UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

August 11, 2010

Mr. Thomas Joyce
President and Chief Nuclear Officer
PSEG Nuclear
P.O. Box 236, N09
Hancocks Bridge, NJ 08038

SUBJECT: SAFETY EVALUATION OF RELIEF REQUEST FOR THE THIRD 10-YEAR INTERVAL OF THE INSERVICE INSPECTION PROGRAM FOR HOPE CREEK GENERATING STATION (TAC NO. ME2256)

Dear Mr. Joyce:

By letter dated September 18, 2009, PSEG Nuclear LLC (PSEG or the licensee) submitted relief request HC-RR-I3R-06 which proposed an alternative to certain requirements specified in Section XI of the American Society of Mechanical Engineers (ASME) *Boiler and Pressure Vessel Code* (Code) for the inservice inspection (ISI) of certain reactor pressure vessel (RPV) nozzle-to-vessel welds and nozzle inner radii at Hope Creek Generating Station (HCGS). Specifically, PSEG proposed an alternative in accordance with ASME Code Case N-702, "Alternative Requirements for Boiling Water Reactor (BWR) Nozzle Inner Radius and Nozzle-to-Shell Welds," without using the visual (VT-1) examination specified in the Code Case. The subject relief request is for the third 10-year interval of the ISI program at HCGS which began on December 13, 2007, and will end on December 12, 2017.

The U.S. Nuclear Regulatory Commission staff has completed its review of the subject relief request as documented in the enclosed Safety Evaluation (SE). Our SE concludes that the proposed alternative provides an acceptable level of quality and safety. Therefore, the proposed alternative is authorized pursuant to Section 50.55a(a)(3)(i) of Title 10 of the *Code of Federal Regulations* (10 CFR). The use of the modified ASME Code Case N-702 is authorized for the remainder of the third 10-year ISI interval.

All other requirements of the ASME Code, Section XI for which relief has not been specifically requested remain applicable, including a third party review by the Authorized Nuclear Inservice Inspector.

If you have any questions concerning this matter, please contact the HCGS Project Manager, Mr. Richard Ennis, at (301) 415-1420.

Sincerely,

Harold K. Chernoff, Chief
Plant Licensing Branch I-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-354

Enclosure:
Safety Evaluation

cc w/encl: Distribution via Listserv

UNITED STATES
NUCLEAR REGULATORY COMMISSION
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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO RELIEF REQUEST FOR THE

THIRD 10-YEAR INTERVAL OF THE INSERVICE INSPECTION PROGRAM

PSEG NUCLEAR LLC

HOPE CREEK GENERATING STATION

DOCKET NO. 50-354

## 1.0 INTRODUCTION

By letter dated September 18, 2009 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML092720863), PSEG Nuclear LLC (PSEG), the licensee for Hope Creek Generating Station (HCGS), submitted Relief Request HC-RR-I3R-06 to use an alternative to American Society of Mechanical Engineers (ASME) *Boiler and Pressure Vessel Code* (Code), Section XI inspection requirements regarding examination of certain reactor pressure vessel (RPV) nozzle-to-vessel welds and nozzle inner radii at HCGS. The proposed alternative is in accordance with ASME Code Case N-702, "Alternative Requirements for Boiling Water Reactor (BWR) Nozzle Inner Radius and Nozzle-to-Shell Welds," without using the visual (VT-1) examination specified in the Code Case. The technical basis for ASME Code Case N-702 was documented in an Electric Power Research Institute (EPRI) report for the Boiling Water Reactor Vessel and Internals Project (BWRVIP), "BWRVIP-108: BWR Vessel and Internals Project, Technical Basis for the Reduction of Inspection Requirements for the Boiling Water Reactor Nozzle-to-Vessel Shell Welds and Nozzle Inner Radii." The BWRVIP-108 report was approved by the Nuclear Regulatory Commission (NRC or the Commission) in a safety evaluation (SE) dated December 19, 2007 (ADAMS Accession No. ML073600374).

