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

September 15, 2015

Mr. Randall K. Edington
Executive Vice President Nuclear/
Chief Nuclear Officer
Mail Station 7602
Arizona Public Service Company
P.O. Box 52034
Phoenix, AZ 85072-2034

SUBJECT: PALO VERDE NUCLEAR GENERATING STATION, UNIT 3 – RELIEF REQUEST 53, ALTERNATIVE TO ASME CODE, SECTION XI REQUIREMENTS (TAC NO. MF6083)

Dear Mr. Edington:

By two letters dated April 17, 2015, as supplemented by letters dated April 24 and July 15, 2015 (two letters), Arizona Public Service Company (APS, the licensee), submitted a request to the U.S. Nuclear Regulatory Commission (NRC) for the use of an alternative to certain requirements of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), Section XI, at Palo Verde Nuclear Generating Station, Unit 3 (PVNGS 3).

Pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) 50.55a(z)(1), the licensee proposed to use an alternative repair for the degraded pressure instrument nozzle attached to the safe end of the suction side of reactor coolant pump 2A in lieu of flaw removal in accordance with the ASME Code, Section XI, IWA-4421. The licensee requested to use the proposed alternative on the basis that the alternative provides an acceptable level of quality and safety.

The NRC staff has reviewed the subject request and concludes, as set forth in the enclosed safety evaluation, that APS has adequately addressed all of the regulatory requirements set forth in 10 CFR 50.55a(z)(1). Therefore, the NRC authorizes the use of Relief Request 53 at PVNGS 3 until the end of the 19th refueling outage, which is currently scheduled for fall 2016.

The NRC staff provided verbal authorization for Relief Request 53 during a teleconference with your staff on April 24, 2015.

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

The detailed results of the NRC staff review are provided in the enclosed safety evaluation. If you have any questions concerning this matter, please contact Ms. Margaret Watford or my staff at (301) 415-1233 or via e-mail at Margaret.Watford@nrc.gov.

Sincerely,

for

Michael T. Markley, Chief
Plant Licensing Branch IV-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-530

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

RELIEF REQUEST 53 REGARDING PROPOSED ALTERNATIVE FOR

REPAIR OF INSTRUMENT NOZZLE AT REACTOR COOLANT PUMP 2A

ARIZONA PUBLIC SERVICE COMPANY

PALO VERDE NUCLEAR GENERATING STATION, UNIT 3

DOCKET NO. 50-530

1.0 INTRODUCTION

By two letters dated April 17, 2015 (Agencywide Documents Access and Management System (ADAMS) Accession Nos. ML15111A422 and ML15111A289[(1)]), as supplemented by letters dated April 24 and July 15, 2015 (two letters) (ADAMS Accession Nos. ML15114A431, ML15198A242,[(1)] and ML15198A232, respectively), Arizona Public Service Company (APS, the licensee), submitted a request to the U.S. Nuclear Regulatory Commission (NRC) for the use of an alternative to certain requirements of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), Section XI, at Palo Verde Nuclear Generating Station, Unit 3 (PVNGS 3).

The request for relief would allow an alternative repair for the degraded pressure instrument nozzle attached to the safe end of the suction side of reactor coolant pump (RCP) 2A in lieu of flaw removal in accordance with the ASME Code, Section XI, IWA-4421.

Specifically, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) 50.55a(z)(1), the licensee proposed an alternative repair for the degraded pressure instrument nozzle attached to the safe end of the suction side of RCP 2A in lieu of flaw removal in accordance with the ASME Code, Section XI, IWA-4421. The licensee requested to use the proposed alternative on the basis that the alternative provides an acceptable level of quality and safety. Relief Request 53 seeks approval for a half-nozzle repair of the degraded pressure instrument nozzle without removing flaws in the nozzle based on analyses to show that the repaired nozzle will perform its required functions for the one fuel cycle of approximately 18 months.

On April 24, 2015 (ADAMS Accession No. ML15117A042), the NRC verbally authorized the use of Relief Request 53 at PVNGS 3 for one fuel cycle to the 19th refueling outage. This safety evaluation (SE) provides the technical basis for the NRC's authorization.

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(1) Portions of the licensee's letters dated April 17 and July 15, 2015, contain sensitive unclassified non-safeguards information (proprietary) and, accordingly, have been withheld from public disclosure.

2.0 REGULATORY EVALUATION

Pursuant to 10 CFR 50.55a(g)(4), the ASME Code Class 1, 2, and 3 components (including supports) must meet the requirements, except the design and access provisions and the preservice examination requirements, set forth in the ASME Code, Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components," to the extent practical within the limitations of design, geometry, and materials of construction of the components.

The regulations in 10 CFR 50.55a(z), state that alternatives to the requirements of paragraph (g) of 10 CFR 50.55a may be used, when authorized by the NRC, if the licensee demonstrates that: (1) the proposed alternative provides 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.

