NMC
Committed to Nuclear Excellence

Palisades Nuclear Plant
Operated by Nuclear Management Company, LLC

August 11, 2005

10 CFR 50.55a

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555

Palisades Nuclear Power Plant
Docket 50-255
License No. DPR-20

Request for Relief from ASME Section XI Code Requirements for Repair of Pressurizer Nozzle Penetrations

By letter dated July 22, 2005, Nuclear Management Company, LLC (NMC) submitted a proposed alternative repair technique for a pressurizer heater sleeve penetration repair at the Palisades Nuclear Plant. NMC plans to implement a Welding Services Incorporated/Structural Integrity Associates outer diameter pad plug design if a repair is necessary for the Palisades Nuclear Plant (PNP). Therefore, in support of the proposed repair design and pursuant to 10 CFR 50.55a, NMC is requesting relief from certain sections of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel (B&PV) Code, Section XI, 1989 Edition, as described in the attached enclosure.

Enclosure 1 contains a request for relief from the ASME Code, Section XI, IWA-3300, "Flaw Characterization," IWB-3142.4, "Acceptance by Analytical Evaluation," and IWB-3420, "Characterization." As an alternative, NMC proposes to assume the worst case cracks in the Alloy 600 pressurizer nozzle base and weld material using the methodology in Topical Report (TR) WCAP-15973-P, "Low Alloy Steel Component Corrosion Analysis Supporting Small-Diameter Alloy 600/690 Nozzle Repair/Replacement Program." By letter dated January 12, 2005, the NRC issued the final safety evaluation (SE) on WCAP-15973-P, approving it to the extent possible under the limitations in the TR and the associated SE. Attachment 1 provides the response to the conditions of the SE. Attachment 2 provides the site specific analysis, as required per the TR and the SE. The proposed alternative, to assume the worst case cracks, provides an acceptable level of quality and safety, pursuant to 10 CFR 50.55a(a)(3)(i).

Relief is requested for the remainder of the current ten-year inspection interval, which will conclude on or before December 12, 2006.

A047

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NMC requests approval of the proposed relief requests by March 1, 2006, to support the upcoming refueling outage at PNP.

Summary of Commitments

This letter contains two new commitments and no revisions to existing commitments.

1. If a pressurizer heater sleeve is repaired at PNP, NMC 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, NMC 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, NMC 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 have been met.

Paul A. Harden
Site Vice President, Palisades Nuclear Plant
Nuclear Management Company, LLC

Enclosure (1)
Attachments (2)

CC Administrator, Region III, USNRC
Project Manager, Palisades, USNRC
Resident Inspector, Palisades, USNRC

ENCLOSURE 1
RELIEF REQUEST: FLAW CHARACTERIZATION
PRESSURIZER VESSEL PENETRATIONS

Background Information

On May 20, 2004, the Westinghouse Owners Group (WOG) submitted Topical Report (TR) WCAP-15973-P, "Low Alloy Steel Component Corrosion Analysis Supporting Small-Diameter Alloy 600/690 Nozzle Repair/Replacement Programs," Revision 01, to the NRC staff for review. The TR allows licensees, seeking relief to use half-nozzle or mechanical nozzle seal assembly (MNSA) repair/replacement techniques, to reference the TR as part of the basis for using the alternate repair methods on leaking Alloy 600 nozzles that are part of the primary coolant pressure boundary (PCPB).

By letter dated January 12, 2005, the Nuclear Regulatory Commission (NRC) issued the final safety evaluation (SE) that found WCAP-15973-P, Revision 01, acceptable for referencing in license applications for Combustion Engineering designed pressurized water reactors. The WCAP was approved to the extent specified and under the limitations delineated in the TR and in the associated SE. The SE defines the basis for acceptance of the TR and requires licensees, proposing to use the half-nozzle and 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 10 CFR 50.55a. Attachment 1 of this enclosure provides the response to the conditions of the SE. Attachment 2 of this enclosure provides the site specific analysis, as required per the TR and SE.

This request pertains to potential repairs of the Palisades Nuclear Plant (PNP) Alloy 600 pressurizer heater sleeve penetrations. The repair method that Nuclear Management Company, LLC (NMC) will be employing is similar to the half nozzle repair, in that a portion of the existing nozzle is removed, and welding is performed on the pressurizer shell. The NMC repair will not replace the nozzle. NMC will install an Alloy 690 plug into the penetration, where a portion of the existing nozzle is removed, and then weld a pad over the Alloy 690 plug. This pad will become a part of the pressurizer pressure boundary. Attachment 1 of letter dated July 22, 2005, described the proposed repair and inspection plan.

WCAP-15973-P, Revision 01, is applicable to the pad repair proposed by NMC because the remnant sleeve that will be left in the pressurizer is identical to that that would be left by repair methods discussed in the WCAP.

ASME Code Component Affected

The affected components are the PNP pressurizer vessel heater sleeves. The PNP has 120 pressurizer heater sleeves penetrating the bottom head. The pressurizer assembly was fabricated in accordance with the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel (B&PV) Code, Section III, Class A components.

Applicable Code Edition and Addenda

The applicable code edition and addenda for the pressurizer vessel heater sleeve repair is the ASME B&PV Code, Section XI, 1989 Edition with no addenda. Palisades is currently in the third ten-year inservice inspection interval.

The original construction code of record for the PNP pressurizer vessel is ASME Section III, Class A, 1965 Edition, including addenda through winter 1965.

Applicable Code Requirement

The applicable code requirement for the pressurizer vessel head penetrations is ASME Section XI. Table IWB-2500-1, examination category B-E, "Pressure Retaining Partial Penetration Welds in Vessels," Item B4.20, is applicable to the inservice examination of the pressurizer vessel lower head to penetration welds. IWA-3300, "Flaw Characterization," IWB-3142.4, "Acceptance by Analytical Evaluation," and IWB-3420, "Characterization," are applicable to any flaws discovered during inservice inspection. 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.

