	4	Axial	268.0°	271.0°	0.13"	OD	B/W	1.09"	0.10"	Yes
31b	5	Axial	290.0°	292.0°	0.17"	OD	B/W	0.80"	0.07"	Yes
33b	1	Axial	25.0°	25.0°	0.26"	OD	B/W	1.11"	0.00"	No
33b	2	Axial	42.0°	44.0°	0.15"	OD	B/W	1.06"	0.07"	No
33b	3	Axial	346.0°	346.0°	0.06"	OD	B/W	0.81"	0.00"	No
33r		NRI								No
36b	1	Axial	18.0°	18.0°	0.27"	OD	B/W/A	1.72"	0.00"	Yes
36r	1	Axial	26.5°	26.5°	0.45"	OD	B/W/A	1.76"	0.00"	Yes
38b	1	Axial	60.5°	60.5°	0.31"	OD	B/W	1.63"	0.00"	No
38b	2	Axial	72.0°	75.1°	0.20"	OD	B/W	1.04"	0.11"	No
38b	3	Axial	87.0°	91.0°	0.09"	OD	B/W	1.20"	0.14"	No
38b	4	Axial	99.0°	101.0°	0.15"	OD	B/W	0.58"	0.07"	No
38b	5	Axial	278.0°	280.0°	0.11"	OD	B/W	0.36"	0.07"	No
38b	6	Axial	298.0°	303.0°	0.11"	OD	B/W	1.39"	0.17	No

Noz #[2]	Ind #	Type	Circumferential Extent[3] (0° = downhill side) Min.	Max.	Flaw Through Nozzle Wall Thickness (in.)	Surface (ID/OD)	Location (B/W/A)[4]	Axial Length (in.)	Circum. Length (in.)	Leak Path Shrink Fit (Yes/No)
38b	7	Axial	317.0°	322.0°	0.15"	OD	B/W	0.70"	0.17"	No
38r	1	Axial	69.2°	79.0°	0.24"	OD	B/W	1.06"	0.34"	No
38r	2	Axial	79.6°	91.3°	0.10"	OD	B/W	0.93"	0.41"	No
38r	3	Axial	86.4°	94.7°	0.13"	OD	B/W	0.78"	0.29"	No
38r	4	Axial	91.9°	102.7°	0.09"	OD	B/W	0.90"	0.38"	No
38r	5	Axial	285.1°	285.1°	0.26"	OD	B/W	0.70"	0.00"	No
38r	6	Axial	306.0°	306.0°	0.22"	OD	B/W	0.32"	0.00"	No
38r	7	Axial	312.0°	312.0°	0.24"	OD	B/W	0.63"	0.00"	No
42b	1	Axial	209.0°	211.0°	0.45"	OD	B/W	1.09"	0.07"	No
42b	2	Axial	304.0°	305.0°	0.15"	OD	B/W	1.02"	0.03"	No
42b	3	Axial	326.0°	328.0°	0.19"	OD	B/W	0.57"	0.07"	No
42r	1	Axial	209.0°	209.0°	0.22"	OD	B/W	1.20"	0.00"	No
42r	2	Axial	304.0°	304.0°	0.17"	OD	B/W	1.30"	0.00"	No
42r	3	Axial	326.0°	326.0°	0.19"	OD	B/W	0.95"	0.00"	No

1 A finalized UT report has not been completed (numbers may change slightly).
2 b = blade probe results, r = rotating probe results.
3 0° = downhill side, 180° = uphill side. The positive direction is clock-wise looking down.
4 B = area of nozzle below the weld. W = area of nozzle opposite weld. A = area of nozzle above the weld. R = root of J-groove weld. Only the Nozzle was volumetrically inspected.

<u>Results of Liquid Penetrant Examination of the J-groove Weld Surface and OD Surface of the CRDM Nozzle:</u>

From the underside of the head, manual PT examinations of were performed by Framatome-ANP on five nozzles (1, 56, 60, 63 and 67). The PT covered an area 3 inches in diameter from the nozzle that included the J-groove weld surface, fillet weld cap, and part of the vessel head cladding. It also extended down the OD of the nozzle from the weld to nozzle interface to the end of the nozzle. The visible dye, solvent removable PT technique was in accordance with Framatome-ANP procedure 54-PT-6-07 (ASME Section III), except that the recording criteria included any indications that showed bleeding out of the dye and the developer was allowed to dry for a minimum of 15 minutes before interpretation. Nozzles 1, 60 and 63 were PT examined because the bare metal visual classified them as masked and no recordable UT indications were found. Nozzle 56 was PT examined because the leak path in the shrink fit area was indeterminate. Nozzle 67 was PT examined because the bare metal visual classified it as leaking and UT found no recordable indications or a leak path in the shrink fit region.

All nozzles showed recordable indications after their initial PT. Nozzles 56 and 60 were both ground twice and examined by PT after each grinding operation. The indications on nozzle 56 were fully removed after grinding. The results of the PT examination of the nozzle OD surface and the J-groove weld surface are given in Table 2.

Table 2 Oconee Unit 2 PT CRDM Nozzle OD Surface and J-groove Weld Surface, October 2002

Nozzle #[1]	CRDM Nozzle OD Surface Axial indications	J-Groove Weld Surface Indication
1	One 1/2" linear indication extending from toe of weld down the nozzle to vent hole.	Two 3/16" rounded indications, and one 1/2" circumferential linear indication.
56	clear	Three 1/4" and two 3/16" rounded indication
56 -1/8"	clear	One 1/8" rounded indication.
56 -1/4"	clear	clear
60	clear	Two 1/2" and two 1/4"circumferential linear indications.
60 -1/32"	clear	Two 1/2", one 3/8" and one 1/4"circumferential linear indications.
60 -5/32"	clear	Indications still there
63	Multiple linear indications 1/4" to 1/2" in length extending from toe of weld down the nozzle.[2]	One 1/4" rounded indication and one 3/16" circumferential linear indication.
67	clear	Two 1/4" circumferential linear indications and six 3/16" rounded indications.

[1] -1/32", -1/8", -5/32" and -1/4" refer to the amount of metal removed.
[2] The indication appeared to be like the shallow axial cracking that has been identified as craze type cracking on the ID of the CRDM nozzles. The area of cracking was centered on the uphill side and extended about 160° around the nozzle.

Results of Ultrasonic Inspection of CRDM Nozzles Using the Framatome-ANP "Top Down" Delivery Tool and a Rotating Probe Configured for Inspecting "ID Temper Bead" Repairs:

UT was performed using the Framatome-ANP "Top Down" delivery tool and a rotating probe configured for inspecting "ID Temper Bead" weld repairs on the four previously repaired CRDM nozzles (4, 6, 18 and 30). The rotating probe contained a transducer array designed specifically for the examination of weld metal and associated HAZ. The transducer array consists of 2.25 MHz, longitudinal wave search units with angles of 0°, 45°, and 70°. The examination was performed in four beam directions to maximize coverage of the examination volume, which includes "ID Temper Bead" weld repair, associated HAZ under the weld, plus ½" of base metal above the weld repair. The 45° search units are utilized to provide coverage in both the axial and circumferential directions while the 70° search units are used only in the axial direction.

The results of this examination were consistent with those from the initial examination. No new indications were found and the original "triple point" indications were unchanged from the initial examintion.

<u>Results of Liquid Penetrant Examination of the Previously "ID Temper Bead" Weld Repairs:</u>

A Framatome-ANP delivery tool from above the head was used to perform a remote color contrast water washable PT examination of two of the previously "ID Temper Bead" repaired nozzles (4 and 18) that were classified as masked during the initial bare metal visual inspection of the RV head. The PT examination was performed by Framatome-ANP qualified personnel using Framatome-ANP procedure 54-ISI-244-07. The area of coverage was ½" below the repair weld to approximately 2" above the weld which covers the roll expansion area of the remaining tube. No recordable PT indications were found.

<u>Review of Bore After Removal of Nozzle in Preparation for Making "ID Temper Bead" Repair Welds</u>:

Fifteen nozzles (1, 8, 9, 11, 15, 19, 21, 24, 31, 36, 38, 42, 60, 63 and 67) were repaired during ONS-2 EOC-19. A Duke Engineer reviewed video tapes made during PT of the machined surface after removal of the tube end to approximately 2 inches above the original J-groove weld for the repaired nozzles. The purpose of the review was to determine if the machined bore of the old J-groove weld contained PT indications and to identify possible wastage due to boric acid corrosion. The machine surface of the J-groove welds that was exposed during boring of all fifteen nozzles contained from one to six PT indications in each nozzle. Axial indications were found on nozzles 9 and 15 that could indicate a possible leak path. Examples of the axial indication observed in nozzle 15 are shown in Figures 8 and 9. An example of a typical rounded indication as found in nozzle 21 is shown in Figure 10. The height of the picture is approximately ½ inch.

No indications of boric acid wastage were observed within the machined bores. The region between the remaining nozzle (that had been rolled prior to machining) and the RV head was checked for gaps. None were found.

