February 26, 2001

Mr. Charles H. Cruse
Vice President - Nuclear Energy
Calvert Cliffs Nuclear Power Plant, Inc.
Calvert Cliffs Nuclear Power Plant
1650 Calvert Cliffs Parkway
Lusby, MD 20657-4702

SUBJECT: CALVERT CLIFFS NUCLEAR POWER PLANT, UNIT NOS. 1 AND 2 - EXEMPTION FROM THE REQUIREMENTS OF 10 CFR PART 50, SECTION 50.60(a) AND APPENDIX G (TAC NOS. MB0001 AND MB0002)

Dear Mr. Cruse:

The Commission has approved the enclosed exemption from specific requirements of Title 10 of the *Code of Federal Regulations* Part 50, Section 50.60(a) and Appendix G, for the Calvert Cliffs Nuclear Power Plant, Unit Nos. 1 and 2 (CCNPP). This action is in response to your letter of September 14, 2000, that submitted new pressure-temperature (P-T) limits for CCNPP. The new P-T limits were developed using the methodology in the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code) Case N-640 "Alternative Reference Fracture Toughness for Development of P-T Curves for ASME Section XI, Division I," which modifies the methods of ASME Code, Section XI, Appendix G.

A copy of the exemption and the supporting safety evaluation are enclosed. The exemption has been forwarded to the Office of the Federal Register for publication.

Sincerely,

/RA/

Donna Skay, Project Manager, Section 1
Project Directorate I
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket Nos. 50-317 and 50-318

Enclosures: 1. Exemption
2. Safety Evaluation

cc w/encls: See next page

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*Input provided by memo dated 12/13/00 **See previous concurrence

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UNITED STATES NUCLEAR REGULATORY COMMISSION

CALVERT CLIFFS NUCLEAR POWER PLANT, INC.

CALVERT CLIFFS NUCLEAR POWER PLANT, UNIT NOS. 1 AND 2

DOCKET NOS. 50-317 AND 50-318

EXEMPTION

1.0 BACKROUND

Calvert Cliffs Nuclear Power Plant, Inc. (CCNPPI, the licensee) is the holder of Renewed Facility Operating License Nos. DPR-53 and DPR-69 which authorize operation of the Calvert Cliffs Nuclear Power Plant, Unit Nos. 1 and 2 (CCNPP). The licenses provide, among other things, that the facility is subject to all rules, regulations, and orders of the U.S. Nuclear Regulatory Commission (NRC, the Commission) now or hereafter in effect.

The facility consists of two pressurized-water reactors located in Calvert County, Maryland.

2.0 PURPOSE

Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, Appendix G, requires that pressure-temperature (P-T) limits be established for reactor pressure vessels (RPVs) for normal operating and hydrostatic or leak rate testing conditions. Specifically, 10 CFR Part 50, Appendix G states, “The appropriate requirements on both the pressure-temperature limits and the minimum permissible temperature must be met for all conditions.” Appendix G of 10 CFR Part 50 also states that the “P-T limits identified as “ASME [American Society of Mechanical Engineers] Appendix G limits” in Table 1 require that the limits must be at least as conservative as limits obtained by following the methods of analysis and the margins of safety of Appendix G of Section XI of the ASME Code.” Section XI of the ASME Code, Appendix G, Figure G-2210-1 specifies a K_{Ia} fracture toughness curve for reactor vessel materials in determining P-T limits.

To address provisions of a proposed license amendment to the Technical Specification P-T limits for CCNPP, the licensee requested, in its submittal of September 14, 2000, that the NRC staff exempt CCNPP from application of specific requirements of 10 CFR Part 50, Section 50.60(a) and Appendix G, and substitute use of ASME Code Case N-640. Code Case N-640 permits the use of an alternate reference fracture toughness (K_{Ic} fracture toughness curve instead of K_{Ia} fracture toughness curve) for reactor vessel materials in determining the P-T limits. Since the K_{Ic} fracture toughness curve shown in ASME Section XI, Appendix A, Figure A-2200-1 (the K_{Ic} fracture toughness curve, K_{Ic} curve) provides greater allowable fracture toughness than the corresponding K_{Ia} fracture toughness curve of ASME Section XI, Appendix G, Figure G-2210-1 (the K_{Ia} fracture toughness curve, K_{Ia} curve), using Code Case N-640 for establishing the P-T limits would be less conservative than the methodology currently endorsed by 10 CFR Part 50, Appendix G, and, therefore, an exemption to apply the Code Case would also be required by 10 CFR 50.60.

