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U. S. Nuclear Regulatory Commission
Washington, DC 20555

ATTENTION: Document Control Desk

SUBJECT: Calvert Cliffs Nuclear Power Plant
Unit No. 2; Docket No. 50-318
Technical Specification Change - Low Temperature Overpressure Protection (TAC No. 76130)

REFERENCES:

(a) Letter from Mr. V. R. Evans (BG&E) to Mr. D. K. Davis (NRC), dated July 21, 1977, Reactor Coolant System Overpressurization

(b) Letter from Mr. R. L. Baer (NRC) to Mr. K. R. Goller (NRC), dated November 17,1977, Safety Evaluation of the Low Temperature Overpressure Protection System

(c) Letter from Mr. R. W. Reid (NRC) to Mr. A. E. Lundvall, Jr. (BG&E), dated August 7, 1978, Issuance of Amendment Nos. 34 and 16

(d) Letter from Mr. G. C. Creel (BG&E) to NRC Document Control Desk, dated August 13, 1990, License Amendment Request - Low Temperature Overpressure Protection (LTOP)

(e) Letter from Mr. D. G. McDonald (NRC) to Mr. G. C. Creel (BG&E), dated March 6, 1990, Issuance of Amendment (TAC No. 75562)

Gentlemen:

In 1976, the Nuclear Regulatory Commission required commercial nuclear plants to institute automatic and administrative controls to prevent exceeding the 10 CFR 50, Appendix G operating limits (Pressure-Temperature [P-T] Limits) for the reactor vessel during operations at low temperature. The Unit 2 Low Temperature Overpressure Protection (LTOP) controls are based on P-T limits for the reactor vessel that are applicable for the first 10 Effective Full Power Years (EFPY) of operation.

On July 21, 1977, a plant specific report on Reactor Coolant System (RCS) overpressure protection at low temperatures (Reference a) was submitted to the NRC. That report detailed the administrative controls and hardware modifications which were necessary to protect Calvert Cliffs from a low temperature overpressurization event for 10 effective full power years (EFPY). The NRC approved this basic system in References (b) and (c). This amendment request proposes to replace the existing 0-10 EFPY and 10 - 40 EFPY heatup and cooldown curves (Figures 3.4-2b and 3.4-2c) with new 0-12 EFPY heatup and cooldown curves based on Regulatory Guide 1.99, Revision 2. The proposed changes are requested to reflect reactor vessel embrittlement conditions projected through 12 EFPY so as to be consistent with the other controls established for the LTOP system. While the Unit 2 vessel has experienced less embrittlement than Unit 1 because of more favorable metallurgical composition and lower neutron fluence, new curves are necessary to reflect the latest guidance for prediction of irradiation damage to the reactor vessel contained in Regulatory Guide 1.99, Revision 2. Attachment (1) provides a System Description along with a discussion of administrative controls and hardware modifications necessary for overpressurization protection. The analytical methodology, the administrative controls and the hardware modifications are the same as proposed for Unit 1 in Reference (d) with the following exceptions:

a. A maximum allowable heatup rate of $75^{o}F/hr$ for all RCS temperatures.

b. A maximum cooldown rate of

Cooldown Rate	RCS Temperature
$100^{o}F/hr$	$> 180^{o}F$
$40^{o}F/hr$	$180^{o}F$ to $140^{o}F$
$15^{o}F/hr$	$< 140^{o}F$

c. MPT Enable $\leq 305^{o}F$

d. Maximum indicated pressure for RCP start is $\leq$ 320 psia.

e. Minimum allowed time of 2 hours after reactor shutdown to be in MPT Enable Region.

The exceptions noted under a, b, and c were due to material property differences between the two reactor vessels and the lower radiation exposure of the Unit 2 vessel. Exceptions d and e make use of margin available in the Unit 1 submittal, but not taken. Likewise, the technical basis for the new heatup and cooldown curves are the same as proposed for Unit 1 in Reference (d). A discussion of the basis for the heatup and cooldown curves is provided in Attachment (2).

The minimum boltup temperature for the Unit 2 reactor vessel is also different than Unit 1 since the reactor vessel flange region material properties are different. For Unit 2, the maximum initial RT_{NDT} associated with the stressed region of the reactor vessel flange area during boltup is $30^{o}F$ as established by the certified material test reports and Branch Technical Position MTEB 5-2. Per the ASME Boiler and Pressure Vessel Code Section III Appendix G, the minimum metal temperature in the stressed

region under full bolt pre-load should be at least the initial RT_{NDT} for the material in the stressed region plus any effects of irradiation. Consequently, the minimum boltup temperature for Unit 2 is 30°F. However, for conservatism the boltup temperature is administratively established as 70°F. As a consequence, we no longer require a change in our minimum boltup temperature from 70°F to 90°F as originally requested in our November 1, 1988 letter, and subsequently withdrawn. For Unit 1, the maximum RT_{NDT} of the higher stressed region of the reactor vessel under full bolt pre-load is -10°F. Consequently, the minimum boltup temperature for Unit 1 is -10°F. Likewise, for conservatism the Unit 1 boltup temperature was administratively established as 70°F.

We will not reinstall the Unit 2 pressurizer manway until LTOP issues are resolved; therefore, we request your approval to the proposed changes be provided by November 27, 1990, per our startup schedule. We will advise you promptly of any schedule changes.

I. SUMMARY

A. APPROACH

Analyses have been performed on Unit 2 for the decay heat loads that exist shortly (i.e., two hours or more) after a reactor shutdown. The results demonstrate that new RCP start controls, in conjunction with revised P-T limits and Power Operated Relief Valve (PORV) setpoint, will prevent challenges to the PORV for RCP starts under these conditions. For HPSI mass addition events, new HPSI pump controls, in conjunction with revised P-T limits and PORV setpoint, will prevent exceeding the minimum Appendix G limit for HPSI mass addition events. All other transients are bounded by the RCP start (energy addition) and HPSI actuation (mass addition) analyses.

B. HEATUP AND COOLDOWN CURVES AND RATES

The proposed 0-12 EFPY heatup and cooldown curves and rates are based on the calculation of a family of P-T limit curves. Each of the P-T limit curves within this "family of curves" is associated with a unique heatup and cooldown rate. The rates chosen permit the low temperature PORV pressure lift setpoint to be set to accommodate decay heat values corresponding to approximately two hours following the reactor shutdown. The Technical Specification Figures 3.4-2b and 3.4-2c permit heatup and cooldown evolutions at temperatures as low as 70°F. The low temperature PORV pressure lift setpoint is based on protecting the most limiting pressure of the applicable heatup and cooldown Appendix G curves.

Revised Technical Specification Figures 3.4-2b and 3.4-2c (heatup and cooldown curves) have been conservatively developed in accordance with the requirements of 10 CFR 50 Appendix G, as supplemented by Appendix G to Section III of the ASME Boiler and Pressure Vessel Code, 1986 Edition. The adjusted RT_{NDT} values used in their development have been conservatively calculated using the methodology provided in

Regulatory Guide 1.99, Revision 2, and are based upon the peak neutron fluence predicted to be experienced by the reactor beltline region through a period of 12 EFPY.

C. LTOP CONTROLS

The low temperature PORV pressure lift setpoint is based on protecting the most restrictive pressure of both the heatup and cooldown curves. The most restrictive pressure (471.2 psia) limitation is for the 15°F/hr cooldown at 70°F in the RCS. A setpoint of 430 psia, which includes instrumentation uncertainties and sufficient margin for PORV response time requirements necessary for the protection of 471.2 psia, was selected.

The LTOP enable temperature of 305°F was developed using the guidance found in NRC Standard Review Plan 5.2.2, Revision 2. The enable temperature was calculated using specific heatup transients up to 75°F/hr.

D. HPSI PUMP CONTROLS

For the LTOP system, one of the design basis events is a mass addition transient. To evaluate this transient, a PORV limiting flow is calculated assuming various mass inputs. The most limiting case includes HPSI pump flow, charging pump flow and the expansion of water in the RCS due to a loss of decay heat removal. The sum of these three factors must be equal to or less than the total limiting flow. The only controllable variable in the three components is the HPSI pump flow. After the total limiting flow of one PORV is determined, the charging pump flow and RCS water expansion are subtracted to determine the maximum allowed HPSI pump flow. Adjustment for instrumentation uncertainty then defines an acceptable indicated HPSI flowrate.

Analyses of the time-dependent response of the PORV to overpressurization events were performed. These new calculations corrected an element of the original analysis submittal in 1977 (Reference a) that had not been treated with sufficient conservatism. Specifically, calculation of the limiting liquid flowrate did not consider possible critical flow effects. If the fluid in the pressurizer is only slightly subcooled, it will flash as it passes through the PORV and flow will reach a critical limit. The original calculations considered only highly subcooled liquid flow as is typical in an initially solid pressurizer. Some mass addition transients, however, can be initiated with only slightly subcooled liquid in the pressurizer, which is typical when a bubble exists. In such cases, it is more limiting to consider critical flow effects than the Bernoulli flow assumed in the original resolution of the LTOP issue in 1977.

