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

January 9, 2019

Mr. Joel P. Gebbie
Senior Vice President and
Chief Nuclear Officer
Indiana Michigan Power Company
Nuclear Generation Group
One Cook Place
Bridgman, MI 49106

SUBJECT: DONALD C. COOK NUCLEAR PLANT, UNITS 1 AND 2 – APPROVAL OF REQUEST FOR ALTERNATIVE FROM VOLUMETRIC/SURFACE EXAMINATION FREQUENCY REQUIREMENTS OF ASME CODE CASE N-729-4 (EPID L-2018-LLR-0105)

Dear Mr. Gebbie:

By letter dated July 25, 2018 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML18208A434), Indiana Michigan Power Company (the licensee) submitted a proposed alternative ISIR-4-09 from the volumetric/surface examination frequency requirements of American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code Case N-729-4 for the Donald C. Cook Nuclear Plant (CNP), Units 1 and 2. ASME Code Case N-729-4 requires volumetric or surface examinations of all primary water stress corrosion cracking-resistant control rod drive mechanism and other nozzles in the reactor pressure vessel closure head every inspection interval and direct visual examinations of the upper head outer surface every third refueling outage (RFO) or 5 years, whichever is less. The licensee proposed to increase the volumetric and surface examination interval from 10 years to approximately 14 years.

Specifically, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) Section 50.55a(z)(1), the licensee requested to use the proposed alternative on the basis that the alternative would provide an acceptable level of quality and safety.

The U.S. Nuclear Regulatory Commission (NRC) staff has reviewed the subject request and concludes, as set forth in the enclosed safety evaluation, that the alternative method proposed by the licensee in ISIR-4-09, provides an acceptable level of quality and safety for the examination frequency requirements of the reactor pressure vessel closure heads. Accordingly, the NRC staff concludes that the licensee has adequately addressed all of the regulatory requirements set forth in 10 CFR 50.55a(z)(1). Therefore, the NRC staff authorizes the one-time use of alternative request ISIR-4-09, at CNP, Units 1 and 2 for the duration up to and including cycle 30 RFO for Unit 1 and cycle 26 RFO for Unit 2, scheduled for fall 2020 and spring 2021, respectively. Both RFOs will occur in the fifth 10-year inservice inspection (ISI) interval.

All other requirements of the ASME Code, Section XI, and 10 CFR 50.55a(g)(6)(ii)(D) for which relief was not specifically requested and authorized herein by the NRC remain applicable, including the third-party review by the Authorized Nuclear Inservice Inspector.

If you have any questions, please contact the Project Manager, Sujata Goetz at 301-415-8004, or via e-mail at Sujata.Goetz@nrc.gov.

Sincerely,

David J. Wrona, Chief
Plant Licensing Branch III
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. 50-315 and 50-316

Enclosure:
Safety Evaluation

cc: Listserv

UNITED STATES
NUCLEAR REGULATORY COMMISSION
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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELIEF REQUEST ISIR-4-09 REGARDING

INDIANA MICHIGAN POWER COMPANY

DONALD C. COOK NUCLEAR PLANT, UNITS 1 AND 2

DOCKET NOS. 50-315 AND 50-316

1.0 INTRODUCTION

By letter dated July 25, 2018 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML18208A434), Indiana Michigan Power Company (the licensee) submitted a proposed alternative ISIR-4-09 from the volumetric/surface examination frequency requirements of American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (B&PV Code) Case N-729-4 for the Donald C. Cook Nuclear Plant (CNP), Units 1 and 2. ASME B&PV Code Case N-729-4 requires volumetric or surface examinations of all primary water stress corrosion cracking (PWSCC)-resistant control rod drive mechanisms (CRDM) and other nozzles in the reactor pressure vessel closure head (RVCH), every inspection interval and direct visual examinations of the upper head outer surface, every third refueling outage (RFO) or 5 years, whichever is less. The licensee proposed to increase the volumetric and surface examination interval from 10 years to approximately 14 years.

Specifically, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) 50.55a(z)(1), the licensee requested to use the proposed alternative on the basis that the alternative would provide an acceptable level of quality and safety.

2.0 REGULATORY EVALUATION

The proposed alternative, ISIR-4-09 was submitted in accordance with 10 CFR 50.55a(z)(1), which addresses requests for alternatives on the basis that the proposed alternative would provide an acceptable level of quality and safety.

The licensee has proposed an alternative to the requirements of ASME B&PV Code Case N-729-4 that requires the 10-year inspection interval for surface and volumetric examinations of PWSCC-resistant RVHC nozzles (including the associated partial-penetration welds).

