April 18, 2003

Mr. P. E. Katz, Vice President
Calvert Cliffs Nuclear Power Plant, Inc.
Calvert Cliffs Nuclear Power Plant
1650 Calvert Cliffs Parkway
Lusby, MD 20657-4702

SUBJECT: CALVERT CLIFFS NUCLEAR POWER PLANT, UNIT NOS. 1 AND 2 - RELAXATION OF THE REQUIREMENTS OF ORDER (EA-03-009), REGARDING REACTOR PRESSURE VESSEL HEAD INSPECTIONS (TAC NOS. MB7752 AND MB7753)

Dear Mr. Katz:

By letter dated February 18, 2003, Calvert Cliffs Nuclear Power Plant (CCNPP) requested relaxation from certain inspection requirements in the Nuclear Regulatory Commission (NRC) Order EA-03-009 for Reactor Pressure Vessel Head Penetration Nozzles for CCNPP Unit Nos. 1 and 2. Additional information supporting your request was provided in letters dated March 13, April 4, April 9, and April 17, 2003.

The NRC staff has reviewed your requested relaxation together with your proposed alternative and the actual inspection findings for CCNPP Unit No. 2 for certain inspection requirements of the Order EA-03-009. Pursuant to Section IV.F of Order EA-03-009, we find that you have shown good cause for relaxation of the order, subject to certain conditions, because the proposed alternative to the inspection requirements of the Order EA-03-009 is acceptable for CCNPP Unit No. 2 for the spring 2003 outage in that compliance with the specifed requirements would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety. Consistent with your letter dated April 17, 2003 this relaxation is granted contingent upon the following conditions:

If the NRC staff finds that the crack growth formula in industry report MRP-55 is unacceptable, the licensee shall revise its analysis that justifies relaxation of the Order within 30 days after the NRC informs the licensee of an NRC-approved crack growth formula. If the licensee's revised analysis shows that the crack growth acceptance criteria are exceeded prior to the end of the current operating cycle, this relaxation is rescinded and the licensee shall, within 72 hours, submit to the NRC written justification for continued operation. If the revised analysis shows that the crack growth acceptance criteria are exceeded during the subsequent operating cycle, the licensee shall, within 30 days, submit the revised analysis for NRC review. If the revised analysis shows that the crack growth acceptance criteria are not exceeded during either the current operating cycle or the subsequent operating cycle, the licensee shall, within 30 days, submit a letter to the NRC confirming that its analysis has been revised.

In regards to CCNPP Unit 1 and Unit 2 for subsequent outages, you have not provided information sufficient to demonstrate that the requested relaxation should be granted. The details of the staff's review are contained in the enclosed SE.

If you have questions regarding this matter, please contact Guy Vissing at 301-415-1441.

Sincerely,

/RA/

Stuart A. Richards, Director
Project Directorate I
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket Nos. 50-317 and
50-318

Enclosure: As stated

cc w/encl: See next page

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

ORDER (EA-03-009) RELAXATION REQUEST, EXAMINATION COVERAGE

FOR REACTOR PRESSURE VESSEL HEAD PENETRATION NOZZLES

CALVERT CLIFFS NUCLEAR POWER PLANT, UNIT NOS. 1 AND 2

CALVERT CLIFFS NUCLEAR POWER PLANT, INC.

DOCKET NUMBERS 50-317 AND 50-318

1.0 INTRODUCTION

Order EA-03-009, issued on February 11, 2003, requires specific examinations of the reactor pressure vessel (RPV) head and vessel head penetration (VHP) nozzles of all pressurized-water reactor (PWR) plants. Section IV, paragraph F, of the Order states that requests for relaxation of the Order associated with specific penetration nozzles will be evaluated by the Nuclear Regulatory Commission (NRC) staff using the procedure for evaluating proposed alternatives to the American Society of Mechanical Engineers Boiler Pressure and Vessel Code (ASME Code) in accordance with Title 10 of the *Code of Federal Regulations* (10 CFR) 50.55a(a)(3). Section IV, Paragraph F, of the Order states that a request for relaxation regarding inspection of specific nozzles shall address the following criteria: (1) the proposed alternative(s) for inspection of specific nozzles will provide an acceptable level of quality and safety, or (2) compliance with this Order for specific nozzles would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

For Calvert Cliffs Unit Nos. 1 and 2, and similar plants determined to have a high susceptibility to primary water stress-corrosion cracking (PWSCC) in accordance with Section IV, paragraphs A and B, of the Order, the following inspections are required to be performed every refueling outage in accordance with Section IV, paragraph C.(1) of the Order:

(a) Bare metal visual [BMV] examination of 100% of the RPV head surface (including 360° around each RPV head penetration nozzle), AND

(b) Either:

(i) Ultrasonic testing of each RPV head penetration nozzle (i.e., nozzle base material) from two (2) inches above the J-groove weld to the bottom of the nozzle and an assessment to determine if leakage has occurred into the interference fit zone, OR

(ii) Eddy current testing or dye penetrant testing of the wetted surface of each J-Groove weld and RPV head penetration nozzle base material to at least two (2) inches above the J-groove weld.

