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

April 7, 2017

Mr. Ken J. Peters
Senior Vice President and
Chief Nuclear Officer
Attention: Regulatory Affairs
TEX Operations Company LLC
P.O. Box 1002
Glen Rose, TX 76043

SUBJECT: COMANCHE PEAK NUCLEAR POWER PLANT, UNIT NO. 2 – REQUEST FOR ALTERNATIVE 2B3-1 REGARDING EXAMINATION OF REACTOR VESSEL CLOSURE HEAD PENETRATION NOZZLES (CAC NO. MF9282)

Dear Mr. Peters:

By letter dated February 14, 2017, as supplemented by letter dated March 28, 2017, TEX Operations Company LLC[1] (the licensee) requested relief from the volumetric inspection coverage of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), Code Case N-729-1, "Alternative Examination Requirements for PWR [Pressurized-Water Reactor] Reactor Vessel Upper Heads with Nozzles Having Pressure-Retaining Partial-Penetration Welds Section XI, Division 1," as conditioned in Title 10 of the *Code of Federal Regulations* (10 CFR) 50.55a, for the examination of five control rod drive mechanism (CRDM) penetration nozzles on the reactor vessel closure head at Comanche Peak Nuclear Power Plant (CPNPP), Unit No. 2.

Specifically, pursuant to 10 CFR 50.55a(z)(2)[2], the licensee requested to use the proposed alternative 2B3-1 on the basis that complying with the specified ASME Code requirements would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety. The request for alternative is for the alternate examination of five CRDM penetration nozzles at CPNPP, Unit No. 2.

The U.S. Nuclear Regulatory Commission (NRC) staff has reviewed the subject request and concludes, as set forth in the enclosed safety evaluation, that TEX Operations Company LLC has adequately addressed all of the regulatory requirements set forth in 10 CFR 50.55a(z)(2) and 10 CFR 50.55a(g)(6)(ii)(D). Therefore, the NRC staff authorizes the use of Relief Request 2B3-1 at CPNPP, Unit No. 2, for the remainder of the CPNPP, Unit No. 2, third 10-year inservice inspection interval, which will end on August 2, 2024.

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[1] Submitted under Vistra Operations Company LLC. By letter dated December 14, 2016, the licensee submitted a license amendment request to change its name from TEX Operations Company LLC to Vistra Operations Company LLC (ADAMS Accession No. ML16351A200). The application is still under review.
[2] The licensee initially submitted the request for alternative 2B3-1 under 10 CFR 50.55a(z)(1). In a letter dated March 28, 2017, the licensee requested that the application be considered under 10 CFR 50.55a(z)(2) due to sufficient basis to demonstrate hardship provided in the original application.

If you have any questions, please contact the Project Manager, Margaret M. Watford at 301-415-1233 or via e-mail at Margaret.Watford@nrc.gov.

Sincerely,

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

Docket No. 50-446

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

REQUEST FOR ALTERNATIVE NO. 2B3-1 REGARDING

EXAMINATION OF REACTOR VESSEL CLOSURE HEAD PENETRATION NOZZLES

TEX OPERATIONS COMPANY LLC

COMANCHE PEAK NUCLEAR POWER PLANT, UNIT NO. 2

DOCKET NO. 50-446

1.0 INTRODUCTION

By letter dated February 14, 2017 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML17054C361), as supplemented by letter dated March 28, 2017 (ADAMS Accession No. ML17097A090), TEX Operations Company LLC[1] (the licensee) requested relief from the volumetric inspection coverage of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), Code Case N-729-1 (N-729-1), "Alternative Examination Requirements for PWR [Pressurized-Water Reactor] Reactor Vessel Upper Heads with Nozzles Having Pressure-Retaining Partial-Penetration Welds Section XI, Division 1," as conditioned in Title 10 of the *Code of Federal Regulations* (10 CFR) 50.55a, "Codes and standards," for the examination of five control rod drive mechanism (CRDM) penetration nozzles on the reactor vessel closure head (RVCH) at Comanche Peak Nuclear Power Plant (CPNPP), Unit No. 2.

Specifically, pursuant to 10 CFR 50.55a(z)(2)[2], the licensee requested to use the proposed alternative 2B3-1 on the basis that complying with the specified ASME Code requirements would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety. The request for alternative is for the alternate examination of five CRDM penetration nozzles at CPNPP, Unit No. 2.

