ATTACHMENT 2
RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

WESTINGHOUSE DOCUMENT LTR-RCPL-06-6, RESPONSE TO NRC REQUEST FOR ADDITIONAL INFORMATION ON PALISADES RELIEF REQUEST TO USE METHODOLOGY OF WCAP-15973-P-A, REV. 0, "LOW ALLOY STEEL COMPONENT CORROSION ANALYSIS SUPPORTING SMALL-DIAMETER ALLOY 600/690 NOZZLE REPAIR/REPLACEMENT PROGRAMS," DATED JANUARY 19, 2006
(NON-PROPRIETARY)

23 Pages Follow

Response to NRC Request for Additional Information on Palisades Relief Request to use Methodology of WCAP-15973-P-A, Rev. 0, "Low Alloy Steel Component Corrosion Analysis Supporting Small-Diameter Alloy 600/690 Nozzle Repair/Replacement Programs"

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Revision 0

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1.0 BACKGROUND

In May 2004 Westinghouse issued topical report WCAP-15973-P, Rev. 1, titled "Low-Alloy Steel Component Corrosion Analysis Supporting Small-Diameter Alloy 600/690 Nozzle Repair/Replacement Programs." The NRC issued its final safety evaluation (SE) of this report (Reference 6) on January 12, 2005, approving it to the extent possible under the limitations of the report and the SE.

The generic methodology of the topical report (TR) is being used by NMC in support of a Palisades pressurizer heater sleeve contingency repair design. As an alternative to using the ASME Code Section XI, IWA-3300, IWB-3142.4 and IWB-3420 methodology to support the design of the repair, NMC submitted a request for relief from these Code requirements to use the methodology of the TR (Reference 7). The NRC has reviewed the NMC relief request and has requested in Reference 3 that additional information be provided.

This document provides Westinghouse responses to RAIs 4.1 and 4.2 of Reference 3. References are provided in Section 4.0.

2.0 QUALITY ASSURANCE

This work was completed under the requirements of the Westinghouse Quality Assurance Program (Reference 9).

3.0 RESPONSES TO REQUESTS FOR ADDITIONAL INFORMATION

The NRC RAIs 4.1 and 4.2 from Reference 3 are re-stated below and each is followed by a response.

3.1 RAI #4.1 GENERAL CORROSION ASSESSMENT

a. *Section 2.4 of WCAP-15973-P, "Low Alloy Steel Component Corrosion Analysis Supporting Small-Diameter Alloy 600/690 Nozzle Repair/Replacement Program," Revision 1, indicates that Palisades' pressurizer nozzles need further analysis using actual thickness measurements to determine acceptable hole diameters.*

RAI 4.1.a — Provide the actual thickness measurement for all nozzles that are being evaluated in this relief request, or justify not needing the measurements..

b. *NMC's response to NRC Condition 1 indicates that an analysis performed by Westinghouse Electric Company calculated the limiting (allowable) diameter for pressurizer heater sleeve penetrations for Palisades relative to the following:*

   (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, Inc., plant

RAI 4.1.b — Provide the following information for the weld shear stress and reinforcement area analyses:

1. *Identify the criteria used to determine the allowable bore-hole size, and include any American Society of Mechanical Engineers code criteria.*
2. *Identify the pressure and thermal transient conditions assumed in the analysis.*
3. *Explain how the information in response to a, b.(1) and b.(2) was used to calculate the allowable bore-hole size.*

c. *NMC's response to NRC Condition 5 indicates that initial sleeve penetration diameter was 1.173 inches.*

RAI 4.1.c — Identify nominal, minimum, and maximum sleeve penetration diameter values for Palisades, and explain why 1.173 inches was used in the analysis.

Response:

RAI 4.1.a – The actual thickness measurements for the Palisades pressurizer bottom head or the heater sleeves are not needed for determining the acceptable pressurizer borehole diameter used in estimating the lifetime of the heater sleeve repair. WCAP-15973 (Reference 2, page 2-7) was unclear and intended to require that actual thickness measurements be used only for the Palisades pressurizer side shell and cold leg piping. The supporting documentation of WCAP-15973 clearly identifies this; see Reference 8, Tables 1 and 2.