ASME B&PV Code Case N-729-4 is incorporated by reference in 10 CFR 50.55a(a)(1)(iii)(C). The regulation in 10 CFR 50.55a(g)(6)(ii)(D)(1) requires holders of operating licenses or combined licenses for pressurized-water reactors to meet the requirements defined in ASME B&PV Code Case N-729-4. Paragraph 10 CFR 50.55a(z) states, in part, that alternatives to the requirements of 10 CFR 50.55a(b)-(h) may be used, when authorized by the U.S. Nuclear Regulatory Commission (NRC), if (1) the proposed alternative would provide an acceptable level of quality and safety; or (2) compliance with the specified requirements would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

Based on the above, and subject to the following technical evaluation, the NRC staff finds that regulatory authority exists for the licensee to request and for the Commission to authorize the alternative requested by the licensee.

3.0 TECHNICAL EVALUATION

3.1 ASME Code Components Affected

The proposed alternative covers the Unit 1 and Unit 2, ASME Class 1 RVCH nozzles and partial penetration welds fabricated from PWSCC-resistant materials. Each unit's nozzle penetration tubes, vent pipe, and reactor vessel level indication system pipe are fabricated from Alloy 690 material with Alloy 52/152 attachment welds.

3.2 ASME Code Requirement

Section 50.55a(g)(6)(ii)(D) of 10 CFR requires the holders of operating licenses or combined licenses for pressurized-water reactors to meet the requirements of ASME B&PV Code Case N-729-4.

Specifically, ASME B&PV Code Case N-729-4 requires that partial-penetration welded RVCH penetration nozzles made using PWSCC-resistant materials be examined using a volumetric or surface technique every inspection interval (nominally 10 calendar years). ASME Code B&PV Case N-729-4 also requires a direct visual examination of the outer surface of the head for evidence of leakage every third RFO or 5 years, whichever is less.

3.3 ASME Codes of Record

The applicable Code edition for the fourth inservice inspection (ISI) interval of both units that began on March 1, 2010, is the 2004 edition of ASME Code, Section XI.

3.4 Proposed Alternative

The licensee proposed an alternative to the volumetric/surface examination frequency for the Unit 1 and Unit 2 RVCH components prescribed in ASME B&PV Code Case N-729-4.

For Unit 1, the licensee proposed to postpone the volumetric/surface examination for one additional fuel cycle beyond that previously approved (alternative ISIR-04-05). Therefore, for CNP Unit 1, this request would extend the volumetric/surface examination currently scheduled for the cycle 29 refueling outage in spring 2019 to the cycle 30 refueling outage that is scheduled for fall 2020. The replacement RVCH manufactured using Alloy 690/52/152 was placed in service in November 2006. The Unit 1 RVCH will have been in service for approximately 13.9 calendar years at the proposed inspection outage (cycle 30 RFO).

For CNP Unit 2, this request would extend the volumetric/surface examination currently scheduled for the cycle 25 refueling outage in fall 2019 to the cycle 26 refueling outage that is scheduled for spring 2021. The original Unit 2 RVCH was replaced with a new RVCH manufactured using Alloy 690/52/152 materials in November 2007. At the proposed inspection outage (cycle 26 RFO), the Unit 2 RVCH will have been in service for approximately 13.4 calendar years.

The licensee did not propose any other alternative examination frequency to those required by ASME Code Case N-729-4, as conditioned by 10 CFR 50.55a(g)(6)(ii)(D). This request does not affect the visual examinations and acceptance criteria as required by Item B4.30 of Table 1 of ASME B&PV Code Case N-729-4. The visual examinations will continue to be performed on a frequency of every third RFO or 5 years, whichever is less.

3.5 Basis for Use

The volumetric/surface examination frequency for RVCHs with Alloy 690 nozzles specified in ASME B&PV Code Cases N-729 through N-729-4 is based on the analysis performed in Electric Power Research Institute (EPRI) materials reliability program (MRP) report, MRP-111, "Materials Reliability Program: Resistance to Primary Water Stress Corrosion Cracking of Alloys 690, 52, and 152 in Pressurized Water Reactors." The analysis results in MRP-111 are also summarized in MRP-110, "Materials Reliability Program: Reactor Vessel Closure Head Penetration Safety Assessment for U.S. PWR Plants."

These MRP reports show that the factor of improvement (FOI) for PWSCC of Alloy 690/52/152 materials over that of mill-annealed Alloys 600/82/182 is in the order of 26 or greater. In August of 2009, EPRI also released MRP-258, "Materials Reliability Program: Resistance to Primary Water Stress Corrosion Cracking of Alloy 690 in Pressurized Water Reactors," which updated MRP-111, stating that "Relative improvement factors of 40 - 100 times versus Alloy 600 can now be derived for the initiation of cracking, but these numbers are clearly conservative, due to an absence of PWSCC in almost all Alloy 690 specimens within the test duration."

