September 27, 2006

Mr. Gene F. St. Pierre, Site Vice President
c/o James M. Peschel
Seabrook Station
FPL Energy Seabrook, LLC
PO Box 300
Seabrook, NH 03874

SUBJECT: SEABROOK STATION, UNIT NO. 1 - RELAXATION OF THE FIRST REVISED ORDER EA-03-009 (TAC NO. MD2112)

Dear Mr. St. Pierre:

By letter to the Nuclear Regulator Commission (NRC) dated March 30, 2006, FPL Energy Seabrook, LLC (FPLE) requested relaxation from certain inspection requirements of First Revised Order EA-03-009 (the Order), dated February 20, 2004. FPLE requested relaxation from the Order for the inspection of certain reactor pressure vessel (RPV) penetration nozzles that are limited by inaccessible areas for Seabrook Station, Unit No. 1 (Seabrook).

The NRC staff has reviewed the information provided by FPLE in support of this request and concludes that FPLE's proposed alternative examination of the RPV penetration nozzles provides reasonable assurance of the structural integrity of the RPV. Further 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, FPLE has demonstrated good cause for relaxation, and pursuant to Section IV.F. of the Order, the NRC staff authorizes the proposed alternative inspection for the RPV at Seabrook 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 G. Edward Miller at (301) 415-2481.

Sincerely,

/RA/

Cornelius F. Holden, Deputy Director
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-443

Enclosure:
Safety Evaluation

cc w/encl: See next page

September 27, 2006

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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

SEABROOK STATION, UNIT NO. 1

FPL ENERGY SEABROOK, LLC

DOCKET NO. 50-443

1.0 INTRODUCTION

The First Revised Order EA-03-009 (the Order), issued by the Nuclear Regulatory Commission (NRC) on February 20, 2004, requires specific examinations of the reactor pressure vessel (RPV) head and vessel head penetration (VHP) nozzles of all pressurized-water reactor plants. Section IV.F of the Order states that requests for relaxation 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 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 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 this Order for specific nozzles would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

For Seabrook Station, Unit No. 1 (Seabrook), 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 NDE nonvisual [nondestructive examination] 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 [see Figure IV-1]); 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 (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 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 [see Figure IV-3]); 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 (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 March 30, 2006, FPL Energy Seabrook, LLC (FPLE) requested relaxation to implement an alternative to the requirements of Section IV.C.(5)(b) of the Order for RPV head penetration nozzles at Seabrook.

2.0 First Revised Order EA-03-009 Relaxation Request for Examination Coverage for RPV Head Penetration Nozzles

2.1 First Revised Order Requirement for Which Relaxation is Requested

Section IV.C of the Order, requires, in part, that inspections of Section IV.C.(5)(b) of the Order be performed by February 11, 2008, for low susceptibility plants similar to Seabrook.

FPLE has requested relaxation from Section IV.C.(5)(b) of the Order. The specific relaxation requested is identified below.

2.2 Licensee's Proposed Alternative

FPLE requested relaxation from the Order as it pertains to the minimum inspection coverage requirement below the J-groove weld for five RPV head control rod drive (CRD) mechanism penetrations (74, 75, 76, 77, and 78) at Seabrook. FPLE's proposed alternative consists of ultrasonic testing (UT) of the five referenced penetration nozzles from 2 inches above the highest point at the root of the J-groove weld (on a horizontal plane perpendicular to the nozzle axis) to the maximum extent practical but not less than 0.30 inches below the lowest point at the toe of the J-groove weld, 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. FPLE requested that this relaxation be granted for the inspection to commence at the end of cycle 11 refueling outage and all future inspections where UT techniques are used to inspect the five affected RPV head penetration nozzles in response to the requirements of the Order, or until inspection technology is developed to a state where the examination volume can be extended to full compliance with the Order, or information is received from the NRC regarding non-acceptance of the crack growth formula in MRP-55 which FPLE used for the structural integrity evaluation of the referenced nozzle penetrations.

