September 18, 2007

Mr. Michael Balduzzi
Sr. Vice President, Regional Operations NE
Entergy Nuclear Operations, Inc.
440 Hamilton Avenue
White Plains, NY 10601

SUBJECT: PALISADES NUCLEAR POWER PLANT - REQUEST FOR RELIEF FROM AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME) SECTION XI CODE REQUIREMENTS FOR REPAIR OF PRESSURIZER NOZZLE PENETRATIONS - RELIEF REQUEST # 2 (TAC NO. MD3166)

Dear Mr. Balduzzi:

By letter dated September 15, 2006 (Agencywide Documents Access and Management System (ADAMS), Accession No. ML062580364), as supplemented by letter dated March 9, 2007 (ADAMS Accession No. ML070680323), Nuclear Management Company, LLC (the licensee, at the time of submittal), submitted Relief Request (RR) Nos. 1 and 2 to support the repair of pressurizer heater sleeve nozzles at the Palisades Nuclear Plant. Specifically, the licensee requested relief from certain requirements in American Society of Mechanical Engineers (ASME) Code, Section XI. RR No. 1 is related to the welding of the nozzle and RR No. 2 is related to the flaw evaluation of the weld. This correspondence is in regards to RR No. 2 only. RR No. 1 will be addressed in a separate correspondence. Entergy Nuclear Operations, Inc. has since become the current licensee, following the license transfer that occurred on April 11, 2007.

The licensee's thermal-fatigue crack growth assessment was for 40 years. These assessments should be considered time-limited aging analyses within the scope of Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, when the repair becomes part of the licensee's current licensing basis. The NRC approved the 20- year license extension for Palisades on Janurary 17, 2007 (Adams Accession No. ML063480220). Therefore, the licensee must validate the assessments for 60 years or provide an aging management program in accordance with 10 CFR 54.21(b).

The Nuclear Regulatory Commission (NRC) staff has reviewed the licensee's proposal and concludes that RR No. 2 will provide an acceptable level of quality and safety, and is acceptable as discussed in the enclosed safety evaluation. Based on the NRC staff's review of the licensee's proposed justification, the NRC staff concludes that granting relief pursuant to 10 CFR 50.55a(g)(6)(i) is authorized by law and will not endanger life or property or the common defense and security, and is otherwise in the public interest giving due consideration to the burden upon the licensee that could result if the requirements were imposed on the facility. Therefore, the NRC staff authorizes the use of RR No. 2 for the repair of pressurizer vessel nozzle heater sleeves at the Palisades Nuclear Power Plant for the fourth 10-year inservice inspection interval.

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

Sincerely,

/RA/

Travis Tate, Acting Chief
Plant Licensing Branch III-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-255

Enclosure:
Safety Evaluation

cc w/encl: See next page

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

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Safety Evaluation

cc w/encl: See next page

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NAME	JPoole	MChawla	THarris	TChan	KChang	NLO/MLoftus	TTate
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cc:

Regional Administrator, Region III
U.S. Nuclear Regulatory Commission
Suite 210
2443 Warrenville Road
Lisle, IL 60532-4351

Supervisor
Covert Township
P. O. Box 35
Covert, MI 49043

Office of the Governor
P. O. Box 30013
Lansing, MI 48909

U.S. Nuclear Regulatory Commission
Resident Inspector's Office
Palisades Plant
27782 Blue Star Memorial Highway
Covert, MI 49043

Michigan Department of Environmental Quality
Waste and Hazardous Materials Division
Hazardous Waste and Radiological
Protection Section
Nuclear Facilities Unit
Constitution Hall, Lower-Level North
525 West Allegan Street
P.O. Box 30241
Lansing, MI 48909-7741

Michigan Department of Attorney General
Special Litigation Division
525 West Ottawa St.
Sixth Floor, G. Mennen Williams Building
Lansing, MI 48913

Mr. Michael R. Kansler
President & CEO/CNO
Entergy Nuclear Operations
1340 Echelon Parkway
Jackson, MS 39213

Mr. John T. Herron
Sr. Vice President
Entergy Nuclear Operations
1340 Echelon Parkway
Jackson, MS 39213

Sr. Vice President,
Engineering and Technical Services
Entergy Nuclear Operations, Inc.
1340 Echelon Parkway
Jackson, MS 39213

Mr. Christopher J. Schwarz
Site Vice President
Entergy Nuclear Operations
Palisades Nuclear Plant
27780 Blue Star Memorial Highway
Covert, MI 49043

General Manager, Plant Operations
Entergy Nuclear Operations
Palisades Nuclear Plant
27780 Blue Star Memorial Highway
Covert, MI 49043

Mr. Oscar Limpias
Vice President, Engineering
Entergy Nuclear Operations
1340 Echelon Parkway
Jackson, MS 39213

Mr. John F. McCann
Director, Nuclear Safety & Licensing
Entergy Nuclear Operations
440 Hamilton Avenue
White Plains, NY 10601

Ms. Charlene D. Faison
Manager, Licensing
Entergy Nuclear Operations
440 Hamilton Avenue
White Plains, NY 10601

Mr. Ernest J. Harkness
Director, Oversight
Entergy Nuclear Operations
1340 Echelon Parkway
Jackson, MS 39213

Mr. William C. Dennis
Assistant General Counsel
Entergy Nuclear Operations
440 Hamilton Avenue
White Plains, NY 10601

Mr. Joseph P. DeRoy
VP, Operations Support
Entergy Nuclear Operations, Inc.
1340 Echelon Parkway
Jackson, MS 39213

