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December 10, 2002

U.S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, DC 20555

SUBJECT: Arkansas Nuclear One, Unit 1
Docket No. 50-313
30-Day Post Outage Response to NRC Bulletins 2001-01, 2002-01 and 2002-02 for ANO-1

REFERENCES:

1. Entergy letter dated September 4, 2001, *30-Day Response to NRC Bulletin 2001-01 for ANO-1; Circumferential Cracking of VHP Nozzles* (1CAN090102)
2. Entergy letter dated April 1, 2002, *15 Day Response to NRC Bulletin 2002-01, Reactor Pressure Vessel Head Degradation and Reactor Coolant Pressure Boundary Integrity* (0CAN040201)
3. Entergy letter dated September 9, 2002, *Entergy 30-Day Response to NRC Bulletin 2002-02, for Arkansas Nuclear One, Unit 1* (1CAN090202)
4. Entergy letter dated October 31, 2002, *Supplemental Response to NRC Bulletin 2002-02 for Arkansas Nuclear One, Unit 1* (1CAN100203)
5. Entergy letter dated December 4, 2002, Licensee Event Report 50-313/2002-003-00 (1CAN120201)

Dear Sir or Madam:

On August 3, 2001, the Nuclear Regulatory Commission (NRC) issued NRC Bulletin 2001-01, *Circumferential Cracking of Reactor Pressure Vessel Head Penetration Nozzles*. The bulletin requested information regarding the structural integrity of the reactor pressure vessel head penetration (VHP) nozzles. A 30-day response was provided for Arkansas Nuclear One, Unit 1 (ANO-1) in Reference 1. In addition, the NRC requested that licensees provide information regarding the reactor head inspections within 30 days after plant restart from the next refueling outage. ANO-1 has completed the inspection of the ANO-1 reactor vessel head during our recent 1R17 refueling outage where the facility was returned to power on November 12, 2002. The response to the 30-day post-outage bulletin request is provided in the attachment to this letter.

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In addition, on March 18, 2002, the NRC issued Bulletin 2002-01, *Reactor Pressure Vessel Head Degradation And Reactor Coolant Pressure Boundary Integrity* and on August 9, 2002, the NRC issued NRC Bulletin 2002-02, *Reactor Pressure Vessel Head And Vessel Head Penetration Nozzle Inspection Programs*. These bulletins also requested 30-day post outage reports to be provided to the NRC. The ANO-1 30-day post outage reports for NRC Bulletins 2002-01 and 2002-02 are also contained in the attachment to this letter.

This letter contains information responding to NRC Bulletins 2001-01, 2002-01 and 2002-02 for ANO-1 and is being submitted pursuant to 10CFR50.54(f). There are no commitments being made by this letter.

If you have any questions or require additional information, please contact Steve Bennett at 479-858-4626.

I declare under penalty of perjury that the foregoing is true and correct. Executed on December 10, 2002.

Sincerely,

Sherrie R. Cotton

Sherrie R. Cotton
Director, Nuclear Safety Assurance

SRC/sab

Attachment: 30-Day Post Outage Response to NRC Bulletins 2001-01, 2002-01 and 2002-02 for ANO-1

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30-Day Post Outage Response to NRC Bulletins 2001-01, 2002-01 and 2002-02 for ANO-1

NRC Required Information

[NRC Bulletin 2001-01] *Addressees are requested to provide the following information within 30 days after plant restart following the next refueling outage:*

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;*

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

[NRC Bulletin 2002-01] *Within 30 days after plant restart following the next inspection of the reactor pressure vessel head to identify any degradation, all PWR addressees are required to submit to the NRC the following information:*

a. *the inspection scope (if different than that provided in response to Item 1.D.) and results, including the location, size, and nature of any degradation detected,*

b. *the corrective actions taken and the root cause of the degradation.*

[NRC Bulletin 2002-02] *Within 30 days after plant restart following the next inspection of the RPV head and VHP nozzles to identify the presence of any degradation, all PWR addressees are requested to provide:*

