June 19, 2000

Mr. Charles H. Cruse
Vice President - Nuclear Energy
Baltimore Gas and Electric Company
Calvert Cliffs Nuclear Power Plant
1650 Calvert Cliffs Parkway
Lusby, MD 20657-4702

SUBJECT: CALVERT CLIFFS NUCLEAR POWER PLANT, UNIT NOS. 1 AND 2 - ISSUANCE OF AMENDMENT RE: TURBINE MISSILES REVISED ANALYSIS (TAC NOS. MA7224 AND MA7225)

Dear Mr. Cruse:

The Commission has issued the enclosed Amendment No. 236 to Renewed Facility Operating License No. DPR-53 and Amendment No. 210 to Renewed Facility Operating License No. DPR-69 for the Calvert Cliffs Nuclear Power Plant, Unit Nos. 1 and 2, respectively. The amendments are in response to your application transmitted by letter dated November 19, 1999, as supplemented April 21, 2000.

The amendments approve changes in the Updated Final Safety Analysis Report (UFSAR) that constitute an unreviewed safety question (USQ) as described in 10 CFR 50.59. These changes increase the probability of occurrence of a malfunction. These changes were not previously evaluated in the UFSAR, specifically, Section 5.3.1, "External Missiles." External Missiles of the UFSAR did not address the probability of a missile from Unit 1 turbine-generator striking: (1) the refueling water tanks, (2) the No. 11 fuel oil storage tank, and (3) the plant equipment through various roof slabs or through non-missile-proof openings in the missile-proofing walls. The UFSAR only discusses a turbine missile striking the containment, control room, switchgear room, and waste processing area. The amendment authorizes the licensee to revise the turbine missile analysis to include the additional targets.

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

Sincerely,

/RA/

Alexander W. Dromerick, Sr. 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. Amendment No. 236 to DPR-53
2. Amendment No. 210 to DPR-69
3. Safety Evaluation

cc w/encls: See next page

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*SE input dated April 27, 2000 was provided and no major changes were made.

Accession No. ML003724507

OFFICE	PDI-1/PM	PDI-1/LA	OGC*	PDI-1/SC(A)	SPLB*
NAME	ADromerick:lcc	TClark for SLittle	Uttal/NLO	MGamberoni	EWeiss 6/15/00
DATE	6/12/00	6/12/00	5/25/00	6/15/00	4/27/00 Memo

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Calvert Cliffs Nuclear Power Plant
Unit Nos. 1 and 2

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DATED: June 19, 2000

AMENDMENT NO. 236 TO RENEWED FACILITY OPERATING LICENSE NO. DPR-53-
CALVERT CLIFFS UNIT 1
AMENDMENT NO. 210 TO RENEWED FACILITY OPERATING LICENSE NO. DPR-69-
CALVERT CLIFFS UNIT 2

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BALTIMORE GAS AND ELECTRIC COMPANY

DOCKET NO. 50-317

CALVERT CLIFFS NUCLEAR POWER PLANT UNIT NO. 1

AMENDMENT TO RENEWED FACILITY OPERATING LICENSE

Amendment No. 236
Renewed License No. DPR-53

1. The Nuclear Regulatory Commission (the Commission) has found that:

   A. The application for amendment by Baltimore Gas and Electric Company (the licensee) dated November 19, 1999, as supplemented April 21, 2000, complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act) and the Commission's rules and regulations set forth in 10 CFR Chapter I;

   B. The facility will operate in conformity with the application, the provisions of the Act, and the rules and regulations of the Commission;

   C. There is reasonable assurance (i) that the activities authorized by this amendment can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the Commission's regulations;

   D. The issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public; and

   E. The issuance of this amendment is in accordance with 10 CFR Part 51 of the Commission's regulations and all applicable requirements have been satisfied.

