SAFETY EVALUATION BY THE OFFICE OF NEW REACTORS

RELATED TO AMENDMENT NO. 36

VIRGIL C. SUMMER NUCLEAR STATION, UNITS 2 AND 3

DOCKET NOS. 52-027 AND 52-028

1.0 Introduction

By letters dated August 24, 2015 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML15236A344), as supplemented on September 23 (ADAMS Accession No. ML15266A459) and October 1, 2015 (ADAMS Accession No. ML15274A519), the South Carolina Electric & Gas Company (licensee) requested that the U.S. Nuclear Regulatory Commission (NRC) amend Combined License (COL) Numbers NPF-93 and NPF-94 for Virgil C. Summer Nuclear Station (VCSNS) Units 2 and 3.

License amendment request (LAR) 15-08, as supplemented, consists of changes to the Updated Final Safety Analysis Report (UFSAR) in the form of departures from the incorporated Design Control Document (DCD) Tier 2* and associated Tier 2 information. The proposed changes are to demonstrate that the capacity of mechanical couplers (couplers) welded to structural steel embedded plates required by American Concrete Institute (ACI) 349-01, “Code Requirements for Nuclear Safety Related Concrete Structures,” is satisfied using American Institute of Steel Construction (AISC) N690-1994, “Specification for the Design, Fabrication, and Erection of Steel Safety-Related Structures for Nuclear Facilities,” analysis and testing provisions. LAR 15-08, as supplemented, contains the analytical and testing methods to confirm the acceptability of couplers with combined partial joint penetration (PJP) and reinforcing fillet welds.

The NRC staff issued a *Federal Register* notice of consideration of issuance of a license amendment, a proposed No Significant Hazard Determination, and an opportunity to request a hearing and petition for leave to intervene on September 3, 2015 (80 FR 53336). The supplements to the license amendment request, dated September 23 and October 1, 2015, provided additional information that did not change the scope or the conclusions of the proposed No Significant Hazard Determination.

2.0 Regulatory Evaluation

Title 10 of the *Code of Federal Regulations* (10 CFR), Part 50, “Domestic Licensing of Production and Utilization Facilities,” Appendix A, “General Design Criteria for Nuclear Power Plants,” General Design Criterion (GDC) 1, “Quality Standards and Records,” requires that structures, systems, and components important to safety shall be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed.

10 CFR Part 50, Appendix A, GDC 2, “Design Bases for Protection Against Natural Phenomena,” requires that structures, systems, and components important to safety shall be designed to withstand the effects of natural phenomena such as earthquakes, tornadoes, hurricanes, floods, tsunami, and seiches without loss of capability to perform their safety functions.

10 CFR Part 50, Appendix A, GDC 4, “Environmental and Dynamic Effects Design Bases,” requires that structures, systems, and components important to safety shall be designed to accommodate the effects of and to be compatible with the environmental conditions associated with normal operation, maintenance, testing and postulated accidents, including loss-of-coolant accidents.

10 CFR Part 52, “Licenses, Certifications, and Approvals for Nuclear Power Plants,” Appendix D, “Design Certification Rule for the AP1000 Design,” Sections VIII.B.5.a and VIII.B.6 require prior NRC approval for changes to Tier 2* information that meet certain criteria specified in Section VIII.B.5. The proposed changes affect some information designated as Tier 2*. Accordingly, the changes require NRC’s approval.

10 CFR 50.90 requires, in part, that an application for an amendment follow as far as applicable, the form prescribed for the original application. Accordingly, the LAR must follow 10 CFR 52.79(a)(41), which requires an evaluation of the design against the Standard Review Plan (SRP), including the difference in analytical techniques of the proposed design and the corresponding techniques given in the SRP acceptance criteria.