Footnote 3 of the Order provides specific criteria for examination of repaired VHP nozzles.

By letter dated February 18, 2003, as supplemented by letters dated March 13, April 4, April 9, and April 17, 2003, Calvert Cliffs Nuclear Power Plant, Inc. (CCNPPI), the licensee, requested relaxation to implement an alternative to the requirements of Section IV, paragraph C.(1)(b)(i), of the Order for the VHP nozzles at Calvert Cliffs Unit Nos. 1 and 2.

2.0 ORDER EA-03-009 RELAXATION REQUEST FOR EXAMINATION COVERAGE FOR REACTOR PRESSURE VESSEL HEAD PENETRATION NOZZLES

2.1 Order Requirements for which Relaxation is Requested

Section IV.C.(1)(b) of Order EA-03-009 requires, in part, that the following inspections be performed every refueling outage for high susceptibility plants similar to Calvert Cliffs Unit Nos. 1 and 2:

> Either:
>
> (i) Ultrasonic testing [UT] of each RPV head penetration nozzle (i.e., nozzle base material) from two (2) inches above the J-groove weld to the bottom of the nozzle and an assessment to determine if leakage has occurred into the interference fit zone, OR
>
> (ii) Eddy current testing or dye penetrant testing of the wetted surface of each J-Groove weld and RPV head penetration nozzle base material to at least two (2) inches above the J-groove weld.

The licensee has requested relaxation from Section IV, paragraph C.(1)(b)(i) of the Order for most of the VHP nozzles. The specific relaxation requested is from the requirement to perform non-destructive examination (NDE) of the RPV head penetration nozzle base material from the bottom of the nozzle below the J-groove weld to a minimum of 2 inches above the J-groove weld.

Relaxation was requested for both units.

2.2 Licensee's Proposed Alternative Method

The proposed alternate examination is to perform a UT examination of the nozzles from 0.56 inches above the bottom of the nozzle to a minimum of 0.75 inch above the J-groove weld.

2.3 Licensee's Basis for Relaxation

The licensee stated that physical restrictions exist in the nozzle configurations that restrict the inspection to less than 2 inches above the J-groove weld. Specifically, the control element drive mechanism (CEDM) penetrations have guide/thermal sleeves with a funneled-end installed. This results in an annular gap of approximately 0.175 inch. There is a counterbore above the J-groove weld that reduces the annular gap to 0.123 inch, which affects inspection using a blade probe. Each sleeve is centered by three expansion points made in the sleeve above the

J-groove weld which contact the CEDM penetration nozzle. UT examination near these expansion points using a blade probe limits the coverage that is achievable in the area of interest. In a letter dated April 9, 2003, the licensee stated that actual coverage ranged from a minimum of 0.95 inch on the nozzle inner diameter surface and 1.38 inch on the nozzle outer diameter surface to more than 2 inches above the J-groove weld, from the inspection recently completed.

In a letter dated April 9, 2003, the licensee requested an additional relaxation based on findings during the current inspection at Unit 2. Section IV, Paragraph C.(1)(b)(i), of the Order requires that UT coverage extend to the bottom of the nozzle. The licensee stated that the additional request for relaxation is for inaccessible examination coverage near the bottom of the CEDM nozzles due to instrument limitations, in particular, the configuration of ultrasonic transducers in the probes used in the examination. The licensee stated that, since the scanning process requires both transducers be in contact with the surface, the probe is not able to scan a small triangular portion (1/8 inch of radius plus an angular area) at the bottom of the nozzle, about 0.56 inch in length axially from the bottom of the nozzle.

The licensee stated that it is possible to comply with the Order requirements by permanently removing the guide/thermal sleeves to allow UT inspection with a rotating probe. This would require attaching new guide funnels after inspection. However, the licensee contends that the additional information would not provide any increase in quality and safety commensurate with the hardship involved - in particular the high radiation dosage that would be incurred by personnel, a significantly extended outage and a higher cost.

The licensee's submittal discussed an evaluation performed by its contractor, which stated that from the results of the inspections performed by this contractor at other PWR units, 260 indications have been detected. None of indications were located beyond 0.75 inches above the J-groove weld. The licensee stated that inspection of 0.75 inch above the top of the J-groove weld is sufficient to detect any evidence of cracking in the nozzle base material. Therefore, the licensee concludes that no cracking is expected above this region. The licensee contends that the proposed alternative will provide an acceptable level of quality and safety.

