May 5, 2004

Mr. Roy A. Anderson
President & Chief Nuclear Officer
PSEG Nuclear, LLC - X04
Post Office Box 236
Hancocks Bridge, NJ 08038

SUBJECT: SALEM NUCLEAR GENERATING STATION, UNIT NO. 1 - EVALUATION OF RELAXATION REQUEST NO. S1-RR-I3-B21, RE: FIRST REVISED ORDER (EA-03-009) ESTABLISHING INTERIM INSPECTION REQUIREMENTS FOR REACTOR PRESSURE VESSEL HEADS AT PRESSURIZED-WATER REACTORS (TAC NO. MC0967)

Dear Mr. Anderson:

On February 20, 2004, the Nuclear Regulatory Commission (NRC) issued First Revised Order Modifying Licenses (EA-03-009) (First Revised Order). The Order Modifying Licenses (Effective Immediately) (EA-03-009), dated February 11, 2003, was superceded by the First Revised Order, which continues to impose requirements for pressurized- water reactor licensees to inspect reactor pressure vessel (RPV) heads and associated penetration nozzles as stated in Sections IV.C.(5), (a) and (b). Sections IV.C.(5)(b)(i), (ii) and (iii) mandate requirements for nondestructive examination (NDE) of each penetration. Section IV.F of the First Revised Order states that requests for relaxation associated with specific penetration nozzles will be evaluated by the NRC staff using its procedure for evaluating proposed alternatives to the American Society of Mechanical Engineers Boiler and Pressure Vessel Code in accordance with Title 10 of the *Code of Federal Regulations*, Section 50.55a(a)(3).

By letter dated September 24, 2003, as supplemented by letters dated March 2, March 31, April 16, and April 29, 2004, PSEG Nuclear LLC (PSEG) submitted Relaxation Request S1-RR-I3-B21 requesting relaxation from the NDE requirements specified in Sections IV.C.(5)(b)(i) and IV.C.(5)(b)(ii) of the First Revised Order for the Salem Nuclear Generating Station, Unit No. 1 (Salem 1). PSEG's basis for the requested relaxation is that NDE of the Salem 1 4-inch diameter reactor pressure vessel head penetration nozzles cannot be completed in accordance with the requirements of the First Revised Order due to the physical configuration of the nozzles and limitations of the testing equipment.

The NRC staff has completed its review, and concludes that you have demonstrated good cause for the requested relaxation in that the proposed alternative provides reasonable assurance of the structural integrity of the RPV head, and that imposition of the requirements of the First Revised Order would result in hardship or unusual difficulty without a compensating

increase in the level of quality and safety. Therefore, pursuant to Section IV.F of the First Revised Order, the NRC staff authorizes the proposed relaxation and alternative inspection of the RPV head penetration nozzles during the period that the Order is in effect, subject to the following condition:

> If the NRC staff finds that the crack-growth formula in industry report MRP-55 is unacceptable, the licensee shall revise its analysis that justifies relaxation of the First Revised Order within 30 days after the NRC informs the licensee of an NRC-approved crack growth formula. If the licensee's revised analysis shows that the crack growth acceptance criteria are exceeded prior to the end of the current operating cycle, this relaxation is rescinded and the licensee shall, within 72 hours, submit to the NRC written justification for continued operation. If the revised analysis shows that the crack growth acceptance criteria are exceeded during the subsequent operating cycle, the licensee shall, within 30 days, submit the revised analysis for NRC review. If the revised analysis shows that the crack growth acceptance criteria are not exceeded during either the current operating cycle or the subsequent operating cycle, the licensee shall, within 30 days, submit a letter to the NRC confirming that its analysis has been revised. Any future crack-growth analyses performed for this and future cycles for RPV head penetrations must be based on an acceptable crack growth rate formula.

The NRC staff's Safety Evaluation is enclosed.