A. *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.*

Response:

Scope of ANO-1 Vessel Head Penetration Inspection for 1R17

Entergy's scope for reactor vessel head penetration (VHP) nozzle inspections was developed as a result of industry findings and NRC concerns as described in NRC Bulletins 2001-01, 2002-01, and 2002-02. The scope for each of these bulletin responses is contained in References 1 through 4. In summary, Entergy performed the following inspections and NDE examinations for the recent 1R17 refueling outage:

1. A qualified bare metal visual (BMV) inspection of the outer surface of the reactor pressure vessel head to identify leaking VHP nozzles.

2. A volumetric inspection of all 69 reactor VHP nozzles using a blade probe (or open housing probe) from under the head.

3. An inspection of the surface of the head for degradation. If throughwall cracks are found and a concentration of boron is found protruding through the annulus region of the penetration, further actions will be taken to determine if there is a potential for wastage of the adjacent vessel material.

1R17 Inspection and Examination Results

Overview – ANO Procedure 2311.009, ANO *Unit 1 and Unit 2 Alloy 600 Inspection*, lists each of the ANO-1 VHP nozzles for inspection each outage. In accordance with this procedure, a qualified bare metal visual inspection was conducted which involved videotaping each of the VHP nozzles on the RV head. These videotapes were used for current outage review and for future outage reference. Members of System Engineering, Design Engineering and Quality Control reviewed the videotapes to determine whether any of the VHP nozzles showed conditions indicative of leakage. Nozzles that were suspected to have potential leakage were identified for further review. As a result of the inspections performed during 1R17, nozzle 56 was the only nozzle determined to be leaking.

Supplemental examinations using ultrasonic examination (UT) methods were also performed. The primary means of UT examination used a Westinghouse blade probe having an axial shooting time of flight diffraction (TOFD) 24pcs (probe center spacing) transducer. However, Entergy also used the Westinghouse open housing ultrasonic probe where control rod drives were planned for removal or where only partial data was able to be obtained from the blade probe. In addition, due to equipment problems experienced while performing ultrasonic examination during the 1R17 outage, Entergy contracted with Framatome Technologies to assist in completing the ultrasonic examinations. The ultrasonic probes and transducers utilized by Framatome are similar to those being employed by Westinghouse. The Framatome UT inspection process performed at ANO-1 is similar to that described in the Oconee Nuclear Station response to Bulletin 2002-02 as well as other B&W facilities. Both the Westinghouse and Framatome transducers have been demonstrated by EPRI to effectively detect axial and circumferential flaws within the nozzle.

The following information provides a summary of the qualified bare metal visual inspection and non-destructive examinations performed during 1R17 for the ANO-1 VHP nozzles:

Qualification (Demonstration) of Equipment, Personnel and Procedures: Testing of the Westinghouse and Framatome blade probes was performed with the oversight of EPRI. Results of these volumetric demonstrations are being documented in an EPRI program report. The procedures to be used for the NDE examinations were also satisfactorily demonstrated to EPRI. The procedure demonstrations are designed to identify the capabilities of the equipment and personnel to accurately detect and size PWSCC cracking. The personnel using the NDE procedures were qualified Level II or Level III in the applicable NDE discipline. Those personnel performing analysis of the NDE data completed flaw analysis training for the specific applications.

Westinghouse/Wesdyne Scope of Inspection - Westinghouse examined a total of 39 nozzles by ultrasonic examination. Thirty nozzles were initially examined with the blade probe and nine with the open housing probe. Of the 39 nozzles examined, 26 nozzles were analyzed using blade probe data, 9 nozzles with open housing data (56, 1, 29, 38, 50, 51, 52, 57, 63) and 4 nozzles with both probes (54, 68, 10, 35).

Seven nozzles were rescanned with the open housing probe to either clarify previous data or to acquire data that had not been fully acquired under previous scans. Nozzles 10 and 35 were from the previous Westinghouse blade probe examination and nozzles 29, 38, 52, 57 and 63, were incomplete examinations performed by Framatome.

