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

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO AMENDMENT NO. 37 TO FACILITY OPERATING LICENSE NO. NPF-37

AND AMENDMENT NO. 37 TO FACILITY OPERATING LICENSE NO. NPF-66

COMMONWEALTH EDISON COMPANY

BYRON STATION, UNITS 1 AND 2

DOCKET NOS. 50-454 AND 50-455

1.0 INTRODUCTION

In response to Generic Letter 88-11, "NRC Position on Radiation Embrittlement of Reactor Vessel Materials and Its Effect on Plant Operations," the Commonwealth Edison Company (the licensee) requested permission to revise the pressure/temperature (P/T) limits in the Byron Station, Unit 1 Technical Specifications, Section 3.4. The request was documented in a letter from the licensee dated November 17, 1989, supplemented January 10, 1990. This revision also changes the effectiveness of the P/T limits from 32 to 29.5 effective full power years (EFPY). The proposed P/T limits were developed based on Section 1 of Regulatory Guide (RG) 1.99, Revision 2. The proposed revision provides up-to-date P/T limits for the operation of the reactor coolant system during heatup, cooldown, criticality, and hydrotest. The January 10, 1990 letter provided clarifying information that did not make substantive changes to the action noticed in the Federal Register on December 29, 1989, or affect the initial determination of no significant hazards consideration.

To evaluate the P/T limits, the staff uses the following NRC regulations and guidance: Appendices G and H of 10 CFR Part 50; the ASTM Standards and the ASME Code, which are referenced in Appendices G and H; 10 CFR 50.36(c)(2); RG 1.99, Revision 2; Standard Review Plant (SRP) Section 5.3.2; and Generic Letter 88-11.

Each licensee authorized to operate a nuclear power reactor is required by 10 CFR 50.36 to provide Technical Specifications for the operation of the plant. In particular, 10 CFR 50.36(c)(2) requires that limiting conditions of operation be included in the Technical Specifications. The P/T limits are among the limiting conditions of operation in the Technical Specifications for all commercial nuclear plants in the U.S. Appendices G and H of 10 CFR Part 50 describe specific requirements for fracture toughness and reactor vessel material surveillance that must be considered in setting P/T limits. An acceptable method for constructing the P/T limits is described in SRP Section 5.3.2.

Appendix G of 10 CFR Part 50 specifies fracture toughness and testing requirements for reactor vessel materials in accordance with the ASME Code and, in particular, that the beltline materials in the surveillance capsules be tested in accordance with Appendix H of 10 CFR Part 50. Appendix H, in turn, refers to ASTM Standards. These tests define the extent of vessel embrittlement at the time of capsule withdrawal in terms of the increase in reference temperature. Appendix G also requires the licensee to predict the effects of neutron irradiation on vessel embrittlement by calculating the adjusted reference temperature (ART) and Charpy upper shelf energy (USE). Generic Letter 88-11 requested that licensees and permittees use the methods in RG 1.99, Revision 2, to predict the effect of neutron irradiation on reactor vessel materials. This guide defines the ART as the sum of unirradiated reference temperature, the increase in reference temperature resulting from neutron irradiation, and a margin to account for uncertainties in the prediction method.

Appendix H of 10 CFR Part 50 requires the licensee to establish a surveillance program to periodically withdraw surveillance capsules from the reactor vessel. Appendix H refers to the ASTM standards which, in turn, require that the capsules be installed in the vessel before startup and that they contain test specimens made from plate, weld, and heat-affected-zone (HAZ) materials of the reactor beltline.

2.0 EVALUATION

2.1 Unit 1

The staff evaluated the effect of neutron irradiation embrittlement on each beltline material in the Byron 1 reactor vessel. The amount of irradiation embrittlement was calculated in accordance with RG 1.99, Revision 2. The staff has determined that the material with the highest ART at 29.5 EFPY was the upper shell forging 5P-5933 with 0.05% copper (Cu), 0.73% nickel (Ni), and an initial RT_{ndt} of 40°F.

The licensee has removed one surveillance capsule from Byron 1. The data was published in WCAP-11651. All surveillance capsules contained Charpy impact specimens and tensile specimens made from base metal, weld metal, and HAZ metal.

For the limiting beltline material, forging 5P-5933, the staff calculated the ART to be 110°F at 1/4T (T = reactor vessel beltline thickness) and 94°F for 3/4T at 29.5 EFPY. The staff used a neutron fluence of 1.8E19 n/cm^2 at 1/4T and 6.49E18 n/cm^2 at 3/4T. The ART was determined using Section 1 of RG 1.99, Revision 2.