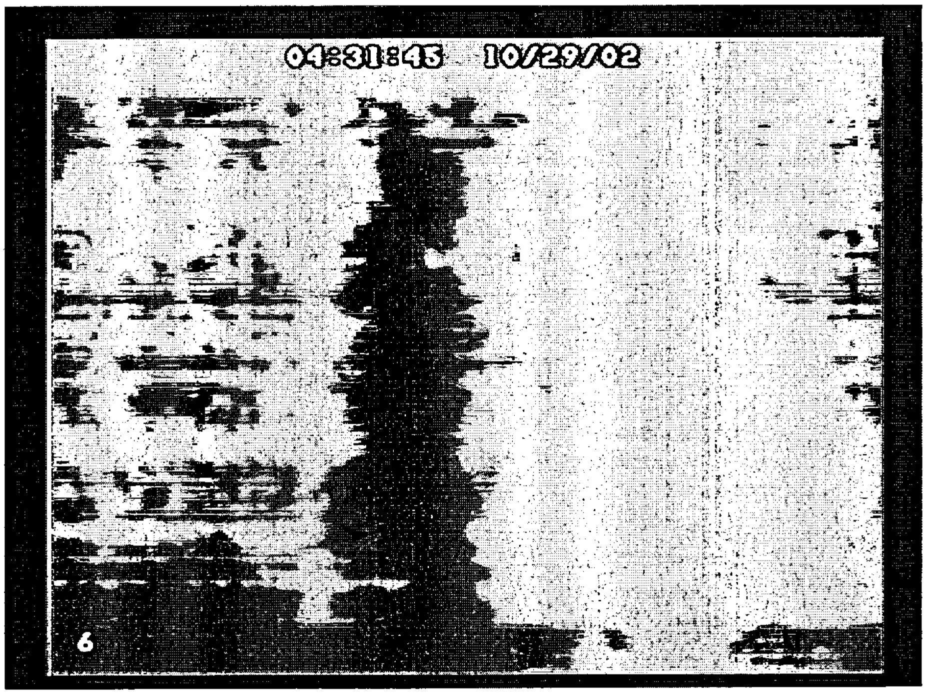


Figure 8 Nozzle 15 axial PT indications, original J-groove weld bore after removal of nozzle, ONS-2 EOC-19

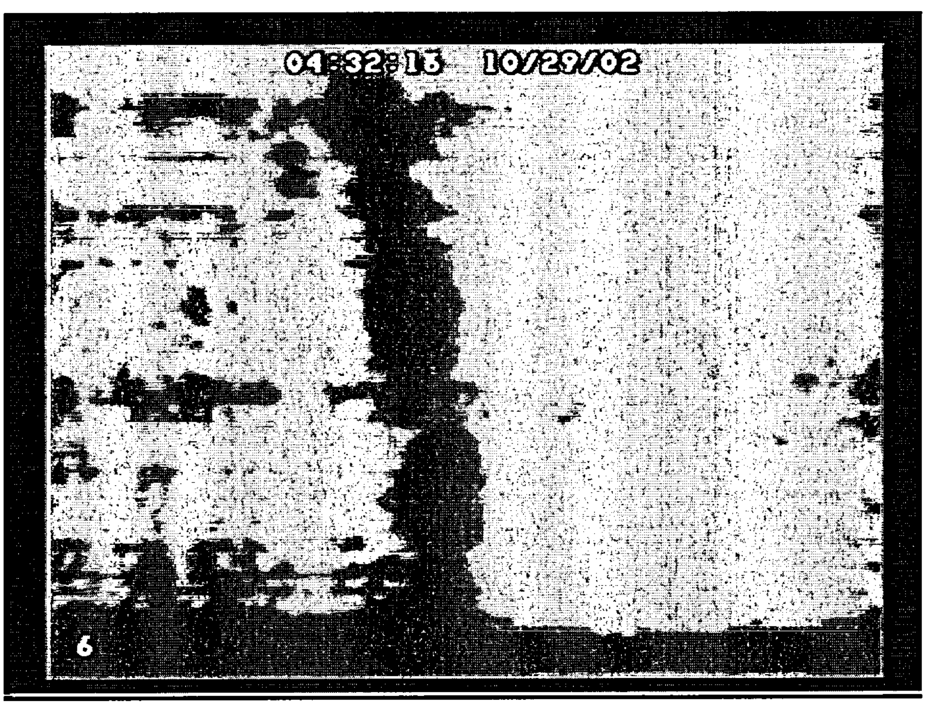


Figure 9 Nozzle 15 continuations of axial PT indications, original J-groove weld bore after removal of nozzle, ONS-2 EOC-19

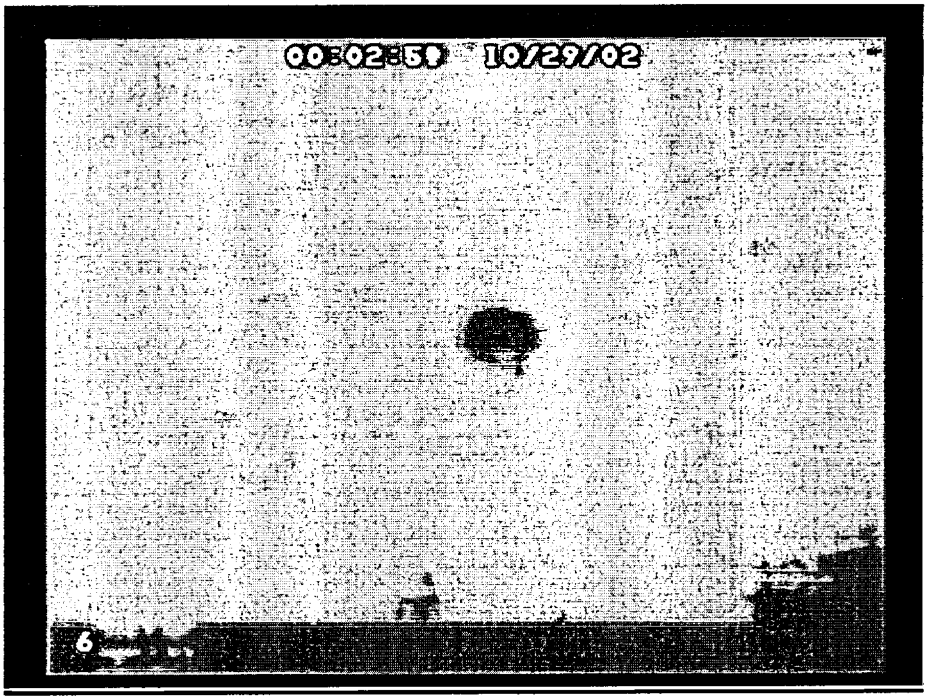


Figure 10 Nozzle 21, rounded PT indications, original J-groove weld bore after removal of nozzle, ONS-2 EOC-19

NRC Bulletin 2001-01

5.b If cracking is identified, a description of the inspection (type, scope qualification requirements, and acceptance criteria) repairs, and other corrective actions you have taken to satisfy applicable requirements. This information is requested only if there are changes from prior information submitted in accordance with the bulletin.

NRC Bulletin 2002-01

2.B The corrective action taken and the root cause of the degradation.

NRC Bulletin 2002-02

2.B The corrective actions taken and the root cause determination for any degradation found.

Inspections Performed During the ONS-2 EOC-19 Refueling Outage for Detection of RV Closure Head PWSCC:

Inspections performed during the ONS-2 EOC-19 were in accordance with Duke Energy's response to NRC Bulletin 2002-02. These inspections included the following:

- A qualified bare metal visual inspection performed of the of the top of the RV closure head by Duke Energy to identify leaking or masked nozzles, and any wastage.
- Ultrasonic inspections performed by Framatome-ANP using a blade probe and rotating probe for non-repaired nozzles, and a rotating probe for repaired nozzles.
- Liquid penetrant inspection of the surface of the J-groove weld and the OD surface of selected nozzles and a remote PT of the "ID Temper Bead" weld on two previously repaired nozzles.

The above questions concerning examination type, scope, qualification requirements, and acceptance criteria are addressed in the preceding section except for UT examinations performed by Framatome-ANP. The requested information was previously submitted by Framatome-ANP letter to the US NRC Document Control Desk, "Procedures for the Conduct of Ultrasonic Examinations of Reactor Vessel Head Penetrations," dated November 11, 2002.

Repairs and Other Corrective Actions Taken to Satisfy Applicable Requirements:

Fifteen CRDM Nozzles (numbers 1, 8, 9, 11, 15, 19, 21, 24, 31, 36, 38, 42, 60, 63 and 67) were repaired during this outage using the automated Framatome-ANP "ID Ambient Temper Bead" weld repair technique as described in the Relief Request 02-07[2]. Corrective actions taken and future outage plans remain consistent with Duke's NRC Bulletin 2001-01, 2002-01 and 2002-02 submittals. Specifically, RV head replacement is scheduled at the next refueling outages for all three Oconee units (i.e., for ONS-3 in the spring of 2003, ONS-1 in the fall of 2003, and ONS-2 in the spring of 2004).

Root Cause of the Degradation:

The root cause of the degradation found in the Alloy 600 CRDM nozzles during the Unit 2 EOC-19 outage is Primary Water Stress Corrosion Cracking (PWSCC). This conclusion is based on:

- Comparison of the Unit 2 NDE data with previous Oconee CRDM inspections documented in the Oconee corrective action program for Units 1, 2, and 3.
- Correlation of the current crack location and orientation with previous Finite Element Analyses (FEA) documented in the corrective action program.
- The recent history of CRDM cracking found in Alloy 600 weld metal attributed to PWSCC at ONS and other Pressurized Water Reactors.

[2] Letter, Duke to NRC, "Request for Alternates to ASME Section XI per 10 CFR 50.55a(a)(3)(ii) – Relief Requests 02-07, Revision 0, and 02-08, Revision 0, dated September 5, 2002.

ENCLOSURE 2

OCONEE UNIT 2

CONTROL ROD DRIVE MECHANISM PENETRATION NOZZLE ULTRASONIC INSPECTION DATA SHEETS FOR NOZZLES WITH RECORDABLE INDICATIONS (OR OTHER NOTABLE CHARACTERISTIC)

NOTES:

1. These data sheets are those CRDMs with indications as shown in Table 1, Enclosure 1 of this report.

2. There is a separate data sheet for each nozzle and type of UT inspection performed (i.e., rotating probe UT from the top down, and blade probe UT from bottom up) as indicated in Table 1.

