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

September 6, 2019

Mr. George A. Lippard, III
Vice President, Nuclear Operations
South Carolina Electric & Gas Company
Virgil C. Summer Nuclear Station
P.O. Box 88, Mail Code 800
Jenkinsville, SC 29065

SUBJECT: VIRGIL C. SUMMER NUCLEAR STATION, UNIT NO. 1 – RELIEF REQUEST (RR-4-22) FOR USE OF ASME CODE CASE N-513-4 (EPID L-2019-LLR-0030)

Dear Mr. Lippard:

By letter dated April 10, 2019, the South Carolina Electric & Gas Company (SCE&G, the licensee) submitted a relief request to the U.S. Nuclear Regulatory Commission (NRC) for relief from certain American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), Section XI, IWA-4000 requirements at Virgil C. Summer Nuclear Station (VCSNS), Unit 1. Specifically, SCE&G requested authorization to use Code Case N-513-4, "Evaluation Criteria for Temporary Acceptance of Flaws in Moderate Energy Class 2 or 3 Piping Section XI, Division 1" for the temporary acceptance of a through-wall leak in a Class 3 service water branch tee in lieu of performing repair/replacement in accordance with ASME Code requirements.

The licensee submitted the proposed alternative pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, Section 50.55a(z)(2) on the basis that the ASME Code requirements would result in hardship or unusual difficulty without a compensating increase in the level of quality or safety.

On April 11, 2019, the NRC staff verbally authorized the use of relief request RR-4-22 until the next refueling outage, which is scheduled to begin in spring 2020, or until the temporary acceptance criteria of Code Case N-513-4 are exceeded, or until the leak rate exceeds 51.7 gallons per minute, whichever event occurs first.

The NRC staff has reviewed the proposed alternative 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)(2). Therefore, the NRC staff authorizes the use of alternative request RR-4-22 for VCSNS, Unit 1.

All other ASME Code, Section XI, requirements 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.

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

Sincerely,

Michael T. Markley, Chief
Plant Licensing Branch II-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket No. 50-395

Enclosure:
Safety Evaluation

cc: Listserv

UNITED STATES
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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELIEF REQUEST RR-4-22

USE OF ASME CODE CASE N-513-4

RENEWED FACILITY OPERATING LICENSE NO. NPF-12

SOUTH CAROLINA ELECTRIC & GAS COMPANY

VIRGIL C. SUMMER NUCLEAR STATION, UNIT NO. 1

DOCKET NO. 50-395

1.0 INTRODUCTION

By letter dated April 10, 2019 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML19101A293), South Carolina Electric & Gas Company (SCE&G, the licensee), requested approval from the U.S. Nuclear Regulatory Commission (NRC) for relief from certain American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), Section XI, IWA-4000 requirements at Virgil C. Summer Nuclear Station (VCSNS), Unit 1. SCE&G requested authorization to use Code Case N-513, Revision 4 (Code Case N-513-4), "Evaluation Criteria for Temporary Acceptance of Flaws in Moderate Energy Class 2 or 3 Piping Section XI, Division 1" for the temporary acceptance of a through-wall leak in a Class 3 service water (SW) branch tee in lieu of performing repair/replacement in accordance with ASME Code requirements.

The licensee submitted the proposed alternative pursuant to Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, Section 50.55a(z)(2) on the basis that the ASME Code requirements would result in hardship or unusual difficulty without a compensating increase in the level of quality or safety.

On April 11, 2019 (ADAMS Accession No. ML19102A070), the NRC staff verbally authorized the use of Relief Request RR-4-22 until the next refueling outage, which is scheduled to begin in spring 2020, or until the temporary acceptance criteria of Code Case N-513-4 are exceeded, or until the leak rate exceeds 51.7 gallons per minute (gpm), whichever event occurs first.

2.0 REGULATORY EVALUATION

Paragraph 10 CFR 50.55a(g)(4), Inservice inspection standards requirement for operating plants, states, in part:

> Throughout the service life of a boiling or pressurized water-cooled nuclear power facility, components (including supports) that are classified as ASME Code Class 1,

> Class 2, and Class 3 must meet the requirements, except design and access provisions and preservice examination requirements, set forth in Section XI, ... to the extent practical within the limitations of design, geometry, and materials of construction of the components.