The analysis also considers decay heat loads based on minimum time to cooldown to an LTOP condition. Decay heat loads cause reactor coolant thermal expansions following a loss of shutdown cooling resulting in a reduction in permissible HPSI flow.

These components, plus instrumentation uncertainty, are compared to the total flow limit of 380 gpm to yield the indicated HPSI flow limit of 210 gpm. Throttling HPSI indicated flow to 210 gpm ensures equilibrium pressurizer pressure would not exceed 471.2 psia, the minimum Appendix G limit.

This HPSI flowrate was reviewed against other design basis events. High Pressure Safety Injection pumps are required to be available to respond to three types of events while LTOP protection is required: excessive reactor coolant leakage, a boron dilution event, or a loss of shutdown cooling. For an excessive reactor coolant leakage event, the flow needed to maintain adequate core cooling is provided as needed to maintain parameters such as pressurizer pressure and adequate subcooled margin. This approach has been previously reviewed and approved by the NRC (Reference e). For a boron dilution event, the Bases to Technical Specification 3.1.2.1 state that the analysis assumed borated water from the Refueling Water Tank was injected at a rate of 44 gpm. A HPSI pump throttled to 210 gpm can clearly provide this amount. For a loss of shutdown cooling, analyses have determined that an actual flowrate of 175 gpm was adequate to prevent uncovering the core. An indicated flow of 210 gpm provides sufficient actual flow to mitigate these events. Thus, the proposed flow limit of 210 gpm meets all design requirements.

E. RCP CONTROLS

The limiting design basis energy addition LTOP transient is an RCP start with isolation of letdown, energy addition from hot steam generators, energy addition from two RCPs, energy addition from pressurizer heaters, and the expansion of water due to a loss of decay heat removal. Controllable variables in this analysis are the initial pressurizer pressure, pressurizer level, and the energy addition from the hot steam generators. The energy addition transient can be mitigated by limiting the initial pressurizer pressure, the initial pressurizer level, and the steam generator secondary-to-primary delta-T. Analytical values are adjusted for instrument uncertainty to define acceptable indicated limits on pressure, level, and differential temperature required prior to RCP start.

The pressurizer insurge following a start of two RCPs was calculated assuming an initial indicated pressurizer level of 170 inches, a maximum indicated secondary-to-primary temperature differential of 30°F, an initial indicated pressurizer pressure of 320 psia, and a decay heat load based on the plant being shutdown for two hours or more. No operator action was credited for the first 10 minutes. The results demonstrated that, for these conditions, the peak RCS pressure is below the PORV

set pressure. Therefore, the results of this analysis satisfy the 10 CFR 50 Appendix G acceptance criteria.

The thermal-hydraulic analysis of RCP start transients conservatively simulates thermodynamic conditions within the pressurizer. Initial conditions for pressurizer pressure, pressurizer level, and steam generator-to-RCS delta-T are determined by statistical combination of instrumentation uncertainties. The statistical analysis provides at least a 95% confidence that 95% of the instrumentation uncertainty combinations are bounded. The methodology used a root-sum-square combination of instrument uncertainties, combined with sensitivity coefficients based on partial derivatives of peak pressure with respect to initial pressurizer pressure and level, and steam generator-to-RCS delta-T.

Pressurizer insurge was calculated for limiting decay heat loads and steam generator-to-RCS delta-T. Analysis includes energy addition from two RCPs. Letdown was assumed to be isolated, and no credit was taken for sensible heat absorption in the RCS component metal mass except as described below. Limiting insurge results are input to the pressurizer model described below.

A simple computer model of the pressurizer was developed to conservatively calculate the transient pressure response as a function of time. The model consists of three regions where Region 1 is the steam space, Region 2 is the initial saturated liquid volume, and Region 3 is the subcooled liquid region at the bottom of the pressurizer which is formed as a result of the transient insurge. The conditions that can exist for each region are: saturated or superheated steam in Region 1, saturated or subcooled water in Region 2, and subcooled water in Region 3.

Mass and energy transfer between Regions 1 and 2 is assumed to occur only as the result of liquid vaporization and/or steam condensation. Mass and energy transport into or out of the pressurizer is assumed to occur only as the result of surge flow, pressurizer heater input, and wall heat transfer for this analysis. No credit is taken for condensation of steam on the liquid-steam interface, or for the mixing of, or transfer of heat between the initially saturated liquid and the colder insurge liquid. Heat transfer is assumed to occur radially through the wall. No credit is taken for heat conduction to other structures.

F. PORV RESPONSE TIME

The actual maximum response time for Unit 1 PORVs was assumed for Unit 2 since the designs are identical and the system cannot currently be pressurized to conduct a test. That response time is compared to the response time required by the analysis to ensure that Appendix G pressure limits are not exceeded. The PORVs are fast-acting Dresser electromatic relief valves. The PORV response time is made up of two elements: the valve mechanical response time and the electronic circuit

response time. For Unit 1 a maximum total valve response time of 0.49 seconds was obtained. This response time is consistent with (1) the results of tests performed by other utilities for similar valves in the field; and (2) bench tests performed by EPRI.

The analyses performed to determine the required PORV response time considered the two most severe mass addition transients: (1) throttled HPSI flow plus one charging pump, with an initial pressurizer bubble; and (2) flow from one charging pump and a solid pressurizer. Both cases include reactor coolant thermal expansion after loss of decay heat removal. The second case yields the limiting required PORV response time of 1.66 seconds. Since this required response time is greater than the actual response time discussed above; therefore, the performance of the PORV has been adequately demonstrated to be acceptable for mitigating LTOP transients.

We are evaluating the need for performing periodic tests of the PORV under the ASME Section XI pump and valve testing program. The results of this evaluation will be provided in our response to NRC Generic Letter 90-06, "Resolution of Generic Issue 70," dated June 25, 1990.

II. REQUEST FOR LICENSE AMENDMENT.

The Baltimore Gas and Electric Company hereby requests an amendment to Operating License DPR-69 for Calvert Cliffs Unit 2 with the submittal of the proposed Technical Specifications in Attachment (3). With the exception of heatup and cooldown rates, MPT Enable temperature, the initial pressurizer pressure required for RCP start and the minimum allowed time after reactor shutdown to be in MPT Enable Region, these changes are the same as proposed for Unit 1.

A. DESCRIPTION OF CHANGES

1. Heatup and Cooldown Curves and Rates.

   a. The 0-10 and 10-40 EFPY heatup and cooldown curves (Figures 3.4-2b, 3.4-2c) would be deleted and replaced with 0-12 EFPY heatup and cooldown curves.

   b. Technical Specification 3.4.9.1.a currently provides a heatup rate of $100^{o}F/hr$ based on 0-10 and 10-40 EFPY of operation. A new heatup rate has been calculated per the requirements of 10 CFR 50, Appendix G, as supplemented by Appendix G to Section III of the ASME Boiler and Pressure Vessel Code, 1986 Edition. The adjusted Reference Temperatures have been developed in accordance with the guidance provided in Regulatory Guide 1.99, Revision 2. A discussion of the calculation is provided in Attachment (2). Based on these

calculations, BG&E proposes to change the existing allowable heatup rate to:

Maximum Allowable Heatup Rate	RCS Temperature
75°F in any one hour period	All Temperatures

c. Technical Specification 3.4.9.1.b currently allows a maximum cooldown rate of 100°F per hour when RCS temperature is above 250°F, and 20°F per hour when RCS temperature is below 250°F.

New cooldown rates have been calculated per the requirements of 10 CFR 50, Appendix G, as supplemented by Appendix G to Section III of the ASME Boiler and Pressure Vessel Code, 1986 Edition. The adjusted Reference Temperatures have been developed in accordance with the guidance provided in Regulatory Guide 1.99, Revision 2. A discussion of the calculation is provided in Attachment (2). Based on these calculations, BG&E proposes to change the existing allowable cooldown rate to:

Maximum Allowable Cooldown Rate	RCS Temperature
100°F in any one hour period	> 180°F
40°F in any one hour period	180°F to 140°F
15°F in any one hour period	< 140°F

d. The ACTION STATEMENT for Technical Specification 3.4.9.1 should be changed to conform with the 0-12 EFPY P-T curves. The ACTION STATEMENT currently requires a cooldown to less than 200°F and 500 psia. When compared to the 0-12 EFPY cooldown curves, this ACTION STATEMENT violates the P-T curve in that 200°F at 500 psia is not a permissible condition. To correct the ACTION STATEMENT, we propose a cooldown to less than 200°F and 300 psia.

e. Changes to the ACTION STATEMENT of Technical Specification 3.4.9.2 are proposed to ensure that cooldown actions required are consistent with the 0-12 EFPY P-T curves. These cooldown actions are consistent with the proposed ACTION STATEMENT in Technical Specification 3.4.9.1. (See d, above.)

f. The bases for Technical Specification 3/4.4.9 have been changed to reflect the changes described above.