Code Case N-640 (formerly Code Case N-626)

The licensee has proposed an exemption to allow use of ASME Code Case N-640 in conjunction with ASME Section XI, 10 CFR 50.60(a) and 10 CFR Part 50, Appendix G, to determine P-T limits. These revised P-T limits have been developed using the K_{Ic} fracture toughness curve, in lieu of the K_{Ia} fracture toughness curve, as the lower bound for fracture toughness.

Use of the K_{Ic} curve in determining the lower bound fracture toughness in the development of P-T operating limits curve is more technically correct than use of the K_{Ia} curve since the rate of loading during a heatup or cooldown is slow and is more representative of a static condition than a dynamic condition. The K_{Ic} curve appropriately implements the use of static initiation fracture toughness behavior to evaluate the controlled heatup and cooldown process of a reactor vessel. The NRC staff has required use of the initial conservatism of the

K_{Ia} curve since 1974 when the curve was codified. This initial conservatism was necessary due to the limited knowledge of RPV materials. Since 1974, additional knowledge has been gained about RPV materials which demonstrates that the lower bound on fracture toughness provided by the K_{Ia} curve is well beyond the margin of safety required to protect the public health and safety from potential RPV failure. In addition, P-T curves based on the K_{Ic} curve will enhance overall plant safety by opening the P-T operating window with the greatest safety benefit in the region of low temperature operations.

3.0 DISCUSSION

Pursuant to 10 CFR 50.12, the Commission may, upon application by any interested person or upon its own initiative, grant exemptions from the requirements of 10 CFR Part 50, when (1) the exemptions are authorized by law, will not present an undue risk to public health or safety, and are consistent with the common defense and security; and (2) when special circumstances are present. These circumstances include the special circumstances that "Application of the regulation in the particular circumstances would not serve the underlying purpose of the rule or is not necessary to achieve the underlying purpose of the rule;..."

The underlying purpose of 10 CFR Part 50, Appendix G is to provide an adequate margin of safety against brittle failure of the RPV. Use of a P-T limit that is at least as conservative as the limits obtained by following the methods of analysis and margin of safety of the ASME Code, Section XI, Appendix G is not necessary, in this case, to achieve the underlying purpose of the rule. Specifically, substitution of the K_{Ic} fracture toughness curve for the K_{Ia} fracture toughness curve for establishing the P-T limits provides a more technically correct outcome in that it accounts for the rate of loading during heatup or cooldown and is more representative of a static condition. In addition, the staff has determined that improved knowledge regarding the RPV materials justifies elimination of unnecessary conservatisms, such as that brought about by the use of the K_{Ia} curve. Use of the less conservative K_{Ic} curve would provide an adequate margin

of safety against brittle failure of the RPV in this case, due in part to the remaining conservatisms incorporated into the methodologies of 10 CFR Part 50, Appendix G and Regulatory Guide 1.99 which would still be applicable. Therefore, use of a P-T limit that is at least as conservative as the limits obtained by following the methods and margins of safety of the ASME Code, Section XI, Appendix G, is not necessary in this case to achieve the underlying purpose of the rule, i.e., to provide sufficient margin of RPV fracture toughness to ensure structural integrity of the RPV.

Therefore, the staff concludes that granting an exemption under the special circumstances of 10 CFR 50.12(a)(2)(ii) is appropriate and that the methodology of Code Case N-640 may be used to revise the P-T limits for CCNPP.

4.0 CONCLUSION

In summary, the ASME Section XI, Appendix G, procedure was conservatively developed based on the level of knowledge existing in 1974 concerning RPV materials and the estimated effects of operation. Since 1974, the level of knowledge about these topics has been greatly expanded. The NRC staff concurs that this increased knowledge permits relaxation of the ASME Section XI, Appendix G, requirements by application of ASME Code Case N-640. Implementation of the proposed P-T limits, as allowed by ASME Code Case N-640, are sufficient to ensure the structural integrity of RPVs during plant operations. Thus, pursuant to 10 CFR 50.12(a)(2)(ii), the underlying purpose of the regulation will continue to be served.

Accordingly, the Commission has determined that, pursuant to 10 CFR 50.12(a), the exemption is authorized by law, will not endanger life or property or common defense and security, and is, otherwise, in the public interest. Also, special circumstances are present in that application of the regulation is not necessary to achieve the underlying purpose of the rule. Therefore, the Commission hereby grants CCNPPI an exemption from the requirements of 10 CFR Part 50, Section 50.60(a) and 10 CFR Part 50, Appendix G, for CCNPP.

Pursuant to 10 CFR 51.32, the Commission has determined that the granting of this exemption will not have a significant effect on the quality of the human environment (66 FR 9729).

This exemption is effective upon issuance.