Sincerely,

/RA/

Cornelius F. Holden, Jr., Director
Project Directorate I
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket No. 50-272

Enclosure: As stated

cc w/encl: See next page

increase in the level of quality and safety. Therefore, pursuant to Section IV.F of the First Revised Order, the NRC staff authorizes the proposed relaxation and alternative inspection of the RPV head penetration nozzles during the period that the Order is in effect, subject to the following condition:

> If the NRC staff finds that the crack-growth formula in industry report MRP-55 is unacceptable, the licensee shall revise its analysis that justifies relaxation of the First Revised Order within 30 days after the NRC informs the licensee of an NRC-approved crack growth formula. If the licensee's revised analysis shows that the crack growth acceptance criteria are exceeded prior to the end of the current operating cycle, this relaxation is rescinded and the licensee shall, within 72 hours, submit to the NRC written justification for continued operation. If the revised analysis shows that the crack growth acceptance criteria are exceeded during the subsequent operating cycle, the licensee shall, within 30 days, submit the revised analysis for NRC review. If the revised analysis shows that the crack growth acceptance criteria are not exceeded during either the current operating cycle or the subsequent operating cycle, the licensee shall, within 30 days, submit a letter to the NRC confirming that its analysis has been revised. Any future crack-growth analyses performed for this and future cycles for RPV head penetrations must be based on an acceptable crack growth rate formula.

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELAXATION REQUEST NO. S1-RR-I3-B21

FIRST REVISED ORDER MODIFYING LICENSES (EA-03-009) ESTABLISHING INTERIM

INSPECTION REQUIREMENTS FOR REACTOR PRESSURE VESSEL HEADS

AT PRESSURIZED-WATER REACTORS

SALEM NUCLEAR GENERATING STATION, UNIT NO. 1

PSEG NUCLEAR, LLC

DOCKET NO. 50-272

1.0 INTRODUCTION

On February 20, 2004, the Nuclear Regulatory Commission (NRC) issued First Revised Order Modifying Licenses (EA-03-009) (hereinafter referred to as the First Revised Order). The Order Modifying License (Effective Immediately) (EA-03-009), dated February 11, 2003, was superceded by the First Revised Order, which continues to impose requirements for pressurized-water reactor (PWR) licensees to inspect reactor pressure vessel (RPV) heads and associated penetration nozzles as stated in Sections IV.C.(5), (a) and (b). Sections IV.C.(5)(b)(i), (ii) and (iii) mandate requirements for nondestructive examination (NDE) of each penetration. Section IV.F of the First Revised Order states that requests for relaxation associated with specific penetration nozzles will be evaluated by the NRC staff using its procedure for evaluating proposed alternatives to the American Society of Mechanical Engineers Boiler and Pressure Vessel Code in accordance with Title 10 of the *Code of Federal Regulations*, Section 50.55a(a)(3). Section IV.F, of the First Revised Order also states that a request for relaxation regarding inspection of specific nozzles shall address the following criteria: (1) the proposed alternative(s) for inspection of specific nozzles will provide an acceptable level of quality and safety, or (2) compliance with the First Revised Order for specific nozzles would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

By letter dated September 24, 2003, as supplemented by letters dated March 2, March 31, April 16, and April 29, 2004, PSEG Nuclear LLC (PSEG or the licensee) submitted Relaxation Request S1-RR-I3-B21 requesting relaxation from the NDE requirements specified in Sections IV.C.(5)(b)(i) and IV.C.(5)(b)(ii) of the First Revised Order for the Salem Nuclear Generating Station, Unit No. 1 (Salem 1). PSEG's basis for the requested relaxation is that NDE of the Salem 1 4-inch diameter RPV head penetration nozzles cannot be completed in accordance with the requirements of the First Revised Order due to the physical configuration of the nozzles and limitations of the testing equipment.

Enclosure

This relaxation would only apply during the period in which the First Revised Order EA-03-009 is in effect.