The December 19, 2007, SE for the BWRVIP-108 report specified plant-specific requirements which must be met for applicants proposing to use this alternative. PSEG's letter dated September 18, 2009, provided information intended to demonstrate that the relevant HCGS RPV nozzle-to-vessel welds and their inner radii meet these plant-specific requirements. The NRC staff evaluation of the proposed alternative is provided below.

## 2.0 REGULATORY EVALUATION

The inservice inspection (ISI) of ASME Code Class 1, 2, and 3 components is to be performed in accordance with Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components," of the ASME Code and applicable edition and addenda as required by Title 10 of the *Code of Federal Regulations* (10 CFR) Section 50.55a(g), except where specific relief has

been granted by the Commission pursuant to 10 CFR 50.55a(g)(6)(i). Pursuant to 10 CFR 50.55a(a)(3), alternatives to the requirements of paragraph (g) may be used, when authorized by the NRC, if the licensee demonstrates that: (i) the proposed alternatives would provide an acceptable level of quality and safety, or (ii) compliance with the specified requirements would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

Pursuant to 10 CFR 50.55a(g)(4), ASME Code Class 1, 2, and 3 components (including supports) must meet the requirements, except the design and access provisions and the preservice examination requirements, set forth in the ASME Code, Section XI, to the extent practical within the limitations of design, geometry, and materials of construction of the components. The regulation requires that inservice examination of components and system pressure tests conducted during the first 10-year interval, and subsequent intervals, comply with the requirements in the latest edition and addenda of Section XI of the ASME Code incorporated by reference in 10 CFR 50.55a(b) 12 months prior to the start of the 120-month interval, subject to the limitations and modifications listed therein.

The subject relief request is for the third 10-year interval of the ISI program at HCGS which began on December 13, 2007, and will end on December 12, 2017. The applicable ISI Code of Record for the third 10-year ISI interval for HCGS is the 2001 Edition, 2003 Addenda of ASME Code, Section XI.

For all RPV nozzle-to-vessel shell welds and nozzle inner radii, ASME Code, Section XI requires 100 percent inspection during each 10-year ISI interval. However, ASME Code Case N-702 proposes an alternative which reduces the inspection of RPV nozzle-to-vessel shell welds and nozzle inner radius areas from 100 percent to 25 percent of the nozzles for each nozzle type during each 10-year interval. As discussed above, the NRC approved the BWRVIP-108 report, which contains the technical basis supporting ASME Code Case N-702, in an SE dated December 19, 2007. Section 5.0, "Plant-Specific Applicability," of the SE states that:

> Licensees who plan to request relief from the ASME Code, Section XI requirements for RPV nozzle-to-vessel shell welds and nozzle inner radius sections may reference the BWRVIP-108 report as the technical basis for the use of ASME Code Case N-702 as an alternative. However, each licensee should demonstrate the plant-specific applicability of the BWRVIP-108 report to their units in the relief request by showing that all the following general and nozzle-specific criteria are satisfied:
>
> (1) the maximum RPV heatup/cooldown rate is limited to less than 115 °F/hour;
>
> <u>For recirculation inlet nozzles</u>
>
> (2) $(pr/t)/C_{RPV} < 1.15$
>
> p = RPV normal operating pressure,
> r = RPV inner radius,
> t = RPV wall thickness, and

$C_{RPV}$ = 19332 (i.e., 1000 psi x 110 inch/5.69 inch, based on the BWRVIP-108 recirculation inlet nozzle/RPV [finite element method (FEM)] model);

(3) $[p(r_o^2 + r_i^2)/(r_o^2 - r_i^2)]/C_{NOZZLE} < 1.15$

p = RPV normal operating pressure,
$r_o$ = nozzle outer radius,
$r_i$ = nozzle inner radius, and
$C_{NOZZLE}$ = 1637 [i.e., 1000 psi x( $13.988^2 + 6.875^2$)/ ($13.988^2 - 6.875^2$)], based on the BWRVIP-108 recirculation inlet nozzle/RPV FEM model];