Reason for Request

Nuclear Management Company, LLC (NMC) is requesting relief from ASME Section XI, IWA-3300, IWB-3142.4, and IWB-3420, pursuant to 10 CFR 50.55a(a)(3)(i). The above sections would require successive inspections and characterization of a flaw existing in the remnant of the J-groove weld that will be left on the pressurizer vessel lower head if a heater sleeve is partially removed.

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 stress corrosion cracking (PWSCC).

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. The analysis in the TR 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, NMC will not be removing the remnant sleeve or its attachment weld.

NMC is proposing an alternative, as discussed below, for not performing flaw characterization or successive inspections, as required in the ASME Code, Section XI. This alternative provides an acceptable level of quality and safety.

Proposed Alternative and Basis for Use

Pursuant to 10 CFR 50.55a(a)(3)(i), NMC is proposing 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, NMC assumed the worst case cracks in the Alloy 600 base and weld material and used the methodology presented in WCAP-15973-P 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.

NMC has reviewed the methods and basis presented in the TR 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. NMC finds that the methods and basis apply to the proposed pad repair of the pressurizer heater sleeve penetrations at PNP. NMC has evaluated these assumptions using appropriate flaw evaluation rules of Section XI, and in lieu of performing successive inspections, NMC has determined that the results demonstrate compliance with ASME Section XI criteria for the expected balance of plant life. Therefore, NMC has determined that the proposed alternatives will provide an acceptable level of quality and safety.

Duration of Proposed Alternative

NMC requests approval of the proposed alternative for the remainder of the third ten-year interval of the Inservice Inspection Program for PNP, which will conclude on or before December 12, 2006.

Precedent

Arizona Public Service Company submitted a relief request for Palo Verde Nuclear Generating Station, Unit 2, dated March 25, 2005 (ADAMS Accession #ML050950358), as supplemented by letter dated April 14, 2005 (ADAMS Accession #ML0511601830). The relief request proposed alternatives to the ASME Code requirements for flaw characterization and successive inspections. The relief request referenced the methods and basis of WCAP-15973-P, Revision 01. The NRC approved this relief request by letter dated May 5, 2005 (ADAMS Accession #ML051290123). The Palo Verde relief request is similar to the NMC relief request in that NMC is proposing alternatives to the ASME Code requirements for flaw characterization and successive inspections. The NMC relief request also references the methods and basis of WCAP-15973-P, Revision 01.

ATTACHMENT 1
NMC RESPONSE TO THE CONDITIONS OF THE FINAL SAFETY EVALUATION ON WCAP-15973-P

By letter dated January 12, 2005, the NRC issued the safety evaluation (SE) on Topical Report (TR) WCAP-15973-P, "Low Alloy Steel Component Corrosion Analysis Supporting Small-Diameter Alloy 600/690 Nozzle Repair/Replacement Program." The SE indicated that the methods and analysis in the TR are generally acceptable. The SE required that the following information be addressed to use the Westinghouse TR as a reference:

4.1 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 Condition 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.

NMC Response

Attachment 1 of NMC letter dated July 22, 2005, described the proposed repair and inspection plan for Palisades Nuclear Plant (PNP). The minimum acceptable wall thinning for the PNP bottom head is independent of the repair method. The more appropriate limiting parameter is the diameter of the heater sleeve penetration.

An analysis was performed by Westinghouse Electric Company (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 CE plant. The limiting diameter is the more conservative of the two values. The limiting diameter for the PNP pressurizer heater penetration is 2.140 inches, based on the reinforcement and effective weld area criteria.

NRC Condition 2

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.

NMC Response

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

- Normal operation: 88%
- Startup conditions: 2%
- Cold shutdown conditions: 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 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 where

  CR = corrosion rate in mils per year
  mpy = mils per year where a mil = 0.001 inch

- CR = 1.53 mpy (0.00153 in/yr)

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%. The ratio of effective full power days (EFPD) to days since the beginning of commercial operations indicates that the plant was at operating conditions for approximately 56% of the time from December 31, 1971 through November 17, 2004 (beginning of the current cycle). 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% of the time, which are 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% normal operations, 2% start-up conditions, and 23.9% cold shutdown conditions, the overall general corrosion rate was calculated as follows:

- CR = 0.741 x 0.4 mpy + 0.02 x 19.0 mpy+ 0.239 x 8.0 mpy

  CR = 2.59 mpy (0.00259 in/yr)

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

NRC Condition 3

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 of whether volumetric inspection of the area is required.

NMC Response

As noted in the response to Condition 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 has been at cold shutdown conditions for more than the assumed time. Assuming 2% 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% of the total time. A review of plant data indicates that this is a conservative assumption for recent operations at PNP. Since the cold shutdown 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 PNP does complete pressurizer heater sleeve repairs in the future, NMC 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, NMC 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 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 and the thickness of the ferritic vessel or piping that will adjoin to the MNSA repair or half-nozzle repair.

NMC 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 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 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.

NMC Response

A review of 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, 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, then,

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, 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.

4.2 *Thermal-Fatigue Crack Growth Assessment*

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

NRC Condition 1

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

NMC Response

The geometry of the PNP 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 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 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 SE.

NMC 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 the PNP 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 a PNP engineering analysis, EA-A600-2004-01, and is included as Attachment 2 to this relief request.

NRC Condition 3

The plant-specific Charpy 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 pressurizer and hot-leg piping, then justification (e.g., based on statistical or lower bound analysis) has to be provided.

NMC Response

NMC did not use plant-specific Charpy test data to bound the USE value used in the analysis. Westinghouse Calculation Note CN-CI-02-71 applied a lower bound CVN_{USE} of 70 ft-lbs in the Elastic-Plastic Fracture Mechanics (EPFM) analysis of the pressurizer flaw analysis. The EPFM was used to justify the effects of the large in-surge transients which do not pass the Linear Elastic Fracture Mechanics (LEFM) criteria.

The comparison of plant specific data to the 70 ft-lbs USE value is not necessary for PNP. The PNP operation of the pressurizer results in less severe transient conditions than those analyzed in CN-CI-02-71. Although, the PNP water 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, provided as Attachment 2, used a 220 °F in-surge transients, in lieu of the 320 °F in-surges 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.

