September 26, 2007

Mr. Christopher M. Crane
President and Chief Nuclear Officer
Exelon Generation Company, LLC
4300 Winfield Road
Warrenville, IL 60555

SUBJECT: BRAIDWOOD STATION, UNIT 1 - RELAXATION OF THE FIRST REVISED ORDER EA-03-009 (TAC NOS. MD3675)

Dear Mr. Crane:

By letter dated November 22, 2006, Exelon Generation Company, LLC (Exelon, the licensee), requested relaxation from certain inspection requirements of the first revised Order EA-03-009 (Order), dated February 20, 2004.

Exelon has requested relaxation from the Order for the inspection at Braidwood Station (Braidwood), Unit 1 of ten reactor pressure vessel (RPV) penetration nozzles, whose inspection is constrained by physical configuration, and one additional RPV penetration nozzle, whose inspection is constrained by a surface anomaly.

The NRC staff has reviewed and evaluated the information provided by Exelon in support of this request and concludes that Exelon's proposed alternative examination of the RPV penetration nozzles reasonably assures the structural integrity of the RPV, and further, that inspection of the RPV in accordance with Section IV.C. of the Order would result in hardship without a compensating increase in the level of quality and safety. Therefore, pursuant to Section IV.F. of the Order, the NRC staff authorizes the proposed alternative inspection for the RPV at Braidwood, for the time period for which the Order is in effect.

The NRC staff's review is provided in the enclosed Safety Evaluation. If you have any questions, please contact Robert F. Kuntz at (301) 415-3733.

Sincerely,

/RA/

Timothy J. McGinty, Deputy Director
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. STN 50-456

Enclosure: As stated

cc w/encl: See next page

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

FIRST REVISED NRC ORDER (EA-03-009) RELAXATION REQUEST

ALTERNATE EXAMINATION COVERAGE

FOR REACTOR PRESSURE VESSEL HEAD

BRAIDWOOD STATION, UNIT 1

EXELON GENERATION COMPANY, LLC

DOCKET NO. STN 50-456

1.0 INTRODUCTION

The First Revised Nuclear Regulatory Commission (NRC) Order EA-03-009 (Order), issued on February 20, 2004 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML040220181), requires specific examinations of the reactor pressure vessel (RPV) head and vessel head penetration nozzles at all pressurized water reactor plants. Section IV.F of the Order states that requests for relaxation of the associated with specific penetration nozzles will be evaluated by the NRC staff using the procedure for evaluating proposed alternatives to the American Society of Mechanical Engineers Code, in accordance with Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, Section 55a(a)(3). Accordingly, Section IV.F of the First Revised Order 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 Order for specific nozzles would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

For Braidwood Station (Braidwood), Unit 1, and similar plants determined to have a low susceptibility to primary water stress corrosion cracking (PWSCC), in accordance with Sections IV.A, IV.B, and IV.C.(3) of the Order, the following inspection is required to be performed by February 11, 2008, in accordance with Section IV.C.(5)(b) of the Order:

(b) For each penetration, perform a nonvisual nondestructive examination (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 two inches above the highest point of the root of the J-groove weld (on a horizontal plane perpendicular to the nozzle axis) to

two 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 two inches [see Figure IV-1]); or from two inches above the highest point of the root of the J-groove weld (on a horizontal plane perpendicular to the nozzle axis) to one 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 (see Figure IV-2). 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 two inches above the highest point of the root of the J-groove weld (on a horizontal plane perpendicular to the nozzle axis) to two 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 two inches [see Figure IV-3]); Or from two inches above the highest point of the root of the J-groove weld (on a horizontal plane perpendicular to the nozzle axis) to one 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 (see Figure IV-4).

(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.

By letter dated November 22, 2006 (ADAMS Accession No. ML063260215), Exelon Generation Company LLC (the licensee) requested relaxation to implement an alternative to the requirements of Section IV.C.(5)(b) of the Order for RPV head penetration nozzles at Braidwood.

2.0 FIRST REVISED NRC ORDER EA-03-009 RELAXATION REQUEST FOR EXAMINATION COVERAGE FOR REACTOR PRESSURE VESSEL HEAD PENETRATION NOZZLES

2.1 First Revised Order Requirements for Which Relaxation is Requested

Section IV.C of the First Revised NRC Order EA-03-009 dated February 20, 2004, requires that inspections of Section IV.C.(5)(b) of the First Revised Order be performed by February 11, 2008, for low susceptibility plants similar to Braidwood.