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 authorize the proposed alternative.

3.0 RELIEF REQUEST NO. 53

3.1 ASME Code Component Affected

The affected component is ASME Class 1, RCP 2A suction pressure instrument nozzle in the cold leg. The nozzle is attached to the safe end of the RCP 2A. The examination category of the subject nozzle is ASME Code Case N-722-1, Class 1 pressurized-water reactor components containing Alloy 600/82/182. The examination Item Number is B15.205, cold-leg instrument connections of Code Case N-722-1. In addition, the ASME Code, Section XI, Table IWB-2500-1, Examination Category B-P applies to the suction pressure instrument nozzle with respect to the pressure test program.

3.2 Applicable Code Edition and Addenda

PVNGS 3 is currently in its third 10-year inservice inspection (ISI) interval, which ends on January 11, 2018. The Code of record for the third 10-year ISI interval is the ASME Code, Section XI, 2001 Edition with Addenda through 2003, as supplemented by 10 CFR 50.55a(g)(6)(ii)(E), *Augmented ISI Requirements: Reactor Coolant Pressure Boundary Visual Inspections.*

3.3 Applicable Code Requirements

Article IWA-4421 of the ASME Code, Section XI, requires defects to be removed or mitigated.

3.4 Reason for Request

During the boric acid program walkdowns at the beginning of the 18th refueling outage (denoted as 3R18) in spring 2015, the licensee detected leakage at the pressure instrument nozzle that is attached to the safe end on the suction side of RCP 2A. The licensee inspected the extent of condition of the remaining Unit 3 reactor coolant system (RCS) cold-leg instrument nozzles as required by ASME Code Case N-722-1 and found no other RCS pressure boundary leakage.

The licensee stated that repair of the subject instrument nozzle and associated J-groove weld would require removal of the RCP internals. Removing the RCP internals would allow access to the internal surface of the reactor coolant piping in order to grind out the attachment J-groove weld and repair or replace the remaining nozzle. The licensee further stated that such an activity would result in high radiation exposure to the personnel involved and present the additional risk of introducing foreign material into the RCS and reactor core. Additionally, ultrasonic testing (UT) examination of the remnant J-groove weld was not feasible because of its configuration and the restrictive access associated with the small bore of the instrument nozzle internal orifice.

3.5 Proposed Alternative

In lieu of Article IWA-4421 of the ASME Code, Section XI, the licensee proposed to use the half-nozzle method to repair the degraded pressure instrument nozzle in accordance with Westinghouse Electric Company LLC Topical Report (TR) WCAP-15973-P-A, Revision 01, "Low-alloy Steel Component Corrosion Analysis Supporting Small-diameter Alloy 600/690 Nozzle Repair/Replacement Program," which the NRC has found acceptable by letter dated January 12, 2005 (ADAMS Accession No. ML050180528). The proposed alternative requires a portion of the subject nozzle inside the bore of the safe end to be removed. A portion of the base metal around the penetration bore at the outside diameter surface of the safe end will also be removed to prepare for the new attachment J-groove weld. The licensee performed penetrant testing of the bore entrance area prior to installing the new nozzle. A new primary water stress-corrosion cracking (PWSCC)-resistant Alloy 690 nozzle was inserted into the bore of the safe end, leaving a 0.06-inch of gap between the remnant nozzle and the new Alloy 690 nozzle to allow for thermal expansion. The Alloy 690 nozzle is attached to the safe-end base metal with a new J-groove Alloy 52M weld. The pressure boundary was relocated from the original J-groove weld on the interior wall of the safe end to the new J-groove weld on the outside diameter surface of the safe end. The proposed repair will not remove flaws in the remnant J-groove weld or remnant Alloy 600 nozzle.

3.6 Duration of Proposed Alternative

The licensee stated that the duration of the request is the 19th operating fuel cycle ending in the refueling outage U3R19, which is scheduled for fall 2016.

3.7 Basis for Use

As stated above, the proposed alternative uses the repair method in the Westinghouse TR. The licensee performed various evaluations to demonstrate that the Westinghouse TR applies to the subject nozzle repair. The technical basis included (1) the replacement nozzle qualification, (2) the attachment weld qualification, (3) flaw evaluation of remnant nozzle and J-groove weld, (4) vibration assessment, (5) loose parts evaluation, (6) examinations, and (7) response to the NRC-imposed conditions on Westinghouse TR. The licensee compared the loading and geometry of the replacement nozzle and new J-groove weld to the loading and geometry of the hot-leg nozzle analyzed in the Westinghouse TR. The licensee's intent was to demonstrate that the analyses in the Westinghouse TR bound the replacement nozzle and new weld for the one operating fuel cycle duration of the proposed relief request.