4.3 Stress Corrosion Crack Growth Assessment

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

NRC 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 ppb for dissolved oxygen, 150 ppb for halide ions, and 150 ppb for sulfate ions.

NMC Response

NMC has conducted appropriate chemistry reviews and has concluded that there is a sufficient level of hydrogen overpressure in the primary coolant system (PCS). A PCS hydrogen overpressure of ≥15 cc/kg 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, Action Level 2 less than 15 cc/kg, and 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.

NMC has reviewed contaminant concentrations in the PCS at PNP and has confirmed that the PCS dissolved oxygen, halide ions, and sulfate ions are within the criteria mentioned above.

NRC Condition 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.

NMC Response

If a pressurizer heater sleeve is repaired at PNP, NMC will perform a review of the PCS chemistry histories, over the last two operating cycles, to confirm that the conditions required by the TR have been met.

4.4 Other Considerations

The WOG's general corrosion rates for normal operations, startups, and cold shutdown conditions, as applied in Equation 1 of the TR, are considered by the staff to be acceptable, as long as the existing corrosion data used to determine the bounding rates is applicable. If additional laboratory or field data becomes available that invalidates the TR's general corrosion rate values for normal operations, startups, and cold shutdown conditions, the WOG should send in an addendum to the TR that evaluates the impact of the new data of the corrosion rate values for normal operations, startups, and cold-shutdown conditions, and that provides a new overall general corrosion rate assessment for the ferritic components under assessment.

The WOG's thermal fatigue crack growth analysis is only applicable to the evaluation of a single flaw. Should the WOG desire to extend the scope of its thermal-fatigue crack growth analysis to the analysis of multiple cracks in near proximity to one another, the WOG is requested to submit an appropriate addendum to the TR that provides the new thermal-fatigue crack growth assessment for the multiple flaw orientation.

The scope of WCAP-15973-P, Revision 01, does not address any welding considerations for the MNSA or half-nozzle designs. Licensees seeking to implement half-nozzle replacements or MNSA repairs of their Alloy 600 nozzles will need to assess the welding aspects of the design and may need to submit a relief request to implement the alternatives to the requirements of the ASME Code, Section XI as required by 10 CFR 50.55a.

The staff's review of the corrections to the flaw evaluation, changes in corrosion rate, and clarification of the stress corrosion cracking in carbon and low alloy steels to WCAP-15973-P, Revision 01, indicates that the changes in the evaluation and analyses are generally acceptable. The requirements addressed in Section 4.0 of this SE must be addressed, along with the following, when this TR is used as the basis for the corrosion and fatigue crack growth evaluation when implementing a half-nozzle or MNSA repair:

NRC 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.

NMC Response

NMC is not currently planning on using the MNSA repair technique for the pressurizer repair.

NRC 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 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.

NMC Response

This letter provides NMC's response to the conditions of Section 4.0 of the SE, as a relief request in accordance with 10 CFR 50.55a.

ATTACHMENT 2
RELIEF REQUEST: FLAW CHARACTERIZATION

PALISADES ENGINEERING ANALYSIS, EA-A600-2004-01, "LOW ALLOY STEEL COMPONENT CORROSION ANALYSIS SUPPORTING SMALL-DIAMETER ALLOY 600/690 NOZZLE REPAIR/REPLACEMENT"

13 Pages Follow
(Attachments to the EA are not being sent)

PALISADES NUCLEAR PLANT
ENGINEERING ANALYSIS COVER SHEET

NUCLEAR MANAGEMENT COMPANY

EA- A600-2004-01

Total Number of Sheets ~~128~~ 176 (1△)

Title Low-Alloy Steel Component Corrosion Analysis Supporting Small-Diameter Alloy 600/690 Nozzle Repair/Replacement

INITIATION AND REVIEW

Calculation Status	Preliminary ☐	Pending ☐	Final ■	Superseded ☐

Rev #	Description	Initiated By	Initiated Date	Init Appd By	Review Method: Alt Calc	Review Method: Detail Rev'w	Review Method: Qual Test	Technically Reviewed By	Technically Reviewed Date	Rev'r Appd By	Sup'v or S/DR Appd
0	Original Issue	JCWong	6/29/04	[signature] 6/29/04		X		[signature] JSErickson	6/29/04	[signature] 6/29/04	
1	ADD SHEET 1A AND ATTACHMENTS	JCWong	7/10/05	[signature]		X		[signature] MWAcker	7/18/05	[signature] 7/21/05	

LIST OF ATTACHMENTS

1. Westinghouse Report WCAP-15973-P,Low-Alloy Steel Component Corrosion Analysis Supporting Small Diameter Alloy 600/690 Nozzle Repair/Replacement Programs, Rev.1.

2. Westinghouse Calculation Note Number CN-CI-02-71 Rev.1, Summary Of Fatigue Crack Growth Evaluation Associated With Small Diameter Nozzles In CEOG Plants.

3. Westinghouse Letter, ~~LTR-CI-04-40,~~ CPAL-04-28 Corrosion Analysis of the Pressurizer Side Shell Nozzle, dated ~~June 25, 2004.~~ August 6, 2004. (Westinghouse letter CPAL-04-28 is a non-proprietary version of LTR-CI-04-40)

4. 50.59 Screen.

5. EA Checklist, 3110 Form, Technical Review Checklist

PROCESSED
AUG 05 2004
ERC - PAL

PALISADES NUCLEAR PLANT
ENGINEERING ANALYSIS COVER SHEET

NUCLEAR MANAGEMENT COMPANY

EA-A600-2004-01

Total Number of Sheets______

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Title Low Alloy Steel Component Corrosion Analysis Supporting Small-Diameter Alloy 600/690 Nozzle Repair/Replacement

INITIATION AND REVIEW

Calculation Status: Preliminary ☐ Pending ☐ Final ☐ Superseded ☐

Rev #	Description	Initiated		Init Appd By	Review Method			Technically Reviewed		Rev'r Appd By	Sup'v or NMC Appd
		By	Date		Alt Calc	Detail Rev'w	Qual Test	By	Date		
1	Updated by adding supplemental plant specific analyses in Attachments 6, 7, 8 and 9; revised 50.59 screen										