Pursuant to 10 CFR 50.55a(z), alternatives to the requirements of paragraphs (b) through (h) of this section may be used when authorized by the Director, Office of Nuclear Reactor Regulation. A proposed alternative must be submitted and authorized prior to implementation. The licensee must demonstrate (1) the proposed alternative would provide an acceptable level of quality and safety; or (2) compliance with the specified requirements of this section would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

ASME Code Case N-513, Revision 3 (Code Case N-513-3) is approved for generic use by licensees in NRC Regulatory Guide (RG) 1.147, "Inservice Inspection Code Case Acceptability, ASME Section XI, Division 1," Revision 18 (ADAMS Accession No. ML16321A336), with one condition. This RG is incorporated into NRC regulations by reference in 10 CFR 50.55a. Code Case N-513 provides criteria, which allows licensees to temporarily accept flaws, including through-wall flaws, in moderate energy Class 2 or 3 piping without performing repair or replacement activities. Code Case N-513-4 contains several revisions including expanding the applicability of the code case beyond straight pipe to include elbows, bent pipe, reducers, expanders, and branch tees. Code Case N-513-4 has not been approved by the NRC for generic use by licensees.

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 Alternative

3.1.1 ASME Code Component Affected

The affected component is an ASME Code Section III, Class 3, SW system branch tee located in the 20-inch diameter piping downstream of the 'B' component cooling water heat exchanger 'B' SW return valve (XVB03123B-SW) below field weld FW-1.

3.1.2 Applicable Code Edition and Addenda

The applicable ASME Code, Section XI, Edition and Addenda for the fourth 10-year Inservice Inspection Interval (ISI) at VCSNS, Unit 1, is the 2007 Edition through 2008 Addenda. The fourth ISI interval at VCSNS, Unit 1, began on January 1, 2014, and is scheduled to end on December 31, 2023.

3.1.3 Applicable Code Requirement

ASME Code Section XI, Article IWA-4000 provides requirements for welding, brazing, metal removal, and installation of repair/replacement activities.

3.1.4 Licensee's Reason for Request

The licensee stated:

> On April 9, 2019, at approximately 02:00, a pinhole leak was discovered in a branch connection below field weld FW-1, downstream of XVB03123B-SW. At the time of discovery, leakage was estimated to be approximately 7 ml/minute (0.0018 gpm). This leaking location does not meet ASME Section III Sub-Section ND Class 3 requirements because it is a localized flaw that violates the minimum allowed wall thickness criteria for this piping. This degraded condition is not in compliance with ASME Section XI, 2007 Edition through 2008 Addenda, IWA-4000.
>
> As a result, a number of limiting conditions for operation (LCOs) of the plant technical specifications are not met, including, but not limited to, LCO 3.7.4, "Service Water System". The action statement requires that with only one SW loop OPERABLE, restore at least two loops to OPERABLE status within 72 hours or be in at least HOT STANDBY within the next 6 hours and in COLD SHUTDOWN within the following 30 hours.
>
> ASME Code Case N-513-3, "Evaluation Criteria for Temporary Acceptance of Flaws in Moderate Energy Class 2 or 3 Piping, Section XI, Division 1," provides criteria to allow temporary acceptance of flaws, including through-wall flaws in moderate energy Class 2 or 3 piping without performing repair or replacement activities. Code Case N-513-3, (Revision 3, January 26, 2009) is approved for generic use by licensees in Nuclear Regulatory Commission (NRC) Regulatory Guide 1.147, "Inservice Inspection Code Case Acceptability, ASME Section XI, Division 1, Revision 18" (ADAMS Accession No. ML 16321A336), with the condition that the repair or replacement activity be temporarily deferred under the provisions of this Code Case shall be performed during the next scheduled outage.
>
> ASME Code Case N-513-3 does not address the evaluation of flaws in certain locations of moderate energy piping components, such as elbows, bent pipe, reducers, expanders, and branch tees. Code Case N-513-4, "Evaluation Criteria for Temporary Acceptance of Flaws in Moderate Energy Class 2 or 3 Piping, Section XI, Division 1," (Revision 4, May 7, 2014) contains several revisions to ASME Code Case N-513-3 including expanding the applicability of the Code Case beyond straight pipe to include elbows, bent pipe, reducers, expanders, and branch tees. ASME Code Case N-513-4, Reference 4, has not been approved by the NRC for generic use by licensees. Use of ASME Code Case N-513-4 is proposed to allow temporary acceptance of the through-wall flaw, which is in a moderate energy Class 3 piping branch tee without performing repair or replacement activities, and thereby avoid a plant shutdown. Use of this alternative evaluation method in lieu of immediate action for such a degraded condition would allow time for safe and orderly long-term repair actions.