3.0 Technical Evaluation

3.1 Evaluation of Proposed Changes

The VCSNS UFSAR, Subsection 3.8.4.5 establishes that the analysis and design of concrete structures conform to ACI 349-01, and the analysis and design of structural steel conform to AISC N690-94. Both ACI 349-01 and AISC N690-94 provide design requirements for the reinforcing bar (rebar), coupler, and connection weld system discussed in the LAR. The mechanical connection of the rebar to the coupler is governed by ACI 349-01, which provides strength requirements to ensure adequate ductility in mechanical connections. Per ACI 349-01, Section 12.14.3.4, “A full mechanical connection shall develop in tension or compression, as required, at least 125% of specified yield strength, f_y, of the bar.” As stated in the LAR, this ACI 349-01 requirement for the mechanical connection has been applied to the coupler weld to demonstrate that the coupler weld is stronger than the rebar, therefore ensuring that the system will function as intended. The coupler weld is governed by AISC N690-94 and American Welding Society (AWS) D1.1-2000, “Structural Welding Code – Steel.” The design function of the rebar, coupler, and connection weld system is to transmit loads from structural steel to reinforced concrete.

During an inspection, test, analysis, and acceptance criteria inspection, an NRC inspector identified that the licensee inappropriately applied load directionality provisions in Section 2.14 of AWS D1.1-2000 for fillet weld capacity for the couplers. To address this issue, the licensee proposed to depart from Tier 2* and associated Tier 2 information in the UFSAR to specify the ACI 349-01, Section 12.14.3.4 required capacity for coupler welds, and to describe how the required capacity is achieved without the use of the directionality provisions. The LAR specifically addresses the connection welds (i.e., the combined PJP and reinforcing fillet weld) associated with the LENTON C2/C3J type coupler manufactured by ERICO. This type of coupler is used in containment internal structures, other seismic Category I structures, and the seismic Category II portion of the annex building located adjacent to the nuclear island.

The NRC staff considered UFSAR Section 3.8, “Design of Category I Structures” in performing the technical evaluation. The staff also reviewed portions of NUREG–1793, Supplement 2, “Final Safety Evaluation Report Related to Certification of the AP1000 Standard Plant Design” (ADAMS Accession No. ML112061231), and the “Final Safety Evaluation Report for the Combined Licenses for Virgil C. Summer Nuclear Station, Volumes 1-3,” (ADAMS Accession Nos. ML13275A125, ML13275A126, ML13275A127), which document the staff’s technical evaluation of the relevant aspects of the AP1000 DCD and VCSNS UFSAR, respectively. The requested change is related to the qualification of the connection weld capacities for couplers used where rebar attached to structural steel. The NRC staff’s review focused on the testing and analysis performed to justify the Westinghouse Electric Company’s (WEC) design specifically in regard to the size of the reinforcing fillet welds. On September 15, 2015, the staff had a phone call with WEC. The staff communicated that AISC N690-94 Section Q1.0.1 is the governing code section that should be referenced in the LAR in place of AISC N690-94 Section Q1.22.2.1.2. The licensee addressed these comments in its supplement dated September 23, 2015.

3.1.1 Evaluation of Analytical Method: Coupler Welds for Reinforcing Bar Sizes #4, #5, and #6

The licensee demonstrated the adequacy of the coupler welds for rebar sizes #4, #5, and #6 by performing calculations without considering the provisions related to the directionality of loading to demonstrate acceptable connection weld capacities in accordance with AISC N690-1994 under demand calculated in accordance with ACI 349-01 requirements. Specifically, the licensee determined the capacity of these coupler welds based on a stress limit coefficient (SLC) of 1.6 in accordance with AISC N690-94, Section Q1.5.7.

The NRC staff reviewed Table Q1.5.7.1 in Section Q1.5.7 and confirmed that this table permits the use of SLCs of 1.6 and 1.7 for loading conditions, including seismic loading, which are applicable to the connection welds. Therefore, on the basis that the licensee used a SLC permitted by Table Q1.5.7.1, the staff finds that the use of a SLC of 1.6 is acceptable. In addition, on August 26, 2015, the NRC staff performed an audit at the WEC office located in Rockville, Maryland (ADAMS Accession No. ML15289A106) for the Vogtle Electric Generating Plant, Units 3 and 4 (Reference 4). Based on the similarities between the Vogtle and Summer license amendment requests, the staff finds that the findings of the audit are equally applicable to the Summer application. In the audit, the NRC staff reviewed the licensee’s calculation for the capacity of the welds associated with rebar sizes #4, #5, and #6, and confirmed these weld capacities to be higher than the ACI 349-01 125% of f_y of the rebar. Based on the above, the staff finds that the connection welds associated with the LENTON C2/C3J couplers for rebar sizes #4, #5, and #6 possess adequate capacity to meet the required strength in ACI 349-01, as referenced in the UFSAR, and are therefore acceptable.

