SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

REGARDING PROPOSED ASME CODE ALTERNATIVE VEGP 3-ALT-16

ALTERNATIVE REQUIREMENTS FOR ASME SECTION III REMEDIATION OF

CONTAINMENT VESSEL UNISTRUT WELDING

SOUTHERN NUCLEAR OPERATING COMPANY

GEORGIA POWER COMPANY

OGLETHORPE POWER CORPORATION

MEAG POWER SPVM, LLC

MEAG POWER SPVJ, LLC

MEAG POWER SPVP, LLC

CITY OF DALTON

VOGTLE ELECTRIC GENERATING PLANT UNIT 3

DOCKET NUMBER 52-025

1.0 INTRODUCTION

By letter dated June 3, 2021 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML21154A210), as supplemented by letter providing responses to an U.S. Nuclear Regulatory Commission (NRC) request for additional information (RAI), dated July 2, 2021 (ADAMS Accession Nos. ML21183A174), Southern Nuclear Operating Company, Inc. (SNC, the licensee) requested NRC approval of an alternative, pursuant to Section 50.55a(z)(1) of Title 10 of the *Code of Federal Regulations* (10 CFR), to the requirements of American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), Section III, for remediation of unqualified welds on the containment vessel (CV). The proposed alternative would allow SNC to mechanically remove six pieces of Unistrut material, grind twelve unqualified welds flush with the CV wall, and leave unqualified weld metal on the inside surface of the CV for the life of the plant at Vogtle Electric Generating Plant (VEGP), Unit 3.

2.0 REGULATORY EVALUATION

10 CFR 50.55a(a)(1)(i), approves, by incorporation by reference, Section III of the ASME Code.

The VEGP Unit 3, Updated Final Safety Analysis Report (UFSAR), Section 3.8.2.2, specifies that the CV is constructed in accordance with the 2001 edition of the ASME Code, Section III, Subsection NE, “Metal Containment,” including the 2002 Addenda.

Per 10 CFR 50.55a(z), 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. In proposing alternatives, the licensee must demonstrate that: (1) the proposed alternative would provide an acceptable level of quality and safety; or (2) compliance would result in hardship or unusual difficulty without a compensating increase in quality and safety.

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

3.0 TECHNICAL EVALUATION

3.1 SNC's Alternative

Applicable ASME Code Edition and Addenda

ASME Code, Section III, 2001 Edition, including the 2002 Addenda

Applicable ASME Code Requirements

ASME Code, Section III, Subsection NCA, paragraph NCA-3131, "Welding During Construction for Divisions 1 and 2," requires that field welding during construction be performed by a certificate holder. NCA-3131 allows the certificate holder to engage contract welders, provided that the conditions of NCA-3131(a)-(g) are met. The conditions of NCA-3131(a)-(g) contain various requirements that promote quality assurance and specify that ASME Code compliance is the responsibility of the certificate holder. In addition, welding procedures shall be properly qualified by the certificate holder, and the welders and welding operators are qualified by the certificate holder to perform such welding using these procedures.

ASME Code, Section III, Subsection NE, paragraph NE-4321, "Welding Qualifications, Records, and Identifying Stamps - Required Qualifications," states that each certificate holder is responsible for the welding done by his organization to join permanent or temporary attachments to pressure parts and to make permanent or temporary tack welds, and the procedures and the testing shall be as required by Article NE-4000 in order to qualify both the welding procedures and the performance of welders and welding operators who apply these procedures.

ASME Code, Section III, Subparagraph NE-4323, "Welding Prior to Qualifications," requires that no welding shall be undertaken until after the welding procedures which are to be used have been qualified and that only welders and welding operators who are qualified in accordance with NE-4320 and ASME Code, Section IX, shall be used.

ASME Code, Section III, Subsection NE, paragraph NE-4331, "Conformance to Section IX Requirements," requires all welding procedure qualification tests shall be in accordance with the requirements of ASME Code, Section IX, as supplemented by the requirements of Article NE-4000.