2. LTOP Controls

a. Technical Specification 3.4.9.3 currently requires two PORVs be operable with a lift setting of ≤ 450 psig, or a reactor coolant system vent of ≥ 1.3 square inches when one or more RCS cold leg temperature is ≤ 275°F. This proposed change would lower the required PORV lift setting to ≤ 430 psia and require system vents equivalent to the number of PORVs not available (Technical Specification 3.4.9.3.a) when the RCS temperature is ≤305°F and the RCS is vented to < 8 square inches. The proposed change would also require two of three HPSI pumps to be disabled (Technical Specification 3.4.9.3.b), and the HPSI loop motor-operated valves to be prevented from automatically aligning HPSI pump flow to the RCS (Technical Specification 3.4.9.3.c). If a HPSI pump is to be used, the total flow will be throttled to less than or equal to 210 gpm or a vent equivalent to two PORVs will be required (Technical Specification 3.4.9.3.d).

The controls of this proposed Technical Specification are not applicable if a system vent greater than or equal to 8 square inches exists. A system vent greater than or equal to 8 square inches has a greater flow area than 6 PORVs (7.8 square inches). Two PORVs can handle the full flow of a HPSI pump and the full flow of three charging pumps. Therefore, a vent of this size will handle the injection from any combination of operable pumps.

ACTION STATEMENT changes are proposed to provide appropriate actions based on the requirements proposed for Technical Specification 3.4.9.3.

Proposed ACTION STATEMENT (a) maintains the same venting requirements found in the existing ACTION STATEMENT, however, the action times have been changed. The current action times are 7 days to restore a PORV to OPERABLE status or the RCS must be vented within 8 hours. The proposed change would only allow 5 days to restore the PORV to OPERABLE status and would increase the time permitted to vent the RCS to 48 hours. This change is proposed because it is impractical to attempt to depressurize and vent the RCS within 8 hours. If the RCS were at 305°F (LTOP entry condition) and 430 psia , BG&E has determined that a cooldown of the RCS to less than 200°F, within 48 hours is practical. In addition, the proposed change does not increase the total

time a PORV could be out-of-service (7 days) before a vent is established in the RCS.

ACTION STATEMENT (b) currently requires that a ≥ 1.3 square inch vent be established within 8 hours if both PORVs are inoperable. The proposed change would increase the vent size to ≥ 2.6 square inches (equivalent to two PORVs) or allow entry into Technical Specification 3.4.9.3.a.2. The action time has been increased from 8 hours to 48 hours for the reasons mentioned above.

ACTION STATEMENT (c) has not been changed. ACTION STATEMENT (d) has been relabeled as ACTION STATEMENT (g).

Three new ACTION STATEMENTS (d), (e) and (f) have been added to reflect the additional controls added to the Technical Specification.

Proposed ACTION STATEMENT (d) requires that with less than two HPSI pumps disabled that we place at least two HPSI pump handswitches in Pull-to-Lock within 15 minutes and disable two HPSI pumps within the next four hours.

Proposed ACTION STATEMENT (e) addresses the disabling of the automatic alignment feature of the HPSI pump flowpath. It requires that the affected MOV handswitch be immediately placed in pull-to-override or the affected HPSI loop MOVs be closed and disabled or the affected HPSI header be isolated within 4 hours. In addition, because a HPSI header may now be isolated, the ACTION STATEMENT directs the operator to enter applicable HPSI pump or boration flowpath ACTION STATEMENTS.

Proposed ACTION STATEMENT (f) addresses actions to be taken if HPSI pump flow exceeds 210 gpm while an RCS vent < 2.6 square inches exists. Flow must be immediately reduced to within limits and the pressure must be verified to have remained within limits. If the RCS pressure exceeded the limits of the existing 0-12 EFPY curve, then a Special Report will be submitted in accordance with ACTION STATEMENT (c).

b. Surveillance Requirement 4.4.9.3.3 is added to verify the new conditions proposed for Technical Specification 3.4.9.3.b and c, above, for overpressure protection. Specifically, the proposed change requires verification that the motor circuit breakers are removed for the two inoperable HPSI pumps or their discharge valves are locked shut. It would also require that the automatic opening feature of the HPSI loop motor operated valves be verified disabled. These verifications are required at least once per 12 hours. These

proposed surveillances and their associated frequency replace the surveillance described in Technical Specification 4.5.3.2. Therefore, Surveillance Requirement 4.5.3.2 is deleted.

c. The bases for Technical Specifications 3/4.4.1 and 3/4.4.9 have been changed to reflect the changes described above.

3. <u>HPSI Pump Controls</u>.

a. Currently, Technical Specifications 3.1.2.1 and 3.1.2.3 allow the use of a HPSI pump to provide a source of boron injection in **MODES** 5 and 6. The proposed change would add a footnote (*) which defines an OPERABLE HPSI pump as being in pull-to-lock and states that HPSI pump use is in accordance with the restrictions outlined in change 2.a. This footnote will provide assurance that the use of a HPSI pump for boration will not overpressurize the RCS.

b. Technical Specification 3.5.3 requires one operable HPSI pump in **MODE 3** (with pressurizer pressure < 1750 psia) and **MODE 4**. Footnote (#) to this Technical Specification states that a maximum of one HPSI pump shall be operable when the temperature of one or more RCS cold legs is $\leq 275^{O}F$. The proposed footnote will now define the operable pump conditions and state that the pump can be operated in accordance with the restrictions outlined in Paragraph 2.a. This change will also assure appropriate overpressure protection is provided in the low temperature region.

c. A footnote has been proposed for the surveillance requirements of Technical Specification 4.5.2. The note allows full flow testing of a HPSI pump to be conducted at RCS temperatures $\leq 305^{O}F$ as long as the HPSI pump is recirculating RCS water. This prevents a mass addition to the RCS from other water sources. If a HPSI pump is to be tested without recirculating RCS water, the controls of Technical Specification 3.4.9.3 apply. These controls, discussed in change 2.a, limit the mass addition from a HPSI pump or require an appropriately sized vent to exist. This prevents overpressurization of the RCS due to a mass addition transient.

d. A footnote to Table 3.3-3 is proposed to provide information on HPSI pump operation. The proposed footnote reads as follows: "When the RCS temperature is: (a) Greater than $350^{O}F$, the required OPERABLE HPSI pumps must be able to start automatically upon receipt of a SIAS signal, (b) Between $350^{O}F$ and $305^{O}F$, a transition region exists where the OPERABLE HPSI pump will be placed in pull-to-lock on a

cooldown and restored to automatic status on a heatup, (c) At 305°F and less, the required OPERABLE HPSI pump shall be in pull-to-lock and will not start automatically." This change clarifies the appropriate temperature range for placing the OPERABLE HPSI pump in pull-to-lock.

e. The bases for Technical Specification 3.5.3 has been changed to reflect the new restrictions on HPSI operation imposed by the above changes.

4. RCP CONTROLS

a. The existing footnote (***) to the APPLICABILITY of Technical Specification 3.4.1.3 requires that an RCP not be started when RCS temperature is less than or equal to 275°F unless (1) the pressurizer water volume is less than 600 cubic feet or (2) the secondary water temperature of each steam generator is less than 46° (34°F when measured by a surface contact instrument) above each of the RCS cold leg temperatures. The proposed change would require that an RCP not be started when the RCS temperature is less than or equal to 305°F unless (1) indicated pressurizer water level is less than or equal to 170 inches, (2) the indicated water temperature for the secondary side of each steam generator is less than or equal to 30°F above the RCS temperature and (3) the pressurizer pressure is less than or equal to 320 psia.

b. Add a footnote (**) to the APPLICABILITY of Technical Specification 3.4.1.2 (p. 3/4 4-2) to provide RCP start controls consistent with those existing in Technical Specification 3.4.1.3.

c. The basis for Technical Specification 3/4.4.1 and 3/4.4.9 are changed to reflect the above restrictions.

B. DETERMINATION OF SIGNIFICANT HAZARDS

These proposed changes have been evaluated against the standards in 10 CFR 50.92 and have been determined to involve no significant hazards considerations, in that operation of the facility in accordance with the proposed amendment would not:

Heatup and Cooldown Curves

(i) involve a significant increase in the probability or consequences of an accident previously evaluated; or

The Unit 2 0-12 EFPY P-T limits were conservatively developed in accordance with the fracture toughness requirements of 10 CFR 50, Appendix G as supplemented by the ASME Code Section III, Appendix G. The mechanical properties and chemical composition of the reactor vessel beltline materials used in the analysis were the same as those used to evaluate the Pressurized Thermal Shock (PTS) concern in January 1986, as approved by the NRC. The peak reactor vessel fluence was calculated using Discrete Ordinate Transport (DOT) calculations with a DOT IV.3 computer code. The analysis of the reactor vessel material irradiation surveillance specimens was used to verify the validity of the fluence calculations. The Adjusted RT_{NDT} values were based on the conservative methodology provided in Regulatory Guide 1.99, Revision 2. This regulatory guide revision is based on a change in the understanding of material properties behavior in the presence of neutron flux. The present curves reflect our previous understanding of irradiated material behavior, while the proposed curves reflect the updated information. The revised P-T limits provide conservative limits on reactor coolant system pressure to minimize material stresses in the RCS due to normal operating transients, and to further minimize the likelihood of a rapidly propagating fracture due to pressure transients at low temperature. Therefore, the proposed amendment does not involve an increase in the probability or consequences of accidents previously evaluated.