3.1.2 Evaluation of Coupler Weld Testing Program: Coupler Welds for Reinforcing Bar Sizes #7, #8, #9, #10, and #11

The licensee performed two sets of testing, Phase I and Phase II, to demonstrate that the failure mode for the rebar, coupler, and connecting weld system always occurred in the rebar or mechanical (threaded) connection. Phase I testing consisted of six static and three cyclic specimens of each coupler size. Each specimen included the rebar, coupler, and coupler connection weld. Phase II testing was performed to determine the additional factor of safety for the coupler welds compared to the coupler system strength (i.e., the coupler, rebar and weld). The connection weld sizes used in testing were made equal to, or less than, the sizes specified on the drawings to prevent oversized welds.

The six static and three cyclic specimens tested during Phase I are required by ACI 349-01 Section 12.14.3.4.1. Specifically, this section requires that mechanical connections shall be qualified for use in construction on the basis that the six static and three cyclic performance tests demonstrate that the mechanical connection is capable of developing at least 125% of f_y of the rebar and that the static tensile strength are not adversely influenced by load cycling.

During the NRC staff's review of the static and cyclic test results for the Phase I testing, the NRC staff questioned why an additional test specimen was performed as a replacement. The applicant supplemented the LAR dated October 1, 2015, that the failure was on the side of the specimen that is not welded to the WEC design specification and, therefore, not being tested. WEC directed the licensee to perform an additional test since the failure of this specimen was below the required limit. The NRC staff finds this response acceptable since the first specimen failed on the side that was not being tested because it was used only for positioning the test specimen in the test fixture. The additional test specimen was tested to failure on the side that was welded to the WEC design specifications, and provided the actual strength of the weld sized to the WEC design specifications which met the requirements of ACI 349-01.

The licensee performed its Phase II testing as permitted by AISC N690-94, Sections Q1.0.1 and Q1.22.2 to demonstrate the adequacy of the coupler welds for rebar sizes #7, #8, #9, #10, and #11. Consistent with these sections, testing as an alternative to the AISC design provisions can be accepted on a case-by-case basis. Specifically, Section Q1.0.1 states that the engineers of any system of design or construction within the scope of AISC N690-94, which does not conform to or is not covered by it, shall have the right to present the data on which their design is based to the regulatory authority for review and approval. Further, Section Q1.22.2 permits, in the context of embedments, the use of design limits less conservative than those in AISC N690-1994 if substantiated by experimental or detailed analytical investigation.

The Phase II test specimens were specifically manufactured to isolate the failure to the coupler welds, thereby providing test results which represent the WEC design and the current production welds. Ten tensile test specimens for each of the #7, #8, #9, #10, and #11 sized couplers were created, providing a total of fifty tensile test specimens. Ten additional tensile test specimens for each of the #9 and #11 sized couplers were created for the Phase II testing. These additional twenty specimens were to re-disposition previous nonconformance reports (NCRs) for undersized welds that were smaller than the WEC design specification. The licensee's Phase II testing program was performed at the VCSNS site by WEC and Chicago Bridge and Iron, the contractor for both Vogtle Electric and Generating Plant and VCSNS.

The NRC staff performed an onsite inspection at VCSNS on July 28, 2015 and July 29, 2015, to review Phase II test specimen preparation and testing in support of the review for the LAR. The staff's onsite inspection activities focused on all aspects of test specimen fabrication and testing to verify that the data derived from the test specimens were adequately representative of the weld population in service per the WEC design specifications. The NRC staff also ensured that specimen preparation was done in accordance with applicable codes and standards.

