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

October 5, 2016

Mr. Mark E. Reddemann
Chief Executive Officer
Energy Northwest
P.O. Box 968 (Mail Drop 1023)
Richland, WA 99352-0968

SUBJECT: COLUMBIA GENERATING STATION – RELIEF REQUEST FOR ALTERNATIVE 4ISI-04 APPLICABLE TO THE FOURTH 10-YEAR INSERVICE INSPECTION PROGRAM INTERVAL (CAC NO. MF7331)

Dear Mr. Reddemann:

By letter dated February 4, 2016, Energy Northwest (the licensee) submitted a request to the U.S. Nuclear Regulatory Commission (NRC) for the use of an alternative to certain American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), Section XI requirements at Columbia Generating Station (CGS). The proposed alternative in Relief Request 4ISI-04 would revise the inservice inspection requirements for certain reactor pressure vessel (RPV) nozzle-to-shell welds and nozzle inner radii from those based on ASME Code, Section XI, Subarticle IWB-2500, to an alternative based on ASME Code Case N-702, "Alternative Requirements for Boiling Water Reactor (BWR) Nozzle Inner Radius and Nozzle-to-Shell Welds, Section XI, Division 1," dated February 20, 2004.

Specifically, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR), Part 50, paragraph 50.55a(z)(1), the licensee requested to use the proposed alternative on the basis that the alternative provides an acceptable level of quality and safety. The ASME Code Case N-702 requires a minimum of 25 percent of BWR RPV nozzle-to-shell welds and associated nozzle inner radii to be inspected during each 10-year inservice inspection, including at least one nozzle from each type and nominal pipe size, in lieu of the 100 percent inspection requirements of ASME Code, Section XI, Subarticle IWB-2500.

The NRC staff has reviewed the subject request and concludes, as set forth in the enclosed safety evaluation, that the licensee has adequately addressed all of the regulatory requirements set forth in 10 CFR 50.55a(z)(1). Therefore, the NRC authorizes the licensee's proposed alternative for inspection of the nozzle-to-vessel shell welds and nozzle inner radii sections of RPV nozzles listed in the enclosed safety evaluation for the duration of the fourth 10-year inservice inspection interval at CGS ending on December 12, 2025.

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

If you have any questions regarding this matter, please contact the NRC project manager, John Klos, at (301) 415-5136 or via e-mail at John.Klos@nrc.gov.

Sincerely,

Robert J. Pascarelli, Chief
Plant Licensing Branch IV-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-397

Enclosure:
Safety Evaluation

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

REQUEST FOR ALTERNATIVE 4ISI-04 REGARDING INSPECTION REQUIREMENTS

FOR REACTOR PRESSURE VESSEL NOZZLE RADIUS AND NOZZLE-TO-SHELL WELDS

ENERGY NORTHWEST

COLUMBIA GENERATING STATION

DOCKET NO. 50-397

1.0 INTRODUCTION

By letter dated February 4, 2016 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML16035A405), Energy Northwest (the licensee) requested U.S. Nuclear Regulatory Commission (NRC) approval of an alternative to certain American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), Section XI requirements at Columbia Generating Station (CGS). The proposed alternative in Relief Request 4ISI-04 would revise the inspection requirements for certain reactor pressure vessel (RPV) nozzle-to-shell welds and nozzle inner radii from those based on ASME Code, Section XI, Subarticle IWB-2500, to an alternative based on ASME Code Case N-702, "Alternative Requirements for Boiling Water Reactor (BWR) Nozzle Inner Radius and Nozzle-to-Shell Welds, Section XI, Division 1," dated February 20, 2004.

Specifically, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR), Part 50, paragraph 50.55a(z)(1), the licensee requested to use the proposed alternative on the basis that the alternative provides an acceptable level of quality and safety. The ASME Code Case N-702 requires a minimum of 25 percent of BWR RPV nozzle-to-shell welds and associated nozzle inner radii to be inspected during each 10-year inservice inspection (ISI) interval, including at least one nozzle from each type and nominal pipe size, in lieu of the 100 percent inspection requirements of ASME Code, Section XI, Subarticle IWB-2500.

2.0 REGULATORY REQUIREMENTS

In accordance with 10 CFR 50.55a(g)(4), the licensee is required to perform ISI of ASME Code Class 1, Class 2, and Class 3 components in compliance with the applicable edition and addenda of Section XI of the ASME Code, 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).