(ii) create the possibility of a new or different type of accident from any accident previously evaluated; or

The P-T limits do not represent a significant change in the configuration or operation of the plant. Specifically, no new hardware is being added to the plant as a result of this proposed change, no existing equipment is being modified, nor are any significantly different types of operations being introduced. Therefore, the proposed amendment would not create the possibility of a new or different kind of accident from those previously evaluated.

(iii) involve a significant reduction in the margin of safety.

The 0-12 EFPY P-T curves provide an adequate margin of safety as defined by 10 CFR 50, Appendix G, as supplemented by ASME Code Section III, Appendix G. The conservative methodology of Regulatory Guide 1.99, Revision 2 also provides an adequate margin of safety for the prediction of reactor vessel neutron embrittlement.

The margin of safety has not been reduced even though a portion of the 0-12 EFPY P-T curves are less restrictive than the 10-40 EFPY curves. The 10-40 EFPY P-T curves are overly conservative. Additionally, the 10-40 EFPY P-T curves were not defined using the methods described in Regulatory Guide 1.99, Revision 2. The margin of safety is defined by 10 CFR 50, Appendix G, which is implemented by Regulatory Guide 1.99, Revision 2 and reflects the current understanding of irradiated material behavior. The proposed 0-12 EFPY curves have been developed in accordance with Regulatory Guide 1.99, Revision 2, therefore, the margin of safety has been maintained.

2. **Heatup Rates**

(i) involve a significant increase in the probability or consequences of an accident previously evaluated; or

New heatup rates have been proposed for Unit 2 (Technical Specification 3.4.9.1.a). These heatup rates were developed using CE methodology that has been reviewed and approved by the NRC in support of other licensees' submittals. The proposed heatup rates ensure that the reactor vessel metal temperature remains sufficiently close to the coolant temperature so that no undue stress occurs. In fact, because the proposed heatup rates reflect our improved understanding of irradiated material behavior, this change would decrease the likelihood that normal plant heatup would result in undue stress to the reactor vessel.

Additionally, the proposed ACTION STATEMENT for cooldown of the reactor vessel (Technical Specification 3.4.9.1) and the pressurizer (Technical Specification 3.4.9.2) would require that the system be cooled down to a final pressure and temperature consistent with the 0-12 EFPY P-T curves. This eliminates any potential conflict between the pressures and temperatures defined by the 0-12 EFPY cooldown curve and the pressures and temperatures given in the ACTION STATEMENTS. Because the proposed change would preclude going to unauthorized pressures at a given temperature, this change would decrease the likelihood that plant operators would take any action that might be inimical to reactor vessel integrity while complying with an action statement.

(ii) create the possibility of a new or different type of accident from any accident previously evaluated; or

No new operations or hardware changes are required to implement these proposed Technical Specifications. The heatup rate is being changed, but the method of plant operation has not changed. Therefore, the proposed amendment would not create the possibility of a new or different kind of accident from those previously evaluated.

(iii) involve a significant reduction in a margin of safety.

The evaluation of the prediction of neutron embrittlement for a period of operation through 12 EFPY provides an adequate margin of safety as required by 10 CFR 50, Appendix G. Reducing the heatup rate (Technical Specification 3.4.9.1.a) ensures that the reactor vessel will not be subject to stresses for which it has not been analyzed. Additionally, changing the ACTION STATEMENT (Technical Specification 3.4.9.1 and 3.4.9.2) to conform to conditions required by the 0-12 EFPY curves ensures that the reactor vessel or pressurizer is not placed in a condition prohibited by Technical Specifications. These proposed changes provide adequate protection of the RCS in accordance with 10 CFR 50, Appendix G. Therefore, the proposed amendment would not reduce the margin of safety.

3. <u>LTOP Controls</u>

(i) involve a significant increase in the probability or consequences of an accident previously evaluated; or

These proposed changes (Technical Specification 3.4.9.3.a and the applicability statement) ensure that the LTOP controls will provide adequate protection against overpressurization events for the reactor vessel. An applicability statement (Technical Specification 3.4.9.3) change is proposed which would not require other LTOP controls if a large enough vent exist in the RCS. An overpressurization can only occur if insufficient venting capacity exists. The proposed vent size (8 square inches) provides enough venting capacity to protect against any postulated event. Therefore, additional controls are not needed when a vent greater than or equal to eight square inches exists. This defines a vent capacity for which LTOP is not required.

The ACTION STATEMENTS (a and b) were changed to require a vent equivalent to the number of PORVs out-of-service. All of the supporting analyses were performed assuming only one PORV opened to mitigate an overpressurization event. Since a single failure must be assumed during an overpressurization event, requiring a total vent capacity equivalent to two PORVs ensures that the most limiting single failure (loss of a PORV) can be accommodated. These changes will provide protection which is equivalent to or better than the existing controls against overpressurization events in the low temperature region. Therefore, these changes do not involve a significant increase in the probability or consequences of an accident previously evaluated.

(ii) create the possibility of a new or different type of accident from any accident previously evaluated; or

This proposed Technical Specification (3.4.9.3) requires larger vents when a PORV is out-of-service. It also defines a vent size beyond which LTOP is not required. This does not represent a significant change in the configuration or operation of the plant. Larger vent openings do not require a significant change to the operation of the facility. No new hardware is being added to the plant and no existing equipment is being modified. Therefore, these changes would not create the possibility of a new or different kind of accident from those previously evaluated.

(iii) involve a significant reduction in a margin of safety.

These proposed changes provide an adequate margin of safety for operations in the low temperature region. The limiting applicable vent size (8 square inches) was chosen based on conservative analyses which show that this vent is large enough to relieve flow from any possible combination of pumps available for operation. The margin of safety has been reestablished for PORV operability by requiring an equivalent amount of vent capacity for each PORV disabled. These changes will ensure that the margin of safety provided by the LTOP system as originally approved by the NRC is maintained.

4. <u>LTOP Controls (3.4.9.3 ACTION STATEMENTS a and b)</u>

(i) involve a significant increase in the probability or consequences of an accident previously evaluated; or

This Technical Specification change (3.4.9.3) proposed altering the PORV out-of-service time and the cooldown and depressurization time. For one PORV out-of-service, the time allowed to restore it to service before a cooldown is required is reduced from 7 days to 5 days. The corresponding cooldown and depressurization time is increased from 8 hours to 48 hours. For two PORVs out-of-service, the depressurization must begin immediately and the time allowed to cooldown and depressurize is increased from 8 hours to 48 hours. These changes in the ACTION STATEMENT do not significantly increase the probability or consequences of an accident previously evaluated. For the case of one PORV out-of-service, the current ACTION STATEMENT allows 7 days and 8 hours from the time the ACTION STATEMENT is entered until the RCS is vented. The proposed ACTION STATEMENT would allow 7 days (5 days plus 48 hours) from the time the ACTION STATEMENT is entered until the RCS is vented. Therefore, the total amount of time that a PORV is out-of-service before a vent is opened in the RCS has been reduced from 7 days, 8 hours to 7 days.

By proposing a 48 hour depressurization time, the operators would then be allowed adequate time to safely transition through a water solid plant condition to the required vented condition. As an example, experience indicates that it takes just under 48 hours to perform the various evolutions necessary to bring the plant from 350°F to a cooled and vented condition. Given the current Technical Specifications, under the worst conditions (275°F, 450 psig), with two PORVs failed, the operators would have to cool the RCS to less than 200°F, collapse the pressurizer bubble, cooldown the pressurizer, draindown, and open a vent, within 8 hours. This would require the plant to enter its most sensitive LTOP condition, water solid, in a hurried fashion. Under conditions such as these, human error becomes an important consideration. An additional consideration is the possibility of personnel injury resulting from opening RCS vents manually before the system is cool enough. Mechanics are required to enter containment to open a vent of adequate size, because it cannot be done from the control room. If the metal in the pressurizer were still too warm, steam could form, causing serious injury to personnel attempting to remove the pressurizer manway. By approving the proposed change, BG&E believes that the probability of an LTOP event during compliance with this ACTION STATEMENT is actually reduced.