ASME Code, Section III, Subsection NE, paragraph NE-4411, “Identification, Storage, and Handling of Welding Materials,” requires certificate holders to maintain proper control of welding electrodes used in the fabrication and installation of components. Proper control consists of adequate identification, storage, and handling of welding materials.

ASME Code, Section III, Subsection NE, paragraph NE-4435, “Welding of Nonstructural and Temporary Attachments and Their Removal,” states that nonstructural attachments may be welded to the CV provided the requirements of NE-4435(a)(1)-(4) are met. The conditions of NE-4435(a)(1)-(4) require that welders and procedures are qualified, the base material and filler metal are compatible, and that welds are postweld heat treated (PWHT) according to the requirements of NE-4620, “Postweld Heat Treatment.” NE-4435(b) states that temporary attachments may be removed according to the requirements of NE-4211.

ASME Code, Section III, paragraph NE-4610, “Welding Preheat Requirements,” requires materials to be preheated prior to welding if required by the qualified welding procedure specification. In addition, ASME Code, Section III, paragraph NE-4620, “Postweld Heat Treatment,” requires all welds to be PWHT, unless exempted by subparagraph NE-4622.7. For welding on the VEGP Unit 3, CV, preheat of 200 °F is required to exempt PWHT.

ASME Code, Section III, Subsection NE, paragraph NE-4620, provides various guidance and requirements for postweld heat treatment. NE-4622.7(b) states that all welds shall be PWHT unless a preheat is applied. For welding to the VEGP Unit 3, CV material, a preheat of 200 °F is required to exempt PWHT.

Noncompliant Welding on the VEGP Unit 3, Containment Vessel

After completion of the construction of the VEGP Unit 3, CV and the application of the N-Certificate Holder's ASME Certification Mark to indicate all requirements of ASME Code, Section III, have been met for the CV, a contractor that was not the “N-Certificate” holder nor was contracted by the N-Certificate holder performed welding of six pieces of 12 gauge Unistrut material (SA 516 Grade 60/70) to the inner surface of the CV at three different locations (two pieces at each location). Two partial penetration fillet welds (4 inches long by 1/4 to 3/8-inch thick) were used to attach each piece of Unistrut material to the CV inner surface for a total of 12 unqualified fillet welds. As a result of this activity, SNC was out of compliance with the above ASME Code, Section III, requirements.

Proposed Alternative

In letter dated June 3, 2021, SNC submitted proposed alternative VEGP 3-ALT-16 in accordance with 10 CFR 50.55a(z)(1). The licensee proposed the following actions to be performed by the N-Certificate holder, Chicago Bridge and Iron Company (CB&I), to demonstrate an acceptable level of quality and safety.

- Mechanically cut and remove the Unistrut material from the CV inner surface.

- Grind the welds flush with the CV inner surface, leaving some amount of unqualified weld material on the inner surface of the CV for the life of the plant.

- Perform ultrasonic digital thickness measurements prior to and after grinding the weld flush to verify minimal wall thickness is still in compliance with the ASME Code, Section III.

- Perform liquid penetrant and magnetic particle examinations using a direct current (DC) yoke technique to identify potential discontinuities, evaluate the discontinuities, and remove any unacceptable flaws in accordance with ASME Code, Section III.

- Perform vacuum box testing to verify that no leak paths have been introduced to the CV shell.

- Prepare welded coupons to simulate unqualified welding performed on the CV.

- Perform Charpy impact and metallurgical testing to demonstrate that the unqualified weld material is compatible with the CV material and has no detrimental effect on the CV material including fracture toughness.

- Document the remediation activities on an N-10A Data Report in accordance with ASME Code Case N-802, "Rules for Repair of Stamped Components by the N Certificate Holder That Originally Stamped the Component, Section III, Division 1," and this alternative request.

The welding and testing records are included as Enclosures 2 and 3 of the licensee's letter dated June 3, 2021. The licensee performed welding of test coupons and associated testing for two cases: welding with 150 °F preheat and without preheat. The 150 °F preheat was used because it is consistent with the typical welding parameters of the unqualified organization's welding procedures. Select welding details from those records are summarized in Table 1.

