October 22, 1999

50-395

MEMORANDUM TO: Richard L. Emch, Chief
Project Section II-1
Division of Licensing Project II

Barry Elliot for Keith Wichman:

FROM: Keith R. Wichman, Chief
Component Integrity Section
Materials and Chemical Engineering Branch
Division of Engineering

SUBJECT: REQUEST TO REVISE TECHNICAL SPECIFICATIONS FOR THE V. C. SUMMER UNIT 1 PRESSURE AND TEMPERATURE LIMITS (TAC NO. MA4868)

By letter dated October 8, 1999, South Carolina Electric and Gas Company (SCE&G, the licensee) submitted a request to amend the pressure-temperature (P-T) limit curves in the technical specifications (TSs) for Virgil C. Summer Unit 1 (V. C. Summer). The amendment was intended to extend the validity of the V. C. Summer P-T limit curves to 32 effective full power years (EFPYs). The current P-T limit curves for V. C. Summer are valid for a service period of 13 EFPYs.

The proposed amendment will revise the P-T limit curves of TS 3/4.4.9 for V. C. Summer to a maximum of 32 EFPYs of operation. The proposed changes are based, in part, on the use of Code Case N-640, which was reviewed by the staff. Approval of Code Case N-640 is covered under a separate document. Upon issuance of the document, Ms. Cotton (Project Manager for V. C. Summer) will provide the appropriate information to the attached safety evaluation.

The Materials and Chemical Engineering Branch has completed its review of the licensee's amendment request to change the current P-T limit curves for V. C. Summer. The staff has concluded that the P-T limits for heatup, cooldown, hydrotest, and criticality of the reactor coolant system meet the requirements in Appendix G to Section XI of the American Society of Mechanical Engineers (ASME) Code and Appendix G to 10 CFR Part 50 for 32 EFPYs. Hence, the P-T limit curves in the licensee's submittal of October 8, 1999, may be incorporated in the V. C. Summer TSs.

The staff's safety evaluation is attached. This completes our effort for TAC number MA4868.

Attachment: As stated

CONTACT: M. Khanna, EMCB/DE
415-2150

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

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

REQUEST TO AMEND THE PRESSURE-TEMPERATURE LIMITS FOR

V. C. SUMMER UNIT 1

SOUTH CAROLINA ELECTRIC AND GAS COMPANY

DOCKET NO. 50-395

1.0 INTRODUCTION

By letter dated October 8, 1999, South Carolina Electric and Gas Company (SCE&G, the licensee) submitted a request to amend operating license NPF-12, for the V. C. Summer Unit 1 Nuclear Station (V. C. Summer). Specifically, the amendment was intended to extend the validity of the V. C. Summer pressure-temperature (P-T) limit curves to 32 effective full power years (EFPYs). The proposed change included the use of ASME Code Case N-640, which was reviewed by the staff. The approval for the use and the application of this code case is covered under a separate memorandum dated **(insert date)**. The licensee's proposed changes to the P-T limit curves affect TS 3/4.4.9 for V. C. Summer. The current P-T limit curves are valid to 13 EFPYs.

The NRC has established requirements in 10 CFR Part 50 to protect the integrity of the reactor coolant pressure boundary in nuclear power plants. The staff evaluates the P-T limit curves based on the following NRC regulations and guidance: 10 CFR 50, Appendix G; Generic Letter (GL) 88-11; GL 92-01, Revision 1; GL 92-01, Revision 1, Supplement 1; Regulatory Guide (RG) 1.99, Revision 2 (Rev. 2); and Standard Review Plan (SRP) Section 5.3.2. GL 88-11 advised licensees that the staff would use RG 1.99, Rev. 2, to review P-T limit curves. RG 1.99, Rev. 2, contains methodologies for determining the increase in transition temperature and the decrease in upper-shelf energy (USE) resulting from neutron radiation. GL 92-01, Rev. 1, requested that licensees submit their reactor pressure vessel (RPV) data for their plants to the staff for review. GL 92-01, Rev. 1, Supplement 1, requested that licensees provide and assess data from other licensees that could affect their RPV integrity evaluations. These data are used by the staff as the basis for the staff's review of P-T limit curves and as the basis for the staff's review of pressurized thermal shock (PTS) assessments (10 CFR 50.61 assessments). Appendix G to 10 CFR Part 50 requires that P-T limit curves for the RPV be at least as conservative as those obtained by applying the methodology of Appendix G to Section XI of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (Code).