Dated at Rockville, Maryland, this 26th day of February 2001.

FOR THE NUCLEAR REGULATORY COMMISSION

/RA/

John A. Zwolinski, Director
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

EXEMPTION REQUEST BY CALVERT CLIFFS NUCLEAR POWER PLANT, INC.

TO UPDATE THE PRESSURE-TEMPERATURE LIMITS

FOR THE CALVERT CLIFFS NUCLEAR POWER PLANT, UNIT NOS. 1 AND 2

DOCKET NOS. 50-317 AND 50-318

RENEWED LICENSE NOS. DPR-53 AND DPR-69

1.0 INTRODUCTION

1.1 Requirements for Generating Pressure-Temperature (P-T) Limits for Nuclear Power Generation Facilities

The U.S. Nuclear Regulatory Commission (NRC) has established requirements in Appendix G of Part 50 to Title 10 of the *Code of Federal Regulations* (10 CFR Part 50, Appendix G), to protect the integrity of the reactor coolant pressure boundary in nuclear power plants. This Appendix to Part 50 requires the P-T limits for an operating plant to be at least as conservative as those that would be generated if the methods of Appendix G to Section XI of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code) were applied. The methodology of Appendix G to the Code postulates the existence of a sharp surface flaw in the reactor pressure vessel (RPV) that is normal to the direction of the maximum applied stress. For materials in the beltline and upper and lower head regions of the RPV, the maximum flaw size is postulated to have a depth that is equal to one-fourth of the thickness and a length equal to 1.5 times the thickness. For the case of evaluating RPV nozzles, the surface flaw is postulated to propagate parallel to the axis of the nozzle's corner radius. The basic parameter in Appendix G to the Code for calculating P-T limit curves is the stress intensity factor, K_I, which is a function of the stress state and flaw configuration. The methodology requires that licensees determine the reference stress intensity (K_{Ia}) factors, which vary as a function of temperature, from the reactor coolant system (RCS) operating temperatures, and from the adjusted reference temperatures (ARTs) for the limiting materials in the RPV. Thus, the critical locations in the RPV beltline and head regions are the 1/4-thickness (1/4T) and 3/4-thickness (3/4T) locations, which correspond to the points of the crack tips if the flaws are initiated and grown from the inside and outside surfaces of the vessel, respectively. Regulatory Guide (RG) 1.99, Revision 2, provides an acceptable method of calculating ARTs for ferritic RPV materials; the methods of RG 1.99, Revision 2, include methods for adjusting the ARTs of materials in the beltline region of the RPV, where the effects of neutron irradiation may induce an increased level of embrittlement in the materials.

The methodology of Appendix G requires that P-T curves must satisfy a safety factor of 2.0 on primary membrane and bending stresses during normal plant operations (including heatups, cooldowns, and transient operating conditions), and a safety factor of 1.5 on primary membrane and bending stresses when leak rate or hydrostatic pressure tests are performed on the RCS. Table 1 to 10 CFR Part 50, Appendix G provides the staff's criteria for meeting the P-T limit requirements of Appendix G to the Code and 10 CFR Part 50, Appendix G.

1.2 Calvert Cliffs Nuclear Power Plant, Inc. (CCNPPI) Submittal of September 14, 2000

On September 14, 2000, CCNPPI submitted an exemption request to use Code Case N-640 as a method that would allow Calvert Cliffs Nuclear Power Plant, Unit Nos. 1 and 2 (CCNPP) to deviate from complying with the requirements in 10 CFR Part 50, Appendix G, for generating the P-T limit curves. Requests for such exemptions are allowed pursuant to 10 CFR 50.60(b), which allows licensees to use alternatives to the requirements of 10 CFR Part 50, Appendices G and H, if an exemption to use the alternatives is granted by the Commission pursuant to 10 CFR 50.12. According to 10 CFR 50.12, the Commission may, upon request, grant exemptions to the requirements of 10 CFR Part 50, if the exemptions are authorized by law, will not present an undue risk to the public health and safety, and are consistent with the common defense and security. In considering the exemptions, the Commission will not consider granting exemptions unless special circumstances are present. These special circumstances include, but are not limited to, the following special cases:

> pursuant to 10 CFR 50.12(a)(2)(ii), the circumstance that application of the regulation in the particular circumstances would not serve the underlying purpose of the rule or is not necessary to achieve the underlying purpose of the rule,
>
> pursuant to 10 CFR 50.12(a)(2)(iii), the circumstance that compliance would result in undue hardship or other costs that are significantly in excess of those contemplated when the regulation was adopted, or that are significantly in excess of those incurred by others similarly situated, and
>
> pursuant to 10 CFR 50.12(a)(2)(vi), the circumstance that there is present any other material circumstance not considered when the regulation was adopted for which it would be in the public interest to grant an exemption

The NRC staff's assessment of the exemption request is given in Section 2.0 below.