3.7.1 Replacement Nozzle Qualification

The licensee considered primary stress, secondary stress, and the fatigue usage factor in the replacement nozzle, as specified in the ASME Code, Section III, subsection NB, 1974 Edition. The licensee considered the required weld reinforcement area, the potential for reduced weld throat due to corrosion, and the design of the socket weld connecting the replacement nozzle to the Class 2 piping. The licensee also considered the following loads: (a) mechanical nozzle loads applied from ASME Class 2 piping, (b) thermal and pressure transient loads, (c) inertial loads due to seismic and pipe break events, and (d) mechanical loads applied from cold-leg piping on the safe end.

The replacement nozzle was qualified by comparing the input loads and geometry to a detailed evaluation of a hot-leg instrumentation nozzle in the Westinghouse TR. The licensee stated that the only significant difference in the geometry of the nozzles is the nozzle length because the replacement half-nozzle is shorter than the compared nozzle. The compared nozzle is also welded to the RCP suction safe end on the inside surface of the RCP rather than on the exterior. However, the difference in the J-groove weld location has been accounted for in the development of nozzle mechanical loads to ensure that the loading evaluated is conservative.

The licensee evaluated the secondary stresses and fatigue usage factors due to pressure and temperature transient loading of the subject instrumentation nozzle by reconciling the input transients with those evaluated in the Westinghouse TR. The licensee noted that the evaluation in the Westinghouse TR was performed for the full life of the plant, while the replacement half-nozzle need only be qualified for 18 months of plant operation. The licensee stated that the proposed replacement nozzle satisfies the requirements of the ASME Code, Section III, subsection NB.

3.7.2 Attachment Weld Qualification

The proposed repair moves the Class 1 pressure boundary to the outside surface of the RCP suction safe end; therefore, the new attachment J-groove weld is treated as a Class 1 component and is designed and evaluated in accordance with the 1974 edition of the ASME Code, Section III, subsection NB. Specifically, the new attachment J-groove weld is designed per the requirements of Section NB-3351.4 as a Category D partial penetration nozzle attachment weld. The licensee stated that the weld depth and fillet leg sizes meet or exceed the required sizing per Figure NB-4244(d)-1 section (c) for a partial penetration connection weld.

The licensee qualified the new attachment J-groove weld based on stress calculations performed in accordance with the ASME Code, Section III. The licensee considered the following loadings when evaluating primary stresses: (a) mechanical nozzle loads applied from Class 2 piping, (b) inertial loads due to seismic and pipe break events, (c) pressure loading in the RCP suction safe end, (d) blow-off pressure load, and (e) mechanical loads applied from cold-leg piping on the suction safe end.

The stresses resulting from the applied loads were combined and compared to applicable stress intensity and shear stress allowable stresses per the ASME Code, Section III, subsection NB, 1974 Edition. The licensee stated that there is sufficient margin in the stress evaluation of primary stresses in the weld. The secondary stresses and fatigue usage factors for the new attachment J-groove weld are evaluated using the same methodology that was used for the nozzle by comparing them to the existing evaluation of a similar nozzle in the Westinghouse TR. The licensee demonstrated that the new attachment J-groove weld satisfies the requirements of the ASME Code, Section III.

The licensee also designed the new ASME Class 2 socket weld at the end of the instrumentation nozzle per the requirements of the ASME Code, Section III, subsection NC-3661.2. The licensee stated that the socket weld stresses are bounded by the qualification of the attached Class 2 piping because the weld is designed according to the sizing rules in Section NC-3661.2.

3.7.3 Flaw Evaluation

The licensee postulated a maximum bounding flaw that propagates axially and circumferentially through the remnant J-groove weld and butter into the carbon steel base material of the safe end. The licensee demonstrated that any flaws in the remnant J-groove weld will not grow to an unacceptable flaw size in the suction safe-end carbon steel metal within the next cycle of operation (18 months).

For Combustion Engineering plants, the licensee stated that the Westinghouse TR postulated bounding flaws including the entire partial penetration J-groove weld at small-bore nozzles in the hot-leg piping for flaw growth and flaw stability as specified in the ASME Code, Section XI, for a plant life of 40 years. As stated by the licensee, Westinghouse demonstrated by analysis that the postulated bounding flaws, which could have been left in place in the remnant J-groove weld after nozzle repairs, are acceptable. The small-bore instrument nozzle repairs evaluated for the hot leg are similar to the proposed Unit 3 half-nozzle repair. The licensee assessed differences between the Unit 3 repair and Westinghouse TR to justify that the flaw evaluation performed for the hot-leg nozzle repair in the Westinghouse TR bound the Unit 3 nozzle repair for the next 18 months of plant operation.

The licensee stated the weld size and bore diameter used in the Westinghouse TR are similar to that of the Unit 3 half-nozzle repair. The thickness of the nozzle used in the Westinghouse TR is 3.75 inches, as compared to the 3.00-inch thickness for the degraded Unit 3 nozzle. The licensee demonstrated that this difference is shown to have an insignificant impact on the fracture mechanics analysis.