Ms. Laurie A. Lahti
Manager, Licensing
Palisades Nuclear Plant
27780 Blue Star Memorial Highway
Covert, MI 49043

Mr. John A. Ventosa
GM, Engineering
Entergy Nuclear Operations
440 Hamilton Aveune
White Plains, NY 10601

Director, NSA
Palisades Nuclear Plant
27780 Blue Star Memorial Highway
Covert, MI 49043

Mr. William DiProfio
48 Bear Hill Road
Newton, NH 03858

Mr. William T. Russell
400 Plantation Lane
Stevensville, MD 21666

Mr. Gary Randolph
1750 Ben Franklin Drive, 7E
Sarasota, FL 34246

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

REQUEST FOR RELIEF FOR PRESSURIZER HEATER SLEEVE NOZZLE REPAIR

PALISADES NUCLEAR POWER PLANT

ENTERGY NUCLEAR OPERATIONS, INC.

DOCKET NO. 50-255

1.0 INTRODUCTION

By letter dated September 15, 2006 (Agencywide Documents Access and Management System (ADAMS), Accession No. ML062580364), as supplemented by letter dated March 9, 2007 (ADAMS Accession No. ML070680323), Nuclear Management Company, LLC (the licensee, at the time of submittal), submitted Relief Request (RR) Nos. 1 and 2 to support the repair of pressurizer heater sleeve nozzles at the Palisades Nuclear Power Plant (PNP). Specifically, the licensee requested relief from certain requirements in American Society of Mechanical Engineers (ASME) Code, Section XI. RR No. 1 is related to the welding of the nozzle and RR No. 2 is related to the flaw evaluation of the weld. This safety evaluation (SE) is focused on RR No. 2 only. Entergy Nuclear Operations, Inc. (ENO) has since become the current licensee, following the license transfer that occurred on April 11, 2007.

The licensee requested Nuclear Regulatory Commission (NRC) staff approval of the relief for the fourth 10-year inservice inspection (ISI) interval which will conclude on or before December 13, 2015. The request for relief would allow an alternative repair for Alloy 600 pressurizer heater sleeve penetrations in lieu of the ASME Code Section XI, paragraph IWB-2420, "Successive Inspections"; subarticle IWA-3300, "Flaw Characterization"; subparagraph IWB-3142.4, "Acceptance by Analytical Evaluation"; and paragraph IWB-3420, "Characterization" requirements. As an alternative, the licensee proposes to assume the worst-case cracks in the Alloy 600 pressurizer nozzle base and weld material using the methodology in Westinghouse Topical Report (TR) WCAP-15973-P, Revision 01, "Low-Alloy Steel Component Corrosion Analysis Supporting Small-Diameter Alloy 600/690 Nozzle Repair/Replacement Program."

By letter dated January 12, 2005 (ADAMS Accession No. ML050180528), the NRC issued the final SE on WCAP-15973-P, Revision 01, approving it to the extent possible under the limitations in the TR and the associated SE. The SE defines the basis for acceptance of the TR, and requires licensees proposing to use the half-nozzle or mechanical nozzle seal assembly (MNSA) repairs to submit to the NRC the required information contained in the TR, by the conditions of the SE, as a relief request in accordance with Section 50.55a of Title 10 of the *Code of Federal Regulations* (10 CFR).

By letters dated August 11, 2005, January 31, and March 13, 2006, the licensee submitted a relief request for the third 10-year ISI interval for the weld repair of pressurizer vessel heater

sleeve nozzles at PNP. In a letter dated April 3, 2006 (ADAMS Accession ML060790251), the NRC staff approved the relief request for the third 10-year ISI interval. The NRC staff used the previous relief requested by letters dated August 11, 2005, January 31, and March 13, 2006, as part of the NRC staff review of the current (RR No. 2) because both relief requests are similar.

The proposed repair method of RR No. 2 is similar to the half nozzle repair of WCAP-15973-P in that a portion of the existing pressurizer heater sleeve nozzle is removed and welding is performed on the pressurizer shell. The repair consists of removing a portion of the existing nozzle, inserting an Alloy 690 plug into the penetration, and welding a pad on the pressurizer shell covering the Alloy 690 plug. The proposed repair will not replace the remnant nozzle. The welding pad will become a part of the pressurizer pressure boundary.

2.0 REGULATORY EVALUATION

The ISI of the ASME Code Class 1, Class 2, and Class 3 components is to be performed in accordance with the ASME Code, Section XI, and applicable edition and addenda as required by 10 CFR 50.55a(g), except where specific relief has been granted by the Commission pursuant to 10 CFR 50.55a(g)(6)(i). Paragraph 10 CFR 50.55a(g)(6)(i) states that "...The Commission will evaluate determinations...that [ASME] code requirements are impractical. The Commission may grant such relief and may impose such alternative requirements as it determines is authorized by law and will not endanger life or property or the common defense and security, and is otherwise in the public interest giving due consideration to the burden upon the licensee that could result if the requirements were imposed on the facility..."

Pursuant to 10 CFR 50.55a(a)(3), alternatives to the requirements of paragraph (g) may be used, when authorized by the NRC, if the applicant demonstrates that: (i) the proposed alternatives would provide an acceptable level of quality and safety, or (ii) compliance with the specified requirements would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

Pursuant to 10 CFR 50.55a(g)(4), ASME Code Class 1, 2, and 3 components (including supports) will meet the requirements, except the design and access provisions and the preservice examination requirements, set forth in the ASME Code, Section XI to the extent practical within the limitations of design, geometry, and materials of construction of the components. Paragraph 10 CFR 50.55a(g)(4) requires that inservice examination of components and system pressure tests conducted during the first 10-year inspection interval and subsequent inspection intervals comply with the requirements in the latest edition and addenda of Section XI of the ASME Code. The latest edition and addenda of Section XI of the ASME Code is incorporated by reference in Paragraph 10 CFR 50.55a(b), 12 months prior to the start of the 10-year inspection interval. The ISI Code of record for PNP for the fourth 10-year ISI interval is the 2001 edition with addenda through 2003 of the ASME Code, Section XI.

