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

December 5, 2014

Mr. C. R. Pierce
Regulatory Affairs Director
Southern Nuclear Operating Company, Inc.
P. O. Box 1295 / Bin - 038
Birmingham, AL 35201-1295

SUBJECT: JOSEPH M. FARLEY, UNITS 1 AND 2, (FNP-ISI-ALT-15, VERSION 1) ALTERNATIVE TO INSERVICE INSPECTION REGARDING REACTOR PRESSURE VESSEL COLD-LEG NOZZLE DISSIMILAR METAL WELDS (TAC NOS. MF3687 AND MF3688)

Dear Mr. Pierce,

By letter dated March 24, 2014, as supplemented on August 1, 2014, Southern Nuclear Operating Company, Inc., requested approval to use an alternative to the inservice inspection requirement of American Society of Mechanical Engineers (ASME) Code Case N-770-1 for the reactor pressure vessel cold-leg nozzle dissimilar metal welds for Joseph M. Farley Nuclear Plant, Units 1 and 2. The proposed alternative would allow ASME dissimilar metal welds to be examined once every six refueling outages based on a nominal cycle length of approximately 1.5 calendar years.

The application was submitted pursuant to Sections 50.55a(a)(3)(i) of Title 10 of the *Code of Federal Regulations* (10 CFR), which requires that the applicant demonstrate that the proposed alternative provides an acceptable level of quality and safety.

The U.S. Nuclear Regulatory Commission (NRC) staff has reviewed the subject request, and concludes that SNC has adequately addressed all of the regulatory requirements and that the proposed alternative provides an acceptable level of quality and safety. Therefore, the NRC staff authorizes the proposed alternative in accordance with 10 CFR 50.55a (a)(3)(i). The NRC staff's safety evaluation is enclosed.

If you have any questions, please contact the Project Manager, Shawn Williams, at 301-415-1009 or via e-mail at Shawn.Williams@nrc.gov.

Sincerely,

Robert J. Pascarelli, Chief
Plant Licensing Branch II-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. 50-348, 50-364

Enclosure: Safety Evaluation

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

ALTERNATIVE TO ASME CODE REQUIREMENTS

FOURTH 10-YEAR INSERVICE INSPECTION PROGRAM INTERVAL

SOUTHERN NUCLEAR OPERATING COMPANY

JOSEPH M. FARLEY NUCLEAR PLANT, UNITS 1 AND 2

DOCKET NOS. 50-348, 50-364

1.0 INTRODUCTION

By letter dated March 24, 2014, as supplemented by letter dated August 1, 2014 (Agencywide Documents Access and Management System (ADAMS) Accession Nos. ML14084A203 and ML14213A484, respectively), Southern Nuclear Operating Company, Inc. (the licensee), requested an alternative from the requirements of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code) for the volumetric examination of the reactor pressure vessel (RPV) inlet cold-leg nozzle dissimilar metal (DM) welds at the Joseph M. Farley Nuclear Plant, Units 1 and 2 (Farley).

Specifically, pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) 50.55a(a)(3)(i), the licensee proposed an alternative frequency of examination for the RPV cold-leg nozzle DM 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)(4), the ASME Code Class 1, 2, and 3 components (including supports) must meet the requirements, except the design and access provisions and the preservice examination requirements, set forth in the ASME Code, Section XI, "Rules for Inservice Inspection [ISI] of Nuclear Power Plant Components," to the extent practical within the limitations of design, geometry, and materials of construction of the components.

Pursuant to 10 CFR 50.55a(g)(6)(ii)(F) "Examination requirements for Class 1 piping and nozzle dissimilar-metal butt welds," licensees of existing, operating pressurized-water reactors (PWR) shall implement the requirements of ASME Code Case N-770-1, "Alternative Examination Requirements and Acceptance Standards for Class 1 PWR Piping and Vessel Nozzle Butt Welds Fabricated With UNS N06082 or UNS W86182 Weld Filler Material With or Without Application of Listed Mitigation Activities Section XI, Division 1," subject to the conditions specified in paragraphs (g)(6)(ii)(F)(2) through (g)(6)(ii)(F)(10) of Section 50.55a, by the first refueling outage after August 22, 2011.