The NRC staff reviewed the applicable weld procedure specification (WPS), and supporting procedure qualification records (PQRs) to determine whether the welding activities were performed in accordance with the design specifications, design drawings, AWS D1.1-2000, and AWS D1.4-1998, "Structural Welding Code – Reinforcing Steel." The staff reviewed the certified material test reports (CMTRs) for the filler metal, base metal, couplers, and rebar to determine whether the material was procured in accordance with WEC design specifications. The NRC staff reviewed the welder qualification records to determine whether the welders performing the activities were qualified in accordance with the applicable AWS D1.1-2000 and AWS D1.4-1998 requirements as were used in production. The staff finds that the WPS, PQRs, CMTRs, and welder qualifications for the testing program are in accordance with the applicable codes, standards, and specifications. During observation of the in-process welding, the NRC staff verified that welding parameters such as voltage, amperage, shielding gas, and preheat and interpass temperatures were in accordance with the applicable WPS. Additionally, the NRC staff verified that the welding parameters were correctly recorded on weld travelers. The NRC staff also reviewed the licensee's weld filler metal control process to verify the traceability of the filler material used for each weld. The NRC staff finds the in-process welding and weld filler metal control process to be acceptable because they were in accordance with the applicable WPS and procedures.

During the onsite inspection, the NRC staff reviewed the welding package and test plan with licensee and WEC staff. The NRC staff observed in-process gas tungsten arc welding (GTAW) on several specimens in the flat, horizontal, and overhead positions. The licensee and WEC updated their test plan to incorporate the three welding positions due to feedback from the NRC staff at the July 16, 2015 public meeting as welding in the flat position alone might not be representative of welding performed in production. The staff finds the licensee's change to the test plan incorporating flat, horizontal, and overhead welding positions acceptable since it is representative of production welding.

The welding process used by the license for the test specimens was GTAW. Furthermore, the LAR states, in part, that, "The GTAW process is used for many of the production welds. However, other processes are also used for production welds." In the supplement to the LAR, dated October 1, 2015, the licensee's response states that approximately 60% of the coupler welds were made using GTAW; 25% were made using flux core arc welding; 10% were made using gas metal arc welding; and 5% were made using shield metal arc welding. The licensee also stated that GTAW was selected to closely control the weld size, which was the critical parameter being investigated as part of the Phase II testing. The staff finds the licensee's use of only GTAW to fabricate test specimens acceptable because GTAW is the welding method used for the majority of the production welds, the test welds were representative of the design drawings with accurate weld sizes, and the test results will be representative of the in-service weld population. Furthermore, the use of qualified welders, processes, and procedures provides reasonable assurance that each welding process produces adequate welds with similar material properties.

The NRC staff performed a direct inspection of a licensee inspector performing visual testing on final welded couplers. The NRC staff verified that the licensee inspector ensured that the weld size conformed to the WEC drawing and final weld acceptance criteria using suitable gages in accordance with AWS D1.1-2000 and licensee procedures. The NRC staff reviewed the qualifications of each licensee inspector to ensure that they are qualified to AWS D1.1-2000 and AWS D1.4-1998. The NRC staff also reviewed training and equipment calibration records to verify that personnel installing rebar into the couplers were qualified in accordance with project requirements, and the equipment being used for this work was properly calibrated.

The NRC staff directly observed tensile testing of specimens and reviewed the applicable tensile test procedures. The NRC staff noted that one of the tensile test specimens observed had a defect located in the weld. However, this tensile test specimen did not have a failure stress that was significantly different than similar sized couplers, which provided further assurance to the NRC staff that the proposed WEC design specification weld sizes are adequate.

The tensile testing for Phase II was performed at ambient temperatures. The NRC staff questioned the licensee regarding testing at ambient temperatures to ensure that the test results would be representative of in-service welds that are subject to different temperatures. To address the NRC observation, the licensee provided information in the supplement to the LAR dated October 1, 2015, that the minimum specified impact energy levels for the weld filler metal are based on AWS A5 requirements. AISC N690-1994 requires that "the Charpy V-notch impact test shall be conducted at a temperature not less than 30°F below the lowest service metal temperature of the structural component." The requirement to test 30°F below the metal's lowest service temperature assures ductile performance at the lowest service temperature. The licensee states that filler metal procured meets the 30°F below the lowest service metal temperature of the structural component requirement. The NRC staff finds the Phase II tensile testing of the coupler welds at ambient temperature acceptable since additional requirements during procurement ensure ductility for material that is subject to different service temperatures.