Table 1: Welding Details Extracted from Enclosures 2 and 3

Welding Process	Shielded Metal Arc Welding
Base Materials	SA738 Grade B to SA 516 Grade 60/70
Thickness	1.125 in.
Preheat	Enclosure 2 – None Enclosure 3 – 150 °F minimum
Electrode Material	E7018
Passes	25
Amps	No Preheat – 101-103 With 150°F Preheat – 99-102
Volts	No Preheat – 21.3-23.8 With 150°F Preheat – 21.1-25.3
Travel Speed	No Preheat – 3.5-11.4 in./min With 150 °F Preheat – 3.4-10.4 in./min
Welding Position	2G (Horizontal)
Heat Input	No Preheat – 12.4-39 kJ/in. With 150 °F Preheat – 13.1-43.8 kJ/in.
Ultimate Tensile Strength (failure at weld)	No Preheat – 80 ksi With 150 °F Preheat –77 ksi
Charpy Impact Testing Temperature	-30 °F
Charpy Impact Energy, Base Metal SA738 Grade B	From Previous Material testing (240 ft-lbs at –58.5 °F)
Charpy Impact Energy, Heat Affected Zone SA738 Grade B	No Preheat – 111.6-130.77 ft-lbs With 150 °F Preheat – 111.77-145.97 ft-lbs
Charpy Impact Energy, Weld Metal	No Preheat – 66.18-98.51 ft-lbs With 150 °F Preheat – 99.5-107.63 ft-lbs

In addition to the details described in Table 1, SNC provided a macrograph of the polished and etched weldment for both the 150 °F minimum preheat and no preheat cases. SNC stated that the heat affected zone width was 1.1-3.0 mm when 150 °F minimum preheat was applied and 1.5-3.75 mm for no preheat.

3.2 NRC Staff Evaluation

The ASME Code of Record for the construction of VEGP Unit 3, CV is the 2001 Edition including the 2002 Addenda of ASME Code, Section III, which requires a qualified welder and welding procedure in accordance with Section III and IX of the ASME Code to be used to weld permanent or temporary attachments to the CV. In addition, ASME Code, Section III, requires a minimum preheat of 200 °F to exempt the weld from PWHT. Since neither a qualified welding procedure nor a qualified welder was used to weld the Unistrut material to the CV, the licensee performed testing to simulate the welding process used by the unqualified welder. Since welding of the Unistrut material was not documented, the licensee used typical welding parameters of the unqualified organization's welding procedures, along with no preheat to bound the most conservative condition since welding records were not available. The licensee also used the material for the CV (SA-738 Grade B) and the equivalent Unistrut material (SA-516 Grade 60/70) to simulate the welding performed on the CV.

The NRC staff's review focused on the simulated weld coupons and the associated testing performed to justify that the unqualified welding had no detrimental effect on the CV material, including fracture toughness, as well as the remediation plan to remove most of the unqualified weld metal.

Simulated Weld Coupons

The N-Certificate holder for the CV, CB&I, performed two weld coupons using the same welding process (manual shielded metal arc welding) and filler metal as used for welding the Unistrut to the CV. The welding parameters used were from a typical welding procedure from the unqualified contractor. The weld coupons consisted of plates using the same CV material, SA-738 Grade B, and the equivalent material (SA-516 Grade 60/70) for the Unistrut material. The NRC staff agrees that the SA-516 material used in lieu of the Unistrut material (A1011 Grade 33) is categorized as the same P-Number and Group Number in Section IX of the ASME Code as the Unistrut material, and therefore is an acceptable representation of the material welded on the CV. The plates were 1-1/8 inch thick and were welded utilizing 3/32 inch E7018 electrode from the same heat and lot used by the contractor to weld the Unistrut to the CV inner surface. One weld coupon was welded using a preheat of 150 °F to simulate the typical welding procedure from the unqualified contractor, and another weld coupon welded with no preheat as a bounding case since preheat was not documented during the welding of the Unistrut to the CV. Based on the material used, the NRC staff agrees that the weld coupons are sufficiently representative of the base materials and filler metal of the actual welds on the CV, and that the weld coupon with no preheat is bounding for the unqualified Unistrut welds.