FRAMATOME ANP

CRDM Nozzle Ultrasonic Examination Data Sheet (Blade)

Customer: Duke Energy Corporation		**Plant:** Oconee	**Unit:** 2	**Procedure:** 54-ISI-100-09	**Nozzle ID:** 8
Nozzle Dimensions:	**ID:** 2.75"	**OD:** 4.0"	**Thickness:** .625"	**Downhill Side of Nozzle:** 0 deg.	**End of Noz. (In.):** 0"

Cal Block ID: 6011137E R/1 "B"	**Probe S/N's:**	**Ch 1:** SO454CN	**Ch 3:**	**Ch 5:**	**Ch 7:**	**Ch 9:**
Calibration Setup: 1		**Ch 2:**	**Ch 4:**	**Ch 6:**	**Ch 8:**	**Ch 10:**

Equipment:	Micro-TomoScan: VH-7969	ACCUSONEX Software: Acquisition 6.2.5, Analysis 3.8	UT Cable: 50' RG-174

Data File:	**Scan Start**	**Scan Stop**	**Cal. Files**	**Examination Results**	
				Recordable Ind.	Leak Path
A2292.14.59.22	0 **deg @** 0.59"	370 **deg @** 11.31"	A2292_08.22.13	No	Yes
A2292.16.01.50	220 **deg @** 0"	370 **deg @** 11.31"	A2294_10.36.28		

Flaw No.	Surface (ID/OD)	Depth to Flaw Tip	End Point 1 Min (In.)	End Point 1 Min (deg.)	End Point 2 Max (In.)	End Point 2 Max (deg.)	Axial Total (In.)	Adjusted Circ. Extent Min (deg.)	Adjusted Circ. Extent Max (deg.)	Adjusted Circ. Extent Total (In.)	Flaw Length (In.)	Flaw Angle (deg.)	Flaw TWD (In.)	Flaw Aspect Ratio	Flaw Orient.
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															

Weld Profile														
	Noz. Loc.	**0**	**30**	**60**	**90**	**120**	**150**	**180**	**210**	**240**	**270**	**300**	**330**	**360**
	MAX.	2.98	3.16	3.40	3.68	4.01	4.20	4.28	4.15	3.96	3.68	3.43	3.28	2.98
	MIN.	1.51	1.72	1.92	2.20	2.41	2.74	2.85	2.66	2.30	2.02	1.84	1.56	1.51

Comments: Leak Path detected with no evidence of cracking in the nozzle wall.

Analysis included 7.03" above the weld root region to support the IDTB weld repair with no recordable indications in this region.

Analyzed by: K. J. Hacker, UT LIII **Date:** 10/19/02 **Reviewed by:** M. G. Hacker, UT LIII **Date:** 10/22/02

FRAMATOME ANP

CRDM Nozzle Ultrasonic Examination Data Sheet (Rotating)

Customer: Duke Energy Corporation	**Plant:** Oconee	**Unit:** 2	**Procedure:** 54-ISI-100-09	**Nozzle ID:** 8

Nozzle Dimensions:	ID: 2.75"	OD: 4.0"	**Thickness:** .625"	**Downhill Side of Nozzle:** 0 deg.	**End of Noz. (in.):** 31.83"

Cal Block ID: 6009876D2-B	**Probe DB/N's:**	**Ch 1:** 35080	**Ch 3:** 35055	**Ch 5:** 34996	**Ch 7:** 35106	**Ch 9:** N/A
Calibration Setup: 1		**Ch 2:** 35205	**Ch 4:** 35080	**Ch 6:** 34996	**Ch 8:** 35177	**Ch 10:** N/A

Equipment:	Micro-TomoScan: VH-8169	ACCUSONEX Software: Acquisition 6.2.5, Analysis 3.8	UT Cable: 50' RG-174

Data File:	**Scan Start**	**Scan Stop**	**Cal. Files**	**Examination Results**	
T2296.02.04.11	-5 deg @ 13.6"	365 deg @ 34.0"	T2295_13.21.15	Recordable Ind.	Leak Path
			T2297_17.43.38	No	Yes

		Depth	End Point 1		End Point 2		Axial	Adjusted Circ. Extent			Flaw	Flaw	Flaw	Flaw	
Flaw No.	**Surface (ID/OD)**	**to Flaw Tip**	**Min (in.)**	**Min (deg.)**	**Max (in.)**	**Max (deg.)**	**Total (in.)**	**Min (deg.)**	**Max (deg.)**	**Total (in.)**	**Length (in.)**	**Angle (deg.)**	**TWD (in.)**	**Aspect Ratio**	**Flaw Orient.**
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															

Weld Profile	**Noz. Loc.**	0	30	60	90	120	150	180	210	240	270	300	330	360
	MAX.	28.98	28.86	28.63	28.39	28.09	27.89	27.93	28.17	28.43	28.63	28.92	28.92	28.98
	MIN.	30.49	30.37	30.15	30.01	29.73	29.52	29.32	29.54	29.85	30.01	30.19	30.39	30.49

Comments: No recordable indications detected in the nozzle wall, however the leak path detected with the circ. blade probe has been verified.

Analyzed by: J. D. Breza, UT II **Date:** 10/24/02 **Reviewed by:** M. G. Hacker, UT LIII **Date:** 10/24/02

FRAMATOME ANP

CRDM Nozzle Ultrasonic Examination Data Sheet (Blade)

Customer: Duke Energy Corporation	Plant: Oconee	Unit: 2	Procedure: 54-ISI-100-09		Nozzle ID: 9
Nozzle Dimensions:	ID: 2.75"	OD: 4.0"	Thickness: .625"	Downhill Side of Nozzle: 0 deg.	End of Noz. (in.): 0"

Cal Block ID: 6011137E R/1 "B"	Probe S/N's:	Ch 1: SO454CN	Ch 3:	Ch 5:	Ch 7:	Ch 9:
Calibration Setup: 1		Ch 2:	Ch 4:	Ch 6:	Ch 8:	Ch 10:

Equipment:	Micro-TomoScan: VH-7969	ACCUSONEX Software: Acquisition 6.2.5, Analysis 3.8	UT Cable: 50' RG-174

Data File:	Scan Start	Scan Stop	Cal. Files	Examination Results	
				Recordable Ind.	Leak Path
A2292_17.31.29	0 deg @ 0.36"	370 deg @ 11.28"	A2292_08.22.13 A2294_10.36.28	No	Yes

Flaw No.	Surface (ID/OD)	Depth to Flaw Tip	End Point 1 Min (in.)	End Point 1 Min (deg.)	End Point 2 Max (in.)	End Point 2 Max (deg.)	Axial Total (in.)	Adjusted Circ. Extent Min (deg.)	Adjusted Circ. Extent Max (deg.)	Adjusted Circ. Extent Total (in.)	Flaw Length (in.)	Flaw Angle (deg.)	Flaw TWD (in.)	Flaw Aspect Ratio	Flaw Orient.
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															

Weld Profile	Noz. Loc.	0	30	60	90	120	150	180	210	240	270	300	330	360
	MAX.	3.06	3.09	3.26	3.57	3.75	3.97	4.04	3.87	3.67	3.40	3.13	2.99	3.06
	MIN.	1.49	1.63	1.76	1.95	2.22	2.44	2.54	2.40	2.15	2.01	1.73	1.59	1.49

Comments: Leak Path detected with no evidence of cracking in the nozzle wall.
Analysis included 7.24" above the weld root region to support the IDTB weld repair with no recordable indications in this region.

Analyzed by: K. J. Hacker, UT LIII   Date: 10/19/02   Reviewed by: M. G. Hacker, UT LIII   Date: 10/22/02

FRAMATOME ANP

CRDM Nozzle Ultrasonic Examination Data Sheet (Rotating)

Customer: Duke Energy Corporation	**Plant:** Oconee	**Unit:** 2	**Procedure:** 54-ISI-100-09		**Nozzle ID:** 9
Nozzle Dimensions:	ID: 2.75"	OD: 4.0"	**Thickness:** .625"	**Downhill Side of Nozzle:** 0 deg.	**End of Noz. (in.):** 31.83"

Cal Block ID: 6009876D2-B	**Probe DB/N's:**	**Ch 1:** 35080	**Ch 3:** 35055	**Ch 5:** 34996	**Ch 7:** 35106	**Ch 9:** N/A
Calibration Setup: 1		**Ch 2:** 35205	**Ch 4:** 35080	**Ch 6:** 34996	**Ch 8:** 35177	**Ch 10:** N/A

Equipment:	Micro-TomoScan: VH-8169	ACCUSONEX Software: Acquisition 6.2.5, Analysis 3.8	UT Cable: 50' RG-174

Data File:	**Scan Start**	**Scan Stop**	**Cal. Files**	**Examination Results**	
T2296.00.09.11	-5 deg @ 13.6"	365 deg @ 34.0"	T2295_13.21.15	Recordable Ind.	Leak Path
			T2297_17.43.38	No	Yes

Flaw No.	Surface (ID/OD)	Depth to Flaw Tip	End Point 1 Min (in.)	End Point 1 Min (deg.)	End Point 2 Max (in.)	End Point 2 Max (deg.)	Axial Total (in.)	Adjusted Circ. Extent Min (deg.)	Adjusted Circ. Extent Max (deg.)	Adjusted Circ. Extent Total (in.)	Flaw Length (in.)	Flaw Angle (deg.)	Flaw TWD (in.)	Flaw Aspect Ratio	Flaw Orient.
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															

Weld Profile	Noz. Loc.	0	30	60	90	120	150	180	210	240	270	300	330	360
	MAX.	28.84	28.78	28.59	28.34	28.08	27.93	27.79	27.93	28.22	28.47	28.63	28.82	28.84
	MIN.	30.43	30.31	30.19	29.92	29.69	29.44	29.32	29.46	29.69	29.90	30.14	30.31	30.43

Comments: No recordable indications detected in the nozzle wall, however the leak path detected with the circ. blade probe has been verified.

Analyzed by: J. D. Breza, UT II **Date:** 10/24/02 **Reviewed by:** M. G. Hacker, UT LIII **Date:** 10/24/02

FRAMATOME ANP

CRDM Nozzle Ultrasonic Examination Data Sheet (Blade)

Customer: Duke Energy Corporation	Plant: Oconee	Unit: 2	Procedure: 54-ISI-100-09		Nozzle ID: 11
Nozzle Dimensions: ID: 2.75"	OD: 4.0"	Thickness: .625"	Downhill Side of Nozzle: 0 deg.		End of Noz. (in.): 0"

Cal Block ID: 6011137E R/1 "B"	Probe S/N's:	Ch 1: SO457CN	Ch 3:	Ch 5:	Ch 7:	Ch 9:
Calibration Setup: 1		Ch 2:	Ch 4:	Ch 6:	Ch 8:	Ch 10:

Equipment: Micro-TomoScan: VH-7969 | ACCUSONEX Software: Acquisition 6.2.5, Analysis 3.8 | UT Cable: 50' RG-174

Data File:	Scan Start	Scan Stop	Cal. Files	Examination Results: Recordable Ind.	Leak Path
A2295_02.22.41	0 deg @ 1.09"	370 deg @ 11.68"	A2294_15.03.55 A2296_10.14.24	Yes	No

Flaw No.	Surface (ID/OD)	Depth to Flaw Tip	End Point 1 Min (in.)	End Point 1 Min (deg.)	End Point 2 Max (in.)	End Point 2 Max (deg.)	Axial Total (in.)	Adjusted Circ. Extent Min (deg.)	Adjusted Circ. Extent Max (deg.)	Adjusted Circ. Extent Total (in.)	Flaw Length (in.)	Flaw Angle (deg.)	Flaw TWD (in.)	Flaw Aspect Ratio	Flaw Orient.
1	OD	0.50	2.75	228.00	3.99	232.00	1.24	228.0	232.0	0.14	1.25	6	0.13	0.10	AXIAL
2	OD	0.22	2.55	249.00	3.68	250.00	1.13	249.0	250.0	0.03	1.13	2	0.41	0.36	AXIAL
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															

Weld Profile													
Noz. Loc.	0	30	60	90	120	150	180	210	240	270	300	330	360
MAX.	3.10	3.21	3.40	3.87	4.31	4.69	4.91	4.85	4.44	3.98	3.56	3.26	3.10
MIN.	2.00	2.06	2.41	2.71	3.02	3.29	3.48	3.29	3.02	2.71	2.44	2.08	2.00

Comments: Analysis included 6.77" above the weld root region to support the IDTB weld repair with no recordable indications in this region.
Indications detected by loss of backwall signal along with tip signals.

