N131-1189

Nebraska Public Power District

DESIGN CALCULATIONS COVER SHEET

Title Control Room Operator Dose due to Inleakage to Control Room	Calculation No. NEDC 94-071
	Supersedes Calc. No. SWEC 13095.16 PR(D)-002
System/Structure Control Room Habitability	Task Identification No. 89214
Component Control Room Emergency Filter	Design Change No. None
Classification: ☒ Essential ☐ Non-Essential	Discipline Mechanical
	*ASME Stress reports shall be approved by Registered P.E.

NPPD Generated Calculation	Non NPPD Generated Calculation
Prepared By _____ Date _____	Prepared By ERIN (Company Name) Date 4-26-94
Checked By _____ Date _____	NPPD Reviewed By David J. Reader Date 4-27-94
Design Verification By _____ Date _____	NPPD Approval Mark A. Hillstrom Date 4/27/94
Approved By _____ Date _____	

Calc. Description:

This calculation reviews the ERIN calculation C122-93-01-01 "CNS Control Room Operator Thyroid Dose Calculation". Control room operator thyroid dose (and whole body dose) due to intake of the accident cloud into the Control Room (filtered and unfiltered) following a design basis accident is calculated. All accident scenarios were considered with actual calculations performed for LOCA and refueling accident. Whole body dose due to cloud inside control room is also determined by this calculation.

~~Maximum dose was determined to be due to a LOCA with 375 cfm flow rate through the control room emergency bypass filter. Dose is 2.139 Rem thyroid and 1.098E-03 Rem whole body.~~ 1

Design Basis or References:

1. USAR Chapter XIV, Section 10.5
2. TECH. SPECS. Section 3/4.12
3. USAR Chapter XIV, Section 6
4. ERIN Report No. TR122-90-09-01, Rev. 0
5. Letter from L. Bennett (ERIN) to M. Hillstrom (NPPD) dated 4-26-94
6. Letter from J. Larson (NPPD) to A. Horn (ERIN) dated 3-22-94
7. NEDC 94-070, Rev. 0
8. NEDC 94-072, Rev. 0
9. NUREG-1465 "Accident Source Terms for Light-Water Nuclear Power Plants" June 1992 1

Attachments:

A. ERIN Calculation C122-93-01-01, Rev. ~~0~~ 4
B. SWEC Calculation 13095.16 PR(D)-002
C. Letter from G. P. Lahti (S&L) to M. A. Hillstrom (NPPD) dated 7-5-94. 1

Rev. No.	Revision Description	Prepared By/Date	~~Checked~~ or Reviewed By/Date (Circle One)	Design Verification/Date	Approved By/Date
1	INCORPORATED THIRD PARTY REVIEW; REPLACED ATT. A WITH REV. 2	ERIN	David J. Reader / 7-8-94	~~DSR 7-8-94~~	Mark A. Hillstrom 7/8/94
2	REPLACED ATT. A WITH REV. 4	ERIN	David J. Reader / 7-16-94	~~DSR 7-16-94~~ DSR 7-16-94	Mark A. Hillstrom 7/18/94

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DESIGN CALCULATIONS SHEET

Calc No. NEDC 94-071

NPPD Generated Calculation

Review of Non-NPPD Generated Calculations

Prepared By: _____

Date: _____ 19____ Company's Name: ERIN

Checked By: _____ NPPD Reviewer: David J. Kunkle

Date: _____ 19____ Date: July 16, 1994

Purpose:

The purpose of this calculation is to review ERIN calculation C122-93-01-01 "CNS Control Room Operator Thyroid Dose Calculation" and thus determine the operator dose due to intake and inleakage of a radiological accident release cloud into the control room.

The purpose of Revision 1 (to NEDC 94-071) is to review changes made per Revision 1 and Revision 2 of ERIN calculation C122-93-01-01. Revision 1 of the ERIN calculation incorporated changes made to the input data due to discrepancies discovered during a third party review by Sargent and Lundy. Revision 2 of the ERIN calculation added additional test cases, two of which were performed to provide more conservative analysis of dose due to a LOCA with filtered control room flow rates of 375 and 666 cfm and the other was to perform analysis of dose due to the Refueling accident at 666 cfm.

