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Southern Nuclear Operating Company
Vogtle Electric Generating Plant Units 3 and 4
Supplement to Request for License Amendment and Exemption Regarding
Hydrogen Venting from Passive Core Cooling System (PXS) Compartments (LAR-17-003S1)

Ladies and Gentlemen:

Southern Nuclear Operating Company, the licensee for Vogtle Electric Generating Plant Units 3 and 4, previously requested an amendment and exemption to Combined License (COL) Numbers NPF-91 and NPF-92 to revise the licensing basis information to reflect changes to the locations of the hydrogen venting primary openings in the passive core cooling system (PXS) valve/accumulator rooms inside containment. This requires changes to the Updated Final Safety Analysis Report (UFSAR) plant-specific Design Control Document (DCD) Tier 2 information, and involves changes to related plant-specific Tier 1 information. This request was provided by Southern Nuclear's letter ND-17-0264 dated February 22, 2017 [ADAMS Accession No. ML17053A425]. Pursuant to the provisions of 10 CFR 52.63(b)(1), an exemption from elements of the design as certified in the 10 CFR Part 52, Appendix D, design certification rule was also requested for the involved Tier 1 information. As noted in SNC's February 22, 2017 letter, the changes proposed in this license amendment request (SNC LAR-17-003) are consistent and identical in technical content with the South Carolina Electric and Gas Company (SCE&G) License Amendment Request (LAR 17-03) submittal [ML17046A660] on this topic.

Subsequent to the submittal of the SNC and SCE&G LARs, questions were asked of SCE&G by the NRC regarding statements in SCE&G LAR 17-03 that addressed the Finite Element Model used to evaluate the equipment hatch cover. SCE&G provided a written response to these NRC questions by letter dated May 18, 2017 [ML17138A385].

Because SNC LAR-17-003 is within the scope of the NRC questions regarding SCE&G LAR 17-03, SNC elects to provide a response to these questions that is consistent with the response provided by SCE&G in their May 18, 2017 letter. The SNC response to these NRC questions is found in Enclosure 6 of this letter, which supplements the original LAR-17-003. Enclosures 1 through 5 were provided in SNC letter ND-17-0264.

The information provided in Enclosure 6 clarifies the information provided in the original license amendment request (LAR-17-003), but does not change the scope of, nor affect the Technical Evaluation or the Significant Hazards Consideration determination in SNC's original license amendment request submitted on February 22, 2017.

This letter contains no regulatory commitments. This letter has been reviewed and confirmed to not contain security-related information.

In accordance with 10 CFR 50.91, SNC is notifying the State of Georgia of this LAR supplement by transmitting a copy of this letter and enclosure to the designated State Official.

Should you have any questions, please contact Ms. Amy Chamberlain at (205) 992-6361.

I declare under penalty of perjury that the foregoing is true and correct. Executed on the 24th of May 2017.

Respectfully submitted,

Brian H. Whitley
Director, Regulatory Affairs
Southern Nuclear Operating Company

Enclosures: 1) - 5) (previously submitted with SNC's original LAR, LAR-17-003, in SNC letter ND-17-0264)

6) Vogtle Electric Generating Plant (VEGP) Units 3 and 4, Changes to LAR-17-003 Regarding Hydrogen Venting from Passive Core Cooling System (PXS) Compartments (LAR-17-003S1)

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Southern Nuclear Operating Company

ND-17-0919

Enclosure 6

(Note that Enclosures 1 through 5 were provided with the original license amendment request, LAR-17-003, in SNC letter ND-17-0264)

Vogtle Electric Generating Plant (VEGP) Units 3 and 4

Changes to LAR-17-003 Regarding Hydrogen Venting from Passive Core Cooling System (PXS) Compartments

(LAR-17-003S1)

(This enclosure contains five pages, including this cover page.)

Southern Nuclear Operating Company, the licensee for Vogtle Electric Generating Plant Units 3 and 4, previously requested an amendment and exemption to Combined License (COL) Numbers NPF-91 and NPF-92 to revise the licensing basis information to reflect changes to the locations of the hydrogen venting primary openings in the passive core cooling system (PXS) valve/accumulator rooms inside containment. This requires changes to the Updated Final Safety Analysis Report (UFSAR) plant-specific Design Control Document (DCD) Tier 2 information, and involves changes to related plant-specific Tier 1 information. This request was provided by Southern Nuclear's letter ND 17-0264 dated February 22, 2017 [ADAMS Accession No. ML17053A425]. Pursuant to the provisions of 10 CFR 52.63(b)(1), an exemption from elements of the design as certified in the 10 CFR Part 52, Appendix D, design certification rule was also requested for the involved Tier 1 information. As noted in SNC's February 22, 2017 letter, the changes proposed in this license amendment request (SNC LAR 17-003) are consistent and identical in technical content with the South Carolina Electric and Gas Company (SCE&G) License Amendment Request (LAR 17-03) submittal [ML17046A660] on this topic.