Analyzed by: K. J. Hacker, UT LIII Date: 10/22/02 Reviewed by: M. G. Hacker, UT LIII Date: 10/22/02

FRAMATOME ANP

CRDM Nozzle Ultrasonic Examination Data Sheet (Rotating)

Customer: Duke Energy Corporation			Plant: Oconee	Unit: 2	Procedure: 54-ISI-100-09			Nozzle ID: 11
Nozzle Dimensions:	ID: 2.75"	OD: 4.0"	Thickness: .625"	Downhill Side of Nozzle: 0 deg.		End of Noz. (in.): 33.77"		
Cal Block ID: 6009876D2-B		Probe DB/N's:	Ch 1: 35080	Ch 3: 35055	Ch 5: 34996	Ch 7: 35106	Ch 9: N/A	
Calibration Setup: 1			Ch 2: 35205	Ch 4: 35080	Ch 6: 34996	Ch 8: 35177	Ch 10: N/A	
Equipment:	Micro-TomoScan: VH-8169		ACCUSONEX Software: Acquisition 6.2.5, Analysis 3.8			UT Cable: 50' RG-174		

Data File:	Scan Start	Scan Stop	Cal. Files	Examination Results	
T2297_01.09.23	-5 deg @ 19.9"	365 deg @ 40.9"	T2295_13.21.15	Recordable Ind.	Leak Path
			T2297_17.43.38	Yes	No

Flaw No.	Surface (ID/OD)	Depth to Flaw Tip	End Point 1 Min (in.)	End Point 1 Min (deg.)	End Point 2 Max (in.)	End Point 2 Max (deg.)	Axial Total (in.)	Adjusted Circ. Extent Min (deg.)	Adjusted Circ. Extent Max (deg.)	Adjusted Circ. Extent Total (in.)	Flaw Length (in.)	Flaw Angle (deg.)	Flaw TWD (in.)	Flaw Aspect Ratio	Flaw Orient.
1	OD	0.31	31.55	221.00	30.08	226.00	1.47	221.0	226.0	0.17	1.48	7	0.32	0.21	AXIAL
2	OD	0.28	31.80	239.00	30.52	249.00	1.28	239.0	249.0	0.35	1.33	15	0.35	0.26	AXIAL
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															

Weld Profile	Noz. Loc.	0	30	60	90	120	150	180	210	240	270	300	330	360
	MAX.	31.20	31.13	30.82	30.27	29.89	29.52	29.38	29.62	30.00	30.41	30.75	31.13	31.20
	MIN.	32.22	32.09	31.85	31.44	31.16	30.85	30.61	30.96	31.23	31.57	31.85	32.19	32.22

Comments: The rotating probe verified the indications detected with the circ. blade probe.
Indications detected by loss of backwall signal along with tip signals.

Analyzed by: J. D. Breza, UT II Date: 10/24/02 Reviewed by: M. G. Hacker, UT LIII Date: 10/24/02

FRAMATOME ANP

CRDM Nozzle Ultrasonic Examination Data Sheet (Blade)

Customer: Duke Energy Corporation		Plant: Oconee	Unit: 2	Procedure: 54-ISI-100-09		Nozzle ID: 15
Nozzle Dimensions:	ID: 2.75"	OD: 4.0"	Thickness: .625"	Downhill Side of Nozzle: 0 deg.	End of Noz. (in.): 0"	
Cal Block ID: 6011137E R/1 "B"	Probe S/N's:	Ch 1: SO454CN	Ch 3:	Ch 5:	Ch 7:	Ch 9:
Calibration Setup: 1		Ch 2:	Ch 4:	Ch 6:	Ch 8:	Ch 10:
Equipment:	Micro-TomoScan: VH-7969	ACCUSONEX Software: Acquisition 6.2.5, Analysis 3.8		UT Cable: 50' RG-174		

Data File:	Scan Start	Scan Stop	Cal. Files	Examination Results	
A2292_18.53.31	0 deg @ .59"	370 deg @ 11.34"	A2292_08.22.13	Recordable Ind.	Leak Path
			A2294_10.36.28	Yes	Yes

Flaw No.	Surface (ID/OD)	Depth to Flaw Tip	End Point 1 Min (in.)	End Point 1 Min (deg.)	End Point 2 Max (in.)	End Point 2 Max (deg.)	Axial Total (in.)	Adjusted Circ. Extent Min (deg.)	Adjusted Circ. Extent Max (deg.)	Adjusted Circ. Extent Total (in.)	Flaw Length (in.)	Flaw Angle (deg.)	Flaw TWD (in.)	Flaw Aspect Ratio	Flaw Orient.
1	OD	0.10	0.66	15.00	3.03	15.00	2.37	15.0	15.0	0.00	2.37	0	0.53	0.22	AXIAL
2	OD	0.27	1.74	61.00	2.68	54.20	0.94	61.0	54.2	0.24	0.97	14	0.36	0.37	AXIAL
3	OD	0.56	2.76	215.00	3.34	216.00	0.58	215.0	216.0	0.03	0.58	3	0.06	0.11	AXIAL
4	OD	0.58	2.62	228.00	3.03	228.00	0.41	228.0	228.0	0.00	0.41	0	0.05	0.11	AXIAL
5	OD	0.41	1.2	359.0	2.6	359.0	1.42	359.0	359.0	0.00	1.42	0	0.22	0.15	AXIAL
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															

Weld Profile														
	Noz. Loc.	0	30	60	90	120	150	180	210	240	270	300	330	360
	MAX.	2.92	2.95	3.24	3.62	4.08	4.40	4.67	4.67	4.32	3.82	3.36	2.95	2.92
	MIN.	1.49	1.70	2.02	2.28	2.63	2.98	3.09	2.92	2.60	2.28	1.96	1.58	1.49

Comments: Analysis included 6.67" above the weld root region to support the IDTB weld repair with no recordable indications in this region.
Indications detected by loss of backwall signal along with tip signals.

Analyzed by: K. J. Hacker, UT LIII Date: 10/19/02 Reviewed by: M. G. Hacker, UT LIII Date: 10/22/02

FRAMATOME ANP

CRDM Nozzle Ultrasonic Examination Data Sheet (Rotating)

Customer: Duke Energy Corporation		Plant: Oconee	Unit: 2	Procedure: 54-ISI-100-09		Nozzle ID: 15
Nozzle Dimensions:	ID: 2.75"	OD: 4.0"	Thickness: .625"	Downhill Side of Nozzle: 0 deg.	End of Noz. (in.): 34.74"	

Cal Block ID: 6009876D2-B	Probe DB/N's:	Ch 1: 35080	Ch 3: 35055	Ch 5: 34996	Ch 7: 35106	Ch 9: N/A
Calibration Setup: 1		Ch 2: 35205	Ch 4: 35080	Ch 6: 34996	Ch 8: 35177	Ch 10: N/A
Equipment:	Micro-TomoScan: VH-8169	ACCUSONEX Software: Acquisition 6.2.5, Analysis 3.8			UT Cable: 50' RG-174	

Data File:	Scan Start	Scan Stop	Cal. Files	Examination Results	
				Recordable Ind.	Leak Path
T2295._21.03.28	-5 deg @ 13.6"	365 deg @ 34.0"	T2295_13.21.15 T2297_17.43.38	Yes	Yes

Flaw No.	Surface (ID/OD)	Depth to Flaw Tip	End Point 1 Min (in.)	End Point 1 Min (deg.)	End Point 2 Max (in.)	End Point 2 Max (deg.)	Axial Total (in.)	Adjusted Circ. Extent Min (deg.)	Adjusted Circ. Extent Max (deg.)	Adjusted Circ. Extent Total (in.)	Flaw Length (in.)	Flaw Angle (deg.)	Flaw TWD (in.)	Flaw Aspect Ratio	Flaw Orient.
1	OD	0.10	31.57	1.00	33.96	1.00	2.39	1.0	1.0	0.00	2.39	0	0.53	0.22	AXIAL
2	OD	0.35	33.05	46.00	32.45	48.90	0.60	46.0	48.9	0.10	0.61	10	0.28	0.45	AXIAL
3	OD	0.48	31.32	206.00	31.87	206.00	0.55	206.0	206.0	0.00	0.55	0	0.15	0.26	AXIAL
4	OD	0.46	31.32	245.00	32.76	245.00	1.44	245.0	245.0	0.00	1.44	0	0.17	0.11	AXIAL
5	OD	0.39	32.27	349.00	33.54	349.00	1.27	349.0	349.0	0.00	1.27	0	0.24	0.19	AXIAL
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															

Weld Profile	Noz. Loc.	0	30	60	90	120	150	180	210	240	270	300	330	360
	MAX.	31.98	31.87	31.50	30.98	30.53	30.35	30.19	30.42	30.76	31.30	31.75	31.98	31.98
	MIN.	33.09	32.89	32.61	32.25	31.82	31.59	31.68	31.87	32.16	32.52	32.82	33.09	33.09

Comments: The rotating probe verified the indications and leak path detected with the circ. blade probe.
Indications detected by loss of backwall signal along with tip signals.

