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*A Member of the  
Constellation Energy Group*

April 21, 2000

U. S. Nuclear Regulatory Commission  
Washington, DC 20555

**ATTENTION:** Document Control Desk

**SUBJECT:** Calvert Cliffs Nuclear Power Plant  
Unit Nos. 1 & 2; Docket Nos. 50-317 & 50-318  
Response to Request for Additional Information Regarding the License  
Amendment Request: Unreviewed Safety Question - Turbine Missiles

**REFERENCES:**

- (a) Letter from Mr. C. H. Cruse (BGE) to NRC Document Control Desk, dated November 19, 1999, "License Amendment Request: Unreviewed Safety Question - Turbine Missiles"
- (b) Telephone Conference between Mr. A. W. Dromerick, et al. (NRC) and Mr. J. M. Osborne et al. (BGE), on February 7, 2000, "Request for Additional Information Regarding the License Amendment Request: Unreviewed Safety Question - Turbine Missiles"

Reference (a) forwarded a request from Baltimore Gas and Electric Company for a one-time Technical Specification change. Reference (b) requested additional information concerning BGE's proposed change. Attachment (1) provides our response to Reference (b). The attached questions and answers are related to the Unit 1 main turbine generator set only. Reference (a) explains why a turbine missile risk for the Unit 2 main turbine generator set can be effectively managed by maintaining its turbine missile generation probability to less than an appropriate value.

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

Very truly yours,

A handwritten signature in black ink, appearing to read 'Charles H. Cruse', written over a white background.

CHC/JMO/bjd

Attachment: (1) Response to Request for Additional Information: Turbine Missile Unreviewed Safety Question

ADD 11

Document Control Desk

April 21, 2000

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cc: A. W. Dromerick

**Without Drawings**

R. S. Fleishman, Esquire

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Director, Project Directorate I-1, NRC

H. J. Miller, NRC

Resident Inspector, NRC

R. I. McLean, DNR

J. H. Walter, PSC

**ATTACHMENT (1)**

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**RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION:**

**TURBINE MISSILE -**

**UNREVIEWED SAFETY QUESTION**

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**Baltimore Gas and Electric Company  
Calvert Cliffs Nuclear Power Plant  
April 21, 2000**

## ATTACHMENT (1)

### **SUMMARY DESCRIPTION AND SAFETY ANALYSIS**

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#### **Question 1:**

To assist this review, a plant layout drawing is needed. Please provide a sketch or drawing of the site plant [sic] showing the relative placement of the safety-related structures, systems, and components with respect to the main turbine generator sets that are within the low trajectory turbine missile strike zone for both units which are within the 25° lines emanating from the centers of the first and last low pressure turbine wheels.

#### **RESPONSE:**

The attached drawings show the only safety-related structures, systems, and components that are within the 25° criteria of question 1. The target area extends from approximately column 102 to column 112. Columns are indicated by circled three-digit numbers near the top of each drawing. As stated in Reference (a), the Auxiliary Building 45' switchgear room, and 69' control room heating, ventilation, and air conditioning (HVAC) equipment room are protected by the 3'-thick and 2'-thick, respectively, concrete missile-proof walls except for the openings at their non-missile-proof doors. A turbine missile that hits one of these doors is assumed to go through them, strike safety-related equipment in the room, and cause it to fail. The annotated drawings show these non-missile-proof openings in the K-line wall as follows:

- 1) On the site plan drawing (Drawing 61502SH0002), the portion of the K-line wall of concern is circled in black and located at drawing coordinates C6. The Unit 1 main turbine generator set is located at approximately the same position as the words "Unit No. 1" at drawing coordinates D6.
- 2) The large double door for the 69' control room HVAC equipment room is circled in black and located in the K-line between columns 111 and 112 on Drawing 62-041-E, Revision 19.
- 3) The three doorways for the 45' Auxiliary Building switchgear room are circled in black and located in the K-line at approximately columns 106 and 107 on Drawing 60-209-E, Revision 6 and column 110 on Drawing 60214, Revision 5.