2. Accordingly, changes to the Updated Final Safety Analysis Report to reflect the revised turbine missile analysis to include additional targets as set forth in Baltimore Gas and Electric Company’s amendment request of November 19, 1999, as supplemented April 21, 2000, is authorized.

3. This license amendment is effective as of the date of its issuance and shall be implemented by December 31, 2000.

FOR THE NUCLEAR REGULATORY COMMISSION

/RA/

Marsha Gamberoni, Acting Chief, Section 1
Project Directorate I
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Date of Issuance: June 19, 2000

BALTIMORE GAS AND ELECTRIC COMPANY

DOCKET NO. 50-318

CALVERT CLIFFS NUCLEAR POWER PLANT, UNIT NO. 2

AMENDMENT TO RENEWED FACILITY OPERATING LICENSE

Amendment No. 210
Renewed License No. DPR-69

1. The Nuclear Regulatory Commission (the Commission) has found that:

   A. The application for amendment by Baltimore Gas and Electric Company (the licensee) dated November 19, 1999, as supplemented April 21, 2000. complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act) and the Commission's rules and regulations set forth in 10 CFR Chapter I;

   B. The facility will operate in conformity with the application, the provisions of the Act, and the rules and regulations of the Commission;

   C. There is reasonable assurance (i) that the activities authorized by this amendment can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the Commission's regulations;

   D. The issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public; and

   E. The issuance of this amendment is in accordance with 10 CFR Part 51 of the Commission's regulations and all applicable requirements have been satisfied.

2. Accordingly, changes to the Updated Final Safety Analysis Report to reflect the revised turbine missile analysis to include additional targets as set forth in Baltimore Gas and Electric Company’s amendment request of November 19, 1999, as supplemented April 21, 2000, is authorized.

3. This license amendment is effective as of the date of its issuance and shall be implemented by December 31, 2000.

FOR THE NUCLEAR REGULATORY COMMISSION

/RA/

Marsha K. Gamberoni, Acting Chief, Section 1
Project Directorate I
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Date of Issuance: June 19, 2000

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO AMENDMENT NO. 236 TO RENEWED FACILITY OPERATING LICENSE NO. DPR-53

AND AMENDMENT NO. 210 TO RENEWED FACILITY OPERATING LICENSE NO. DPR-69

BALTIMORE GAS AND ELECTRIC COMPANY

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

DOCKET NOS. 50-317 AND 50-318

1.0 INTRODUCTION

By letter dated November 19, 1999, as supplemented April 21, 2000, Baltimore Gas & Electric Company (BGE or the licensee) requested to revise the Updated Final Safety Analysis Report (UFSAR) for the Calvert Cliffs Nuclear Power Plant, Unit 1 and 2, that involve an unreviewed safety question (USQ) as defined in 10 CFR 50.59. The USQ is pertinent to an incomplete turbine missile analysis previously evaluated in the UFSAR that would increase the probability of occurrence of malfunction of the equipment important to safety. Specifically, Section 5.3.1, "External Missiles," of the UFSAR did not address the probability of a missile from the Unit 1 turbine-generator striking: (1) the refueling water tanks, (2) the No. 11 fuel oil storage tank, and (3) the plant equipment through various roof slabs or through non-missile-proof openings in the missile-proofing walls. The UFSAR only discusses a turbine missile striking the containment, control room, switchgear room, and waste processing area. Therefore, the licensee revised the turbine missile analysis to include the additional targets. The April 21, 2000, letter provided clarifying information that did not change the initial proposed no significant hazards consideration determination or expand the scope of the original *Federal Register* notice.