3.0 RELIEF REQUEST NO. 2

3.1 Components For Which Relief Is Requested

The affected components are the PNP pressurizer heater sleeve nozzles. The PNP has 120 heater sleeve nozzles penetrating the bottom head of the pressurizer. The pressurizer assembly was fabricated in accordance with the ASME Code, Section III, Class A components.

3.2 Applicable ASME Code Edition And Addenda

The applicable ASME Code edition and addenda for the pressurizer vessel heater sleeve nozzle repair is the ASME Code, Section XI, 2001 Edition with addenda through 2003. The original construction code of record for the PNP pressurizer vessel is ASME Code, Section III, Class A, 1965 Edition, including addenda through winter 1965.

3.3 Applicable ASME Code Requirement

The applicable ASME Code requirement for repair/replacement activities of the pressurizer vessel head penetrations is ASME Code, Section XI, and is discussed in the following subarticles of the ASME Code, Section XI. Table IWB-2500-1, examination category B-P, “All Pressure Retaining Components,” Item B15.10, is applicable to the inservice examination of the pressurizer vessel lower head to penetration welds. Subarticles IWA-3300, “Flaw Characterization”; IWB-3142.4, “Acceptance by Analytical Evaluation”; and IWB-3420, “Characterization” are applicable to any flaws discovered during ISI. Specifically:

(a) Subarticle IWA-3300 contains a requirement for flaw characterization.

(b) Sub-subparagraph IWB-3142.4 allows for analytical evaluation to demonstrate that a component is acceptable for continued service. It also requires that components found acceptable for continued service by analytical evaluation be subsequently examined in accordance with IWB-2420(b) and (c).

(c) Paragraph IWB-3420 requires the characterization of flaws in accordance with the rules of IWA-3300.

3.4 Proposed Alternative

In its application, the licensee stated that: “during fabrication of the pressurizer heater sleeve penetrations, Alloy 600 small-bore nozzles were welded to the interior of the pressurizer bottom head. Industry experience has shown that cracks may develop in the nozzle, or in the weld metal joining the nozzles to the pressurizer, and lead to leakage of the primary coolant system. The cracks are caused by primary water stress-corrosion cracking.”

The licensee also stated that: “the total removal of all Alloy 600 small-bore nozzles and weld metal would require accessing the interior surface of the pressurizer, and grinding out the attachment weld and any remaining nozzle [material]. The analysis in the TR[, WCAP-15973-P, Revision 01,] has shown that any remnant cracks in the nozzle, the attachment weld[,] and the vessel carbon steel base metal following a repair, will not affect structural integrity, or propagate through the primary coolant pressure boundary. There is no increase in the level of quality and safety as a result of removing the nozzle or the attachment weld, and therefore, [the licensee] will not be removing the remnant sleeve [nozzle] or its attachment weld.”

The licensee proposed an alternative, as discussed below, for not performing flaw characterization or successive inspections, as required in the ASME Code, Section XI.

Pursuant to 10 CFR 50.55a(a)(3)(i), the licensee proposed alternatives to the required flaw characterization (IWA-3300) and successive inspections (IWB-2420). In lieu of fully characterizing/sizing existing cracks that may be found, the licensee assumed the worst-case cracks in the Alloy 600 base and weld material, and used the methodology presented in TR, WCAP-15973-P, Revision 01 for determining the following:

1. The overall general/crevice corrosion rate for the internal surfaces of the low-alloy or carbon steel materials, which will now be exposed to the primary coolant, and for calculating the amount of time the ferritic portions of the vessel or piping would be acceptable if corrosive wall thinning occurred.

2. Calculating the thermal-fatigue crack-growth life of existing flaws in the Alloy 600 nozzles and/or Alloy 82/182 weld material into the ferritic portion of the vessels or piping.

3. Providing an acceptable method and basis for concluding that unacceptable growth of the existing flaw by stress corrosion into the vessel or piping is improbable.

The licensee has reviewed the methods and basis presented in the TR, WCAP-15973-P, Revision 01, for the overall general/crevice corrosion rate, thermal-fatigue crack growth life of existing flaws, and the basis for concluding that growth of the existing flaw by stress corrosion into the vessel or piping is improbable. Attachment 1 of Enclosure 2 of the September 15, 2006, submittal, provides the licensee’s response to the requirements of the NRC’s SE for WCAP-15973-P and is discussed below. Attachment 2 of Enclosure 2 of the September 15, 2006, submittal, provides the site specific analysis, as required by the TR and associated NRC’s SE. Attachment 3 of Enclosure 2 of the September 15, 2006, submittal, provides plant-specific corrosion analysis.

3.5 NMC’s Response To The NRC’s SE On WCAP-15973-P

The NRC’s SE for TR, WCAP-15973-P, Revision 01, indicates that the Westinghouse Owners Group’s (WOG) methods and analysis in the TR are generally acceptable. To use the Westinghouse TR as a reference, the NRC’s SE requires the following information be addressed:

3.5.1 General Corrosion Assessment

Licensees seeking to use the methods of the TR will need to perform the following plant-specific calculations in order to confirm that the ferritic portions of the vessel or piping within the scope of the TR will be acceptable for service throughout the licensed lives of their plants (40 years if the normal licensing basis plant life is used, or 60 years if the facility is expected to be approved for extension of the operating license):

NRC Requirement 1

Calculate the minimum acceptable wall thinning thickness for the ferritic vessel or piping that will adjoin to the MNSA repair or half-nozzle repair.