In the April 9, 2003, letter the licensee described the inaccessible area at the bottom of each nozzle, which starts no less than 0.4 inch from the J-groove weld in all cases. The nozzle is essentially an open-ended tube and the inaccessible portion of the nozzle is not part of the reactor coolant system pressure boundary. The licensee stated that, based on a fracture mechanics evaluation, it will take more than 2 years (one cycle of operation before the next required inspection) for a crack initiating from this region to grow into the J-groove weld. In particular, over the 2-year cycle, the licensee stated that a through-wall crack in this uninspectable (by UT) portion of the nozzle could grow 0.376 inch vertically, nearly to the bottom of the J-groove weld.

This analysis used the approach described in footnote 1 of the Order as the criteria to set the necessary height of the examination. However, this analysis incorporates a crack growth formula different from that described in footnote 1 of the Order, as provided in the Electric Power Research Institute's (EPRI) Report, "Material Reliability Program (MRP) Crack Growth Rates for Evaluating Primary Water Stress Corrosion Cracking (PWSCC) of Thick Wall Alloy 600 Material (MRP-55), Revision 1."

2.4 Evaluation

The NRC staff's review of this request was based on criterion (2) of paragraph F of Section IV of the Order, which states:

> Compliance with this Order for specific nozzles would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

Order EA-03-009 requires, in part, that UT of each RPV head penetration nozzle extend from 2 inches above the J-groove weld to the end of the nozzle. However, full coverage is not achievable because access by a UT blade probe is restricted due to physical interferences caused by the nozzle configurations. To meet the requirement of inspecting to a point 2 inches above the J-groove weld, the licensee would have to modify the nozzle configurations and remove the guide/thermal sleeves. Specifically, the guide/thermal sleeves would have to be cut to allow UT inspection with a rotating probe. When inspection is completed, new guide funnels would have to be welded to the nozzles. Based on the licensee's estimate, the associated modification would result in a significant radiation exposure to personnel and an extension of the outage of 2 to 3 weeks. This additional work would result in hardship to the licensee.

The alternative proposed by the licensee is to examine at least 0.75 inch above the J-groove weld (the accessible areas) instead of the 2 inches required by the Order. The current Unit 2 inspection actually achieved a minimum of 0.95 inch above the J-groove weld including 1.38 inches on the ID surface. The NRC staff reviewed various evaluations and analyses performed by the licensee in support of this request, as described below.

Stress profiles, based on the licensee's finite element analysis of CEDM penetrations, show that the residual stresses decrease significantly at elevations 0.95 inch above the J-groove weld and higher. Based on the inspection results provided, most nozzles received considerable UT coverage, from the weld portion where stresses are high to locations away from the weld where stresses decrease considerably. However, four nozzles, #43, #44, #51 and #61, received limited coverage of 0.95 inch to 1.05 inches above the J-groove weld. The licensee performed an additional stress evaluation on these nozzles which received the least UT coverage. The evaluation shows that the worst case occurred on the "uphill" side of the nozzle where UT coverage is very limited. The stress level for the nozzle base material beyond the UT coverage, as determined by the licensee, is 27.4 ksi. The nominal yield stress of the CEDM penetration base material is 37.5 ksi. Cracking at these locations is unlikely due to the fact that examination of high-stress locations of these nozzles and high-stress locations in other nozzles (i.e., nozzle locations adjacent to the J-groove weld and associated heat affected zone areas) found no cracks.

Operating experience, based on an evaluation of 260 indications by the licensee's contractor, revealed that distances beyond 0.95 inch above the J-groove weld have shown no evidence of

cracking in the CEDM base material. In addition, if a crack initiated from the uninspected locations, it would propagate downward towards the weld, and would be detected by the UT examination of that area.

The safety issues that are addressed by the inspections mandated by Order EA-03-009 are degradation (corrosion) of the low-alloy steel RPV head, reactor coolant pressure boundary integrity and ejection of the VHP nozzle due to circumferential cracking of the nozzle above the J-groove weld. The above evaluation provides reasonable assurance that these safety issues are addressed. Based on the above discussion, the alternative proposed by the licensee to inspect a minimum of 0.95 inch above the J-groove weld will provide an acceptable level of quality and safety.

The staff evaluated the information provided by the licensee in its letter dated April 9, 2003, concerning the triangular portion on the lower part of the nozzle that is inaccessible for inspection. In order to comply with the requirements specified in the Order, the licensee would have to remove the guide/thermal sleeve to allow examination with a different type of UT probe. This would result in hardship in terms of radiation exposure. Since the Order allows either UT examination or a surface examination of the penetration base material, the staff requested the licensee to evaluate the possibility of using eddy current testing in those areas where UT is incapable of interrogating, in order to accomplish 100% coverage of the required inspection area. In its response dated April 4, 2003, the licensee stated that it was not possible to deliver eddy current probes to the restricted location during this inspection. The licensee acknowledged that there is another contractor that may be able to perform such inspection. However, that specific contractor was not available for the Unit 2 spring 2003 outage due to scheduling constraints. Based on the information provided, if the licensee had sufficient time to more fully plan its outage, full inspection coverage would likely have been achievable.