2.0 REGULATORY EVALUATION

The First Revised Order requires specific examinations of the RPV head and vessel head penetration (VHP) nozzles of all PWR plants. The Salem 1 RPV head is currently in the high susceptibility category for primary water stress corrosion cracking (PWSCC). In accordance with Section IV, paragraphs A and B, of the First Revised Order, the following inspections are required to be performed every refueling outage as specified in Section IV, paragraph C.(5)(a) and paragraph C.(5)(b):

(a) Bare metal visual examination of 100 percent of the RPV head surface (including 360° around each RPV head penetration nozzle). For RPV heads with the surface obscured by support structure interferences which are located at RPV head elevations downslope from the outermost RPV head penetration, a bare metal visual inspection of no less than 95 percent of the RPV head surface may be performed provided that the examination shall include those areas of the RPV head upslope and downslope from the support structure interference to identify any evidence of boron or corrosive product. Should any evidence of boron or corrosive product be identified, the licensee shall examine the RPV head surface under the support structure to ensure that the RPV head is not degraded.

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

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

(ii) Eddy current testing or dye penetrant testing of the entire wetted surface of the J-groove weld and the wetted surface of the RPV head penetration nozzle base material from at least 2 inches above the highest point of the root of the J-groove weld (on a horizontal plane perpendicular to the nozzle axis) to 2 inches below the lowest point at the toe of the J-groove weld on a horizontal plane perpendicular to the nozzle axis (or the bottom of the nozzle if less than 2 inches); OR from 2 inches above the highest point of the root of the J-groove weld (on a horizontal plane perpendicular to the nozzle axis) to 1.0-inch below the lowest point at the toe of the J-groove weld (on a horizontal plane perpendicular to the nozzle axis) and including all RPV head penetration nozzle

surfaces below the J-groove weld have an operating stress level (including all residual and normal operation stresses) of 20 ksi tension and greater.

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

1. On nozzle material below the J-groove weld, both the outside diameter and inside diameter surfaces of the nozzle must be examined.

2. On nozzle material above the J-groove weld, surface examination of the inside diameter surface of the nozzle is permitted provided a surface examination of the J-groove weld is also performed.

Footnote 3 of the First Revised Order provides specific criteria for examination of repaired VHP nozzles.

The licensee has requested relief from Section IV, paragraph C.(5)(b)(i) and paragraph C.(5)(b)(ii) of the First Revised Order. The specific relaxation requested is identified below.

2.1 Licensee's Proposed Alternative

The licensee seeks relaxation from the First Revised Order requirements where inspection coverage may be limited on the 79 reactor VHP nozzles with respect to NDE, including ultrasonic testing (UT), eddy current testing (ECT), and dye penetrant testing (PT) below the J-groove weld. (This request excludes the original head vent which is covered under Relief Request S1-RR-I3-B22.)

The licensee proposes to meet the First Revised Order Requirements, or to examine each of the subject head nozzles to the maximum extent possible using UT and ECT from the inner-diameter (ID) of the 4-inch VHP nozzles.

2.2 Licensee's Basis for Proposed Alternative

The First Revised Order requires that ultrasonic or surface examinations extend to 2 inches below the J-groove weld or 1 inch below the J-groove weld and include all VHP nozzle surfaces below the J-groove weld that have an operating stress level (including residual and normal operation stresses) of 20 ksi tension and greater. PSEG is requesting approval of a proposed alternative to requirements that are appropriate to the ultrasonic and eddy current probes used at Salem 1, the geometric design of the bottom portion of the nozzles, and the phenomena of concern as identified in the First Revised Order. Reasons for requesting the proposed alternative are as follows:

a. Ultrasonic probes used to detect circumferential flaws are not effective near the end of the nozzle. These probes have separate transducers for sending and receiving the ultrasonic signal that are arranged vertically. The transducers in the probe are approximately 1 inch apart. With this configuration, the lower transducer will not contact

the inside wall of the nozzle unless the upper transducer is inserted greater than approximately 1 inch into the nozzle. Since the scanning process requires that both transducers be in contact with the surface, the probe cannot scan the lower end of the nozzle. Based on the geometry involved in the transducer location and the radius at the lower end of the nozzle, the portion that cannot be scanned is the portion extending from the bottom of the nozzle upward for a distance of approximately 1 inch.