The licensee used the method in RG 1.99, Revision 2, to calculate an ART of 109.7°F at 29.5 EFPY at 1/4T for the same limiting forging metal. The staff judges that a difference of 0.3°F between the licensee's ART of 109.7°F and the staff's ART of 110°F is acceptable. Substituting the ART of 110°F into equations in SRP 5.3.2, the staff verified that the proposed P/T limits for heatup, cooldown, and hydrotest meet the beltline material requirements in Appendix G of 10 CFR Part 50.

In addition to beltline materials, Appendix G of 10 CFR Part 50 also imposes P/T limits based on the reference temperature for the reactor vessel closure flange materials. Section IV.2 of Appendix G states that when the pressure exceeds 20% of the preservice system hydrostatic test pressure, the temperature of the closure flange regions highly stressed by the bolt preload must exceed the 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 flange reference temperature of 60°F, the staff has determined that the proposed P/T limits satisfy Section IV.2 of Appendix G.

Section IV.B of Appendix G requires that the predicted Charpy USE at end of life be above 50 ft-lb. The unirradiated Charpy USE is 77 ft-lb for the upper to lower shell girth weld metal. Using the method in RG 1.99, Revision 2, the predicted Charpy USE of the weld metal at the end of life will be 58 ft-lb. This is greater than 50 ft-lb and, therefore, is acceptable.

2.2 Unit 2

The staff evaluated the effect of neutron irradiation embrittlement on each beltline material in the Byron 2 reactor vessel. The amount of irradiation embrittlement was calculated in accordance with RG 1.99, Revision 2. The staff has determined that the material with the highest ART at 10 EFPY was the circumferential weld (WF447) between the upper and lower shells with 0.059% copper (Cu), 0.62% nickel (Ni), and an initial RT_{ndt} of 10°F.

The licensee has removed one surveillance capsule from Byron 2. All surveillance capsules contained Charpy impact specimens and tensile specimens made from base metal, weld metal, and HAZ metal.

For the limiting beltline material, (WF447), the staff calculated the ART to be 134°F at 1/4T (T = reactor vessel beltline thickness) and 103.9°F at 3/4T at 10 EFPY. The staff used a neutron fluence of 5.69E18 n/cm^2 at 1/4T and 2.15E18 n/cm^2 at 3/4T. The ART was determined using Section 1 of RG 1.99, Revision 2.

The licensee used the method in RG 1.99, Revision 2, to calculate an ART of 134.9°F at 10 EFPY at 1.4T for the same limiting weld metal. The staff judges that a difference of 0.5°F between the licensee's ART of 134.9°F and the staff's ART of 134.4°F is acceptable. Substituting the ART of 134.9°F into equations in SRP 5.3.2, the staff verified that the proposed P/T limits for heatup, cooldown, and hydrotest meet the beltline material requirements in Appendix G of 10 CFR Part 50.

In addition to beltline materials, Appendix G of 10 CFR Part 50 also imposes P/T limits based on the reference temperature for the reactor vessel closure flange materials. Section IV.2 fo Appendix G states that when the pressure exceeds 20% of the preservice system hydrostatic test pressure, the temperature of the closure flange regions highly stressed by the bolt preload must exceed the 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 flange reference temperature of 30°F, the staff has determined that the proposed P/T limits satisfy Section IV.2 of Appendix G.

Section IV.B of Appendix G requires that the predicted Charpy USE at end of life be above 50 ft-lb. The unirradiated Charpy USE is 80 ft-lb for the upper to lower shell weld metal. Using the method in RG 1.99, Revision 2, the predicted Charpy USE of the weld metal at the end of life will be 59 ft-lb. This is greater than 50 ft-lb and, therefore, is acceptable.

3.0 SUMMARY

The staff concludes that the proposed P/T limits for the reactor coolant system for heatup, cooldown, leak test, and criticality are valid through 29.5 EFPY for Unit 1 and through 10 EFPY for Unit 2 because the limits conform to the requirements of Appendices G and H of 10 CFR Part 50. The licensee's submittal also satisfies Generic Letter 88-11 because the licensee used the method in RG 1.99, Revision 2 to calculate the ART. Hence, the proposed P/T limits may be incorporated into the Byron Technical Specifications.

4.0 ENVIRONMENTAL CONSIDERATION

The amendment involves changes 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. 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 exposures. The Commission has previously issued a proposed finding that the amendment involves no significant hazards consideration and there has been no public comment on such finding. Accordingly, the amendment meets the eligibility criteria for categorical exclusion set forth in 10 CFR Section 51.22(c)(9). Pursuant to 10 CFR 51.22(b), no environmental impact statement or environment assessment need be prepared in connection with the issuance of the amendment.

5.0 CONCLUSION

The staff has further 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.

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Dated: February 8, 1990