For recirculation outlet nozzles

(4) $(pr/t)/C_{RPV} < 1.15$

p = RPV normal operating pressure,
r = RPV inner radius,
t = RPV wall thickness, and
$C_{RPV}$ = 16171 (i.e., 1000 psi x 113.2 inch/7.0 inch, based on the BWRVIP-108 recirculation outlet nozzle/RPV FEM model); and

(5) $[p(r_o^2 + r_i^2)/(r_o^2 - r_i^2)]/C_{NOZZLE} < 1.15$

p = RPV normal operating pressure,
$r_o$ = nozzle outer radius,
$r_i$ = nozzle inner radius, and
$C_{NOZZLE}$ = 1977 [i.e., 1000 psi x( $22.31^2 + 12.78^2$)/ ($22.31^2 - 12.78^2$)], based on the BWRVIP-108 recirculation outlet nozzle/RPV FEM model].

It should be noted that only the recirculation inlet and outlet nozzles need to be checked because the P(F|E)s [probabilities of failure] for other nozzles are an order of magnitude lower. Also, only the driving force needs to be checked because the nozzle material fracture toughness-related $RT_{NDT}$ values used in the PFM [probabilistic fracture mechanics] analyses were based on data from the entire fleet of BWR RPVs.

The plant-specific information was required by the NRC staff to ensure that the PFM analysis documented in the BWRVIP-108 report applies to the RPV of the applicant's plant.

## 3.0 TECHNICAL EVALUATION

### 3.1 Licensee Evaluation

#### 3.1.1 ASME Code Requirement for which Alternative is Requested

The licensee's application dated September 18, 2009, proposed an alternative to the following requirements of the ASME Code, Section XI, 2001 Edition, 2003 Addenda:

> [ASME Code] Class 1 nozzle-to-vessel weld and nozzle inner radii examination requirements are given in Subsection IWB, Table IWB-2500-1, "Examination Category B-D, Full Penetration Welded Nozzles in Vessels - Inspection Program B," Item Numbers B3.90, "Nozzle-to-Vessel Welds" and B3.100, "Nozzle Inside Radius Section," respectively. Volumetric examination is required each interval for all nozzles with full penetration welds to the vessel shell (or head) and integrally cast nozzles. All of the nozzle assemblies identified are full penetration welds.

#### 3.1.2 Components for which the Alternative is Requested

The licensee's application dated September 18, 2009, listed the following components applicable to the proposed alternative:

| | |
|---|---|
| ASME Code Class: | 1 |
| Examination Category: | B-D, Full Penetration Welded Nozzles in Vessels |
| Item Number: | B3.90 (Nozzle-to-Vessel Welds) and B3.100 (Nozzle Inner Radius Sections) |
| Description: | See table[1] below |

[Note: The HCGS RPV recirculation outlet nozzles, feedwater nozzles, and control rod drive return nozzles are not included within the scope of this request.]

#### 3.1.3 Licensee's Proposed Alternative to the ASME Code

The licensee's application dated September 18, 2009, proposed the following alternative:

> In accordance with 10CFR50.55a(a)(3)(i), relief is requested from performing the required examinations on 100 percent of the listed nozzle assemblies. As an alternative, in accordance with ASME Code Case N-702, PSEG will perform examinations of 25 percent of the reactor pressure vessel nozzle inner radius

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[1] This refers to the table on page 1 of the licensee's September 18, 2009, proposed alternative, which shows a complete list of applicable nozzles. This table is not included in this SE.

sections and nozzle-to-vessel welds, including at least one nozzle from each system and nominal pipe size. For each of the identified nozzle assemblies, both the inner radius and the nozzle-to-shell weld would be examined. The following nozzle assemblies would be selected for examination: three of the ten 12-inch recirculation inlet nozzle (N2) assemblies; one of the four 26-inch main steam nozzle (N3) assemblies; one of the two 10-inch core spray nozzle (N5) assemblies; one of the three RPV head nozzle (N6 and N7) assemblies; one of the two 4-inch jet pump instrumentation nozzle (N8) assemblies; and one of the four 12-inch LPCI [low pressure coolant injection] nozzle (N17) assemblies.