The regulation in 10 CFR 50.55a(z), "Alternatives to codes and standards requirements," states, in part, that the Director of the Office of Nuclear Reactor Regulation may authorize an alternative to the requirements of 10 CFR 50.55a(b) through (h) given that the licensee demonstrates one of the two justifications. First, per 10 CFR 50.55a(z)(1), the licensee must demonstrate that the proposed alternative would provide an acceptable level of quality and safety. For the second possible justification for an alternative to be authorized, described in 10 CFR 50.55a(z)(2), the licensee must show that following the ASME Code requirements would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

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 is listed in Regulatory Guide (RG) 1.147, Revision 17, "Inservice Inspection Code Case Acceptability, ASME Section XI, Division 1," August 2014 (ADAMS Accession No. ML13339A689), as a conditionally acceptable alternative to the ASME Code requirement and allows for a reduction in the inspection population of BWR 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 ISI interval.

3.0 TECHNICAL EVALUATION

3.1 Background

The NRC approved the Electric Power Research Institute (EPRI) Boiling Water Reactor Vessel and Internals Project (BWRVIP)-108 report, "Technical Basis for the Reduction of Inspection Requirements for the Boiling Water Reactor Nozzle-to-Vessel Shell Welds and Nozzle Inner Radii," October 2002, in a safety evaluation (SE) dated December 19, 2007 (ADAMS Accession No. ML073600374). In an SE dated April 19, 2013 (ADAMS Accession No. ML13071A240), the NRC approved the EPRI BWRVIP-241 report, "Probabilistic Fracture Mechanics Evaluation for the Boiling Water Reactor Nozzle-to-Vessel Shell Welds and Nozzle Blend Radii," October 2010 (ADAMS Accession No. ML11119A043), which contains the technical basis supporting ASME Code Case N-702. The BWRVIP-241 report contains additional probabilistic fracture mechanics (PFM) results supporting revision of the evaluation criteria in the BWRVIP-108 report. Hence, the conditions and limitations specified in the SE dated April 19, 2013, for the BWRVIP-241 report supersede those in the SE dated December 19, 2007, for the BWRVIP-108 report.

The NRC staff's SE for the BWRVIP-241 report specified plant-specific requirements, which must be met for applicants proposing to use the alternative. The licensee's request for alternative 4ISI-04 intended to demonstrate that the relevant CGS RPV nozzle-to-vessel welds and inner radii meet these plant-specific requirements. Licensees can demonstrate the plant-specific applicability of the BWRVIP-241 report by meeting the following general and nozzle-specific criteria specified in Section 5.0 of the SE for the BWRVIP-241 report:

(1) the maximum RPV heat-up/cool-down rate is limited to less than 115 °F/hour;

For recirculation inlet nozzles

(2) $(pr/t)/C_{RPV} \leq 1.15$

p = RPV normal operating pressure (psi),
r = RPV inner radius (inch),
t = RPV wall thickness (inch), and
C_{RPV} = 19332;

(3) $[p(r_o^2 + r_i^2)/ (r_o^2 - r_i^2)] / C_{NOZZLE} \leq 1.47$

p = RPV normal operating pressure (psi),
r_o = nozzle outer radius (inch),
r_i = nozzle inner radius (inch), and
C_{NOZZLE} = 1637;

For recirculation outlet nozzles

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

p = RPV normal operating pressure (psi),
r = RPV inner radius (inch),
t = RPV wall thickness (inch), and
C_{RPV} = 16171; and

(5) $[p(r_o^2 + r_i^2)/ (r_o^2 - r_i^2)]/C_{NOZZLE} \leq 1.59$

p = RPV normal operating pressure (psi),
r_o = nozzle outer radius (inch),
r_i = nozzle inner radius (inch), and
C_{NOZZLE} = 1977.

This plant-specific information is required by the NRC staff to ensure that the PFM analysis documented in the BWRVIP-241 report applies to the RPV of the licensee's plant.

The BWRVIP-241 report documents additional PFM results supporting revision of the five evaluation criteria in the BWRVIP-108 report. Since the objective of the BWRVIP-241 report is limited (i.e., revision of the limitations and conditions specified in the SE dated December 19, 2007, for the BWRVIP-108 report), it is considered as a supplement to the BWRVIP-108 report, not a replacement. Nonetheless, the conditions and limitations specified in the SE for the BWRVIP-241 report supersede those in the SE for the BWRVIP-108 report.

