



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

June 19, 2020

Mr. Ernest J. Kapopoulos, Jr.  
Site Vice President  
H. B. Robinson Steam Electric Plant  
Duke Energy Progress, LLC  
3581 West Entrance Road, RNPA01  
Hartsville, SC 29550

SUBJECT: H. B. ROBINSON STEAM ELECTRIC PLANT UNIT NO. 2 – RELIEF REQUEST  
RA-19-0106 REGARDING PROPOSED ALTERNATIVE TO ASME CODE  
CASE N-729-4 VOLUMETRIC OR SURFACE EXAMINATION REQUIREMENTS  
(EPID-L-2019-LLR-0065)

Dear Mr. Kapopoulos:

By letter dated July 10, 2019 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML19191A139), Duke Energy Progress, LLC (the licensee) requested relief from the requirements of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code Case N-729-4, "Alternative Examination Requirements for PWR [Pressurized Water Reactor] Reactor Vessel Upper Heads with Nozzles Having Pressure Retaining Partial-Penetration Welds, Section XI, Division 1," at H. B. Robinson Steam Electric Plant Unit No. 2 (Robinson).

Specifically, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) 50.55a(z)(1), the licensee proposed an alternative, RA-19-0106, regarding extending the frequency of volumetric and/or surface examination for the reactor vessel closure head) penetration nozzles and their associated attachment partial penetration (J-groove) welds, on the basis that the alternative provides 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 licensee has adequately addressed all of the regulatory requirements set forth in 10 CFR 50.55a(z)(1). Therefore, the NRC staff authorizes use of RA-19-0106 at Robinson up to and including the 34<sup>th</sup> refueling outage, which is currently scheduled for the fall of 2024.

All other ASME Code, Section XI requirements for which relief was not specifically requested and approved remain applicable, including the third-party review by the Authorized Nuclear Inservice Inspector.

E. Kapopoulos, Jr.

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If you have any questions, please contact the Project Manager, Andy Hon, at 301-415-8480 or [Andrew.Hon@nrc.gov](mailto:Andrew.Hon@nrc.gov).

Sincerely,

Undine Shoop, Chief  
Plant Licensing Branch II-2  
Division of Operating Reactor Licensing  
Office of Nuclear Reactor Regulation

Docket No. 50-261

Enclosure:  
Safety Evaluation

cc: Listserv



UNITED STATES  
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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION  
RELIEF REQUEST RA-19-0106 REGARDING PROPOSED ALTERNATIVE TO  
ASME CODE CASE N-729-4 VOLUMETRIC OR SURFACE EXAMINATION REQUIREMENTS  
DUKE ENERGY PROGRESS, LLC  
H. B. ROBINSON STEAM ELECTRIC PLANT UNIT NO. 2  
DOCKET NO. 50-261

1.0 INTRODUCTION

By letter dated July 10, 2019 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML19191A139), Duke Energy Progress, LLC (the licensee) requested relief from the requirements of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code Case N-729-4, "Alternative Examination Requirements for PWR [Pressurized Water Reactor] Reactor Vessel Upper Heads with Nozzles Having Pressure Retaining Partial-Penetration Welds, Section XI, Division 1," at H. B. Robinson Steam Electric Plant Unit No. 2 (Robinson).

Specifically, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) 50.55a(z)(1), the licensee proposed an alternative, RA-19-0106, regarding extending the frequency of volumetric and/or surface examination for the reactor vessel closure head (RVCH) penetration nozzles and their associated attachment partial penetration (J-groove) welds, on the basis that the alternative provides an acceptable level of quality and safety.

2.0 REGULATORY EVALUATION

Pursuant to 10 CFR 50.55a(g)(6)(ii)(D), "Augmented ISI Requirements: Reactor vessel head inspections," "(1) All licensees of pressurized water reactors must augment their inservice inspection program by implementing ASME Code Case N-729-4, subject to the conditions specified in paragraphs (g)(6)(ii)(D)(2) through (4) of [10 CFR 50.55a]."

The regulations in 10 CFR 50.55a(z) state that alternatives to the requirements of paragraphs (b) through (h) of 10 CFR 50.55a, or portions thereof, may be used when authorized by the Director, Office of Nuclear Reactor Regulation. A proposed alternative must be submitted and authorized prior to implementation. Section 50.55a(z)(1) of 10 CFR states that alternatives to the requirements of paragraphs (b) through (h) may be used when authorized by the NRC if the licensee demonstrates that "the proposed alternative would provide an acceptable 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 the NRC to authorize, the proposed alternative requested by the licensee.

### 3.0 TECHNICAL EVALUATION

#### 3.1 Background

The Robinson RVCH was fabricated with Alloy 690/52/152 materials and has been in service for approximately 14 calendar years in October 2005.

