



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

April 30, 2014

Mr. Thomas D. Gatlin
Vice President, Nuclear Operations
South Carolina Electric & Gas Company
Virgil C. Summer Nuclear Station
Post Office Box 88, Mail Code 800
Jenkinsville, SC 29065

SUBJECT: VIRGIL C. SUMMER NUCLEAR STATION, UNIT 1 – ALTERNATIVE REQUEST
WELD REPAIR FOR REACTOR VESSEL UPPER HEAD PENETRATIONS
(TAC NO. MF3546)

Dear Mr. Gatlin:

By letter dated February 24, 2014, South Carolina Electric & Gas Company (SCE&G), the licensee, submitted an alternative request to certain American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (B&PV Code), Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components" requirements at Virgil C. Summer Nuclear Station, Unit 1. Specifically, the licensee requested for approval for generic use of the embedded flaw repair for upper head penetration nozzle repairs. The application was submitted pursuant to Section 50.55a(a)(3)(i) of Title 10 of the *Code of Federal Regulations (10 CFR)*, which requires the applicant to demonstrate that the proposed alternatives would provide an acceptable level of quality and safety.

The NRC staff has reviewed the subject request and concludes, as set forth in the enclosed safety evaluation, that SCE&G has adequately addressed all of the regulatory requirements set forth in 50.55a(a)(3)(i), and therefore authorizes the proposed alternative.

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,

A handwritten signature in cursive script, appearing to read "R. Pascarelli".

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

Docket No. 50-395

Enclosure: Safety Evaluation

cc w/encl: Distribution via Listserv

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO ALTERNATIVES TO ASME CODE REQUIREMENTS

FOURTH TEN-YEAR INSERVICE INSPECTION PROGRAM INTERVAL

SOUTH CAROLINA ELECTRIC & GAS COMPANY

SOUTH CAROLINA PUBLIC SERVICE AUTHORITY

VIRGIL C. SUMMER NUCLEAR STATION, UNIT 1

DOCKET NO. 50-395

1.0 INTRODUCTION

By letter dated February 24, 2014, South Carolina Electric & Gas Company (SCE&G, the licensee), submitted proposed alternative RR-4-05, "Alternative Weld Repair for Reactor Vessel Upper Head Penetrations," (Reference 1) for Nuclear Regulatory Commission (NRC) review and authorization. The licensee is requesting relief from American Society of Mechanical Engineers Boiler and Pressure Vessel Code (B&PV Code or ASME Code) Section XI, Part IWA 4000 requirements for repair of flaws that may be identified in control rod drive mechanism (CRDM) penetration nozzle tubes at Virgil C. Summer Nuclear Station, Unit 1. Specifically, pursuant to Title 10 of the *Code of Federal Regulations (10 CFR) 50.55a(a)(3)(i)* the licensee is proposing to use the provisions of Westinghouse Topical Report WCAP-15987-A, Revision 2, (WCAP-15987, Reference 2) for performing the embedded flaw repair technique on penetration nozzles and associated J-groove welds as necessary. The licensee has submitted the proposed alternative on the basis that the proposed alternative provides an acceptable level of quality and safety.

The licensee requested that applicability for alternative request to include the fourth 10-year inservice inspection (ISI) program interval which began in January 1, 2014 and ends December 31, 2023.

2.0 REGULATORY EVALUATION

Pursuant to Title 10 of the *Code of Federal Regulations*, Part 50 (10 CFR 50), paragraph 55a(g)(4), Inservice Inspection Requirements, ASME Code Class 1, 2, and 3 components (including supports) shall meet the requirements, except the design and access provisions and the pre-service examination requirements, set forth in the ASME Code, Section XI, "Rules for Inservice Inspection of Nuclear Power Plant Components," to the extent practical within the limitations of design, geometry, and materials of construction of the components.

Paragraph 55a(a)(3) of 10 CFR 50 states, in part, that alternatives to the requirements of 10 CFR 50.55a(g) may be used, when authorized by the NRC, if (i) the proposed alternatives would provide an acceptable level of quality and safety or (ii) compliance with the specified

Enclosure

requirements would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

Based on the above analysis of the regulatory requirements and subject to the following technical analysis, the NRC staff finds that it has the regulatory authority to authorize the proposed alternative on the basis that it provides an acceptable level of quality and safety. Accordingly, the NRC staff has reviewed the licensee's proposed alternative pursuant to 10 CFR 50.55a(a)(3)(i).

3.0 TECHNICAL EVALUATION

3.1 Licensee's Request for Alternative

3.1.1 Components for which Relief is Being Requested

Vessel Head Penetrations (VHP), ASME Code Case N-729-1, Table No. 1, Item Number B4.20

3.1.2 ASME Code Requirements

The code of record for the Virgil C. Summer, Unit 1, fourth 10-year ISI interval that is scheduled to end on December 31, 2023, is the 2007 Edition through the 2008 Addenda of the ASME Code, Section XI. Subparagraph IWA-4000 contains requirements for the removal of defects from and welded repairs performed on ASME Code components. For the removal or mitigation of defects by welding, IWA-4411 requires that repairs and installation of replacement items shall be performed in accordance with the Owner's Design Specification and the original Construction Code of the component or system.