(ii) create the possibility of a new or different type of accident from any accident previously evaluated; or

The revised ACTION STATEMENT times do not represent a change in the operation of the plant. Specifically, no new hardware is being added to the plant as a result of these proposed changes, no existing equipment is being modified, nor are any different types of operations being introduced. Additionally, more time is available for an orderly cooldown. There is less likelihood of rapid plant changes resulting in an unforeseen situation. A normal cooldown process would require about 48 hours. Therefore, the proposed amendment would not increase the possibility of a new or different kind of accident from those previously evaluated.

(iii) involve a significant reduction in a margin of safety.

For this change, the margin of safety is in minimizing the probability of an LTOP initiating event while the RCS is protected by one or less PORVs. The proposed ACTION STATEMENT addressing one PORV operable allows a 5 day out-of-service time before RCS depressurization must begin. This is a reduction in the allowed out-of-service time for a PORV, from 7 days to 5 days. When both PORVs are out-of-service, a cooldown and depressurization must begin immediately, as in the current Technical Specifications. BG&E is requesting the cooldown and depressurization time be extended from 8 hours to 48 hours to allow adequate time for operator action to safely cooldown and depressurize the RCS. The depressurization process requires that the RCS be filled

water solid to collapse the steam bubble and then drained. This is the most limiting condition for LTOP and poses the greatest vulnerability for initiation of an overpressurization event. The need to rapidly open a vent in the RCS must be balanced against the potential danger posed by rushing the plant through its most limiting LTOP transient condition. During the cooldown and depressurization required by these ACTION STATEMENTS, operators will be procedurally directed to monitor the plant status. Action to depressurize will be initiated sooner (with one PORV out-of-service) than currently stated in the Technical Specifications. With two PORVs out-of-service, action to depressurize will still be initiated immediately. BG&E believes that the margin of safety is increased by allowing additional time to conduct an orderly transition to a stable, safe condition.

5. <u>HPSI Controls</u>

(i) involve a significant increase in the probability or consequences of an accident previously evaluated; or

Various controls are proposed to ensure that the HPSI system cannot initiate an overpressurization event by adding too much fluid mass to the RCS. The HPSI pumps will be disabled, so that they will not start automatically and the HPSI loop MOVs will be closed and disabled, so they will not align flow to the RCS automatically (Technical Specification 3.4.9.3.b and c, ACTION STATEMENTS d and e). When required for use, the HPSI pump flow will be throttled to less than or equal to 210 gpm (Technical Specification 3.4.9.3.d and ACTION STATEMENT f). An exception to this flow restriction (210 gpm) is permitted when the operators respond to an excessive reactor coolant leakage event. This accident response has been previously described to the NRC and been found acceptable for Unit 1. HPSI pump use could also be required to respond to an RCS boron dilution event (Technical Specification 3.5.3, 3.1.2.1 and 3.1.2.3), or to recover from a loss of shutdown cooling (Generic Letter 88-17). In both of these cases, the HPSI pump is the second of two systems available to respond to the event. Additionally, the operators have a greater response time for these events when compared to an excessive reactor coolant leakage event. Therefore, the probability or consequences of a previously evaluated accident have not increased. The use of the HPSI system has been altered to provide adequate protection against an LTOP event, while maintaining its availability for required uses.

Surveillance testing of the HPSI pumps is performed at low temperature conditions. Some of these tests require the HPSI pumps to inject water into the RCS. Controls have been proposed (Technical Specification 4.5.2) to ensure that these tests will not overpressurize the RCS. The surveillance testing is required to ensure proper system response if an accident were to occur. By providing proper controls on the testing, the probability or consequences of an LTOP event resulting from surveillance testing requirements are not increased.

The proposed footnote added to Table 3.3-3 provides clarification. The intention of the footnote is to allow an operating band for placing the pump in pull-to-lock since HPSI pumps must be prevented from starting automatically while in the low temperature region of operation. The pumps are disabled prior to enabling the LTOP system. A temperature band (between 350°F and 305°F) is needed to allow this. This proposed change is administrative in nature, in that it clarifies an existing Technical Specification. It does not impact the operation of the facility and therefore, the proposed change does not increase the probability or consequences of a previously evaluated accident.

(ii) create the possibility of a new or different type of accident from any accident previously evaluated; or

The proposed HPSI system controls do not represent a significant change in the configuration or operation of the facility. Specifically, no new hardware is being added as a result of these proposed changes and no equipment is being modified. Changes have been made in the way the HPSI pumps are operated. Now, when operated in the low temperature region, their flow must be throttled or an RCS vent provided. However, no new accident scenarios are introduced as a result of operating the HPSI system in this fashion.

System redundancy and adequate operator action time ensure that the HPSI system can continue to perform its intended function. The proposed changes do not create the possibility of a new or different kind of accident from those previously evaluated.

The proposed change to Table 3.3-3 is administrative in nature, in that it provides clarification. No new operations are introduced and no hardware changes are required. Therefore, this change does create the possibility of a new or different kind of accident from those previously evaluated.

(iii) involve a significant reduction in a margin of safety.

HPSI system operability has been altered to ensure that an inadvertent mass addition which could overpressurize the RCS does not occur. This ensures that the margin of safety is maintained in regard to low temperature overpressure protection. By providing redundant controls

(disabling pumps and valves), a single failure can be tolerated in this scheme while still maintaining adequate protection. Therefore, the proposed change would not reduce the margin of safety.

No change to the margin of safety is created by the proposed change to Table 3.3-3. The change is administrative in nature and does not alter the previously approved method of operating the facility. It provides clear requirements for the operation of HPSI pumps at low temperatures. The margin of safety established by allowing these operations is not changed.

6. **RCP Controls**

(i) involve a significant increase in the probability or consequences of an accident previously evaluated; or

The current Technical Specification allows RCP starts while the RCS is water solid as long as the difference between the RCS and secondary water temperatures is small or RCP starts with an adequate bubble in the pressurizer. The proposed Technical Specification (3.4.1.2 and 3.4.1.3) would change these conditions for starting RCPs. Reactor coolant pump starts will be allowed only with an adequate bubble in the pressurizer, and a secondary-to-primary temperature difference that is sufficiently small to limit energy addition to the primary system. Also, a new control is being added in that the initial indicated pressurizer pressure will be limited to less than or equal to 320 psia.

This revised set of RCP start controls was selected to permit RCP starts without challenging the PORVs.

(ii) create the possibility of a new or different type of accident from any accident previously evaluated; or

No new type of accident is created by altering the RCP start criteria in the Technical Specifications. No new hardware is being added to the plant as a result of this proposed change, no existing equipment is being modified, nor are any different types of operations being introduced. Reactor coolant pumps are now only started while there is a bubble in the pressurizer. Pressurizer pressure and level are controlled during an RCP start. Therefore, the proposed change does not create the possibility of a new or different kind of accident from those previously evaluated.

(iii) involve a significant reduction in a margin of safety.

This change will ensure that the margin of safety is maintained with respect to an energy addition event. It eliminates an operation (i.e., RCP start while water solid) that is currently allowed by Technical Specifications but is no longer performed by procedure. Insufficient energy is available to cause an overpressurization event as long as the indicated secondary-to-primary side temperature difference is less than or equal to 30°F, initial indicated pressurizer level is less than or equal to 170 inches, and the initial indicated pressurizer pressure is less than or equal to 320 psia. Therefore, this proposed amendment ensures the margin of safety is maintained, in that the acceptance criteria of 10 CFR 50 Appendix G continue to be satisfied for all postulated energy addition LTOP transients.

SAFETY COMMITTEE REVIEW

The attached proposed changes to the Technical Specifications and our determination of significant hazards have been reviewed by our Plant Operations Safety Review Committee and Off-Site Safety Review Committee, and they have concluded that implementation of these changes will not result in an undue risk to the health and safety of the public.

Should you have any further questions regarding this matter, we will be pleased to discuss them with you.

Very truly yours,

G. C. Creel

STATE OF MARYLAND :
: TO WIT :
County of Calvert :

I hereby certify that on the 22nd day of October, 1990, before me, the subscriber, a Notary Public of the State of Maryland in and for Calvert County, personally appeared George C. Creel, being duly sworn, and states that he is Vice President of the Baltimore Gas and Electric Company, a corporation of the State of Maryland; that he provides the foregoing response for the purposes therein set forth; that the statements made are true and correct to the best of his knowledge, information, and belief; and that he was authorized to provide the response on behalf of said Corporation.