b. Eddy current probes do not maintain adequate contact with the nozzle at its lower end due to nozzle geometry. The nozzles have a chamfer on the ID at the lower end of the tube for approximately 0.233 inch and are threaded on the outside diameter (OD) for approximately 0.75 inch.

c. UT or ECT of portions of the nozzle significantly below the J-groove weld is not significant to the phenomena of concern. The phenomena that are of concern are leakage through the J-groove weld and circumferential cracking in the nozzle above the J-groove weld. This is appropriately reflected in the requirement that the UT or ECT extend 2 inches above the J-groove weld. However, the First Revised Order also requires that UT or ECT be extended to 2 inches below the toe of the J-groove weld. The nozzle is essentially an open-ended tube and the nozzle wall below the J-groove weld is not part of the reactor coolant system pressure boundary.

d. The First Revised Order allows for performing PT in lieu of ECT or UT. Performing PT on the bottom nozzle area would result in significant radiation exposure to personnel without a compensating increase in the level of quality or safety. In addition, the OD portion of the nozzle is threaded at the lower end (from the nozzle end up to 0.75 inch) for attaching guide cones. The guide cones would need to be removed in order to perform PT, and then the cones would need to be reinstalled.

2.4 Evaluation

The NRC staff's review of this request was based on criterion (2) of Section IV, paragraph F of the First Revised Order, which contains a provision for relaxation in cases where compliance with the First Revised Order for specific nozzles would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety. Within the context of the licensee's proposed alternative examination of the RPV head penetration nozzles, the licensee has demonstrated the hardship that would result from implementing examinations to the bottom end of these nozzles.

The phenomenon of concern is PWSCC, which typically initiates in the areas of highest stress. The area of control rod drive mechanism penetrations that has the highest residual stress is the area adjacent to the J-groove attachment weld. Therefore, it is most likely that PWSCC will initiate in an area adjacent to the J-groove attachment weld. Stress profiles, based on the licensee's finite element analysis of VHP nozzles at Salem 1, show that the stresses decrease to 20 ksi or less at the examination distances obtained for 78 out of the 79 VHP nozzles examined. For the one nozzle (nozzle number 78) where all of the stresses did not decrease to less than 20 ksi, the stresses decreased to less than 20 ksi on the ID of the weld and were less than 30 ksi on the OD of the weld at the distance examined. The nominal yield strength of the VHP nozzles at Salem 1 varies from 35 ksi to 63 ksi. The stress level of 20 ksi is a conservative value below which PWSCC initiation is unlikely and is referenced in the First

Revised Order. Crack initiation would be more likely to occur at the weld region where the stresses are higher. These regions were examined by the licensee for the subject 79 nozzles. In addition, the NRC staff finds that the higher stress (30 ksi) on the OD of nozzle number 78 at a distance of 0.28 inch below the weld is less than the yield stress and should provide adequate assurance that crack initiation is unlikely.

The licensee's April 16, 2004, submittal lists the extent of coverage obtained for the 79 VHP nozzles. For 78 of the penetrations, the licensee was able to obtain at least 0.5 inch coverage below the toe of the weld on the downhill side using UT examination. Nozzle number 78, which had less coverage, will be discussed later in this evaluation. The actual distances inspected below the J-groove weld were much less than what the design drawing estimates predicted due to the as-fabricated reinforcing fillet welds. Table 1, below, summarizes the range of examination distances that were obtained below the weld for the different nozzle angles using UT examination and ECT examination from the ID of the nozzles.

