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December 21, 2005

U. S. Nuclear Regulatory Commission
Washington, DC 20555

ATTENTION: Document Control Desk

SUBJECT: Calvert Cliffs Nuclear Power Plant
Unit Nos. 1 & 2; Docket Nos. 50-317 & 50-318
ASME Section XI Relief Request to Use Alternative Techniques for Repair and Examination of Unacceptable Indications in Welded Nozzles

Pursuant to 10 CFR 50.55a(a)(3)(i), Calvert Cliffs Nuclear Power Plant, Inc. (CCNPP) hereby proposes an alternative to the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel (B&PV) Code requirements concerning repair/replacement activities for pressure retaining welds subject to Article IWA-4000 in Section XI for the Third Ten-Year Inservice Inspection interval. Paragraph 50.55a(a)(3)(i) allows the use of alternatives to the requirements of Paragraph 50.55a(g), that provide an acceptable level of quality and safety, when authorized by the Director of the Office of Nuclear Reactor Regulation.

During the upcoming refueling outages for each Unit (2006 for Unit 1 and 2007 for Unit 2) certain Reactor Coolant System (RCS) hot leg instrument nozzles (designated in Attachment 2) are scheduled to be inspected and replaced. No evidence of degradation or leakage has been identified to date, however, we have determined that a proactive program of nozzle replacement is appropriate as a part of our Alloy 600 management program. We intend to use a half nozzle design to replace the existing nozzles. American Society of Mechanical Engineers B&PV Code, Section XI, with no code case, contains the requirements for the half-nozzle design and installation, assuming no identified leakage. An inspection will be conducted prior to the modification to determine if any leakage exists on the affected nozzles. Assuming no leakage is found, we will perform the half-nozzle modifications as designed under ASME Code Section XI and Section III. This modification meets the requirements set forth in 10 CFR 50.59 and therefore, no relief is requested for the installation of replacement half-nozzles in locations without identified leakage.

RELIEF REQUEST

If leakage is identified during the pre-modification inspection, then we request relief as detailed in Attachment (1) to allow the repair of the leaking nozzles using a half nozzle repair technique. Because no need has been defined at this time, this request is made as a contingency in case leaking RCS hot leg nozzles are identified. We plan to repair the leaking RCS hot leg instrument nozzles (using the half-

A047

nozzle repair technique) based on Westinghouse Topical Report WCAP-15973-P, Revision 01, as approved by the NRC on January 12, 2005. Our compliance with all conditions and restrictions set forth in the Topical Report and NRC Safety Evaluation are described in the attached request for relief (Attachment 1). Our compliance with the approved Westinghouse topical report constitutes an acceptable alternative to the requirements of 10CFR 50.55a(g).

SCHEDULE

If leakage is identified in the RCS hot leg nozzles and a repair is required, approval for the proposed alternative is needed. To support completion of the first outage where this contingency relief may be needed, we request that the NRC review and approve our proposed contingency by March 10, 2006. Note that to date, these welds have not been determined to contain unacceptable flaws. If no flaws are identified, then half-nozzle modifications will be installed under the existing site procedures during the CCNPP Unit 1 Spring 2006 and Unit 2 Spring 2007 refueling outages and no code relief is required.

Should you have questions regarding this matter, please contact Mr. L. S. Larragoite at (410) 495-4922.

Very truly yours,

GV/JTJ/bjd

Attachments: (1) Relief Request to Use Alternative Techniques for Repair and Examination of Unacceptable Indications in Welded Nozzles

(2) List of Half-Nozzle Locations for Units 1 and 2 Using Alternative Techniques for Repair and Examination of Unacceptable Indications in Welded Nozzles

cc: P. D. Milano, NRC
S. J. Collins, NRC
Resident Inspector, NRC
R. I. McLean, DNR

ATTACHMENT (1)

RELIEF REQUEST TO USE ALTERNATIVE TECHNIQUES FOR REPAIR AND EXAMINATION OF UNACCEPTABLE INDICATIONS IN WELDED NOZZLES

Calvert Cliffs Nuclear Power Plant, Inc.
December 21, 2005

ATTACHMENT (1)

RELIEF REQUEST TO USE ALTERNATIVE TECHNIQUES FOR REPAIR AND EXAMINATION OF UNACCEPTABLE INDICATIONS IN WELDED NOZZLES

ASME CODE COMPONENT(S) AFFECTED:

Small bore Alloy 600 nozzles welded to the reactor coolant system (RCS) piping hot legs.