Testing Results of the Weld Coupons

The weld coupons were tested in accordance with Section III and IX of the ASME Code, and included tensile testing, Charpy V-notch testing, and metallographic examination of the welds to characterize weld penetration and heat affected zone depth.

The Charpy V-notch test results demonstrated that the fracture toughness of 111 ft-lbs for the CV heat affected zone (HAZ) met the minimum required fracture toughness value of 40 ft-lbs. with considerable margin. The initial fracture toughness of 240 ft-lbs for the CV base material is very high to account for welding, so that the minimum fracture toughness of welded joints can still meet the required minimum fracture toughness. Therefore, the NRC staff concludes that the welding would not have detrimental effects on the necessary fracture toughness of the CV material. The fracture toughness for the E7018 weld (66 ft-lbs) also met the minimum required fracture toughness of 40 ft-lbs, and therefore the NRC staff concludes that, after grinding, any remaining embedded weld metal will have no detrimental effect on the fracture toughness of the CV.

The metallographic examination was used to quantify the depth of the HAZ in the CV base material caused by welding, which was determined to range from 1.5 mm to 3.75 mm for the weld coupon with no preheat applied. In addition, the NRC staff noted that based on the dimension of the weld joint and the metallographic photos of the weld, the depth of weld penetration could be quantified to be approximately 3 to 4 mm deep. This depth of penetration would be conservative since the weld coupons were full penetration 1-1/8 inch thick plates that would require more welding than the ¼ to 3/8 inch thick fillet welds used on the VEGP Unit 3 CV. Therefore, the amount of weld metal that would remain in the 1-¾ inch thick CV after the remediation plan to grind the weld flush would be minimal. Based on the acceptable fracture toughness of the weld and the CV HAZ, there is reasonable assurance that the minimal amount of weld remaining on the inner surface of the CV would not affect the ability of the CV to perform its safety function.

Although the tensile test results of 77 and 80 ksi for the weld coupons were below the minimum tensile strength of 85 ksi of the SA-738, Grade B material; this would be expected since the filler metal (E7018) used during welding has a minimum tensile strength of 70 ksi. Since the tensile test broke in the weld material, and not in the heat affected zone of the SA-738, Grade B material, it is reasonable to conclude that the welding did not have a significant detrimental effect on the base material tensile strength. In addition, the remediation plan will remove most of the weld metal with a potential of only 3 to 4 mm weld metal remaining in the CV. With only a minimal amount of weld metal (both in depth and area) remaining in the CV, there is reasonable assurance the CV will withstand its intended design loads and maintain its structural integrity.

Remediation Plan to Remove Unqualified Weld

SNC proposed to mechanically remove the Unistrut material from the CV inner surface, thereby treating the Unistrut as a temporary attachment under the rules of ASME Code, Section III, Subsection NE, NE-4435(b). In addition, any unqualified weld material left after mechanical removal of the Unistrut will be ground flush with the CV inner surface. This is acceptable to the NRC staff because mechanical removal of the Unistrut and partial removal of the associated weld material does not present any significant adverse impacts on the CV material and restores the configuration of the CV.

SNC proposed to grind any unqualified weld material left after mechanical removal of the Unistrut flush with the CV. During welding of the Unistrut, the weld material penetrated and mixed with the CV base metal. Although trace amounts of unqualified weld material would be left in place, the metallurgical testing presented in Enclosures 2 and 3 of the licensee's letter dated June 3, 2021, provides evidence of the relatively small penetration of the unqualified weld material into the CV base metal, and acceptable fracture toughness. Therefore, the staff finds

that the remaining unqualified weld material will not have detrimental effects on the ability of the CV to perform its safety function.

SNC proposed to perform ultrasonic thickness measurements of the CV both before grinding and after grinding. This operation ensures that the CV wall maintains the design thickness at the unqualified weld locations after the cutting and grinding operations. The NRC staff finds the performance of ultrasonic thickness measurements acceptable because it will provide assurance of compliance with minimum wall thickness requirements in accordance with ASME Code, Section III.