[ASME] Code Case N-702 states that VT-1 visual examination may be used in lieu of volumetric examination for the inner radii (Item No. B3.100). However, this allowance in ASME Code Case N-702 is not included in the proposed alternative. PSEG currently uses ASME [Code] Case N-648-1, "Alternative Requirements for Inner Radius Examinations of Class 1 Reactor Vessel Nozzles, Section XI, Division 1," within the limitations imposed by the NRC staff in Regulatory Guide (RG) 1.147, Revision 15, "Inservice Inspection Code Case Acceptability, ASME Section XI, Division 1," which allows VT-1 visual examination for nozzle inner radii. During the remainder of the interval, Hope Creek will perform either UT [ultrasonic test] examinations or VT-1 examinations per ASME Code Case N-648-1 as described above.

3.1.4 Licensee's Basis for Alternative

The licensee's application dated September 18, 2009, summarized the basis for the proposed alternative as follows:

All HCGS RPV nozzle-to-vessel shell full penetration welds and nozzle inner radii sections, with the exception of the recirculation outlet nozzles, meet the general and nozzle-specific criteria in BWRVIP-108. Therefore, ASME Code Case N-702 is applicable. See Appendix A for details.

Use of ASME Code Case N-702 provides an acceptable level of quality and safety in accordance with 10 CFR 50.55a(a)(3)(i) for all RPV nozzle-to-vessel shell full penetration welds and nozzle inner radii sections, with the exception of the recirculation outlet nozzles.

Appendix A to the licensee's application dated September 18, 2009, provided the following details for HCGS with respect to the criteria in Section 5.0 of the NRC staff's SE for the BWRVIP-108 report in order to demonstrate the plant-specific applicability of the report:

*Criterion 1 - the maximum RPV heatup/cooldown rate is less than 115° F/hour*

(1) Hope Creek Technical Specification Limiting Condition for Operation 3.4.6.1 limits the maximum heatup and cooldown rates to less than or equal to 100 °F in any one hour period.

*Criteria 2 and 3 - recirculation inlet nozzles*

(2) $(pr/t)/C_{RPV} = 1.08 < 1.15$

(3) $[p(r_o^2 + r_i^2)/(r_o^2 - r_i^2)]/C_{NOZZLE} = 0.95 < 1.15$

*Criteria 4 and 5 - recirculation outlet nozzles*

(4) $(pr/t)/C_{RPV} = 1.29 > 1.15$

(5) $[p(r_o^2 + r_i^2)/(r_o^2 - r_i^2)]/C_{NOZZLE} = 0.98 < 1.15$

3.2 NRC Staff Evaluation

The December 19, 2007, SE for the BWRVIP-108 report specified five plant-specific criteria that licensees must meet to demonstrate that the BWRVIP-108 report results apply to their plants. The five criteria are related to the driving force of the PFM analyses for the recirculation inlet and outlet nozzles. It was stated in the December 19, 2007, SE that the nozzle material fracture toughness-related reference temperature ($RT_{NDT}$) used in the PFM analyses was based on data from the entire fleet of BWR RPVs. Therefore, the BWRVIP-108 report PFM analyses are bounding with respect to fracture resistance, and only the driving force of the underlying PFM analyses needs to be evaluated. It was also stated in the December 19, 2007, SE that, except for the RPV heatup/cooldown rate, the plant-specific criteria are for the recirculation inlet and outlet nozzles only because the probabilities of failure, P(F|E)s, for other nozzles are an order of magnitude lower. The plant-specific heatup/cooldown rate that the NRC staff established in Criterion 1 regards the rate under the plant's normal operating condition, which is limiting. Events with excursions of heatup/cooldown rates exceeding 115° F/hour are considered as transients. According to the December 19, 2007, SE, the PFM results with a very severe low temperature overpressure (LTOP) transient is not limiting, largely because the event frequency for that transient is $1x10^{-3}$ as opposed to 1.0 for the normal operating condition.