WITNESS my Hand and Notarial Seal: Donna L. McCready
Notary Public

My Commission Expires: January 1, 1994
Date

GCC/DBO/dlm

Attachments:
(1) LTOP System Description
(2) Final Report on P-T Limits for Unit 2
(3) Proposed Technical Specification Changes

cc: D. A. Brune, Esquire
J. E. Silberg, Esquire
R. A. Capra, NRC
D. G. McDonald, Jr., NRC
T. T. Martin, NRC
L. E. Nicholson, NRC
R. I. McLean, DNR

BG&E Letter dated October 22, 1990
License Amendment Request
Low Temperature Overpressure Protection

LTOP SYSTEM DESCRIPTION
CALVERT CLIFFS NUCLEAR POWER PLANT
UNIT 2

1.0 INTRODUCTION

On July 21, 1977, a plant specific report on Reactor Coolant System (RCS) overpressure protection (LTOP) at low temperatures (Reference 8.1) was submitted to the NRC. That report detailed the administrative controls and hardware modifications which were necessary to protect Calvert Cliffs from an LTOP event for 10 effective full power years (EFPY). This document describes additional measures required to continue adequate 10 CFR Appendix G protection for 12 EFPY. It addresses the same issues as the 1977 report and therefore could be considered an extension of the original submittal. The focus of this description is not on the technical detail of supporting analyses, although some information is provided. Rather, a general overview of LTOP protective measures at CCNPP is presented. These measures (for 12 EFPY) supersede those established in 1977.

Since no major modifications to systems affecting LTOP have been made, the important overpressurization events are the same as those postulated in the 1977 report; i.e., letdown isolation, safety injection (SI) pump start, charging pump start, reactor coolant pump (RCP) start, and full pressurizer heater actuation. The re-analysis of these events is similar to the analysis discussed in the 1977 report.

2.0 GENERAL APPROACH TO OVERPRESSURIZATION PROTECTION

BG&E's approach to LTOP is based primarily on the fact that the potential for overpressurization of the RCS can be minimized by a combination of administrative procedures and operator action. However, because operator action cannot always be assumed, and because possible equipment malfunctions must be considered, BG&E has put in place additional controls to ensure adequate protection exists for all postulated events. Analyses have been performed which demonstrate that a combination of administrative controls and hardware modifications provide this protection. In general, this protection includes the following:

- Procedural precautions and controls;
- Disabling of non-essential components whenever LTOP is required (below MPT Enable temperature and RCS not vented);

- Maintenance of a non-solid system whenever practical; and,

- Use of the low relief setpoint in the Power Operated Relief Valve (PORV) control logic.

Calculations used to assure overpressure protection for Unit 2 are listed in Reference 8.1.

2.1 Design Criteria

The basic criteria to be satisfied in determining the adequacy of overpressure protection is that no single equipment failure or operator error shall result in violation of the pressure-temperature (P-T) limits. This is in accordance with the criteria originally stated in Reference 8.2. The applications of these criteria are addressed in Section 6.0, after the specific means of overpressure protection have been presented.

2.2 Basis for Pressure-Temperature Limits

The P-T limits for heatup and cooldown curves (Technical Specification Figures 3.4-2b and 3.4-2c), were calculated per the requirements of 10 CFR 50, Appendix G as supplemented by the Appendix G to Section III of the ASME Boiler and Pressure Vessel Code, 1986 Edition. Pressure-Temperature limits for 12 EFPY were calculated using Adjusted Reference Temperatures developed from the guidance of Regulatory Guide 1.99, Revision 2. In addition, these P-T limits were corrected for pressure drops and for pressure and temperature instrument uncertainties (Reference 8.3).

2.3 Basis for Low Pressure PORV Setpoint

The low temperature PORV pressure lift setpoint is based on protecting the most restrictive pressure of both the heatup and cooldown curves. Technical Specification Figures 3.4-2b and 3.4-2c permit heatup and cooldown operations at temperatures as low as 70^{o}F. The low temperature PORV pressure lift setpoint is set to protect the most restrictive Appendix G pressure limit (471.2 psia). A PORV setpoint of 430 psia, which includes instrumentation uncertainties and sufficient margins for PORV response time requirements necessary for the protection of 471.2 psia, was selected.

2.4 Basis for MPT Enable Temperature and Pressure Setpoints

The LTOP enable temperature (MPT enable) has been developed using the guidance found in NRC Standard Review Plan (SRP) 5.2.2, Revision 2. This SRP defines MPT enable as "the water temperature

corresponding to a metal temperature of at least $RT_{NDT}+90^{o}F$ at the beltline location (1/4 T or 3/4 T) that is controlling the Appendix G limit calculations". MPT enable temperature was calculated accordingly by using specific heatup transients up to $75^{o}F/hr$. The MPT enable temperature for Unit 2 is $305^{o}F$.

3.0 DESCRIPTION OF ANALYTICAL MODELS

Overpressurization analyses were performed as follows:

- The worst case overpressurization scenarios were identified for both mass and energy addition events; and
- The effectiveness of the PORV to terminate an overpressurization event was evaluated.

The worst case events were identified and reported in Reference 8.2. To determine the worst case events, water solid RCS conditions were considered. This was/is a conservative assumption since the time delay in the transient due to a non-solid system is eliminated. Also, all letdown flow paths which could mitigate or terminate a particular overpressurization event were assumed isolated. The following subsections discuss the solid system mass and energy input analysis, and effectiveness of the PORVs to mitigate an LTOP event.

3.1 RCS Mass Addition Analysis

The following mass addition were postulated:

- Inadvertent High Pressure Safety Injection (HPSI) pump start;
- Inadvertent HPSI and Charging pump start; and
- Inadvertent mismatch of charging and letdown flow.

3.2 RCS Energy Addition Analysis

The following energy addition events were postulated:

- RCS expansion following loss of shutdown cooling, including steam generator heat addition;
- Inadvertent pressurizer heater actuation; and,
- Energy addition from the steam generator secondary side to the RCS due to a start of any RCP when the steam generators are at a higher temperature than the reactor vessel inventory.

Energy additions which are constant with time include inadvertent pressurizer heater actuation and decay heat addition. Hand calculations were sufficient to model the resulting transients.

3.3 Effectiveness of PORV Protection

The effectiveness of a single PORV was examined for (1) the RCP start transient, and (2) inadvertent mass addition from a HPSI and charging pump. These incidents are considered the Design Basis Events as will be discussed in Section 4.0.

3.3.1 For the RCP start transient, the analyses were performed to avoid opening a PORV for normal operational transients. Initial saturated conditions are assumed in the pressurizer. Assumptions include letdown isolation and no sensible heat absorption by the RCS component metal mass. These assumptions yield results which are considered the upper bound of anticipated RCS pressures.

3.3.2 For the case of mass addition, the equilibrium pressure at which the HPSI and charging pump deliveries including expansion in the RCS caused by loss of decay heat removal match the capability of a single PORV is determined. The complete range of operating pressures and temperatures for LTOP are considered. Valve discharge rates are based on limiting thermodynamic conditions, including critical flow effects. The backpressure at the discharge of the PORV is a maximum of 115 psia, based upon a quench tank rupture pressure of 100 psig.

4.0 RESULTS OF ANALYSIS

The design basis events assuming a water solid system are:

- An RCP start with hot steam generators; and,
- An inadvertent HPSI actuation with concurrent charging.

Any measures which will prevent or mitigate the design basis events are sufficient for any of the less severe incidents. Therefore, this section will discuss the results of the RCP start and mass addition transient analyses.

4.1 RCP Start Transient

The RCP start transient is a severe LTOP challenge for a water solid RCS. Therefore, during water solid operations all four RCPs are tagged out-of-service. However, analysis indicated an RCP start transient is mitigated without the assistance of the PORVs by

controlling initial pressurizer pressure and level, and the steam generator secondary-to-primary temperature difference (delta-T). Initial pressurizer pressure cannot exceed 320 psia, initial pressurizer level must be less than or equal to 170 inches, and initial delta-T must be less than or equal to 30°F. These limits are all indicated values, reflecting adjustment of analytical limits for instrumentation uncertainty. These controls ensure the PORV is not challenged for at least 10 minutes after RCP starts. Because RCP seal consideration makes it desirable to start two RCPs, the analysis was conducted for this limiting case.

4.2 Inadvertent Safety Injection Transient

Starting one HPSI pump in conjunction with one charging pump is the most severe mass addition overpressurization event. Analyses were performed assuming one PORV available with the existing orifice area of 1.29 in^2. The entire LTOP pressure and temperature range was considered to determine limiting fluid conditions, including critical flow effects. The RETRAN code was used to provide an accurate calculation of the pressurizer liquid thermodynamic condition, ensuring an appropriate, conservative PORV flow model was used. From Figure 1, sufficient overpressure protection results when the equilibrium pressure does not exceed the limiting Appendix G curve pressure. Because the equilibrium pressure exceeds the Appendix G limit for full HPSI flow, HPSI flow is throttled to no more than 210 gpm. The HPSI flow limit includes allowances for instrumentation uncertainty, charging flow addition, and RCS expansion following loss of decay heat removal. The HPSI flow is injected through only one HPSI loop motor-operated valve (MOV) to limit instrumentation uncertainty. No more than one charging pump (44 gpm) is allowed to operate during the HPSI mass addition.

