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

August 7, 2020

Mr. Rod L. Penfield
Site Vice President
Energy Harbor Nuclear Corp.
Beaver Valley Power Station
Mail Stop P-BV-SSEB
P.O. Box 4, Route 168
Shippingport, PA 15077

SUBJECT: BEAVER VALLEY POWER STATION, UNIT 2 – ISSUANCE OF RELIEF REQUESTS 2-TYP-4-RV-06 AND 2-TYP-4-RV-07 FROM THE REQUIREMENTS OF THE ASME CODE (EPID L-2020-LLR-0053 AND EPID L-2020-LLR-0054 [COVID-19])

Dear Mr. Penfield:

By letters dated April 2, 2020, and April 3, 2020 (Agencywide Documents Access and Management System (ADAMS) Accession Nos. ML20093E657 and ML20094G936, respectively), Energy Harbor Nuclear Corp. (the licensee) requested relief from the inservice inspection requirements of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), Section XI Code Cases at Beaver Valley Power Station, Unit 2.

Specifically, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) 50.55a(z)(2), the licensee requested to use the proposed alternatives in requests 2-TYP-4-RV-06 and 2-TYP-4-RV-07 on the basis that complying with the requirements of Code Cases N-722-1 and N-770-2 would result in hardship or unusual difficulty, without a compensating increase in the level of quality and safety.

The U.S. Nuclear Regulatory Commission (NRC) staff concludes that requests 2-TYP-4-RV-06 and 2-TYP-4-RV-07 will provide reasonable assurance of structural integrity of subject hot leg welds and bottom mounted instrumentation penetrations until the next scheduled bare metal visual examinations to be performed in fall 2021. The NRC staff finds that complying with the requirements of the Code Cases N-722-1 and N-770-2 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 the regulatory requirements set forth in 10 CFR 50.55a(z)(2). Therefore, the NRC authorizes the use of requests 2-TYP-4-RV-06 and 2-TYP-4-RV-07 at Beaver Valley Power Station, Unit 2, until the next scheduled refueling outage (2R22) in fall 2021.

The enclosed safety evaluation documents the technical basis for the NRC's verbal authorization of April 9, 2020 (ADAMS Accession No. ML20100N322).

All other requirements in ASME Code, Section XI; 10 CFR 50.55a(g)(6)(ii)(E); and 10 CFR 50.55a(g)(6)(ii)(F) for which relief was not specifically requested and approved in

these two requests remain applicable, including third-party review by the Authorized Nuclear Inservice Inspector.

If you have any questions, please contact Jennifer Tobin, Project Manager, at 301-415-2328 or by e-mail to Jennifer.Tobin@nrc.gov.

Sincerely,

James G. Danna

Digitally signed by James G. Danna
Date: 2020.08.07 15:59:55 -04'00'

James G. Danna, Chief
Plant Licensing Branch I
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-412

Enclosure:
Safety Evaluation

cc: Listserv

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

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELIEF REQUESTS 2-TYP-4-RV-06 AND 2-TYP-4-RV-07

REGARDING ALTERNATE EXAMINATION OF HOT LEG DISSIMILAR METAL BUTT WELDS

AND BOTTOM MOUNTED INSTRUMENTATION PENETRATIONS

ENERGY HARBOR NUCLEAR CORP.

BEAVER VALLEY POWER STATION, UNIT 2

DOCKET NO. 50-412

1.0 INTRODUCTION

By letters dated April 2, 2020, and April 3, 2020 (Agencywide Documents Access and Management System (ADAMS) Accession Nos. ML20093E657 and ML20094G936), Energy Harbor Nuclear Corp. (the licensee) requested relief from the inservice inspection (ISI) requirements of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), Section XI Code Cases at Beaver Valley Power Station, Unit 2 (Beaver Valley 2).

Specifically, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) 50.55a(z)(2), the licensee requested to use the proposed alternatives in requests 2-TYP-4-RV-06 and 2-TYP-4-RV-07 on the basis that complying with the requirements of ASME Code Cases N-722-1 and N-770-2 would result in hardship or unusual difficulty, without a compensating increase in the level of quality and safety.