Analyzed by: J. D. Breza, UT II Date: 10/24/02 Reviewed by: M. G. Hacker, UT LIII Date: 10/24/02

FRAMATOME ANP

CRDM Nozzle Ultrasonic Examination Data Sheet (Blade)

Customer: Duke Energy Corporation	**Plant:** Oconee	**Unit:** 2	**Procedure:** 54-ISI-100-09	**Nozzle ID:** 19
Nozzle Dimensions: ID: 2.75" OD: 4.0"	**Thickness:** .625"	**Downhill Side of Nozzle:** 0 deg.	**End of Noz. (in.):** 0"	
Cal Block ID: 6011137E R/1 "B"	**Probe S/N's:**	**Ch 1:** SO454CN	**Ch 3:**	**Ch 5:**
Calibration Setup: 1		**Ch 2:**	**Ch 4:**	**Ch 6:**
		Ch 7:	**Ch 9:**	
		Ch 8:	**Ch 10:**	
Equipment:	Micro-TomoScan: VH-7969	ACCUSONEX Software: Acquisition 6.2.5, Analysis 3.8	UT Cable: 50' RG-174	

Data File:	**Scan Start**	**Scan Stop**	**Cal. Files**	**Examination Results**	
A2292_14.24.05	0 deg @ 0.53"	370 deg @ 11.48"	A2292_08.22.13	Recordable Ind.	Leak Path
			A2294_10.36.28	Yes	Yes

Flaw No.	Surface (ID/OD)	Depth to Flaw Tip	End Point 1 Min (in.)	End Point 1 Min (deg.)	End Point 2 Max (in.)	End Point 2 Max (deg.)	Axial Total (in.)	Adjusted Circ. Extent Min (deg.)	Adjusted Circ. Extent Max (deg.)	Adjusted Circ. Extent Total (in.)	Flaw Length (in.)	Flaw Angle (deg.)	Flaw TWD (in.)	Flaw Aspect Ratio	Flaw Orient.
1	OD	0.20	1.00	14.30	2.92	14.50	1.92	14.3	14.5	0.01	1.92	0	0.43	0.22	AXIAL
2	OD	0.48	2.46	106.00	3.63	108.00	1.17	106.0	108.0	0.07	1.17	3	0.15	0.12	AXIAL
3	OD	0.47	2.77	205.00	4.08	208.00	1.31	205.0	208.0	0.10	1.31	5	0.16	0.12	AXIAL
4	OD	0.35	2.67	218.00	3.88	219.00	1.21	218.0	219.0	0.03	1.21	2	0.28	0.23	AXIAL
5	OD	0.50	1.67	239.00	3.89	244.00	2.22	239.0	244.0	0.17	2.23	4	0.13	0.06	AXIAL
6	OD	0.52	2.08	265.00	2.62	265.00	0.54	265.0	265.0	0.00	0.54	0	0.11	0.19	AXIAL
7	OD	0.53	1.25	308.70	2.52	304.00	1.27	308.7	304.0	0.16	1.28	7	0.10	0.07	AXIAL
8	OD	0.29	1.24	332.00	2.72	331.00	1.48	332.0	331.0	0.03	1.48	1	0.34	0.23	AXIAL
9	OD	0.51	1.42	350.00	1.86	352.00	0.44	350.0	352.0	0.07	0.45	9	0.12	0.26	AXIAL
10															
11															
12															
13															
14															
15															

Weld Profile	Noz. Loc.	0	30	60	90	120	150	180	210	240	270	300	330	360
	MAX.	2.85	2.97	3.38	3.78	4.22	4.39	4.45	4.28	3.96	3.46	3.09	2.79	2.85
	MIN.	1.69	1.84	2.07	2.48	2.77	3.06	3.17	3.00	2.71	2.30	1.87	1.63	1.69

Comments: Analysis included 7.03" above the weld root region to support the IDTB weld repair with no recordable indications in this region.
Indications detected by loss of backwall signal along with tip signals.

Analyzed by: K. J. Hacker, UT LIII **Date:** 10/21/02 **Reviewed by:** M. G. Hacker, UT LIII **Date:** 10/22/02

FRAMATOME ANP

CRDM Nozzle Ultrasonic Examination Data Sheet (Blade)

Customer: Duke Energy Corporation	**Plant:** Oconee	**Unit:** 2	**Procedure:** 54-ISI-100-09	**Nozzle ID:** 21
Nozzle Dimensions: ID: 2.75" OD: 4.0"	**Thickness:** .625"	**Downhill Side of Nozzle:** 0 deg.		**End of Noz. (in.):** 0"

Cal Block ID: 6011137E R/1 "B"	**Probe S/N's:**	**Ch 1:** SO454CN	**Ch 3:**	**Ch 5:**	**Ch 7:**	**Ch 9:**
Calibration Setup: 1		**Ch 2:**	**Ch 4:**	**Ch 6:**	**Ch 8:**	**Ch 10:**

Equipment:	Micro-TomoScan: VH-7969	ACCUSONEX Software: Acquisition 6.2.5, Analysis 3.8	UT Cable: 50' RG-174

Data File:	**Scan Start**	**Scan Stop**	**Cal. Files**	**Examination Results**	
A2293_12.54.10	0 deg @ 0.57"	370 deg @ 11.24"	A2292_08.22.13	Recordable Ind.	Leak Path
			A2294_10.36.28	Yes	N/A

Flaw No.	Surface (ID/OD)	Depth to Flaw Tip	End Point 1 Min (in.)	End Point 1 Min (deg.)	End Point 2 Max (in.)	End Point 2 Max (deg.)	Axial Total (in.)	Adjusted Circ. Extent Min (deg.)	Adjusted Circ. Extent Max (deg.)	Adjusted Circ. Extent Total (in.)	Flaw Length (in.)	Flaw Angle (deg.)	Flaw TWD (in.)	Flaw Aspect Ratio	Flaw Orient.
1	OD	0.40	2.60	126.00	3.13	127.00	0.53	126.0	127.0	0.03	0.53	4	0.23	0.42	AXIAL
2	OD	0.39	2.63	145.00	3.59	138.00	0.96	145.0	138.0	0.24	0.99	14	0.24	0.24	AXIAL
3	OD	0.38	2.29	181.00	4.04	190.00	1.75	181.0	190.0	0.31	1.78	10	0.25	0.14	AXIAL
4	OD	0.38	2.24	205.00	3.44	210.00	1.20	205.0	210.0	0.17	1.21	8	0.25	0.20	AXIAL
5	OD	0.29	2.23	226.00	3.28	235.00	1.05	226.0	235.0	0.31	1.10	17	0.34	0.31	AXIAL
6	OD	0.26	1.69	237.00	3.08	247.00	1.39	237.0	247.0	0.35	1.43	14	0.37	0.25	AXIAL
7	OD	0.52	1.85	259.00	2.73	262.00	0.88	259.0	262.0	0.10	0.89	7	0.11	0.12	AXIAL
8															
9															
10															
11															
12															
13															
14															
15															

Weld Profile													
Noz. Loc.	0	30	60	90	120	150	180	210	240	270	300	330	360
MAX.	2.78	2.86	3.13	3.44	3.91	4.32	4.53	4.48	4.04	3.53	3.10	2.82	2.78
MIN.	1.61	1.65	1.87	2.29	2.78	3.06	3.30	3.00	2.68	2.20	1.79	1.57	1.61

Comments: Unable to perform leak path verification due to fit of nozzle.
Analysis included 6.67" above the weld root region to support the IDTB weld repair with no recordable indications in this region.
Indications detected by loss of backwall signal along with tip signals.

Analyzed by: K. J. Hacker, UT LIII **Date:** 10/20/02 **Reviewed by:** M. G. Hacker, UT LIII **Date:** 10/22/02

FRAMATOME ANP

CRDM Nozzle Ultrasonic Examination Data Sheet (Rotating)

Customer: Duke Energy Corporation	Plant: Oconee	Unit: 2	Procedure: 54-ISI-100-09		Nozzle ID: 21
Nozzle Dimensions: ID: 2.75"	OD: 4.0"	Thickness: .625"	Downhill Side of Nozzle: 0 deg.		End of Noz. (in.): 34.72"
Cal Block ID: 6009876D2-B	Probe DB/N's:	Ch 1: 35080	Ch 3: 35055	Ch 5: 34996	Ch 7: 35106 / Ch 9: N/A
Calibration Setup: 1		Ch 2: 35205	Ch 4: 35080	Ch 6: 34996	Ch 8: 35177 / Ch 10: N/A
Equipment:	Micro-TomoScan: VH-8169	ACCUSONEX Software: Acquisition 6.2.5, Analysis 3.8		UT Cable: 50' RG-174	

Data File:	Scan Start	Scan Stop	Cal. Files	Examination Results	
T2295._22.03.22	-5 deg @ 20.90"	365 deg @ 41.90"	T2295_13.21.15	Recordable Ind.	Leak Path
			T2297_17.43.38	Yes	No

Flaw No.	Surface (ID/OD)	Depth to Flaw Tip	End Point 1 Min (in.)	End Point 1 Min (deg.)	End Point 2 Max (in.)	End Point 2 Max (deg.)	Axial Total (in.)	Adjusted Circ. Extent Min (deg.)	Adjusted Circ. Extent Max (deg.)	Adjusted Circ. Extent Total (in.)	Flaw Length (in.)	Flaw Angle (deg.)	Flaw TWD (in.)	Flaw Aspect Ratio	Flaw Orient.
1	OD	0.42	31.39	127.00	32.21	127.00	0.82	127.0	127.0	0.00	0.82	0	0.21	0.25	AXIAL
2	OD	0.28	30.82	139.90	32.23	145.90	1.41	139.9	145.9	0.21	1.43	8	0.35	0.24	AXIAL
3	OD	0.40	30.84	190.00	31.85	181.50	1.01	190.0	181.5	-0.30	1.05	164	0.23	0.21	AXIAL
4	OD	0.41	31.30	205.00	31.95	208.50	0.65	205.0	208.5	0.12	0.66	11	0.22	0.33	AXIAL
5	OD	0.34	30.61	220.00	32.10	223.00	1.49	220.0	223.0	0.10	1.49	4	0.29	0.19	AXIAL
6	OD	0.38	31.34	237.90	32.36	247.00	1.02	237.9	247.0	0.32	1.07	17	0.25	0.23	AXIAL
7	OD	0.31	32.48	255.00	31.13	264.00	1.35	255.0	264.0	0.31	1.39	13	0.32	0.23	AXIAL
8															
9															
10															
11															
12															
13															
14															
15															
Weld Profile		Noz. Loc.	0	30	60	90	120	150	180	210	240	270	300	330	360
		MAX.	31.95	31.80	31.50	31.18	30.68	30.29	30.16	30.33	30.79	31.23	31.63	31.93	31.95
		MIN.	33.20	33.12	32.87	32.50	32.00	31.68	31.56	31.83	32.10	32.48	32.87	33.13	33.20

Comments: The rotating probe verified the indications detected with the circ. blade probe.
Indications detected by loss of backwall signal along with tip signals.