4.2.1 Three 100% capacity HPSI pumps are installed at Calvert Cliffs. Procedures will require that two of the three HPSI pumps be disabled (breakers racked out) at RCS temperature less than or equal to 305°F, and that the remaining HPSI pump shall be throttled to less than or equal to 210 gpm when used to add mass to the RCS and shall be in pull-to-lock when not being used. Exceptions are provided for ECCS testing and for response to LOCAs. These cases are discussed in Sections 5.4.1 and 5.4.3.

4.2.2 Figure 1 is used to demonstrate that a maximum allowed liquid flow of 380 gpm through the PORV will result in a pressurizer pressure below the minimum Appendix G limit of 471.2 psia. A total flow limit of 380 gpm will protect the minimum Appendix G limit for a range of initial RCS temperatures from 70°F to 305°F, and pressures from 50 psia to 400 psia. HPSI flow is limited to 210 gpm to allow for

instrumentation uncertainty, charging flow, and RCS expansion following loss of decay heat removal.

4.3 Summary of Results

A single PORV and the administrative controls described above will provide satisfactory control of all transients. Overpressurization due to the spurious actuation of full flow from a HPSI pump will be precluded for temperatures at and below 305°F by disabling two HPSI pumps, placing the third in pull-to-lock, and by throttling the third pump when used to add volume at a rate less than or equal to 210 gpm flow through only one HPSI loop MOV. Lifting of the PORV on an RCP start will be precluded by limiting the initial indicated pressurizer pressure to less than or equal to 320 psia, the initial indicated secondary-to-primary temperature delta-T to less than or equal to 30°F, and the indicated initial pressurizer level to less than or equal to 170 inches. Note that only the design basis events are discussed in detail since the less severe transients are bounded by the RCP start and inadvertent HPSI actuation analysis.

5.0 PROVISIONS FOR OVERPRESSURE PROTECTION

Low temperature overpressure protection is provided at Calvert Cliffs by a combination of administrative controls and hardware provisions. The hardware provisions include the incorporation of a dual setpoint capability in the PORV control circuitry and enabling the low temperature pressure setpoint of the PORVs during low temperature operations. Although the PORVs are the primary means of protection, it is desirable to avoid challenging them. Therefore, maintenance of administrative controls is integral to overpressure protection. Disabling components when unnecessary for plant operation will prevent their inadvertent actuation and therefore minimize their potential for causing overpressurization. This section discusses specific administrative and hardware modifications including procedural limitations for plant operation during startup, shutdown, surveillance testing, and RCS filling.

5.1 Administrative Measures

This subsection discusses the administrative measure being taken to preclude RCS over pressurization.

5.1.1 Maintenance of a Pressurizer Steam Volume

Where RCS pressure, temperature, and other operating considerations permit, a maximum level of 170 inches will be maintained. Limitations which govern pressurizer operations are heatup and cooldown rates, spray valve, temperature differentials, and pressurizer-to-hot leg temperature

differentials. A steam bubble may be formed and maintained as long as the pressurizer operations do not exceed these limits. There is a general precaution in applicable procedures to instruct operating personnel to minimize the time in which the RCS is in a water solid condition.

5.1.2 Deactivation of Non-Essential Components

In general, any component capable of an energy or mass input which would result in RCS overpressurization will be disabled when its operation is not essential to plant operations. The following are specific limitations:

5.1.2.1 Reactor Coolant Pumps - shall be disabled during water solid operations. Pressurizer steam volume (ensured by limiting pressurizer level to less than or equal to 170 inches indicated), initial pressurizer pressure (less than or equal to 320 psia indicated) and secondary-to-primary Delta-T (less than or equal to 30^{o}F indicated) will be verified prior to operation of an RCP. Primary temperature is read using Shutdown Cooling System (SDC) temperature indication in the Control Room or core exit thermocouples if shutdown cooling is not in operation. Steam generator secondary temperature is determined by using a hand-held surface instrument at the steam generator (for example, at the steam generator head, or steam generator shell between the tubesheet and head) or main steam line temperature if generating steam. Steam generator temperatures will be reduced to 220^{o}F concurrently with allowing the RCS to be cooled by the SDC system. In addition, during water solid operations and during a cooldown below 150^{o}F, all four RCPs are tagged out-of-service. Anytime in MPT enable, administrative controls are in place to prevent an inadvertent RCP actuation.

5.1.2.2 High Pressure Safety Injection Pumps - Two of the HPSI pumps are disabled and one is placed in pull-to-lock at RCS temperatures equal to and below 305^{o}F. Also, the eight HPSI loop MOVs are prevented from operating automatically, typically by placing their handswitches in pull-to-override. This ensures that no SIAS can cause flow to the RCS given a single failure. In addition, when the RCS is solid and cold, either the HPSI header isolation valves (SI-654-MOV and SI-656-MOV) or equivalent valves in the HPSI discharge flowpath are locked shut or equivalent protection is provided by racking

out and tagging the third HPSI pump breaker. Caution tags are used where operation of a pump or valve could result in RCS overpressurization.

5.1.2.3 Pressurizer heaters are disabled and tagged during solid system operations, except as provided by procedure to allow drawing a bubble.

5.1.2.4 Charging pumps that are not required during water solid operations are disabled and tagged. Typically only one charging pump is required to be operating under cold shutdown conditions. Whenever the RCS is below MPT enable temperature and a HPSI pump is being used to inject into the RCS for testing, at least two charging pumps shall be maintained in pull-to-lock.

5.2 Hardware Features

This subsection discusses the hardware provided to mitigate overpressurization events. High setpoint (2400 psia) PORVs and Code Safety Valves prevent overpressurization at temperatures above 305°F. At this temperature and below, the low setpoint relief capabilities of the system must be enabled. A discussion of this operation and related hardware considerations follows.

5.2.1 Indication and Alarms

An automatic computer-activated high pressure alarm will be set to alarm at an increasing RCS pressure prior to installation of the pressurizer manway. The alarm is automatically enabled by the plant computer, whenever the RCS temperature is less than the MPT Enable temperature. This alarm provides an audible and visual alarm on the control room panel and a typewritten message on the alarm typewriter. The pressure sensors used for this alarm function are PT103 and PT103-1. Each sensor loop provides a separate input to the computer.

Additionally, a computer-activated high pressure alarm is manually set to alarm at an increasing pressure based on existing RCS temperature. By procedure, the plant operator resets this alarm to correspond with plant conditions as RCS temperature changes. This alarm provides the plant operator with a flashing display on the plant computer and is designed to provide three alarm levels upon sensing increasing RCS pressure; i.e., "warning," "alert," and "critical." The pressure sensors for this alarm function are also PT103 and PT103-1.

5.2.2 The mitigation system against RCS overpressurization at low RCS temperatures is based on the use of the existing PORVs (ERV-402 and ERV-404) enabled to provide relief capability at low pressures. In conjunction with specific procedural controls, each PORV will provide sufficient and therefore redundant relief capacity to ensure that RCS pressure remains within the operating limit curves. The PORV low pressure setpoint will be 430 psia, which will be manually aligned when RCS temperature decreases to 305°F or less. Assurance of preventing inadvertent PORV actuation is provided by the inclusion of a temperature interlock in the circuity. This interlock automatically prevents the low pressure setpoint from actuating the PORVs at RCS temperatures above MPT enable. The mitigating system is provided with separate and independent P-T signals, bistables and power supplies to each PORV. This approach is consistent with separation and single failure criteria used in the original design of the plant.

5.3 Summary of Operation

The following discussion summarizes the sequence of events that ensures overpressure protection is available:

5.3.1 By normal plant cooldown procedures the RCS temperature and pressure are decreased to 308°F and 400 psia, respectively. An annunciator light will come on to indicate that MPT enable is required. Prior to cooling the RCS equal to or less than 305°F, normal operating procedures will require the activation of the manual computer generated high pressure alarm, the resetting of the hand switch to the "MPT Enable" position, checking that the PORV block valves indicate "open," disabling of two HPSI pumps by racking out their supply breakers, placing the third HPSI pump in pull-to-lock, and placing the HPSI loop MOV handswitches in pull-to-override. When the PORVs are reset to the LTOP setpoint the annunciator window light will clear, indicating that the low temperature PORV mode of operation is in service. The setpoint of the plant computer high pressure alarm is manually adjusted as called for in procedures so that the operator will be alerted whenever RCS pressure approaches the operating limits. Upon entering MODE 4, shutdown cooling may be used to cool the RCS. Steam generators must continue to be cooled to 220°F. RCPs are disabled by locking and tagging out their supply breakers at RCS temperatures less than 150°F. Anytime in MPT enable, administrative controls are in place to prevent inadvertent RCP actuation.

5.3.2 During plant heatup, normal operating procedures will maintain the RCS pressure at or below 400 psia until the RCS temperature is greater than 305°F. When the RCS temperature exceeds MPT enable, normal operating procedures will require that the PORVs be reset to the normal (high) relief setpoint of 2,385 psig. At the same time, alarms will be deactivated by procedure, and the temperature interlock will activate; thereby preventing the lifting of the PORVs at the low setpoint. Prior to exceeding 350°F, two HPSI pumps must be returned to automatic service.