Licensee Response

The planned PNP repair (if needed) will be a plug and will not be the MNSA repair or half-nozzle repair. The minimum acceptable wall thinning for the PNP bottom head is independent of the repair method. An analysis was performed (A-CEOG-9449-1242, "Evaluation of the Corrosion Allowance for Reinforcement and Effective Weld to Support Small Alloy 600 Nozzle Repairs," Revision 00, dated June 13, 2000) which calculated the limiting (allowable) diameter for pressurizer heater sleeve penetrations for PNP relative to (1) the reduction in the effective weld shear area, and (2) the required area of reinforcement for the nozzle bore-holes for each type nozzle (and heater sleeve) in the pressurizer, primary coolant system piping, and steam generator primary head for each Combustion Engineering plant. The limiting diameter is the more conservative of the two values. The limiting diameter for the PNP pressurizer heater sleeve is 2.140 inches, based on the reinforcement and effective weld area criteria.

The following is provided as justification for not using actual thickness measurements for the corrosion analysis:

The actual thickness measurements for the PNP pressurizer bottom head or the heater sleeves are not needed for determining the acceptable pressurizer bore-hole diameter used in estimating the lifetime of the heater sleeve repair. WCAP-15973 was unclear and intended to require that actual thickness measurements be used only for the PNP pressurizer side shell and cold-leg piping. The supporting documentation of WCAP-15973 clearly identifies this (see Westinghouse Report: A-CEOG-9449-1242, Revision 00, "Evaluation of the Corrosion Allowance for Reinforcement and Effective Weld to Support Small Alloy 600 Nozzle Repairs," dated June 13, 2000, Tables 1 and 2).

The following is provided to identify the criteria used to determine the allowable bore-hole size, ASME code criteria, pressure and thermal transient conditions assumed in the analysis and describe how the information was used to calculate the allowable bore-hole size:

For the effective weld shear area analysis, the shear stress in the weld area did not exceed 0.6 Sm (design stress intensity) for the design conditions, per paragraph

NB-3227.2(a) of Section III of the ASME Code. For the required area of reinforcement around an opening, the criteria in paragraphs NB-3332, NB-3334, and NB-3643.3(c)(1)(c) of Section III of the ASME Code were used to determine the allowable bore-hole size.

The assumed pressure was the pressure blow-off load at a maximum pressure of 3.125 ksi (2.5 ksi times 1.25) as stated in Paragraph NB-3226 (d) of Section III of the ASME Code. The assumed temperature was the PNP pressurizer design temperature. The analysis assumed steady-state conditions.

Two methods were used in determining the allowable PNP heater sleeve bore-hole diameter, D. The reduction in the effective weld shear area was first evaluated. The J-groove weld of the nozzle repair must be able to withstand the internal pressure on the diameter of the corroded bore-hole. The strength of the weld was examined, then the allowable diameter, D, was calculated for a maximum pressure of P = 3.125 ksi. The allowable shear stress for the J-groove weld is 0.6 Sm (design stress intensity) per paragraph NB-3227.2(a) of Section III of the ASME Code. Next, the maximum allowable bore-hole diameter was determined based on the required area of reinforcement. The Code requirements for reinforcement of openings per paragraphs NB-3332, NB-3334, and NB-3643.3(c)(1)(c) of Section III of the ASME Code were used. The minimum, limiting allowable bore diameter, D_{lim}, was conservatively selected to be the smaller of the two diameter values calculated above.

The following is provided to explain why PNP used 1.173 inches in the analysis:

The minimum and maximum sleeve penetration diameter values for PNP are 1.158 inches and 1.160 inches, respectively. The 1.173 inch value was conservatively used for the entire bore-hole. The value corresponds to the nominal counter bore (spot face) on the outer diameter of the pressurizer bottom head. The same value was used in the original analytical report of record in the required area of reinforcement calculation.

<u>NRC Requirement 2</u>

Calculate the overall general corrosion rate for the ferritic materials based on the calculation methods in the 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.

<u>Licensee Response</u>

The assumptions used in the TR corrosion rate analysis relative to the percentage of times at each of the operating modes were as follows:

- Normal Operation: 88%,
- Startup Condition: 2%,
- Cold Shutdown Condition: 10%

An overall corrosion rate was developed in the TR by considering the available corrosion rate data for ferritic steels (carbon and low alloy steels) in water containing boric acid at up to 2500 parts per million (ppm) boron at low temperature (100 °F) aerated conditions, at operating temperatures and deaerated conditions, and at intermediate temperatures and aerated conditions (which simulated the conditions between cold shutdown and operating conditions). Equation 1 of the TR calculated an overall corrosion rate considering the available corrosion data and the assumed percentages of time in each of the operating modes as follows:

CR = 0.88 x 0.4 mpy + 0.02 x 19.0 mpy + 0.10 x 8.0 mpy =1.53 mpy (0.00153 in/yr).
mpy = mils per year where a mil = 0.001 inch.

The calculations performed below through Condition 5 are unchanged from those contained in the previous relief request submitted by letter dated August 11, 2005. The calculations are considered bounding since during Cycle 18 (November 17, 2004, to April 1, 2006), the plant operated at greater than 74.1 percent of the time. In addition, the remaining life of the PNP license has decreased by approximately 18 months.