Analyzed by: J. D. Breza, UT II **Date:** 10/24/02 **Reviewed by:** M. G. Hacker, UT LIII **Date:** 10/24/02

FRAMATOME ANP

CRDM Nozzle Ultrasonic Examination Data Sheet (Blade)

Customer: Duke Energy Corporation	Plant: Oconee	Unit: 2	Procedure: 54-ISI-100-09		Nozzle ID: 24
Nozzle Dimensions:	ID: 2.75"	OD: 4.0"	Thickness: .625"	Downhill Side of Nozzle: 0 deg.	End of Noz. (in.): 0"

Cal Block ID: 6011137E R/1 "B"	Probe S/N's:	Ch 1: SO454CN	Ch 3:	Ch 5:	Ch 7:	Ch 9:
Calibration Setup: 1		Ch 2:	Ch 4:	Ch 6:	Ch 8:	Ch 10:

Equipment:	Micro-TomoScan: VH-7969	ACCUSONEX Software: Acquisition 6.2.5, Analysis 3.8	UT Cable: 50' RG-174

Data File:	Scan Start	Scan Stop	Cal. Files	Examination Results	
A2292_13.39.18	0 deg @ 0.59"	370 deg @ 11.33"	A2292_08.22.13	Recordable Ind.	Leak Path
			A2294_10.36.28	Yes	Yes

Flaw No.	Surface (ID/OD)	Depth to Flaw Tip	End Point 1 Min (in.)	End Point 1 Min (deg.)	End Point 2 Max (in.)	End Point 2 Max (deg.)	Axial Total (in.)	Adjusted Circ. Extent Min (deg.)	Adjusted Circ. Extent Max (deg.)	Adjusted Circ. Extent Total (in.)	Flaw Length (in.)	Flaw Angle (deg.)	Flaw TWD (in.)	Flaw Aspect Ratio	Flaw Orient.
1	OD	0.48	1.42	9.00	2.42	9.00	1.00	9.0	9.0	0.00	1.00	0	0.15	0.15	AXIAL
2	OD	0.41	1.34	40.20	2.48	42.00	1.14	40.2	42.0	0.06	1.14	3	0.22	0.19	AXIAL
3	OD	0.23	2.67	231.00	3.84	257.00	1.17	231.0	257.0	0.91	1.48	38	0.40	0.27	AXIAL
4	OD	0.44	1.81	291.00	2.93	292.00	1.12	291.0	292.0	0.03	1.12	2	0.19	0.17	AXIAL
5	OD	0.52	1.44	315.00	2.32	316.00	0.88	315.0	316.0	0.03	0.88	2	0.11	0.12	AXIAL
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															

Weld Profile														
	Noz. Loc.	0	30	60	90	120	150	180	210	240	270	300	330	360
	MAX.	2.77	2.95	3.39	3.93	4.54	4.99	5.25	5.14	4.57	3.84	3.36	2.98	2.77
	MIN.	1.68	1.68	2.10	2.63	3.07	3.36	3.42	3.28	2.89	2.48	2.01	1.68	1.68

Comments: Analysis included 6.08" above the weld root region to support the IDTB weld repair with no recordable indications in this region.
Indications detected by loss of backwall signal along with tip signals.

Analyzed by: K. J. Hacker, UT LIII Date: 10/19/02 Reviewed by: M. G. Hacker, UT LIII Date: 10/22/02

FRAMATOME ANP

CRDM Nozzle Ultrasonic Examination Data Sheet (Blade)

Customer: Duke Energy Corporation	**Plant:** Oconee	**Unit:** 2	**Procedure:** 54-ISI-100-09		**Nozzle ID:** 31
Nozzle Dimensions: ID: 2.75"	OD: 4.0"	**Thickness:** .625"	**Downhill Side of Nozzle:** 0 deg.	**End of Noz. (in.):** 0"	
Cal Block ID: 6011137E R/1 "B"	**Probe S/N's:**	**Ch 1:** SO454CN	**Ch 3:**	**Ch 5:**	**Ch 7:** / **Ch 9:**
Calibration Setup: 1		**Ch 2:**	**Ch 4:**	**Ch 6:**	**Ch 8:** / **Ch 10:**
Equipment:	Micro-TomoScan: VH-7969	ACCUSONEX Software: Acquisition 6.2.5, Analysis 3.8		UT Cable: 50' RG-174	

Data File:	**Scan Start**	**Scan Stop**	**Cal. Files**	**Examination Results** Recordable Ind.	Leak Path
A2292_19.32.08	0 deg @ 0.56"	370 deg @ 11.34"	A2292_08.22.13 A2294_10.36.28	Yes	Yes

Flaw No.	Surface (ID/OD)	Depth to Flaw Tip	End Point 1 Min (in.)	End Point 1 Min (deg.)	End Point 2 Max (in.)	End Point 2 Max (deg.)	Axial Total (in.)	Adjusted Circ. Extent Min (deg.)	Adjusted Circ. Extent Max (deg.)	Adjusted Circ. Extent Total (in.)	Flaw Length (in.)	Flaw Angle (deg.)	Flaw TWD (in.)	Flaw Aspect Ratio	Flaw Orient.
1	OD	0.17	3.34	181.00	4.60	181.00	1.26	181.0	181.0	0.00	1.26	0	0.46	0.36	AXIAL
2	OD	0.18	2.49	219.00	4.79	244.00	2.30	219.0	244.0	0.87	2.46	21	0.45	0.18	AXIAL
3	OD	0.32	2.76	246.00	4.09	259.00	1.33	246.0	259.0	0.45	1.41	19	0.31	0.22	AXIAL
4	OD	0.50	2.60	268.00	3.69	271.00	1.09	268.0	271.0	0.10	1.10	5	0.13	0.11	AXIAL
5	OD	0.46	2.18	290.00	2.98	292.00	0.80	290.0	292.0	0.07	0.80	5	0.17	0.21	AXIAL
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															

Weld Profile	Noz. Loc.	0	30	60	90	120	150	180	210	240	270	300	330	360
	MAX.	2.83	3.00	3.37	3.82	4.36	4.84	5.16	5.12	4.69	4.01	3.37	2.89	2.83
	MIN.	1.53	1.87	2.27	2.75	3.27	3.70	3.80	3.64	3.35	2.81	2.32	1.88	1.53

Comments: Analysis included 6.18" above the weld root region to support the IDTB weld repair with no recordable indications in this region.
Indications detected by loss of backwall signal along with tip signals.

Analyzed by: K. J. Hacker, UT LIII **Date:** 10/20/02 **Reviewed by:** M. G. Hacker, UT LIII **Date:** 10/22/02

FRAMATOME ANP

CRDM Nozzle Ultrasonic Examination Data Sheet (Blade)

Customer: Duke Energy Corporation	Plant: Oconee	Unit: 2	Procedure: 54-ISI-100-09		Nozzle ID: 33
Nozzle Dimensions:	ID: 2.75"	OD: 4.0"	Thickness: .625"	Downhill Side of Nozzle: 0 deg.	End of Noz. (in.): 0"

Cal Block ID: 6011137E R/1 "B"	Probe S/N's:	Ch 1: SO454CN	Ch 3:	Ch 5:	Ch 7:	Ch 9:
Calibration Setup: 1		Ch 2:	Ch 4:	Ch 6:	Ch 8:	Ch 10:

Equipment:	Micro-TomoScan: VH-7969	ACCUSONEX Software: Acquisition 6.2.5, Analysis 3.8	UT Cable: 50' RG-174

Data File:	Scan Start	Scan Stop	Cal. Files	Examination Results: Recordable Ind.	Examination Results: Leak Path
A2293.05.31.13	0 deg @ 0.60"	370 deg @ 11.3"	A2292_08.22.13	Yes	No
A2293.05.41.12	98 deg @ 0.60"	333 deg @ 11.3"	A2294_10.36.28		
A2293_06.07.14	333 deg @ 0.60"	370 deg @ 11.3"			

Flaw No.	Surface (ID/OD)	Depth to Flaw Tip	End Point 1 Min (in.)	End Point 1 Min (deg.)	End Point 2 Max (in.)	End Point 2 Max (deg.)	Axial Total (in.)	Adjusted Circ. Extent Min (deg.)	Adjusted Circ. Extent Max (deg.)	Adjusted Circ. Extent Total (in.)	Flaw Length (in.)	Flaw Angle (deg.)	Flaw TWD (in.)	Flaw Aspect Ratio	Flaw Orient.
1	OD	0.37	1.02	25.00	2.13	25.00	1.11	25.0	25.0	0.00	1.11	0	0.26	0.23	AXIAL
2	OD	0.48	1.07	42.00	2.13	44.00	1.06	42.0	44.0	0.07	1.06	4	0.15	0.14	AXIAL
3	OD	0.57	1.31	346.00	2.12	346.00	0.81	346.0	346.0	0.00	0.81	0	0.06	0.07	AXIAL
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															

Weld Profile	Noz. Loc.	0	30	60	90	120	150	180	210	240	270	300	330	360
	MAX.	2.78	2.93	3.25	3.82	4.47	5.06	5.41	5.23	4.84	4.07	3.30	2.80	2.78
	MIN.	1.51	1.60	2.13	2.46	3.02	3.52	3.83	3.60	3.12	2.57	2.01	1.60	1.51

Comments: Indications detected by loss of backwall response. Characterization performed with signals that resembled low amplitude tip signals at noise level.