TABLE 1

Penetration Number	Head Angle degrees	UT Volumetric Coverage below J-weld (inches)		ECT Coverage below J-weld ID surface (inches)	
		Uphill side	Downhill side	Uphill side	Downhill side
0	0	1.34	1.30	2.08	2.04
2-5	8	1.56-1.92	0.68-1.28	2.32-2.48	1.44-1.84
6-9	11.4	1.62-2.06	0.86-1.22	2.42-2.76	1.66-2.04
10-13	16.2	2.02-2.67	0.7-1.18	2.72-3.2	1.4-1.94
14-21	18.2	2.1-2.58	0.62-1.26	2.46-3.28	1.1-1.80
22-25	23.3	2.62-3.02	0.5-0.98	3.04-2.62	0.92-1.68
26-29	24.8	2.88-3.20	0.60-1.0	3.6-3.2	1.24-1.92
30-37	26.2	2.46-3.0	0.58-1.02	3.04-3.6	1.16-1.67
38-45	30.2	2.98-3.74	0.74-0.94	3.52-4.36	1.16-1.52
46-49	33.9	3.38-3.82	0.54-0.86	3.8-4.28	0.72-1.36
50-57	35.1	3.34-3.90	0.58-1.14	4.06-4.32	0.84-1.68
58-61	36.3	3.78-4.18	0.62-1.18	4.26-4.78	1.10-1.70
62-69	38.6	3.86-4.46	0.50-0.78	4.22-4.92	1.10-1.32
70-73	44.3	4.62-4.98	0.50-0.98	5.16-5.48	1.04-1.40
74-79	48.7	5.74-6.06	0.28-0.94	6.28-6.67	0.83-1.48

The 0.5 inch inspection distance of the nozzle base material below the attachment weld is supported by the licensee's analysis which concluded that no flaw located at or below 0.5 inch below the toe of the J-groove weld would propagate to a level adjacent to the J-groove weld within the next operating period. The licensee's flaw evaluation was performed by postulating an axial flaw in the assumed area of missed coverage below the weld. The methodology was described in WCAP-16214, Rev. 0, "Structural Integrity Evaluation of Reactor Vessel Upper

Head Penetrations to Support Continued Operation: Salem Units 1 and 2," dated February 2004. This methodology was used to generate the crack growth curves illustrated in WCAP-16214, Rev. 0 and in the licensee's March 2, 2004, response to an NRC staff request for additional information (RAI). The licensee identified the conservatisms embedded in the flaw evaluation, and they are listed below:

- The postulated axial flaw is assumed to be a through-wall flaw.
- The flaw has been assumed to initiate in and propagate from a region below the proposed inspection coverage area. Flaws have never been observed in this low stress region away from the weld without the presence of other flaws in the high stressed region at or near the weld.
- The stress intensity factor calculation was based on the highest stress anywhere along the postulated flaw and was applied uniformly along the entire length of the through-wall axial flaw.
- The crack growth curves shown in the March 2, 2004, RAI response to question 9 were generated based on the hoop stress distribution for the as-designed weld configuration which is more conservative than the as-built weld configuration.

The licensee provided graphs in a letter dated March 2, 2004, showing the time in effective full-power years (EFPYs) for the upper-crack tip to reach the bottom of the weld for a through-wall axial crack tip located at a minimum inspection coverage distance below the weld. The results, provided in Table 2 below, show that even with the conservatisms in the analysis, the as-calculated inspection frequency based on a through-wall flaw located at the hypothesized locations listed above is longer than the Salem 1 operating cycle. The operating cycle for Salem 1 is approximately 1.5 EFPYs which is shorter than the calculated value of 3.0 EFPYs for a 44.3-degree nozzle with a postulated crack located 0.3 inch below the weld to grow to the toe of the weld.