The SE for the BWRVIP-108 concluded, in part, that (1) the fracture toughness-related reference temperatures used in the PFM analyses were based on data from the entire fleet of BWR RPVs, making the PFM analyses bounding with respect to fracture resistance and leaving the driving force of the underlying PFM analyses the only item to be evaluated, and (2) 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 for other nozzles are an order of magnitude lower. Based on the above, the BWRVIP-241 report documents additional PFM analyses on the recirculation inlet and outlet nozzles having the highest driving force among the BWR fleet to demonstrate that the associated vessel failure probability for normal operation is still consistent with the NRC safety goal, thus supporting the proposed revision of the five evaluation criteria. The SE for the BWRVIP-241 report accepted the proposed revision of the five evaluation criteria in the BWRVIP-108 report.

3.2 Licensee's Request for Alternative 4ISI-04

ASME Code Class 1 Components Affected

In the submittal dated February 4, 2016, the licensee provided the affected ASME Code Class 1 components in the Table below. All items are classified as examination category B-D.

Table 1		
Identification Number	**Description**	**Item Number**
N1-0	Reactor Recirculation (RRC) Nozzle to Vessel Weld @ 0 Degree (Deg)	B3.90
N1-0-IR	RRC Nozzle Inner Radius @ 0 Deg	B3.100
N1-180	RRC Nozzle to Vessel Weld @ 180 Deg	B3.90
N1-180-IR	RRC Nozzle Inner Radius @ 180 Deg	B3.100
N2-30	RRC Nozzle to Vessel Weld @ 30 Deg	B3.90
N2-30-IR	RRC Nozzle Inner Radius @ 30 Deg	B3.100
N2-60	RRC Nozzle to Vessel Weld @ 60 Deg	B3.90
N2-60-IR	RRC Nozzle Inner Radius @ 60 Deg	B3.100
N2-90	RRC Nozzle to Vessel Weld @ 90 Deg	B3.90
N2-90-IR	RRC Nozzle Inner Radius @ 90 Deg	B3.100
N2-120	RRC Nozzle to Vessel Weld @ 120 Deg	B3.90
N2-120-IR	RRC Nozzle Inner Radius @ 120 Deg	B3.100
N2-150	RRC Nozzle to Vessel Weld @ 150 Deg	B3.90
N2-150-IR	RRC Nozzle Inner Radius @ 150 Deg	B3.100
N2-210	RRC Nozzle to Vessel Weld @ 210 Deg	B3.90
N2-210-IR	RRC Nozzle Inner Radius @ 210 Deg	B3.100
N2-240	RRC Nozzle to Vessel Weld @ 240 Deg	B3.90
N2-240-IR	RRC Nozzle Inner Radius @ 240 Deg	B3.100
N2-270	RRC Nozzle to Vessel Weld @ 270 Deg	B3.90
N2-270-IR	RRC Nozzle Inner Radius @ 270 Deg	B3.100
N2-300	RRC Nozzle to Vessel Weld @ 300 Deg	B3.90
N2-300-IR	RRC Nozzle Inner Radius @ 300 Deg	B3.100
N2-330	RRC Nozzle to Vessel Weld @ 330 Deg	B3.90