The licensee provided in the submittal plant-specific data for the HCGS RPV and its evaluation of the five driving force factors, or ratios, against the criteria established in the SE dated December 19, 2007. The NRC staff verified the licensee's evaluation, which indicated that, except for the fourth criterion (related to recirculation outlet nozzles), all other criteria are satisfied. As a result, the reduced inspection requirements in accordance with ASME Code Case N-702 do not apply to HPGS RPV recirculation outlet nozzles. The NRC staff agrees with the licensee's decision to exclude the recirculation outlet nozzles from the scope of this request based upon the licensee's evaluation. Considering that the driving force factor for the recirculation outlet nozzles (1.29) is only moderately higher than the plant-specific criterion (1.15) and the P(F|E)s for other RPV nozzles are an order of magnitude lower than the recirculation outlet nozzles, the NRC staff concluded that the licensee's proposed alternative for all HCGS RPV nozzles included in this application (see Section 3.1.2 of this SE) provides an acceptable level of quality and safety. It should be noted that RPV feedwater nozzles and control rod drive return line nozzles are outside the scope of ASME Code Case N-702 and are, accordingly, outside the scope of this application.

PSEG currently uses ASME Code Case N-648-1, "Alternative Requirements for Inner Radius Examinations of Class 1 Reactor Vessel Nozzles, Section XI, Division 1," with the conditions stated in RG 1.147, Revision 15. The condition placed on the use of Code Case N-648-1 is that "[i]n place of a UT examination, licensees may perform a visual examination with enhanced magnification that has a resolution sensitivity to detect a 1-mil width wire or crack..." The licensee's application dated September 18, 2009, noted that ASME Code Case N-720 stipulates that the VT-1 visual examination method may be used in lieu of the volumetric examination method for the inner radius sections. The licensee stated that this allowance in ASME Code Case N-702 is not included in the proposed alternative. PSEG will perform either UT examinations or VT-1 examinations per ASME Code Case N-648-1 (with the condition imposed by RG 1.147) for the remainder of the interval. The NRC staff finds the licensee's proposed alternative examination acceptable as it provides reasonable assurance of verifying structural integrity of the nozzle's inner radii.

## 4.0 CONCLUSION

The NRC staff has reviewed the submittal regarding the licensee's evaluation of the five plant-specific criteria specified in the December 19, 2007, SE for the BWRVIP-108 report, which provides technical bases for use of ASME Code Case N-702, to examine RPV nozzle-to-vessel welds and nozzle inner radii at HCGS. Based on the evaluation in Section 3.2 of this SE, the staff determined that the licensee's proposed alternative, pursuant to 10 CFR 50.55a(a)(3)(i), provides an acceptable level of quality and safety and applies to all requested HCGS RPV nozzles, with the exception of the RPV recirculation outlet nozzles, feedwater nozzles, and control rod drive return nozzles. It should be noted that the licensee's request did not include the VT-1 visual examination specified in ASME Code Case N-702. The use of the modified ASME Code Case N-702 is authorized for the remainder of the third 10-year ISI interval.

All other ASME Code, Section XI requirements for which relief was not specifically requested and approved remain applicable, including third-party review by the Authorized Nuclear Inservice Inspector.

Principal Contributor: S. Sheng

Date: August 11, 2010

If you have any questions concerning this matter, please contact the HCGS Project Manager, Mr. Richard Ennis, at (301) 415-1420.

Sincerely,

***/ra/***

Harold K. Chernoff, Chief
Plant Licensing Branch I-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-354

Enclosure:
Safety Evaluation

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