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

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION
RELATED TO AMENDMENT NO. 36 TO FACILITY OPERATING LICENSE NO. NPF-30

UNION ELECTRIC COMPANY
CALLAWAY PLANT, UNIT 1
DOCKET NO. STN 50-483

INTRODUCTION

By letter dated July 31, 1987, as supplemented by letter dated February 19, 1988, the Union Electric Company requested revision of the pressure-temperature limits in Callaway Plant Technical Specifications Section 3/4.4.9. The proposed limits will incorporate the updated pressure vs. temperature curves through 9 effective full power years (EFPY) to account for irradiation effects on the reactor vessel material. The proposed limits were based on the Westinghouse analysis (WCAP-11374, Rev. 1) of irradiation data taken from surveillance specimen Capsule U. The limits provide maximum permissible pressure at temperature for three reactor operations--system hydrostratic and leakage test, heatup or cooldown, and core critical condition. The pressure-temperature limits have to satisfy the requirements in Appendix G of 10 CFR Part 50. The licensee also requested revision of the maximum allowed power-operated relief valve (PORV) curve for the cold overpressure mitigation system, and a revision to the surveillance capsule withdrawal schedule based on the neutron fluence data taken from Capsule U.

DISCUSSION

Part of the NRC's effort to ensure integrity of the reactor vessel is to periodically evaluate the reduction in fracture toughness of the vessel material due to neutron irradiation damage. The effort consists of three steps. First, the licensee is required to establish a a surveillance program in accordance with Appendix H of 10 CFR Part 50, which requires periodic withdrawal of surveillance capsules from the reactor vessel. The capsules are installed in the vessel prior to startup and they should contain test specimens that were made from the plate, weld, and heat-affected zone materials of the reactor beltline. Secondly, the licensee is required to perform Charpy impact tests, tensile tests, and neutron fluence measurements of the specimens. These tests provide data for the actual neutron irradiation damage to the reactor vessel in terms of the reference temperature, RT_{NDT}, and the upper shelf energy (USE). The neutron damage is indicated by the decrease in USE and temperature shift in RT_{NDT}. The USE is the average energy value for all specimens whose test temperature is above the upper end of the transition temperature region. The USE decreases as a function of neutron fluence and copper content in the irradiated material. The shift of the adjusted reference temperature is the temperature shift in the Charpy curve for the irradiated material relative to that for the unirradiated

material. According to Appendix G of 10 CFR Part 50, the USE must not be less than 50 ft-lb and the adjusted RT_{NDT} not more than 200°F. Thirdly, the licensee is required to construct pressure-temperature limit curves in the Technical Specifications. To construct the curves, the licensee may use the guidelines delineated in Reg. Guide 1.99, Revision 2, and Appendix G, Section III of the ASME Code.

EVALUATION

The Callaway Plant has six surveillance capsules for monitoring the effects of neutron irradiation on the reactor vessel material properties and they are located in the reactor vessel between the core barrel and vessel wall. Capsule U was removed after 1.05 EFPY and the withdrawal schedule for the next three capsules will be at 5, 9, and 15 EFPY. Capsule U contained specimens taken from base metal, weld metal, and heat-affected zone metal. The controlling material, which is the base plate, was included in the capsule. The withdrawal schedule for the capsules and the testing of Capsule U were performed in accordance with ASTM standard E185-82, and 10 CFR Part 50, Appendix H.

Capsule U experienced an average fast neutron fluence of 3.27×10^{18} n/cm². The lower shell plate material, R2708-1, has the highest initial RT_{NDT}, 50°F, the highest percentage of copper, 0.07%, and the highest percentage of nickel 0.59%. Using Regulatory Guide 1.99, Rev. 2, the adjusted RT_{NDT} of the plate was calculated to be 122°F and 112.5°F at the 1/4 T and 3/4 T vessel-wall-thickness locations, respectively. These results show that the predicted transition temperature shift based on Regulatory Guide 1.99, Rev. 2 is higher than the shift obtained directly from the surveillance capsule. Therefore, it is conservative and acceptable using the results of the Regulatory Guide to develop the pressure-temperature curves.

