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SUBJECT: Forwards rept describing post-LOCA control room dose analysis calculation basis & results for plant.

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H. B. ROBINSON STEAM ELECTRIC PLANT, UNIT NO. 2
DOCKET NO. 50-261/LICENSE NO. DPR-23
CONTROL ROOM HABITABILITY
TMI ITEM II.D.3.4

Gentlemen:

The attached report describes the Post-LOCA Control Room Dose Analysis calculation basis and results for Carolina Power & Light Company's (CP&L) H. B. Robinson Steam Electric Plant, Unit No. 2. This analysis has been revised to reflect the redesigned Control Room Ventilation System which was discussed in our July 26, 1988 submittal.

Carolina Power & Light Company is currently in the process of procuring long lead items necessary to support our Refueling Outage 13 installation schedule. Therefore, timely resolution of any outstanding items associated with the revised design is essential. Carolina Power & Light Company is prepared to support any meetings or presentations to the staff which will facilitate review and final resolution of this issue.

If there are any questions or need to schedule further meetings, please contact Mr. R. W. Prunty at (919) 546-7318.

Yours very truly,

L. I. Loflin
Manager
Nuclear Licensing Section

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Attachment

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CALCULATION BASIS
CONTROL ROOM DOSE
POST-LOCA
H. B. ROBINSON STEAM ELECTRIC PLANT
CONTROL ROOM HABITABILITY

Summary:

The calculation shows that the 30-day post-LOCA inhalation dose (iodine) to control room personnel afforded by the proposed Control Room Ventilation System (CRVS) is 25.48 rem thyroid.

Purpose:

The HBR2 commitments to paragraph III.D.3.4 of NUREG 0737 require the installation of new Control Room Ventilation System (CRVS) components. As such, the performance of the new CRVS must be evaluated with respect to the dose received by control room personnel post-LOCA (NUREG 0737, paragraph III.D.3.4(3)).

History:

In response to NUREG 0737, the existing (pre refueling outage 13) CRVS was evaluated against NUREG 0800 - Standard Review Plan - 6.4, 6.5.1, and 9.4.1 by NUS (NUS-3696*). This evaluation showed that the existing system provided adequate protection from immersion dose (wholebody gamma and skin beta) but did not provide sufficient protection from inhalation (iodine) dose. The revised CRVS modifications proposed by our July 26, 1988 letter will resolve the inhalation dose concern. The improved CRVS will still provide adequate protection from immersion dose (the filtered makeup rate will not be increased), and thus immersion dose need not be recalculated. In addition, the dose from shine has already been evaluated as part of previous NUREG 0737 submittals and is still within the existing UFSAR description (UFSAR Section 6.4.2.5). Therefore, this calculation summary will only evaluate the control room inhalation dose to the thyroid due to iodine.

The following assumptions are per the guidance of NUREG 0800 - Standard Review Plan 6.4:

Regulatory Guide 1.4 - Assumptions for Evaluating the Potential Radiological Consequences of a Loss of Coolant Accident for Pressurized Water Reactors - Paragraphs C.1.a, .b, .c, .d, and .e and paragraphs C.2.a., b., and g. are used to define the accident.

Per these paragraphs, the accident is evaluated over four time periods: 0-8 hours, 8-24 hours, 1-4 days, and 4-30 days. There are two sources of leakage, these being the containment and the ECCS system. Containment leak rates vary in two discrete steps, the Technical Specification evaluated leak rate for the first 24 hours and 50 percent of this leak rate for the remainder of the accident. These leak rates correspond to 0.1 weight percent of the

*NUS-3696 - Control Room Habitability Evaluation - H. B. Robinson Steam Electric Plant Unit No. 2, transmitted to NRC by letter dated December 31, 1980

containment inventory per 24 hour period (Tech Spec. 4.4.1.1 f(1)) and 0.050 weight percent of the containment inventory per 24 hour period, respectively. The ECCS leak rate is calculated as follows:

- 215,000 gal sump inventory (UFSAR 6.3.2.2.2 c) minimum volume
- Leakage rate from ECCS = 2 x maximum allowable Tech Spec leakage of 2 gal/hr = 4 gal/hr (NUREG 0800 - 15.6.5 - Appendix B.III and Tech Spec 4.4.3)
- 4 gal/hr divided by 215,000 gal divided by 3600 sec/hr = 5.170E-9 sec^{-1}.
- This converts to 0.045 %/day.

No credit is taken in the calculation for the removal of iodine by the Auxiliary Building charcoal filters.

There are three forms of iodine considered: particulate, elemental, and organic. Per Reg Guide 1.4, paragraph C.1.a, the distribution of the three forms is: five percent particulate, four percent organic, and ninety-one percent elemental. Per the CRVS design basis, filter efficiencies are: 99% for particulate, 95% for elemental, and 95% for organic.

Five iodine isotopes are evaluated. These are I^{131}, I^{132}, I^{133}, I^{134}, and I^{135}. The initial core inventory for this calculation is that postulated for fuel enrichment anticipated for the foreseeable future. Normally the existing FSAR fuel would be used but future enrichment and the resulting core iodine inventories will be used to show that the system has been sized with margin. The postulated inventories are shown below. Per Reg Guide 1.4, paragraph C.1.a, 25% of the available iodine inventory is immediately available for airborne release from the containment, post-LOCA.

ISOTOPE	CORE INVENTORY
I^{131}	6.98E+07 Ci.
I^{132}	9.83E+07 Ci.
I^{133}	1.25E+08 Ci.
I^{134}	1.40E+08 Ci.
I^{135}	1.09E+08 Ci.