Overall, the staff finds that WEC and the licensee's fabrication and testing methods produce specimens that are adequately representative of the weld population being put into service. Therefore, the staff has reasonable assurance that the data derived from the test specimen population is adequately representative of the weld population.

3.1.3 Evaluation of Test Results: Coupler Welds for Reinforcing Bar Sizes #7, #8, #9, #10, and #11

For the Phase I testing, the licensee indicated that the 90%/95% confidence interval (i.e., 90% probability that the calculated limits contain 95% of the population) break strength observed from this testing exceeds 125% of f_y (75 ksi) of the rebar, and 100% of the specified tensile strength (90 ksi) of the rebar. The staff notes that in all cases the limiting break strengths were due failure of the rebar or mechanical (threaded) connection of the rebar. The NRC staff finds the licensee's results for the Phase I testing acceptable because the test assembly weld design was representative of the WEC design and exceeds, as demonstrated by both the static and cyclic test results, 125% of f_y of the rebar in accordance with the applicable sections of ACI 349-01. Additionally, the staff notes that the performance of six static and three cyclic tests was consistent with the requirements in ACI 349-01, Section 12.14.3.4.1 related to the qualification of mechanical connections.

In the supplement to the LAR dated October 1, 2015, the licensee summarized its analysis demonstrating that at the ACI 349-01 125% of f_y of the rebar, the coupler weld would remain in a linear elastic stress state. This demonstration provides assurance that the coupler welds behave in a manner consistent with the intent of the ACI Code allowable stresses (i.e., linear elastic behavior at required strength levels) and included calculations and finite element analysis. During an NRC audit dated September 29, 2015 (Reference 4) at the Vogtle Electric Generating Plant, the staff reviewed the details of these calculations and analysis. Based on the similarities between the Vogtle and Summer license amendment requests, the staff finds that the findings of the audit are equally applicable to the Summer application. Based on the calculations, the #9 coupler weld was observed to be the highest stressed weld. The NRC staff's review of this analysis confirmed that the #9 coupler weld remains linear elastic at the ACI 349-01 125% of f_y of the rebar. Further, the NRC staff's review concluded that the calculation results for the other coupler weld sizes adequately demonstrate linear elastic behavior at the ACI 349-01 125% of f_y for the rebar.

Regarding the Phase II testing results, the LAR, as supplemented, contains the approach WEC and the licensee used to justify the additional factor of safety between the proposed static stress limit and the static ultimate strength of the weld. The specific test results and analysis were provided in two proprietary WEC technical reports.

During the August 26, 2015 audit (Reference 4), the NRC staff reviewed the two technical reports that contain the test data used in the LAR, as supplemented. The NRC staff reviewed and independently verified the licensee's methodology used to calculate factors of safety relative to 125% of f_y of the rebar and the upper confidence level results from the Phase I testing. The licensee provided additional information in the supplement to the LAR dated October 1, 2015, explaining their calculation of the 90%/95% confidence interval and the use of 125% of f_y for the rebar and the upper confidence level results from the Phase I testing.

Independent of the licensee's methodology, the staff reviewed the raw data provided by WEC to determine an acceptable factor of safety of the coupler weld compared to the rebar. For each coupler size, the staff used a 95%/95% lower bound value of the weld failure strength to compare with the ACI 349-01 125% of f_y of the rebar. The staff used a 95%/95% confidence interval for additional conservatism. The staff used these values as they were a direct comparison of the actual weld strength for each coupler size as opposed to the minimum required coupler strength by the ACI Code. The 95%/95% confidence interval gave the staff adequate assurance that the ten test specimens for each coupler size would bound the production weld strengths. Using the ACI Code values took into account the required design strengths. Using this method, the staff calculated factors of safety in a range between 2.11 and 2.77 for the five coupler sizes. Table 1 contains the factors of safety calculated for the five coupler sizes as well as the additional twenty specimens produced to re-disposition the NCRs.