For pressurized water reactors (PWRs), Title 10 of the *Code of Federal Regulations* (10 CFR) paragraph 50.55a(g)(6)(ii)(E) mandates the use of ASME Code Case N-722-1, "Additional Examinations for PWR Pressure Retaining Welds in Class 1 Components Fabricated With Alloy 600/82/182 Materials Section XI, Division 1," to perform bare metal visual examinations of ASME Code Class 1 components that are fabricated with nickel-based Alloy 600 material and welds that use nickel-based Alloy 82/182 filler metal.

In addition, 10 CFR 50.55a(g)(6)(ii)(F) mandates the use of ASME Code Case N-770-2, "Alternative Examination Requirements and Acceptance Standards for Class 1 PWR Piping and Vessel Nozzle Butt Welds Fabricated With UNS N06082 or UNS W86182 Weld Filler Material With or Without Application of Listed Mitigation Activities," to perform bare metal visual examinations and volumetric examinations of ASME Code Class 1 welds that use nickel-based Alloy 82/182 filler metal.

The licensee submitted request 2-TYP-4-RV-06 to eliminate the bare metal visual examination in the Beaver Valley 2 spring 2020 refueling outage (RFO) (2R21) for the three dissimilar metal butt welds: 2RCS-REV21-N-24, 2RCS-REV21-N-26, and 2RCS-REV21-N-28, which join the reactor vessel nozzles to the safe ends of the hot legs. Also, the licensee submitted request 2-TYP-4-RV-07 to defer the bare metal visual examination of the Unit 2 reactor vessel bottom mounted instrumentation (BMI) penetrations from the spring 2020 RFO to the fall 2021 RFO (2R22).

The NRC verbally authorized the licensee's requests on April 9, 2020 (ADAMS Accession No. ML20100N322).

2.0 REGULATORY EVALUATION

Adherence to Section XI of the ASME Code is mandated by 10 CFR 50.55a(g)(4), which states, in part, that ASME Code Class 1, 2, and 3 components will meet the requirements, except the design and access provisions and the preservice examination requirements, set forth in the ASME Code, Section XI.

Pursuant to 10 CFR 50.55a(g)(6)(ii), "Augmented ISI program," the U.S. Nuclear Regulatory Commission (NRC or the Commission) may require licensees to follow an augmented ISI program for systems and components for which the Commission deems that added assurance of structural reliability is necessary.

The regulation at 10 CFR 50.55a(g)(6)(ii)(E), "Augmented ISI requirements: Reactor coolant pressure boundary visual inspections," requires PWR plants to augment their ISI of ASME Code Class 1 components that are fabricated from Alloy 600/82/182 materials based on Code Case N-722-1 with conditions.

The regulation at 10 CFR 50.55a(g)(6)(ii)(F), "Augmented ISI requirements: Examination requirements for Class 1 piping and nozzle dissimilar-metal butt welds," (1), "Implementation," requires licensees to implement the requirements of Code Case N-770-2, subject to the conditions specified in paragraphs (g)(6)(ii)(F)(2) through (13) of 10 CFR 50.55a.

Paragraph 50.55a(z) of 10 CFR states, in part, that alternatives to the requirements of paragraphs (b) through (h) of 10 CFR 50.55a, or portions thereof, may be used when authorized by the Director, Office of Nuclear Reactor Regulation. A proposed alternative must be submitted and authorized prior to implementation. The applicant or licensee must demonstrate that: (1) the proposed alternative would provide an acceptable level of quality and safety; or (2) compliance with the specified requirements of this section would result in hardship or unusual difficulty, without a compensating increase in the level of quality and safety.

Based on the above, and subject to the following technical evaluation, the NRC staff finds that regulatory authority exists for the licensee to request the use of an alternative and the NRC to grant relief and the use of the proposed alternative.