The licensee stated that the transient stresses in the Westinghouse TR envelop the transient stresses of the Unit 3 nozzle repair; therefore, the licensee stated the transient stresses used in the allowable flaw size and fatigue crack growth evaluation in the Westinghouse TR bound the transient stresses at the Unit 3 nozzle.

The stress intensity factor model used for the nozzle flaw evaluation in the Westinghouse TR is based on a hole in a flat plate, with two cracks emanating from the corners. The hole diameter used in the Westinghouse TR is similar in size to the hole diameter of the Unit 3 nozzle. The licensee stated that the difference in the thickness of the hot-leg nozzle of 3.75 inches in the Westinghouse TR, as compared to the Unit 3 nozzle thickness of 3.00 inches, will have an insignificant impact on the fracture mechanics analysis and the stress intensity factor calculation. The licensee noted that there is ample margin between the calculated and the allowable stress intensity factors to account for any small changes in component geometries between the Westinghouse TR and the Unit 3 nozzle.

With respect to allowable circumferential flaw size, the licensee stated that the limiting transient was the end of the cooldown transient because of the low temperature that affects the fracture toughness of the component. The licensee stated that the Westinghouse TR performed fracture mechanics evaluations according to the 1992 Edition of the ASME Code, Section XI, where IWB-3612 determined acceptability for normal and upset condition transients based on the criterion, $K_I < K_{Ia}/\sqrt{10}$, where K_I is the applied stress intensity factor and K_{Ia} is the fracture toughness based on crack arrest. However, the licensee stated that Unit 3 uses the 2001 Edition with 2003 Addenda Section XI, ASME Code as the code of record. The acceptance criterion for normal and upset condition transients in IWB-3612 in the 2001 Edition with 2003 Addenda of Section XI of the ASME Code is based on the criterion, $K_I < K_{Ic}/\sqrt{10}$, where K_{Ic} is fracture toughness based on crack initiation. Since K_{Ic} is less limiting than K_{Ia}, the calculated axial and circumferential flaw stress intensity factors for the end of cooldown transient would have additional margin over the allowable factors based on the current ASME Code, Section XI, edition that is applicable to Unit 3.

The licensee stated that the nil-ductility reference temperature (RT_{NDT}) value of 60 degrees Fahrenheit (°F) was used in the allowable stress intensity factor calculation for the hot-leg base metal in the Westinghouse TR. For the Unit 3 safe end, the RT_{NDT} is 40 °F or less according to the Unit 3 RCP suction safe-end Certified Material Test Report and Updated Final Safety Analysis Report Table 5.2-29B. Therefore, the licensee stated that the lower RT_{NDT} value of 40 °F would result in a less limiting allowable flaw size than the RT_{NDT} of 60 °F. As such, the allowable flaw size evaluation performed in Westinghouse TR would be conservatively representative for the Unit 3 suction safe-end instrumentation nozzle repair.

The licensee noted that the fatigue crack growth evaluation performed in the Westinghouse TR demonstrated that the crack growth for 40 years was small, and that the axial and circumferential flaws will remain within the allowable crack growth. The licensee stated that since the stresses, stress intensity factors, and allowable flaw sizes used in the Westinghouse TR are considered bounding for the Unit 3 suction safe-end instrumentation nozzle repair, the amount of fatigue crack growth for 40 years is expected to far exceed the anticipated fatigue crack growth for an 18-month duration in the Unit 3 suction safe-end instrumentation nozzle.

The licensee noted that the fracture mechanics evaluation in the Westinghouse TR stated that the half-nozzle repair was acceptable with respect to Section XI of the ASME Code for 40 years of operation and has been found to be bounding for the Unit 3 half-nozzle repair. The licensee stated that the proposed repair will remain acceptable in terms of flaw evaluation for an operating duration of 18 months in accordance with the ASME Code, Section XI.

3.7.4 Vibration Assessment

The licensee moved the new attachment J-groove weld from the inside surface of the RCP suction safe end to the outside surface as part of the proposed repair. As a result, the licensee considered the effects of vibration affecting the instrumentation nozzle and attached Class 2 piping. The licensee considered the natural frequency of the instrumentation nozzle and attached piping to ensure that the natural frequency of the piping is outside the range of the vibration frequency of the RCP. The calculated natural frequency of the instrumentation nozzle and Class 2 piping was also used to determine the inertial loads on the nozzle due to seismic and pipe break inputs. The licensee added these inertial loads to the mechanical loads used to evaluate the instrumentation nozzle and attachment weld. The licensee determined that the natural frequency of the nozzle and Class 2 piping is outside the range of the RCP vibration.