APPLICABLE CODE EDITION AND AGENDA:

American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel (B&PV) Code, Section XI, Rules for In-Service Inspection of Nuclear Power Plant Components, 1998 Edition. The Third Ten-Year Inservice Inspection Program Plan for CCNPP Units 1 and 2 meets the requirements of the 1998 Edition, no Addenda of Section XI of the ASME B&PV Code (except for Subsections IWE and IWL), as approved by Nuclear Regulatory Commission (NRC) letter (Reference 1).

APPLICABLE CODE REQUIREMENT:

Pursuant to 10 CFR 50.55a(a)(3)(i) Calvert Cliffs Nuclear Power Plant (CCNPP) requests an alternative to the requirements of paragraph IWB-3132.2, Acceptance by Repair/Replacement Activity, that states "A component whose volumetric or surface examination detects flaws that exceed the acceptance standards of Table IWB-3410-1 is unacceptable for continued service until the additional examination requirements of IWB-2430 are satisfied and the component is corrected by repair/replacement activity to the extent necessary to meet the acceptance standards of IWB-3000."

REASON FOR REQUEST:

Small bore Alloy 600 nozzles were partial penetration welded with Alloy 82/182 to the interior of the RCS hot leg during fabrication of the piping. Industry experience has shown that cracks may develop in the nozzle base metal or in the weld metal joining the nozzles to the RCS pipe and lead to leakage of the RCS fluid. The cracks are typically caused by primary water stress corrosion cracking. The exact leak path, through the weld or through the base metal or through both, cannot be determined due to the lack of an inspection technique to volumetrically inspect the partial penetration weld. A hardship exists to remove all possible leak paths by requiring access to the internal surface of the RCS piping and grinding out the attachment weld and any remaining nozzle base metal. Such an activity results in high radiation exposure to the personnel involved. Grinding within the pipe also exposes personnel to safety hazards. Additionally, grinding on the internal surface of the RCS piping increases the possibility of introducing foreign material that could damage the fuel cladding. The Nuclear Regulatory Commission (NRC)-approved Safety Evaluation, Reference 3, and the following "basis for use" show that there is "no compensating increase in the level of quality or safety."

PROPOSED ALTERNATIVE AND BASIS FOR USE

ALTERNATIVE

The leaking nozzles will be modified by relocating the attachment weld from the interior surface of the pipe to the exterior surface of the pipe. The nozzles will be modified using the half-nozzle technique, where the outboard end of the Alloy 600 nozzle is removed by machining to approximately mid-wall of the hot leg piping. The outboard end of the nozzle is replaced with a short section (half-nozzles) of austenitic stainless steel, which is a partial penetration welded to the exterior surface of the pipe. The remainder of the Alloy 600 nozzle, including the original fabrication partial penetration weld, remains in place.

BASIS FOR USE

A plant-specific evaluation of the small bore nozzles located in the hot leg piping for CCNPP Units 1 and 2 has been completed. These nozzles are at locations where half-nozzles could be utilized (Attachment 2), thereby leaving flaws in the original weldments, which could potentially grow into adjacent ferritic material. Postulated flaws were assessed for flaw growth and flaw stability as specified in the ASME B&PV Code, Section XI. The results demonstrate compliance with the requirements of the ASME B&PV Code, Section XI.