List of Attachments (continued)

6. NRC Final Safety Evaluation For Topical Report WCAP-15973-P Revision 01. Dated 1/12/2005. 19 pages
7. DIT No.1 for PO P806643, From James Wong to John Hall of Westinghouse, "Analysis inputs to address NRC SER requirements on WCAP-15973-P". 2 pages
8. Westinghouse letter LTR-CI-05-46 dated 6/22/05, "Pressurizer Alloy 600 Small Borehole Fatigue Crack Growth Analyses". 19 pages
9. Westinghouse Letter LTR-CI-05-43 dated 6/16/05, "Corrosion Analysis of the Palisades Pressurizer Material After Heater Sleeve Repairs". 6 pages

1.0 Objectives:

The objectives of this analysis are to:

(1) Provide a cover EA for the vendor reports in Attachment 1 (referred as WCAP-15973 hereinafter) and Attachment 2 (referred as CN-CI-02-71 hereinafter). This EA is prepared in accordance with the Reference 2.1 requirements for Vendor Technical Evaluations and Reports. Section 6.2.6 of the Reference 2.1 requires this cover EA to evaluate the effects that the WCAP-15973 and CN-CI-02-71 have on the design of the plant.

WCAP-15973, performed on a generic industry level, is a bounding ASME Code Section XI analysis for the repair of the Combustion Engineering design of hot leg piping RTD and sampling nozzles, pressurizer instrument nozzles and pressurizer heater sleeves. CN-CI-02-71 is a supporting calculation for WCAP-15973 and is considered in this EA as an integral part of WCAP-15973. These reports are applied to the repairs of the small-bore nozzles whose pressure boundaries have been breached by the PWSCC attack in the J-weld penetration areas. Generally speaking, the flaws in a nozzle remnant (J-weld included) are difficult to remove and these reports provide a justification for leaving a flaw in the nozzle remnant. The justification includes the evaluations of the effects of corrosion, stress corrosion cracking, fatigue crack growth and environmental factors. More comprehensive descriptions of the scope of each vendor reports are in the front sections of these reports.

(2) Supercede the engineering analysis of Reference 2.2. In essence, Reference 2.2 is the cover EA for Rev.0 of the Attachments 1 and 2 reports. The difference is the Reference 2.2 fatigue crack analysis was prepared specifically for Palisades' pressurizer temperature nozzles repair. Both of the pressurizer temperature nozzles were repaired under Specification Change No.SC-93-087 in 1993. This EA provides broader applications than the temperature nozzles. Besides that, this EA also corrected several analysis deficiencies from the previous analysis, i.e. Revision 1 of WCAP-15973 and Reference 2.2. A description of the analysis deficiencies is presented in WCAP-15973 Executive Summary section.

(3) Close Corrective Action CA024362. The analysis deficiencies mentioned in the preceding paragraph were officially communicated to Palisades via Westinghouse Nuclear Safety Advisory Letter NSAL-04-4. The NSAL-04-4 was placed in the corrective action program to ensure the proper evaluation and actions be performed. Noting that the original overall conclusion to leave small bore piping J-Welds in service with pre-existing flaws is unchanged. The corrective action requires the maintaining of configuration control by replacing Reference 2.2 with this cover EA.

2.0 References

2.1 Administrative Procedure No. 9.11, Engineering Analysis, Revision 15.

2.2 EA-SC-93-087-06, Evaluation of Fatigue Crack Growth of Postulated Flaw at Repaired Pressurizer Temperature Nozzle, Rev.0.

2.3 DBD 2.11 Rev.1, Pressurizer Pressure Control.

2.4 System Operating Procedure SOP-1, Rev. 54.

2.5 Combustion Engineering Specification No. 70P-01, Engineering Specification for A Pressurizer Assembly for Palisades Nuclear Plant, Vendor File M1-L-A, Rev.3.

2.6 Combustion Engineering Owners Group report CEN-NPSD 546-P. Pressurizer Surge Line Flow Stratification Evaluation, Rev. 1-P.

2.7 EOP Supplement 1, Pressure Temperature Curves, Rev. 5

2.8 Technical Specification Amendment 189.

2.9 ASME B&PV Code, 1989 Edition

2.10 Drawing M1-LA-5003-1, Bottom Head Forming and Welding, Rev.4.

2.11 Drawing M1-D-106, Piping Assembly Details, Rev. 9.

2.12 Drawings: M1-LA-989, Internal Details, Rev. 7. M1-LA-985, Nozzle Details, Rev.13

2.13 Reactor Log Book, current record of the Perpetual Log of Pressurizer Spray Cycle with High Delta Temperature, up to date.

2.14 ABB-CE Report, Pressurizer Spray Nozzle Fatigue Evaluation, dated October 1991 Cartridge/Frame (C775/0650).

2.15 EA-A-PAL-92-095-01, Pressure-Temperature Curves and LTOP Setpoint Curve for Maximum Reactor Vessel Fluence of 2.192 x 10^{19} Neutrons/cm^2, Rev.0.

2.16 Palisades 40 Year Master Inservice Inspection Plan, Revision 10.

2.17 Drawing: M1-LA-982, Vessel Forming and Welding, Rev.10.

2.18 Combustion Engineering Report Palisades PCS System Description Revision 0.

2.19 Emergency Operating Procedure EOP-1 Supplement 1 Revision 5.

3.0 Acceptance Criteria

3.1 Leaving flaws in a nozzle remnant by analytical evaluation is permitted by ASME XI Para. IWB-3132.4. Referring to IWB-3132.4, the acceptance criteria for the analytical evaluation of the flaw are given in ASME XI Para. IWB-3600 and in Regulatory Guide 1.161 for Elastic-Plastic Fracture Mechanics approach. The ASME Code acceptance criteria for the flaw evaluation are presented in Section 4.0 of the CN-CI-02-71. WCAP-15973 evaluates the corrosion of low alloy steel in the primary coolant system. The corrosion allowables are described in Section 2.4 of WCAP-15973, which was established based on ASME Section III design requirements. Compliance to the corrosion and flaw growth acceptance criteria has been demonstrated in WCAP-15973 and are not further evaluated by this cover EA.