2.0 REQUEST FOR EXEMPTION TO USE CODE CASE N-640 AS PART OF THE METHOD USED FOR GENERATION OF THE UPDATED P-T CURVES

2.1 Exemption Request to Use Code Case N-640

CCNPPI has requested, pursuant to 10 CFR 50.60(b), an exemption to use ASME Code Case N-640 as the basis for establishing the P-T limit curves. Code Case N-640 permits application of the lower bound static initiation fracture toughness value equation (K_{Ic} equation) as the basis for establishing the curves in lieu of using the lower bound crack arrest fracture toughness value equation (i.e., the K_{Ia} equation, which is based on conditions needed to arrest a dynamically propagating crack, and which is the method invoked by Appendix G to Section XI of the ASME Code). Use of the K_{Ic} equation in determining the lower bound fracture toughness in the

development of the P-T operating limits curves is more technically correct, although less conservative, than the use of the K_{Ia} equation since the rate of loading during a heatup or cooldown is slow and is more representative of a static condition than a dynamic condition. The K_{Ic} equation appropriately implements the use of the static initiation fracture toughness behavior to evaluate the controlled heatup and cooldown process of a reactor vessel. The staff has required use of the initial conservatism of the K_{Ia} equation since 1974 when the equation was codified. This initial conservatism was necessary due to the limited knowledge of RPV materials. Since 1974, additional knowledge has been gained about RPV materials which demonstrates that the lower bound on fracture toughness provided by the K_{Ia} curve is well beyond the margin of safety required to protect the public health and safety from potential RPV failure. Therefore, the lower bound static fracture toughness K_{Ic} equation provides an acceptable method for calculating P-T limits. In addition, P-T curves based on the K_{Ic} equation will enhance overall plant safety by opening the P-T operating window with the greatest safety benefit in the region of lower temperature operations.

Compliance with Appendix G to the Code, without the relief provided by ASME Code Case N-640 results in needless transitions to and from shutdown cooling. This can occur because, during startup from an outage, operation of two reactor coolant pumps (RCPs) to heat up the reactor coolant system (RCS) challenges the existing allowed heatup rate. Two RCPs in the low temperature region generate a heatup rate that can exceed the existing heatup rate. Single RCP operation is currently prohibited at CCNPP. Prior to planned heatup, operators allow the temperature of the RCS to drift up. The steam generators (SGs) act as a large heat sink limiting the maximum temperature achievable in the RCS with decay heat. Therefore, the SGs frequently require heating with sparged condensate to meet the RCP start criteria. Sparging the condenser and reducing vacuum to raise the temperature of the SG feedwater raises the saturation temperature of the water and increases the oxygen concentration to a level that creates a corrosion environment on the outside of the SG tubes. In addition, the temperature differential between the SGs and the RCS is restricted to prevent exceeding the existing cooldown rates. This restriction imposes a limit to the maximum RCS temperature for an RCP start and needless transitions to and from shutdown cooling can occur due to these restrictions. This places an unnecessary burden on the plant operators.

It should also be noted that the ASME Working Group on Operating Plant Criteria (WGOPC) has concluded that application of Code Case N-640 to plant P-T limits are still sufficient to ensure the structural integrity of RPVs during plant operations.

3.0 CONCLUSION

The staff has determined that CCNPPI has provided sufficient technical basis for using the methods of Code Case N-640 in the calculation of the P-T limits for CCNPP. The staff has also determined that application of Code Case N-640 to the P-T limit calculations will continue to serve the purpose in 10 CFR Part 50, Appendix G, for protecting the structural integrity of the CCNPP RPV and reactor coolant pressure boundary. In this case, since strict compliance with requirements of 10 CFR 50.60(a) and 10 CFR Part 50, Appendix G, is not necessary to serve the underlying purpose of the rule, the staff concludes that application of the Code Case N-640 to the P-T limit calculations meets the special circumstance provisions in 10 CFR 50.12(a)(2)(ii), for granting exemptions to the regulations, and that pursuant to 10 CFR 50.12(a)(1), the

granting of these exemptions is authorized by law, will not present undue risk to the public health and safety, and is consistent with the common defense and security. The staff therefore grants exemptions to 10 CFR 50.60(a) and 10 CFR Part 50, Appendix G, to allow CCNPPI to use Code Case N-640 as part of the basis for generating the P-T limit curves for CCNPP.

Principal Contributor: E. Andruszkiewicz

Date: February 26, 2001

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