UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

April 8, 2009

Mr. James A. Spina, Vice President
Calvert Cliffs Nuclear Power Plant, Inc.
Calvert Cliffs Nuclear Power Plant
1650 Calvert Cliffs Parkway
Lusby, MD 20657-4702

SUBJECT: SAFETY EVALUATION FOR RELIEF REQUESTS ISI-020 AND 021 REACTOR VESSEL WELD EXAMINATION EXTENSION – CALVERT CLIFFS NUCLEAR POWER PLANT, UNIT NO. 2 (TAC NOS. MD9773 AND MD9774)

Dear Mr. Spina:

By letter dated October 1, 2008, as supplemented by letters dated December 18, 2008, and January 23, 2009, Calvert Cliffs Nuclear Power Plant, Inc., the licensee, requested Nuclear Regulatory Commission (NRC) approval for the Calvert Cliffs Nuclear Power Plant, Unit No. 2, to use two related alternatives to the requirements of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), Section XI, Paragraph IWB-2412, Inspection Program B. The first proposed alternative, ISI-020, was requested pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) Section 50.55a(a)(3)(i), and would extend the inservice inspection (ISI) interval for examinations of the reactor pressure vessel (RPV) welds (Category B-A) as well as the nozzle-to-vessel welds and inner radius sections (Category B-D) from 10 years to 20 years, up to the end of license. The second proposed alternative, ISI-021, was requested pursuant to 10 CFR Section 50.55a(a)(3)(ii), and would place the visual inspections of Category B-N-2 and B-N-3 Welded Core Support Structures and Interior Attachment Welds on the same 20-year interval as the Category B-A and B-D components.

The NRC staff has completed its review of the information provided by the licensee for ISI-020 and ISI-021. The staff concludes that the information provided by the licensee supports the granting of alternative ISI-020 pursuant to 10 CFR 50.55a(a)(3)(i) because the alternative provides an acceptable level of quality and safety. For ISI-021, the staff concludes that the inspections required by Section XI of the ASME Code would result in hardship without a compensating increase in the level of quality and safety and the alternative can be granted according to the provisions of 10 CFR 50.55a(a)(3)(ii). Both alternatives are approved until the end of the current operating license for the Calvert Cliffs Nuclear Power Plant, Unit No. 2, which is effective through August 13, 2036.

On February 18, 2009, the NRC staff provided verbal approval for the subject relief requests in support of the ongoing refueling outage. At that time, the staff indicated that the written safety evaluation would be issued in the near future. Accordingly, the staff's safety evaluation is enclosed.

Please contact Douglas Pickett at 301-415-1364 or Douglas.Pickett@nrc.gov if you have any questions.

Sincerely,

John D. Boska for

Mark G. Kowal, Chief
Plant Licensing Branch I-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-318

Enclosure:
Safety Evaluation

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

REACTOR VESSEL INSERVICE INSPECTION INTERVAL EXTENSION

REQUEST FOR RELIEF NOS. ISI-020 AND ISI-021

CALVERT CLIFFS NUCLEAR POWER PLANT, UNIT NO. 2

1.0 INTRODUCTION

By letter dated October 1, 2008,[1] as supplemented by letters dated December 18, 2008,[2] and January 23, 2009,[3] Calvert Cliffs Nuclear Power Plant, Inc., the licensee, requested Nuclear Regulatory Commission (NRC) approval for the Calvert Cliffs Nuclear Power Plant, Unit No. 2 (CCNPP-2) to use two related alternatives to the requirements of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), Section XI, Paragraph IWB-2412, Inspection Program B. The first proposed alternative, ISI-020, was requested pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) Section 50.55a(a)(3)(i), and would extend the inservice inspection (ISI) interval for examinations of the reactor pressure vessel (RPV) welds (Category B-A) as well as the nozzle-to-vessel welds and inner radius sections (Category B-D) from 10 years to 20 years, up to the end of license (EOL). The second proposed alternative, ISI-021, was requested pursuant to 10 CFR Section 50.55a(a)(3)(ii), and would place the visual inspections of Category B-N-2 and B-N-3 Welded Core Support Structures and Interior Attachment Welds on the same 20-year interval as the Category B-A and B-D components.

On February 18, 2009,[4] the NRC staff provided verbal approval for the subject relief requests in support of the ongoing refueling outage. At that time, the staff indicated that the written safety evaluation (SE) would be issued in the near future.