Analyzed by: K. J. Hacker, UT LIII Date: 10/20/02 Reviewed by: M. G. Hacker, UT LIII Date: 10/22/02

FRAMATOME ANP

CRDM Nozzle Ultrasonic Examination Data Sheet (Rotating)

Customer: Duke Energy Corporation		Plant: Oconee	Unit: 2	Procedure: 54-ISI-100-09		Nozzle ID: 33
Nozzle Dimensions:	ID: 2.75"	OD: 4.0"	Thickness: .625"	Downhill Side of Nozzle: 0 deg.		End of Noz. (In.): 39.70"
Cal Block ID: 6009876D2-B	Probe DB/N's:	Ch 1: 35080	Ch 3: 35055	Ch 5: 34996	Ch 7: 35106	Ch 9: N/A
Calibration Setup: 1		Ch 2: 35205	Ch 4: 35080	Ch 6: 34996	Ch 8: 35177	Ch 10: N/A
Equipment:	Micro-TomoScan: VH-8169	ACCUSONEX Software: Acquisition 6.2.5, Analysis 3.8		UT Cable: 50' RG-174		

Data File:	Scan Start	Scan Stop	Cal. Files	Examination Results	
T2295._16.50.27	-5 deg @ 20.90"	365 deg @ 41.90"	T2295_13.21.15	Recordable Ind.	Leak Path
			T2297_17.43.38	No	No

Flaw No.	Surface (ID/OD)	Depth to Flaw Tip	End Point 1 Min (In.)	End Point 1 Min (deg.)	End Point 2 Max (In.)	End Point 2 Max (deg.)	Axial Total (In.)	Adjusted Circ. Extent Min (deg.)	Adjusted Circ. Extent Max (deg.)	Adjusted Circ. Extent Total (In.)	Flaw Length (In.)	Flaw Angle (deg.)	Flaw TWD (In.)	Flaw Aspect Ratio	Flaw Orient.
1															
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															

Weld Profile	Noz. Loc.	0	30	60	90	120	150	180	210	240	270	300	330	360
	MAX.	37.30	37.13	36.70	36.14	35.41	34.83	34.63	34.87	35.41	36.08	36.85	37.26	37.30
	MIN.	38.38	38.19	37.82	37.50	36.83	36.33	36.18	36.44	37.05	37.58	38.12	38.47	38.38

Comments: The rotating probe did not verify the indications detected with the circ. blade probe.

Analyzed by: J. D. Breza, UT II Date: 10/24/02 Reviewed by: M. G. Hacker, UT LIII Date: 10/24/02

FRAMATOME ANP

CRDM Nozzle Ultrasonic Examination Data Sheet (Rotating)

Customer: Duke Energy Corporation		Plant: Oconee	Unit: 2	Procedure: 54-ISI-100-09	Nozzle ID: 36
Nozzle Dimensions:	ID: 2.75"	OD: 4.0"	Thickness: .625"	Downhill Side of Nozzle: 0 deg.	End of Noz. (in.): 39.59

Cal Block ID: 6009876D2-B	Probe DB/N's:	Ch 1: 35080	Ch 3: 35055	Ch 5: 34996	Ch 7: 35106	Ch 9: N/A
Calibration Setup: 1		Ch 2: 35205	Ch 4: 35080	Ch 6: 34996	Ch 8: 35177	Ch 10: N/A

Equipment:	Micro-TomoScan: VH-8169	ACCUSONEX Software: Acquisition 6.2.5, Analysis 3.8	UT Cable: 50' RG-174

Data File:	Scan Start	Scan Stop	Cal. Files	Examination Results	
T2295_17.45.35	-5 deg @ 20.90"	365 deg @ 41.90"	T2295_13.21.15	Recordable Ind.	Leak Path
			T2297_17.43.38	Yes	Yes

Flaw No.	Surface (ID/OD)	Depth to Flaw Tip	End Point 1 Min (in.)	End Point 1 Min (deg.)	End Point 2 Max (in.)	End Point 2 Max (deg.)	Axial Total (in.)	Adjusted Circ. Extent Min (deg.)	Adjusted Circ. Extent Max (deg.)	Adjusted Circ. Extent Total (in.)	Flaw Length (in.)	Flaw Angle (deg.)	Flaw TWD (in.)	Flaw Aspect Ratio	Flaw Orient.
1	OD	0.18	38.28	26.50	36.52	26.50	1.76	26.5	26.5	0.00	1.76	0	0.45	0.25	AXIAL
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															

Weld Profile	Noz. Loc.	0	30	60	90	120	150	180	210	240	270	300	330	360
	MAX.	36.96	36.96	36.49	35.76	34.86	34.44	34.10	34.30	34.77	35.69	36.50	36.79	36.96
	MIN.	37.81	37.77	37.57	36.97	36.37	36.00	35.81	35.99	36.44	37.00	37.51	37.68	37.96

Comments: The rotating probe verified the indications and leak path detected with the circ. blade probe.
Indications detected by loss of backwall signal along with tip signals.

Analyzed by: J. D. Breza, UT II **Date:** 10/24/02 **Reviewed by:** M. G. Hacker, UT LIII **Date:** 10/24/02

FRAMATOME ANP

CRDM Nozzle Ultrasonic Examination Data Sheet (Blade)

Customer: Duke Energy Corporation	**Plant:** Oconee	**Unit:** 2	**Procedure:** 54-ISI-100-09		**Nozzle ID:** 36
Nozzle Dimensions:	**ID:** 2.75"	**OD:** 4.0"	**Thickness:** .625"	**Downhill Side of Nozzle:** 0 deg.	**End of Noz. (in.):** 0"

Cal Block ID: 6011137E R/1 "B"	**Probe S/N's:**	**Ch 1:** SO454CN	**Ch 3:**	**Ch 5:**	**Ch 7:**	**Ch 9:**
Calibration Setup: 1		**Ch 2:**	**Ch 4:**	**Ch 6:**	**Ch 8:**	**Ch 10:**

Equipment:	Micro-TomoScan: VH-7969	ACCUSONEX Software: Acquisition 6.2.5, Analysis 3.8	UT Cable: 50' RG-174

Data File:	**Scan Start**	**Scan Stop**	**Cal. Files**	**Examination Results**	
A2293_09.55.51	0 deg @ 0.60"	370 deg @ 11.25"	A2292_08.22.13	Recordable Ind.	Leak Path
			A2294_10.36.28	Yes	Yes

Flaw No.	Surface (ID/OD)	Depth to Flaw Tip	End Point 1 Min (in.)	End Point 1 Min (deg.)	End Point 2 Max (in.)	End Point 2 Max (deg.)	Axial Total (in.)	Adjusted Circ. Extent Min (deg.)	Adjusted Circ. Extent Max (deg.)	Adjusted Circ. Extent Total (in.)	Flaw Length (in.)	Flaw Angle (deg.)	Flaw TWD (in.)	Flaw Aspect Ratio	Flaw Orient.
1	OD	0.36	1.15	18.00	2.87	18.00	1.72	18.0	18.0	0.00	1.72	0	0.27	0.15	AXIAL
2															
3															
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															

Weld Profile	Noz. Loc.	0	30	60	90	120	150	180	210	240	270	300	330	360
	MAX.	2.63	2.71	3.18	4.02	4.80	5.20	5.50	5.22	4.67	3.78	3.01	2.64	2.63
	MIN.	1.71	1.82	1.99	2.53	3.15	3.54	3.67	3.50	2.89	2.47	1.96	1.76	1.71

Comments: Analysis included 5.75" above the weld root region to support the IDTB weld repair with no recordable indications in this region.
Indications detected by loss of backwall signal along with tip signals.

Analyzed by: K. J. Hacker, UT LIII **Date:** 10/21/02 **Reviewed by:** M. G. Hacker, UT LIII **Date:** 10/22/02

FRAMATOME ANP

CRDM Nozzle Ultrasonic Examination Data Sheet (Blade)

Customer: Duke Energy Corporation		Plant: Oconee	Unit: 2	Procedure: 54-ISI-100-09		Nozzle ID: 38
Nozzle Dimensions:	ID: 2.75"	OD: 4.0"	Thickness: .625"	Downhill Side of Nozzle: 0 deg.		End of Noz. (in.): 0"

Cal Block ID: 6011137E R/1 "B"	Probe S/N's:	Ch 1: SO457CN	Ch 3:	Ch 5:	Ch 7:	Ch 9:
Calibration Setup: 1		Ch 2:	Ch 4:	Ch 6:	Ch 8:	Ch 10:

Equipment:	Micro-TomoScan: VH-7969	ACCUSONEX Software: Acquisition 6.2.5, Analysis 3.8	UT Cable: 50' RG-174

Data File:	Scan Start	Scan Stop	Cal. Files	Examination Results	
A2294_17.39.37	0 deg @ 0.60"	370 deg @ 11.20"	A2294_15.03.35	Recordable Ind.	Leak Path
				Yes	No

Flaw No.	Surface (ID/OD)	Depth to Flaw Tip	End Point 1 Min (in.)	End Point 1 Min (deg.)	End Point 2 Max (in.)	End Point 2 Max (deg.)	Axial Total (in.)	Adjusted Circ. Extent Min (deg.)	Adjusted Circ. Extent Max (deg.)	Adjusted Circ. Extent Total (in.)	Flaw Length (in.)	Flaw Angle (deg.)	Flaw TWD (in.)	Flaw Aspect Ratio	Flaw Orient.
1	OD	0.32	1.46	60.50	3.09	60.50	1.63	60.5	60.5	0.00	1.63	0	0.31	0.19	AXIAL
2	OD	0.43	1.90	75.10	2.94	72.00	1.04	75.1	72.0	0.11	1.05	6	0.20	0.19	AXIAL
3	OD	0.54	2.24	91.00	3.44	87.00	1.20	91.0	87.0	0.14	1.21	7	0.09	0.07	AXIAL
4	OD	0.48	2.56	101.00	3.14	99.00	0.58	101.0	99.0	0.07	0.58	7	0.15	0.25	AXIAL
5	OD	0.52	2.18	278.00	2.54	280.00	0.36	278.0	280.0	0.07	0.37	11	0.11	0.29	AXIAL
6	OD	0.52	1.75	303.00	3.14	298.00	1.39	303.0	298.0	0.17	1.40	7	0.11	0.07	AXIAL
7	OD	0.48	1.63	317.00	2.33	322.00	0.70	317.0	322.0	0.17	0.72	14	0.15	0.20	AXIAL
8															
9															
10															
11															
12															
13															
14															
15															

Weld Profile	Noz. Loc.	0	30	60	90	120	150	180	210	240	270	300	330	360
	MAX.	2.70	2.91	3.38	4.34	5.17	5.93	6.15	5.96	5.25	4.27	3.42	2.86	2.70
	MIN.	1.52	1.67	2.04	2.59	3.33	3.78	4.21	3.91	3.29	2.55	2.08	1.72	1.52

Comments: Analysis included 5.05" above the weld root region to support the IDTB weld repair with no recordable indications in this region.
Indications detected by loss of backwall signal along with tip signals.

