



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

September 9, 2010

Mr. Michael J. Pacilio  
President and Chief Nuclear Officer  
Exelon Nuclear  
4300 Winfield Road  
Warrenville, IL 60555

SUBJECT: LIMERICK GENERATING STATION, UNITS 1 AND 2 – PROPOSED  
ALTERNATIVE REQUEST RR-I3R-14, NOZZLE-TO-VESSEL WELD AND  
INNER RADII EXAMINATIONS (TAC NOS. ME3306 AND ME3307)

Dear Mr. Pacilio:

By letter dated February 1, 2010 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML100330138), supplemented by letter dated July 27, 2010 (ADAMS Accession No. ML102090133), Exelon Generation Company, LLC submitted a proposed alternative request for Limerick Generating Station (LGS), Units 1 and 2. The request proposes an alternative to the requirements of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components," 2001 Edition through 2003 Addenda, Table IWB-2500-1, concerning nozzle-to-vessel weld and nozzle inner radii examination requirements.

Specifically, the request proposes to examine a minimum of 25 percent of the applicable LGS, Units 1 and 2, nozzle-to-vessel welds and inner radii sections, including at least one nozzle from each system and nominal pipe size, in accordance with ASME Code Case N-702, "Alternative Requirements for Boiling Water Reactor (BWR) Nozzle Inner Radius and Nozzle-to-Shell Welds Section XI, Division 1." The proposed alternative would be performed in lieu of meeting the requirements of ASME Section XI, Table IWB-2500-1, Item Numbers B3.90 and B3.100, for the applicable components, which require 100 percent volumetric examination each 10-year inservice inspection (ISI) interval. The request applies to the third ISI interval at LGS, Units 1 and 2, which began on February 1, 2007, and ends on January 31, 2017.

The U.S. Nuclear Regulatory Commission (NRC) staff has completed its review of RR-I3R-14 and has determined that the proposed alternative provides an acceptable level of quality and safety. Consequently, pursuant to 10 CFR 50.55a(a)(3)(i), the alternative is authorized through the end of the third 10-year ISI interval from the requirements of Table IWB-2500-1 (Inspection Program B) of ASME Code, Section XI, pertaining to inspection of reactor pressure vessel nozzle-to-vessel shell welds and inner radii for nozzles specified in Enclosure 1 to the licensee's February 1, 2010, submittal. The nozzles from Enclosure 1 are: recirculation inlet (N2), main steam (N3), core spray (N5), head spray (N6), head vent (N7), jet pump instrumentation (N8), and residual heat removal (N17).

M. Pacilio

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If you have any questions, please contact the LGS Project Manager, Mr. Peter J. Bamford, at 301-415-2833.

Sincerely,

A handwritten signature in black ink, appearing to read "Harold K. Chernoff". The signature is fluid and cursive, with a long, sweeping tail that extends to the right.

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

Docket Nos. 50-352 and 50-353

Enclosure:  
As stated

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

LIMERICK GENERATING STATION, UNITS 1 AND 2

PROPOSED ALTERNATIVE REQUEST RR-I3R-14

NOZZLE-TO-VESSEL WELD AND INNER RADII EXAMINATIONS

EXELON GENERATION COMPANY, LLC

DOCKET NOS. 50-352 AND 50-353

1.0 INTRODUCTION

By letter dated February 1, 2010 (Agencywide Documents Access and Management System, (ADAMS), Accession No. ML100330138), as supplemented by letter dated July 27, 2010 (ADAMS Accession No. ML102090133), Exelon Generation Company, LLC (the licensee), requested U.S. Nuclear Regulatory Commission (NRC) approval of a request for alternative, I3R-14, to the requirements of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), Section XI, Table IWB-2500-1, Nozzle-to-Vessel Welds and Nozzle Inside Radius Section examination requirements for Limerick Generating Station (LGS), Units 1 and 2. The request was submitted pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) Paragraph 50.55a(a)(3)(i). 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," and BWR Vessel Internals Project (BWRVIP)-108, "BWR Vessel Internals Project Technical Basis for the Reduction of Nozzle-to-Vessel Shell Welds and Nozzle Blend Radii," was proposed.