2.0 REGULATORY REQUIREMENTS

In accordance with 10 CFR 50.55a(g)(4), the licensee is required to perform ISI of ASME Code Class 1, 2, and 3 components and system pressure tests during the first 10-year interval and subsequent 10-year intervals that comply with the requirements in the latest edition and addenda of Section XI of the ASME Code, incorporated by reference in 10 CFR 50.55a(b), subject to the limitations and modifications listed therein.

For the next ISI interval at CCNPP-2, which should be performed before June 30, 2009, the code of record for the inspection of ASME Code Class 1, 2, and 3 components will be Section XI of the ASME Code 1998 Edition (with no addenda). The regulation in 10 CFR 50.55a(a)(3) states, in part, that the Director of the Office of Nuclear Reactor Regulation (NRR) may

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1 Agencywide Documents Access and Management System (ADAMS) Accession No. ML082760280
2 ADAMS Accession No. ML083530980
3 ADAMS Accession No. ML090230517
4 ADAMS Accession No. ML090490753

authorize an alternative to the requirements of 10 CFR 50.55a(g). For an alternative to be authorized pursuant to 10 CFR 50.55a(a)(3)(i), the licensee must demonstrate that the proposed alternative would provide an acceptable level of quality and safety. For an alternative to be authorized pursuant to 10 CFR 50.55a(a)(3)(ii), the licensee must show that adherence to the ASME Code requirements would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

2.1 Background

The ISI of Category B-A and B-D components consists of visual and ultrasonic examinations intended to discover whether flaws have initiated, whether pre-existing flaws have extended, and whether pre-existing flaws may have been missed in prior examinations. The visual inspection of Category B-N-2 and B-N-3 components has always been done at the same time as the ISI of Category B-A and B-D components. These examinations are required to be performed at regular intervals, as defined in Section XI of the ASME Code. Performing all of these inspections at the same time reduces the number of times that the unit's full core and internals must be moved to gain access for the examinations.

2.2 Summary of WCAP-16168-NP, Revision 2

In 2006, the Pressurized Water Reactor (PWR) Owners Group submitted Topical Report WCAP-16168-NP, Revision 1[5] (the WCAP), to the NRC in support of making a risk-informed assessment of extensions to the ISI intervals for Category BA and B-D components. In the report, the PWR Owners Group took data associated with three different PWR plants (referred to as the pilot plants), one designed by each of the main contractors for nuclear power plants in the USA, and performed the necessary studies on each of the pilot plants required to justify the proposed extension for the ISI interval for Category B-A and B-D components from 10 to 20 years.

The analyses in the WCAP used probabilistic fracture mechanics tools and inputs from the work described in the NRC's pressurized thermal shock (PTS) risk re-evaluation.[6,7] The PWR Owners Group analyses incorporated the effects of fatigue crack growth and inservice inspection. Design basis transient data was used as input to the fatigue crack growth evaluation. The effects of ISI were modeled consistently with the previously-approved probabilistic fracture mechanics codes.[8] These effects were put into evaluations performed with the Fracture Analysis of Vessels-Oak Ridge (FAVOR) code.[9] All other inputs were identical to those used in the PTS risk re-evaluation.

From the results of the studies, the PWR Owners Group concluded that the ASME Code, Section XI 10-year inspection interval for Category B-A and B-D components in PWR reactor vessels can be safely extended to 20 years. Their conclusion from the results for the pilot plants was considered to apply to any plant designed by the three vendors (Westinghouse, Combustion Engineering, and Babcock and Wilcox) as long as the critical, plant-specific parameters (defined in Appendix A of the WCAP) are bounded by the pilot plants.

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[5] WCAP-16168-NP, Rev. 2, ADAMS Accession No. ML060330504
[6] NUREG-1806, ADAMS Accession No. ML061580318
[7] NUREG-1874, ADAMS Accession No. ML070860156
[8] WCAP-14572-NP-A, ADAMS Accession Nos. ML012630327, ML012630349, and ML012630313
[9] ONRL/NRC/LTR0418, ADAMS Accession No. ML042960391

2.3 Summary of NRC SE

The NRC staff's conclusion in its SE[10] accepting the WCAP indicates that the methodology, in concert with the guidance provided by Regulatory Guide 1.174, is acceptable for referencing in requests to implement alternatives to ASME Code inspection requirements for PWR plants in accordance with the limitations and conditions in the SE. In addition to showing that the subject plant is bounded by the pilot plants' information from Appendix A in the WCAP, the key points of the SE are summarized below.