2.0 REGULATORY EVALUATION

Pursuant to 10 CFR 50.55a(g)(6)(ii), "Augmented ISI [inservice inspection] program", the U.S. Nuclear Regulatory Commission (NRC) may require the licensee to follow an augmented ISI program for systems and components for which the Commission deems that added assurance of structural reliability is necessary. The regulations in 10 CFR 50.55a(g)(6)(ii)(D), "Augmented ISI requirements: Reactor vessel head inspections," require augmented ISI of

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[2] The licensee initially submitted the request for alternative 2B3-1 under 10 CFR 50.55a(z)(1). In letter dated March 28, 2017, the licensee requested that the application be considered under 10 CFR 50.55a(z)(2) due to sufficient basis to demonstrate hardship provided in the original application.

RVCH penetration nozzles of PWRs in accordance with N-729-1, subject to the conditions specified in paragraphs (2) through (6) of 10 CFR 50.55a(g)(6)(ii)(D).

The regulations in 10 CFR 50.55a(z), "Alternatives to codes and standards requirements," state, in part, that alternatives to the requirements of 10 CFR 50.55a(g) may be used when authorized by the NRC if the licensee demonstrates: (1) the proposed alternatives would provide an acceptable level of quality and safety, or (2) compliance with the specified requirements would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

3.0 TECHNICAL EVALUATION

3.1 The Licensee's Request for Alternative

3.1.1 Affected ASME Code Components

The affected components are five ASME Code Class 1 RVCH penetration nozzles, numbers 74 through 78, at CPNPP, Unit No. 2. The affected components include nozzle base material (UNS N06600) and J-groove partial penetration weld (UNS N06082 or UNS W86182) that attaches the nozzle base material to the underside of the RVCH.

3.1.2 Applicable Code Edition and Addenda

ASME Code Section XI, 2007 Edition through 2008 Addenda, as augmented by N-729-1 as conditioned by 10 CFR 50.55a(g)(6)(ii)(D).

3.1.3 Applicable Code Requirement

Paragraph 10 CFR 50.55a(g)(6)(ii)(D)(1) requires that examinations of the RVCH penetration nozzles be performed in accordance with N-729-1, subject to the conditions specified in paragraphs 10 CFR 50.55a(g)(6)(ii)(D)(2) through (6).

Figure 2 in N-729-1, requires that the volumetric examination of nozzle penetrations with an incidence angle greater than 30 degrees has a required coverage length below the weld of 1.0 inch (in). This length is identified in Figure 2 in N-729-1 as the dimension "a."

3.1.4 Reason for Request

The licensee stated that during refueling outages in 2005 and 2011 (2RF08 and 2RF12, respectfully), the subject five CRDM penetration nozzles were volumetrically examined to a coverage length below the weld identified in Table 1 below.

Table 1: Actual Coverage Length of Five Subject CRDM Nozzles

Penetration Nozzle Number	Nozzle Intersection Angle (degrees)	N-729-1 Required Inspection Length Below the J-groove Weld "a" (in)	Actual Coverage Length (in)
74	48.7	1.0	0.81
75	48.7	1.0	0.30
76	48.7	1.0	0.73
77	48.7	1.0	0.33
78	48.7	1.0	0.36

3.1.5 Proposed Alternative

As an alternative to the required volumetric and surface examination requirements of N-729-1, to the length below the J-groove weld of dimension "a" in Figure 2 of N-729-1, the licensee proposes the use of the attainable ultrasonic examination distances shown in Table 1 in this safety evaluation (SE) for those CRDM nozzles.

3.1.6 Basis for Use

The licensee stated that it had contracted Westinghouse to perform a deterministic fracture mechanics analysis to show that "an assumed flaw of 0.2 inch below the weld will grow to the bottom of the weld toe after 6.6 EFPY [effective full power years], greater than the 6.2 EFPY that is equivalent to 2.25 RIY [reinspection years] at [CPNPP, Unit No. 2]. The assumed flaw is also conservative because the minimum actual inspection coverage is 0.30 inch...."

The licensee also supported its proposed alternative with the fact that no previous primary water stress corrosion cracking had been found in the CPNPP, Unit No. 2, CRDM nozzle or associated J-groove weld during the previous volumetric and bare metal visual examinations. Further, a volumetric leak path assessment would be performed during the upcoming refueling outage to provide defense-in-depth that no leakage from the nozzle or weld would occur for each of the subject nozzles.