2.0 REGULATORY EVALUATION

Inservice inspection (ISI) of the ASME Code Class 1, 2, and 3 components is performed in accordance with Section XI of the ASME Code and applicable addenda as required by 10 CFR 50.55a(g), except where specific relief has been granted by the Commission pursuant to 10 CFR 50.55a(g)(6)(i).

Paragraph 50.55a(a)(3) of 10 CFR states that alternatives to the requirements of paragraph (g) may be used, when authorized by the NRC, if: (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. Paragraph 50.55a(g)(4) of 10 CFR further states that ASME Code Class 1, 2, and 3 components (including supports) must meet the requirements, except design and access provisions and 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 regulations require 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

Enclosure

the limitations and modifications listed therein. The applicable ISI Code of Record for the third 10-year ISI interval for LGS, Units 1 and 2, is the ASME Code, Section XI, 2001 Edition through 2003 Addenda.

For all Reactor Pressure Vessel (RPV) nozzle-to-vessel shell welds and nozzle inner radii, the ASME Code, Section XI requires 100 percent inspection during each 10-year ISI interval. However, ASME Code Case N-702 describes 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. The NRC has approved the BWRVIP-108 report (ADAMS Accession No. ML073600374), which is the underlying technical basis document for ASME Code Case N-702. The staff's December 19, 2007, safety evaluation (SE) regarding the BWRVIP-108 report (ADAMS Accession No. ML073600374) specified the following for applicants using ASME Code Case N-702:

... 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/cool-down rate is limited to less than 115 [degrees Fahrenheit] °F/hour;

For recirculation inlet nozzles

- (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 FEM [finite element method] 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<sup>2</sup> + 6.875<sup>2</sup>) / (13.988<sup>2</sup> - 6.875<sup>2</sup>)], 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

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

p = RPV normal operating pressure,

$r_o$  = nozzle outer radius,

$r_i$  = nozzle inner radius, and

$C_{\text{NOZZLE}} = 1977$  [i.e.,  $1000 \text{ psi} \times (22.31^2 + 12.78^2) / (22.31^2 - 12.78^2)$ ], based on the BWRVIP-108 recirculation outlet nozzle/RPV FEM model].

This plant-specific information was required by the NRC staff to ensure that the probabilistic fracture mechanics (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

##### ASME Code Requirements for which Relief is Requested

The licensee requested an alternative to the following requirements of the ASME Code, Section XI, 2001 Edition with 2003 Addenda:

... Table IWB-2500-1, "Examination Category B-D, Full Penetration Welded Nozzle in Vessels – Inspection Program B." [ASME Code] Class 1 nozzle-to-vessel weld and nozzle inner radii examination requirements are delineated in Item Number B3.90, "Nozzle-to-Vessel Welds," and B3.100, "Nozzle Inside Radius Section." The required method of examination is volumetric. All nozzles with full penetration welds to the vessel shell (or head) and integrally cast nozzles are examined each interval.

##### Components for which Relief is Requested

The licensee provided the following information regarding the components under the scope of this request:

ASME Code Class: 1

Component Numbers: N2 (Recirculation Inlet Nozzles), N3 (Main Steam Nozzles), N5 (Core Spray Nozzles), N6 (Head Spray Nozzle), N7 (Head Vent Nozzle), N8 (Jet Pump Instrumentation), and N17 (Residual Heat Removal Nozzles)

Examination Category: B-D (Inspection Program B)

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

The licensee stated the following regarding their proposed alternative:

In accordance with 10 CFR 50.55a(a)(3)(i) relief is requested from performing the required examinations on 100 percent of the nozzle assemblies identified in [February 1, 2010, submittal] Tables 5-1 and 5-2 below (see Enclosure 1 [of the February 1, 2010, submittal] for complete list of RPV Nozzles). As an alternative for all welds and inner radii identified in Tables 5-1 and 5-2, Exelon Generation

Company, LLC proposes to examine a minimum of 25 percent of the LGS, Units 1 and 2 nozzle-to-vessel welds and inner-radii sections, including at least one nozzle from each system and nominal pipe size, in accordance with Code Case N-702...