Additional evaluations were performed to demonstrate the resistance of Alloys 690/52/152 to PWSCC under an EPRI MRP initiative provided in MRP-375, "Materials Reliability Program: Technical Basis for Reexamination Interval Extension for Alloy 690 PWR Reactor Vessel Top Head Penetration Nozzles." This report combined an assessment of the test data and operating experience developed since the technical basis for the 10-year interval of ASME B&PV Code Case N-729 was developed in 2004 with deterministic and probabilistic evaluations to assess the improved PWSCC resistance of Alloys 690/52/152 relative to Alloys 600/82/182. Further research was recently performed under an EPRI MRP initiative provided in MRP-386, "Materials Reliability Program: Recommended Factors of Improvement for Evaluating Primary Water Stress Corrosion Cracking (PWSCC) Growth Rates of Thick-Wall Alloy 690 Materials and Alloy 52, 152, and Variants Welds." This report compiles over 530 data points for Alloy 690 crack growth rate (CGR) and over 130 data points for Alloy 52/152 CGR from seven research laboratories further supporting the improved PWSCC resistance of Alloys 690/52/152.

The licensee has assessed the minimum Alloy 690/52/152 FOI that supports the requested Unit 1 and Unit 2 examination extension periods for comparison with the laboratory CGR data presented in MRP-375. Based on the evaluation result that a reexamination interval between volumetric/surface examinations of the 2-year operating cycle is acceptable for a head with Alloy 600 nozzles operating at a temperature of 605 °F, an extension of the examination interval to 14.5 years would imply a factor of 14.5/2 or 7.25 relative to Alloys 600 and 182 for the proposed period between volumetric/surface examinations for a head operated at a temperature of 605 °F. This relative ratio (7.25) is sufficiently bounded by the FOI for Alloy 690 materials over Alloy 600 materials as demonstrated by the PWSCC test data and assessment results discussed above. To calculate the minimum implied FOI for Unit 1 and Unit 2 operating temperature of 601 °F, the reinspection year (RIY) parameter for the requested examination interval is compared with the ASME B&PV Code Case N-729-4 interval for Alloy 600 nozzles of RIY = 2.25.

The representative Unit 1 and Unit 2 RVCH operating temperature of 601 °F corresponds to an RIY temperature adjustment factor of 1.025 (versus the reference temperature of 600 °F) using the activation energy of 130 kJ/mol (31 kcal/mol) for crack growth of ASME B&PV Code Case N-729-4. It is appropriate to apply this standard activation energy for modeling crack growth of Alloys 690/52/152 plant components. Conservatively assuming that the effective full power years of operation accumulated at Unit 1 and Unit 2 since RVCH replacement are equal to the calendar years since replacement, the RIY for extended periods for Unit 1 and Unit 2 would be (1.025 temperature factor for growth rate) x (14.5 total calendar years for extended interval) = 14.9 RIY 690. The FOI implied by this RIY value for Unit 1 and Unit 2 is 14.9/2.25 = 6.6. This relative ratio (6.6) is sufficiently bounded by the FOI for Alloy 690 materials over Alloy 600 materials as demonstrated by the PWSCC test data and assessment results discussed above.

3.6 Duration of Proposed Alternative

For Unit 1, the proposed alternative is applied up to and including the cycle 30 RFO that is currently scheduled to commence in fall 2020. The fall 2020 RFO will occur in the fifth 10-year ISI interval that is scheduled to begin on March 1, 2020.

For Unit 2, the proposed alternative covers up to and including the cycle 26 RFO that is currently scheduled to commence in spring 2021. The spring 2021 RFO will occur in the fifth 10-year ISI interval that is scheduled to begin on March 1, 2020.

This proposed alternative ISIR-4-09 extends the time for the next inspection by one cycle for each unit compared to the previously authorized ISIR 04-05, dated April 19, 2018 (ADAMS Accession No. ML18103A059).

4.0 NRC STAFF EVALUATION

The licensee proposed to perform the volumetric/surface examinations of the PWSCC-resistant RVCH nozzles at CNP, Units 1 and 2, during cycle 30 and cycle 26 RFOs, respectively. ASME B&PV Code Case N-729-4 requires the inspections to be performed every 10 years. Relief request ISIR-4-09 proposes to extend the 10-year inspection interval to a total of 13.9 and 13.4 years, for Units 1 and 2, respectively. In comparison, this is an increase of approximately one operating cycle from the previous proposed alternative ISIR 04-05 that was authorized by letter dated April 19, 2018.