A review of the PNP operating history as indicated in the Palisades Fuel Management Plan indicates that the time at operational conditions has been significantly less than the assumed value of 88 percent. The ratio of effective full power days to days since the beginning of commercial operations, indicates that the plant was at operating conditions for approximately 56 percent of the time from December 31, 1971, through November 17, 2004. Major contributors to the relatively low percentage of time at operating conditions were several steam generator problems, which were resolved by replacing the original steam generators. The new steam generators entered service in March 1991. Since that time, PNP has been at operational conditions approximately 74.1 percent of the time, which is still less than the value assumed for the TR analysis. The operational times since steam generator replacement are most appropriate for calculating the plant-specific overall general corrosion rate for the ferritic materials required by Section 4.1 of WCAP-15973-P. Assuming 74.1 percent normal operations, 2 percent start-up conditions, and 23.9 percent cold shutdown conditions, the overall general corrosion rate (in mils per year, mpy) was calculated as follows:

CR = 0.741 x 0.4 mpy + 0.02 x 19.0 mpy + 0.239 x 8.0 mpy = 2.59 mpy (0.00259 in/yr)

This corrosion rate will be used to calculate the amount of general corrosion for the pressuirzer bottom head over the remaining plant life, as described below.

<u>NRC Requirement 3</u>

Track the time at cold shutdown conditions to determine whether this time does not exceed the assumptions made in the 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.

Licensee Response

As noted in the response to Condition 2 [NRC Requirement 2] above, the time at cold shutdown conditions for PNP exceeds the assumptions made in the TR analysis. Since steam generator replacement in 1991 through completion of the most recent refueling outage, PNP has been at operating conditions for less than the assumed time and thus, has been at cold shutdown conditions for more than the assumed time. Assuming 2 percent of the total time since steam generator replacement has been at start-up conditions, the time at cold shutdown conditions has been approximately 23.9 percent of the total time. Since the assumptions were exceeded, a revised general corrosion rate has been calculated based on the plant-specific times at each of the operating modes.

At the present time, PNP has not completed any repairs to pressurizer heater sleeves; thus, the ferritic material in the pressurizer bottom head has not been exposed to primary coolant and no corrosion has occurred. If a pressurizer heater sleeve is repaired at PNP, ENO will track the percentage of plant time at normal, shut down and start-up modes of operation to ensure that the corrosion rate calculated above is not exceeded. If the calculated corrosion rate is exceeded, ENO will provide a revised analysis to the NRC evaluating the effect of the increased corrosion rate on the analysis described below, including a discussion of whether volumetric inspection of the ferritic material is required at PNP.

NRC Requirement 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 Condition 2 [NRC Requirement 2 above] and the thickness of the ferritic vessel or piping that will adjoin to the MNSA repair or half-nozzle repair.

Licensee Response

The plant[-]specific corrosion rate calculated in response to Condition 2 (2.59 mpy) was used to calculate the amount of general corrosion that could occur over the remaining plant life for the normal licensing basis (40 years) and for an additional 20 years, assuming that PNP is approved for an extension of the current operating license. [The NRC approved the 20-year license extension for PNP on January 17, 2007 (ADAMS Accession ML063480220)].

The analysis assumes that the earliest date at which a pressurizer heater sleeve repair will be implemented, is the end of the current cycle of operation, estimated at March 19, 2006. The current license expires on March 24, 2011, which would provide a lifetime of 5.01 years for the current license for a repair and a lifetime of 25.01 years, if PNP receives approval for extension of the operating license.

For the current license, metal loss (increase in the heater sleeve hole size) because of corrosion can be calculated by:

Metal loss = CR x remaining life
= 0.00259 in/year x 5.01 years = 0.013 inch (radially) or
= 0.026 inch (diametrically)

For the extended life, if approved, the corrosion (increase in hole size) can be calculated by:

Metal loss = CR x remaining life
= 0.00259 in/yr x 25.01 years = 0.065 inch (radially)
= 0.130 inch (diametrically)

NRC Requirement 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.

Licensee Response

Reference 3 [Westinghouse report, A-CEOG-9449-1242] indicates the initial sleeve penetration diameter was 1.173 inches. The final diameter of the heater sleeve penetration, as a result of general corrosion resulting from the exposure of the ferritic material to primary coolant, can be calculated as follows:

Final diameter = initial diameter + increase in diameter.
For the current license, final diameter = 1.173 in. + 0.026 in. = 1.199 in.
For the extended life, final diameter = 1.173 in. + 0.130 in. = 1.303 in.

From Condition 1 [NRC Requirement 1], the limiting diameter for the PNP pressurizer heater penetration is 2.140 inches. Thus, the limiting diameter will not be exceeded over the remaining life of the plant.

3.5.2 Thermal-Fatigue Crack Growth Assessment

Licensees seeking to reference this TR for future licensing applications need to demonstrate that:

NRC Requirement 1

The geometry of the leaking penetration is bounded by the corresponding penetration reported in Calculation Report CN-CI-02-71, Revision 01.

Licensee Response

The geometry of Palisades's pressurizer heater penetration is bounded by the configurations applied in the pressurizer heater penetration fatigue growth analysis of the Westinghouse Calculation Note CN-CI-02-71. The reference drawings listed in the Reference Section 7.4.1 of CN-CI-02-71 are applicable for the pressurizer heater penetrations, the shell and the support skirt.

NRC Requirement 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 TR WCAP-15973-P, Revision 01.