#### **Question 2:**

As stated in the licensee's submittal, the evaluation of turbine missiles in the [original] Updated Final Safety Analysis Report (UFSAR) was incomplete as a result of the revised turbine missile analysis for Units 1 and 2. Explain in detail those portions of the strike and damage analysis that were not previously evaluated in the UFSAR with respect to the new targets and discuss the methodology and guidance used for the revised turbine missile analysis.

#### **RESPONSE:**

##### **Missile Strike Probability P2**

The area considered vulnerable to a low-trajectory turbine missile is that area bounded by lines included at 25° to the turbine wheel planes and passing through the end wheels of the low-pressure turbine stages. The only equipment within this range vulnerable to a turbine-missile strike is the equipment located in the 45' switchgear room and the control room HVAC equipment room on the 69' level. These rooms are vulnerable only because they have non-missile-proof doors. For this analysis, the doors to these rooms are considered the targets.

## ATTACHMENT (1)

### SUMMARY DESCRIPTION AND SAFETY ANALYSIS

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The missile hazard rate is calculated using guidance in Regulatory Guide 1.115 as discussed in Reference (a). The Missile Strike probability (P2) is the probability of a missile striking a target once a missile is generated (P1). This may be calculated fairly simply based on a ratio of the target area to the total possible area that the missile could strike at the targets' distance from the turbine.

The target area is simply the area of the doors in question. The total area that the missile could strike is calculated as follows:

#### **P2 for the 45' Switchgear Room Doors**

A missile can be ejected radially in any direction (360 degrees) around the rotors. It may also come off longitudinally at any point along the length of the turbine rotors. Therefore, the total possible strike area may be described as a cylinder with an axis coincident with the turbine rotor axis, a radius equal to the distance between the rotor axis and the individual targets (i.e., the doors annotated on the attached drawings), and length equal to the length of the turbine rotors. The additional length resulting from the 25° angle conservatively was not considered for the switchgear room analysis since the doors are directly across from the turbine rotors and it is believed that the missile is more likely to impact this area.

The area of the cylinder (CA) is calculated as follows:

#### **Total Possible Area (CA):**

$$CA = \text{Circumference} \times \text{length (axial length of Low Pressure Rotors A, B, and C)}$$

$$\text{Circumference} = 2\pi (\text{radius})$$

$$\text{Radius} = \text{distance between turbine rotor axis and the roll-up door} = 115 \text{ ft}$$

The length used to calculate the strike probability of the switchgear room doors is 100 feet. Two of the three switchgear room doors lie within lines extending radially away from the turbine axis toward the K-line. The third switchgear room door is not far outside of this region. Therefore, for simplicity, the length used to calculate the strike probability for the 45' switchgear room doors was conservatively taken as the distance between the outboard ends of Low Pressure Turbine A (LPA) and Low Pressure Turbine C (LPC).

$$\text{Length} = 100 \text{ ft}$$

$$CA = 2\pi (115 \text{ ft}) (100 \text{ ft}) = 72,257 \text{ ft}^2$$

#### **Door Area (DA)**

$$\text{Roll-up door} = 120 \text{ ft}^2$$

$$\text{Two personnel access doors at } 24.4 \text{ ft}^2 \text{ each} = 48.8 \text{ ft}^2$$

$$\text{Total door area for the switchgear room} = 168.8 \text{ ft}^2$$

#### **Therefore, P2 for the 45' Switchgear Room Doors is:**

$$\begin{aligned} P2 &= DA / CA \\ &= 168.8 \text{ ft}^2 / 72,257 \text{ ft}^2 \\ &= 2.34 \text{ E-03} \end{aligned}$$

ATTACHMENT (1)

**SUMMARY DESCRIPTION AND SAFETY ANALYSIS**

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**P2 for the 69' Control Room HVAC Equipment Room Door**

The control room HVAC equipment room on the 69' level has a large double door. The area of the large door is 80 ft<sup>2</sup>.