3.1.6.1 Hardship Justification

The licensee explained that the limitation in inspection coverage was due to geometric limitations, which prevented the volumetric examination of the five subject nozzles. The licensee noted that the N-729-1 examination coverage could be completed by volumetric, surface or a combination of the two methods. However, the licensee estimated that a radiological dose for performing these surface examinations of the CRDM nozzles would require 2.5 to 3.5 roentgen equivalent man (rem) to inspect all of the CRDM nozzles. Further, the licensee claimed that the outside surface of the nozzle region of interest is threaded and the surface examination results would be of limited value due to the thread geometry.

3.1.7 Duration of Proposed Alternative

The duration of the proposed alternative is for the remainder of the CPNPP, Unit No. 2, third 10-year ISI interval, which will end on August 2, 2024.

3.2 NRC Staff Evaluation

Pressurized-water reactors have experienced primary water stress corrosion cracking in RVCH CRDM nozzles as the result of the combination of susceptible material, such as nickel-based Alloy 600 or Alloy 82/182 weld metal, sufficient environment, and tensile stresses. The examination and analysis requirements of N-729-1, as conditioned by 10 CFR 50.55a(g)(6)(ii)(D), are intended to monitor to provide reasonable assurance of leak tightness and structural integrity of CRDM penetration nozzles and associated J-groove welds.

The licensee identified five CRDM nozzles for which the full volumetric inspection requirement of N-729-1 could not be met due to a geometric limitation. Under N-729-1, the licensee may supplement the volumetric examination with a surface examination of the missed inspection areas. However, the licensee has noted that to perform such a surface examination would require a radiological dose estimate of 2.5 to 3.5 rem to perform all of the required examinations. The NRC staff recognizes and confirms these hardships on the licensee to perform the full inspection requirements of N-729-1. Due to these hardships, the licensee submitted a proposed alternative to the NRC under 10 CFR 50.55a(z)(2) to request that compliance with the specified requirements of N-729-1 would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety. The licensee's proposed alternative is to volumetrically inspect each of the CRDM nozzles to the extent possible listed in Table 1 of this SE.

In order to demonstrate that the proposed alternative would maintain the same level of quality and safety, the licensee performed a deterministic fracture mechanics analysis to show that any hypothetical crack in the uninspected region would not grow into the reactor coolant pressure boundary portion of the CRDM nozzle or associated J-groove weld within the time period for the next volumetric examination of the CRDM nozzles in accordance with N-729-1. The NRC staff reviewed the licensee's analysis and performed an independent analysis to verify the licensee's conclusions.

The licensee's analysis assumed an axial flaw of 0.2 inches below the weld will grow to the bottom of the weld toe after 6.6 EFPY, greater than the 6.2 EFPY that is equivalent to 2.25 RIY at CPNPP, Unit No. 2. The NRC notes that a circumferential flaw could spiral in a way to interact with the reactor coolant pressure boundary, due to the weld residual stresses in the location, previous operating experience for the predominance of axial cracking, and the direct growth path of an axial flaw. The NRC staff determined that the axial flaw in this specific condition is the limiting safety significant flaw type.

The NRC staff notes that the licensee used the proper inspection frequency criteria of 2.25 RIY, as defined in N-729-1. The NRC staff also confirmed that given an estimated RVCH temperature of 294 degrees Celsius (561 degrees Fahrenheit), the CRDM nozzles at CPNPP, Unit No. 2, are required to be volumetrically inspected prior to reaching 6.21 EFPY from the previous volumetric inspection. Since these inspections must be performed while the reactor is shut down and the RVCH is removed, these exams are performed during scheduled refueling outages. In order to ensure the 2.25 RIY criteria is not exceeded, a licensee will typically perform the volumetric examination the outage before the operating cycle in which 2.25 RIY is met. As such, the NRC determined that the 6.2 EFPY estimation by the licensee to be adequate and conservative for the amount of operating time between required volumetric inspections.

