

August 30, 2006

Mr. D. E. Grissette
Vice President
Southern Nuclear Operating
Company, Inc.
Post Office Box 1295
Birmingham, AL 35201-1295

SUBJECT: VOGTLE ELECTRIC GENERATING PLANT, UNITS 1 AND 2 - RELAXATION
OF REQUIREMENTS ASSOCIATED WITH *FIRST REVISED ORDER
MODIFYING LICENSES EA-03-009*, DATED FEBRUARY 20, 2004,
RELAXATION REQUEST, INSPECTION COVERAGE REQUIREMENTS (TAC
NOS. MD1805 AND MD1806)

Dear Mr. Grissette:

By letter dated May 18, 2006, and supplemented by letter dated June 2, 2006, Southern Nuclear Operating Company, Inc. (SNC), requested relaxation from certain inspection requirements of the *First Revised Order Modifying Licenses EA-03-009* (Order), dated February 20, 2004.

SNC requested relaxation from the Order for the inspection of certain reactor pressure vessel head (RPVH) penetration nozzles that are limited by inaccessible areas for Vogtle Electric Generating Plant, Units 1 and 2 (Vogtle).

The Nuclear Regulatory Commission (NRC) staff has reviewed and evaluated the information provided by SNC in support of this request and concludes that SNC's proposed alternative examination of the RPVH provides reasonable assurance of the structural integrity of the RPVH. Further inspection of the RPVH 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 Order EA-03-009, the NRC staff authorizes the proposed alternative inspection of the RPVH at Vogtle until the Order is replaced or rescinded.

The NRC staff's review is provided in the enclosed Safety Evaluation. If you have any questions, please contact Christopher Gratton at (301) 415-1055.

Sincerely,

/RA/

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

Docket Nos. 50-424 and 50-425

Enclosure:
Safety Evaluation

cc w/encl: See next page

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D. Grissette

Vogtle Electric Generating Plant, Units 1 & 2

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

FIRST REVISED ORDER MODIFYING LICENSES EA-03-009

RELAXATION REQUEST, ALTERNATE EXAMINATION COVERAGE

FOR REACTOR PRESSURE VESSEL HEAD

VOGTLE ELECTRIC GENERATING PLANT, UNITS 1 AND 2

SOUTHERN NUCLEAR OPERATING COMPANY, INC.

DOCKET NOS. 50-424 AND 50-425

1.0 INTRODUCTION

The *First Revised Order Modifying Licenses EA-03-009* (Order), issued by the Nuclear Regulatory Commission (NRC) 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 (VHP) nozzles of all pressurized water reactor (PWR) plants. Section IV.F. of the Order states that requests for relaxation of the Order 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 (ASME), *Boiler and Pressure Vessel Code* (Code) in accordance with Title 10 of the *Code of Federal Regulations* (10 CFR), Part 50, 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 Vogtle Electric Generating Plant, Units 1 and 2 (Vogtle), 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, an inspection meeting the requirements of Section IV.C.(5)(b) of the Order is required to be performed by February 11, 2008, as described below:

- (b) For each penetration, perform a nonvisual NDE [nondestructive examination] in accordance with either (i), (ii), or (iii):
 - (i) Ultrasonic testing [UT] 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

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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 [thousand pounds per square inch] 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 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 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 May 18, 2006 (ML061390036), and supplemented by letter dated June 2, 2006 (ML061580121), Southern Nuclear Operations Company, Inc. (SNC or 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 Vogtle.

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

2.1 Order Requirements 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 Vogtle.

The licensee 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

The licensee seeks relaxation from the Order to revise the minimum inspection coverage requirement below the J-groove weld for Vogtle, to the maximum extent possible with a minimum inspection distance below the J-groove weld as defined by Table 1. The licensee also requests this relaxation be granted until the Order is replaced or rescinded.