5.4 Operating Guidelines

5.4.1 Surveillance and Component Testing

When ECCS system HPSI testing is required at RCS temperatures of 305°F and less, testing will be performed such that no new mass is introduced to the RCS unless HPSI flow is throttled to no more than 210 gpm and a pressurizer bubble exists or an adequate vent exists. When HPSI suction is taken from the shutdown cooling system, no limit is placed on discharge to the RCS since no new mass is being added. If addition of non-recirculated mass to the RCS in excess of 210 gpm is required for testing, then the reactor coolant system must be vented through at least 2.6 in^2 for one pump or 8 in^2 for multi-pump testing. Testing of Safety Injection and CVCS system components (i.e., pumps, valves, automatic signals, etc.) that are affected by LTOP controls will only be accomplished with a non-solid RCS. Such testing is only performed in accordance with approved procedures which establish adequate overpressure protection prior to component testing. No ECCS testing is allowed when water solid.

5.4.2 Reactor Filling

Reactor coolant system filling operations during a heatup are normally accomplished by using the containment spray pumps which have a shutoff head that is well below the limiting pressure of the MPT curve. To collapse the steam bubble during a cooldown, a single charging pump is used.

5.4.3 LOCA Response

In response to unidentified RCS leakage HPSI flow will be controlled to maintain pressurizer level and avoid overpressurization events. Depending on the size of the RCS leakage, flow greater than 210 gpm may be required.

5.4.4 Operator Training

Operator training through required reading and/or on shift briefings will ensure adequate operator awareness of the latest approved LTOP controls.

6.0 DESIGN CRITERIA

The design criteria for LTOP protection system were addressed in Reference 8.2. A brief discussion of the criteria follows:

6.1 Operator Action

In each of the transient analyses, operator action was not credited for the first 10 minutes. The pressure alarms detailed in Section 5.2.1, in addition to other plant condition indications, will make the operator aware of the transient.

6.2 Single Failure

A single failure must be considered in the overpressure mitigation system response to an initiating event.

6.2.1 The sensing/actuating/relieving system consists of two redundant and independent trains.

6.2.2 For the normal operational energy addition transient following an RCP start with a hot steam generator, the PORV setpoint will not be challenged for at least 10 minutes if initial conditions for the pump start are satisfied. In this case, failure of a PORV cannot result in overpressurization, since the valve setpoint is not challenged. Failure to satisfy one of the initial conditions may result in opening one or both PORVs. In this case, the PORV has sufficient capacity to ensure the Appendix G limit is not exceeded.

6.2.3 For the mass addition design basis event (HPSI actuation), a single PORV provides protection provided that 2 of the 3 HPSI pumps are disabled and the remaining pump's flow is throttled. If we assume that the LTOP system single failure is failure to throttle the HPSI while adding mass through one HPSI loop motor-operated valve, then two PORVs are available to maintain the pressurization below Appendix G limits.

6.3 Seismic and IEEE-279 Design Criteria

Presently installed PORVs meet seismic criteria consistent with the basic objective of preventing a potential LOCA pathway. Design of equipment added for overpressure mitigation is consistent with existing plant design criteria, and with the single failure criteria previously discussed. Design is such that (1) no additional risk of LOCA or other accident is imposed, and (2) design criteria of existing safety related systems are maintained, and these systems are not degraded.

6.3.1 In addition, the intent of seismic and IEEE-279 criteria is met for the operability and effectiveness of the mitigating system in that a single failure that initiates an overpressurization event does not disable the mitigating system.

6.3.2 Power is supplied to the PORVs from vital supplies designed to operate during a seismic event and following loss of off-site power. Cable raceways for this equipment are supported to withstand a seismic event.

6.4 Testability

The system is designed to be tested with a frequency that will ensure the system is operable when needed.

7.0 SUMMARY

Overpressure protection is provided by a combination of hardware and procedural controls. Two PORVs are set to lift at 430 psia (protecting 471.2 psia in the pressurizer) for temperatures at and below 305^{o}F. Alarms are provided to the operators to alert them to implement LTOP protective measures and to warn them when pressure limits are being approached. Components that can challenge MPT limits are disabled when not needed and in particular are disabled for water solid operations. Testing of components is controlled so as to minimize any potential challenge to MPT limits and testing is prohibited during water solid operations.

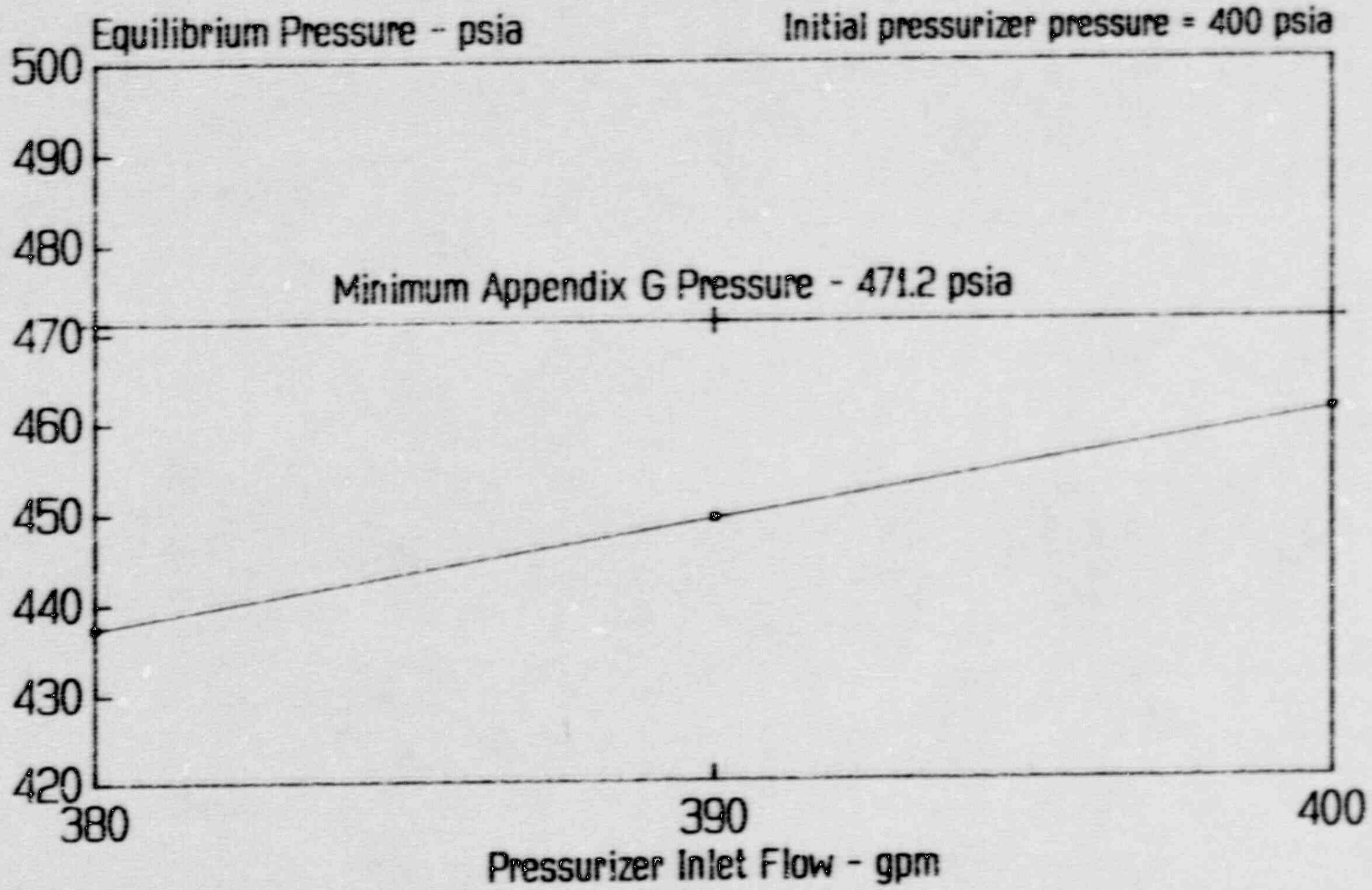
8.0 REFERENCES

8.1 Letter from W. C. Sherbin (BG&E) to W. J. Lippold (BG&E), dated October 5, 1990, "LTOP Unit 2 Calculations References," NEU-90-775

8.2 Letter from V. R. Evans (BG&E) to D. K. Davis (NRC), dated July 21, 1977, "Reactor Coolant System Overpressurization"

8.3 ABB Combustion Engineering Nuclear Power B-MPS-90-155, June 28, 1990, Craig D. Stewart to Randal Boyd (BG&E), "Transmittal of Final Report on Reactor Vessel Pressure-Temperature Limits"

Figure 1
Calvert Cliffs PORV Performance
Liquid Discharge Equilibrium Pressure



ATTACHMENT (1)