3.1.5 Licensee's Proposed Alternative and Basis for Use

The licensee's proposed alternative is to use ASME Code Case N-513-4 for the evaluation and temporary acceptance of a degraded SW system branch tee, with a through-wall flaw, downstream of the 'B' component cooling water heat exchanger 'B' SW return valve (XVB03123B-SW), below field weld FW-1.

The licensee stated that it will follow all requirements of the code case and will take no exceptions. The licensee will perform a permanent repair/replacement activity at the next scheduled outage which is in the spring of 2020.

The licensee stated that the limitations in NRC approved Code Case N-513-3 related to its use on piping components, such as elbows, bent pipe, reducers, expanders, branch tees, and external tubing or piping attached to heat exchangers, have been addressed in Code Case N-513-4.

The licensee stated that significant changes in Code Case N-513-4 when compared to NRC approved Code Case N-513-3 are discussed in Section 8, Reference 5, of the application, "Technical Basis for Proposed Fourth Revision to ASME Code Case N-513," from the *Proceedings of the ASME 2014 Pressure Vessels & Piping Conference,* July 20-24, 2014, Anaheim, California.

The licensee performed ultrasonic testing (UT) of the degraded area and used the "Through-Wall Flaws in Branch Tees" approach from Code Case N-513-4 to perform a flaw evaluation. The results of the flaw evaluation determined that the flaw is acceptable in the configuration evaluated, in accordance with Code Case N-513-4. The flaw evaluation is provided in Enclosure 2 of the licensee's April 10, 2019, application.

The licensee installed PMCaps during the Fall 2018 refueling outage to repair previously identified thin wall areas and pinhole leaks within the subject tee fitting [See Section 3.2.2 below for a description of PMCaps]. One of PMCaps was installed in the vicinity of the degraded area that is the subject of the currently proposed alternative. The licensee stated that the pinhole is outside the area of reinforcement of both the branch run of the tee and the PMCap. Enclosure 3 to the licensee's application contains the evaluation for continued acceptability of the PMCap adjacent to the thinned region around the discovered pinhole leak.

The proposed alternative includes a maximum allowable leakage rate of 51.7 gpm. The licensee stated that the SW system has a flow margin of 799 gpm and that its maximum allowable leakage rate is conservative. The licensee stated that a postulated leakage of 51.7 gpm would not adversely affect SW system flow margin. The licensee contends that this is a conservative approach since the 51.7 gpm leak would be located downstream of all cooling loads and throttle valves. Therefore, it would have an insignificant effect on cooling load flow.

3.1.6 Licensee's Hardship Justification

The licensee stated:

> Code repair is considered a hardship without a compensating increase in the level of quality and safety. A Code repair would require a plant shutdown. The branch tee is located between valve XVB03123B-SW and the SW pond. The piping cannot be isolated from other portions of the SW system.
>
> Plant shutdown activities result in additional plant risk. Such a shutdown would be inappropriate when an affected ASME Code component in a degraded condition is demonstrated to retain adequate margin to fulfill the component's function. Accordingly, compliance with the current code requirements results in a hardship without a compensating increase in the level of quality and safety.

3.1.7 Duration of Proposed Alternative

The licensee requested use of the proposed alternative until the repairs are completed during the next refueling outage, which is scheduled for the spring of 2020.

3.2 NRC Staff Evaluation

The NRC staff evaluated the adequacy of the proposed alternative in maintaining structural integrity of the branch tee located on the service water piping between valve XVB03123B-SW and the service water pond. The NRC staff also evaluated the hardship or unusual difficulty without a compensating increase in the level of quality and safety if the licensee performed an ASME Code repair in accordance with ASME Code Section XI, IWA-4000.

Code Case N-513-3, which is conditionally approved for use in RG 1.147, Revision 18, provides alternative evaluation criteria for temporary acceptance of flaws, including through-wall flaws, in moderate energy Class 2 and 3 piping. However, Code Case N-513-3 contains limitations that the licensee considers restrictive and could result in an unnecessary plant shutdown. Code Case N-513-3 is limited to straight pipe with provisions for flaws that extend for a short distance into the fitting at the pipe to fitting weld. Evaluation criteria for flaws in elbows, bent pipe, reducers, expanders, branch tees and heat exchanger tubing and piping are not included within the scope of N-513-3. Code Case N-513-4 addresses evaluation of these additional piping components. Given that the previous revision of this code case (Code Case N-513-3) is conditionally approved for use in RG 1.147, Revision 18, which is incorporated by reference in 10 CFR 50.55a, the NRC staff focused its review on the differences between Code Cases N-513-3 and N-513-4 as they apply to this plant-specific review of the evaluation of the subject SW branch tee. Code Case N-513-4 has not been approved by the NRC for generic use.