3.0 TECHNICAL EVALUATION

3.1 ASME Code Components Affected

Request 2-TYP-4-RV-06

The affected components are three reactor vessel hot leg nozzle-to-safe end dissimilar metal butt welds: 2RCS-REV21-N-24, 2RCS-REV21-N-26, and 2RCS-REV21-N-28. These ASME Code Class 1 welds are required to be examined in accordance with Item A-2 in Table 1 of Code Case N-770-2 and Item B15.90 in Table 1 of Code Case N-722-1.

Request 2-TYP-4-RV-07

The affected components are the ASME Code Class 1 reactor vessel BMI penetrations, 2 REV-BMI-PENE-OD, numbers 1 through 50. The BMI penetrations are required to be examined in accordance with Item B15.80 in Table 1 of Code Case N-722-1.

3.2 Applicable Code Edition and Addenda

The applicable Code edition and addition is ASME Code, Section XI, 2013 Edition.

3.3 Applicable Code Requirement

Paragraph (g)(6)(ii)(E) of 10 CFR 50.55a states, "All licensees of pressurized water reactors must augment their inservice inspection program by implementing ASME Code Case N–722–1, subject to the conditions specified in paragraphs (g)(6)(ii)(E)(2) through (4) of this section." Table 1, "Examination Categories," of ASME Code Case N-722-1, states that for item B15.90, "Hot leg nozzle-to-pipe connections," the weld surface must be bare-metal visually examined each RFO.

Paragraph (g)(6)(ii)(F) of 10 CFR 50.55a states, "Holders of operating licenses or combined licenses for pressurized-water reactors as of or after June 3, 2020, shall implement the requirements of ASME BPV Code Case N-770-5 instead of ASME BPV Code Case N-770-2, subject to the conditions specified in paragraphs (g)(6)(ii)(F)(2) through (15) of this section…" Table 1, "Examination Categories," of ASME Code Case N-770-2 states that for item A-2, "Unmitigated butt weld at hot leg operating temperature ≤ 625°F," the weld surface must be visually examined each RFO.

3.4 Reason for Request

The licensee plans to start the 21st RFO (2R21) at Beaver Valley 2 on April 12, 2020. The visual examination of the subject hot leg nozzle welds and BMI penetrations is required to be performed in the 2R21 RFO in accordance with the schedule in ASME Code Case N-770-2 and ASME Code Case N-722-1.

The licensee stated that on March 13, 2020, the President of the United States declared a national emergency due to the spread and infectious nature of the Coronavirus-2019 (COVID-19) virus and resulting pandemic. The most recent guidance from the Centers for Disease Control and Prevention includes recommendations for social distancing by maintaining approximately 6 feet from other personnel to limit the spread of the virus. On March 28, 2020, the Governor of Pennsylvania issued a stay-at-home order for Beaver County and the

surrounding counties of Allegheny and Butler. Furthermore, on March 28, 2020, the Department of Homeland Security identified workers in the nuclear energy sector as essential critical infrastructure workers.

To prevent the spread of COVID-19 and to protect the health and safety of plant personnel while maintaining responsibilities to support critical infrastructure, the licensee intends to reduce the amount of personnel on site, which will pose a hardship for completing the currently planned 2R21 RFO work scope. The licensee has a contingency plan in case some of its workforce becomes unavailable due to the COVID-19 outbreak. The licensee stated that with the current work scope and potential loss of personnel, it may not be able to complete the RFO in a timely manner, which could affect critical infrastructure that is needed during this time.

The licensee submitted both relief requests considering the expected hardship of obtaining and maintaining onsite staff sufficient to prepare, perform, and recover from the examination. The licensee stated that the examination of subject hot leg nozzle welds requires workers to open hatches in the floor of the refueling cavity, install temporary lighting, remove neutron shield material, and remove insulation. Additional contract and onsite staff are required to perform radiological surveys and perform the weld examinations. The licensee further stated that the examination of BMI penetrations requires setup by construction trades to establish a temporary fall protection connection point, install temporary lighting, remove a hatch in the reactor support structure, and remove insulation. Also required are other contract and onsite staff to establish ventilation, perform radiological surveys, and perform the examination.