Westinghouse Topical Report WCAP-15973-P-A Revision 01, Reference 2, evaluates the effect of component corrosion resulting from primary coolant in the crevice region on component integrity and evaluates the effects of propagation of the flaws left in place by fatigue crack growth and stress corrosion cracking mechanisms. In the half-nozzle modification, small gaps of 1/8 inch or less remain between the remnants of the Alloy 600 nozzles and the new stainless steel nozzles. As a result, primary coolant (borated water) will fill the crevice between the nozzle and the wall of the pipe. Low alloy and carbon steels used for RCS components are clad with austenitic stainless steel to minimize corrosion resulting from exposure to primary coolant.

Reference 2 provides bounding analyses for the maximum material degradation estimated to result from corrosion of the carbon or low alloy steel in the crevices between the nozzles and components. When applied on a CCNPP plant-specific basis, the topical report demonstrates that the carbon and low alloy steel RCS components at CCNPP Units 1 and 2 will not be unacceptably degraded by general corrosion as a result of the Alloy 600 half-nozzles replacement campaign. Although some minor corrosion may occur in the crevice region of the replaced nozzles, the degradation will not proceed to the point where ASME B&PV Code requirements will be exceeded before the end-of-plant life, including the period of extended operation. The report also provides results of fatigue crack growth evaluations and crack stability analyses for hot leg pipe nozzles. The results indicate that the ASME B&PV Code, Section XI acceptance criteria for crack growth and crack stability are met. Further, available laboratory data and field experience indicate that continued propagation of cracks into the carbon and low alloy steels by a stress corrosion mechanism is unlikely.

Reference 3 states "The staff has found that WCAP-15973-P, Revision 01, is acceptable for referencing in licensing applications for Combustion Engineering designed pressurized water reactor to the extent specified and under the limitations delineated in the Topical Report (TR) and in the enclosed NRC Safety Evaluation (SE)."

Sections 4.1, 4.2, and 4.3 of the SE present additional conditions to assess the applicability of the topical report. The CCNPP response for each additional condition is provided below. The discussion shows that Reference 2 is applicable to CCNPP Units 1 and 2.

Section 4.1 of the SE states that licensees seeking to use the methods of the TR will need to perform the following plant-specific calculation in order to confirm that the ferritic portions of the vessels or piping within the scope of the TR will be acceptable for service through the licensed lives of their plants (40 years if the normal licensing basis plant life is used or 60 year if the facility is expected to be approved for extension of the operating license):

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

   Response:

   The maximum allowable penetration bore diameter due to general corrosion is 1.27" based on Reference 12 of WCAP-15973-P, Revision 01.

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 condition) and cold shutdown conditions and the respective plant-specific times (in-percentages of total plant life) at each of the operating modes.

   Response:

   The overall general corrosion rate for the CCNPP hot leg material was calculated in accordance with the methods described in Section 2.3.4 of Reference 2. The percentages of total plant life for each of the three operating conditions that were used in the calculation of the overall general corrosion rate are provided below.

   The estimated time spent at the various modes of operation for the remaining life of CCNPP Units 1 and 2 is as follows:

Intermediate temperature start-up conditions	0.7%
Low temperature shutdown conditions	2.7%
Power operations	96.6%

   The resulting corrosion rate is 0.74 mils per year (mpy).

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 on whether volumetric inspection of the area is required.

   Response:

   It is not necessary to track the time of cold shutdown relative to this general corrosion evaluation due to the significant margin that exists between actual plant operating time and the time to reach the maximum allowable penetration bore diameter, as discussed below in the response to question #5 below.

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 mechanical nozzle seal assembly repair or half-nozzle repair.

   Response:

   The maximum initial penetration bore diameter after the half-nozzle modification is applied is 1.088". The final penetration bore diameter can be expressed as described below:

   $$D_{FINAL} = 1.088" + 2*(0.00074"/yr * \# \text{ years of operation})$$

Calvert Cliffs Nuclear Power Plant Unit 1 has <29 years of operation remaining after the first hot leg modification and CCNPP Unit 2 has <30 years of operation remaining after the first hot leg modification. For both CCNPP Units 1 and 2 the bounding final penetration bore diameter can be expressed as described below:

$$D_{FINAL} = 1.088" + 2*(0.00074"/yr * 30\ yr) = 1.132"$$

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.