FPLE also stated that if the NRC staff finds that the crack-growth formula in MRP-55 is unacceptable, it will revise its analysis that justifies the relaxation of the Order within 30 days from the date that the NRC informs it of an NRC-approved crack-growth rate formula. Further, FPLE stated that if the revised analysis 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 it will, within 72 hours, submit to the NRC a written justification for continued operation. If the revised analysis shows that the crack-growth acceptance criteria are to be exceeded during the subsequent operating cycle, FPLE 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, FPLE will, within 30 days, submit a letter to the NRC confirming that its analysis has been revised.

2.3 Licensee's Basis for the Proposed Alternative

FPLE stated that it is its intent to perform the UT to the maximum extent possible for all RPV head nozzle penetrations. However, due to the design limitations for nozzle penetrations 74 through 78, the licensee will perform UT two inches above the J-groove weld down to the lowest elevation with the open housing probe, but not less than 0.30 inches below the toe of the weld

on the downhill side of the affected penetrations. FPLE anticipates fully complying with the Order requirements for UT of remaining penetrations 1 through 73, because each of these penetrations is essentially a smooth cylinder in shape with a 0.203 radius at the outer diameter (OD) and inner diameter (ID) and poses no known impediments for compliance with the Order. If the Order-required examination coverage cannot be achieved for penetrations 1 through 73, FPLE will submit a separate relaxation request for those penetrations.

The design of RPV head penetration nozzles 74 through 78 includes an external threaded section, approximately 1.19 inches in length, and an internal taper at the bottom of the nozzles. These penetrations are located at the 48.7-degree location. The loss of UT probe coupling due to the internal taper and the disruption of the UT signal due to the external threads will prevent UT data acquisition from the ID and the threads on the OD.

FPLE stated 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. FPLE believes the proposed inspection coverage does not preclude full UT coverage of the portions of these affected nozzles that are of primary interest.

To support its relaxation request, FPLE included a structural integrity evaluation which was performed for Seabrook RPV head penetrations. A series of crack growth calculations was performed presuming a flaw where the lower extremity of this initial through-wall flaw is conservatively postulated to be located on the nozzle penetration where either the inside or outside surface hoop stress drops below 0 ksi. 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 MRP-55 Revision 1, were provided in WCAP-16550-P, ”Structural Integrity Evaluation of Reactor Vessel Upper Head Penetrations to Support Continued Operation: Seabrook Station,” Westinghouse Electric Co. LLC, Revision 0, April 2006. The calculation demonstrated that, for RVP head nozzle penetrations 74 through 78, an axial through-wall flaw that has its upper extremity located at 0.15 inches below the J-groove weld would take over 6 effective full power years (EFPYs) of operation to reach the toe of the J-groove weld which is part of the RCS pressure boundary.

Seabrook is in the low susceptibility category, therefore, nonvisual NDE will be performed once every four refueling outages or within seven calendar years, whichever occurs sooner.
The results of the 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 results further demonstrate that the extent of the proposed inspection coverage would provide reasonable assurance of the structural integrity of the five affected RPV head nozzle penetrations and the associated J-groove welds at Seabrook.

FPLE also stated that dye penetrant testing of threaded surfaces is possible; however, it is not practical because of excessive bleed out from the threads. In addition, the radiation levels under the reactor vessel head are estimated to be 7000 mR/hour to 9000 mR/hour at the bottom of nozzles, resulting in an exposure of approximately 1750 to 2250 mR per nozzle.

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.

Full inspection coverage is not achievable for five RPV head penetration, nozzles, 74 through 78, (located at 48.7 degrees) at Seabrook. Specifically, the bottom ends of these nozzles are externally threaded and internally tapered. Thus, the geometry of the nozzle ends makes inspection in accordance with the Order difficult, and would involve a hardship, specifically, increased personnel radiation dose for the implementation of the surface examination options. This evaluation focuses on the issue of whether there is a compensating increase in the level of quality and safety such that these nozzles should be inspected in accordance with the Order despite this hardship.

