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

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO AMENDMENT NO. 171 TO FACILITY OPERATING LICENSE NO. DPR-53

BALTIMORE GAS AND ELECTRIC COMPANY

CALVERT CLIFFS NUCLEAR POWER PLANT, UNIT NO. 1

DOCKET NO. 50-317

1.0 INTRODUCTION

By letter dated February 6, 1992, the Baltimore Gas and Electric Company (the licensee) submitted a request for changes to the Calvert Cliffs Nuclear Power Plant, Unit No. 1, Technical Specifications (TS). The requested changes would revise the TS for Unit 1 to provide new heatup and cooldown curves which allow operation beyond 12 effective full power years (EFPY). The Power Operated Relief Valve (PORV) setpoints would also be revised, and the minimum pressure and temperature (MPT) enable temperature would be increased to 355 °F to provide low temperature overpressure protection (LTOP) for an allowable fluence corresponding to approximately 22 EFPY based on the current core loading pattern. The temperature at which the high pressure safety injection (HPSI) pumps are placed under manual control during a reactor cooldown would be increased to 375 °F due to the higher MPT temperature. To accommodate the lower 10 CFR Part 50, Appendix G, pressure limits associated with the new curves, the maximum allowed HPSI pump flow rate would be reduced from 210 gpm to 200 gpm when used to add mass to the reactor coolant system (RCS). The criterion for the reactor to be shutdown for 8 hours or longer before a reactor coolant pump (RCP) is started would be removed from the TS Bases, since it is no longer required. The initial indicated RCS pressure for starting an RCP has been increased to 300 psia. The adjusted reference temperature (ART) for the 1/4 T and 3/4 T positions in the TS Bases would be changed to 253.7 °F and 193.8 °F, respectively. Finally, the associated TS Bases would be updated to reflect the other proposed changes described above.

2.0 BACKGROUND

To evaluate the proposed changes, the staff uses the following NRC regulations and guidance: Appendices G and H of 10 CFR Part 50; the American Society for Testing and Materials (ASTM) Standards, and the American Society of Mechanical Engineers (ASME) Code, which are referenced in Appendices G and H; 10 CFR 50.36(c)(2); Regulatory Guide (RG) 1.99, Rev. 2; Standard Review Plan (SRP), Sections 5.2.2 and 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 TS for the operation of the plant. In particular, 10 CFR 50.36(c)(2) requires that limiting conditions of operation be included in the TS. The Pressure-Temperature (P/T) limits are among the limiting conditions of operation in the TS for all commercial nuclear plants in the United States. 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 American 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 ART and Charpy upper shelf energy (USE). Generic Letter 88-11 requested that licensees and permittees use the methods in RG 1.99, Rev. 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.

The licensee's approach to addressing LTOP is based primarily on reducing the potential for overpressurization of the RCS through a combination of additional controls, administrative procedures, and operator action. This includes the following: procedural precautions and controls; disabling of non-essential components whenever LTOP is required (below the MPT enable temperature when the RCS is not vented); avoidance of water solid RCS whenever practical; and use of low relief setpoint in the PORV logic. The licensee's safety analysis/justification in the February 6, 1992, letter presented information on heatup and cooldown curves and rates, LTOP controls, RCP start criteria, mass addition transients, HPSI pumps, and the ART.

3.0 EVALUATION - APPENDIX G HEATUP AND COOLDOWN CURVES AND RATES

The staff independently evaluated the effect of neutron irradiation embrittlement on each beltline material in the Calvert Cliffs Unit 1 reactor vessel. The amount of irradiation embrittlement was calculated in accordance with RG 1.99, Rev. 2. The staff determined that the material with the highest ART at 22 EFPY was the intermediate shell weld 2-203A, B, and C with 0.21% copper (Cu), 0.87% nickel (Ni), and an initial RT_{ndt} of -50 °F.