Licensee Response

> The analyzed transient conditions described in Figure 6-2(a) of Calculation Note CN-CI-02-71 bound the pressure and temperature profiles of Palisades operation of the pressurizer. An evaluation of the CN-CI-02-71 described transients has been performed against the plant operating data and procedures. This evaluation is documented in Palisades Engineering Analysis, EA-A600-2004-01, and is included as Attachment 2 to [Relief Request No. 2].

NRC Requirement 3

The plant-specific Charpy USE [upper shelf energy] 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.

Licensee Response

> Westinghouse Calculation Note CN-CI-02-71 applied a lower bound CVN_{USE} [Charpy USE] of 70 ft-lbs in the Elastic-Plastic Fracture Mechanics (EPFM) analysis of the pressurizer flaw analysis. The EPFM analysis was used to justify the effects of the large in-surge transients which do not pass the Linear Elastic Fracture Mechanics (LEFM) criteria.
>
> Palisades operation of the pressurizer results in less severe transient conditions than those analyzed in CN-CI-02-71. Although, Palisades solid operation of the pressurizer practically eliminates the in-surge and the out-surge transients postulated in CN-CI-02-71, a plant-specific flaw fatigue growth analysis was performed. The analysis used a 220 °F in-surge transient, in lieu of the 320 °F in-surge transient applied in the generic analysis. The resultant final flaw sizes were found to be acceptable to the LEFM criteria. EPFM used in the generic flaw evaluation in CN-CI-02-71 was not required and not used in the plant-specific flaw evaluation. Therefore, the upper-shelf energy data for the pressurizer lower head is not required.

3.5.3 Stress Corrosion Crack Growth Assessment

Licensees seeking to implement MNSA repairs or half-nozzle replacements may use the WOG's stress corrosion assessment as the bases for concluding that existing flaws in the weld metal will not grow by stress corrosion if they meet the following:

NRC Requirement 1

Conduct appropriate plant chemistry reviews and demonstrate that a sufficient level of hydrogen overpressure has been implemented for the reactor coolant system (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.

Licensee Response

> A chemistry review has been performed and confirmed the Palisades' primary coolant (PCS) hydrogen, oxygen, chloride[,] and sulfate concentrations are within the criteria mentioned above.
>
> A PCS hydrogen overpressure of ≥ 15 cc/kg [cubic centimeters per kilogram] is established prior to critical (hard hold point) and is maintained in a range of 25 to 50 cc/kg in Mode 1. In Mode 1[,] PCS hydrogen is a Control Parameter with Action Level 1 outside the range of 25 - 50 cc/kg, an Action Level 2 less than 15 cc/kg, and an Action Level 3 less than 5 cc/kg. Chemistry administrative control procedures do not allow critical reactor operation with the PCS hydrogen less than 15 cc/kg without immediate corrective action. The nominal operating band for PCS hydrogen is 25 to 50 cc/kg.

NRC Requirement 2

During the outage in which the half-nozzle or MNSA repairs are scheduled to be implemented, licensees adopting the 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.

Licensee Response

> Palisades has reviewed the PCS chemistry histories over Fuel Cycles 17 and 18 and confirmed that the hydrogen overpressure, dissolved oxygen, halide[,] and sulfate concentrations are controlled.
>
> If a pressurizer heater sleeve is repaired at PNP, [ENO] will perform a review of the [PCS] chemistry histories over, the last two operating cycles, to confirm that the conditions required by WCAP-15973-P[, Revision 01,] have been met.

3.5.4 Other Considerations

In addition to general corrosion, thermal fatigue crack growth, and stress corrosion issues discussed above, the NRC's SE indicates that licensees seeking to use the methods of Westinghouse TR WCAP-15973-P, Revision 01 will need to address the following:

NRC Requirement 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 ISI program.

Licensee Response

> [The licensee] is not currently planning on using the MNSA repair technique for the pressurizer repair.

NRC Requirement 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 WCAP-15973-P, Revision 01, by the conditions of this SE, to the NRC as a relief request in accordance with 10 CFR 50.55a.

Licensee Response

> This letter [dated September 15, 2006,] provides [the licensee's] response to the conditions of the [NRC's] SE as a relief request in accordance with 10 CFR 50.55a.

3.6 Regulatory Commitments

In the September 15, 2006, letter, the licensee made two new commitments without revising existing commitments.

1. If a pressurizer heater sleeve is repaired at PNP, the licensee will track the percentage of plant time at normal, shut down and start-up modes of operation to ensure that the corrosion rate calculated is not exceeded. If the calculated corrosion rate is exceeded, the licensee will provide a revised analysis to the NRC evaluating the effect of the increased corrosion rate on the analysis, including a discussion of whether volumetric inspection of the ferritic material is required at PNP.

2. If a pressurizer heater sleeve is repaired at PNP, the licensee will perform a review of the primary coolant system chemistry histories, over the last two operating cycles, to confirm that the conditions required by WCAP-15973-P, Revision 01 have been met.

3.7 Duration Of Relief Request No. 2

The licensee requests approval of the proposed alternative for the fourth 10-year interval of the ISI program for PNP, which will conclude on or before December 13, 2015.

4.0 NRC STAFF EVALUATION

RR No. 2 pertains to potential repairs of the PNP Alloy 600 pressurizer heater sleeve penetrations. The licensee will remove a portion of the existing nozzle, install an Alloy 690 plug into the penetration where the existing nozzle is removed, and then weld a pad over the Alloy 690 plug at the outer surface of the pressurizer bottom head. The welded pad will become a part of the pressurizer pressure boundary. In the March 9, 2007, letter, the licensee stated it was conservatively determined that 12 heater sleeves could be repaired with the proposed repair technique without challenging the intended function of the pressurizer. Further evaluation would be required if more than 12 heater sleeves require repair.