Enclosure

Pursuant to 10 CFR 50.55a(a)(3), alternatives to the requirements of paragraph (g) of 10 CFR 50.55a may be used, when authorized by the U.S. Nuclear Regulatory Commission (NRC), if the licensee demonstrates (i) the proposed alternatives 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 alternative requested by the licensee.

3.0 TECHNICAL EVALUATION

3.1 The Licensee's Request for an Alternative

The components affected are ASME Code Class 1 RPV inlet cold-leg nozzle DM butt welds. In accordance with ASME Code Case N-770-1 (Table 1), they are classified as Inspection Item B.

The code of record for the fourth 10-year ISI interval at Farley, Units 1 and 2, is the 2001 Edition through 2003 Addenda of the ASME Code.

ASME Code Case N-770-1, Table 1, Inspection Item B, requires that the unmitigated butt welds at cold-leg temperatures greater than or equal to 525 degrees Fahrenheit (°F) and less than 580°F is volumetrically examined every second inspection period not to exceed 7 years.

The licensee proposed an alternative to this requirement of ASME Code Case N-770-1. The licensee proposed to perform the ultrasonic testing (UT) of the subject DM welds once every six refueling outages (i.e., 9.0 calendar years or 8.6 effective full-power years (EFPY)) considering a fueling cycle length of 1.5 calendar years. The licensee included a discussion of its previously performed supplemental surface examination of these DM welds using the eddy current testing (ET). The licensee stated that it will perform the UT with the procedure developed in accordance with the performance demonstration requirements of Supplement 10, Appendix VIII of Section XI, of the ASME Code.

In the August 1, 2014, letter, the licensee stated that the qualification process for its ET procedure included a technical justification and practical qualification trials. The licensee developed the technical justification in accordance with European Network for Inspection Qualification (ENIQ) guidelines, and performed the practical qualification trials in 2003 on a nozzle to safe end test specimen supplied by Ringhals AB. The Swedish Qualification Centre (SQC) is an inspection qualification body that proctored the licensee's procedure qualification trials, and reviewed and approved the licensee's ET procedure and technical justification. The licensee's procedure qualification trials were in a non-blind manner. The test specimen included clad SA 508 carbon steel forging, buttered with Alloy 600 material, and welded to a SA312 Type 316 stainless steel forging. The test specimen included 10 inside diameter (ID) surface connected branch cracks ranging in depth from 0.24 inch (6.1 mm) to 1.33 inches (33.7 mm) and in length from 0.67 inch (17.1 mm) to 2.78 inches (70.5 mm) located in the weld and buttering. In addition, the licensee performed parametric evaluations on test specimens that contained fatigue cracks as small as 0.04 inch (1 mm) deep by 0.24 inch (6 mm) long located in the center of an Alloy 182 weld. The target flaw for detection by the ET was 0.04 inch (1 mm) deep by 0.24 inch (6 mm) long ID surface connected crack oriented either parallel or transverse to the weld. Inspection personnel were required to undergo blind qualification trials using the approved procedure. These personnel qualification trials included collected data from a test specimen similar to that used in the procedure qualification trial. Additionally, the SQC required procedure technique verification on supplemental test specimens containing flaws representing intergranular stress corrosion cracking (IGSCC) interdendritic stress corrosion cracking (IDSCC) conditions. The supplemental test specimens were made as part of the SQC investigation of the degradation mechanism. In the procedure technique verification, the test specimens were scanned and the data interpreted in accordance with the qualified procedure. The qualification documentation for the procedure stated that the ET is capable of detecting fatigue and IGSCC/IDSCC cracks 0.04 inch (1 mm) deep by 0.24 inch (6 mm) long and length sizing such cracks within a range of ±0.39 inch (±10 mm).