TABLE 2

Nozzle Angle (°)	hypothesized location of upper crack tip below the toe of the J-groove weld (inches)	EFPYs
0	0.5	5.25
26.2	0.5	5.5
44.3	0.3	3.0
48.7	0.3	4.5

The licensee's UT examination of nozzle number 78 (a 48.7-degree nozzle) was limited to 0.28 inch below the toe of the J-groove weld. The licensee provided supplemental information in its RAI response dated April 16, 2004, to support the adequacy of the limited examination. The licensee conservatively took into account the instrument uncertainty of 0.04 inch in the measurement and postulated the upper extremity of an axial through-wall flaw to be located at 0.24 inch below the J-groove weld. The resulting crack growth curve showed that the period of time required for an undetected flaw, located at a distance of 0.24 inch below the weld, would

take 2.4 EFPYs, which is more than one fuel cycle (~1.5 EFPYs). In addition, the ID surface of this nozzle was examined to a distance of 0.83 inch below the toe of the weld, which indicates that a through-wall flaw does not exist in the region from the toe of the weld to 0.83 inch below the weld.

The licensee's analysis in WCAP-16214, Rev. 0 used the crack growth formula in Electric Power Research Institute Report Material Reliability Program (MRP) Report MRP-55, "Material Reliability Program (MRP) Crack Growth Rates for Evaluating Primary Water Stress Corrosion Cracking (PWSCC) of Thick Wall Alloy 600 Material (MRP-55), Revision 1." The NRC staff has not yet made a final determination on the acceptability of the subject industry report. Should the NRC staff determine the crack growth formula used by the licensee to be unacceptable, the licensee will be required to revise its analysis to incorporate an acceptable crack growth formula as described below.

> If the NRC staff finds that the crack-growth formula in industry report MRP-55 is unacceptable, the licensee shall revise its analysis that justifies relaxation of the First Revised Order within 30 days after the NRC informs the licensee of an NRC-approved crack growth formula. If the licensee's revised analysis shows that the crack growth acceptance criteria are exceeded prior to the end of the current operating cycle, this relaxation is rescinded and the licensee shall, within 72 hours, submit to the NRC written justification for continued operation. If the revised analysis shows that the crack growth acceptance criteria are exceeded during the subsequent operating cycle, the licensee shall, within 30 days, submit the revised analysis for NRC review. If the revised analysis shows that the crack growth acceptance criteria are not exceeded during either the current operating cycle or the subsequent operating cycle, the licensee shall, within 30 days, submit a letter to the NRC confirming that its analysis has been revised. Any future crack-growth analyses performed for this and future cycles for RPV head penetrations must be based on an acceptable crack growth rate formula.

As an added conservatism, the crack growth curves do not include the time that would be required for an axial crack to propagate through the attachment weld and result in a leakage path. Additional operating time would be required for a safety concern (ejection of a nozzle or substantial corrosion of the low-alloy steel RPV head) to develop as a result of that leak. Therefore, it would take more than one operating cycle for a flaw that initiates in the uninspected region to develop into a safety concern.

The licensee inspected all 79 penetrations using a volumetric UT examination including a UT leak path assessment. The UT examination was performed from the nozzle ID and covered the area from 2 inches above the J-groove weld down to the point where the thread relief on the OD of the nozzles interfered with data acquisition (this is approximately 0.75 inch from the bottom of the nozzle penetration). In addition, the inside surface of the VHP nozzles were inspected with supplemental ECT surface examination from the ID. The ECT examination covered the area from 2 inches above the J-groove weld down to the top of the chamfer on the ID of the tube. This distance is 0.233 inch from the bottom of the tube.

No surface examinations were performed on the OD side of the VHP due to there being only a small available region (0.081 inch) that was not covered by UT examination. Below this region the nozzle is threaded such that meaningful UT data cannot be obtained. In addition, to gain access to perform a surface examination would require the removal of the guide cones. The licensee estimated that the dose incurred to remove a guide cone, perform the surface

examination, and reinstall the guide cone would be approximately 4 Rem per nozzle. To use ECT on the OD surface would only gain a small region of 0.081 inch and the licensee would incur a dose of 4 Rem per nozzle. Therefore, the NRC staff finds that additional examination on the OD surface would be a hardship without a compensating increase in the level of quality or safety.