1. The dates identified in the request for an alternative should be within plus or minus one refueling cycle of the dates identified in the implementation plan provided to the NRC. Any deviations from the implementation plan[11] should be discussed in detail in the request for an alternative ISI interval. The maximum interval for a proposed ISI is 20 years.

2. The requirements for reporting the results of ISIs found in the voluntary PTS rule apply in all cases. Licensees that do not implement the voluntary PTS rule must amend their licenses to require that the information and analyses requested in the voluntary PTS rule be submitted for NRC staff review and approval. The amendment to the license shall be submitted at the same time as the request for an alternative ISI interval.

3. The request for an alternative ISI interval can use any NRC-approved method to calculate ΔT_{30} and RT_{MAX-X}. However, if the request uses the NUREG-1874 methodology to calculate ΔT_{30}, then the request should include the analysis described in paragraph (6) of subsection (f) to the voluntary PTS rule. The analysis should be done for all of the materials in the beltline area with at least three surveillance data points

4. If the subject plant is a *B&W* plant:

   - Licensees must verify that the fatigue crack growth of 12 heat-up/cool-down transients per year bound the fatigue crack growth for all of its design basis transients
   - Licensees must identify the design basis transients that contribute to significant fatigue crack growth

5. If the subject plant has RPV forgings that are susceptible to underclad cracking or if the RPV includes forgings with RT_{MAX-FO} values exceeding 240 °F, then the WCAP analyses are not applicable. The licensee must submit a plant-specific evaluation for any extension to the 10-year inspection interval for ASME Code, Section XI, Category B-A and B-D RV welds.

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[10] US NRC SE for Footnote 4, ADAMS Accession No. ML0929200462
[11] OG-06-356, ADAMS Accession No. ML082210245

3.0 ALTERNATIVES PROPOSED FOR CCNPP-2

3.1 Description of Proposed Alternatives

Regarding ISI-020, the licensee proposes to defer the ASME Code required Category B-A and B-D weld ISI for CCNPP-2 until 2019 (20-year interval from the last inspection) and continuing with the next inspection in 2039. This schedule is consistent with the information in PWR Owners Group Letter, OG-06-356.

Regarding ISI-021, the licensee proposes the interval for Category B-N-2 and B-N-3 inspections be the same as that for Category B-A and B-D inspections.

3.2 Components for Which Relief is Requested

The affected components are the subject plant RPV and its interior attachments and core support structure. The following examination categories and item numbers from IWB-2500 and Table IWB-2500-1 of the ASME Code, Section XI, are addressed in this request:

Relief Request ISI-020

Examination Category	Item Number	Description
B-A	B1.11	Circumferential Shell Weld
B-A	B1.12	Longitudinal Shell Welds
B-A	B1.21	Circumferential Head Weld
B-A	B1.22	Meridional Head Weld
B-A	B1.30	Shell-to-Flange Weld
B-D	B3.90	Nozzle-to-Vessel Welds
B-D	B3.100	Nozzle Inner Radius Areas

Relief Request ISI-021

Examination Category	Item Number	Description
B-N-2	B13.50	Interior Attachments Within Beltline Region
B-N-2	B13.60	Interior Attachments Beyond Beltline Region
B-N-3	B13.70	Core Support Structure

3.3 Basis for Proposed Alternatives

3.3.1 Basis for ISI-020

The basis for the first alternative is found in the NRC-approved version of the WCAP[12] (referred to as WCAP-A). Plant-specific parameters for the subject plant are summarized in Attachment (1) to the licensee's letter of October 1, 2008. The format of the information is patterned after that found in Appendix A of the WCAP.

All of the critical parameters listed in Tables 1, 2, and 3 of Attachment (1) to the licensee's letter of October 1, 2008, are bounded by the WCAP-A pilot plant evaluations with one exception.

[12] WCAP-16168-NP-A, Rev. 2, ADAMS Accession No. ML0828200462

The most recent ISI of CCNPP-2 performed in 1999 found a single indication (referred to as Indication #1 in this SE) in a beltline plate near an axial weld that exceeded the maximum flaw size for the voluntary PTS rule. The licensee presented the following three additional pieces of evidence as to why the presence of Indication #1 should not be expected to significantly increase the calculated through-wall cracking frequency (TWCF) value above that of the pilot plant.