Table 1: Minimum Required Volumetric/Surface Inspection Coverage Below the Toe of the J-groove Weld		
Nozzle Number	Requested Minimum Required Coverage Below J-groove Weld with > 6 EFPY* by Crack Growth Evaluation (inches)	Time to Reach the Minimum Required Coverage Below the Toe of the J-groove Weld (EFPY)
1-21	0.55	7.1
22-61	0.50	7.4
62-73	0.35	8.8
74-78	0.25	9.2

*Effective Full Power Years

2.3 Licensee's Basis for Proposed Alternative

It is the licensee's intent to perform ultrasonic testing (UT) to the maximum extent possible. The licensee will utilize inspection option (b)(l) and will achieve UT coverage 2 inches above the J-groove weld down to the lowest elevation that can be practically inspected on each nozzle with the UT probe being used with a minimum required inspection distance as stated in Table 1 below the J-groove weld.

The licensee 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.

A structural integrity evaluation has been performed for Vogtle RPV head penetrations. 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 demonstrated that more than 7.1 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. Vogtle is in the low susceptibility category, therefore, nonvisual NDE will be performed once every four refueling outages or within 7 calendar years whichever is less.

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, "Material Reliability Program (MRP) Crack Growth Rates for Evaluating Primary Water Stress Corrosion Cracking (PWSCC) of Thick-Walled Alloy 600 Materials," Revision 1, dated November 2002, were provided in WCAP-16493-P, Revision 0, "Structural Integrity Evaluation of reactor Vessel Upper Head Penetrations to Support Continued Operation: Vogtle Units 1 and 2," dated November 2005.

The calculation demonstrates that the minimum time for a flaw to propagate up the nozzle from the distances below the J-groove weld list in Table 1 for various nozzles to the bottom of the J-groove weld would be at least 7 EFPY. 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 demonstrate that the extent of the proposed inspection coverage would provide reasonable assurance of the structural integrity of Vogtle RPV head-penetration nozzles and the J-groove welds.

In summation of the results which led to the conclusions above, the licensee provided a table in their letter dated May 18, 2006. This table provided information from WCAP-16493-P in support of the licensee's proposal including various crack-growth predictions for Vogtle RPV head-penetration nozzles. As the crack growth rate formula used in the structural integrity evaluation for Vogtle is the same as the PWSCC crack growth rate recommended in MRP-55, Revision 1, the licensee states the following from the May 18, 2006, letter:

SNC recognizes that the NRC staff has not yet made a final determination on the acceptability of MRP-55. Should the staff determine the crack growth formula used by SNC is unacceptable, SNC will revise the analysis that justifies relaxation of [the] NRC First Revised Order EA-03-009 within 30 days after the NRC advises SNC of an NRC-approved crack growth formula. If the revised analysis shows that the crack growth acceptance criteria are exceeded prior to the end of the then current operating cycle, this relaxation request will be considered rescinded and written justification for continued operation shall be submitted to the NRC within 72 hours. If the revised analysis shows that the crack growth acceptance criteria are exceeded during the subsequent operating cycle, SNC will submit the revised analysis for NRC review within 30 days. If the

revised analysis shows that the crack growth acceptance criteria are not exceeded during either the current operating cycle or the next operating cycle, SNC shall confirm that the analysis was performed in a letter to the NRC within 30 days. Any crack growth analyses performed for RPVH inspections after the NRC advises SNC of an NRC-approved crack growth formula shall use that formula.

The licensee requests approval of the proposed alternative through the period in which the Order is in effect, provided that conditions do not change that would otherwise invalidate this relaxation request.

