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JOSEPH A. TIERNAN
VICE PRESIDENT
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March 5, 1986

Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

ATTENTION: Mr. A. C. Thadani, Project Director
PWR Project Directorate #8
Division of PWR Licensing - B

SUBJECT: Calvert Cliffs Nuclear Power Plant
Unit Nos. 1 & 2; Docket Nos. 50-317 & 50-318
Control Room Dose

REFERENCES: (a) Letter from J. A. Tiernan, to T. T. Martin, Inspection Report 50-317/85-31; 50-318/85-26, dated January 13, 1986

(b) Letter from D. G. Eisenhut, to All Licensees, Post-TMI Requirements, dated October 31, 1980

(c) Letter from R. A. Clark, to A. E. Lundvall, Jr., Safety Evaluation Report, dated September 3, 1982

(d) Letter from C. H. Poindexter, to D. G. Eisenhut, Subject: Response to NUREG-0737, dated December 30, 1980

(e) Letter from A. E. Lundvall, Jr., to R. A. Clark, Subject: NUREG-0737 Item III.D.3.4, dated July 27, 1982

(f) Letter from A. E. Lundvall, Jr. to R. W. Reid, Subject: Control Room Dose, dated April 10, 1978

Gentlemen:

In Reference (a), we agreed to determine a total control room inleakage rate by direct measurement and, if necessary, use this rate in a new dose calculation for control room operators. This letter and its attachments provide the results of the inleakage determination and the new dose calculation.

Background

Reference (b) issued NUREG-0737 which contains post-TMI requirements approved by the Commission for implementation. One of the requirements, III.D.3.4 Control Room Habitability, states that licensees shall assure that control room operators will be adequately protected against the effects of accidental release of toxic and radioactive gases and that the nuclear power plant can be safely operated or shut down under design basis accident conditions.

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Reference (c) forwarded a safety evaluation by the Office of Nuclear Reactor Regulation which states, in part, that based on the information we provided in References (d) and (e), our control room design meets the criteria identified in NUREG-0737 and is acceptable. This determination was made by the NRC after reviewing the assumptions we used in calculating the radiation dose from airborne radioactivity. Among these assumptions was the use of 19 cfm unfiltered inleakage. At that time, the NRC concluded that our use of 19 cfm unfiltered inleakage in the Control Room dose calculation was acceptable.

In the years following our safety evaluation, extensive research has been conducted in the areas of source terms and control room design. As part of the ongoing research in control room design, individuals from NRC/NRR, NRC/I&E, and Argonne National Laboratory visited Calvert Cliffs in September 1985. During the discussions that followed the NRC staff indicated that our use of 19 cfm unfiltered inleakage is now highly suspect. This concern was formally presented as an inspection finding in Inspection Report 50-317/85-31; 50-318/85-26.

Further discussions with the NRC staff indicated that the dose criteria of GDC 19 to Appendix A of 10 CFR Part 50 (5 rem whole body, or its equivalent to any part of the body) is being implemented in staff reviews as 5 rem whole body and 30 rem beta skin exposure. The previous staff review criteria, and that used when we submitted our response, was 5 rem whole body, 30 rem beta skin exposure, and 30 rem thyroid. The thyroid dose criteria has been suspended because the NRC staff is presently reviewing the iodine source term for the design basis loss-of-coolant accident. We understand that the thyroid exposure limit will be addressed as a separate action from NUREG-0737 after the source term resolution.

Control Room Dose Calculation

As stated earlier, Reference (d) provided our response to NUREG-0737, Item III.D.3.4, Control Room Habitability. We referenced previous submittals in our response, the most signficant being Reference (f). Reference (f) provided a summary of our calculation to determine the doses to control room operators following a postulated LOCA.

Attachment A to this letter restates our response to NUREG-0737, Item III.D.3.4. The format and information is identical to that provided in Reference (d) except for the reference for infiltration leakage rate. Revisions are noted by vertical lines in the right-hand margin.

Attachment B to this letter revises the summary of our control room dose calculation. Its format is identical to Reference (f). Changes in the summary information which resulted from our inleakage measurements and new calculation are noted by vertical lines in the right-hand margin. The revised control room dose calculation results in a 30-day integrated whole body dose of 1.5 rem and skin dose of 24 rem. These doses are well below the GDC 19 dose criteria of 5 rem whole body and 30 rem skin.

Should you have any questions regarding this matter, please do not hesitate to contact us.

Very truly yours,

JAT/WPM/dmk

cc: D. A. Brune, Esq.
J. E. Silberg, Esq.
Mr. D. H. Jaffe, NRC
Mr. T. Foley, NRC

REFERENCES FOR CONTROL ROOM HABITABILITY EVALUATION

(a) Calvert Cliffs Nuclear Power Plant Final Safety Analysis Report.