For the limiting beltline material, the intermediate shell weld, the staff calculated the ART to be 251.8 °F at 1/4T (T = reactor vessel beltline thickness) and 192.3 °F for 3/4T at 22 EFPY. The staff used a neutron fluence of 1.94E19 n/cm^2 at 1/4T and 6.88E18 n/cm^2 at 3/4T. The ART was determined by Section 1 of RG 1.99, Rev. 2, because only one surveillance capsule has been removed from the reactor vessel.

The licensee used the method in RG 1.99, Rev. 2, to calculate an ART of 253.7 °F at 1/4T and 193.8 at 3/4T for the same limiting weld, 2-203A. The licensee's ARTs are more conservative than the staff's ARTs; therefore, they are acceptable. Substituting the licensee's ARTs 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.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 regions highly stressed by the bolt preload must exceed the nil-ductility transition 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 -10 °F, the staff has determined that the proposed P/T limits satisfy Section IV.A.2 of Appendix G.

Section IV.A.1 of Appendix G requires that the predicted Charpy USE at end of life be above 50 ft-lb. The limiting unirradiated USE is that of lower shell course plate D-7207-1 which is 77 ft-lb. Using Figure 2 of RG 1.99, Rev. 2, the staff determined that the USE at end of life would be 53.2 ft-lb. This is greater than 50 ft-lb and, therefore, is acceptable.

The staff has determined that the proposed P/T limits for the reactor coolant system for heatup, cooldown, leak test, and criticality are valid for a neutron fluence up to 3.25E19 n/cm^2 at the inner surface of the reactor vessel (about 22 EFPY) because the proposed limits conform to the requirements of Appendix G of 10 CFR Part 50. The proposed P/T limits also satisfies Generic Letter 88-11 because the licensee used the method in RG 1.99, Rev. 2, to calculate the adjusted reference temperature. Hence, the proposed P/T limits, TS 3.4.9.1, TS 3.4.9.2, Figures 3.4.2.2 and 3.4.2.b, and their supporting TS Bases may be incorporated into the Calvert Cliffs Unit 1, TS.

4.0 EVALUATION - FAST NEUTRON FLUENCE

The proposed P/T limit curves and rates are based on a fluence value of 3.25E+19 n/cm^2 (Greater than 1 MeV) at the inside surface of the pressure vessel which corresponds to 22 EFPY of operation, at the present core loading pattern. However, information submitted in connection with the Pressurized Thermal Shock (PTS) rule, i.e., - 10 CFR 50.61 indicates that Unit 1 will reach the PTS screening criteria at an inside surface fluence value of 2.61E+19 n/cm^2. It appears that the reactor will never reach the assumed fluence for the proposed limits on LTOP, which is discussed in Section 5.0 of this Safety Evaluation, due to 10 CFR 50.61 requirements which are more limiting. The proposed LTOP criteria are conservative and we find the proposed fluence for application to LTOP acceptable.

The fluence information utilized for the Unit 1 vessel was derived from a Southwest Research Institute report. In this report the fluence estimate was performed using the DOT two dimensional discrete ordinates code, with a P_3 scattering and a S_8 angular quadrature approximations. The cross section library was based on ENDF/B-IV and the spectrum on ENDF/B-V. Pin-wise source distribution was assumed and a three-dimensional synthesis method was employed based on o(r,) and o(r,z) results.

The above summarized methodology is acceptable and the resultant fluence used for the P/T curves/rates and LTOP is also acceptable.

5.0 EVALUATION - LTOP

As noted previously the, new P/T limit curves were presented based on a fluence of $\leq 3.25 \times 10^{19}$ m/cm^2 at the inner surface of the reactor vessel. This corresponds to approximately 22 EFPY of operation based on the current loading pattern. The new fluence is higher than the existing fluence (for 12 EFPY) and results in increased reactor vessel embrittlement. To accommodate the more restrictive P/T limits resulting from consideration of RG 1.99, Rev. 2, a new LTOP setpoint, a new enable temperature and new heatup rates are proposed for the Calvert Cliffs Unit 1 TS.

The revisions to the P/T limit curves also made it necessary to revise the ART for 1/4°T position and 3/4°T position in the bases. The ART for 1/4 T position was changed from 222 °F to 253.7 °F and the ART for 3/4 was changed from 162.5 °F to 193.8 °F.