3.0 TECHNICAL 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 at Vogtle for all VHP 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 a hardship including increased personnel radiation dose due to possible 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 the licensee for the VHP nozzles is to volumetrically examine each nozzle from 2 inches above the weld down to the maximum extent possible with a minimum required inspection distance below the J-groove weld as shown in Table 1. SNC's previous bare metal visual inspection results above the RPV head for Vogtle indicate no evidence of head material wastage or of leaking VHP 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 in WCAP-16493-P of VHPs at Vogtle 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 seven (7) EFPY to reach the J-groove weld. The staff's assessment of the licensee's

conclusion is based on analysis of the supporting figures of the crack growth predictions for various nozzle angles, as provided in WCAP-16493-P. NRC staff performed an independent crack-growth calculation, the results of which support the licensee's analysis. Therefore, the 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 seven (7) EFPY to reach the J-groove weld.

As Vogtle is in the low susceptibility category, nonvisual NDE will be performed every four refueling outages or 7 calendar years, whichever is less. 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 examination below the J-groove weld to the maximum extent possible with a minimum inspection distance below the J-groove weld as defined in Table 1.

However, this analysis incorporates a crack-growth formula as provided in the Electric Power Research Institute's Report, "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 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 condition has been included regarding the approval of the proposed relaxations. The condition was agreed to by the licensee in their May 18, 2006, letter to the NRC, as stated,

SNC recognizes that the NRC staff has not yet made a final determination on the acceptability of MRP-55. Should the staff determine the crack growth formula used by SNC is unacceptable, SNC will revise the analysis that justifies relaxation of [the] NRC First Revised Order EA-03-009 within 30 days after the NRC advises SNC of an NRC-approved crack growth formula. If the revised analysis shows that the crack growth acceptance criteria are exceeded prior to the end of the then current operating cycle, this relaxation request will be considered rescinded and written justification for continued operation shall be submitted to the NRC within 72 hours. If the revised analysis shows that the crack growth acceptance criteria are exceeded during the subsequent operating cycle, SNC will submit the revised analysis for NRC review within 30 days. If the revised analysis shows that the crack growth acceptance criteria are not exceeded during either the current operating cycle or the next operating cycle, SNC shall confirm that the analysis was performed in a letter to the NRC within 30 days. Any crack growth analyses performed for RPVH inspections after the NRC advises SNC of an NRC-approved crack growth formula shall use that formula.

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. The licensee's proposed alternative inspection, to perform the UT examination below the J-groove weld to the maximum extent possible with a minimum inspection distance below the J-groove weld as defined by Table 1 and as conditioned, provides reasonable assurance that these safety issues are addressed.

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 staff finds 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 staff finds that the licensee's proposed alternative examination is acceptable as it provides reasonable assurance of the structural integrity of the RPV head, VHP nozzles and 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, 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 of Vogtle VHP nozzles, to perform the UT examination below the J-groove weld to the maximum extent possible with a minimum inspection distance below the J-groove weld as defined in Table 1 and as conditioned, provides reasonable assurance of the structural integrity of the RPV head, VHP nozzles and welds. Further inspections of these VHP 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 staff authorizes the proposed alternative inspection as stated above at Vogtle until the Order is replaced or rescinded, subject to the following condition:

SNC recognizes that the NRC staff has not yet made a final determination on the acceptability of MRP-55. Should the staff determine the crack growth formula used by SNC is unacceptable, SNC will revise the analysis that justifies relaxation of [the] NRC First Revised Order EA-03-009 within 30 days after the NRC advises SNC of an NRC-approved crack growth formula. If the revised analysis shows that the crack growth acceptance criteria are exceeded prior to the end of the then current operating cycle, this relaxation request will be considered rescinded and written justification for continued operation shall be submitted to the NRC within 72 hours. If the revised analysis shows that the crack growth acceptance criteria are exceeded during the subsequent operating cycle, SNC will submit the revised analysis for NRC review within 30 days. If the revised analysis shows that the crack growth acceptance criteria are not exceeded during either the current operating cycle or the next operating cycle, SNC shall confirm that the analysis was performed in a letter to the NRC within 30 days. Any crack growth analyses performed for RPVH inspections after the NRC advises SNC of an NRC-approved crack growth formula shall use that formula.

Principal Contributor: JCollins, NRR

Date: August 30, 2006