Code Case N-702 stipulates that a VT-1 examination may be used in lieu of the volumetric examination for the inner radii... However, EGC is not currently using Code Case N-648-1 at [LGS] for the identified components... Volumetric examinations of all nozzle inside radius sections will be completed.

#### Licensee's Basis for Alternative

The licensee included the following information in the February 1, 2010, submittal regarding the basis for the proposed alternative:

Electric Power Research Institute (EPRI) Technical Report 1003557, "BWRVIP-108: Boiling Water Reactor Vessel and Internals Project Technical Basis for the Reduction of Inspection Requirements for the Boiling Water Reactor Nozzle-to-Vessel Shell Welds and Nozzle Blend Radii," provides the basis for Code Case N-702. The evaluation found that failure probabilities at the nozzle blend radius region and nozzle-to-vessel shell weld due to a Low Temperature Overpressure event are very low (i.e.,  $<1 \times 10^{-6}$  for 40 years) with or without inservice inspection. The report concludes that inspection of 25 percent of each nozzle type is technically justified.

This EPRI report was approved by the NRC in a Safety Evaluation (SE) dated December 19, 2007 (ie., ADAMS Accession No. ML073600374). Section 5.0, "Plant-Specific Applicability," of the SE indicates that each licensee who plans to request relief from ASME Code, Section XI requirements for RPV nozzle-to-vessel shell welds and nozzle inner radii 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 criteria from the BWRVIP-108 report to its units in the relief request by showing that all the general and nozzle-specific criteria addressed below are satisfied (i.e., as described in Enclosure 2 [of the February 1, 2010, submittal]).

The results of the licensee's analysis were matched to the appropriate criteria from BWRVIP-108 below.

Criterion 1: the maximum RPV heatup/cool-down rate is less than 115° F/hour

LGS, Units 1 and 2 Technical Specification (TS) 3.4.6.1, "Pressure/Temperature Limits," provides a limiting condition for operation (LCO) of 100°F in any 1-hour period. The heatup/cool-down rate is referenced in the Limerick, Units 1 and 2 operating procedures. This heatup/cool-down rate is also described in the LGS Updated Final Safety Analysis Report (UFSAR), Section 5.3.3.6, "Operating Conditions."

Criterion 2: for recirculation inlet nozzles,  $(pr/t)/C_{RPV} < 1.15$

$$(pr/t)/C_{RPV} = 1.064 < 1.15$$

Criterion 3: for recirculation inlet nozzles,  $[p(r_o^2+r_i^2)/(r_o^2-r_i^2)]/C_{NOZZLE} < 1.15$

$$[p(r_o^2+r_i^2)/(r_o^2-r_i^2)]/C_{NOZZLE} = 0.976 < 1.15$$

Criterion 4: for recirculation outlet nozzles,  $(pr/t)/C_{RPV} < 1.15$

$$(pr/t)/C_{RPV} = 1.272 > 1.15$$

Criterion 5: for recirculation outlet nozzles,  $[p(r_o^2+r_i^2)/(r_o^2-r_i^2)]/C_{NOZZLE} < 1.15$

$$[p(r_o^2+r_i^2)/(r_o^2-r_i^2)]/C_{NOZZLE} = 1.044 < 1.15$$

The licensee concludes,

Based upon the above information [criterion calculations], all LGS 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, Code Case N-702 is applicable.

#### Licensee Proposed Duration of Alternative

The licensee proposes that the alternative will be utilized through the remainder of the third ISI interval for LGS, Units 1 and 2. This third interval began on February 1, 2007, and will end on January 31, 2017.