Subsequent to the submittal of LAR 17-03, questions were asked of SCE&G by the NRC regarding statements in SCE&G LAR 17-03 that addressed the Finite Element Model used to evaluate the equipment hatch cover. In response to these questions, SCE&G submitted a voluntary supplement to SCE&G LAR 17-03 to provide additional information. Because SNC LAR-17-003 is within the scope of the NRC questions regarding SCE&G LAR 17-03, SNC elects to provide a response to these questions that is consistent with the response provided by SCE&G in their May 18, 2017 letter. The SNC response to these NRC questions is provided in the following text, which supplements the original LAR-17-003.

The text below replaces the second paragraph on page 9 of 17 in Enclosure 1 of SNC letter ND-17-0264 with nine paragraphs as follows:

Within the equipment hatch barrel are two rubber gaskets that seal the door against leakage. The seals of the equipment hatch are made of EPDM rubber, which has a design temperature and pressure of 300°F and 59 psig. The seals are exposed to a lower temperature than the hatch barrel surface because they are embedded within the barrel; however, during the hydrogen diffusion flame event, the seal temperature will exceed the design temperature of 300ºF. As described below, the seal material has been tested to temperatures beyond 390°F. The figure of merit for the survivability is the "compression set" of the seal material, a standard rubber property that measures the ability of the seal to recover its shape after being compressed for a period of time at a specified temperature. The lower the compression set, the more the material springs back from being compressed. The EPDM rubber compression set has been tested at temperatures beyond the design temperature for durations greater than 24 hours.

Equipment qualification (EQ) testing was performed on the AP1000 plant hatch seals and the data was reviewed. In the thermal aging process, the hatch seals were held above 300°F for approximately 10 days. In the subsequent LOCA EQ testing, the seals were tested to an EQ environment envelope peak temperature of 450°F for approximately one minute and then were held above 300°F for greater than 2 hours. Following the initial peak, they were exposed to approximately 290°F for 95 hours. The peak test pressure was 100 psia and the pressure while the test was above 300°F was over 60 psia. The long term pressure was above 50 psia. While the EQ environmental temperature transient exceeded 400°F and was held above 300°F for an extended period, the actual temperature of the hatch seals within the testing fixture was not measured. However, it is reasonable to assume the seals reached at least 300°F for an extended time. The acceptance criterion for compression set is specified to be less than 50% for the EQ conditions at 300°F. The EQ tested compression set based on ASTM D395 was measured to be 42%.

The seal manufacturer provided information regarding seal performance in high temperatures. The seal manufacturer reported compression set data for EPDM rubber heated to 200°C (392°F), 225°C (437°F) and 250°C (482°F) for a minimum of 24 hours. The testing was performed by the rubber manufacturer according to Japanese Testing Standard JIS K 6262. At 200°C, the compression set of irradiated seal material is approximately 45%. For unirradiated material, at 200°C, the compression set is 60%. For temperatures greater than 200°C, the compression set was more than 60%. Because it is bounding and the degree of irradiation of the seals within the hatch door is uncertain, the tested compression set of the unirradiated EPDM rubber was used in the analysis. The test results show the EPDM rubber exhibits a reasonable recovery of the seal height at temperatures less than or equal to 200°C (390°F). The predicted inner seal ring maximum temperature is slightly above 390ºF while the outer seal ring temperature remains well below 390°F based upon the equipment hatch seal temperature profile during hydrogen burn as modeled in GOTHIC. The hatch seal acceptance criterion for the beyond design basis conditions was chosen to be 390°F at the midpoint of the hatch barrel (less than 200°C) for the thermal analysis. The compression sets of the seals were calculated as 47.7% and 62.0% at 330°F and 400°F, respectively. The temperatures represent the midline temperature of the two seals. The compression sets were linearly interpolated and extrapolated based on the values obtained from testing at 302°F and 390°F.

Because the predicted duration that the seals are above their design temperature (on the order of 2 hours based upon results of the hydrogen burn modeling) is short compared to the tested duration, the test results demonstrate the structural integrity of the seal is not compromised. The material properties of the EPDM rubber remain essentially unchanged at temperatures up to 250°C [482°F] for 2 hours. Tests of EPDM rubber samples [Experiment Research on the Mechanical Performance of EPDM Insulation Pyrolysis Process, Jing Jiang, Jin-sheng Xu, Xiong Chen & Zhoug-shui Zhang] exposed the samples to temperatures reaching 300°C [572°F]. The stress-strain curves show a linear response at temperature below 250°C [482°F]. Thus the postulated temperature excursions of 200°C [390°F] would not impact the compression and/or pressure retaining capabilities at the elevated temperatures. This justifies that there is reasonable assurance that the equipment hatch seal is leak-tight at the temperatures predicted in the thermal analysis.