3.7.5 Loose Parts Evaluation

The licensee evaluated the possibility that fragments of the remnant J-groove weld could come loose inside the RCS during the next cycle of operation (18 months is assumed). The licensee postulated that the crack(s) in the remnant nozzle and weld are part through wall in the axial direction with no evidence of circumferential cracks based on previously observed for PWSCC in instrument nozzles in the hot leg. The remnant nozzle is recessed inside the safe-end bore. It remains constrained by a relatively tight radial clearance between the bore and the nozzle. This is further helped by the weld deposited in this annular gap during the welding process. The licensee stated that the hypothetical cracks are likely longitudinal part through wall, and as such the nozzle is able to maintain its structural integrity. Also, the licensee noted that if the remnant weld had several longitudinal radial cracks, it would require at least two other crack planes oriented in the circumferential direction in order to release a piece of any significant size. The licensee stated that because circumferentially-oriented cracks were not identified by the UT, the likelihood for a fragment of the weld to be released is very low.

The licensee evaluated the structural and functional impacts of the postulated loose weld fragment(s) on affected systems, structures, and components (SSCs) based on fragments of different sizes, shapes, and weights. This evaluation included the RCPs, the main coolant piping, the reactor vessel and its internals, the fuel, the pressurizer, steam generators, as well as other systems attached to the RCS, including the spent fuel pool. The licensee stated that the postulated loose parts will have no adverse impact on the RCS and connected SSCs after one cycle of plant operation.

3.7.6 Examinations

In accordance with the licensee's welding traveler, the new J-groove weld preparation (one-half inch depth) received a liquid penetrant examination. The licensee stated that the adjacent one-half inch of the bore beyond the weld preparation area also received a liquid penetrant examination. The entire machined surface of the bore area received a visual examination. The licensee stated that it did not identify any imperfections in these examinations.

The licensee stated that after the repair, the new J-groove weld will not be categorized within the scope of ASME Code Case N-722-1 because PWSCC-resistant Alloy 690 and 52M materials are used. The licensee further stated that the new J-groove weld will remain categorized as B-P in accordance with the ASME Code, Section XI, Table IWB-2500-1 with respect to the routine pressure test program. In addition, the RCP 2A suction pressure instrument nozzle is included in the scope of the boric acid walkdown procedure and is performed during each refueling outage. These walkdowns are governed by the Boric Acid Corrosion Control Program.

3.7.7 NRC-Imposed Conditions on Westinghouse TR

As stated in the NRC SE in its letter dated January 12, 2005, for the Westinghouse TR in Section 4.0, "Conclusions and Conditions," licensees seeking to use the repair methods of the Westinghouse TR are required to satisfy NRC-imposed conditions on general corrosion, thermal-fatigue crack growth, stress corrosion crack growth, and other considerations. The licensee has addressed each of NRC's imposed conditions as follows.

3.7.7.1 General Corrosion Assessment

In the NRC's letter dated January 12, 2005, Section 4.1, "General Corrosion Assessment," lists five conditions that licensees seeking to use the Westinghouse TR must perform.

Condition 1: Calculate the minimum acceptable wall thinning thickness for the ferritic vessel or piping that will adjoin to the [mechanical nozzle seal assembly (MNSA)] repair or half-nozzle repair.

APS Response: In Attachment 1 to the April 17, 2015 submittal, the licensee determined that the corrosion allowance (i.e., minimum acceptable wall thinning thickness) for the subject Unit 3 nozzle would be larger than the corrosion allowance specified in Section 2.4 of the Westinghouse TR. For conservatism, the licensee used the corrosion allowance of the Westinghouse TR for the proposed Unit 3 nozzle repair.

Condition 2: Calculate the overall general corrosion rate for the ferritic materials based on the calculational methods in the [Westinghouse] TR, the general corrosion rates listed in the TR for normal operations, startup conditions (including hot standby conditions), and cold shutdown conditions, and the respective plant-specific times (in-percentage of total plant life) at each of the operating modes.

APS Response: The licensee provided the corrosion rate for the carbon steel material, such as that of SA-508, Class 1, for the Unit 3 RCP suction safe end for three separate operating conditions: full power operation, startup mode (assumed to be at intermediate temperature with aerated primary coolant), and refueling mode (100 °F with aerated primary coolant). The corrosion rates for each mode of operation and associated percentage of time spent are listed in Attachment 2 of the letter dated April 17, 2015. For normal, startup and cold shutdown conditions, the growth rates were 0.4 mils per year (mpy), 19 mpy and 8 mpy, respectively, and the associated percentage of time spent in each mode of operation was 88%, 2%, and 10%. The licensee stated that based on a review of Unit 3 operation data, the percentage of time spent in startup and cold shutdown conditions for the 18 months is bounded by the values in the Westinghouse TR. The licensee calculated the overall corrosion rate to be 1.53 mpy.