SNC proposed to perform both liquid penetrant and magnetic particle examination in accordance with Subsection NE of ASME Code, Section III, (2001 Edition with 2002 Addenda) and Articles 6 and 7 of ASME Code, Section V, (2001 Edition with 2002 Addenda) to investigate the potential for discontinuities as a result of the unqualified welding. The staff notes that Subsection NE of ASME Code, Section III, provides the rules for examination of CVs and Articles 6 and 7 of ASME Code, Section V, provides rules for performing the proposed surface exams. Liquid penetrant examination is an acceptable method for detecting surface flaws and cracking. Since magnetic particle examination utilizing a DC yoke technique, as proposed in the alternative, provides some subsurface detection of flaws and cracking, this examination technique will be able to detect flaws in the unqualified weld and CV HAZ that remains in the CV. These examinations will provide sufficient information on any flaws in the weld and CV HAZ to allow the licensee to develop appropriate corrective actions. As stated in the licensee's response to NRC's RAI, dated July 2, 2021, discontinuities detected by these examinations will be dispositioned using the acceptance criteria in paragraph NE-5342 of ASME Code, Section III, for the magnetic particle examination and paragraph NE-5352 of ASME Code, Section III, for the liquid penetrant examination. The staff finds the use of the ASME Code, Section III, acceptance criteria acceptable because this approach maintains compliance with the VEGP Unit 3, UFSAR to ensure the removal of unacceptable fabrication defects that could initiate inservice degradation. The licensee also stated that detected flaws will be removed by mechanical methods such as grinding or buffing, followed by reperforming the examination and verifying the minimal wall thickness is met. The NRC staff finds the licensee's use of both the liquid penetrant and magnetic particle examination with DC yoke technique acceptable since it will provide assurance of detecting flaws in the remaining unqualified weld and HAZ and appropriately removing flaws that do not meet ASME Code, Section III.

The alternative also proposed to perform vacuum box testing after removal of the Unistrut material and grinding flush of the remnant weld. This testing allows the licensee to determine if a leak path was introduced in the CV during the unqualified welding and the subsequent remediation activities. This testing would only provide leak path information on the current state of the weld after the remediation activities. The NRC staff finds vacuum box testing acceptable for finding localized leak path caused by the unqualified welding or remediation activities. Other activities proposed by the SNC alternative, such as the nondestructive examinations and weld coupon testing, already provided a basis that the trace amount of weld metal remaining will not have detrimental effects on the CV material or its ability to perform its safety function.

SNC also proposed in the alternative that the remediation activities performed on the VEGP Unit 3, CV would be documented on an N-10A Data Report in accordance with ASME Code Case N-802 and this alternative request. The NRC staff finds this acceptable since the specific activities performed on the CV will be documented in accordance with an established record and retained for the life of the plant in accordance with ASME Code, Section III.

Summary

The NRC staff reviewed the information provided and finds that SNC has demonstrated, as described above, that the proposed alternative provides an acceptable level of quality and safety because the weld coupon testing and remediation plan to remove the unqualified weld on the VEGP Unit 3, CV: (1) demonstrated that the unqualified welding would not have detrimental effects on the fracture toughness of the CV material, (2) provides reasonable assurance that the minimal amount of weld to remain on the inner surface of the CV would not affect the CV integrity to perform its safety function, and (3) provides assurance of detecting flaws in the remaining unqualified weld and HAZ and removing these flaws that do not meet ASME Code, Section III.

4.0 CONCLUSION

As set forth above, the NRC staff determines that the proposed alternative to the requirements of the 2001 Edition, including the 2002 Addenda, of ASME Code, Section III, Articles NCA-3000, NE-4300, NE-4400, and NE-4600 provides an acceptable level of quality and safety in accordance with 10 CFR 50.55a. Accordingly, the staff concludes that the licensee has adequately addressed all of the regulatory requirements set forth in 10 CFR 50.55a(z)(1), and otherwise is in compliance with the applicable ASME Code requirements. Therefore, the staff authorizes VEGP 3-ALT-16 for the remediation of unqualified welding of Unistrut on the VEGP Unit 3, CV. All other requirements of ASME Code, Sections III and XI, and 10 CFR 50.55a, for which an alternative has not been specifically requested and authorized, remain applicable.

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