**Total Possible Area (CA):**

$$CA = \text{Circumference} \times \text{length}$$

$$\text{Circumference} = 2\pi (\text{radius})$$

$$\text{Radius} = \text{distance between turbine rotor axis and the roll-up door} = 115 \text{ ft}$$

In the case of the control room HVAC equipment room door, the length is greater than the 100' distance used for the switchgear room doors. The area vulnerable to a low trajectory missile is bounded by lines inclined at 25° to the turbine wheel planes and passing through the end wheels of the low-pressure stages. The large control room HVAC equipment room door is near the edge of the 25° boundary of LPC and outside of the 25° limit for Low Pressure Turbine B (LPB) and LPA. The length, then, is the distance along the K-line measured from lines extending outward at a 25° inclination from each end of LPC.

$$\text{Length} = 136 \text{ ft}$$

$$CA = 2\pi (115 \text{ ft}) (136 \text{ ft}) = 98,300 \text{ ft}^2$$

**Door Area (DA)**

$$\text{Total door area for the control room HVAC equipment room} = 80 \text{ ft}^2$$

**Therefore, P2 for the 69' Control Room HVAC Equipment Room Door is:**

$$\begin{aligned} P2 &= DA / CA \\ &= 80 \text{ ft}^2 / 98,300 \text{ ft}^2 \\ &= 8.14 \text{ E-04} \end{aligned}$$

**Missile Damage Probability (P3)**

The missile damage probability is assumed to be 100% or 1.0.

**Missile Risk (P4)**

**P4 for 45' Switchgear room doors**

$$P4 = P1 \times P2 \times P3 \text{ (Note that P1 has been revised based on the March 2000 inspection results.)}$$

$$P4 = 3.2\text{E-05} \times 2.33\text{E-03} \times 1.0$$

$$P4 = 7.46\text{E-08} / \text{yr}$$

ATTACHMENT (1)

**SUMMARY DESCRIPTION AND SAFETY ANALYSIS**

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**P4 for the 69' Control Room HVAC Equipment Room Doors**

$P4 = P1 \times P2 \times P3$  (Note that P1 has been revised based on the March 2000 inspection results.)

The control room HVAC equipment room doors are only susceptible to a missile generated by LPC. Therefore, only LPC's turbine missile generation probability (P1) is used here.

$$\begin{aligned} P4 &= 8.5E-06 \times 8.14E-04 \times 1.0 \\ &= 6.92E-09 / \text{yr} \end{aligned}$$

**Total P4**

The total missile risk from the 45' switchgear room and 69' control room HVAC equipment room doors is the sum of the P4 values calculated above.

$$\begin{aligned} P4_{\text{Total}} &= P4_{\text{SWGR}} + P4_{\text{CRHVAC}} \\ &= 7.46E-08 + 6.92E-09 \\ &= 8.15E-08 / \text{yr} \end{aligned}$$

Since the Total P4 is less than NRC  $1E-07 / \text{yr}$  criteria, turbine missile risk is acceptable.

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61502SH0002, Rev. 13:  
PLANT PROPERTIES AND  
BUILDINGS**

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TURBINE BLDG. UNIT NO 1 PLAN-  
FLOOR EL. 45 Ft. - 0 Inches**

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60214, Rev. 5:  
EQUIPMENT LOCATION  
TURBINE BLDG. UNIT NO 1&2  
FLOOR PLAN EL. 45 Ft. - 0 Inches &  
69 Ft. - 0 Inches**

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**62-041-E, Rev. 19:**

**ACCESS CONTROL AREA  
PARTIAL FLOOR PLAN &  
SECTIONS AT EL. 69 Ft. - 0 Inches  
ELECTRIC PRODUCTION PLANT**

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