Condition 3: Track the time at cold shutdown conditions to determine whether this time does not exceed the assumptions made in the [Westinghouse TR] analysis. If these assumptions are exceeded, the licensees shall provide a revised analysis to the NRC, and provide a discussion on whether volumetric inspection of the area is required.

APS Response: The licensee tracked the time at cold shutdown in the previous relief requests for hot-leg Alloy 600 small-bore nozzle repairs in order to provide assurance that the allowable hole diameter is not exceeded over the life of the plant. The licensee stated that the cold shutdown conditions for 18 months do not exceed the assumptions made in the Westinghouse TR analysis.

Condition 4: Calculate the amount of general corrosion-based thinning for the vessels or piping over the life of the plant, as based on the overall general corrosion rate calculated in Step 2 [i.e., Condition 2 above] and the thickness of the ferritic vessel or piping that will adjoin to the MNSA repair or half-nozzle repair.

APS Response: The licensee used Westinghouse TR corrosion rates to calculate the amount of general corrosion over a 40-year period. The general corrosion is 0.0612 inches radially, relative to penetration, or 0.1224 inches diametrically, relative to penetration.

The licensee stated that the allowable increase in hole diameter to the Unit 3 instrumentation nozzle bore is less than the corrosion allowance per the Westinghouse TR. The licensee stated that the diameter of the Unit 3 safe-end instrument nozzle bore after the repair would remain acceptable beyond the next 40 years of operation. The NRC staff notes that the proposed relief request is applicable for only one fuel cycle.

Condition 5: Determine whether the vessel or piping is acceptable over the remaining life of the plant by comparing the worst case remaining wall thickness to the minimum acceptable wall thickness for the vessel or pipe. [The reference to "wall thickness" is actually the penetration diameter.]

The NRC staff notes that Condition 5 is not applicable to the proposed relief request, which is applicable for only one fuel cycle.

3.7.7.2 Thermal-Fatigue Crack Growth Assessment

In the NRC's letter dated January 12, 2005, Section 4.2, "Thermal-Fatigue Crack Growth Assessment," lists three conditions that licensees seeking to use the Westinghouse TR must perform.

Condition 1: The geometry of the leaking penetration is bounded by the corresponding penetration reported in [Westinghouse Calculation Report CN-CI-02-71, Revision 01, "Summary of Fatigue Crack Growth Evaluation Associated with Small Diameter Nozzles in CEOG Plants", dated March 31, 2004].

APS Response: The licensee has determined that the Westinghouse Calculation Report CN-CI-02-71, Revision 1, "Summary of Fatigue Crack Growth Evaluation Associated with Small Diameter Nozzles in CEOG Plants," dated March 31, 2004, is applicable to the previously repaired hot-leg nozzles in Units 1, 2, and 3. The geometry of the leaking penetration identified in the referenced Westinghouse calculation bounds the Unit 3 nozzle geometry. The licensee noted that the hole diameter used in the hot-leg nozzle repair evaluation in the Westinghouse TR is similar in size to the hole diameter in the subject Unit 3 nozzle. The slight difference in the diameter would have an insignificant effect of the calculated stress intensity factors. The difference in the thickness of the hot-leg nozzle of 3.75 inches, as compared to the cold-leg nozzle thickness of 3.0 inches, will have an insignificant impact on the fracture mechanics analysis and the stress intensity factor calculation.

Condition 2: The plant-specific pressure and temperature profiles in the pressurizer water space for the limiting curves (cooldown curves) do not exceed the analyzed profiles shown in Figure 6-2 (a) of Calculation Report CN-CI-02-71, Revision 01, as stated in Section 3.2.3 of [the NRC's SE for the Westinghouse TR].

The NRC staff notes that Condition 2 is not applicable to the proposed relief request, which is not related to the pressurizer.

Condition 3: The plant-specific Charpy [upper-shelf energy (USE)] data shows a USE value of at least 70 ft-lb to bound the USE value used in the analysis. If the plant-specific Charpy USE data does not exist and the licensee plans to use Charpy USE data from other plants' pressurizers and hot-leg piping, then justification (e.g., based on statistical or lower bound analysis) has to be provided.

APS Response: In Attachment 1 of the April 17, 2015, submittal, the licensee stated that an RT_{NDT} value of 60 °F was used in the allowable stress intensity factor calculation for the hot-leg base metal in the Westinghouse TR. The use of an RT_{NDT} value of 60 °F was confirmed based on a review of the allowable stress intensity factor for the end of cooldown transient. For the subject Unit 3 RCP suction safe end, the RT_{NDT} is 40 °F or less according to the Certified Material Test Report and Updated Final Safety Analysis Report Table 5.2-29B. The licensee stated that the lower RT_{NDT} value of 40 °F for the Unit 3 RCP suction safe end would result in a less limiting allowable flaw size than the hot-leg nozzle RT_{NDT} of 60 °F in the Westinghouse TR. The licensee stated that the allowable flaw size for a hot-leg nozzle in the Westinghouse TR would be conservatively representative for the Unit 3 suction safe end.