NUREG 0800 - 15.6.5 Appendix B.III requires that 50% of the core inventory be mixed with the sump water being recirculated through the ECCS piping. The flashing fraction from the ECCS leakage for HBR2 is approximately 5.3 percent (263°F max water temp flashing to atmosphere) so 5.3 percent of the leakage from the ECCS system is assumed available for airborne release. The 263°F comes from UFSAR Section 6.3.2.2.2 c).

The 5.3 percent is based upon a conservative set of assumptions. In the analysis the sump water is conservatively assumed to remain at 263°F even though it would be reduced to 212°F within a short time after the start of recirculation. A fraction of water at 263°F would flash into steam after leaking into the ECCS area. This fraction is 5.3 percent based on heat balance. After flashing, the remaining liquid would be collected in the drains and removed from the area.

The 5.3 percent value is higher than that obtained using a partition coefficient and is a conservative estimate in the dose evaluation.

The atmospheric diffusion ratios, X/Q, have been reconfirmed and are the same as those given in NUS 3696. There are four X/Q values, one for each of the four time periods described above. They are:

Time Period	X/Q
0-8 Hours	2.00E-03 SEC/M^3
8-24 Hours	1.10E-03 SEC/M^3
1-4 Days	3.40E-04 SEC/M^3
4-30 Days	5.80E-05 SEC/M^3

An occupancy factor has been included in the four X/Q values per NUS-3696 and Table 1 from 13th AEC Air Cleaning Conference, NUCLEAR POWER PLANT CONTROL ROOM VENTILATION SYSTEM DESIGN FOR MEETING GENERAL CRITERION 19. These are:

Time Period	Occupancy Factor
0-8 Hours	1.0
8-24 Hours	1.0
1-4 Days	0.6
4-30 Days	0.4

Per Reg Guide 1.4, paragraph C.2.d, the iodine dose conversion factors are taken from ICRP Publication 30, which supersedes ICRP Publication 2, Report of Committee II, "Permissible Dose for Internal Radiation," 1959.

The breathing rate is constant for the 30-day period using the larger value given in Reg. Guide 1.4, paragraph C.2.c. which is 3.47×10^{-4} cubic meters per second. This is the same as the active breathing rate described in TID 14844 which is half the total of 20 $meters^3$ per day inhaled by the "standard man".

Per Reg Guide 1.4, paragraph C.2.b, no correction has been made for depletion of the effluent plume of radioactive iodine due to deposition on the ground, or for the radiological decay of iodine in transit.

The design of the CRVS is zone isolation with filtered recirculated air and positive pressure. The mathematical model for the CRVS is the Figure 4(a) model from the 13th AEC Air Cleaning Conference, NUCLEAR POWER PLANT CONTROL ROOM VENTILATION SYSTEM DESIGN FOR MEETING GENERAL CRITERION 19, where the Iodine Protection Factor (IPF) calculation requires the values of F1 (filtered inleakage or makeup rate), F2 (filtered recirculation rate), F3 (unfiltered inleakage rate), and n (filter efficiency).

The design basis values for the above parameters are:

F1 = 400 CFM (average)
F2 = 2600 CFM (average)
F3 = 15 CFM
n = .99 for particulate, .95 for elemental, and .95 for organic.

The design uncontrolled inleakage is 15 cfm. This is consistent with NRC Standard Review Plan, NUREG 0800, paragraph 6.4, CONTROL ROOM HABITABILITY SYSTEM, subparagraph III.3.d.3-footnote which requires 10 cfm inleakage for door openings. An additional 5 cfm inleakage has been included to account for leakage from pressurized duct passing through the control room which contains unfiltered air and ductwork in the control room ventilation system which is both negative with respect to the equipment room and located downstream of the filter.

Containment radioiodine inventories are reduced by containment spray while ECCS sump inventories are not. Containment spray is assumed to only mitigate elemental iodine. Spray rate for elemental iodine would be 10 HR^{-1} per NUS-3696. This is also the minimum suggested cleanup factor from TID-14844, section V.A.3. This is below the value calculated in UFSAR Section 6.5.2.3.2 c) for removal of elemental iodine and, as such, would be conservative.

The control room volume is 19,342 cubic feet.

Conservatism:

The concentration in the control room is assumed to vary directly with the concentration at the intake. In fact, this is not the case and the assumption that it varies directly is conservative.

Condensation effects of containment spray cooling have not been considered for particulate iodine which is conservative (UFSAR 6.5.2.1, 6.5.2.3.1, 15.6.5.5.2).

Calculated containment spray removal rates are larger than the value used in this calculation which is conservative (UFSAR Table 6.5.3-1 and UFSAR 15.6.5.5.2, 15.6.5.5.3).

The production of organic forms of airborne iodine assumed by Reg. Guide 1.4 are large compared to the production used for the existing H. B. Robinson Offsite Dose evaluation and existing CRVS (UFSAR 15.6.5.5.2). For this improved CRVS system, the larger values are conservative.

The containment leak rates assumed by Reg. Guide 1.4 are large compared to the calculated containment leak rate for H. B. Robinson (UFSAR Table 6.5.3-1). The larger values are conservative.

Design Basis Reconstitution:

The Robinson Design Basis Reconstitution Project and the Appendix K single failure analysis are in progress. These efforts involve the research of historical data and are being used to define the Robinson design basis relative to active and passive single failures. Any effects of these efforts on the design basis of the Control Room Habitability System have not been incorporated into the current design but will be addressed as part of the Design Basis Reconstitution Project.