By letter dated September 22, 2017, the licensee submitted RR-12 proposing to use an alternative volumetric or surface examination schedule (ADAMS Accession No. ML17269A016). Specifically, the licensee requested to extend the volumetric or surface examinations for its RVCH penetration nozzles to the 32<sup>nd</sup> refueling outage which is scheduled to begin in September of 2020, an extension of approximately five years from the required 10-year examination frequency. The NRC staff approved the proposed alternative by letter dated June 25, 2018 (ADAMS Accession No. ML18163A412). Licensee's current request RA-19-0106, will supersede the prior request by extending the volumetric or surface examinations by an additional four years.

#### 3.2 Applicable ASME Code and Components Affected

The regulation in 10 CFR 50.55a(g)(6)(ii)(D)(1) requires, in part, that holders of operating licenses or combined licenses of PWRs implement the requirements of ASME Code Case N-729-4, "Alternative Examination Requirements for PWR [Pressurized-Water Reactor] Reactor Vessel Upper Heads with Nozzles Having Pressure-Retaining Partial-Penetration Welds." The affected components are ASME Code Class 1 RVCH penetration nozzles and their associated J-groove welds fabricated with primary water stress corrosion cracking (PWSCC)-resistant Alloy 690/52/152 materials. In accordance with ASME Code Case N-729-4, Table 1, these welds are classified as Item No. B4.40. There are 47 nozzle penetrations at Robinson, 45 of these are used for the control rod drive mechanisms, one is used for the reactor head vent, and one for the reactor vessel level indication system.

#### 3.3 Code Requirement for Which Relief is Requested

ASME Code Case N-729-4, Item No. B4.40 (Table 1) requires that the RVCH penetration nozzles and their associated J-groove welds of PWSCC-resistant materials be subject to volumetric or surface examination every inspection interval (nominally 10 calendar years), if flaws attributed to PWSCC have not been identified.

#### 3.4 Proposed Alternative

The licensee requests to extend the frequency of the volumetric or surface examination of the Robinson RVCH penetration nozzles by an additional four years beyond what had previously been approved by the NRC in accordance with licensee's prior request, RR-12 (ADAMS Accession No. ML17269A016). With the current request RA-19-0106, the licensee is requesting to extend the volumetric or surface examination to the 34<sup>th</sup> refueling outage, which is scheduled to commence in the fall of 2024. The licensee's current request would result in a deferral of the performance of the volumetric or surface examinations by nine years relative to the requirements of ASME Code Case N-729-4.

### 3.5 Licensee's Basis for Proposed Alternative

The licensee requested the proposed alternative pursuant to 10 CFR 50.55a(z)(1) on the basis that it provides an acceptable level of quality and safety.

The licensee stated that the requirements of ASME Code Case versions N-729 through N-729-4 were intended to be conservative and subject to reassessment pending the availability of additional data as well as plant experience on the performance of Alloy 690/52/152. The licensee noted that on March 3, 2016, the ASME Code Committee approved the sixth revision of ASME Code Case N-729 (N-729-6). This revision superseded previous revisions and included changes to the frequency of volumetric or surface examinations of RVCH penetration nozzles and their attachment partial penetration welds of PWSCC-resistant materials (i.e., Alloy 690/52/152 material). The examination frequency requirements for Code Case N-729-6 revised the inspection frequency to 20 calendar years for PWSCC-resistant materials.

In further justifying the adequacy of its proposal, the licensee referenced the Electric Power Research Institute (EPRI) report, "Materials Reliability Program: Technical Basis for Reexamination Interval Extension for Alloy 690 PWR Reactor Vessel Top Head Penetration Nozzles (MRP-375)," dated February 2014 (ADAMS Accession No. ML14283A046). The licensee noted that the evaluations and analysis performed by MRP-375 bounded the design and operation of the Robinson RVCH. Specifically, the licensee stated that the MRP-375 analyses assume a RVCH operating temperature of 613 degrees Fahrenheit (°F), while the Robinson RVCH average temperature is approximately 599.75°F. The licensee further noted that the technical basis of EPRI MRP-375 demonstrated that the examination frequency can be extended to 20 years while maintaining an acceptable level of quality and safety.

The licensee also referenced the preservice volumetric examinations performed using ultrasonic scans as well as eddy current examinations for the Robinson RVCH. These examinations did not identify any flaws. The licensee further referenced the periodic bare metal visual examinations performed in 2010, 2015, and again in 2018. The licensee indicated that these examinations did not reveal any relevant indications.

Based on the above, the licensee concluded that Alloy 690/52/152 materials used for the Robinson RVCH provide for a superior resistance to PWSCC and the potential for PWSCC is very low as evidenced by current industry operating experience with these alloys. The licensee further concluded that its proposed revised examination frequency of 19 years will provide a reasonable assurance of structural integrity and provides an acceptable level of quality and safety.

### 3.6 NRC Staff Evaluation

In evaluating the technical sufficiency of the licensee's proposed alternative, the NRC staff considered the licensee's use of the proposed alternative in accordance with 10 CFR 50.55a(z)(1), on the basis that the alternative examination frequency provides an acceptable level of quality and safety.