(b) Letter from A. E. Lundvall, Jr., to R. W. Reid, dated April 10, 1978, Doses to Control Room Operators Following a Design Basis LOCA.

(c) Letter from A. E. Lundvall, Jr., to R. W. Reid, dated November 20, 1978, same subject.

(d) Control Room Habitability Study for Calvert Cliffs Nuclear Power Station, prepared for BG&E by Bechtel Power Corporation, as amended, (Attachment 1 to letter from C. H. Poindexter, to D. G. Eisenhut, Response to NUREG-0737, dated December 30, 1980), dated November 1980 and revised December 1980.

(e) Attachment 2 to letter from C. H. Poindexter, to D. G. Eisenhut, Response to NUREG-0737, dated December 30, 1980.

(f) Attachment B to this letter.

(g) Letter from A. E. Lundvall, Jr., to R. A. Clark, NUREG-0737, Item III.D.3.4, dated July 27, 1982.

(1) Control room mode of operation, i.e., pressurization and filter recirculation for radiological accident isolation or chlorine release, Ref. (a) Section 7.6.2 and 9.8.2.3, and Ref. (b).

(2) Control room characteristics

(a) air volume control room - Ref. (b)

(b) control room emergency zone (control room, critical files, kitchen, washroom, computer room, etc.) - Ref. (a), Sections 7.6.2 and 9.8.2.3, Ref. (6) (sic) and Ref. (c)

(c) control room ventilation system schematic with normal and emergency airflow rates. - Ref. (a), Figure 9-20

(d) infiltration leakage rate - Ref. (f)

(e) high efficiency particulate air (HEPA) filter and charcoal adsorber efficiencies - Ref. (b)

(f) closest distance between containment and air intake - Ref. (c) and Ref. (d)

(g) layout of control room, air intakes, containment building, and chlorine, or other chemical storage facility with dimensions - Ref. (d) and Ref. (a), Figures 1-8 and 1-12

(h) control room shielding including radiation streaming from penetrations, doors, ducts, stairways, etc. - Ref. (e)

(i) automatic isolation capability - damper closing time, damper leakage and area - Ref. (b)

(j) chlorine detectors or toxic gas (local or remote) - Ref. (d)

(k) self-contained breathing apparatus availability (number) - Ref. (g)

(l) bottled air supply (hours supply) - Ref. (g)

(m) emergency food and potable water supply (how many days and how many people) - Ref. (d)

(n) control room personnel capacity (normal and emergency) - Ref. (d)

(o) potassium iodide drug supply - Ref. (d)

(3) Onsite Storage of chlorine and other hazardous chemicals - Ref. (d)

(a) total amount and size of container

(b) closest distance from control room air intake

(4) Offsite manufacturing, storage, or transportation facilities of hazardous chemicals - Ref. (d)

(a) identify facilities within a 5-mile radius

(b) distance from control room

(c) quantity of hazardous chemicals in one container

(d) frequency of hazardous chemical transportation traffic (truck, rail and barge)

(5) Technical specifications (refer to standard technical specifications) - Ref. (b) and Ref. (d)

(a) chlorine detection system

(b) control room emergency filtration system including the capability to maintain the control room pressurization at 1/8-in. water gauge, verification of isolation by test signals and damper closure times, and filter testing requirements.

Radiation Doses to Control Room Operators Following a Design Basis LOCA

I. General

The radiation doses to control room operators following a design basis LOCA are calculated to show compliance with 10 CFR 50, Appendix A, General Design Criterion 19. FSAR Section 14.24 discusses the off-site dose consequences as a result of LOCA and is used in this analysis to provide the source terms.

II. Description of Control Room Ventilation System

The control room ventilation system is discussed in FSAR Section 9.8.2.3 and shown in FSAR Figure 9-20C.

The system consists of two full capacity supply fans and recirculation filters. Outside air is supplied to each fan suction independently. Each supply has its own supply damper. One of the two trains is in operation with the second in "standby". In the recirculation mode, only the supply damper for the operable fan will be subject to a significant differential pressure.

This system provides year-round cooling utilizing outside air in the winter and air-conditioning in the summer. As the outside temperature rises to 56°F, increased quantities of outside air are brought in. At 56°F, a maximum of 24,225 cfm is provided. Above 56°F, the air-conditioning system is utilized. During its use, 4150 cfm of outside air are brought in to provide the necessary ventilation.

When high radiation is detected in the incoming air, the supply damper is automatically closed to isolate the control room. A recirculation system including iodine removal filters is utilized to maintain the dose to operators at acceptable levels.