### 3.2 NRC Staff Evaluation

#### Criteria for Applying the BWRVIP-108 Report

The December 19, 2007, SE on the BWRVIP-108 specified five plant-specific criteria that licensees must meet in order to demonstrate that the BWRVIP-108 report results apply to their plants. The five criteria are related to the driving force of the PFM analysis for the recirculation inlet and outlet nozzles. It was stated in the December 19, 2007, SE that the nozzle material fracture toughness-related  $RT_{NDT}$  (reference temperature for nil ductility transition) values used in the PFM analyses were 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 only plant-specific criteria are for the recirculation inlet and outlet nozzles because the probabilities of failure for other nozzles are an order of magnitude lower.

The licensee stated that Criterion 1 is satisfied because the TS 3.4.6.1 for LGS, Units 1 and 2, provides an LCO specifying a maximum heatup or cooldown of 100° F/hour in any 1-hour period. The licensee further stated that this heatup/cooldown rate requirement is in accordance with Section 5.3.3.6, "Operating Conditions" of the Updated Final Safety Analysis Report for both units. Criterion 1 applies to normal operating conditions. The TS are incorporated into the plant operating license and clearly govern during normal plant operating conditions. Therefore, TS 3.4.6.1 provides sufficient assurance that Criterion 1 will be met for both LGS units.

For the remaining criteria the licensee provided, in Enclosure 2 of the February 1, 2010, submittal, plant-specific data and an evaluation of the driving force factors, or ratios, against the criteria

established in the SE to BWRVIP-108 dated December 19, 2007. The licensee's calculated results showed that three of the remaining four criteria are satisfied; the exception being Criterion 4 (as shown above) and independent staff calculations confirmed the accuracy of the licensee results. As a consequence, the licensee appropriately excluded the LGS, Units 1 and 2, recirculation outlet nozzles from the scope of this request. The staff finds the analysis for the remaining nozzles acceptable.

The staff requested in a letter dated June 25, 2010, (ADAMS Accession No. ML101540503) a synopsis of previous inspections and whether any indications were found in the components for which the alternative was requested. In their response, dated July 27, 2010, the licensee indicated that a number of indications had been found but that these indications were found to be acceptable per ASME Code, Section XI. Furthermore this synopsis provided a detailed list of how many inspections had been conducted on the components, at least two for each, providing assurance that substantial inspection of the components has already been conducted without finding indications inconsistent with the expectations used in BWRVIP-108.

Finally, the staff questioned the use of one set of values for nozzle dimensions used in the submittal calculations, but was assured that these values represent minimum design values for both LGS units. This clarification was found to be acceptable because actual plant "as-built" parameters for the nozzles on each LGS unit would be expected to meet or conservatively exceed these values.

#### 4.0 CONCLUSION

The NRC staff has reviewed the submittal and finds that the LGS, Units 1 and 2, RPVs meet the applicable plant-specific criteria specified in the December 19, 2007, SE on the BWRVIP-108 report, which provides the technical basis for use of ASME Code Case N-702. Meeting the technical basis for the use of ASME Code Case N-702 ensures that the proposed alternative provides an adequate level of quality and safety.

Consequently, pursuant to 10 CFR 50.55a(a)(3)(i), the proposed alternative from the requirements of Table IWB-2500-1 (Inspection Program B) of ASME Code, Section XI, pertaining to inspection of RPV nozzle-to-vessel shell welds and inner radii for nozzles specified in Enclosure 1 to the licensee's February 1, 2010, submittal is authorized through the end of the third 10-year ISI interval because an acceptable level of quality and safety would be provided under the alternative.

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

Principal Contributor: D. Widrevitz

Date: September 9, 2010



M. Pacilio

- 2 -

If you have any questions, please contact the LGS Project Manager, Mr. Peter J. Bamford, at 301-415-2833.

Sincerely,

*/ra/*

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

Docket Nos. 50-352 and 50-353

Enclosure:  
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