Westinghouse Volumetric/Entergy Visual and Surface Examinations

Nozzle No. Examined By	NDE (Rel Ind.)	Indication (No. from Report) [1,2]	Length [4]	Depth	Location (Theta)
56 - EOI	VT-2 – 1	Boric acid	N/A	N/A	N/A
56- W	UT – 6 [5]	1a repair area [6]	0.56"	0.177"	20°
		2a repair area [6]	0.44"	0.145"	37°
		4a	0.28"	0.177"	175°
		5a	0.60"	0.125"	164°
		1c repair area [6]	0.40"	0.266"	24°
		2c repair area [6]	0.68"	0.180"	39°
56- EOI	PT - 8	8 RIs on J-weld	0.185" max	N/A	15°
54 - W	UT - 1	3	0.60"	0.135"	~220°
54- EOI	PT ->15	LI on tube	0.75" max	N/A	~220°
68 - W	UT - 0	N/A	N/A	N/A	N/A
68- EOI	PT - 1	RI on J-weld	0.125" max	>0.157"	45°
Nozzles with no relevant indications from UT data by Westinghouse: 1, 10, 21, 24, 25, 26, 29, 32, 35, 36, 37, 38, 40, 41, 43, 44, 45, 46, 47, 49, 50, 51, 52, 53, 55, 57, 59, 60, 61, 62, 63, 64, 65, 66, 67, and 69					

Framatome ANP Scope of Inspection - Framatome ultrasonically examined 30 nozzles using the blade probe. Of these 30 nozzles, Framatome also performed supplemental scans with their open housing probe on 6 nozzles (3, 6, 15, 17, 33 and 56) to determine dimensional information and characterize the nozzle tube prior to beginning repairs. The only NDE data credited from the Framatome open housing probe was for nozzle 3 where approximately 13° of data was needed to obtain 100% examination data.

Framatome Volumetric Examinations

Nozzle No. Examined By	NDE (Relevant Ind)	Indication (No. from Report [1, 3]	Length [4]	Depth	Location (Theta)
3 – FTI	UT-8	1	0.96"	0.22"	56°
		2	1.16"	0.18"	73°
		3	0.73"	0.25"	91°
		4	1.17"	0.18"	106°
		5	1.23"	0.25"	117°
		6	1.42"	0.34"	144°
		7	1.17"	0.20"	304°
		8	1.50"	0.23"	320°
6 – FTI	UT-6	1	1.81"	0.37"	65°
		2	0.51"	0.22"	72°
		3	1.03"	0.30"	87°
		4	1.26"	0.23"	99°
		5	1.46"	0.28"	121°
		6	0.97"	0.24"	231°
15 – FTI	UT-2	1	1.65"	0.38"	63°
		2	0.98"	0.23"	318°
17 - FTI	UT-8	1	0.51"	0.13"	15°
		2	0.64"	0.15"	37°
		3	1.60"	0.28"	52°
		4	0.76"	0.27"	62°
		5	1.13"	0.23"	72°
		6	0.96"	0.26"	134°
		7	0.78"	0.17"	328°
		8	1.04"	0.24"	339°
33- FTI	UT- 2	1	0.72"	0.32"	212°
		2	0.96"	0.37"	225°
Nozzles with no relevant indications from UT data by Framatome: 2, 4, 5, 7, 8, 9, 11, 12, 13, 14, 16, 18, 19, 20, 22, 23, 27,28, 30, 31, 34, 39, 42, 48, and 58					

Legend:

VT-2	Bare Metal Visual Inspection	UT	Ultrasonic examination
LI	Linear Indication	PT	Dye penetrant examination
RI	Rounded Indication		

Notes:

1 All LIs are reported individually and dimensions listed for the UT examination are measured values with no error factor applied. No circumferential indications were reported by the ultrasonic examination.