The licensee has requested relaxation from Section IV.C.(5)(b) of the First Revised NRC Order EA-03-009. The specific relaxation requested is identified below.

2.2 Licensee's Proposed Alternative

2.2.1 Inspection Coverage Below the J-groove Weld

The licensee seeks relaxation from the Order to revise the minimum volumetric inspection coverage requirement below the J-groove weld for 10 penetration nozzles at Braidwood, to the lowest elevation that can be practically inspected. During the previous refueling outage for Braidwood, the licensee performed volumetric examinations to the maximum extent practical to meet all requirements of the Order. The inspection distance below the J-groove weld for 10 penetration tubes did not meet the full requirements of the Order. The specific coverage obtained for these penetration nozzles is provided in Table 1.

Table 1: Braidwood, Spring 2006 (A1R12) Refueling Outage Volumetric/Surface Inspection Coverage Below the Toe of the J-groove Weld

Nozzle Number	A1R12 Inspection Coverage (Inches Below the J-groove Weld)			
	Uphill		Downhill	
	Inner Diameter (ID)	Outer Diameter (OD)	ID	OD
42	1.85	0.61	0.93	0.43
49	1.85	0.61	0.93	0.43
54	1.85	0.61	0.93	0.43
63	2.9	0.61	0.64	0.49
65	2.9	0.61	0.64	0.49
66	3.02	0.62	0.60	0.47
71	3.02	0.62	0.60	0.47
72	3.02	0.62	0.60	0.47

77	3.29	0.54	0.48	0.44
78	3.29	0.54	0.48	0.44

2.2.2 Inspection Coverage Above the J-groove Weld

In addition to the limited examination coverage of the 10 penetrations noted in Table 1, the licensee could not achieve full Order-required inspection coverage for penetration nozzle number 74. The area of missed coverage was located at the upper bounds of the 2-inch inspection zone above the J-groove weld, and measured an estimated 0.25-inch in circumferential extent and 0.6-inch in axial height. The missed coverage area was less than 6 percent of the total inspection requirement for penetration nozzle number 74. The licensee's proposed alternative inspection for penetration nozzle number 74 is to perform bare metal visual examination of the penetration nozzle to head interface, including a 1-inch annulus 360 degrees around the penetration every refueling outage until the next scheduled volumetric examination for Braidwood, scheduled for the spring of 2012.

2.3 Licensee's Basis for Proposed Alternative

2.3.1 Inspection Coverage Below the J-groove Weld

It is the licensee's relaxation request, in part, to perform the volumetric examination required by the Order to the lowest elevation that can be practically inspected for 10 penetration nozzles identified in Table 1. The licensee will utilize inspection option (b)(i) and will achieve volumetric and surface coverage two inches above the J-groove weld down to the lowest elevation that can be practically inspected on each of these penetration nozzles, with a minimum distance below the J-groove weld for 10 penetration nozzles as stated in Table 1.

The licensee states that the bottom of each RPV upper head penetration nozzle includes a threaded region approximately 1-inch long on the outside diameter along with a chamfered area at the inside diameter which extends approximately 0.76 inches from the bottom of the penetration nozzle. The chamfered surface is machined at a 20 degree angle. Each of these items invoke physical restraints to full effective coverage of the Order required volumetric inspection area with ultrasonic examination probes and surface examination using eddy current probes.

The licensee notes that while the Order allows provisions for dye penetrant inspection, it would require extensive work under and around the RPV upper head. The licensee estimates the general area radiation level under the Braidwood RPV upper head at 4.0 rem per hour. In addition, the threaded region of the penetration nozzles would make a dye penetrant inspection impractical. Therefore, the licensee concludes, that additional manual inspection of the uninspected regions of each penetration nozzle for which full Order coverage could not be met would result in significant radiation exposure to personnel without a compensating increase in the level of quality or safety.

The licensee further states that testing 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. 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 (RCS) pressure boundary. The licensee believes the proposed inspection coverage does not preclude full UT examination coverage of the portions of these nozzles that are of primary interest.