2.0 BACKGROUND

General Design Criterion (GDC) 4 of Appendix A to 10 CFR Part 50 requires, in part, that structures, systems, and components (SSCs) important to safety be appropriately protected against the effect of missiles that might result from equipment failures, in this case the large steam turbine. The two broad categories of turbine failures that may generate high energy missiles are: (1) the design over-speed failure resulting from brittle fracture of turbine blade wheel or rotor, and (2) the destructive over-speed failure as a result of over-speed protection system malfunction. Generally, the missiles generated from a turbine failure can be divided into two groups, i.e., high-trajectory missiles (HTMs) and low-trajectory missiles (LTMs). The risk from the HTM strike is considered low for its indirect striking a target with lower energy. The LTMs would strike the essential systems directly with high energy and this is critical.

Turbine orientation and placement, shielding, quality assurance in design and fabrication, inspection and testing programs, and over-speed protection systems are the principal means of safeguarding against turbine missiles.

The probability of unacceptable damage from a turbine missile (P) is expressed as a product of the following items:

(1) the probability of turbine missile generation resulting in the ejection of turbine disk (or internal structure) fragments through the turbine casing (P1),

(2) the probability of the ejected missile perforating intervening barriers and striking safety-related SSCs (P2), and

(3) the probability of safety-related SSCs failing to perform their safety functions (P3).

Operating experience showed that turbine disc cracking, turbine stop and control valves failure, or disc rupture could result in the generation of high-energy missiles. Since there is little information available on failure of large turbines, considerable uncertainty attends the current practice of using damage prediction based on limited statistical data. In the past, analyses assumed the probability of missile generation (P1) for material failures to be approximately 10^{-4} per year. However, the design over-speed failure rate of a turbine generator can be minimized through turbine design improvement and specific turbine control system maintenance and testing. The strike probability (P2) was estimated on the basis of postulated missile sizes, shapes, energies, and on available plant-specific information such as turbine placement and orientation, number and type of intervening barriers, target geometry, and potential missile trajectories. Regulatory Guide (RG) 1.115 states that protection of an essential system within the LTM strike zone is considered adequate against LTMs if the system is either small enough or far enough removed from the turbine that the probability (P2) of it being struck by a turbine missile is less than or equal to 10^{-3} per year. The damage probability (P3) was generally assumed to be 1.0. A reasonable accuracy of P3 is difficult to determine because the missile impact energy required to cause safety-related systems failure to perform their safety functions is hard to define. To define an LTM strike zone in a plant site, the staff considers the LTM targets that are within an area bounded by lines inclined at 25 degrees to the turbine wheel plane.

The acceptable risk rate for a turbine missile is based on the regulatory guidelines provided in (1) RG 1.115, “Protection Against Low-Trajectory Turbine Missiles,” (2) Standard Review Plan (SRP) 10.2.3, “Turbine Disk Integrity,” and (3) SRP 3.5.1.3, “Turbine Missiles.” In recent years, the NRC has shifted emphasis on the review of turbine missile issues from the strike and damage probabilities (P2xP3) to missile generation probability (P1). The NRC staff has previously recommended a probabilistic approach to determine specific turbine system inspection and testing frequencies and turbine control system maintenance requirements for the Westinghouse steam turbine system so as to maintain the integrity of the as-built turbine generator. This logic places the regulatory emphasis on strike probability and disregards all the plant-specific factors that determine the actual P1 and its unique time dependency. According to NRC guidelines stated in SRP 2.2.3, “Evaluation of Potential Accidents,” and RG 1.115, the probability of unacceptable damage from turbine missiles (P) should be less than or equal to10^{-7} per year for a individual plant.

3.0 EVALUATION

To resolve the USQ, the licensee re-analyzed the following safety-related structures and components for the postulated turbine missiles generated from the Unit 1 (General Electric) turbine generator:

- containment cylinder and dome,
- intake structure El. 28.5' roof slab and El.10' roof slab,
- turbine building auxiliary feedwater (AFW) pump room roof slab at the El. 27' level,
- turbine building AFW pump room walls and 6-ft by 6-ft door opening,
- auxiliary building El. 69' roof slab (except refueling tank pump room),
- auxiliary building El. 91.5' roof slab (except the roof area over the control room HVAC and spent fuel area ventilation equipment room)
- auxiliary building El.118.5' roof slabs over (and not over) the spent fuel pool,
- auxiliary building missile-proof wall between the turbine building and the auxiliary building (The non-missile-proof openings on the K-line wall),
- auxiliary building wall at the east face of the cask handling structure,
- auxiliary building El. 3' service water pump room,
- auxiliary building El. 27' and El. 45' switchgear rooms,
- yard structures: safety-related diesel generator duct bank/manholes, and other safety-related yard structures.