3.2 In order to make use of WCAP-15973 and its supporting calculation CN-CI-02-71, Palisades must ensure that the plant is operated such that the pressure and temperature heat-up and cool-down profiles do not exceed the analyzed profile applied in CN-CI-02-71 (see Section 3.2 of CN-CI-02-71). The pressure and temperature profile applied in CN-CI-02-71 is shown in the Figure 1 below.

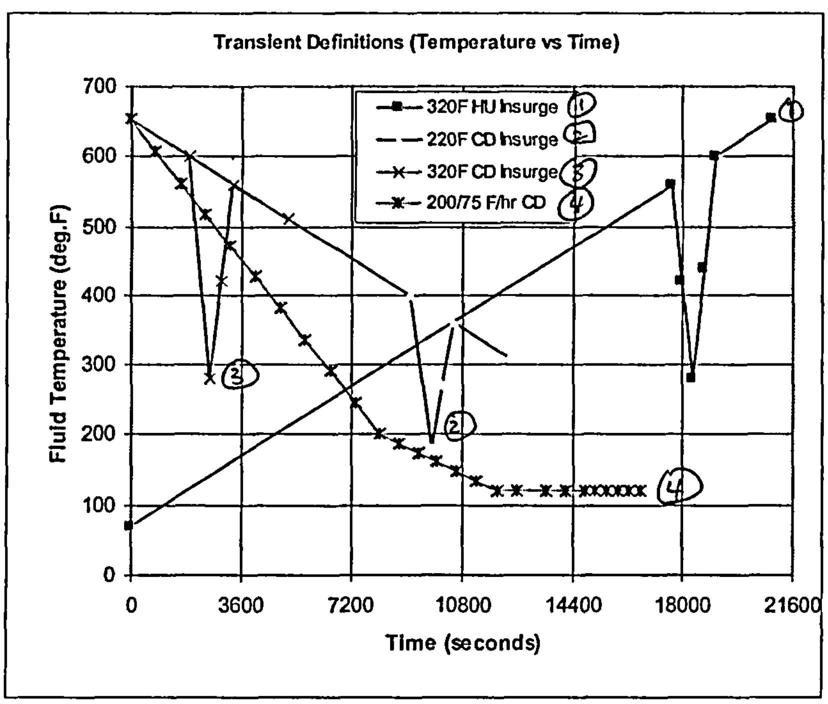

Figure 1 Fluid Temperature vs Time

4.0 Inputs

4.1 The in-surge transients described in Figure 1 are not part of Palisades design basis, except for the purpose of the evaluation of this EA. Westinghouse has not revealed the mechanics of the in-surge transients and has not incorporated such transients in design requirements.

4.2 Palisades operators are sensitive to the adverse effects on components due to a large differential temperature between the pressurizer and the PCS (PCS-PZR ΔT). Palisades operations of the heatup and cooldown of the PCS result in, relative to the industry's norm, a small PCS-PZR ΔT. The relatively small ΔT is achieved by a combination of the high pressurizer heater input and the use of a continuous spray flow for pressure control. A brief description of the Palisades operation in this respect is below.

To heat up the PCS from shutdown condition, all the pressurizer heaters are energized. [SOP-1 7.1.3.c.2]. There is a total of 1500 KW (nominal) of heater capacity available. 90% of the total heater capacity is powered by fixed input and the other 10% heater capacity is powered by variable power input [DBD 2.11, Section 3.2.1]. The fixed input heater capacity, which amounts to 1350 KW (nominal), stays energized through out the fuel cycle [DBD 2.11 Section 3.3.1.4] and provides a constant high heat input to the pressurizer. Palisades starts the Primary Coolant Pumps (PCPs) when the pressurizer is solid which provides both the driving force for the spray flow and the energy to heat up the PCS simultaneously with the pressurizer. Both factors of the high pump heat input and a continuous spray flow reduce the PCS-PZR ΔT. A limit of the PCS-PZR ΔT is included in SOP-1. Section 7.1.3 of the operating procedure requires that [Reference 2.4] when PCS is greater than 185°F the maximum delta between the lowest cold leg temperature and PZR vapor temperature be less than 200° F.

To cool down the PCS, SOP-1 Section 7.1.4.o.5 says to "MAINTAIN maximum possible PZR heaters energized while controlling pressure with pressure control through out the collapsing the bubble." That is, spray flow must be available for pressure control. The PCPs are operated until near the end of the cool down process when the PCS is at about 150° F [SOP-1 Section 7.1.4]. Like the heat-up process, the heat input from the PCP operation during the cool-down reduces the magnitude of the PCS-PZR ΔT.

4.3 Palisades operators recognize the potential harmful effects of a large PCS-PZR ΔT on the equipment. To minimize thermal transients on the spray nozzle, the operating procedures require operators recording and trending the occurrences of "when the differential temperature between the spray water and pressurizer vapor phase is greater than 200° F". Based on the record [References 2.13 and 2.14], the occurrences of 200° F can be described as infrequent and largely involved with the use of aux spray under off-normal operating conditions.

4.4 As discussed in Section 4.2 above, Palisades operates the pressurizer with 90% of total heater capacity energized all the time and offsets the heat input with a continuous spray flow. The continuous spray flow minimizes the potential of the harmful effects due to thermal stratification in the surge line and spray line as well as the effects of the in-surge transients. During normal operation in which there are small changes in pressurizer level, prior to an in-surge, the surge line is filled with out-surged fluid from the pressurizer. When an in-surge transient occurs, the front of the flow is the fluid in the surge line that is at about the same temperature as the pressurizer. Unless there is a sustained in-surge flow, the effect of cooling the pressurizer is expected to be small.

During heat-up and cool-down processes, the spray flow rate varies over time. EA-GEJ-97-03 calculated spray flow rates might provide some perspective of the system operation. For a 100°F PCS-PZR ΔT, a flow rate of 83 gpm (nominal) is needed to offset the 90% of the heater capacity. This flow rate estimate took into consideration ambient heat loss.

The in-surge transient is unlikely to occur during heat-up when the system volume is in expansion.