Table 1: Factors of Safety Calculated by NRC Staff

Coupler Size	95%/95% lower bound, ksi [1]	1.25x Rebar Yield Code Value, ksi	Safety Margin
#7	109.5	45.0	2.43
#8	145.9	59.3	2.46
#9	158.4	75.0	2.11
#10	263.8	95.3	2.77
#11	308.3	117.0	2.63
Additional tests to re-disposition NCRs			
#9 (undersize)	158.5	75.0	2.11
#11 (undersize)	251.9	117.0	2.15
[1]: = (Mean) - 2.31*(Standard Deviation)			

These factors of safety demonstrate that, with a high degree of confidence and margin, the coupler welds possess much higher strength than the coupler rebar. The staff concludes that the factors of safety provide reasonable assurance that welds will not fail before the rebar under normal and accident conditions and are therefore adequate for fulfilling their intended functions.

Based on the applicant's use of testing, as permitted by AISC N690-94, Sections Q1.0.1 and Q1.22.2, and based on the factors of safety determined and verified by the NRC staff, the NRC staff finds that the Phase II testing demonstrates that adequate margin exists prior to weld failure consistent with the ACI 349-01 strength requirement and the system capacity determined by the Phase I testing.

3.1.4 Coupler Weld Evaluation for Disposition of Non-Conforming Fillet Weld Size for Module CA20

The LAR additionally identifies non-conforming ¼ inch fillet welds for #9 and #11 C3J couplers identified in module CA20. These weld sizes were undersized relative to applicable WEC design documents. To address the capacity of these non-conforming welds, as part of the Phase II testing, the licensee tested ten additional test specimens for each of the #9 and #11 coupler sizes. These test specimens used a ¼ inch fillet weld in order to confirm the consistency in the results regarding the adequate weld capacity.

For these non-conforming welds, the licensee also used the test results to determine factors of safety relative to the 125% of f_y of the rebar and the upper confidence level results from the Phase I testing, respectively. The tests demonstrated that the factor of safety between the weld 90%/95% lower confidence limit and the 125% of f_y of the rebar exceeds 1.3. The test also demonstrated that the factor of safety between the weld 90%/95% lower confidence limit and the 90%/95% upper confidence limit of the coupler system static tension test results exceeds 1.0.

The staff performed an independent review of the Phase II test results associated with the non-conforming welds and compared the 95%/95% lower bound value of the weld failure strength to the ACI 349-01 125% of f_y of the rebar. Based on this approach, the staff determined a minimum factor of safety of 2.11 for these non-conforming connection weld sizes. For the additional 20 specimens, the factors of safety determined and verified by the NRC staff provided further assurance to the NRC staff that the proposed WEC design specification weld sizes are adequate.

As stated in the LAR, the engineering disposition to accept these welds as-is was to perform an engineering evaluation through testing to see if the welds meet the minimum acceptance criteria of the design. These test results were only used to provide an engineering disposition of non-conforming welds described in the licensee's NCR for the #9 and #11 coupler size welds identified in module CA20, and are not used for future weld sizing. The staff finds the re-disposition of the #9 and #11 C3J couplers' non-conforming ¼ inch fillet welds acceptable in module CA20 as addressed by the NCR in this LAR, and not for future applications.

3.1.5 Licensing Basis Changes

In Enclosure 9 of the supplement to the LAR dated October 1, 2015, the licensee proposed changes to the UFSAR proprietary information, given in a non-proprietary manner in Enclosure 1 to the August 24, 2015 application supporting changes to the UFSAR. Specifically, the licensee proposed addition of the following Tier 2* and Tier 2 information to UFSAR Subsection 3.8.4.5.1, "Supplemental Requirements for Concrete Structures."

[Weldable coupler connections of rebar to structural steel shall develop 125% of the specified yield strength of the bar in accordance with ACI349-01 Section 12.14.3.4. Qualification of the C2/C3J coupler welds is demonstrated as follows:

For reinforcing bar sizes #4, #5, and #6, the coupler connection weld adequacy is demonstrated by calculations in accordance with AISC N690-1994 requirements using a stress limit coefficient (SLC) of 1.6.