The licensee performed turbine missile analyses for Unit 1 and Unit 2 separately because the probability of turbine over-speed that generate missiles is different due to different turbine manufacturers. The Unit 1 has a General Electric turbine generator and Unit 2 has a Westinghouse turbine generator. In the Unit 1 turbine missile analysis, the licensee indicated that the following unprotected rooms and components in both Units 1 and 2 are subject to HTM or LTM strikes that were not included in the original turbine missile analysis:

- the refueling water tanks (subject to HTM),

- the non-missile-proofed No. 11 fuel oil storage tank (subject to HTM),

- the saltwater pumps through roof hatches in the intake structure roof (subject to HTM),

- the roof slabs over the refueling water tank pump room, the control room heating, ventilation, and air conditioning (HVAC) equipment room, the spent fuel pool area ventilation equipment room, and a portion of El.118' level roof over the fuel cask handling area (subject to HTM), the control room HVAC equipment room through its non-missile-proof door (subject to LTM).

In addition to the above items, for Unit 1 only, there is a USQ for the Auxiliary building El. 45' switchgear room due to an increase in probability of occurrence of an LTM strike through its non-missile-proof doors that was not previously evaluated in the original turbine missile analysis.

The NRC staff reviewed the licensee's submittal and found that (1) the relative placement of the safety-related structures within the 25E projection lines of the LTM strike zones with respect to each turbine wheel plan were not provided and (2) the strike and damage probabilities for the new targets in the turbine missile analyses and the methodology to perform the analysis were not properly explained. The staff requested the licensee to provide additional information and held a conference call on February 8, 2000, to discuss the open issues. To properly address the staff's concern with its initial submittal, the licensee provided additional information via a letter dated April 21, 2000.

The licensee provided drawings (dwg Nos. 61502SH0002, 60214, 60-209-E, and 62-041-E) which show the plant site, the turbine building floor plans and equipment locations, and the safety-related structures and components within the 25^{o} line of the LTM strike zone. The licensee stated that the only equipment within this range vulnerable to a turbine missile strike is the equipment located in El. 45' switchgear room and the control room HVAC equipment room on El. 69' level because they have non-missile-proof doors. The staff reviewed these drawings and found that they have shown all the new missile targets for the analyses.

The licensee evaluated the risk associated with an LTM striking on safety-related structures, including the auxiliary building K-line wall, the AFW pump room, El. 27' and El. 45' switchgear rooms, and the El. 69' control room HVAC equipment room. Protection for the auxiliary building against an LTM is provided by a concrete missle-proof wall between the turbine building and auxiliary building (K-line wall) and the AFW pump room is completely protected from an LTM by the concrete turbine-generator pedestal at the EL 45' level. The auxiliary building EL 27' switchgear room doors are protected from an LTM by the 11.5" turbine deck slab at EL 45'. The shallow angle does not give the LTM sufficient energy to penetrate the slab. The auxiliary building missile-proof wall (the K-line wall) between the turbine building and the auxiliary building has four non-missile-proof doors that could be perforated by an LTM. The LTM could strike the safety-related equipment within the El. 45' switchgear room and the El. 69' control room HVAC equipment room in the Unit 1 auxiliary building or the control room HVAC equipment room in the Unit 2 auxiliary building. The licensee evaluated the probabilities of an LTM striking these rooms through the non-missile-proof doors. The results indicate that the missile strike probability (P2) for these new targets being struck by a turbine missile are less than 10^{-3} per year which are found acceptable. The total risk for an unacceptable damage from turbine missiles (P=P1xP2xP3) was calculated to be 7.46×10^{-8} per year (in which P1 was revised based on the March 2000 inspection results). This calculation result is within the acceptable limit of 10^{-7} per year required by RG 1.115. Therefore, the staff concludes that the probability of a missile from the Unit 1 turbine-generator striking the unprotected structures or components is a negligible increase in the probability of occurrence of malfunction of equipment associated with Units 1 and 2. Therefore, the analysis for the LTM strikes is acceptable.