1. the plate with Indication #1 was not the limiting beltline material and the location of Indication #1 was not in the region of peak fluence,

2. the total number of flaws (indications) detected in the last ISI was less than allowed by the voluntary PTS rule, and

3. the calculated TWCF for CCNPP-2 was more than 3 orders of magnitude below that for the bounding pilot plant in WCAP-A.

Additional input from the licensee (Footnotes 2 and 3) documented the results of preservice inspection as well as the ISI performed in 1989, summarized the methods used in each previous inspection, clarified that Indication #1 was embedded at a depth of 0.4" below the cladding layer, and estimated the maximum embrittlement of the plate at Indication #1.

The WCAP notes that all reactor coolant pressure boundary failures to date have been identified as a result of leakage and were discovered by visual examinations. The Category B-N-1 visual examinations and the Category B-P pressure tests required at the end of each refueling outage are not affected by this alternative. The interval extension does not impact on the defense-in-depth elements associated with the overall inspection philosophy.

3.3.2 Basis for ISI-021

The basis for the second alternative is that performing the visual inspections of the B-N-2 and B-N-3 components on a different schedule than the Category B-A and B-D components would result in significant hardship without a compensating increase in safety. The licensee points out that the Category B-N-2 and B-N-3 components have been inspected regularly in the past and no significant indications were noted. Likewise, a review of the same Category B-N-2 and B-N-3 inspections at other, similar nuclear power plants have been performed many times without finding a significant indication.

Furthermore, the licensee notes that Category B-N-1 visual inspections and B-P pressure tests are always done during each refueling outage and are not affected by this alternative.

3.4 Duration of Proposed Alternatives

The duration of the two proposed alternatives is the remainder of the renewed operating license for the subject plant, which expires on August 13, 2036.

4.0 STAFF TECHNICAL EVALUATION

4.1 ISI-020

The NRC staff has reviewed the licensee's application dated October 1, 2008, and the information provided in the licensee's letters dated December 18, 2008, and January 23, 2009,

to make this evaluation. The "Frequency and Severity of Design Basis Transients" found in Table 1 of the original application (i.e., 13 heatups/cooldowns per year) for CCNPP-2 is bounded by WCAP-A. Also, CCNPP-2 is a single-layer clad RPV and is bounded by WCAP-A.

Table 2 of the submittal includes additional information pertaining to previous RPV inspections and the schedule for future ones. The proposed third ISI interval inspection for CCNPP-2 would be in 2019, consistent with the PWR Owners Group Letter OG-06-356. The information in Table 2 meets the regulatory guidance with the exception of Indication #1 (0.96 inches long and a through-wall dimension of 3.36% of the wall thickness) found in the beltline region of the RPV during the second ISI in 1999. Indication #1 was noted in the first ISI (1987) as a spot indication (no measurable through-wall dimension) with a length of about 1 inch. The same region was inspected in 1976 as part of the pre-service inspection, but no recordable indication was observed. Each inspection was performed with a progressively more sensitive inspection procedure that would allow for smaller and smaller flaws to be detected. This information allows the staff to conclude that Indication #1 from the 1999 ISI could have been present in the RPV before it was placed into service, but was not detected. There is no evidence that Indication #1 is growing due to any active aging mechanism; the size is acceptable per IWB-3500 of the ASME Code, Section XI, and there is no requirement for remedial action.

However, the size of Indication #1 exceeds the limits set in the proposed voluntary PTS rule, and the WCAP-A that forms the basis for this request no longer bounds the conditions present in the CCNPP-2 RPV. The calculated TWCF presented in Attachment 1 to the licensee's letter of October 1, 2008, cannot be accepted as a conservative estimate of the RPV's integrity without additional justification.

To make a quantitative assessment of TWCF for the CCNPP-2 RPV, the NRC requested that additional computer calculations be performed by Oak Ridge researchers.[13] The calculations were performed with Indication #1 as the only flaw in the physical model of the Palisades Plant RPV (designed and built by Combustion Engineering as was CCNPP-2) used for the WCAP-A. The analysis used the chemistry and unirradiated reference temperature for the plate that included Indication #1 as well as an inside diameter (ID) fluence of 7.22×10^{19} n/cm^2 (E > 1.0MeV), which is the maximum ID fluence projected for the subject plant after 60 effective full-power years of service. With this input, a TWCF on the order of 10^{-17} per reactor year was calculated as the additional risk associated with the addition of Indication #1. As stated in the licensee's relief request, Indication #1 is not in a region of the beltline that is exposed to the maximum fluence so this should be viewed as an implicit, additional conservatism of the analysis. From these results, the staff concludes that the presence of Indication #1 in the specific plate found in CCNPP-2 does not significantly change the TWCF. Therefore, the NRC staff concludes that the presence of Indication #1 has a negligible contribution with respect to the issues considered within the context of this SE.