Based on the sample flow rate and the actual length of tubing between the sample point and the detector, it will take 2.1 seconds for the high radiation to be sensed. By test, the supply damper closes in 23.3 seconds. Consequently, the control room is isolated in 25.4 seconds.

III. Method of Analysis

A. Assumptions

Unless stated otherwise, all assumptions are consistent with FSAR Section 14.24. This includes power level (2700 MWt), activity released to containment atmosphere, iodine dose reduction factors, penetration room effect, etc.

Additional assumptions are as follows:

1. The containment leak rate is assumed to be 0.2% per day for the first 24 hours and 0.1% per day after 24 hours.

2. Release from the penetration room is filtered (see FSAR Section 6.6) and released via the plant stack.

3. With respect to atmospheric dispersion (X/Q) factors the following were utilized:

	Containment Leakage	Stack Release
X/Q 0-8 hours (sec/m^3)	7.7×10^{-4}	8.6×10^{-4}
X/Q 8-24 hours (sec/m^3)	4.5×10^{-4}	5.0×10^{-4}
X/Q 1-4 days (sec/m^3)	2.5×10^{-4}	2.8×10^{-4}
X/Q 4-30 days (sec/m^3)	6.3×10^{-5}	7.0×10^{-5}
Release Height	Uniform from EL 45' to EL 193'	EL 203'6"
Receptor (Control Room Air Intake) Height	EL 96'6"	EL 96'6"
Distance from Release Point to Receptor	72'	77'
Direction from Release Point to Receptor (from true North)	E	ESE
Building Wake Factor	3.1	3.5

The above is based on three years of on-site data and assumes the LOCA occurs in the unit closer to the control room air intake. A constant wind direction blowing directly from the release point to the receptor is assumed.

4. Since the quantity of outside air supplied is a function of outside air temperature (i.e., Meteorology), 21,100 cfm were assumed for the analysis. Meteorological conditions resulting in this value or higher will occur less than 5 percent of the time.

5. Time to isolate the control room is 25.4 seconds. During the first 2.1 seconds outside air is supplied at 21,100 cfm. From 2.1 seconds to 25.4 seconds the damper is closing and the quantity of air is assumed to decrease linearly to zero at 25.4 seconds.

6. Unfiltered inleakage across HVAC ducting will be 727 cfm during recirculation. This is based on the results of a system leak test modified to account for conditions applicable to this analysis.

7. Additional sources of unfiltered inleakage include dampers, doors and penetrations. Local leak rate testing has determined that the total contribution from these sources is 486 cfm. This includes 10 cfm for the opening and closing of the doors to the control room during the postulated accident. The sum of inleakage sources identified in this and the previous assumption is 1213 cfm.

8. The control room recirculation flow is 2000 cfm.

9. The control room volume is 166,000 cu. ft.

10. Control room occupancy factors are 1 for zero to 24 hours, 0.6 for 1 day to 4 days, and 0.4 for 4 days to 30 days.

11. No credit is taken for respiratory protection devices.

B. Model

The calculational model used for the evaluation of the post-LOCA radiological consequences to the control room personnel is based on an analytical solution of the problem.

The analytical model uses the source terms of Regulatory Guide 1.4, i.e., 25% of the equilibrium noble gas core inventory immediately available for leakage from the primary containment. Proper atmospheric dispersion factors (X/Qs) are applied to the releases to obtain the airborne isotope concentration at the control room intake.

The airborne isotopic concentration in the control room is calculated on the basis of initial intake rate, inleakage following control room isolation, and filtered recirculation.

The dose models used are based on applicable Regulatory Guides. These models are part of the AXIDENT computer code (Ref. 2) which has been used by BG&E for other dose calculations. AXIDENT has been approved by the NRC as part of its review of the Calvert Cliffs proposed containment vent system (Ref. 3).

IV. Results

The following results are calculated for the 30 day dose to the control room operator.

	Skin Dose (rem)	Total Body (rem)
Calculated	24	1.5
Criteria per GDC19/SRP6.4	30	5

V. Conclusions

Since the whole body and skin calculated dose to the control room operator is less than the GDC 19 limit, it is concluded that the dose to the operators is acceptable, and that the present design meets all necessary criteria.

VI. References

1. A. K. Postma, M. F. Paredogy, "A Review of Mathematical Models for Predicting Spray Removal of Fission Productions in Reactor Containment Vessels", BNWL-B-268, June 1973.

2. S. J. Nathan, "AXIDENT: A Digital Computer Dose Calculation Model", NUS-1954 Revision 3, February 1984.

3. Letter from D. H. Jaffe, to J. A. Tiernan, Containment Vent System, dated February 20, 1986.