For reinforcing bar sizes #7, #8, #9, #10, and #11, coupler connection weld adequacy is demonstrated through testing, as permitted by AISC N690-1994 Section Q1.0.1, and more specifically, Section Q1.22.2. Two sets of testing are performed to demonstrate that the strength of the reinforcing bar is the limiting feature of the coupler reinforcing bar splice and weld system:

> *(1) Six static tension tests are performed for each reinforcing bar size on samples of the coupler reinforcing bar splice and weld system, retaining the 90%/95% upper confidence limit of the coupler system static tension test results. Three cyclic tests are also performed as described in ACI349-01 12.14.3.4.1(b) to confirm that there is not significant coupler system degradation under cyclic demand.*
>
> *(2) Static tension testing of the coupler weld to failure using ten representative sample weld configurations from each of the five reinforcing bar coupler sizes is performed to determine the 90%/95% lower confidence limit weld capacity.*

The tests demonstrate that the factor of safety between the weld 90%/95% lower confidence limit and 125% of the specified yield strength of the reinforcing bar exceeds 1.4. The tests also demonstrate that the factor of safety between the weld 90%/95% lower confidence limit and the 90%/95% upper confidence limit of the coupler system static tension test results exceeds 1.0. The analyses and tests establish a minimum fillet reinforcement size for the C2/C3J couplers:

C2/C3J Coupler Size	*#4*	*#5*	*#6*	*#7*	*#8*	*#9*	*#10*	*#11*
Min. Fillet Weld Size (inches)	*1/4*	*1/4*	*1/4*	*1/4*	*1/4*	*5/16*	*1/4*	*3/8]*

The tests also demonstrate that non-conforming 1/4-inch fillet welds for #9 and #11 C3J couplers identified in module CA20 are acceptable by comparing the 90%/95% lower confidence limit weld strength to 125% of the specified yield strength of the rebar and to the 90%/95% upper confidence limit of the coupler system static tension test results. The factor of safety exceeds 1.3 in comparison to 125% of the specified yield strength of the rebar and 1.0 in comparison to the 90%/95% upper confidence limit of the coupler system.

The NRC staff reviewed the proposed changes and finds the proposed changes to be acceptable on the technical basis as set forth above, and because the additions provide clarity to the licensing basis. Moreover, the additions are acceptable because they are based on analysis and testing that are in accordance and permitted, respectively, by the design codes acceptable to the staff.

Summary

The staff reviewed the licensee's proposed changes provided in the LAR. Based on the staff's technical evaluation documented above, the staff finds that:

(1) The use of a SLC of 1.6 to be conservative and therefore acceptable for the determination of the capacity of the connection welds for rebar sizes #4, #5, and #6. The staff also finds the licensee's weld capacity calculations for these connection

welds to be in accordance with AISC N690-1994, and therefore acceptable.

(2) The fabrication and testing methods for the #7, #8, #9, #10, and #11 sized couplers produce specimens, and therefore data, that are adequately representative of the weld population being put into service.

(3) The licensee's methodology to determine acceptable factors of safety for the WEC design of the #7, #8, #9, #10, and #11 sized couplers is adequate. The staff concludes that the factors of safety provide reasonable assurance that welds will not fail before the rebar under normal and accident conditions, and therefore fulfill their intended functions. The staff also finds the licensee's method of calculating the factors of safety acceptable because the licensee demonstrated additional conservatisms to show that the rebar will fail before the weld.

(4) In accordance with AISC N690-1994, Sections Q1.01 and Q1.22.2, the staff reviewed the licensee's qualification of the connection welds associated with the LENTON C2/C3J couplers for rebar sizes #4, #5, #6, #7, #8, #9, #10, and #11, and concludes that the licensee successfully demonstrated adequate weld capacity by either analysis or testing. On this basis, the staff finds the following proposed fillet weld sizes acceptable:

C2/C3J Coupler Size	*#4*	*#5*	*#6*	*#7*	*#8*	*#9*	*#10*	*#11*
Min. Fillet Weld Size (inches)	*1/4*	*1/4*	*1/4*	*1/4*	*1/4*	*5/16*	*1/4*	*3/8*

(5) The testing of and factor of safety derived from the twenty additional #9 and #11 sized test couplers created in order to re-disposition the NCRs for undersized welds relative to the WEC design specification was determined to be acceptable. However, this approval does not grant the licensee permission to produce future undersized welds relative to the WEC design specification and revision to the UFSAR.