Due to increased reactor vessel embrittlement caused by the higher fluence, the above changes require the low temperature PORV pressure trip setpoint to be lowered. The low temperature PORV pressure trip setpoint is based on preventing RCS pressure from exceeding the most limiting pressure of the applicable heatup and cooldown Appendix G curves. This occurs during a cooldown at a temperature of 70 degrees F. Specifically, the maximum analytical pressurizer pressure (not including pressure instrument loop uncertainty and overshoot) when in MPT enable has decreased from 464.1 psia to 444.5 psia. The MPT enable temperature has been increased from 317 degrees F to 355 degree F (includes temperature instrument loop uncertainty).

LTOP is provided by the PORVs on the pressurizer. These PORVs are set to open at a pressure low enough to prevent violation of the Appendix G heatup and cooldown curves should a RCS pressure transient occur during low temperature operations. The PORV setpoint limit has been set by two design criteria. These are the limiting transients for mass addition and energy addition.

The changes in PORV setpoints and P/T limits affect the existing mass addition transient controls. Lowering the maximum analytical pressurizer pressure from 464.1 psia to 444.5 psia requires lowering the total flow limit into the pressurizer during a mass addition event. The existing throttled HPSI pump flow limit of 210 gpm has been changed to 200 gpm to preclude exceeding the Appendix G limit when adding mass to the RCS.

The limiting energy addition transient is the startup of a reactor coolant pump while steam generator secondary temperature is greater than the primary coolant temperature. The current limit is for the indicated steam generator secondary temperature to be no more than 30 degrees F higher than indicated RCS temperature. The current limit will remain. The new PORV setpoint provides margin to accommodate possible pressurization transients after starting two RCPs at the same time. The licensee stated that the thermal-hydraulic analysis of RCP start transients simulate thermodynamic conditions within the pressurizer. Calculations have also statistically combined instrumentation uncertainties, providing additional margin in assumed initial conditions for transient analysis. These provide a set of operating conditions which permit normal RCP start without challenging the PORV. The RCP start transient analysis (two RCPs started at the same time) provides additional analytical margin to specify a higher maximum pressurizer pressure and a shorter allowable time after shutdown for RCP start. The licensee is now taking credit for this additional margin and has increased the maximum initial indicated pressurizer pressure from 290 psia to 300 psia and has deleted the 8-hour criteria in the Bases for the RCP start transient.

The LTOP enable temperature has been raised from 327 degrees F to 355 degrees F. This change is a result of following the guidance provided in SRP 5.2.2, Revision 2. The SRP considers the enable temperature as the water temperature corresponding to a metal temperature at the reactor vessel beltline that is controlling in the Appendix G calculation.

As a result of the higher enable temperature, the transition range at which the HPSI pumps are placed under manual control on cooldown and restored to automatic status on heatup has been changed from a range of 327 degrees F - 350 degrees F to a range of 355 degrees F - 375 degrees F in the technical specifications and Bases. Calculations performed by the licensee indicate that adequate LOCA protection below 375 degrees F is provided by the safety injection tanks. The licensee states that this is sufficient to allow operator action to manually start a HPSI pump, if required.

The low temperature PORV pressure setpoint is based on protecting against exceeding the most restrictive pressure of both the heatup and cooldown curves which is for the 10 degrees F/hr cooldown at 70 degrees F in the RCS. With the proposed P/T limits the maximum analytical pressurizer pressure (not including pressure instrument uncertainty and response time) when in MPT enable has been decreased from 464.1 psia to 444.5 psia. The existing PORV lift setting in the TS 3.4.9.3 is $\leq$ 430 psia. This value represents the "as left" trip setpoint, which includes all instrument loop uncertainties and response time. The term "lift setting" has been replaced by "trip setpoint" and the new trip setpoint value is less than or equal to 429 psia and is to include response time and total loop uncertainties.