Due to concerns about PWSCC, many licensees have replaced RVCHs containing Alloy 600/182/82 nozzles with RVCHs containing Alloy 690/152/52 nozzles. The inspection frequencies specified in ASME B&PV Code Case N-729-4 for RVCH penetration nozzles using Alloy 600/182/82 were developed based, in part, on the materials' crack growth rate equations documented in the following reports: (a) MRP-55, "Crack Growth Rates for Evaluating Primary Water Stress Corrosion Cracking (PWSCC) of Thick-Wall Alloy 600 Material," and (b) MRP-115, "Crack Growth Rates for Evaluating Primary Water Stress Corrosion Cracking (PWSCC) of Alloy 82, 182, and 132 Welds." As its primary technical basis for the proposed alternative, the licensee presented crack growth rate data for the more crack-resistant materials, Alloy 690/152/52 to demonstrate a sufficient FOI of these materials versus the older Alloy 600/82/182 materials. This FOI would then provide the basis for the extension of the inspection interval as requested by the licensee in its proposed alternative.

The NRC staff's review used Alloy 690/152/52 crack growth rate data from Pacific Northwest National Laboratory (PNNL) and Argonne National Laboratory (ANL) documented in data summary report, "PNNL and ANL Preliminary Primary Water Stress Corrosion Cracking (PWSCC) Data for Alloys 690, 52, and 152," dated October 30, 2014 (ADAMS Accession No. ML14322A587. The research data documented in these reports generally support the assertion that the Alloy 690/52/152 materials are more PWSCC-resistant.

The licensee calculated that an extension of the inspection interval to 14.9 calendar years would require an FOI of 6.6. The NRC staff concludes that the licensee's calculated FOI of 6.6, to support an extension of the ASME Code Case N-729-4 inspection frequencies is acceptable by the staff's calculation. The staff also concludes that the application of an FOI of 6.6 to the 75th percentile curves in MRP-55 and MRP-115 bounded essentially all of the NRC data included in the PNNL and ANL data summary report in a conservative manner. Therefore, the NRC staff concludes that this analysis supports the assertion that the Units 1 and 2 RVCHs inspected at intervals not exceeding 14.9 years do not pose a higher risk than an Alloy 600/182/82 RVCH inspected at intervals of 2.25 re-inspection years per ASME B&PV Code Case N-729-4.

The NRC staff concludes that the past bare metal visual examinations on the RVCHs is a reasonable means to demonstrate the absence of leakage through the nozzle/J-groove weld prior to the time the examination was conducted. The NRC staff also concludes that performance of future bare metal visual examinations in accordance with the code case is adequate to demonstrate the absence of leakage at or prior to the time the examinations are conducted. Finally, the NRC staff concludes that the bare metal visual examination frequency, which is not affected in the proposed alternative, in conjunction with the new volumetric examination interval is sufficient to provide reasonable assurance of the structural integrity of the RVCH at each unit.

Based on the above, the staff concludes that the licensee's technical basis for the proposed alternative is acceptable and that the proposed alternative provides an acceptable level of quality and safety as required by 10 CFR 50.55a(z)(1).

4.0 CONCLUSION

As set forth above, the NRC staff has reviewed the subject request and concludes, the alternative method proposed by the licensee in ISIR-4-09, provides an acceptable level of quality and safety for the examination frequency requirements of the reactor pressure vessel closure heads. Accordingly, the NRC staff concludes that the licensee has adequately addressed all of the regulatory requirements set forth in 10 CFR 50.55a(z)(1). Therefore, the NRC staff authorizes the one-time use of alternative request ISIR-4-09, at CNP, Units 1 and 2 for the duration up to and including cycle 30 RFO for Unit 1 and cycle 26 RFO for Unit 2, scheduled for fall 2020 and spring 2021, respectively. Both RFOs will occur in the fifth 10-year ISI interval.

All other requirements of the ASME Code, Section XI, and 10 CFR 50.55a(g)(6)(ii)(D) for which relief was not specifically requested and authorized herein by the NRC staff remain applicable, including the third-party review by the Authorized Nuclear Inservice Inspector.

Principal Contributor: SCumbidge

Date: January 9, 2019

SUBJECT: DONALD C. COOK NUCLEAR PLANT, UNITS 1 AND 2 – APPROVAL OF REQUEST FOR ALTERNATIVE FROM VOLUMETRIC/SURFACE EXAMINATION FREQUENCY REQUIREMENTS OF ASME CODE CASE N-729-4 (EPID L-2018-LLR-0105) DATED JANUARY 9, 2019

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