The licensee reported that visually examining the subject hot leg nozzle welds and BMI penetrations creates a hardship due to expected challenges with obtaining and maintaining staffing levels sufficient to perform the examinations during the 2R21 RFO because of the COVID-19 pandemic. The licensee stated that elimination of these examinations could reduce the risk of exposure to the COVID-19 virus for critical contractor and plant personnel to.

3.5 Proposed Alternative

In request 2-TYP-4-RV-06, the licensee asked for relief not to perform the bare metal visual examination of the subject hot leg nozzle welds during the 2R21 RFO. However, the licensee stated that it will perform the bare metal visual examination of the subject hot leg nozzle welds during the next RFO (2R22) and subsequent RFOs in accordance with the requirements of Code Cases N-770-2 and N-722-1.

In request 2-TYP-4-RV-07, the licensee asked for relief to defer the bare metal visual examination of the BMI penetrations from the current 2R21 RFO to the next RFO (2R22), which is scheduled for fall 2021. After the deferral, the licensee will follow the examination frequency of every other RFO in accordance with Code Case N-722-1.

3.6 Basis for Use

The primary degradation mechanism addressed by the examination requirements of Code Cases N-770-2 and N-722-1 is primary water stress corrosion cracking (PWSCC). This degradation mechanism occurs when a susceptible material is exposed to a primary water environment, elevated stress levels, and high operating temperatures. The licensee noted that BMI penetrations experience approximate cold leg temperatures and, therefore, are less susceptible to PWSCC.

The proposed alternative is based on past Beaver Valley 2 inspection results, industry operating experience, compensatory actions that would detect leakage if it were to occur, and the chemical mitigation benefits that result from zinc addition to the reactor coolant system (RCS) as follows.

Examination History

The licensee stated that Beaver Valley 2 operating cycles are approximately 18 months. The licensee examined the subject hot leg nozzle welds during the 2R14 RFO (fall 2009), 2R15 RFO (spring 2011), 2R16 RFO (fall 2012), 2R18 RFO (fall 2015), 2R19 RFO (spring 2017), and 2R20 RFO (fall 2018). In the latest examination performed during the 2R20 RFO, the licensee obtained full examination coverage of the subject hot leg nozzle welds using both ultrasonic and eddy current testing in accordance with the requirements of Code Case N-770-2. The licensee did not identify any pressure boundary leakage or corrosion of hot leg nozzle welds during any of the previous visual and ultrasonic examinations.

The licensee visually inspected BMI penetrations during the 2R12 RFO (fall 2006), 2R13 RFO (spring 2008), 2R14 RFO (fall 2009), 2R15 RFO (spring 2011), 2R17 RFO (spring 2014), and 2R19 RFO (spring 2017). The licensee did not find any indications of pressure boundary leakage in the BMI penetrations or corrosion of the adjacent ferritic steel components during the previous examinations.

Industry Operating Experience

The licensee stated that with respect to reactor vessel hot leg nozzle weld examinations, PWSCC flaws are generally discovered using ultrasonic examination techniques. The licensee indicated that the industry hot leg nozzle PWSCC indications that have been discovered to date were found prior to the issuance of Code Case N-770-2. The licensee stated that the ultrasonic examinations at Beaver Valley 2 are performed at the frequency required by Code Case N-770-2; therefore, it has addressed the relevant ultrasonic examination operating experience to ensure that any PWSCC flaws in the Beaver Valley 2 hot leg nozzles would be discovered and mitigated before they would become a safety concern.

The licensee noted that recent industry operating experience revealed that a visual examination did identify leakage in a reactor vessel nozzle weld. However, this was the first flaw identified in a reactor vessel hot leg nozzle weld, and it was identified prior to the time that more routine examinations were required. The licensee stated that for the case where through-wall flaw occurred in the reactor vessel hot leg nozzle weld, significant repairs were performed in the nozzle weld during the construction of the plant that would have likely increased its PWSCC susceptibility. The licensee reported that its available records did not identify any known weld repairs within the Beaver Valley 2 reactor vessel hot leg nozzle welds.