SRP 5.3.2 provides an acceptable method of determining the P-T limit curves for ferritic materials in the beltline of the RPV based on the linear elastic fracture mechanics (LEFM) methodology of Appendix G to Section XI of the ASME Code. The basic parameter of this methodology is the stress intensity factor K_I, which is a function of the stress state and flaw configuration. Appendix G requires a safety factor of 2.0 on stress intensities resulting from reactor pressure during normal and transient operating conditions; for hydrostatic testing curves, Appendix G requires a safety factor of 1.5.

Attachment

The methods of Appendix G postulate the existence of a sharp surface flaw in the RPV that is normal to the direction of the maximum stress. This flaw is postulated to have a depth that is equal to 1/4 of the RPV beltline thickness and a length equal to 1.5 times the RPV beltline thickness. The critical locations in the RPV beltline region for calculating heatup and cooldown P-T curves are the 1/4 thickness (1/4T) and 3/4 thickness (3/4T) locations, which correspond to the depth of the maximum postulated flaw, if initiated and grown from the inside and outside surfaces of the RPV, respectively.

The Appendix G ASME Code methodology requires that licensees determine the adjusted reference temperature (ART or adjusted RT_{NDT}). The ART is defined as the sum of the initial (unirradiated) reference temperature (initial RT_{NDT}), the mean value of the adjustment in reference temperature caused by irradiation (ΔRT_{NDT}), and a margin (M) term.

The ΔRT_{NDT} is a product of a chemistry factor and a fluence factor. The chemistry factor is dependent upon the amount of copper and nickel in the material and may be determined from tables in RG 1.99, Rev. 2, or from surveillance data. The fluence factor is dependent upon the neutron fluence at the maximum postulated flaw depth. The margin term is dependent upon whether the initial RT_{NDT} is a plant-specific or a generic value and whether the chemistry factor (CF) was determined using the tables in RG 1.99, Rev. 2, or surveillance data. The margin term is used to account for uncertainties in the values of the initial RT_{NDT}, the copper and nickel contents, the fluence and the calculational procedures. RG 1.99, Rev. 2, describes the methodology to be used in calculating the margin term.

The licensee's P-T limit curves satisfy the requirements of 10 CFR 50.60 (a), with the additional provisions allowed by ASME Code Case N-640. This code case allows the P-T limit curves to be developed using the K_{IC} fracture toughness curve of ASME Section XI, Appendix A, instead of the K_{Ia} curve of Appendix G, as authorized and explained in Reference 2.

2.0 EVALUATION

2.1 Licensee Evaluation

As stated above, the licensee submitted ART calculations and P-T limit curves valid for up to 32 EFPYs. For the V. C. Summer reactor vessel, the licensee determined that the most limiting material at the 1/4T and 3/4T locations is the lower shell plate that was fabricated using plate heat number C9923-1,2. The licensee calculated an ART of 107°F at the 1/4 T location and 94°F at the 3/4T location at 32 EFPYs. The neutron fluence used in the ART calculation is 2.41×10^{19} n/cm^2 at the 1/4T location and 9.52×10^{18} n/cm^2 at the 3/4T location. The ΔRT_{NDT} values at the 1/4T and 3/4T locations are 63.2°F and 50.3°F, respectively. The initial RT_{NDT} for the limiting plate is 10°F. The margin term used in calculating the ART for the limiting plate is 34°F at the 1/4T and 3/4T locations, as permitted by Position 1.1 of RG 1.99, Revision 2. The licensee's limiting ART for the vessel flange, head flange, and upper shell plate and weld material is 10°F.