Table 1		
Identification Number	**Description**	**Item Number**
N2-330-IR	RRC Nozzle Inner Radius @ 330 Deg	B3.100
N3-72	Main Steam (MS) Nozzle to Vessel Weld @ 72 Deg	B3.90
N3-72-IR	MS Nozzle Inner Radius @ 72 Deg	B3.100
N3-108	MS Nozzle to Vessel Weld @ 108 Deg	B3.90
N3-108-IR	MS Nozzle Inner Radius @ 108 Deg	B3.100
N3-252	MS Nozzle to Vessel Weld @ 252 Deg	B3.90
N3-252-IR	MS Nozzle Inner Radius @ 252 Deg	B3.100
N3-288	MS Nozzle to Vessel Weld @ 288 Deg	B3.90
N3-288-IR	MS Nozzle Inner Radius @ 288 Deg	B3.100
N5-120	Low Pressure Coolant Spray (LPCS) Nozzle to Vessel Weld @ 120 Deg	B3.90
N5-120-IR	LPCS Nozzle Inner Radius @ 120 Deg	B3.100
N6-45	Low Pressure Core Injection (LPCI) Nozzle to Vessel Weld @ 45 Deg	B3.90
N6-45-IR	LPCI Nozzle Inner Radius @ 45 Deg	B3.100
N6-135	LPCI Nozzle to Vessel Weld @ 135 Deg	B3.90
N6-135-IR	LPCI Nozzle Inner Radius @ 135 Deg	B3.100
N6-315	LPCI Nozzle to Vessel Weld @ 315 Deg	B3.90
N6-315-IR	LPCI Nozzle Inner Radius @ 315 Deg	B3.100
N9-105	Jet Pump (JP) Instrumentation Nozzle to Vessel Weld @ 105 Deg	B3.90
N9-105-IR	JP Instrumentation Nozzle Inner Radius @ 105 Deg	B3.100
N9-285	JP Instrumentation Nozzle to Vessel Weld @ 285 Deg	B3.90
N9-285-IR	JP Instrumentation Nozzle Inner Radius @ 285 Deg	B3.100
N16-240	High Pressure Core Spray (HPCS) Nozzle to Vessel Weld @ 240 Deg	B3.90
N16-240-IR	HPCS Nozzle Inner Radius @ 240 Deg	B3.100
N7	Top Head Spray Nozzle to Top Head Weld	B3.90
N7-IR	Top Head Spray Nozzle Inner Radius	B3.100
N8	Top Head Vent Nozzle to Top Head Weld	B3.90
N8-IR	Top Head Vent Nozzle Inner Radius	B3.100
N18	Top Head Spare Nozzle to Top Head Weld	B3.90
N18-IR	Top Head Spare Nozzle Inner Radius	B3.100

Applicable ASME Code Edition and Addenda (as stated by the licensee)

> The applicable ASME Section XI Code Edition and Addenda for Columbia Generating Station's (Columbia) fourth 10-year ISI interval is the 2007 Edition through the 2008 Addenda. Additionally, for ultrasonic examinations, [ASME Code,] Section XI, Appendix VIII, "Performance Demonstration for Ultrasonic Examination Systems," is implemented as required and as modified by 10 CFR 50.55a.

ASME Code Requirement

ASME Code, Section XI, Subsection IWB-2500, "Examination and Pressure Test Requirements," stipulates that components shall be examined and tested as specified in Table IWB-2500-1, "Examination Category B-D, Full Penetration Welded Nozzles in Vessels." Items B3.90 and B3.100 require 100 percent volumetric examination, as defined by Figures IWB-2500-7 (a) through (d), as applicable, of all full penetration Class 1 RPV nozzle-to-shell welds and nozzle inside radius sections.

Licensee's Proposed Alternative and Basis for Use

The licensee proposed an alternative to the ASME Code-required examinations on 100 percent of the identified nozzle assemblies in Table 1 at the beginning of this section. The proposed alternative reduces the ASME Code-required examinations to a minimum of 25 percent of the nozzle-to-vessel welds and inner radius sections, including at least one nozzle/inner radius section from each system and nominal pipe size during each inspection interval. For the components identified in Table 1, this would mean at least one nozzle/inner radius section from each of the groups identified below in Table 2 will be examined. This alternative is contained in Code Case N-702.

Table 2		
Group	**Total Number**	**Number to be Examined**
RRC Outlet (N1)	2	1
RRC Inlet (N2)	10	3
MS (N3)	4	1
Core Spray (N5, N16)	2	1
LPCI (N6)	3	1
Top Head Nozzles (N7, N8, N18)	3	1
JP (N9)	2	1

Code Case N-702 specifies that VT-1 examination may be used in lieu of the volumetric examination for the inner radii (Item No. B3.100). Energy Northwest stated in its application that it will utilize Code Case N-648-1, "Alternative Requirements for Inner Radius Examination of Class 1 Reactor Vessel Nozzles, Section XI Division 1," with associated required conditions in RG 1.147 if VT examinations are performed in lieu of volumetric examinations.

The BWRVIP-241 report provides the technical basis for use of Code Case N-702. BWRVIP-241 was developed to propose a relaxation of the criteria in the NRC staff's SE for the BWRVIP-108 report, which would subsequently allow BWRs to obtain inspection relief for RPV nozzles. In its request dated February 4, 2016, the licensee stated, in part, that:

> Based on the two evaluations (BWRVIP-241 and BWRVIP-108NP), the failure probabilities due to a low temperature over pressure (LTOP) event at the nozzle blend radius region and the nozzle-to-vessel shell weld for Columbia recirculation nozzles are very low and meet the NRC safety goal.
>
> Based on the results of this evaluation, the report concluded that the inspection of 25% of each nozzle type is technically justified as per Code Case N-702.