After irradiation, the average USE of the plate material decreased from 104 to 93 ft-lb. and the limiting weld decreased from 112 to 101 ft-lb. The transition temperature increase for the plate and weld are 0°F and 70°F, respectively. Based on these data, the USE and adjusted RT_{NDT} of both materials should be within the 50 ft-lb limit and the 200°F limit through the proposed 9 EFPY. The proposed pressure-temperature curves have included the safety margins required by 10 CFR Part 50, Appendix G.

The staff has used the method of calculating pressure-temperature limits in USNRC Standard Review Plan 5.3.2, NUREG-0800, to evaluate the proposed pressure-temperature limits. The amount of neutron irradiation damage was calculated based on Regulatory Guide 1.99, Rev. 2. The staff concludes that the proposed pressure-temperature limits meet the requirements of 10 CFR Part 50, Appendix G for 9 EFPY and may be incorporated into the Callaway Plant's Technical Specification. Also, the revised surveillance capsule withdrawal schedule satisfies the requirements of 10 CFR Part 50, Appendix H, and is acceptable.

The Callaway low temperature overpressure protection is accomplished with the Cold Overpressure Mitigation System (COMS), which consists of three subsystems, namely, (1) two residual heat removal suction relief valves, (2) two pressurizer PORV's, and (3) a reactor coolant system (RCS) vent of greater than or equal to 2 square inches. The limiting conditions for operation in TS 3.4.9.3 requires at least one of these three subsystems to be operable during modes 3, 4, 5 and 6. The TS also requires that the PORV setpoints do not exceed the maximum allowable limits established in Figure 3.4-4. This restriction is necessary to maintain the RCS pressure within the pressure-temperature limits specified in Figures 3.4-2 and 3.4-3 during low temperature heatup and cooldown operations. Therefore, a reevaluation of the PORV setpoint limits is necessary any time the pressure-temperature limit curves are revised.

The analysis must be done with consideration of the single failure criteria such that operation of one of the two PORV's is sufficient to prevent the RCS pressure from exceeding the Appendix G pressure limits which are determined from the heatup and cooldown pressure-temperature limit curves specified in Figures 3.4-2 and 3.4-3. The analysis is performed with the limiting transients having maximum mass and energy additions to the reactor coolant system.

At the staff's request, the licensee provided the analyses, including the limiting mass and heat addition transients analyzed, the initial conditions, major assumptions and the results of the analyses, to support the maximum allowable PORV setpoints in the revised Figure 3.4-4.

The limiting mass addition transient involves the operation of a single charge pump at the maximum flow with inadvertent isolation of letdown flow and residual heat removal system (RHRS) relief valves. The limiting heat addition transient is an inadvertent RCS coolant pump startup in one loop with a temperature asymmetry in the RCS, whereby the steam generator is at a temperature 50°F higher than the rest of the RCS. The initial conditions and major assumptions include the pressurizer being water solid to maximize the pressure surge, the failure of one PORV, and the time delay in the PORV operation. As indicated in the licensee's response dated February 19, 1988, these transients and assumptions are identical to those used in the previous analyses in the Callaway FSAR Section 5.2.2.10 except for the use of the revised Figure 3.4-4 for the PORV setpoints.

The results of analyses indicate that the peak RCS pressures for the transients analyzed fall below the nominal Appendix G pressure limits. The staff, therefore, concludes that the revised Figure 3.4-4 is also acceptable.

ENVIRONMENTAL CONSIDERATION

This amendment involves a change to a requirement with respect to the installation or use of a facility component located within the restricted area as defined in 10 CFR Part 20 or a change to a surveillance requirement. The 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 this amendment involves no significant hazards consideration and there has been no public comment on such finding. Accordingly, this 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 this amendment.

CONCLUSION

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

ACKNOWLEDGEMENT

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Dated: May 24, 1988