The inspection frequencies developed in Code Case N-729-4 for RVCH penetration nozzles made of Alloy 690/52/152 were developed based, in part, on a conservative assessment of the limited crack growth rate data and operating experience for these materials available at the

time. The licensee's primary technical basis is that the available crack growth rate data and operating experience for Alloy 690/52/152 materials is now sufficient to justify a longer inspection interval based on a satisfactory factor of improvement (FOI) for the Alloy 690/52/152 materials as compared to the Alloy 600/82/182 materials. The FOI can provide the basis for evaluating the licensee's proposed alternative to extend the inspection frequency for its RVCH nozzle penetration and associated J-groove welds. In its past request, the licensee calculated that a FOI of 6.6 would be needed to justify its requested alternate inspection interval of 15 calendar years. The staff used the parameters defined by ASME Code Case N-729-4 and Robinson's estimated RVCH operating temperature of 599.75 °F to calculate the FOI for the current request. The licensee's current requested inspection interval represents an implied FOI of 8.4.

In evaluating the licensee's technical basis for the proposed alternative, the NRC staff notes that the licensee referenced the evaluations performed in MRP-375 to justify extending the examination frequency for the Robinson RVCH. MRP-375 makes use of Alloy 690/52/152 crack growth rate data from various sources to develop FOIs for Alloy 690/52/152 versus Alloy 600/82/182. However, the NRC staff has not validated all of the data reported in MRP-375. Therefore, the NRC staff does not consider it appropriate to limit the review of available data to only the crack growth data from MRP-375.

A more detailed review of the data provided in MRP-375 has been performed by an international group of experts and documented in report, "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 (MRP-386)," which has not been submitted for NRC review. However, the staff has noted some limitations in MRP-386 with respect to its use for supporting plant-specific relief requests. Therefore, the staff found that the licensee's implied FOI cannot be justified by these reports alone.

Instead, the staff reviewed Alloy 690/152/52 crack growth rate data from two NRC contractors, Pacific Northwest National Laboratory (PNNL) and Argonne National Laboratory (ANL). Specifically, the staff compared the licensee's information to data documented by letter dated October 30, 2014 (ADAMS Accession No. ML14322A587). Most of the data from PNNL and ANL for Alloy 690 test samples support the licensee's current request. PNNL and ANL data associated with weld dilution zone specimens do not, however, support an implied FOI of 8.4. Therefore, this data would not support the licensee's requested inspection frequency extension. However, the NRC staff noted that the PNNL and ANL weld dilution data was very limited and general conclusions have not been reached regarding the use or applicability of the weld dilution data.

The NRC staff chose to exclude the weld dilution zone data from this analysis primarily due to: the limited number of data points available, (2) the variability in the results, and (3) the limited area of continuous weld dilution for potential flaws to grow through. For example, in the case of dilution zone measured crack growth rates, a flaw would have to travel at the interface between the J-groove weld and the low alloy steel interface in the RVCH. Since such a hypothetical flaw would have to grow through a region of stainless steel, non-diluted Alloy 52/152, or a dilution of Alloy 52/152 and stainless steel (a condition for which dilution testing has shown limited or no growth), the NRC staff finds it is not reasonable to expect a significantly increased probability of leakage or component failure. Therefore, the NRC staff considers the impact of these weld dilution zone crack growth rates to be of limited relevance for this specific relief request.

The NRC staff finds that the licensee's request which has an implied FOI of 8.4 is reasonable and is supported by the current available data. Additionally, a significant factor in accepting the licensee's proposal is the absence of any known instances of in-service PWSCC of components fabricated from Alloy 690/152/52 materials. Therefore, the NRC staff finds that the licensee's proposed alternative examination frequency is justified and bounded by the relevant available data included in the PNNL and ANL reports, and it provides an acceptable level of quality and safety.

The NRC staff finds that the licensee's proposed alternative of extending the volumetric/surface inspection interval for the Robinson RVCH to 19 calendar years is acceptable because it does not pose a higher risk than the inspection frequency associated with an RVCH with Alloy 600/82/182 nozzles and associated J-groove welds that are inspected at intervals as specified by current NRC regulations (i.e., 10 CFR 50.55a(g)(6)(ii)(D)). Therefore, the NRC staff finds the licensee's 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 determined that the alternative examination frequency proposed by the licensee in RA-19-0106 provides an acceptable level of quality and safety for the examination of the RVCH penetration nozzles at Robinson. 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 use of RA-19-0106 at Robinson up to and including the 34<sup>th</sup> refueling outage, which is currently scheduled for the fall of 2024.

All other ASME Code, Section XI requirements for which relief was not specifically requested and approved remain applicable, including the third-party review by the Authorized Nuclear Inservice Inspector.

Principal Contributor: Roger Kalikian

Date: June 19, 2020

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