A structural evaluation of the equipment hatch integrity under the thermal loads was performed. The 27.6 kip specified equipment hatch bolt pretension was not considered as a conservatism. The preload on the bolts helps maintain the seal and has to be exceeded to cause separation of the joint. It was assumed that the preload in the joint would not impact the maximum calculated bolt loads or maximum joint opening. This is reasonable since preload would tend to reduce joint opening and would maintain the maximum bolt load near the preload value until the preload in the bolts is exceeded. The tension preload produces a stress in the bolts of 15.5 ksi, which is roughly equivalent to the maximum bolt stress of 15.9 ksi during the event.

The structural analysis was completed to evaluate the equipment hatch which experiences uneven heating due to the asymmetric thermal loading condition. The plume is postulated to hit the upper portion of the equipment hatch which leads to a temperature differential in meridional and hoop direction of the containment vessel shell. This uneven heating could lead to a potential distortion of the equipment hatch cover relative to the barrel flange. The additional analysis determined whether this distortion could lead to potential leakage. The two rubber seals inside the flange function to prevent leakage. These rubber seals are designed with a high temperature resistance and elasticity. Based on this design, as long as the bolts around the perimeter of the equipment hatch cover are not stressed and stretched to the point where the flange gap around the perimeter of the equipment hatch cover can open up a gap larger than the acceptable recovery of the seals, there is no potential path for leakage. The flatness and parallelism tolerance for the self-seating joint are near zero so it will not contribute to the gaps formed during the hydrogen burn event. The joint is designed for metal-to-metal contact between the cover flange and the hatch penetration sleeve which provides proper compression of the seals under application of proper bolt preload.

To analyze this configuration and loading, a three dimensional finite element (FE) model in ANSYS was generated which included the equipment hatch details including the contact between the barrel flanges as well as a stiffness representation for the bolts holding the EQ hatch cover in place. A normal contact stiffness factor of 1.0 was used for the flange contact elements to allow minimal penetration and maximize potential prying effects. The following load cases were applied to the Containment Vessel (CV) shell: dead load of the CV shell, polar crane dead load, internal pressure of 7.25 psig, and hydrogen plume temperature. To investigate leak tightness of the joint if the bolts in the hot spot of the hydrogen burn plume reach a temperature much greater than the equipment hatch assembly, three bolts were removed from the top of the hatch joint corresponding to the hot spot location. The results of the gap size and bolt stress were more favorable than the case with all the bolts in place. With the bolts removed from the top of the hatch cover, the assembly is less constrained under the thermal load. The uneven temperature distribution and loads have been applied and a geometrically nonlinear analysis has been performed. The relative deformation between the hatch and barrel and bolt yielding were investigated. The analysis concluded that the maximum bolt stress magnitude was 15.9 ksi and the allowable bolt stress is 92 ksi giving a stress margin of 0.83, thus the equipment hatch bolts remain in the elastic region and do not deform to distort the connection. Additionally, non-uniform gaps form in the equipment hatch joint during the thermal loading, but the gaps are smaller than the gap that the seals in the joint fill.

From the equipment hatch gasket specification, the nominal height of the half round gaskets is 14.8 mm and the nominal depth of the gasket groove is 11.5 mm. This represents a design squeeze of 22% (1-11.5/14.8) if the seal is fully compressed. The 22% seal compression is in the typical industry recommended seal compression range of 15% to 30%. Assuming the largest joint gap at the gasket midline locations from the FE analysis, the resulting compression would be (1-(11.5+1.19)/14.8) = 14%. Given that 22% compression of the seal can retain 59 psi, 14% compression is sufficient to retain the 7.25 psi pressure. Taking into account the compression set of the gasket material, a squeeze of 2.7% is necessary to maintain 7.25 psig pressure inside containment (Note: 7.25 psig is 12.3% of 59 psig and 2.7% is 12.3% of 22%). The outer gasket experiences a minimum squeeze of 4.04% over a very small distance of the circumference (average over entire circumferential length: 9.48%) and the inner gasket a minimum squeeze of 2.60% over a very small distance of the circumference (average over entire circumferential length: 6.85%). During the event, the gaskets are always in contact with the flanges and the equipment hatch is leak tight since at least one gasket always maintains the necessary squeeze over the entire circumferential length.

Even considering the extreme case with the gasket material properties affected by the high temperatures, a 4% squeeze is maintained on the seal. There is no leakage through the equipment hatch as reasonable assurance exists that equipment hatch seal integrity will be maintained during and after this extremely low probability beyond-design basis event. Therefore, the containment remains leak tight following a hydrogen burn at the vent openings in Rooms 11206 and 11207.

NOTE: The following legend applies to revised text for the above changes:

Additions are identified by blue underlined text.