Engineering Specification for the pressurizer [Reference 2.5] sets forth the pressurizer's design requirements. The sudden cooling due to the change of surge flow temperature has been considered in several design transients. The largest surge temperature considered was a step change of about 70°F due to Unloading at 15% per minute. The designed number of occurrences of this transient is 15,000 cycles. It should be noted that the transients Loading and Unloading at 15%/minute are not in Palisades licensing basis for PCS system [FSAR 4.2]. This transient was apparently deemed as unrealistically conservative for the PCS design.

4.5 Palisades Pressure Temperature Limits (P-T Curves) are defined in Tech Spec 3.4 (Reference 2.8). These P-T curves set limits on the rate of heating up and cooling down of the PCS. The limits are much more restrictive than the heatup and cool down rates applied in the component design, i.e. 100° F per hour for heat-up and 200° F per hour for cool-down [Reference 2.5]. The current P-T curves are applicable through the plant current licensed life [Reference 2.15]. The P-T curves may need to be revised for plant life extension. However, as the reactor is being aged with fluence, the limits on heatup and cooldown rates will be more restrictive, so the conclusions from this EA will not be affected by the future amendments of the P-T curve.

4.6 The loading conditions, design transients and cycles applied in CN-CI-02-71 were not identical to that of the Palisades specifications. Most of the loadings applied bound the Palisades design requirements. The few exceptions were the transient cycle numbers, i.e. the occurrences of the reactor trip, the Loss of Reactor Coolant Flow and Loss of Load were less than the occurrences specified in Palisades pressurizer design specification [Reference 2.5]. However, CN-CI-02-71 has determined that these under reported transient occurrences make no significant contribution to the fatigue crack growth and has eliminated them from consideration, therefore, the differences in these cycle numbers have no bearing on the analysis results.

4.7 Palisades current ISI Code of record is the 1989 Edition of ASME Code [Reference 2.16.]. Since CN-CI-02-71 invoked the 1992 edition of ASME III and XI, a comparison of the material properties have been performed for the pressurizer and the Hot Leg pipe material. The pressurizer shell material is SA-533 GR.B CL.1 [References 2.10 and 2.17]. The Hot Leg Pipe is made of SA-264 [Reference 2.11], which is the specification of roll-bonded stainless steel clad with the base material of carbon or low alloy steel. The base material for the loop pipe is SA-516 GR.70. Comparison of the material properties confirmed that the stress allowables of these materials are identical in 1992 and 1989 ASME editions. No further code reconciliation is necessary for using the WCAP in Palisades's application.

4.8 For the purpose of supporting the discussion in Section 6 of this EA, a plot of pressurizer cooldown data from the 2003 refueling outage is included in Figure 2 of this EA. The source of the data is the Palisades Plant Computer down loaded to a PI® system. Referring to the upper portion of the plot, the vapor temperatures deviates from the water temperature twice during the cooldown process. Such deviations were likely indications of the occurrence of in-surge flow. The first occurrence of in-surge causes a differential temperature of about 80°F between the water phase and vapor phase. The change of temperature was fairly steady and it took several hours as the pressurizer water level rose slowly. The second occurrence was hardly noticeable in this plot; it took place at the end of bubble collapse. A Developer's note for SOP-1 Section 7.1.2.p.2 relates the cause of the diverging temperatures between the water and steam space to the non-condensable vapor bubble. The evaluation of the diverging temperature is documented in C-PAL-95-0479B. The plot also showed a step change of the vapor temperature during this occurrence. However, close examination of the data concluded that the step change was false data. The time span of the signal was only 2 seconds, which is not credible for such a significant temperature swing. It is believed that the false signal was due to the sudden heat transfer coefficient change when the water level reached the upper temperature element. Clearly, there was no substantial in-surge flow observed.

5.0 Assumptions:

5.1 Major Assumptions:

The attached Westinghouse reports assume operational transients bound the actual transients that occur during plant operation as controlled by the Technical Specifications and plant operating procedures. This engineering analysis assumes that the Westinghouse assumed transients will continue to bound these actual plant transients in the future. This assumption is appropriate because all but one of the plant actual transients are controlled by the Technical Specification P - T curves, and a license amendment would be required to change the curves. The only transient not controlled by the Technical Specification P/T curves is a sudden in-surge flow of 220°F delta T (see Section 6.5). This transient is controlled by plant operating procedures, rather than the Technical Specifications, and occurs when the pressurizer bubble is collapsed during cooldown. It is very unlikely that operating procedures would be revised in the future such that a sudden surge could occur in excess of 220°F delta T. Bubble collapse normally takes hours to complete due to limited charging system makeup capacity. Moreover, operating procedures require pressurizer heater operation and continuous spray flow, which would limit the in-surge delta T. Finally, all of the transients assumed in the Westinghouse reports will be described in Design Basis Document 2.04, "Primary Coolant System", to help ensure that plant operation is not changed in the future such that these Westinghouse assumed transients are no longer bounding.

5.2 Minor Assumptions:

There are a number of conservative assumptions described in WCAP-15973 Section 2.3 Corrosion Evaluation and in CN-CI-02-071 Sections 3.0 and 6.3.3. Those are the assumptions in association with the structural analysis approach. Westinghouse reports discuss assumptions and their bases in the body of the reports. Nonetheless, there is also a very conservative assumption that neither the WCAP-15973 nor the CN-CI-02-71 has explicitly acknowledged. That is, the analyses assumed the in-surge transient is a local phenomenon. The in-surge flow does not mix with the fluid in the pressurizer, thus the pressure boundary material is subject to the in-surge flow temperature.

The pressurizer water phase (lower) temperature instrument is located near the lower shell to bottom head juncture. It is judged that the in-surge temperature detected by this instrument would be close to the lowest fluid temperature in contact with the shell. This is based on the surge nozzle screen assembly extending 36" above the bottom of the pressurizer ID [Reference 2.12], the upward flow momentum of the in-surge flow, and the limited mixing in the bottom dome which is a plenum occupied with 120 heaters.