The NRC staff performed an independent flaw evaluation to validate the licensee's analysis. The NRC staff used the licensee's head temperature estimation and nozzle dimensional information supplied in the licensee's request for alternative. The NRC staff also used the licensee's weld residual stress profile, but evaluated it against other weld residual stress profiles for similar nozzles including those provided in the Electric Power Research Institute report "Materials Reliability Program [MRP]: Generic Evaluation of Examination Coverage Requirements for Reactor Pressure Vessel Head Penetration Nozzles, Revision 1 (MRP-95R1)" (not publicly available; proprietary information). The NRC staff analysis required a conservative third order polynomial fit of the weld residual stress profile. The NRC staff also conservatively assumed a through-wall axial flaw. The NRC staff analysis found that the time for a flaw to grow from 0.2 inches below the 48.7 degree nozzle at CPNPP was only 5 EFPY. The NRC staff analysis also found that the time for a flaw to grow from 0.3 inches below the weld of a 48.7 degree nozzle at CPNPP was greater than 8.2 EFPY. The NRC staff notes there is significant variability in performing flaw analysis based on the inputs, assumptions, and methods. While the licensee's calculation of 6.6 EFPY was not as conservative as the NRC staff's 5 EFPY calculation, the NRC staff's calculation of greater than 8.2 EFPY for a flaw to grow from 0.3 inches below the J-groove weld, does support the licensee's conclusion of its flaw analysis. The licensee concluded that it would take an axial flaw significantly longer than the 6.2 EFPY (conservatively stated as the time between volumetric inspections of the CRDM nozzles) to grow from the uninspected area of the CRDM nozzle, minimum of 0.3 inches below the weld, to the J-groove weld, and thereby the reactor coolant pressure boundary. Further, it would take such a flaw longer to grow to a point to cause leakage. Therefore, the NRC staff confirms the licensee's conclusion of the flaw analysis that no hypothetical flaw missed in the uninspected region should challenge the structural integrity or leak-tightness of the RVCH under the current N-729-1 volumetric inspection frequency.

The NRC staff also notes that the licensee has not identified previous indications of primary water stress corrosion cracking in any CRDM nozzles or associated J-groove welds at CPNPP, Unit No. 2. As such, the NRC has found the current volumetric inspection frequency of N-729-1 is adequate to provide reasonable assurance of structural integrity of the RVCH. If a crack were to be identified in a CRDM nozzle or associated J-groove weld during the duration of this proposed alternative, due the current regulatory requirements of N-729-1, as conditioned by 10 CFR 50.55a(g)(6)(ii)(D), volumetric and visual inspections would be increased to each refueling outage. The NRC staff determined that the lack of cracking in the RVCH at CPNPP, Unit No. 2, provides some additional assurance, while regulatory requirements are in place to ensure if cracking were to occur, the basis for this proposed alternative would not be invalidated.

Given the sufficiency of the licensee's technical basis to ensure structural integrity and leak-tightness, the NRC staff determined that the licensee's conditions of hardship is sufficient to support the licensee's proposed alternative versus the regulatory requirement. Therefore, the NRC staff concluded that the licensee's proposed alternative is acceptable, and that compliance with the inspection requirements of ASME Code Case N-729-1, for the five subject nozzles of Table 1 of this SE, would result in hardship without a compensating increase in the level of quality and safety per 10 CFR 50.55a(z)(2).

4.0 CONCLUSION

The NRC staff concludes that the proposed alternative provides reasonable assurance of structural integrity of the RVCH and the five subject CRDM penetration nozzles such that complying with the ASME Code requirement would result in hardship or unusual difficulty

without a compensating increase in the level of quality and safety. Accordingly, the NRC staff concludes that the licensee has adequately addressed all of the regulatory requirements set forth in 10 CFR 50.55a(z)(2) and 10 CFR 50.55a(g)(6)(ii)(D). Therefore, the NRC staff authorizes the use of request for alternative 2B3-1 at CPNPP, Unit No. 2, for the remainder of the third 10-year ISI interval for CPNPP, Unit No. 2, which will end on August 2, 2024.

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

Principal Contributor: Jay Collins

Date: April 7, 2017

SUBJECT: COMANCHE PEAK NUCLEAR POWER PLANT, UNIT NO. 2 – REQUEST FOR ALTERNATIVE 2B3-1 REGARDING EXAMINATION OF REACTOR VESSEL CLOSURE HEAD PENETRATION NOZZLES (CAC NO. MF9282) DATED APRIL 7, 2017

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