   Response:

   The maximum allowable penetration bore diameter due to general corrosion is 1.27" based on Reference 12 of WCAP-15973-P, Revision 01. The final calculated penetration bore diameter after general corrosion is 1.132" inches. 1.132" is less than 1.27", therefore the result is acceptable.

   Based on the plant-specific corrosion rate of 0.74 mpy it will take 123 years of operation to reach the maximum allowable penetration bore diameter of 1.27". There is greater than a factor of four margin when comparing actual plant operating time and the time to reach the maximum allowable penetration bore diameter. It is unlikely that the plant will spend sufficient time in shutdown or start-up conditions such that this margin would be exceeded for the remainder of plant life.

Section 4.2 of the SE states that licensees seeking to reference this TR for future licensing applications need to demonstrate that:

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

   Response:

   Reference 4, specifically identifies CCNPP Units 1 and 2 hot leg and pressurizer small bore Alloy 600 J-groove welds geometry as being bounded by Reference 4.

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

   Response:

   As stated in Section 6.2.1.1 of Reference 4, Figure 6-2 applies to the pressurizer. The hot leg piping does not see the transients experienced by the pressurizer. The remainder of the RCS, including the hot leg, is limited to a 100°F per hour cooldown by Technical Specifications. Therefore, the evaluation of the pressurizer limiting curves is considered not applicable.

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' pressurizers and hot leg piping, then justification (e.g., based on statistical or lower bound analysis) has to be provided.

   Response:

   The Charpy USE data supports an elastic-plastic fracture mechanics analysis of a flaw associated with a nozzle in the lower head of a pressurizer and not the hot leg piping as described in Reference 4. Therefore, the evaluation of Charpy USE is not applicable for the CCNPP half-nozzle modifications to the hot leg piping nozzles. The linear elastic fracture mechanics analysis of RCS hot piping nozzles in Reference 4 is applicable to CCNPP Units 1 and 2.

Section 4.3 of the SE states that licensees seeking to implement or half-nozzle replacements may use the Westinghouse Owner Group'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 conditions:

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.

   Response:

   A review of RCS fluoride, chloride, and dissolved oxygen concentrations over the last three operating cycles was performed to ensure that the operating chemistry did not challenge the limits set by Technical Requirements Manual, Section 15.4.1. Operating above these limits would contribute to increased stress corrosion susceptibility of RCS components. The Technical Requirements Manual requirements, during steady-state operation, are to maintain chloride and fluoride below 150 ppb at all times, and dissolved oxygen below 100 ppb when RCS is greater than 250°F. Fluoride, chloride, and sulfate never exceeded the limit of 150 ppb, and routinely were below 10 ppb within three months post refueling outage start-up.

   The primary chemistry specifications and surveillance procedure contains a start-up hold point to ensure that RCS dissolved oxygen is maintained at < 100 ppb prior to RCS temperature > 250°F. Hydrazine is added while on shutdown cooling prior to Mode 4 to provide a chemical oxygen scavenger. Hydrogen is also added as soon as two reactor coolant pumps are running to take advantage of the oxygen-hydrogen reaction to consume oxygen and form H_2O in a neutron/gamma flux. No oxygen start-up hold violations were found. Hydrogen overpressure was applied and maintained to ensure dissolved oxygen concentrations were below 10 ppb.

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

   Response:

   No incident of elevated fluoride, chloride, or dissolved oxygen concentrations which would challenge the Technical Requirements Manual limits occurred within the time frame of this data review. Hydrogen was maintained within the recommendations of the Electric Power Research

Institute's Pressurized Water Reactor, Water Chemistry Guidelines. Therefore, chemical control at CCNPP was well maintained during the past three cycles and no increased stress corrosion cracking due to poor chemical control is expected.