The licensee stated that it performs the UT of the RPV cold-leg nozzle DM welds from the ID surface of the pipe due to access limitations to the outside surface of the pipe. To access the ID surface of the weld, removal of the vessel internal core barrel assembly is necessary every 6 or 7 calendar years to comply with the ASME Code Case N-770-1 required volumetric examination of the cold-leg DM welds. However, if the licensee performs the volumetric examination once every six refueling outages (i.e., 9.0 calendar years or 8.6 EFPY) to coincide with the frequency of inspection of the RPV shell welds that is typically done every interval, the core barrel removal evolutions will be minimized. The removal of the core barrel is a critical lift due to weight of the component, tight clearances, risks of damaging equipment, and risk of personnel exposure to radiation emitted by the assembly.

The licensee stated that it performed the ASME Code Case N-770-1 required baseline volumetric examinations of the RPV cold-leg nozzle DM welds in 2007 at Farley, Unit 1, and in 2010 at Farley, Unit 2. The licensee performed the UT with the procedure developed in accordance with the performance demonstration requirements of Supplement 10, Appendix VIII. The licensee performed the UT using the encoded, remotely operated, and mechanized technique from the ID surface. The licensee achieved 100 percent coverage of the required volume in the axial and circumferential directions. Due to the flat and uniform ID surface of the weld, the licensee did not use site-specific mockups. The licensee did not detect any unacceptable indications during the baseline volumetric examinations.

The licensee stated that, in addition to the required baseline volumetric examinations, it conducted the owner-elected surface examination of the RPV cold-leg nozzle DM welds using the ET. In the August 1, 2014, application, the licensee stated that its ET procedure qualification process was approved by the SQC and the personnel underwent blind qualification trials using the approved procedure. The subject DM welds are shop welds and essentially have a flat surface across the DM weld volume. The licensee's ET achieved 100 percent coverage of the required surface area. The licensee did not detect any unacceptable indications during the surface examinations.

To support extension of the reexamination interval for the subject RPV cold-leg DM welds, the licensee provided its technical justifications in the letters dated October 1, 2012 (ADAMS Accession No. ML12276A110), May 6, 2013 (ADAMS Accession No. ML13130A119), May 24, 2013 (ADAMS Accession No. ML13149A021), and July 19, 2013, (ADAMS Accession No. ML13200A341). Specifically, the licensee stated that it developed a generic technical basis document (i.e., Enclosure 2 to relief request (RR) FNP-ISI-ALT-13 in the October 1, 2012, letter) by compiling all existing flaw tolerance analyses performed to date on Alloy 82/182 welds. The results of the licensee's generic flaw tolerance analysis for an assumed circumferential flaw in the RPV inlet nozzle DM welds are shown in Figure 5-4, Enclosure 2 to request FNP-ISI-ALT-13 in the October 1, 2012, letter. Figure 5-4 showed that an assumed initial ID surface connected 10 percent through wall circumferential flaw in the RPV cold-leg nozzle DM weld would not grow to the ASME Code maximum allowable 75 percent through wall flaw in less than 10 years of continued operation. The licensee stated that the results provided in Figure 5-4 are not representative of any single plant in the Westinghouse PWR fleet, rather they are based on the limiting thickness in the Westinghouse PWR fleet combined with limiting piping loads. Therefore, the results are conservative. The analysis underlying assumptions were a 25 percent ID weld repair because the review of the fabrication weld traveler records indicates that no repairs were performed from the ID surface of any of the six cold-legs DM welds, a postulated initial ID surface connected circumferential flaw of 10 percent through wall thickness, a short and a long stainless steel safe end, and the cold-leg operating temperature as high as 565 °F and as low as 535 °F. Therefore, the underlying assumptions are limiting.