2 Only the largest RI was identified (obtained by PT examinations).

3 All indications are linear. No PT examinations were performed on the Framatome identified indications.

4 All reported flaws with the ultrasonic examination (except nozzle 56) appeared to initiate below the weld in the nozzle tube and extend upward toward the weld and in some cases past the plane of the lower weld toe.

5 Only nozzle 56 had indications that breached the triple point which had a maximum extent of 0.32" above J-weld.

6 Indications are around the Alloy 690 J-weld repair "nugget" installed in 1R16

Nozzle Repairs Performed during 1R17

Based on the above findings, eight nozzles required repair during the 1R17 outage. Nozzles 54 and 68 were repaired by the Westinghouse method which installed a complete overlay of the J-groove weld from the stainless steel cladding to the outside diameter (OD) of the nozzle. In addition, a thin "splash" weld was added to the OD of the nozzle as a means of mitigating further PWSCC of the nozzle. The weld overlay process was presented to the NRC at a meeting in the Rockville, MD offices on October 16, 2002. Neither one of these nozzles required an inside diameter (ID) repair since the depth of the volumetric flaws did not exceed the repair acceptance criteria of 0.25" into the nozzle wall from the OD.

Six nozzles (3, 6, 15, 17, 33 and 56) were repaired using the Framatome repair process. This process establishes a new pressure boundary weld by cutting the nozzle mid-plane in the vessel head (between the J-groove weld and the top of the head) and welding the nozzle remnant to the carbon steel of the reactor vessel head using a temper-bead process. This repair was performed on the nozzles, which exceeded the measured acceptance criteria depth.

Wastage Evaluation

CRDM nozzle 56 was identified as leaking from the qualified bare metal visual examination performed. The 1R17 boric acid deposits at and around the annulus were very similar to that experienced during the 1R16 outage. This included popcorn type kernels of boric acid at or near the down hill side of the nozzle and boric acid in the annulus itself. There was only a small flow of boric acid coming from the nozzle annulus that proceeded partway down the head. The quantity of boron present on the head was likely no more than a few ounces. A picture of the pre- and post-cleaned nozzle 56 annulus was presented to the NRC in a meeting with Entergy on October 16, 2002. The boric acid did not show any discoloration, which would indicate that there was no significant corrosion to the carbon steel head occurring. No chemical analysis was determined necessary to evaluate the ferritic content of the boric acid residue.

After inspection of the boric acid, the RV head was cleaned of boric acid from around nozzle 56 and the annulus area was inspected for potential wastage. The carbon steel interface around the annulus did not show any noticeable degradation or loss of metal. The nozzle annulus as-found configuration was essentially the same as other non-leaking nozzles. Since the nozzle was repaired during 1R16 and the head was cleaned prior to startup from the outage, the leakage present could not have occurred for more than one cycle of operation. Therefore, it is concluded that little if any wastage has occurred as a result of the boric acid leakage identified during 1R17 at nozzle 56.

In addition, even though not part of Entergy's inspection commitment, the ultrasonic transducers on the blade probes, as well as the open housing probe, have the ability to see signals corresponding to the backwall of the nozzle to investigate the integrity of the nozzle-to-shell shrinkfit area. This was further discussed in Reference 4. The UT data from both Westinghouse and Framatome indicated that there was no "leak path" through the annulus of each nozzle except for nozzle 56. However, one nozzle (nozzle 39) had an inadequate interference fit to allow for determination of a leak path. The UT data acquired did not identify any flaws in this nozzle.

Root Cause Evaluation

The root cause for flaws identified in ANO-1 nozzles 3, 6, 15, 17, 33, and 54 is PWSCC of Alloy 600 materials due to increased time at temperature. The root cause for the flaws and leakage path for nozzle 56 is also PWSCC, but had contributing residual stresses in the original weld material due to the J-groove weld repair performed during 1R16. The root cause of the indication in nozzle 68 was what appeared to be a rounded porosity in the J-groove weld that was likely not associated with PWSCC. Details of the root cause evaluation were submitted in ANO-1 Licensee Event Report 50-313/2002-003-00 (Reference 5).