Most of the new targets are under the HTM strikes except the El. 45' switchgear room and the El. 69' control room HVAC equipment room. The licensee indicated that the HTMs have nearly vertical trajectories that their speed is too low to impact any plant structures or components with significant hazard. The licensee's analysis concluded that the risk from the HTMs is insignificant unless the vulnerable target area is on the order of 10^{4} square foot or more for each unit based on the guidance provided in SRP 3.5.1.3. The SRP also states that the probability of a HTM landing within a few hundred feet from the turbine is on the order of 10^{-7} per

square foot of horizontal target area. As a result of this review, the staff concludes that the licensee's analysis for the HTM is consistent with the NRC guidelines and is acceptable.

The licensee also evaluated the risk of turbine missiles from the Unit 2 turbine and concluded that there is no USQ associated with the Westinghouse turbine generator. This conclusion is based on a letter of February 2, 1987 (from C. E. Rossi to J. A. Martin), which forwarded a safety evaluation report. In the safety evaluation, the NRC approved the Westinghouse Topical Report (WCAP-14732) regarding turbine missile analyses. The turbine missile generation probability calculated in the topical report shows that the value for P1 is less than 10^{-5} per year. The licensee stated that the analysis for the turbine missiles from the Unit 2 turbine generator is based on current missile generation probabilities provided by Westinghouse and its current maintenance and testing schedules. Since the turbine missile analysis for the Westinghouse plants was previously approved by the staff for referencing in license applications, the staff believes that the chance of design speed failure or destructive over-speed failure for a Westinghouse turbine system is very low assuming the licensee's testing and maintenance on the turbine governor and throttle valves are in accordance with Westinghouse recommended frequencies. On the basis of this review, the staff concludes that the licensee's turbine missile analysis for the Unit 2 turbine system is consistent with the NRC's guidelines. Therefore, the staff agrees with the licensee that there is no USQ for the Unit 2 turbine generator.

On the basis of its review, the staff concludes that the licensee's turbine missile analysis for the unevaluated portion in the UFSAR is conservative and is consistent with the guidelines addressed in SRP 3.5.1.3 and RG 1.115. Therefore, the USQ is resolved.

4.0 STATE CONSULTATION

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

5.0 ENVIRONMENTAL CONSIDERATION

The amendments change a requirement with respect to installation or use of a facility component located within the restricted area as defined in 10 CFR Part 20. The NRC staff has determined that the amendments involve no significant increase in the amounts, and no significant change in the types, of any effluents that may be released offsite, and that there is no significant increase in individual or cumulative occupational radiation exposure. The Commission has previously issued a proposed finding that the amendments involve no significant hazards consideration, and there has been no public comment on such finding (64 FR 70079). Accordingly, the amendments meet the eligibility criteria for categorical exclusion set forth in 10 CFR 51.22(c)(9). Pursuant to 10 CFR 51.22(b) no environmental impact statement or environmental assessment need be prepared in connection with the issuance of the amendments.

6.0 CONCLUSION

The Commission has concluded, based on the considerations discussed above that (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, (2) such activities will be conducted in compliance with the Commission's regulations, and (3) the issuance of the amendments will not be inimical to the common defense and security or to the health and safety of the public.

Principal Contributors: J. Guo

Date: June 19, 2000