In addition, the results of the licensee's Farley specific flaw tolerance analysis in Figure 1 of RR FNP-ISI-ALT-15 showed that an assumed initial ID surface connected 7.5 percent (0.25 inch) through wall axial flaw in the RPV cold-leg nozzle DM weld would not grow to the ASME Code maximum allowable 75 percent through wall flaw in less than 10 EFPY. The licensee stated that its plant-specific flaw tolerance analysis for axial flaw conservatively assumed a 50 percent weld repair even though the review of the fabrication weld traveler records indicated that no weld repairs were performed from the ID surface of any of the six RPV cold-leg nozzle DM welds. In its analysis, the licensee assumed a postulated initial ID surface connected axial flaw of 7.5 percent through wall thickness, a plant-specific safe end length that bounds the Farley, Units 1 and 2, safe ends, and a plant-specific operating temperature that bounds the Farley, Units 1 and 2, RPV inlet nozzles operating temperature.

The licensee submitted this relief request for the fourth 10-year ISI interval of Farley, Units 1 and 2, which commenced on December 1, 2007, and will end on November 30, 2017. The licensee stated that the approval of this relief request for Farley, Unit 1, would permit the deferral of the volumetric examinations of the RPV inlet cold-leg nozzle DM welds currently scheduled for the spring of 2015 to be moved to the fall of 2016. Furthermore, the approval of this relief request for Farley, Unit 2, would permit the deferral of the volumetric examinations of the RPV inlet cold-leg nozzle DM welds currently scheduled for the fall of 2017 to be moved to the spring of 2019.

3.2 NRC Staff Evaluation

The NRC staff has evaluated the licensee's request pursuant to 10 CFR 50.55a(a)(3)(i). The NRC staff focuses on whether the proposed alternative provides an acceptable level of quality and safety.

In the August 8, 2013 (ADAMS Accession No. ML13212A176), letter, the NRC authorized the licensee's proposed alternative FNP-ISI-ALT-13 dated July 19, 2013, which was to extend frequency of the volumetric examinations to once per five refueling outages (i.e., every 7.5 calendar years or 7.1 EFPY). In the current RR FNP-ISI-ALT-15, the licensee proposed to extend the frequency of the volumetric examinations of the RPV cold leg nozzle DM welds at Farley, Units 1 and 2, to once per six refueling outages (i.e., 9.0 calendar years or 8.6 EFPY). For technical justification, the licensee used the same flaw tolerance analysis previously provided in RR FNP-ISI-ALT-13. In addition, the licensee performed supplemental surface examinations on these DM welds in the spring of 2010 at Farley, Unit 2, and the fall of 2007 at Farley, Unit 1, to demonstrate the structural integrity of the DM welds. The licensee performed the surface examination using the qualified and performance demonstrated ET on the ASME Code required surface area of the DM welds in conjunction with the UT. As such, the licensee stated that because its qualified and performance demonstrated ET is capable of detecting surface connected fatigue and IGSCC/IDSCC cracks of 0.04 inch deep by 0.24 inch long, the postulated initial ID surface connected flaw in the flaw tolerance evaluation could be assumed to be bounded by a 7.5 percent (0.25 inch) through wall deep flaw rather than the previously assumed 10 percent (0.327 inch) deep flaw. As shown in Figure 1 (RR FNP-ISI-ALT-15) and Figure 5-4 (Enclosure 2 to RR FNP-ISI-ALT-13), an assumed initial ID surface connected 7.5 percent deep axial or circumferential flaw in the RPV cold-leg nozzle DM weld would not grow to maximum allowable 75 percent deep flaw in less than 10 EFPY. The NRC staff notes that the 10 percent ID surface connected through wall flaw was generally assumed in the flaw tolerance analysis due to the UT uncertainty that all flaws with depth less than 10 percent through wall thickness would not be reliably detected and recorded by UT.