The NRC staff's review of the proposed alternative included the following significant changes in Code Case N-513-4, which are discussed in subsections of this safety evaluation below.

The NRC staff also evaluated the licensee's proposed limitation on the leakage rate and its hardship justification.

3.2.1 Temporary Acceptance Period

Code Case N-513-3 specifies a temporary acceptance period of a maximum of 26 months. Code Case N-513-3 is acceptable for generic use as listed in RG 1.147, Revision 18, with the following condition:

> The repair or replacement activity temporarily deferred under the provisions of this Code Case shall be performed during the next scheduled outage.

Code Case N-513-4 includes wording that limits the use of the code case to the next refueling outage and the licensee confirmed in its proposed alternative that it will repair the degraded branch tee, in accordance with the ASME Code, Section XI, at the next refueling outage. The NRC staff finds that Code Case N-513-4 and the proposed alternative appropriately address the NRC condition on Code Case N-513-3, and is, therefore, acceptable

3.2.2 Flaw Evaluation Criteria for Elbows, Bent Pipe, Reducers/Expanders and Branch Tees

Evaluation and acceptance criteria have been added to Code Case N-513-4 for flaws in elbows, bent pipe, reducers, expanders and branch tees using a simplified approach, which is based on the Second International Piping Integrity Research Group (IPIRG-2) program reported in NUREG/CR-6444, BMI-2192, "Fracture Behavior of Circumferentially Surface-Cracked Elbows," published in December 1996.

The flaw evaluation methodology approach in Code Case N-513-4 for piping components is conducted as if in straight pipe by scaling hoop and axial stresses using ASME piping design code stress indices and stress intensification factors to account for the stress variations caused by the geometric differences. Equations used in the code case are consistent with the piping design by rule approach in ASME Code Section III, NC/ND-3600. NUREG/CR-6444 shows that this approach is conservative for calculating stresses used in flaw evaluations in piping elbows and bent pipe. The code case also applies this methodology to reducers, expanders and branch tees.

The NRC staff finds that the flaw evaluation and acceptance criteria in Code Case N-513-4 for elbows, bent pipe, reducers, expanders and branch tees are acceptable because the flaw evaluation methods in the code case are consistent with ASME Code Section XI, and ASME Code Section III design by rule approach and provide a conservative approach. This is confirmed by comparing the failure moments predicted using this approach to the measured failure moments from the elbow tests for through-wall circumferential flaws, which was conducted as part of the IPIRG-2 program.

The licensee stated that in the fall of 2018, it installed a PMCap on a degraded area of the subject branch tee which is adjacent to the thinned region around the newly discovered pinhole leak. A PMCap is a code compliant method used to perform permanent and temporary repairs of vessels and piping. The PMCap is welded to the outside surface of a component using a full penetration weld to encapsulate a degraded area. The licensee verified that the newly discovered degraded area and pinhole leak, which is the subject of the current proposed alternative, do not impact the previously installed PMCap and the stresses at the PMCap restoration hardware to tee weld juncture remain within ASME Code acceptance criteria. The evaluation performed by the licensee's vendor is documented in Enclosure 3 to its April 10, 2019 application.

The NRC staff reviewed the licensee's evaluation of the through-wall flaw and verified that it was performed in accordance Code Case N-513-4, Paragraph 3.0, Flaw Evaluation, and is, therefore, acceptable. In addition, the NRC staff finds that the licensee has appropriately considered the impact of the degraded area and pinhole leak on the previously installed PMCap.

3.2.3 Limit Use to Liquid Systems

Use of Code Case N-513-4 is specifically limited to liquid systems.

The proposed alternative is limited to a liquid system and, therefore, the NRC staff finds the request is consistent with Code Case N-513-4.

3.2.4 Treatment of Service Load Combinations

Modifications in Code Case N-513-4 now make clear that all service load combinations must be considered in flaw evaluations to determine the most limiting condition. Although previously implied in Code Case N-513-3, Code Case N-513-4 makes this requirement clear.