The original construction code of the Virgil C. Summer, Unit 1, reactor vessel is the ASME Code, Section III, 1971 Edition with no addenda. Subparagraphs NB-4131, NB-2538, NB-2539.1, and NB-2539.4 pertain to the removal of base material defects prior to repair by welding, and NB-4451, NB-4452, and NB-4453.1 pertain to the removal of weld material defects prior to repair by welding.

3.1.3 Licensee's Proposed Alternative

The licensee proposes to repair any VHPs requiring repair in accordance with WCAP-15987, as described and modified in Section 5 of the licensee's submittal. The cited topical report has been previously reviewed and generically approved for use in a safety evaluation by the NRC staff.

3.1.4 Licensee's Duration of Relief Request

The licensee requests this alternative through the fourth 10-year ISI interval which began on January 1, 2014 and ends December 31, 2023.

3.1.5 Licensee's Basis for Requesting Relief

The licensee will perform examinations of the reactor VHPs in accordance with ASME Code Case N-729-1, as required by 10 CFR 50.55a(g)(6)(ii)(D) during the fourth 10-year ISI interval.

Unacceptable flaws that are found in VHP nozzles will require repair prior to returning the vessel head to service. The licensee proposes to use the embedded flaw process as an alternative to the defect removal of flaws under the requirements of ASME Code, Section XI and Section III.

The embedded flaw repair technique is considered a permanent repair since as long as a primary water stress corrosion cracking (PWSCC) flaw remains isolated from the primary water environment, it cannot propagate. Since an Alloy 52 weldment is considered highly resistant to PWSCC, a new PWSCC flaw is significantly less likely to initiate and grow through the Alloy 52 seal weld to reconnect the primary water environment with the embedded flaw. The structural integrity of the affected J-Groove weld and/or nozzle will be maintained by the remaining unflawed portion of the weld and/or the VHP and will be verified by the continued inspections required by this alternative and 10 CFR 50.55a(g)(ii)(D).

3.2 NRC Staff Evaluation

PWSCC of nickel-based pressure boundary materials is a safety concern. Operational experience has shown that PWSCC can occur as the result of the combination of susceptible material, corrosive environment, and tensile stresses, resulting in leakage and the potential for loss of structural integrity. The subject VHPs meet these conditions thus may be susceptible to PWSCC. Examination per Code Case N-729-1, as required by 10 CFR 50.55a(g)(6)(ii)(D), is intended to ensure the structural integrity and leak tightness of VHPs.

Licensee's examination of the VHPs, in accordance with Code Case N-729-1, may find unacceptable indications. These penetrations would need to be repaired prior to returning the vessel head to service. In order to perform the design, implementation, and inspection of the VHP repairs, the licensee proposes to use the provisions of WCAP-15987 (Reference 2). The NRC staff has reviewed the technical basis of WCAP-15987 and has generically accepted it, subject to the specified limitations and conditions, for referencing in licensing applications as an alternative to Section XI of the ASME Code (Reference 3).

The licensee states that the proposed alternative, as described by Section 5 of the submittal, will use the methodology of the NRC approved WCAP-15987 with modifications. The NRC staff reviewed Section 5 of the proposed alternative to ensure the licensee's proposed actions would meet the requirements of WCAP-15987, and that any modifications would be acceptable.

As part of this review the NRC staff identified the following technical changes:

1. Cracks in the Alloy 600 penetration nozzle tube material will be embedded with two weld layers of Alloy 52 rather than the three layers specified in WCAP-15987.
2. A single layer consisting of at least 3 beads of stainless steel 309L will be installed on the reactor vessel head clad surface 360 degrees around at a distance of approximately 0.5 inches from the toe of the J-groove weld prior to deposition of the first Alloy 52 layer.
3. Nondestructive examination of the repair will be performed in accordance with ASME Code Case N-729-1, as required by 10 CFR 50.55a(g)(6)(ii)(D).

The NRC staff reviewed the licensee's proposal to allow a reduction in the maximum three layers of the seal weld over the Alloy 600 nozzle material to only 2 layers. The NRC staff finds that operational experience has shown that two layers of Alloy 52 material deposited on Alloy 600 material are adequate to maintain the high chromium content of the Alloy 52 material, the principle reason for the material's resistance to PWSCC, even after weld dilution effects are considered. The NRC staff finds that the embedded flaw will be isolated from the primary coolant environment necessary for continued PWSCC growth and a lower residual stress will be introduced in the base metal with the proposed repair. The staff NRC therefore finds that two layers of Alloy 52 are acceptable.