Regarding BMI penetrations, the licensee found that only one nuclear plant constructed with Westinghouse systems has experienced BMI penetration leakage. The two leaks found at the nuclear plant were associated with a lack of fusion in the attachment weld during the construction. The two leaks were identified relatively early in the life of that plant and would likely have been identified by this point in the operating life of Beaver Valley 2 if similar flaws were to exist there. Additionally, one nuclear plant constructed with Combustion Engineering systems has experienced BMI penetration leakage. The leakage in the BMI penetration at the Combustion Engineering plant was attributed to a void in the attachment weld material that

promoted PWSCC in the weld and nozzle materials. The licensee stated that Beaver Valley 2 does not have the similar conditions of these plants.

Compensatory Measures

The licensee stated that without inspecting the hot leg nozzle welds directly in the 2R21 RFO, there are other inspections and equipment in the area that would identify a leak, should one occur. The general area around and below the reactor is examined as part of the pressure test program walkdown during Mode 3 startup. The licensee indicated that any leakage noted would be investigated to determine the source. During operation, an increase in radiation levels within containment would be noted if significant leakage occurred.

The licensee stated that without inspecting the BMI penetrations directly in the 2R21 RFO, leakage may still be detected if present. The general area beneath the bottom of the reactor vessel is examined as part of the pressure test program walkdown during Mode 3 startup. Also, a leak or increase in radiation levels within containment would be captured in the containment sump and detected by radiation monitoring during operation if a leak were to develop from the BMI penetrations.

The licensee stated that it implemented zinc addition to the primary reactor coolant at Beaver Valley 2 in October 2010, and the zinc deposits have been building since that time. The licensee further stated that zinc addition decreases the PWSCC susceptibility of Alloy 600/82/182 components in the RCS, including the reactor vessel hot leg nozzles and BMI nozzles. The progress of the zinc buildup on the primary system surfaces is measured in terms of parts per billion (ppb)-months, which is the product of the concentration of zinc in the chemical mitigation and the time over which it has been applied. The licensee reported that in October 2017, the plant reached 300 parts ppb-months, at which time significant chemical mitigation against PWSCC was achieved. According to the licensee, this decreases the PWSCC susceptibility of the subject hot leg nozzle welds and BMI nozzles.

The licensee stated that Westinghouse report, WCAP-16372-P, “Beaver Valley Alloy 600 Decision Advisor Report,” published in 2005, recommends actions for various Alloy 600 components in response to industry experiences at the time. The analysis performed in WCAP-16372-P used the crack growth rates contained in Electric Power Research Institute report MRP-21, “Crack Growth of Alloy 182 Weld Metal in PWR Environments,” published in 2000 for weld material, and in report MRP-55, “Crack Growth Rates for Evaluating Primary Water Stress Corrosion Cracking (PWSCC) of Thick-Wall Alloy 600 Material,” published in 2002 for base material. In WCAP-16372-P, Westinghouse determined that the probability of PWSCC initiation and flaw growth leading to a leak in the BMI penetrations is under 1 percent at the end of plant life, including the current license extension. Westinghouse determined the probability of crack initiation using a Weibull failure model. Westinghouse used the crack growth model in MRP-55 to determine the anticipated crack growth rates in the BMI penetration materials.

Westinghouse’s analysis assumed 50 effective full power years (EFPY) of operation. Currently, Beaver Valley 2 is at 27.8 EFPY, approximately halfway to the life required to reach the <1 percent probability. These probabilities were calculated without taking zinc addition into account, and WCAP-16372-P states that a significant reduction in risk is introduced with the zinc addition. The licensee stated that this provides reasonable assurance that at this point in the life of Beaver Valley 2, the detection of a leak during the 2R21 RFO due to PWSCC is unlikely.

Leakage Detection Capabilities

The licensee stated that Beaver Valley 2 has an integrated leakage monitoring program that monitors potential RCS leakage from the hot leg nozzle welds or BMI penetrations. According to the licensee, the RCS water inventory balance is calculated by plant-specific procedures, with a surveillance test requirement to be performed every 72 hours. The RCS integrated leakage program provides guidance where the RCS leakage is quantified and compared to the recent history of RCS leakage to verify if current changes are outside normally expected values.