In conclusion, the ASME B&PV Code requirement, IWB-3132.2, is to replace material containing a flaw. The proposed alternative is to not remove the material containing the flaw, but show by analysis that the material and the presence of the flaw will not be detrimental to the pressure retaining function of the RCS piping. Analyses, References 2 and 4, have shown that allowing the material containing a flaw to remain in place and in service would not result in a reduction of the level of quality or safety.

DURATION OF PROPOSED ALTERNATIVE

Relief is requested for the remainder of the third ten year Inservice Inspection interval and to the end of licensed life for CCNPP Units 1 and 2.

REFERENCES

1. Letter from Ms. M. Gamberoni (NRC) to Mr. C. H. Cruse (BGE), dated April 5, 2000, Safety Evaluation of Proposed Alternate American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code) Section XI, 1998 Edition for the Third 10-Year Inspection Interval – Calvert Cliffs Nuclear Power Plant, Unit Nos. 1 and 2 (TAC Nos. MA4647 and MA4648)
2. WCAP-15973-P-A, Revision 01, "Low-Alloy Steel Component Corrosion Analysis Supporting Small-Diameter Alloy 600/690 Nozzle Repair/Replacement Programs," Westinghouse Electric Company LLC, dated February 2005
3. NRC letter to WOG, Final Safety Evaluation for Topical Report WCAP-15973-P, Revision 01, "Low-Alloy Steel Component Corrosion Analysis Supporting Small-Diameter Alloy 600/690 Nozzle Repair/Replacement Program," dated January 12, 2005
4. Westinghouse Calculation Report CN-CI-02-71, Revision 01 (Proprietary), "Summary of Fatigue Crack Growth Evaluation Associated with Small Diameter Nozzles in CE Plants," dated October 28, 2002

ATTACHMENT (2)

LIST OF HALF-NOZZLE LOCATIONS FOR UNITS 1 AND 2 USING ALTERNATIVE TECHNIQUES FOR REPAIR AND EXAMINATION OF UNACCEPTABLE INDICATIONS IN WELDED NOZZLES

ATTACHMENT (2)

LIST OF HALF-NOZZLE LOCATIONS FOR UNITS 1 AND 2 USING ALTERNATIVE TECHNIQUES FOR REPAIR AND EXAMINATION OF UNACCEPTABLE INDICATIONS IN WELDED NOZZLES

Unit 1 Dissimilar Metal Weld Population*					
Designator/ID	Weld Material	Nozzle Size	Location	Function	Base Material
1-TE-112-HA/B/C/D	82/182	0.993	11 Hot Leg	RTD	SB-166
1-TE-111X	82/182	0.993	11 Hot Leg	RTD	SB-166
1-SX-6452	82/182	0.993	11 Hot Leg	Sampling Connection	SB-166
1-PDT-111A/B/C/D	82/182	0.993	11 Hot Leg	PDT HP Tap	SB-166
1-TE-122-HA/B/C/D	82/182	0.993	12 Hot Leg	RTD	SB-166
1-TE-121X	82/182	0.993	12 Hot Leg	RTD	SB-166
1-PDT-121A/B/C/D	82/182	0.993	12 Hot Leg	PDT HP Tap	SB-166

Unit 2 Dissimilar Metal Weld Population*					
Designator/ID	Weld Material	Nozzle Size	Location	Function	Base Material
2-TE-112-HA/B/C/D	82/182	0.993	21 Hot Leg	RTD	SB-166
2-TE-111X	82/182	0.993	21 Hot Leg	RTD	SB-166
2-SX-6452	82/182	0.993	21 Hot Leg	Sampling Connection	SB-166
2-PDT-111A/B/C/D	82/182	0.993	21 Hot Leg	PDT HP Tap	SB-166
2-TE-122-HA/B/C/D	82/182	0.993	22 Hot Leg	RTD	SB-166
2-TE-121X	82/182	0.993	22 Hot Leg	RTD	SB-166
2-PDT-121A/B/C/D	82/182	0.993	22 Hot Leg	PDT HP Tap	SB-166

* Sampling and PDT nozzles have exactly the same geometry and are thus one configuration.