Therefore, the NRC staff finds this change acceptable. In addition, the NRC staff verified that the licensee considered all service load combinations in its evaluation of the branch tee flaws.

3.2.5 Minimum Wall Thickness Acceptance Criteria to Consider Longitudinal Stress

Although it is unlikely that a minimum wall thickness calculated based on the longitudinal stress would be limiting when compared to a minimum wall thickness calculated based on hoop stress, Code Case N-513-4 includes revisions that require consideration of longitudinal stress in the calculation of minimum wall thickness. Previous versions of the code case only required the use of hoop stress. The NRC staff finds this acceptable because it will ensure that the more limiting of the longitudinal or hoop stress is used to determine minimum wall thickness.

3.2.6 Leakage Monitoring for Through-Wall Flaws

Code Case N-513-3 required through-wall leakage to be observed via daily walkdowns to confirm the analysis conditions used in the evaluation remain valid. Code Case N-513-4 modifies this requirement by continuing to require that leakage be monitored daily, but now allows other techniques to be used to monitor leakage such as using visual equipment or leakage detection systems to determine if leakage rates are changing. The NRC staff finds this change acceptable because the code case continues to require through-wall leaks to be monitored daily and the expanded allowable monitoring methods should have no adverse impact. In addition, the licensee verified that it will perform daily walkdowns to quantify the leakage.

3.2.7 Leakage Rate

Code Case N-513-3, Paragraph 1(d) states:

> The provisions of this Case demonstrate the integrity of the item and not the consequences of leakage. It is the responsibility of the Owner to demonstrate system operability considering effects of leakage.

Code Case N-513-4 modified the last sentence, now located in paragraph (f), to state:

> It is the responsibility of the Owner to consider effects of leakage in demonstrating system operability and performing plant flooding analyses.

To address the above, the licensee considered the SW system flow margin, spray effects and building flooding. The licensee determined that the limiting factor of the above considerations is the design margin for flooding in the Intermediate Building 412' which is 271 gpm leakage. The maximum allowable leakage rate under the proposed alternative is 51.7 gpm. The maximum leakage rate of 51.7 gpm provides a safety factor greater than 4 when compared to the 271 gpm margin calculated by the licensee. The staff notes that the leak is downstream of all cooling loads and throttle valves. Therefore, leakage at or below 51.7 gpm would have little or no effect on cooling load flow. The NRC staff finds that the licensee's proposed allowable leakage rate is

acceptable because it will provide sufficient time for corrective measures to be taken before significant increases in leakage erodes defense-in-depth, which could lead to adverse consequences.

3.2.8 Hardship Justification

The NRC staff finds that performing an ASME Code repair of the subject piping branch tee will require a plant shutdown which would unnecessarily cycle the unit, resulting in unnecessary transients, potential plant risk and personnel exposure. Therefore, the NRC staff determined that compliance with the specified ASME Code repair requirements would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

3.3 Summary

The NRC staff finds that the proposed alternative will provide reasonable assurance of structural integrity of the subject branch tee because: (1) Code Case N-513-4 addresses the NRC condition in RG 1.147, Revision 18, for Code Case N-513-3; (2) flaw evaluations for branch tees are based on acceptable methodologies; and (3) the method for determining the allowable leakage rate is adequate to provide early identification of a significant increase in leakage. In addition, complying with ASME Code, Section XI requirements would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

4.0 CONCLUSION

As set forth above, the NRC staff determined that the proposed alternative provides reasonable assurance that the structural integrity of the subject branch tee and its intended safety function will be maintained until the next scheduled refueling outage, and that complying with ASME Code, Section XI, would result in hardship or unusual difficulty without a compensating increase in the 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(z)(2). Therefore, the NRC staff authorizes the use of the proposed alternative described in the licensee's application until the end of the next refueling outage, which is scheduled to begin in spring 2020, or until the temporary acceptance criteria of Code Case N-513-4 are exceeded, or until the leak rate exceeds 51.7 gpm, whichever event occurs first.

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

The NRC staff notes that approval of this alternative does not imply NRC approval of ASME Code Case N-513-4 for generic use.

Principal Contributor: Robert Davis, NRR

Date: September 6, 2019

SUBJECT: VIRGIL C. SUMMER NUCLEAR STATION, UNIT NO. 1 – RELIEF REQUEST (RR-4-22) FOR USE OF ASME CODE CASE N-513-4 (EPID L-2019-LLR-0030) DATED SEPTEMBER 6, 2019

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