The licensee identified 13 nozzles with craze cracking indications. These indications are located on the ID of the nozzle at the weld region. The depths of these indications are less than 0.040 inch. The licensee provided crack growth curves for bounding cases of crack depth and crack length. The results of the crack growth calculations show that the remaining service life of the nozzles where these craze cracks are located is more than one fuel cycle before repair is necessary. This information was provided in the licensee's submittal dated April 16, 2004.

In addition, the licensee identified a 0.5-inch ID circumferential indication on penetration number 19. The licensee determined the depth of the indication by UT to be 0.047 inch. This indication is located 0.16 inch below the weld on the uphill side of the penetration. The concern for a circumferential flaw below the weld is loose parts due to failure of the lower piece of the tube and is not a pressure boundary issue. The licensee states that, based on WCAP-16214-P, circumferential flaws below the weld are acceptable for the period of service until the next inspection, regardless of depth, provided the length is less than 75 percent of the penetration nozzle circumference. The subject circumferential indication length is less than 5 percent of the penetration nozzle circumference. In addition, the licensee's April 16, 2004, submittal provided a crack growth curve for penetration number 19, having an initial flaw length of 0.5 inch and a depth of 0.047 inch. That curve indicates that the penetration 19 circumferential indication would need 4.28 EFPYs to become a through-wall flaw. The NRC staff concurs with the licensee's determination that this is not a pressure boundary issue.

Based upon the information above, the NRC staff finds that the licensee's examinations to the extent described above are acceptable and provide reasonable assurance of the structural integrity of the RPV head, VHP nozzles and welds. Further inspections to comply with the First Revised Order requirements would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety. The NRC staff also notes that the licensee is planning to replace the reactor vessel head during the next outage.

3.0 CONCLUSION

The NRC staff concludes that the licensee's examinations of the subject 79 VHPs at Salem 1 from 2 inches above the J-groove weld to the level below the weld identified in Table 1 provide reasonable assurance of the structural integrity of the RPV head, VHP nozzles and welds at Salem 1. Further inspections of these VHP nozzles in accordance with Section IV, paragraph C.(5)(b), of the First Revised Order (EA-03-009) dated February 20, 2004, would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety. Therefore, pursuant to Section IV, paragraph F, of the First Revised Order the NRC staff authorizes the proposed alternative inspection for the 79 VHPs at Salem 1, subject to the following condition:

> If the NRC staff finds that the crack-growth formula in industry report MRP-55 is unacceptable, the licensee shall revise its analysis that justifies relaxation of the [First Revised] Order within 30 days after the NRC informs the licensee of an NRC-approved

crack growth formula. If the licensee's revised analysis shows that the crack-growth acceptance criteria are exceeded prior to the end of the current operating cycle, this relaxation is rescinded and the licensee shall, within 72 hours, submit to the NRC written justification for continued operation. If the revised analysis shows that the crack-growth acceptance criteria are exceeded during the subsequent operating cycle, the licensee shall, within 30 days, submit the revised analysis for NRC review. If the revised analysis shows that the crack-growth acceptance criteria are not exceeded during either the current operating cycle or the subsequent operating cycle, the licensee shall, within 30 days submit a letter to the NRC confirming that its analyses has been revised. Any future crack-growth analyses performed for this and future cycles for RPV head penetrations must be based on an acceptable crack-growth rate formula.

In the licensee's RAI response dated March 2, 2004, the licensee agreed to comply with the condition language as stated above should the crack growth formula be found unacceptable to the NRC staff.

Principal Contributor: A. Keim

Date: May 5, 2004