The RCS integrated leakage program includes the following guidance to determine if any program action level criteria are exceeded.

Level 1	Is the rolling average of the last seven performances of unidentified RCS leak rate greater than 0.1 gallons per minute (gpm)?
Level 1	Are the last nine consecutive unidentified RCS leak rates greater than baseline mean?
Level 2	Are the last two consecutive unidentified RCS leak rates greater than 0.15 gpm?
Level 2	Are the last two consecutive unidentified RCS leak rates greater than [mean unidentified RCS leakage + 2 standard deviation]?
Level 3	Is this unidentified RCS leak rate greater than 0.3 gpm?
Level 3	Is this unidentified RCS leak rate greater than [mean + 3 standard deviation]?

The licensee stated that the 0.1 gpm leak rate is consistent with the criteria in WCAP-16465-NP, "Pressurized Water Reactor Owners Group Standard RCS Leakage Action Levels and Response Guidelines for Pressurized Water Reactors," and is one-tenth of the technical specification (TS) limit for unidentified leakage. The RCS integrated leakage program includes the requirement to identify the leakage source and could include entering containment to identify the source of the leakage. If the source of the leakage is found and isolated, the program directs operation personnel to re-perform an RCS leak rate calculation to confirm that the source of leakage has been addressed.

As part of leakage monitoring, the licensee reviews the RCS leakage against the leakage criteria in the plant TSs. Depending on the source identified, a shutdown could be required in accordance with TS Limiting Condition for Operation (LCO) 3.4.13, which has the following specific limits:

a. No pressure boundary leakage,
b. 1 gpm unidentified leakage,
c. 10 gpm identified leakage, and
d. 150 gallons per day primary to secondary leakage through any one steam generator.

The licensee indicated that a through-wall leak from a reactor vessel hot leg nozzle weld or a BMI nozzle would constitute pressure boundary leakage. The licensee further stated that should any of these limitations be exceeded, the appropriate LCO would be entered and the required actions performed within the specified completion time, including plant shutdown if required.

3.7 Duration of Proposed Alternative

For request 2-TYP-4-RV-06, the licensee requested relief to eliminate the visual examination of the hot leg nozzle welds during the 2R21 RFO. The licensee stated that it will resume the normal outage examination frequency at the next opportunity, currently expected to be the next RFO (2R22) in fall 2021.

For request 2-TYP-4-RV-07, the licensee stated that the proposed alternative will remain in effect until the next reasonable opportunity for examination. Currently, this opportunity would be during the next RFO (2R22) in fall 2021. After performing the examination in the 2R22 RFO, the normal Code case-required examination frequency of every other outage would resume.

3.8 NRC Staff Evaluation

The NRC staff evaluates the proposed alternatives in the key areas of hardship, examination history, industry operating experience, compensatory measures, RCS leakage detection capabilities, and structural integrity of the subject components.

Hardship

The NRC staff recognizes the severity of the COVID-19 virus as shown in the declaration of the national emergency by the President of the United States and by the stay-at-home order of the governor of Pennsylvania. The NRC staff finds that should the required visual examinations of the subject hot leg nozzle welds and BMI penetrations be performed during the spring 2020 RFO, the COVID-19 virus may be introduced into the plant and affect many plant operating personnel, which would jeopardize the safe operation of the plant. The NRC staff determines that the required examinations would not increase the plant safety when evaluated against the potential negative consequence of virus-infected plant personnel. Therefore, the NRC staff finds that the required examinations of the hot leg nozzle welds and BMI penetrations are a hardship, without a compensating increase in the level of quality and safety of the plant.

Examination History

The NRC staff notes that the subject hot leg nozzle welds are not mitigated to reduce susceptibility to PWSCC. As such, the NRC staff verified that the hot leg nozzle welds are required to be examined under Item A-2 in Table 1 of Code Case N-770-2. Code Case N-770-2 requires the hot leg nozzle welds to be bare-metal visually examined every RFO and ultrasonically examined every 5 years. The licensee requested relief from bare metal visual examination only, not ultrasonic examination, for the current 2R21 RFO (spring 2020). The NRC staff noted that the licensee has visually examined the hot leg nozzle welds from the 2R14 RFO (2009) to the 2R20 RFO (2018) except the 2R17 RFO (2014). The licensee did not visually examine the hot leg nozzle welds in the 2R17 RFO because the licensee performed a volumetric examination of the weld during the 2R17 RFO. Footnote 3 to Table 1 of Code Case N-770-2 permits the use of the volumetric examination in lieu of the bare metal visual examination.