The licensee contracted for a structural integrity evaluation for Braidwood and Byron RPV upper head penetration nozzles. A series of crack growth calculations were performed presuming a flaw where the lower extremity of this initial through-wall flaw is conservatively postulated to be located on the penetration nozzle where either the inside or outside surface hoop stress drops below 0 ksi. The calculation was preformed to demonstrate that more time in effective full power years (EFPY) of operation would elapse before a postulated flaw in the unexamined area of the penetration nozzle would propagate into the pressure boundary formed by the J-groove weld. Braidwood is in the low susceptibility category, and, nonvisual NDE will be performed once every four refueling outages or within seven calendar years whichever is less. Braidwood, is on an 18 month operating cycle. Therefore four refueling outages will limit non-visual NDE inspection to every 6 calender years. Further, each refueling outage is conservatively projected by the licensee to accumulate 1.5 EFPY of operational time. A conservatively predicted maximum of 6.0 EFPY would be produced in 6 calendar years of operation at Braidwood.

The methodology and the technical basis of the crack growth calculation, which was based on the hoop stress distribution and the PWSCC crack growth rate recommended in the Electric Power Research Institute Report, "Material Reliability Program (MRP) Crack Growth Rates for Evaluating PWSCC of Thick Wall Alloy 600 Material (MRP-55), Revision 1," were provided in WCAP-16394-P. The calculation demonstrates that the minium time for a flaw to propagate from the distances below the J-groove weld listed in Table 1 for the limiting RPV upper head penetration nozzles to the bottom of the J-groove weld would be at least 6.8 EFPY. The results of the conservative flaw propagation calculation indicate that, even if a flaw were to occur in the region of the penetration nozzle not being inspected, there would be adequate opportunity for detection prior to the crack reaching the RCS pressure boundary. The licensee asserts that the results demonstrate that the extent of the proposed inspection coverage would provide reasonable assurance of the structural integrity of both Braidwood RPV head penetration nozzles and the J-groove welds.

As the crack growth rate formula used in the structural integrity evaluation for Braidwood is the same as the PWSCC crack growth rate recommended in MRP-55, Revision 1, the licensee states the following:

> If the NRC finds that the crack-growth formula in industry report MRP-55 is unacceptable, then the licensee will revise its analysis that justifies relaxation of the Order within 30 days after the NRC informs the licensee of an NRC-approved crack-growth formula. If the licensee's revised analysis for Braidwood Station Unit 1 shows that the crack-growth acceptance criteria are exceeded prior to the end of the current operating cycle, this relaxation request will be rescinded and the licensee will, 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 will, 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 will, 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.

2.3.2 Inspection Coverage Above the J-groove Weld

It is the licensee's relaxation request, in part, that during the Braidwood spring 2006 outage, due to an area of missed volumetric inspection coverage located at the upper bounds of the 2-inch inspection zone above the J-groove weld, the license will perform a bare metal visual examination of vessel head penetration number 74 including 1-inch around the penetration, each outage until the next scheduled volumetric examination in spring of 2012. The area of missed coverage measured an estimated 0.25-inch in circumferential extent and 0.6-inch in axial height and was due to a surface anomaly which caused probe liftoff in this area.

The licensee notes that accelerating the schedule for the reconditioning of VHP number 74 and performing a 100 percent volumetric examination would result in an unnecessary hardship without a compensating increase in quality or safety. The missed coverage area was less than 6 percent of the total inspection requirement for penetration nozzle number 74. Ultrasonic and eddy current inspection was effectively performed of the penetration nozzle from a height of the root pass level of the J-groove weld to the bottom of the missed examination area. No indications were found in this higher weld residual stress region. Further, no indications were found in any penetration nozzle during the spring 2006 inspection.

The licensee states that the low susceptibility of the Braidwood RPV head combined with the following commitment;

> A bare metal visual examination of the RPV head surface, consistent with the Order Section IV.C.(5)(a), at the number 74 reactor head penetration location, including a 1-inch annulus 360 degrees around the penetration, will be preformed every refueling outage until the next required volumetric examination is performed. At that time, the inner surface of penetration 74 will be reconditioned and a complete volumetric examination will be performed of the penetration.

assures that the small unexamined volume (less than 6 percent) of the penetration presents no challenge to the integrity of the nozzle housing nor to the reactor coolant pressure boundary.