3.7.7.3 Stress Corrosion Crack Growth Assessment

In the NRC's letter dated January 12, 2005, Section 4.3, "Stress Corrosion Crack Growth Assessment," lists two conditions that licensees seeking to use the Westinghouse TR must perform.

Condition 1: Conduct appropriate plant chemistry reviews and demonstrate that a sufficient level of hydrogen overpressure has been implemented for the RCS, and that the contaminant concentrations in the reactor coolant have been typically maintained at levels below 10 [parts per billion (ppb)] for dissolved oxygen, 150 ppb for halide ions, and 150 ppb for sulfate ions.

APS Response: The licensee stated that Unit 3 chemistry records show that the halide/sulfate concentration levels have been maintained below 150 ppb for chloride, fluoride, and sulfate over the two operating cycles prior to the repair. Oxygen levels are maintained below 10 ppb during power operation and below 100 ppb during plant startups (RCS temperature >250 °F). The licensee noted that there is no oxygen limit when the RCS temperature is below 250 °F.

The licensee stated that an RCS hydrogen overpressure of greater than 15 cubic centimeters per kilogram (cc/kg) is established prior to criticality (hard hold point) and is maintained in a range of 25 to 50 cc/kg in Modes 1 and 2. In Modes 1 and 2, RCS hydrogen is a control parameter with Action Level 1 outside the range of 25 to 50 cc/kg, Action Level 2 less than 15 cc/kg, and an Action Level 3 less than 5 cc/kg. The licensee stated that chemistry administrative control procedures do not allow critical reactor operation with the RCS hydrogen concentration less than 15 cc/kg without immediate corrective action. The nominal operating band for RCS hydrogen is 25 to 50 cc/kg. The licensee stated the plant chemistry is expected to be within the standards of Westinghouse TR for the next fuel cycle; therefore, the conclusion reached in the Westinghouse TR would apply to Unit 3 for that period.

Condition 2: During the outage in which the half-nozzle or MNSA repairs are scheduled to be implemented, licensees adopting the [Westinghouse] TR's stress corrosion crack growth arguments will need to review their plant-specific RCS coolant chemistry histories over the last two operating cycles for their plants, and confirm that these conditions have been met over the last two operating cycles.

APS Response: The licensee has reviewed the plant-specific RCS coolant chemistry for the two operating cycles prior to the proposed repair.

3.7.7.4 Other Considerations

In the NRC's letter dated January 12, 2005, Section 4.4, "Other Considerations," lists two conditions that licensees seeking to use the Westinghouse TR must perform.

Condition 1: Licensees using the MNSA repairs as a permanent repair shall provide resolution to the NRC concerns addressed in the NRC letter dated December 8, 2003, from H. Berkow to H. Sepp (ADAMS Accession No. ML033440037), concerning the analysis of the pressure boundary components to which the MNSA is attached, and the augmented inservice inspection program.

APS Response: The NRC staff notes that Condition 1 is not applicable to the proposed relief request which does not use a MNSA for the repair.

Condition 2: Currently, half-nozzle and MNSA repairs are considered alternatives to the ASME Code, Section XI. Therefore, licensees proposing to use the half-nozzle and MNSA repairs shall submit the required information contained in [TR] WCAP-15973-P, Revision 01, by the conditions of [the NRC SE for the TR], to the NRC as a relief request in accordance with 10 CFR 50.55a.

APS has submitted Relief Request 53 and, therefore, has satisfied this condition.

4.0 NRC STAFF EVALUATION

The NRC staff has reviewed the following topics that are significant to the structural integrity of the replacement nozzle and new J-groove weld in the Unit 3 safe end of the suction pipe of RCP 2A: Replacement nozzle qualification, attachment weld qualification, flaw evaluation of the remnant nozzle and original J-groove weld, vibration assessment, loose parts evaluation, examinations, and the licensee's response to NRC-imposed conditions on the Westinghouse TR.

4.1 Replacement Nozzle Qualification

The NRC staff concludes that the licensee qualified the replacement nozzle based on the stress calculations in accordance with ASME Code, Section III and Westinghouse TR and the licensee included appropriate loads and the stresses. The NRC staff concludes that the replacement nozzle satisfies the allowable stresses of the ASME Code, Section III and, therefore, the replacement nozzle is acceptable for use.

4.2 Attachment Weld Qualification

The NRC staff concludes that the new attachment J-groove weld was qualified based on the stress calculations in accordance with the ASME Code, Section III and Westinghouse TR. The licensee included appropriate loads and the stresses in the design analysis. The NRC staff concludes that the new J-groove weld satisfies the allowable stresses of the ASME Code, Section III and, therefore, the attachment weld is acceptable for use.