The calculation of $TWCF_{95\text{-}TOTAL}$ was performed using Table 3 as a basis. The request uses the NUREG-1874 methodology to calculate ΔT_{30}, and the response to NRC questions includes the statistic analysis from the voluntary PTS rule specified in paragraphs (f)(6)(i) through (f)(6)(iv). The only beltline material from the subject plant with at least three surveillance results was the weld metal 33A277 (Welds 3-203A, B, and C). Two of the surveillance test results come from CCNPP, Unit No. 1 and the other six are from Farley, Unit No. 1. The analysis demonstrated that the surveillance results pass all three tests for mean deviation, slope deviation, and outlier deviation. The calculations were independently verified via NRC staff calculation and found to

[13] ADAMS Accession No. ML090370650

be within regulatory guidance. The TWCF was found to be acceptably low as calculated through the methodology prescribed in WCAP-A and detailed in Table 3 of the licensee's submittal.

In summary, with one exception, the licensee has demonstrated through the submittal that the RPV for CCNPP-2 is bounded by WCAP-A. That exception, Indication #1 (an embedded indication that exceeds the size limits of the voluntary, proposed PTS rule), was shown to make negligible contribution to the calculated TWCF. The NRC staff concludes that the submittal, along with the additional computer calculations, demonstrate that there is no significant additional risk associated with extending the ISI interval for Category B-A and B-D components from 10 years to 20 years.

4.2 ISI-021

The NRC staff has considered ISI-021 and agrees that the subject inspections can only be done after the fuel and internals are removed from the RPV, which is usually only done at the same time as the ISI of Category B-A and B-D components. All of the previous inspections of Category B-N-2 and B-N-3 components at CCNPP-2 have failed to find any significant indications of cracking or any other problems. No evidence of service-induced degradation has been noted in the same inspections at other similar nuclear power plants. The staff notes that no other nuclear power plant performs the Category B-N-2 and B-N-3 ISI on a different interval schedule than that for the ISI for Category B-A and B-D welds. Furthermore, the staff agrees that the change in interval for the inspections does not impact the defense-in-depth philosophy. Hence, the staff concludes that the alternative proposed is acceptable under the provisions of 10 CFR 50.55a(a)(3)(ii).

4.0 CONCLUSION

The NRC staff has completed its review of the submittals for ISI-020 and ISI-021 for CCNPP-2. Regarding Request for Relief ISI-020, the staff concludes that increasing the ISI interval for Category B-A and B-D components from 10 years to 20 years shows no appreciable increase in risk. The staff comes to this conclusion based on the fact that the plant-specific information provided by the licensee is bounded by the data in WCAP-A with the one exception that is justified based on additional calculations of TWCF, and the request meets all the conditions and limitations described in WCAP-A. Therefore, the staff concludes that Request for Relief ISI-020 provides an acceptable level of quality and safety and the alternative can be granted pursuant to 10 CFR 50.55a(a)(3)(i) until the EOL for CCNPP-2, August 13, 2036.

Regarding Request for Relief ISI-021, the NRC staff concludes that performing the ISI of Category B-N-2 and B-N-3 components every 10 years as required by Section XI of the ASME Code would result in hardship without a compensating increase in the level of quality and safety. The staff agrees that the Category B-N-2 and B-N-3 inspections should be performed every 20 years, as proposed and the alternative can be granted according to the provisions of 10 CFR 50.55a(a)(3)(ii) until the EOL for CCNPP-2, August 13, 2036.

All other requirements of the ASME Code, Section XI, not specifically included in the request for the proposed alternatives, remain in effect.

Principal Contributor: Patrick Purtscher

Date: April 8, 2009

Please contact Douglas Pickett at 301-415-1364 or Douglas.Pickett@nrc.gov if you have any questions.

Sincerely,

/ra/ (JBoska for)

Mark G. Kowal, Chief
Plant Licensing Branch I-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-318

Enclosure:
Safety Evaluation

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