The licensee states that the 309L is used to mitigate the risk of solidification cracking or hot cracking in the region where the Alloy 52 weld beads intersect the RPV cladding, insulating the outermost Alloy 52 weld beads from possible contaminants in the cladding. The NRC staff finds the 309L layer, applied only to the periphery, will allow for a quality seal weld by mitigating the potential for solidification cracking and hot cracking. The NRC staff notes that this technique has been previously accepted. Therefore, the NRC staff finds that the application of the 309L weld metal is acceptable.

The staff reviewed the licensee's proposed alternative for NDE examination requirements of the seal weld and future ISI requirements. During the time period in which WCAP-15987 was approved by the NRC staff, the regulatory requirements for upper head inspection were found under NRC Order EA-03-009. In September 2008, by rule, the NRC established 10 CFR 50.55a(g)(6)(ii)(D) that defines the current regulatory requirements for upper head inspections and rescinded NRC Order EA-03-009. The NRC staff finds that the licensee's proposed alternative inspections for the upper head penetration nozzle conform to the current regulatory requirements and satisfy the previous NRC limitations on the NDE required for implementation of an embedded flaw repair under WCAP-15987. Thus, the NRC staff finds them acceptable. The NRC staff finds that all of the changes in the licensee's proposed alternative from the NRC-approved WCAP-15987 either meet or provide additional quality for the embedded flaw repair technique and, as such, provide an acceptable level of quality and safety.

In order to support the use of WCAP-15987, the licensee has submitted a plant-specific technical basis, Westinghouse WCAP-17758-P, "Technical Basis for Westinghouse Embedded Flaw Repair for V. C. Summer Unit 1 Reactor Vessel Head Penetration Nozzles and Attachment Welds," (Reference 4). The submission evaluated the expected lifetime based on fatigue crack growth of flaws in a bounding penetration nozzle and flaw analysis assuming that the entire J-groove weld was cracked. The results of this analysis showed that the fatigue crack growth of the flaw and cracked J-groove weld is acceptable for at least 20 years. The NRC staff has examined this data and found the methodology and calculations to be valid for the analysis performed. Additionally the NRC staff finds WCAP-17758-P to be consistent with analysis required under Appendix C of WCAP-15987-P, as accepted by Section 3.2 of the NRC safety evaluation of WCAP-15987-P (Reference 3). Therefore the NRC staff finds the licensee's use of the embedded flaw technique, per the proposed alternative, provides reasonable assurance of the structural integrity and leaktightness of each repaired VHP for a period of up to 20 years.

In summary, the NRC staff concludes that the proposed alternative for embedded flaw repair of the VHPs provides an acceptable level of quality and safety in accordance with 10 CFR 50.55a(a)(3)(i) for 20 years. Therefore given the above, the NRC staff finds the proposed alternative acceptable for initiating repairs for the fourth 10-year ISI interval and that the NRC staff finds that repairs made under this alternative are acceptable to remain in service for a period of 20 years from the time the repair is made.

4.0 CONCLUSION

As set forth above, the NRC staff finds that the proposed alternative for embedded flaw repair of VHPs will provide an acceptable level of quality and safety. 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) and therefore authorizes use of the proposed alternative at Virgil C. Summer Nuclear Station, Unit 1, for the remainder of the fourth 10-year ISI interval that ends December 31, 2023.

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

5.0 REFERENCES

1. Letter from South Carolina Electric & Gas Company to NRC, "Alternative Weld Repair for Reactor Vessel Upper Head Penetrations," dated February 24, 2014, Agencywide Documents Access and Management System (ADAMS) Accession No. ML14063A067
2. Westinghouse Topical Report WCAP-15987-NP, Revision 2-NP-A, "Technical Basis for the Embedded Flaw Process for Repair of Reactor Vessel Head Penetrations," December 2003, ADAMS Accession Nos. ML040290246 (non-proprietary), ML040290256 (proprietary)
3. NRC Safety Evaluation of WCAP-15987-P, Revision 2, "Technical Basis for the Embedded Flaw Process for Repair of Reactor Vessel Head Penetrations," July 2003, ADAMS Accession No. ML031840237
4. WCAP-17758-NP, Revision 0, "Technical Basis for Westinghouse Embedded Flaw Repair for V.C. Summer Unit 1 Reactor Vessel Head Penetration Nozzles and Attachment Welds," August 2013, ADAMS Accession Nos. ML13252A242 (non-proprietary), ML13252A144 (proprietary)

Principle Contributor: Jay Collins, NRR/EPNB

April 30, 2014

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Sincerely,
/RA/
Robert J. Pascarelli, Chief
Plant Licensing Branch II-1
Division of Operating Reactor Licensing
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Docket No. 50-395

Enclosure: Safety Evaluation

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