Regarding the transient loadings, Westinghouse has not provided the detailed description of the mechanics and component responses to the in-surge transients described in Figure 1. At this point in time, this EA assumes the in-surge transients are applicable to the flaw evaluations of Palisades pressurizer. The analysis of this EA purports that the assumed in-surge transients, in Palisades case, bound transients during plant operation.

6.0 Analysis

6.1 WCAP-15973 mentioned that Palisades' pressurizer lower temperature nozzle repair requires additional evaluation to accept the long-term corrosion degradation. Such an evaluation has since been completed and is documented in Attachment 3 of this cover EA.

Section 3.2 of WCAP-15973 asked the users to evaluate the applicability to their plants of the transients depicted in Figure 1. The preceding Inputs and Assumptions sections have pointed out, in a general sense, the conservatisms involved in the generic evaluation. To demonstrate that Palisades is operated within the Figure 1 transients, the four pressurizer pressure-temperature profiles presented in Figure 1 are analyzed in Sections 6.2 through 6.5.

6.2 Heatup at a rate of 100° F per hour and with a sudden cooling of the pressurizer due to 320°F cooler insurge flow.

A magnitude of 320°F PCS-PZR ΔT have been observed in many other PWR operations and has been used as a bounding value for surge line thermal stratification [Reference 2.6 applied a bounding value of 340°F]. During heatup, this large ΔT typically occurred at the startup of the Primary Coolant Pump when the PCS temperature is near shut down condition. If there is no pressurizer spray, the fluid in the surge line may remain at the ambient temperature. In the event that an in-surge occurs, the pressurizer shell would be subject to the surge line temperature. However, this magnitude of ΔT does not apply to Palisades. The high heat input from the pressurizer heaters and the the use of spray flow to control the heat-up rate keep the pressurizer surge line temperature close to that of the pressurizer. For a sustainned in-surge, the pressurizer would be subject to the hot leg fluid. As discussed in Section 4.2 of this EA, the PCS-PZR ΔT is limited to less than 200°F, well below the postulated 320°F. In addition, Palisades Tech Spec requirements (P-T Limit Curves) would not allow such a PCS-PZR ΔT.

Let's give an example of how the P-T Limit Curves are involved. Say, the pressurizer is at 550°F, which corresponds to a saturation pressure of 1045 psia. Per VLTOP set point of the P-T Limit Curves, the minimum PCS temperature at this pressure is around 375°F. Accordingly, the maximum PCS-PZR ΔT is 550-375 = 175°F; a ΔT much smaller than the 320°F value. Regarding the heat-up rate, Figure 1 postulated a 100°F per hour rate. For Palisades' operation, the pressurizer heatup rate is limited to 60° F/hour when the Shutdown Cooling System is in service [SOP-1 Section 4.4.2]. When Shutdown Cooling is secured, the limit on pressuirizer heat up rate is 100°F per hour. Therefore, both the heat up rate and PCS-PZR ΔT shown in Figure 1 bound Palisades operating parameters.

6.3 Cool-down at a rate of 200°F per hour until the pressurizer is at 200°F, then cooldown at a rate of 75°F per hour when Pressuizer temperature reaches 200°F.

Pressurizer cooldown rate is largely dictated by the PCS cooldown rate, which is limited by the P-T Limit Curves and by the administratively required subcooling margin. A constant cooldown at 200° F/hour rate bounds the allowed PCS cooldown rate. When pressurizer temperature is at or below 200° F, the PCS cooldown is near completion at the maximum temperature of 175°F. The pressurizer is in a solid condition and the Shut Down Cooling system is in service [SOP-1 7.1.4]. The PCS cool-down rate is limited to less than 40 °F per hour [SOP-1 4.4.1.c]. The conservatism of the 75°F/hour cool-down rate can be illustrated by a simplified analysis below.

Assume the pressurizer cool-down is by the auxiliary spray flow driven by the maximum allowed charging flow of 80 gpm net [see SOP-1 7.1.4.o, SOP-1 5.3.1.e limits the flow to 53 gpm]. A maximum of 4800 gallons is delivered to the pressurizer in one hour. The pressurizer has a capacity of 1503.7 cubic feet [Reference 18 section 5.0], which amounts to 1503.7 x 7.48 = 11248 gallons. Conservatively ignore the latent heat in the pressurizer shell; conservatively assume the pressurizer heaters are turned off and a spray flow temperature of 70°F. The pressurizer temperature after one hour time is computed as (200°F x 11248 + 70°F x 4800) / (11248 gallons + 4800 gallons) = 161°F. It thus shows a cool-down rate of 200 – 161 = 39°F in one hour of time.

Therefore, the cool-down rate of 75°F per hour bounds Palisades operating parameters.

6.4 Cool-down at 100° F per hour with a sudden in-surge flow of 320°F ΔT coolant when pressurizer is at a temperature of about 600° F

In this scenario, an in-surge flow to the pressurizer occurs when the pressurizer temperature is near 600° F and the PCS temperature is about 300° F. This postulated transient is very conservative since such a large ΔT is not permissible by Palisades Tech Spec. At 600° F pressurizer temperature, the saturation pressure is 1543 psia. Per VLTOP set point of the P-T Limit Curves, the PCS must be at least 400° F. In other words, the PCS-PZR ΔT is limited to 200°F by Palisades Technical Specification and a 320° F ΔT well bounds that of the Palisades operation. In terms of cool-down rate, a pressurizer cool-down rate exceeding 100° F per hour is unlikely due to the restriction on the PCS cooldown rate. Palisades pressurizer cool-down rate has been well within 100° F per hour to maintain a subcooling margin and to meet the P-T Limits. The conservatism of 100°F per cool-down is illustrated in the plot in Figure 2. Therefore, both the cool-down rate and PCS-PZR ΔT shown in Figure 1 bound Palisades operating parameters.