In the March 9, 2007, letter, the licensee stated that during the 2006 refueling outage, a bare metal visual inspection was performed on the 120 pressurizer heater sleeve penetrations at PNP. The bare metal visual inspection yielded acceptable results. There were no repairs of the pressurizer penetration nozzles during the 2006 outage.

The NRC staff's assessment of TR, WCAP-15973-P, Revision 01, indicated that the WOG's methods and analysis in the TR were generally acceptable. Specifically, the NRC staff determined that TR, WCAP-15973-P, Revision 01, provided sufficient basis to accomplish the above objectives with respect to implementing the half-nozzle repair to which PNP's pressurizer heater sleeve nozzle repair is similar. The NRC staff concluded that licensees could use the methods of the TR as a basis for the half-nozzle repair, provided that answers to several plant-specific questions were submitted to the NRC for review in the areas of general corrosion assessment, thermal fatigue crack growth assessment, stress corrosion cracking growth assessment, and a few other considerations.

Although the proposed repair of RR No. 2 is neither the half-nozzle nor MNSA, the licensee has demonstrated by analysis that TR, WCAP-15973-P, Revision 01, is applicable to the proposed repair. The NRC staff agrees with the licensee that TR, WCAP-15973-P, Revision 01, is applicable to the proposed repair. The NRC staff's evaluation of the licensee's response to the NRC requirements as specified in the NRC SE for WCAP-15973-P, Revision 01, is discussed below.

4.1 General Corrosion Assessment

In the area of general corrosion assessment, the NRC staff finds the licensee's responses met the requirements of the NRC's final SE for TR, WCAP-15973-P, Revision 01. The limiting diameter for the PNP pressurizer heater penetration is 2.140 inches, based on the reinforcement and effective weld area criteria. The licensee stated further, as shown in its response to NRC Requirement 1 above, that the limiting diameter was calculated using ASME Code criteria. The NRC staff finds that because the limiting diameter was calculated using ASME Code criteria, the allowable values are adequate for determining the impact of corrosion.

The licensee calculated the overall general corrosion rate for PNP to be 2.59 mpy in accordance with the methodology of TR, WCAP-15973-P, Revision 01, considering plant-specific operating history. The licensee has committed to tracking the time at cold shutdown conditions to verify that the corrosion rate is not exceeded if the repairs are installed.

The licensee stated that the initial diameter of the penetration bore-hole was 1.173 inches in its response to NRC Requirement 1. The licensee indicated that this value is the nominal counter bore (spot face) on the outer diameter of the pressurizer bottom head. The minimum and maximum sleeve penetration values for the PNP are 1.158 inches and 1.160 inches, respectively. Thus, the NRC staff finds that the use of 1.173 inches for bore-hole diameter would be conservative because the licensee used a larger diameter in the analysis than the actual diameter of the penetration. If PNP implements a repair at the next scheduled outage, the penetration diameter over the remaining 40 year license was calculated to increase to 1.199 inches and to increase to 1.303 inches for a 60 year license as a result of general corrosion. Since the calculated bore size resulting from corrosion for both a 40 year and 60 year licensed life is less than the limiting allowable bore diameter (i.e., 2.140 inches), the licensee's analysis indicates that general corrosion should not impact the integrity of the proposed weld repair. The licensee indicated that if a repair is necessary, it plans to perform the ASME Code, Section III design analysis. The licensee is not requesting relief from any Section III requirements. Therefore, the structural and leakage integrity of the primary system pressure boundary would be maintained by the repaired heater sleeve design.

In the March 9, 2007, letter, the licensee responded that the earliest date for a pressurizer heater sleeve repair would be during the upcoming refueling outage, which is scheduled to begin in September 2007. The corrosion rate analysis described in NRC Requirement 4, calculates the amount of general corrosion for the pressurizer bottom head over the remaining plant life, following repairs to a pressurizer heater sleeve. The analysis uses the March 19, 2006, date as the earliest date for a pressurizer repair, as this date provides a bounding corrosion rate for PNP. Therefore, this analysis remains acceptable because the remaining life of the PNP license has decreased by approximately 18 months and the earliest repair date is less than assumed in the analysis. The response to NRC Requirement 4 remains acceptable, with the correction of the earliest repair date of September 2007. Also the licensee noted that subsequent to the September 15, 2006, submittal, PNP received license extension approval.

4.2 Thermal Fatigue Crack Growth Assessment

The licensee indicated that although the PNP water solid operation of the pressurizer practically eliminates the in-surge and out-surge transients postulated in CN-CI-02-71, a plant-specific flaw fatigue growth analysis was performed. The analysis used a 220 °F in-surge transient in lieu of the 320 °F in-surge transient applied in the generic analysis. The licensee provided the results from the PNP plant-specific flaw fatigue growth analysis. The PNP plant-specific flaw fatigue growth analysis was performed using LEFM and used the methodology documented in CN-CI-02-71, Revision 1. The NRC staff reviewed Report, CN-CI-02-71, Revision 1, as part of NRC staff's evaluation of TR, WCAP-15973-P, Revision 01, and found the results in CN-CI-02-71, Revision 1, acceptable.