4.3 Flaw Evaluation

The NRC staff concludes that the analyses for the hot-leg nozzle in Westinghouse TR bound the subject Unit 3 nozzle in the proposed repair for the duration of 18 months. The NRC staff further concludes that the remnant nozzle and J-groove weld satisfy the requirements of the ASME Code, Section XI and, therefore, are acceptable to remain in service.

4.4 Vibration Assessment

The NRC staff concludes that the pump vibration, including the vibration loading in the design of the replacement nozzle and existing piping, was evaluated. The NRC staff further concludes that the design of the replacement nozzle considered the vibration loading and, therefore, the NRC staff concludes that the licensee has addressed the vibration issue satisfactorily.

4.5 Loose Parts Evaluation

The NRC staff concludes that the loose parts from the remnant nozzle and J-groove weld are not likely because a flaw in the remnant nozzle and J-groove weld are not likely to grow, in the 18-month period, to the size that would cause the loose parts to fall into the RCS flow. Therefore, the NRC staff has concluded that the licensee has addressed the loose parts issue satisfactorily.

4.6 Examinations

The NRC staff concludes that the inservice examination of the repaired nozzle is acceptable because the licensee will follow the inspection requirements of the ASME Code, Section XI, Table IWB-2500-1.

4.7 NRC-Imposed Conditions on Westinghouse TR

4.7.1 General Corrosion Assessment

Regarding general corrosion assessment, the NRC staff concludes that the overall general corrosion rate was calculated in accordance with the methodology of the Westinghouse TR considering the Unit 3-specific operating history and that the corrosion during this 18-month period will be minimal. The licensee is tracking the time at cold shutdown conditions, which is the limiting transient. The NRC staff concludes that the licensee has addressed the NRC's conditions in the area of general corrosion assessment satisfactorily.

4.7.2 Thermal-Fatigue Crack Growth Assessment

Regarding thermal-fatigue crack growth assessment, the NRC staff concludes that for the 18-month period, the thermal fatigue crack growth of postulated flaws propagating into safe-end base metal would be minimal. The NRC staff further concludes that the licensee has addressed the NRC's condition on thermal-fatigue crack growth satisfactorily.

4.7.3 Stress Corrosion Crack Growth Assessment

Regarding stress corrosion cracking growth assessment, the NRC staff concludes that a sufficient level of hydrogen overpressure is implemented for the RCS, and the contaminant concentrations in the reactor coolant are maintained within the acceptable levels. The licensee also completed a review of its plant-specific RCS coolant chemistry histories and confirmed that these chemistry conditions were met over the two operating cycles prior to the repairs. The NRC staff concludes that the NRC Condition on stress corrosion cracking growth has been addressed satisfactorily.

4.7.4 Other Considerations

Regarding other considerations, the NRC staff concludes that NRC Condition 1 is not applicable to the proposed alternative and the licensee has met NRC Condition 2 by submitting Relief Request 53 for the use of the Westinghouse TR.

4.7.5 Staff Evaluation

The NRC further concludes that the response to all NRC-imposed conditions on the Westinghouse TR were answered satisfactory and, therefore, the use of the Westinghouse TR for the proposed repair is acceptable.

In summary, the NRC staff concludes that the replacement nozzle and new J-groove weld satisfy the requirements of the ASME Code, Section III, for 18 months of operation during the next fuel cycle. The NRC staff further concludes that the Westinghouse TR is applicable for the repair of Unit 3 RCP suction nozzle. The NRC staff notes that the licensee's flaw evaluation satisfies the ASME Code, Section XI. Therefore, the NRC staff concludes that the proposed alternative provides reasonable assurance that the structural integrity of the repaired nozzle will be maintained for one fuel cycle of operation.

5.0 CONCLUSION

As set forth above, the NRC staff concludes that the proposed repair will restore the primary system pressure boundary and provide reasonable assurance that the structural integrity of the repaired pressure instrument nozzle will be maintained for one fuel cycle. The NRC staff further concludes that the proposed alternative for the repair of the subject pressure instrument nozzle provides an acceptable level of quality and safety and 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 use of Relief Request 53 at PVNGS 3 until the end of the 19th refueling outage, which is currently scheduled for fall 2016.

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

Principal Contributor: John Tsao

Date: September 15, 2015

The detailed results of the NRC staff review are provided in the enclosed safety evaluation. If you have any questions concerning this matter, please contact Ms. Margaret Watford or my staff at (301) 415-1233 or via e-mail at Margaret.Watford@nrc.gov.

Sincerely,

/RA/ Lisa Regner for/

Michael T. Markley, Chief
Plant Licensing Branch IV-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-530

Enclosure:
Safety Evaluation

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