2.2 Staff Evaluation

The staff independently calculated the ARTs, using the staff-reviewed and approved data and calculations of the NRC Reactor Vessel Integrity Database (RVID). In addition, the staff

independently generated P-T limit curves for normal operations and inservice hydrostatic testing condition effective to 32 EFPYs for V. C. Summer. Although the staff's calculations using the NRC approved data and methodology differed slightly from the licensee's data and methodology, the licensee's P-T limit curves were found to be conservative with respect to the staff's determinations, and therefore, acceptable. The details of this evaluation are provided below.

The ART was determined using the chemistry values of percent copper and percent nickel for each beltline material of V. C. Summer. The RVID contains chemistry values for each beltline material for all light water reactors in the U.S. The licensee's and the vendor's data were verified by the staff before incorporation into the RVID. It should be noted that the staff used the most recent updated chemistry data for the beltline materials in the evaluation of the V. C. Summer P-T limit curves. The staff independently verified the data for the chemical compositions, initial RT_{NDT}, fluence, and margin values for V. C. Summer. In addition, the staff found that the calculated values, as proposed in SCE&G's submittal, were at least as conservative as those values derived by the staff.

The staff also performed an independent evaluation of the surveillance data for V. C. Summer. In calculating the P-T limits, the margin term was 34°F. This value was calculated from the sigma delta value, which in this case was 17°F; the 2-sigma delta value would be 34°F. The staff verified that the measured ΔRT_{NDT} values from all of the surveillance data were within 2-standard deviations of the predicted ΔRT_{NDT} values. Therefore, the surveillance data indicates that the predicted ΔRT_{NDT} values and margin term from RG 1.99, Rev. 2, are appropriate.

The staff evaluated each of the licensee's P-T limit curves for acceptability by performing independent calculations, using the methodology referenced in the Code (as indicated by SRP 5.3.2), and verified that the licensee's proposed P-T limits satisfy the requirements in Paragraph IV.A.2 of Appendix G, 10 CFR Part 50. The staff independently generated P-T limit curves for normal operations and hydrostatic test pressures effective to 32 EFPYs for V. C. Summer. In comparing the staff's generated P-T limit curves to the licensee's generated P-T limit curves, the staff determined that the licensee's proposed P-T limit curves for V. C. Summer meet the requirements of Appendix G of Section XI of the ASME Code, as modified by Code Case N-640. Therefore, the staff determined that the licensee's proposed P-T limit curves were acceptable, since they met the requirements of 10 CFR 50.60 and Appendix G, 10 CFR Part 50, as modified by Code Case N-640.

In addition to beltline materials, Appendix G of 10 CFR 50 also imposes a minimum temperature at the RPV based on the reference temperature for the flange material. Section IV.A.2 of Appendix G states that when the pressure exceeds 20% of the preservice system hydrostatic test pressure, the temperature of the closure flange region, highly stressed by the bolt preload must exceed the adjusted reference temperature of the material in those regions by at least 120°F for normal operation and by 90°F for hydrostatic pressure tests and leak tests. Based on the RT_{NDT} of 10°F for the limiting flange and upper shell materials, as stated in the RVID, and also confirmed by the licensee, the staff has determined that the proposed P-T limits satisfy the requirement for the closure flange region of Appendix G, 10 CFR Part 50, during normal operation and hydrostatic pressure test and leak test for V. C. Summer.

3.0 CONCLUSIONS

The staff concludes that the proposed P-T limits for the reactor coolant system for heatup, cooldown, leak test, and criticality satisfy the requirements in Appendix G to Section XI of the ASME Code and Appendix G of 10 CFR 50 for 32 EFPYs. The proposed P-T limits also satisfy Generic Letter 88-11, because the method in RG 1.99, Rev. 2, was used to calculate the ART. Hence, the proposed P-T limit curves may be incorporated into the V. C. Summer technical specifications.