The alternative inspection proposed by FPLE for the five affected RPV nozzles is to perform UT from 2 inches above the highest point of the root of the J-groove weld to the maximum extent practical, but not less than 0.30 inches below the lowest point at the toe of the J-groove weld. The NRC staff reviewed evaluations and analyses performed by the licensee in support of this request, as described below.

The stress profiles applicable to RPV head penetration nozzles at Seabrook are based on a three-dimensional elastic-plastic finite element analysis provided in WCAP-16550-P. The stress profiles show that most hoop stresses decrease significantly at short distances below the J-groove weld. For RPV head penetration nozzles 74 through 78, the hoop stresses at the downhill side drop down to below 20 ksi at a distance of 0.30 inches below the bottom of the J-groove weld. The stress analyses considered the pressure loads associated with steady state operation, as well as the residual stresses that are produced by the fabrication process. Since the hoop stress level at the unexamined area is low (below 20 ksi), initiation of PWSCC is considered to be 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.

FPLE's analysis used the methodology described in footnote 1 of the Order and conservative criteria to set the height of the alternative examination. The analysis postulated a through-wall crack in the unexamined area which is 0.15 inches below the toe of the J-groove weld and showed that it would take the postulated crack more than six EFPYs to reach the J-groove weld. The NRC staff's assessment of the licensee's conclusion is based in part on the verification of the supporting figures pertaining to the crack growth predictions for the affected nozzles which are provided in WCAP-16550-P. The NRC staff concurs with the licensee's conclusion that a crack located beyond a minimum distance of 0.30 inches below the J-groove weld at the five affected RPV head penetration nozzles would take more than six EFPYs to reach the J-groove weld.

As Seabrook is in the low susceptibility category, nonvisual NDE will be performed every four refueling outages or seven calender years, whichever occurs sooner. The NRC staff notes that Seabrook is operating on an 18-month cycle. Therefore, an inspection frequency based on the licensee's crack growth assessment above provides a reasonable basis for the proposed alternative inspection, to perform the UT below the J-groove weld to the maximum extent practical, but not less than 0.30 inches below the J-groove weld.

The safety issues that are addressed by the Order are degradation (corrosion) of the low-alloy steel RPV head, reactor coolant pressure boundary integrity and ejection of the VHP nozzle due to circumferential cracking of the nozzle above the J-groove weld. FPLE's proposed alternative inspection, to perform the UT from 2 inches above the highest point at the root of the J-groove weld to the maximum extent practical, but not less than 0.30 inches below the J-groove weld, provides reasonable assurance that these safety issues are addressed.

The NRC staff notes that surface inspection through dye penetrant examination could be performed to increase the inspection coverage for the five (5) affected nozzles, however, these additional inspections would require extensive work in very high radiation fields. Furthermore, the inspection results may not be meaningful due to the potential of excessive bleeding from the threads. Thus, the NRC staff finds that performing these additional surface examinations would result in hardship through significant radiation exposure without a compensating increase in the level of quality and safety.

Based upon the evaluation above, the NRC staff finds that the licensee's proposed alternative examination of the five affected nozzles is acceptable, as it provides reasonable assurance of the structural integrity of the RPV head, VHP nozzles and associated J-groove welds. 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, FPLE has demonstrated good cause for relaxation from the requirements of the First Revised NRC Order EA-03-009, dated February 20, 2004.

4.0 CONCLUSION

The NRC staff concludes that FPLE's proposed alternative inspection of five Seabrook RPV head penetration nozzles (74 through 78), including the performance of the UT from 2 inches above the highest point of the root of the J-groove weld to the maximum extent practical, but not less than 0.30 inches below the lowest point at the toe of the J-groove weld, provides reasonable assurance of the structural integrity of the RPV head, VHP nozzles and associated J-groove welds. Further inspections of these five RPV head penetration nozzles in accordance with Section IV.C.(5)(b) of the Order, would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety. Given that FPLE has demonstrated good cause for relaxation, and pursuant to Section IV.F of the Order, the NRC staff authorizes the proposed alternative inspection of the five affected nozzles at Seabrook as stated above.

Principal Contributor: W. Koo

Date: September 27, 2006