After reviewing the licensee's ET qualification process, the NRC staff finds that the licensee's qualification for the ET included the following steps – (1) ET procedure was prepared in accordance with the ENIQ guidelines, (2) SQC inspection qualification body reviewed and approved the licensee's ET procedure, (3) SQC proctored a non-blind procedure qualification trails on specimens with DM welds containing several ID surface connected branch cracks (4) a parametric evaluation of ET procedure was performed with specimens containing fatigue flaws as small as 0.04 inch deep by 0.24 inch long oriented in axial and circumferential flaws, and (5) an additional verification of the ET procedure was performed using specimens containing IGSCC/IDSCC cracks. Furthermore, the inspection personnel was qualified in a blind testing manner using the SQC approved ET procedure on a test specimen similar to the one used in the procedure qualification trials. The NRC staff finds the licensee's ET procedure and personnel qualifications acceptable because the qualification process involved non-blind ET procedure qualification and blind personnel qualification on wide range of specimens containing various flaws in size and orientation including IGSCC/IDSCC cracks, and oversight and approval by the third party (i.e., the SQC). The NRC staff notes that there is no performance demonstration qualification for the ET technique in the ASME Code, Section XI, for the surface examination of the DM welds. Given the licensee's ET qualification process, the NRC staff finds that the licensee's bounding initial flaw size assumption of 7.5 percent through wall is conservative.

After reviewing the licensee's flaw tolerance analysis, the NRC staff performed an independent flaw evaluation to verify the licensee's analysis. The staff's independent flaw analyses determined the maximum flaw depth, leak, and rupture characteristics of the subject welds to a postulated initial ID surface connected (circumferential or axial) flaw. The analyses were performed based on the requirements of the ASME Code, Section XI, IWB-3640, and an assumed postulated initial flaw due to primary water stress corrosion cracking (PWSCC). The staff used the Farley's WRS distributions provided by the licensee. The water reactor safety profile for the axial and the hoop direction were curve-fit by a fourth order polynomial approximation. For the PWSCC crack growth, the staff used the 75th percentile crack growth rate data for Alloy 182.

The NRC staff based its assessment of the licensee's proposed alternative on the time for an assumed 7.5 percent (0.25 inch) deep initial surface connected (circumferential or axial) crack to grow to the ASME Code allowable crack depth of 75 percent through wall thickness. The NRC staff finds that the licensee's assumption is conservative since it is reasonable to expect that the ID surface connected flaw of 7.5 percent deep in the DM welds would be detected by the qualified ET performed in conjunction with the UT before the flaw reaches the allowable crack depth of 75 percent through wall. The NRC staff finds sufficient safety margins in its independent flaw evaluation and the licensee's flaw tolerance analysis to conclude that inspecting these welds once every six refueling outages (approximately every 9.0 calendar years or 8.6 EFPY) would provide an acceptable level of quality and safety.

Therefore, given the flaw evaluation demonstrating sufficient safety margins, the ID surface examinations by a qualified ET demonstrating reasonable assurance of no surface connected flaws, and the volumetric examinations by UT, the NRC staff finds that the licensee has provided adequate technical basis to demonstrate that its proposed alternative examination frequency would provide an acceptable level of quality and safety.

4.0 CONCLUSION

As set forth above, the NRC staff determines that the licensee's proposed alternative provides an acceptable level of quality and safety for the RPV inlet cold-leg nozzle DM welds. Accordingly, the NRC staff concludes that the licensee has adequately addressed all of the regulatory requirements set forth in 10 CFR 50.55a(a)(3)(i). Therefore, the NRC staff authorizes the use of alternative FNP-ISI-ALT-15, Version 1.0, at Farley, Unit 1, for the fourth 10-year ISI interval which commenced on December 1, 2007, and will end on November 30, 2017. For Farley, Unit 2, the NRC staff authorizes the use of alternative FNP-ISI-ALT-15, Version 1.0, up to and including the refueling outage in the spring of 2019.

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

Principal Contributor: Ali Rezai, NRR/DE/EPNB

Date of issuance: December 5, 2014

If you have any questions, please contact the Project Manager, Shawn Williams, at 301-415-1009 or via e-mail at Shawn.Williams@nrc.gov.

Sincerely,

/RA/

Robert J. Pascarelli, Chief
Plant Licensing Branch II-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. 50-348, 50-364

Enclosure: Safety Evaluation

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