In a letter dated March 13, 2006 (part of the relief request for the third 10-year ISI interval), the licensee indicated that the allowable flaw size is based on criteria in paragraph IWB-3612 of Section XI of the ASME Code and the primary stress limits in Article NB-3000 of Section III of the ASME Code. The allowable stress intensities at the final crack size in tables in Sections 3.4 and 3.5 of WCAP-15973-P, Revision 01, are based on criteria in paragraph IWB-3612 of Section XI of the ASME Code. In the March 13, 2006, letter, the licensee stated that the fatigue

crack assessment was evaluated for 40 years of operation. While this information was provided as part of the relief request for the third 10-year ISI interval, it is still applicable to this relief request. The PNP plant-specific flaw fatigue growth analysis indicates that the total crack growth for the PNP geometry and transient conditions are relatively low and compare favorably to their allowable crack sizes. In addition, at the end of the 500 heatup and cooldown cycles and after the 220 °F insurges, there remains significant margin to the allowable crack tip stress intensity factor.

The licensee compared the reference temperature, RT_{NDT}, value of the bottom head plates used to fabricate the PNP pressurizer to the RT_{NDT} value used in the PNP plant-specific flaw fatigue growth analysis. The RT_{NDT} for the plates were determined from plate specific Charpy impact test data and drop weight test data. The test data was evaluated in accordance with a NRC staff methodology for converting the data into RT_{NDT} values. The RT_{NDT} value used in the PNP plant-specific flaw fatigue growth analysis was conservative relative to the RT_{NDT} values of the bottom head plates. This comparison indicates that the material properties used in the PNP plant-specific flaw fatigue growth analysis conservatively represent the PNP pressurizer bottom plate.

In the area of thermal fatigue crack growth assessment, the NRC staff finds the licensee's responses met the requirements of the NRC's SE for TR, WCAP-15973-P, Revision 01. The licensee provided a plant-specific calculation using PNP geometry which shows sufficient margin of the final flaw size and the allowable axial flaw sizes of TR, WCAP-15973-P, Revision 01, for 40 years of operation. The analysis also shows sufficient margin for the stress intensities at the final crack size at the end of 40 years of operation. The plant-specific pressure and temperature profiles bound the analyzed transient conditions in Figure 6-2(a) of report, CN-CI-02-71, Revision 1. The plant-specific Charpy USE data was not applicable because the licensee used a LEFM methodology. The RT_{NDT} value used in the PNP plant-specific flaw fatigue growth analysis is conservative relative to the RT_{NDT} values of the bottom head plates. Therefore, in the area of thermal fatigue crack growth assessment, the NRC staff finds the licensee's proposed alternative acceptable.

4.3 Stress Corrosion Crack Growth Assessment

The NRC staff's SE for TR, WCAP-15973-P, Revision 01, indicates that licensees seeking to implement MNSA repairs or half-nozzle repairs may use the WOG's stress corrosion assessment as the bases for concluding that existing flaws in the weld metal will not grow by stress corrosion if they conduct appropriate plant chemistry reviews which demonstrate that a sufficient level of hydrogen overpressure has been implemented for the RCS and that the oxygen and halide/sulfate concentrations in the reactor coolant have been typically maintained at levels below 10 parts per billion (ppb) and 150 ppb, respectively. During the outage in which the half-nozzle or MNSA repairs are scheduled to be implemented, licensees adopting the 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.

The NRC staff finds that the licensee has confirmed that the PNP chemistry history over fuel cycle 17 and 18 met the concentration limits on hydrogen overpressure, dissolved oxygen, halides and sulfate concentrations discussed in the previous paragraph. In the area of stress

corrosion cracking growth assessment, the NRC staff finds the licensee's responses met the requirements of the NRC's final SE for TR, WCAP-15973-P, Revision 01. In addition, the licensee has committed to perform a review of the PNP primary system chemistry over the prior two operating cycles when a pressurizer heater sleeve repair is affected.

4.4 Other Considerations

The NRC staff finds that the licensee provided the information required by the NRC final SE for TR, WCAP-15973-P, Revision 01, as a relief request. The information provided was sufficient to meet the requirements for PNP to use TR, WCAP-15973-P, Revision 01, as a basis for a relief request. Therefore, in the area of other considerations, the NRC staff finds the licensee's proposed alternative acceptable.

The NRC staff's review of the licensee's responses in the areas of general corrosion assessment, thermal fatigue crack growth assessment, stress corrosion crack growth assessment, and other considerations, supports the licensee's use of the TR, WCAP-15973-P, Revision 01, as a basis for this relief request. Therefore, with the regulatory commitments listed above, the NRC staff finds that approval of this relief request will provide reasonable assurance of structural integrity of the pressurizer nozzle penetrations for PNP for the fourth 10-year ISI interval, which will conclude on or before December 13, 2015.

5.0 CONCLUSION

The NRC staff has reviewed the licensee's proposed RR No. 2 as an alternative to the ASME Code, Section XI, requirements for required flaw characterization and successive examinations for 120 PNP pressurizer heater sleeve nozzles. Based on the NRC staff's review of the licensee's proposed justification, the NRC staff concludes that granting relief pursuant to 10 CFR 50.55a(g)(6)(i) is authorized by law and will not endanger life or property or the common defense and security, and is otherwise in the public interest giving due consideration to the burden upon the licensee that could result if the requirements were imposed on the facility. Therefore, with the licensee's accepted regulatory commitments listed above, the licensee's request as stated in RR No. 2 is granted for PNP for the fourth 10-year ISI interval.

The licensee's general corrosion assessment was performed to cover operational periods of 40 and 60 years. The licensee's thermal-fatigue crack growth assessment was for 40 years of operation. These assessments should be considered time-limited aging analyses within the scope of 10 CFR Part 50, when the repair becomes part of the licensee's current licensing basis. The NRC approved the 20-year license extension for Palisades on January 17, 2007, (ADAMS Accession No. ML063480220). Therefore, the licensee must validate the assessments for 60 years or provide an aging management program in accordance with 10 CFR 54.21(b).

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

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