Analyzed by: K. J. Hacker, UT LIII Date: 10/21/02 **Reviewed by:** M. G. Hacker, UT LIII **Date:** 10/22/02

FRAMATOME ANP

CRDM Nozzle Ultrasonic Examination Data Sheet (Rotating)

Customer: Duke Energy Corporation		Plant: Oconee	Unit: 2	Procedure: 54-ISI-100-09		Nozzle ID: 38
Nozzle Dimensions:	ID: 2.75"	OD: 4.0"	Thickness: .625"	Downhill Side of Nozzle: 0 deg.	End of Noz. (In.): 42.8"	

Cal Block ID: 6009876D2-B	Probe DB/N's:	Ch 1: 35080	Ch 3: 35055	Ch 5: 34996	Ch 7: 35106	Ch 9: N/A
Calibration Setup: 1		Ch 2: 35205	Ch 4: 35080	Ch 6: 34996	Ch 8: 35177	Ch 10: N/A

Equipment:	Micro-TomoScan: VH-8169	ACCUSONEX Software: Acquisition 6.2.5, Analysis 3.8	UT Cable: 50' RG-174

Data File:	Scan Start	Scan Stop	Cal. Files	Examination Results	
T2297_03.30.11	-5 deg @ 23.6"	365 deg @ 45"	T2296_21.53.07	Recordable Ind.	Leak Path
T2297_04.25.18	160 deg @ 23.6"	365 deg @ 45"	T2297_17.43.38	Yes	No

Flaw No.	Surface (ID/OD)	Depth to Flaw Tip	End Point 1 Min (in.)	End Point 1 Min (deg.)	End Point 2 Max (in.)	End Point 2 Max (deg.)	Axial Total (in.)	Adjusted Circ. Extent Min (deg.)	Adjusted Circ. Extent Max (deg.)	Adjusted Circ. Extent Total (in.)	Flaw Length (in.)	Flaw Angle (deg.)	Flaw TWD (in.)	Flaw Aspect Ratio	Flaw Orient.
1	OD	0.39	39.77	69.18	40.83	79.02	1.06	69.2	79.0	0.34	1.11	18	0.24	0.21	AXIAL
2	OD	0.53	39.75	79.60	40.68	91.30	0.93	79.6	91.3	0.41	1.02	24	0.10	0.09	AXIAL
3	OD	0.50	39.62	86.40	40.40	94.71	0.78	86.4	94.7	0.29	0.83	20	0.13	0.15	AXIAL
4	OD	0.54	39.29	91.90	40.19	102.70	0.90	91.9	102.7	0.38	0.98	23	0.09	0.09	AXIAL
5	OD	0.37	39.86	285.10	40.56	285.10	0.70	285.1	285.1	0.00	0.70	0	0.26	0.36	AXIAL
6	OD	0.41	40.48	306.00	40.80	306.00	0.32	306.0	306.0	0.00	0.32	0	0.22	0.67	AXIAL
7	OD	0.39	40.6	312.0	41.3	312.0	0.63	312.0	312.0	0.00	0.63	0	0.24	0.37	AXIAL
8															
9															
10															
11															
12															
13															
14															
15															

Weld Profile	Noz. Loc.	0	30	60	90	120	150	180	210	240	270	300	330	360
	MAX.	40.06	39.90	39.35	38.46	37.43	36.74	36.61	36.77	37.40	38.42	39.29	39.87	40.06
	MIN.	41.20	41.20	40.76	40.12	39.42	38.91	38.74	38.84	39.32	40.00	40.57	40.90	41.20

Comments: Indications detected by loss of backwall signal along with tip signals.

Analyzed by: J. D. Breza, UT II **Date:** 10/24/02 **Reviewed by:** M. G. Hacker, UT LIII **Date:** 10/24/02

FRAMATOME ANP

CRDM Nozzle Ultrasonic Examination Data Sheet (Blade)

Customer: Duke Energy Corporation	Plant: Oconee	Unit: 2	Procedure: 54-ISI-100-09	Nozzle ID: 42
Nozzle Dimensions: ID: 2.75" OD: 4.0"	Thickness: .625"	Downhill Side of Nozzle: 0 deg.	End of Noz. (in.): 0"	

Cal Block ID: 6011137E R/1 "B"	Probe S/N's:	Ch 1: SO454CN	Ch 3:	Ch 5:	Ch 7:	Ch 9:
Calibration Setup: 1		Ch 2:	Ch 4:	Ch 6:	Ch 8:	Ch 10:

Equipment:	Micro-TomoScan: VH-7969	ACCUSONEX Software: Acquisition 6.2.5, Analysis 3.8	UT Cable: 50' RG-174

Data File:	Scan Start	Scan Stop	Cal. Files	Examination Results: Recordable Ind.	Examination Results: Leak Path
A2292_10.01.01	0 deg @ 0.58"	370 deg @ 11.22"	A2292_08.22.13	Yes	No
A2292_22.18.36	0 deg @ 0.58"	370 deg @ 11.22"	A2294_10.36.28		

Flaw No.	Surface (ID/OD)	Depth to Flaw Tip	End Point 1 Min (in.)	End Point 1 Min (deg.)	End Point 2 Max (in.)	End Point 2 Max (deg.)	Axial Total (in.)	Adjusted Circ. Extent Min (deg.)	Adjusted Circ. Extent Max (deg.)	Adjusted Circ. Extent Total (in.)	Flaw Length (in.)	Flaw Angle (deg.)	Flaw TWD (in.)	Flaw Aspect Ratio	Flaw Orient.
1	OD	0.18	3.58	209.00	4.67	211.00	1.09	209.0	211.0	0.07	1.09	4	0.45	0.41	AXIAL
2	OD	0.48	1.58	304.00	2.60	305.00	1.02	304.0	305.0	0.03	1.02	2	0.15	0.14	AXIAL
3	OD	0.44	1.58	326.00	2.15	328.00	0.57	326.0	328.0	0.07	0.57	7	0.19	0.32	AXIAL
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															

Weld Profile														
	Noz. Loc.	0	30	60	90	120	150	180	210	240	270	300	330	360
	MAX.	2.98	3.24	3.65	4.43	5.06	6.08	6.34	6.05	5.44	4.37	3.53	2.98	2.98
	MIN.	1.71	1.83	2.32	2.87	3.53	4.20	4.46	3.99	3.45	2.90	2.12	1.83	1.71

Comments: Analysis included 4.88" above the weld root region to support the IDTB weld repair with no recordable indications in this region.
Indications detected by loss of backwall signal along with tip signals.

Analyzed by: K. J. Hacker, UT LIII Date: 10/19/02 Reviewed by: M. G. Hacker, UT LIII Date: 10/22/02

FRAMATOME ANP

CRDM Nozzle Ultrasonic Examination Data Sheet (Rotating)

Customer: Duke Energy Corporation	**Plant:** Oconee	**Unit:** 2	**Procedure:** 54-ISI-100-09		**Nozzle ID:** 42
Nozzle Dimensions:	ID: 2.75"	OD: 4.0"	**Thickness:** .625"	**Downhill Side of Nozzle:** 0 deg.	**End of Noz. (in.):** 42.60"

Cal Block ID: 6009876D2-B	**Probe DB/N's:**	**Ch 1:** 35080	**Ch 3:** 35055	**Ch 5:** 34996	**Ch 7:** 35106	**Ch 9:** N/A
Calibration Setup: 1		**Ch 2:** 35205	**Ch 4:** 35080	**Ch 6:** 34996	**Ch 8:** 35177	**Ch 10:** N/A

Equipment:	Micro-TomoScan: VH-8169	ACCUSONEX Software: Acquisition 6.2.5, Analysis 3.8	UT Cable: 50' RG-174

Data File:	**Scan Start**	**Scan Stop**	**Cal. Files**	**Examination Results**	
T2295._15.17.24	-5 deg @ 23.60"	365 deg @ 45.00"	T2295_13.21.15	Recordable Ind.	Leak Path
			T2297_17.43.38	Yes	No

Flaw No.	Surface (ID/OD)	Depth to Flaw Tip	End Point 1 Min (in.)	End Point 1 Min (deg.)	End Point 2 Max (in.)	End Point 2 Max (deg.)	Axial Total (in.)	Adjusted Circ. Extent Min (deg.)	Adjusted Circ. Extent Max (deg.)	Adjusted Circ. Extent Total (in.)	Flaw Length (in.)	Flaw Angle (deg.)	Flaw TWD (in.)	Flaw Aspect Ratio	Flaw Orient.
1	OD	0.41	38.00	209.00	39.20	209.00	1.20	209.0	209.0	0.00	1.20	0	0.22	0.18	AXIAL
2	OD	0.46	39.73	304.00	41.03	304.00	1.30	304.0	304.0	0.00	1.30	0	0.17	0.13	AXIAL
3	OD	0.44	40.69	326.00	41.64	326.00	0.95	326.0	326.0	0.00	0.95	0	0.19	0.19	AXIAL
4															
5															
6															
7															
8															
9															
10															
11															
12															
13															
14															
15															

Weld Profile	Noz. Loc.	0	30	60	90	120	150	180	210	240	270	300	330	360
	MAX.	39.59	39.54	39.00	38.29	37.53	36.56	36.38	36.61	37.55	38.49	39.23	39.84	39.58
	MIN.	40.99	40.88	40.48	39.90	39.28	38.67	38.42	38.85	39.43	39.94	40.58	40.99	40.99

Comments: The rotating probe verified the indications detected with the circ. blade probe.
Indications detected by loss of backwall signal along with tip signals.

Analyzed by: J. D. Breza, UT II **Date:** 10/24/02 **Reviewed by:** M. G. Hacker, UT LIII **Date:** 10/24/02