Duration of the Proposed Alternative

The licensee's proposed alternative will extend through the remainder of the fourth 10-year ISI interval ending on December 12, 2025.

3.3 NRC Staff Evaluation

The NRC staff's SE dated December 19, 2007, for BWRVIP-108, specified five plant-specific criteria that licensees must meet in order to demonstrate that BWRVIP-108 results apply to their plants. In the application, the licensee stated, in part, that:

> The RPV is low alloy steel plate specification SA-533 grade B class I, the nozzles are low alloy steel forging specification SA-508 class 2 and the weld metal used in the welds specified in Table 1 is carbon/low alloy steel, which are the typical materials identified in Table 3-2 of BWRVIP-108NP therefore, the BWRVIP-108NP evaluation is applicable and appropriate.

The licensee's submittal provided plant-specific data for CGS and an evaluation of the five driving force factors, or ratios, against the criteria established in the NRC staff's SE for the BWRVIP-241 report. Regarding the first criterion, Section 3.4.11, "RCS [Reactor Coolant System] Pressure and Temperature (P/T) Limits," of the licensee's technical specifications requires that the RCS heat-up and cooldown rates remain less than or equal to 100 degrees Fahrenheit in any 1-hour period; therefore the first criterion has been met. The NRC staff further verified that the licensee met criteria (2) – (5) by reproducing the associated calculations using the data submitted by the licensee. Therefore, the reduced inspection requirements in accordance with ASME Code Case N-702 are applicable to all of the proposed CGS RPV nozzle-to-shell welds and associated nozzle inner radii.

The licensee stated that the results from the most recent examination of the components listed in Table 1 displayed no recordable indications or indications exceeding ASME limits. Excluding N3-72, N3252, N3-288, N5-120, N6-45, N6-135, and N18, the licensee was able to obtain at least 90 percent examination coverage of the subject components as required by the ASME Code. Relief from the ASME Code was granted by the NRC staff for the excluded components on the basis that the licensee achieved the maximum possible examination.

Lastly, the licensee discussed further analyses performed in response to operating experience related to fluence assumptions made in BWRVIP-108NP. Specifically, in the report, the number of thermal cycles that the RPV is exposed to is based on a 40-year design life assumption, and recirculation inlet nozzle welds are considered to be exposed to a negligible level of fluence. The licensee stated that CGS's N6 nozzle was applicable to the operating experience and provided the NRC staff with a calculation package by Structural Integrity Associates, Inc., "Code Case N-702 Evaluation of the Columbia Generating Station," dated October 30, 2014 (ADAMS Accession No. ML16182A302), which shows that CGS's limiting N1 nozzles meet the acceptable failure probability even when considering fluence levels predicted in the beltline region to 60 years of operation.

4.0 CONCLUSION

The NRC staff has completed its review of the request for alternative 4ISI-04 regarding the use of ASME Code Case N-702 to reduce the percentage of nozzle-to-shell welds and associated nozzle inner radii examinations to a minimum of 25 percent during each 10-year ISI, in lieu of the 100 percent inspection requirements of ASME Code. Based on the evaluation in this SE, the NRC staff concludes that licensee's proposed alternative provides an acceptable level of quality and safety because the licensee has met the conditions required for ASME Code Case N-702. Specifically, the licensee's evaluation met the five plant-specific criteria specified in the April 19, 2013, NRC staff's SE for the BWRVIP-241 report, which serves as the technical basis for the use of ASME Code Case N-702.

Accordingly, the NRC staff concludes that the licensee has adequately addressed all of the regulatory requirements set forth in 10 CFR 50.55a(z)(1), and is in compliance with the ASME Code's requirements. Therefore, the NRC authorizes the licensee's proposed alternative for inspection of nozzle-to-vessel shell welds and nozzle inner radii sections of RPV nozzles listed in Section 3.2 of this SE for the remainder of the fourth 10-year ISI interval at CGS, ending on December 12, 2025.

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: A. Young, NRR

Date: October 5, 2016

If you have any questions regarding this matter, please contact the NRC project manager, John Klos, at (301) 415-5136 or via e-mail at John.Klos@nrc.gov.

Sincerely,

/RA/

Robert J. Pascarelli, Chief
Plant Licensing Branch IV-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-397

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Safety Evaluation

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