3.0 STAFF EVALUATION

The NRC staff's review of this request was based on criterion (2) of Section IV.F of the Order, which states:

> Compliance with this Order for specific nozzles would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

3.0.1 Inspection Coverage Below the J-groove Weld

Full inspection coverage is not achievable at Braidwood, for all RPV upper head penetration nozzles, because of nozzle end geometry. Specifically, the bottom end of these nozzles are externally threaded, or internally tapered, or both. Thus, the geometry of the nozzle ends makes inspection in accordance with the Order difficult and would involve hardship, including increased personnel radiation dose due to possible surface examination options.

The alternative inspection proposed by the licensee for 10 RPV upper head penetration nozzles is to volumetrically examine each nozzle from two inches above the weld down to the maximum extent practical with a minimum required inspection distance below the J-groove weld as shown in Table 1. Previous Order inspections at both Braidwood, including bare metal visual inspection above the RPV head and non-visual NDE below the RPV upper head, indicate no evidence of head material wastage, leaking penetrations or reportable indications in the penetration nozzles. The NRC staff reviewed evaluations and analyses performed by the licensee in support of this request, as described below.

Stress profiles, based on the finite element analysis provided of RPV upper head penetration nozzles at Braidwood show that most residual stresses decrease significantly at short distances, less than one half inch, below the J-groove weld. Since the stress level at the unexamined area is low, initiation of a crack is very unlikely. Operating experience also indicates that locations with this low stress level have been much less susceptible to cracking. In addition, if examination of the high stress locations of these nozzles (i.e., nozzle locations adjacent to the J-groove weld and associated heat affected zone areas) finds no cracks, then cracking at the low stress locations is unlikely.

The licensee's analysis used the methodology described in footnote 1 of the Order and conservative criteria to set the necessary height of the examination. The analysis postulated a through-wall crack in the unexamined area and showed that it would take the crack more than 6.8 EFPY to reach the J-groove weld. The NRC staff's assessment of the licensee's conclusion is based on data analysis of the supporting figures of the crack growth predictions for various nozzle angles. NRC staff performed an independent crack growth calculation, the results of which support the licensee's analysis. Therefore, NRC staff concurs with the licensee's conclusion, that a crack located beyond a minimum distance below the J-groove weld as provided in Table 1 would take more than 6.8 EFPY to reach the J-groove weld.

As Braidwood is in the low susceptibility category, nonvisual NDE will be performed every four refueling outages or 7 calender years whichever is less. The NRC staff finds that the licensee's estimate of a maximum of 6.0 EFPY of operation in-between Order required examination periods is conservative. Therefore, an inspection frequency based on the licensee's crack growth assessment above provides a reasonable basis for the proposed alternative inspection.

However, the licensee's analysis incorporates a crack growth formula as provided in MRP-55. The NRC staff has completed a preliminary review of the crack growth formula, but has not yet made a final assessment regarding the acceptability of the report. Therefore, a commitment has been included regarding the approval of the proposed relaxations. The commitment was agreed to by the licensee in their August 28, 2006, letter to the NRC, and is as follows:

> If the NRC staff finds that the crack-growth formula in industry report MRP-55 is unacceptable, then the licensee will revise its analysis that justifies relaxation of

the 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 for Braidwood Station Unit 1 to the end of the current operating cycle, this relaxation request will be rescinded and the licensee will, 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 will, 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 will, 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 safety issues that are addressed by the First Revised NRC Order EA-03-009 are degradation (corrosion) of the low-alloy steel RPV upper head, reactor coolant pressure boundary integrity and ejection of the RPV upper head penetration nozzle due to circumferential cracking of the nozzle above the J-groove weld. The licensee's proposed alternative inspection, to perform the ultrasonic examination below the J-groove weld for 10 penetration nozzles to the maximum extent practical with a minimum inspection distance below the J-groove weld as defined by Table 1 and the associated commitment, provides reasonable assurance that these safety issues are addressed at Braidwood.

The licensee has noted that surface examination could be performed to increase the inspection coverage for each nozzle, however, these additional inspections would require extensive work in very high radiation fields. The NRC staff agrees that performing these additional surface examinations would result in hardship through significant radiation exposure without a compensating increase in the level or quality or safety.