A revision was made to the TS 3/4.4.9.3 to ensure that when the HPSI pump is not in use its handswitch is in pull-to-lock. This does not change the intent of the TS which states that the operable high pressure safety injection pump is required to be under manual control when the RCS temperature is less than or equal to 355 degrees F and the RCS is vented to less than 8-square inches.

Some changes were made to the current TS Bases to eliminate unnecessary discussion of instrument uncertainty relative to the minimum temperature at which the reactor vessel head can be bolted on, i.e., the "minimum bolt-up temperature." Also, a reference to a figure relative to calculated RCS pressure versus time which is no longer used in the TS is removed and a more appropriate discussion has been added which addresses the mass addition transient, which is the basis for the PORV setpoint.

The following TS were proposed for LTOP controls and RCP start criteria:

TS 3.4.9.a.1 and 2 was changed from "lift setting ≤430 psia" to "trip setpoint of ≤429 psia."

The MPT enable temperature was changed from 327 °F to 355 °F. The TS that are affected by this change are 3.1.2.1, 3.1.2.3, Table 3.3-3, 3.4.1.2, 3.4.1.3, 3.4.9.3, 4.5.2, 3.5.3.

Due to the higher MPT enable temperature, the transition region at which the HPSI pumps are placed under manual control on cooldown and restored to automatic status on heatup was changed from a range of 327 °F to 350 °F to a range of 355 °F to 375 °F. This affects TS 3.5.3 and Table 3.3-3.

The allowable HPSI pump flowrate was changed from "less than or equal to 210 gpm" to "less than or equal to 200 gpm" when used to add mass to the RCS. This affects TS 3.4.9.3.

TS 3.4.9.3, "Overpressure Protection System," identified the overpressure protection requirements to be met to ensure that Appendix G limits are maintained. The LCOs were revised to identify the proposed PORV trip setpoint, MPT enable temperature and HPSI pump flowrate changes.

TS 3.4.1.2 and 3..1.3 concern RCP controls for hot standby (Mode 3) and shutdown (Modes 4 and 5), respectively. To accommodate the LTOP conditions for these modes, a footnote appended to the applicability of each LCO is revised to require that a RCP not be started when a RCS cold leg temperature is less than or equal to 355 (instead of 327 °F) unless: (1) the pressurizer indicated water level is less than 170 inches, (2) the secondary water temperature of each steam generator is less than or equal to 30 °F above the RCS temperature, and (3) pressurizer pressure is less than or equal to 300 psia. Also, the criteria for reactor shutdown of 8-hours or longer prior to RCP start was removed from the Bases. These changes reflect the analysis assumptions for the limiting energy addition transient discussed above and are, therefore, acceptable.

These changes are necessary, as previously discussed, to provide LTOP protection based on the more restrictive P/T curves and are, therefore, acceptable.

We have determined that the above proposed TS and their supporting TS Bases may be incorporated into the Calvert Cliffs Unit 1 TS.

6.0 SUMMARY

The staff has concluded, based on the discussions in the safety evaluation sections 3.0, 4.0, and 5.0 above, that the proposed TS supporting the new 22 EFPY heatup and cooldown curves and rates, the LTOP controls, RCP start criteria, and supporting TS Bases are acceptable.

7.0 STATE CONSULTATION

In accordance with the Commission's regulations, the Maryland State official was notified of the proposed issuance of the amendment. The State official had no comments.

8.0 ENVIRONMENTAL CONSIDERATION

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 and the surveillance requirements. 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, and there has been no public comment on such finding (57 FR 9437). 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.

9.0 CONCLUSION

The Commission 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, (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.

Principal Contributors:
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Date: June 16, 1992

A copy of the related Safety Evaluation is enclosed. A Notice of Issuance will be included in the Commission's next regular biweekly Federal Register notice.

Sincerely,

Original Signed By

Daniel G. McDonald, Senior Project Manager
Project Directorate I-1
Division of Reactor Projects - I/II
Office of Nuclear Reactor Regulation

Enclosures:
1. Amendment No.171 to DPR-53
2. Safety Evaluation

cc w/enclosures:
See next page

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