For the reasons specified above, the NRC staff finds that the proposed changes to UFSAR Subsection 3.8.4.5 are acceptable. Based on these findings, the NRC staff concludes that there is reasonable assurance that the requirements of GDC 1, GDC 2, and GDC 4 in Appendix A to 10 CFR Part 50 will continue to be met. Therefore, the staff finds the proposed changes to be acceptable.

4.0 <u>State Consultation</u>

In accordance with the Commission's regulations in 10 CFR 50.91(b)(2), the State of South Carolina official was notified of the proposed issuance of the amendment. The State official had no comments.

5.0 <u>Environmental Consideration</u>

The amendment changes a requirement with respect to installation or use of a facility component located within the restricted area as defined in 10 CFR Part 20, "Standards for Protection Against Radiation." The NRC staff has determined that the amendment involves no significant increase in the amounts, and no significant change in the types, of any effluents that may be released offsite, and that there is no significant increase in individual or cumulative occupational radiation exposure. The Commission has previously issued a proposed finding that the amendment involves no significant hazards consideration (80 FR 53336; published on September 3, 2015), and has now made a final finding that the amendment involves no significant hazards consideration. Accordingly, the amendment meets the eligibility criteria for categorical exclusion set forth in 10 CFR 51.22(c)(9). Pursuant to 10 CFR 51.22(b), no environmental impact statement or environmental assessment need be prepared in connection with the issuance of the amendment.

6.0 Conclusion

The Commission has concluded, based on the considerations discussed above, that: (1) the health and safety of the public will not be endangered by construction activities in the proposed manner; (2) such activities will be conducted in compliance with the Commission's regulations; and (3) the issuance of the amendment will not be inimical to the common defense and security or to the health and safety of the public.

8.0 REFERENCES

1. NND-15-0518, Virgil C. Summer Nuclear Station Units 2 and 3, "LAR 15-08 License Amendment Request: Supplemental Requirements for Mechanical Coupler Weld Acceptability," dated August 24, 2015 (ADAMS Accession No. ML15236A344)

2. NND-15-0567, Virgil C. Summer Nuclear Station Units 2 and 3, "LAR 15-08 S1 License Amendment Request: Supplemental Requirements for Mechanical Coupler Weld Acceptability," dated September 23, 2015 (ADAMS Accession No. ML15266A459)

3. NND-15-0572, Virgil C. Summer Nuclear Station Units 2 and 3, "LAR 15-08 S2 License Amendment Request: Supplemental Requirements for Mechanical Coupler Weld Acceptability," dated October 1, 2015 (ADAMS Accession No. ML15274A519)

4. Audit Report, "Summary of Vogtle Electric Generating Plant Units 3 and 4, Combined Licenses, Audit Related to Supplemental Requirements for Mechanical Coupler Weld Acceptability (LAR 15-010)," dated October 20, 2015 (ADAMS Accession No. ML15289A106)

5. American Concrete Institute, "Code Requirements for Nuclear Safety Related Concrete Structures," (ACI 349-01).

6. American Institute of Steel Construction, "Specification for the Design, Fabrication, and Erection of Steel Safety-Related Structures for Nuclear Facilities," (AISC N690-1994).

7. American Welding Society "Structural Welding Code – Steel," (AWS D1.1-2000).

8. American Welding Society "Structural Welding Code – Reinforcing Steel," (AWS D1.4-1998).

9. NUREG-1793, Supplement 2, Final Safety Evaluation Report Related to Certification of the AP1000 Standard Plant Design, dated August 5, 2011 (ADAMS Accession No. ML112061231).

10. Virgil C. Summer Nuclear Station Updated Final Safety Analysis Report (UFSAR), Revision 2, dated July 22, 2014 (ADAMS Accession No. ML14206A850).

11. AP1000 Design Control Document (DCD), Revision 19, dated June 13, 2011 (ADAMS Accession No. ML11171A500).

12. Virgil C. Summer Nuclear Station, “Final Safety Evaluation Report for the Combined Licenses for Virgil C. Summer Nuclear Station, Volumes 1-3,” (ADAMS Accession Nos. ML13275A125, ML13275A126, and ML13275A127).