6.5 Cooldown at 100° F per hour with a sudden in-surge flow of 220° F ΔT coolant when pressurizer is at a temperature about 400° F

This scenario is most likely to occur during the collapsing of the pressurizer bubble, though the collapsing of the bubble normally takes hours of time due to the equipment capacity when charging the system volume. A sudden in-surge is unlikely due to bubble collapsing. As a reference, SOP-1 Section 7.1.4.0. addresses the steps of collapsing bubble. It requires the operator to "Maintain maximum possible PZR heaters energized while controlling pressure with sprays to aid in pressure control". Nevertheless, while collapsing the bubble, the colder PCS fluid enters into the pressurizer creating a temperature transient. Noting that the pressurizer cool-down rate is administratively limited to 100°F per hour [SOP-1 7.1.4.p] when pressurizer is in a solid condition. As to the in-surge flow temperature, Palisades operation of pressurizer high heat input and a continuous spray flow has kept the PCS-PZR ΔT within the 220°F value. This point is demonstrated in the experience data of Section 4.3 of this EA and can be seen in the pressure temperature profile plot in Figure 2. The in-surge temperature appeared to be bounded by the design basis transients, i.e. the 15% per minute Loading/Unloading discussed in Section 4.4 of this EA. Therefore, both the cool-down rate and PCS-PZR ΔT shown in Figure 1 bound Palisades operating parameters.

7.0 Conclusions

WCAP-15973 and its supporting calculation CN-CI-02-71 may be used by Palisades as a justification for leaving in place the remnant of a small bore nozzle that contains flaws. The small bore nozzles include the RTD and sampling nozzles on the hot leg, the pressurizer instrumentation nozzles and the pressurizer heater sleeves. This EA supercedes the Reference 2.2 EA, which supported the design modification of the pressurizer temperature nozzles. It should be noted that the acceptance of the vendor report is contingent on the methods of heating up and cooling down the PCS (see section 5.1 of this EA). All the applications of this EA need to be recorded in Attachment 4 of this EA for tracking purpose.

Based on the evaluation in this EA, it is concluded that the in-surge transients applied in the CN-CI-02-71 are conservative with respect to Palisades operation. CA024362 may be closed without further action.

The in-surge transients described in the Figure 1 are not part of Palisades design basis, except for the purpose of the evaluation of this EA. Westinghouse has not revealed the mechanics of the in-surge transients and has not incorporated such transients in design requirements. These transients need not to be considered as the equipment's design basis except for the compliance to the ASME XI flaw evaluation.

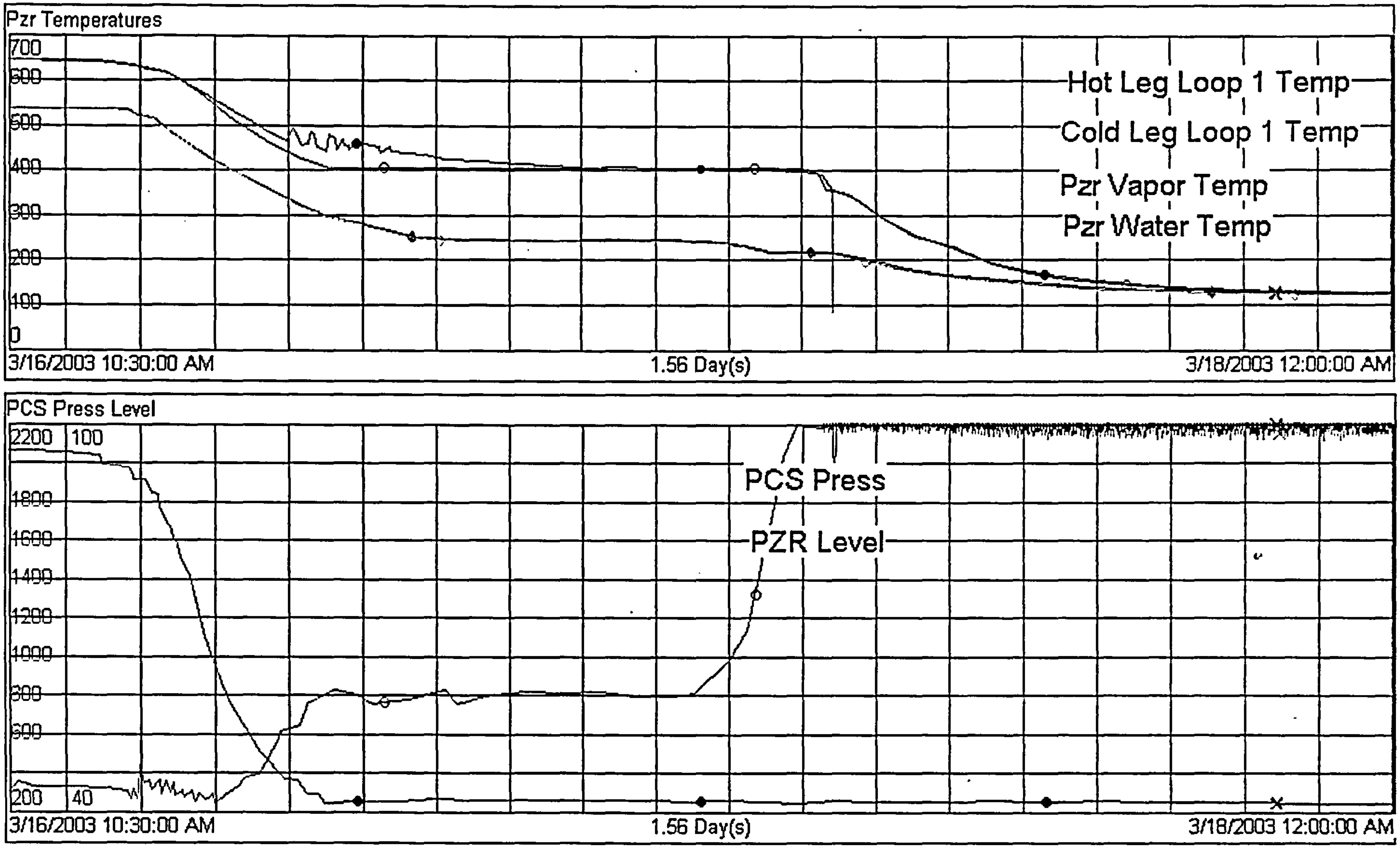

Figure 2, 2003 Refueling Outage Pressurizer Cool-down Profile