The portion of the nozzle where coverage could not be achieved is located at the bottom of each nozzle. This location is several inches below the J-groove weld for all nozzles except those in the outer periphery. For a limited number of nozzles in the outer periphery, the inaccessible portion is at least 0.4 inch from the bottom of the J-groove weld on the “downhill” side of the penetration. This is the portion of the nozzle that is not part of the pressure boundary. Operating experience indicates that this location of the nozzle is not susceptible to cracking since it is subject to relatively low stresses. An analysis provided by the licensee demonstrates that even if a crack initiates from this location, it will take more than 2 years (one cycle of operation before the next required inspection) for this hypothetical crack to propagate into the J-groove weld. This analysis used the approach described in footnote 1 of the Order as the criteria to set the necessary height of the examination. Therefore, the coverage currently achieved provided an acceptable level of quality and safety. However, this analysis incorporates a crack growth formula different from that described in footnote 1 of the Order, as provided in the EPRI Report, “Material Reliability Program (MRP) Crack Growth Rates for Evaluating Primary Water Stress Corrosion Cracking (PWSCC) of Thick Wall Alloy 600 Material (MRP-55), Revision 1.” The NRC staff has completed a preliminary review of the crack growth formula but has not yet made a final assessment regarding the acceptability of the report.

If the NRC staff finds that the crack growth formula in industry report MRP-55 is unacceptable, the licensee shall revise its analysis that justifies relaxation of the Order within 30 days after the NRC informs the licensee of an NRC-approved crack growth formula. If the licensee’s revised analysis shows that the crack growth acceptance criteria are exceeded prior to the end of th-e

current operating cycle, this relaxation is rescinded and the licensee shall, within 72 hours, submit to the NRC written justification for continued operation. If the revised analysis shows that the crack growth acceptance criteria are exceeded during the subsequent operating cycle, the licensee shall, within 30 days, submit the revised analysis for NRC review. If the revised analysis shows that the crack growth acceptance criteria are not exceeded during either the current operating cycle or the subsequent operating cycle, the licensee shall, within 30 days, submit a letter to the NRC confirming that its analysis has been revised.

Because the proposed alternative provides reasonable assurance of structural integrity of the component, the licensee has demonstrated hardship for the Unit 2 2003 outage without a compensating increase in the level of quality and safety. However, the license has not demonstrated a hardship for Unit 1 or for subsequent Unit 2 outages.

3.0 CONCLUSION

The NRC staff concludes that the licensee's proposed alternative examination of the RPV head penetration nozzles from at least 0.95 inch above the J-groove weld to about 0.56 inch above the bottom of the nozzles provides reasonable assurance of the structural integrity of the RPV head, VHP nozzles, and welds at Calvert Cliffs Unit No. 2 for the Spring 2003 outage. Further inspection of these VHP nozzles during the outage in accordance with Section IV, paragraph C.(1)(b), of Order EA-03-009 would result in hardship without a compensating increase in the level of quality and safety. Therefore, the licensee has shown good cause for relaxation of the order and, pursuant to Section IV, paragraph F, of Order EA-03-009, the NRC staff authorizes the proposed relaxations for VHP nozzles only for Calvert Cliffs Unit No. 2, for the spring 2003 outage inspection, as conditioned below.

If the NRC staff finds that the crack growth formula in industry report MRP-55 is unacceptable, the licensee shall revise its analysis that justifies relaxation of the Order within 30 days after the NRC informs the licensee of an NRC-approved crack growth formula. If the licensee's revised analysis shows that the crack growth acceptance criteria are exceeded prior to the end of the current operating cycle, this relaxation is rescinded and the licensee shall, within 72 hours, submit to the NRC written justification for continued operation. If the revised analysis shows that the crack growth acceptance criteria are exceeded during the subsequent operating cycle, the licensee shall, within 30 days, submit the revised analysis for NRC review. If the revised analysis shows that the crack growth acceptance criteria are not exceeded during either the current operating cycle or the subsequent operating cycle, the licensee shall, within 30 days, submit a letter to the NRC confirming that its analysis has been revised.

With regards to Unit 1 and Unit 2 for subsequent outages, the license has not demonstrated hardship without a compensating increase in the level of quality and safety.

Principal Contributors: A. Hiser
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Date: April 18, 2003