Based upon the information above, the NRC staff finds that the licensee's proposed alternative examination reasonably assures the structural integrity of the RPV upper head, associated penetration nozzles and J-groove welds. Further inspections to comply with the terms of the Order would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety. Therefore, the licensee has demonstrated good cause for relaxation from the requirements of the Order.

3.0.2 Inspection Coverage Above the J-groove Weld

The licensee was unable to perform a full volumetric inspection of vessel head penetration number 74 due to a physical impediment, in this case a surface anomaly. The area of missed volumetric inspection coverage was located at the upper bounds of the 2-inch inspection zone above the J-groove weld, which is a lower stress region, but in the reactor coolant pressure boundary region of the nozzle. The area of missed coverage measured an estimated 0.25-inch in circumferential extent and 0.6-inch in axial height, which is less than 6 percent of the total inspection requirement for the penetration nozzle.

In lieu of performing the complete volumetric inspection of this nozzle penetration to the requirements of the Order, the licensee will perform a bare metal visual examination of vessel

head penetration number 74 including 1-inch around the penetration, each outage until the next scheduled volumetric examination in spring of 2012. At that time, the licensee will recondition the surface to allow a full volumetric examination of the penetration nozzle, if necessary.

The licensee notes that accelerating the schedule for the reconditioning of VHP number 74 and performing a 100 percent volumetric examination would result in an unnecessary hardship without a compensating increase in quality or safety. To meet the requirements of the Order, during the Fall 2007 outage, a special volumetric inspection would need to be set up for only one vessel head penetration nozzle. The NRC staff finds the radiological dose necessary to setup, perform and closeout this activity is a significant hardship for only capturing less than 6 percent of the ultrasonic inspection area. Further, no indications were found in this or any other penetration nozzle during the spring 2006 inspection.

Given the licensee's following commitment for Braidwood:

> "A bare metal visual examination of the RPV head surface, consistent with the Order Section IV.C.(5)(a), at the number 74 reactor head penetration location, including a 1-inch annulus 360 degrees around the penetration, will be preformed every refueling outage until the next required volumetric examination is performed. At that time, the inner surface of penetration 74 will be reconditioned and a complete volumetric examination will be performed of the penetration."

the NRC staff finds that the licensee's proposed alternative examination reasonably assures the structural integrity of vessel head penetration nozzle number 74, and further, inspections to comply with the Order requirements would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety. Therefore, the licensee has demonstrated good cause for relaxation from the requirements of the Order.

4.0 CONCLUSION

The NRC staff concludes that the licensee's proposed alternative inspection, to perform the ultrasonic testing of 10 penetration nozzles at Braidwood, to the maximum extent practical below the J-groove weld, with a minimum inspection distance as defined in Table 1 and relax the 100 percent inspection requirement for penetration nozzle number 74 until the next volumetric examination, scheduled for the spring of 2012, reasonably assures the structural integrity of the RPV upper head, associated penetration nozzles and J-groove welds. Further inspections of these penetration nozzles in accordance with Section IV.C.(5)(b), of the Order, would result in hardship without a compensating increase in the level of quality and safety. Therefore, the licensee has demonstrated good cause for relaxation, and pursuant to Section IV.F of the Order, the NRC staff authorizes the proposed alternative inspection as stated above at Braidwood, until the Order is replaced or rescinded, subject to the following commitments:

1) If the NRC finds that the crack-growth formula in industry report MRP-55 is unacceptable, then the licensee will revise its analysis that justifies relaxation of the Order within 30 days after the NRC informs the licensee of an NRC-approved crack-growth formula. If the licensee's revised analysis for Braidwood Station Unit 1 shows that the crack-growth acceptance criteria are exceeded prior to the end of the current operating

cycle, this relaxation request will be rescinded and the licensee will, 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 will, 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 will, 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.

2) A bare metal visual examination of the RPV head surface, consistent with the Order Section IV.C.(5)(a), at the number 74 reactor head penetration location, including a 1-inch annulus 360 degrees around the penetration, will be preformed every refueling outage until the next required volumetric examination is performed. At that time, the inner surface of penetration 74 will be reconditioned and a complete volumetric examination will be performed of the penetration.

Principal Contributor: J. Collins, NRR

Date: September 26, 2007