RAI 4.1.b.1 – 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 borehole size.

RAI 4.1.b.2 – 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 Palisades pressurizer design temperature. The analysis assumed steady-state conditions.

RAI 4.1.b.3 – Two methods were used in determining the allowable Palisades heater sleeve borehole 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 borehole. The strength of the weld was examined, then the allowable diameter, Dc, 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 borehole 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.

RAI 4.1.c – The minimum and maximum sleeve penetration diameter values for the Palisades nuclear plant are 1.158 inches and 1.160 inches, respectively. The 1.173 inch value was conservatively used for the entire borehole. 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.

3.2 RAI #4.2 THERMAL FATIGUE CRACK GROWTH ASSESSMENT

NMC's response to NRC Condition 3 says that although Palisades' water-solid operation of its pressurizer practically eliminates in-surge and out-surge transients postulated in Westinghouse Calculation Note CN-CI-02-71, a plant-specific flaw fatigue growth analysis was performed. The analysis, provided as Attachment 2 to NMC's letter of August 11, 2005, used a 220°F in-surge transient in lieu of the 320°F in-surge transient applied in the generic analysis. The plant-specific flaw fatigue growth analysis was not provided in Attachment 2.

RAI 4.2 — Provide the linear elastic fracture mechanics (LEFM) analysis, and include an evaluation of the available Charpy impact test data to demonstrate the reference temperature (RT_{NDT}) used in the LEFM is limiting for all Palisades nozzle penetrations included in this relief request.

Response:

The methodology and results of the WOG topical report and its supporting calculation (References 1 and 2) are generically applicable to the Combustion Engineering NSSS design. Representative geometry, transients, and material properties for fracture toughness were assumed. In support of the NMC relief request (Reference 7) and using the generic WOG methodology, Westinghouse performed a Palisades-specific crack growth evaluation applicable to the pressurizer heater sleeve locations and transients. A summary of the results from the LEFM (linear elastic fracture mechanics) analysis and from the evaluation of the Charpy impact test data (Reference 4) is given below. The detailed LEFM evaluation is included in Appendix A.

LEFM Analysis Results and Conclusions

a, c

By comparing the final crack sizes listed in Table 3 with those of Table 1, it can be seen that the total crack growth for the Palisades geometry and transient conditions are relatively low and compare favorably to their allowable crack sizes. From Table 4, at the end of the 500 heatup and cooldown cycles and after 220°F insurges, there remains significant margin to the allowable crack tip stress intensity factor (SIF). As an illustration of how little the postulated flaws grow, Figure 3 compares flaw depth growth in the direction along the borehole and along vessel inner diameter as a function of heatup and cooldown transient cycles.

In summary, the total flaw growth is relatively small and there is adequate margin relative to the final flaw sizes. The detailed evaluation is provided separately in Appendix A of this document because of its Mathcad format.

Table 1
Pressurizer Lower Head Crack Dimensions (Heater Sleeve)

[ ]a, b, c

Table 2
Pressurizer Lower Head Stress Intensities at Final Crack Size (Heater Sleeve)

[ ]a, c

Table 3
Palisades Pressurizer Lower Head Crack Dimensions (Heater Sleeve)

[ ]a, b, c

Table 4
Palisades Pressurizer Lower Head Stress Intensities at Final Crack Size (Heater Sleeve)