The NRC staff verified that the BMI penetrations are bare metal visually examined every other RFO under Item B15.80 in Table 1 of Code Case N-722-1. The licensee has visually examined the BMI penetrations since the 2R12 RFO (fall 2006) following the inspection schedule in Code Case N-722-1. The licensee reported no degradation was observed in the BMI penetrations.

The NRC staff finds acceptable that the licensee has examined the hot leg nozzle welds and BMI penetrations in accordance with both Code cases, respectively. The NRC staff finds that the examination results have shown that so far, the hot leg nozzle welds and BMI penetrations do not have an active degradation mechanism to challenge their structural integrity.

Industry Operating Experience

As the licensee reported, the NRC staff noted that repairing of a reactor vessel hot leg nozzle weld during the original construction at a nuclear plant caused a through-wall flaw in the later years. The NRC staff recognizes that a repaired weld during the construction is susceptible to cracking in the later years. The licensee indicated that the subject Beaver Valley 2 hot leg nozzle welds were not repaired during their original fabrication.

Regarding BMI penetrations, the NRC staff recognizes the two nuclear plants that had leakage from BMI penetrations. Both leaking events were attributed to fabrication defects in the BMI penetration attachment welds. The licensee stated that BMI penetrations at Beaver Valley 2 do not have the similar welding issue. The NRC staff finds that currently, the hot leg nozzle welds and BMI penetrations at Beaver Valley 2 do not have the similar fabrication issues as found in the affected nuclear plants; therefore, the degradation in industry operating experience may not be applicable to the subject Beaver Valley 2 components at present.

As the licensee discussed above, the zinc addition in the PWR environment may be beneficial to some aspects of system operation. However, the NRC staff notes that stress corrosion cracking has existed in PWRs that have implemented zinc addition. At this point, the NRC staff does not credit the effectiveness of zinc addition in mitigating PWSCC in components that are fabricated with Alloy 600/82/182 material. The NRC staff notes that without considering zinc addition, the licensee has provided the following compensatory measures in terms of walkdowns and leakage detection capabilities to adequately maintain structural integrity of the subject components

Compensatory Measures

The NRC staff finds that the licensee will visually examine (not bare metal visual examination) the general area underneath the reactor vessel during the walkdown as part of the pressure test program while in Mode 3 startup after completion of the spring 2020 RFO. The NRC staff notes that the licensee's pressure test is consistent with the ASME Code, Section XI, IWA-5000, which requires a VT-2 visual examination associated with the system leakage test of the ASME Code Class 1 pressure-retaining components such as hot leg nozzle welds and BMI penetrations. The licensee further stated that any leakage identified during the visual examination would be investigated to determine the source. The NRC staff notes that the licensee-proposed visual examination is not as effective as the bare metal visual examination as required by Code Cases N-722-1 and N-770-2 but is a reasonable compensatory measure.

Leakage Detection Capabilities

Another compensatory measure is the leakage detection capability at Beaver Valley 2 in concert with TS limits. The NRC staff notes that Beaver Valley 2 TS LCO 3.4.13.a prohibits any leakage in the RCS pressure boundary. In addition, TS LCO 3.4.13.b limits unidentified leakage to 1 gpm, and TS LCO 3.4.13.c limits identified leakage to 10 gpm. If a pressure boundary leak occurs, TS 3.4.13 Action Statements A and B require the licensee to perform corrective actions within specific hours to reduce leakage. Specifically, TS 3.4.13 Action Statement B requires

that if the leakage cannot be reduced to within the limits, the plant is required to enter into Mode 3 (hot standby) and eventually enter into Mode 5 (i.e., cold shutdown) within specific timeframes.