[ ]a, c

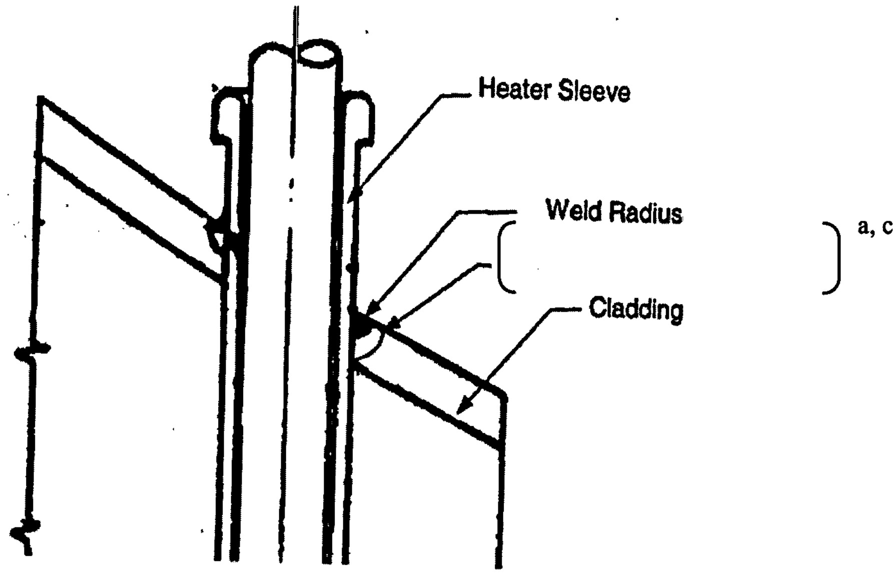

Figure 1: Palisades Pressurizer Heater Sleeve

a, c

Figure 2: Palisades Transient Definitions

a, c

Figure 3: Flaw Growth as Function of Heatup and Cooldown Cycles

Evaluation of Charpy Impact Test Data – Heater Boreholes

a, c

a, c

4.0 REFERENCES

1. Westinghouse Calculation: CN-CI-02-71, Revision 1, "Summary of Fatigue Crack Growth Evaluation Associated with Small Diameter Nozzles in CEOG Plants"
2. Westinghouse Report: WCAP-15973-P-A, Revision 0, "Low-Alloy Steel Component Corrosion Analysis Supporting Small-Diameter Alloy 600/690 Nozzle Repair/Replacement Programs," Feb 2005
3. NRC Letter from L.M. Padovan to P.A. Harden (NMC), "Palisades Plant - Request for Additional Information Related to Request for Relief from ASME Section XI Code Requirements For Repair of Pressurizer Nozzle Penetrations (TAC NO. MC8170)," December 28, 2005
4. Westinghouse Letter: LTR-CI-02-89, Rev. 0, "Base Material RT_{NDT} Values for Palisades Pressurizer Plates," June 6, 2002
5. NMC Design Information Transmittal, Tracking Number PO P806643, James Wong (NMC) to J.F. Hall (Westinghouse), June 1, 2005
6. USNRC, "Safety Evaluation by the Office of Nuclear Reactor Regulation WCAP-15973-P, Revision 01, Low-Alloy Steel Component Corrosion Analysis supporting Small-diameter Alloy 600/690 Nozzle Repair/Replacement Program," Westinghouse Owners Group Project No. 694
7. NMC Letter to NRC, "Request for Relief from ASME Section XI Code Requirements for Repair of Pressurizer Nozzle Penetrations," August 11, 2005
8. Westinghouse Report: A-CEOG-9449-1242, Rev. 00, "Evaluation of the Corrosion Allowance for Reinforcement and Effective Weld to Support Small Alloy 600 Nozzle Repairs," June 13, 2000
9. Westinghouse Policies & Procedures, Nuclear Services Edition, Revision 22

Appendix A

Evaluation of Fatigue Crack Growth and Stability Check of Postulated Flaws at Palisades Pressurizer Heater Sleeve Locations

Plant:
NMC Consumers Power - Palisades Nuclear Plant

Loading Condition:
Start-up/Shut-down and Turbine/Reactor Trip for fatigue crack growth
Cooldown, Reactor trip and Loss of secondary flow for stability check

Component/Location:
Lower Head Heater Sleeves

Evaluation type:
Fatigue Crack Growth
Stability of final flaw sizes

Global Variables

a, c

a, c

a, c

a, c

a, c

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a, c

a, c

Results and conclusions are summarized in Section 3.2 of the main body of this document.