The NRC staff determines that to avoid challenging the TS leakage limits, the Beaver Valley 2 RCS integrated leakage program has procedures and actions to monitor leakage when the leakage reaches certain administrative limits. The NRC staff notes that the RCS integrated leakage program has a low administrative limit of and can detect a leak rate as low as 0.1 gpm, which provides an adequate margin with respect to the TS limit of 1 gpm. The NRC staff finds that the RCS integrated leakage program requires the licensee to identify the leakage source. If the leakage is found and isolated, the licensee is required to re-perform the RCS leak rate calculation to confirm that the leakage has been addressed. The NRC staff noted that during operation, an increase in radiation levels within containment would be detected if there was significant leakage.

The NRC staff finds that the Beaver Valley 2 RCS integrated leakage program has adequate procedures to detect and monitor potential leakage from the hot leg nozzle welds and BMI penetrations to ensure the TS leakage limits are not challenged.

Structural Integrity

The NRC staff noted that the licensee has a plant-specific analysis performed by Westinghouse regarding potential crack growth in BMI penetrations. The licensee determined that that the probability of PWSCC initiation and flaw growth leading to a leak in the BMI penetrations is under 1 percent at the end of plant life, including the current license extension. The NRC staff did not review the Westinghouse analysis because it finds that the licensee has provided sufficient information to justify structural integrity of the BMI penetrations under the proposed alternative.

The NRC staff further notes that the material used in the subject hot leg nozzle welds and BMI penetrations has sufficient fracture toughness to resist sudden crack propagation. If a flaw does occur during normal operation, the likely scenario is that the flaw will grow slowly to become 100 percent through-wall in a localized area, and a leak will occur rather than a sudden catastrophic failure. If leakage does occur, the RCS leakage detection systems can detect a leak rate of 0.1 gpm and will alert the plant personnel to take corrective actions. Based on the industry operating experience, the NRC staff finds that a flaw that causes a leak rate of 0.1 gpm would be small and would not challenge structural integrity of the subject components.

Summary

The NRC staff finds reasonable assurance that structural integrity of the subject hot leg nozzle welds and BMI penetrations will be adequately maintained because (1) the subject hot leg nozzle welds and BMI penetrations have not shown degradation in the past inspections, (2) the licensee's RCS integrated leakage program has the capability of detecting a small leak rate of 0.1 gpm, (3) the licensee has administrative leakage limits with associated actions to ensure leakage will not reach TS limits, (4) the fracture toughness of the material used in the subject components will resist uncontrollable flaw propagation, and (5) the licensee will perform a VT-2 visual examination of the subject components as part of system leakage test at the end of the spring 2020 RFO.

4.0 CONCLUSION

The NRC staff concludes that requests 2-TYP-4-RV-06 and 2-TYP-4-RV-07 will provide reasonable assurance of structural integrity of subject hot leg nozzle welds and BMI penetrations until the next scheduled bare metal visual examinations to be performed in fall 2021. The NRC staff finds that complying with the requirements of ASME Code Cases N-722-1 and N-770-2 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 the regulatory requirements set forth in 10 CFR 50.55a(z)(2). Therefore, the NRC authorizes the use of requests 2-TYP-4-RV-06 and 2-TYP-4-RV-07 at Beaver Valley 2 until the next scheduled RFO (2R22) in fall 2021.

All other requirements in ASME Code, Section XI; 10 CFR 50.55a(g)(6)(ii)(E); and 10 CFR 50.55a(g)(6)(ii)(F) for which relief was not specifically requested and approved in these two requests remain applicable, including third-party review by the Authorized Nuclear Inservice Inspector.

Principal Contributor: John Tsao

Date: August 7, 2020

SUBJECT: BEAVER VALLEY POWER STATION, UNIT 2 – ISSUANCE OF RELIEF REQUESTS 2-TYP-4-RV-06 AND 2-TYP-4-RV-07 FROM THE REQUIREMENTS OF THE ASME CODE (EPID L-2020-LLR-0053 AND EPID L-2020-LLR-0054 [COVID-19]) DATED AUGUST 7, 2020

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