The purpose of Revision 2 (to NEDC 94-071) is to review changes made per Revision 3 and Revision 4 to ERIN calculation C122-93-01-01. These revisions performed additional cases to further document the current capabilities of the Control Room Habitability System and to support potential modifications to the system.

Requirements:

Requirements for control room habitability per 10CFR50, Appendix A GDC 19 (per Standard Review Plan, Section 6.4) is that the 30-day integrated operator dose be less than 5 Rem whole body and 30 Rem thyroid.

Only information concerning radiological doses to control room operators due to intake or inleakage into the control room (excluding filter shine dose, see Ref. 7) should be considered accurate in Attachment A. All other information, such as off-site dose, is not accurate for CNS.

Assumptions:

The assumptions (Section 3.0) and design inputs (Section 5.0) of Attachment A are consistent with both the assumptions for the design basis accident analysis in Reference 4 and expected response and performance of the CNS engineered safety features involved (i.e. Standby Gas Treatment System, Control Room Emergency Bypass Filter System, etc.,).

Methodology:

To determine the control room dose, ERIN employed a computer program, Post Accident Design Dose (PADD). The formulas used by PADD are shown in Section 4.4 of Attachment 1. The PADD code was previously validated and verified by GE to provide safety-related dose calculations. A NPPD QA surveillance audit has examined ERIN's safety-related computer software control (Ref. 6).

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Date: _____ 19____ Company's Name: ERIN

Checked By: _____ NPPD Reviewer: David J. Rooks

Date: _____ 19____ Date: July 6, 19 94

Discussion & Results:

The case study results of the ERIN calculation as shown in Section 8.0 of Attachment A, indicate the effect of varying key design inputs. It should be noted that all cases that are presented are acceptable for calculating the dose to CNS control room operators as long as the value of the key input parameters are representative of the current configuration and operation of the Control Room Habitability System at CNS. 2

Case #1 is the design basis LOCA which models the current condition of the Control Room Habitability System. These results superseded the previous control room thyroid dose calculation by Stone & Webster (Attachment B). The ERIN calculation corrected several inconsistencies found in the S&W calculation which were identified in Reference 4. Power level and MSIV leak rate used in the calculation were decreased to their Technical Specification limits and control room and primary containment volumes were increased to closer to their actual values, all of which would tend to decrease the calculated dose. Contrastingly, the SGT and control room filter efficiencies were decreased by the ERIN calculation from 99% and 99% to 95% and 90% respectively and the actuation time for Secondary Containment (Rx Bldg) was increased from instantaneous to 90 seconds, which causes an increase in the dose. Overall, the ERIN calculation resulted in increasing the control room operator thyroid dose from the 1.09 Rem that was calculated in Attachment B.

Case #s 2, 3, 5, and 7 increase the control room filtered flow rate to values of 666, 1000, 1500, and 2000 cfm respectively. This causes a slight change in dose. These results are expected since an increased flow rate will cause an increased amount of activity to enter the control room, but will also result in additional act vity leaving the room, thereby decreasing the activities residence time and resulting in only a small increase in dose. 2

Case #15 used identical design inputs as case #1 with the exception of increasing unfiltered inleakage from 10 cfm to 1000 cfm and decreasing the filtered flow from 375 cfm to 305 cfm. This case was done to calculate the dose if positive control room pressure can not be claimed and additional unfiltered inleakage has to be assumed. 1000 cfm was assigned as the bounding unfiltered inleakage based upon the guidelines provided in the Standard Review Plan (SRP), Section 6.4. (Base infiltration rate is estimated as 1/2 the flow rate required to pressurize the Control Room envelope to 1/8" w.g.) The filtered flow rate was decreased to 305 cfm since this value produced higher doses than 375 cfm with these higher infiltration rates. For these cases, the filtered flow rate dilutes the larger unfiltered flow and therefore a lower filter flow rate is more conservative. This case results in an increase in thyroid dose to 27.08 Rem, whole body dose to 0.073 Rem, and beta skin dose to 0.653 Rem due to the increased activity entering the control room.

Case #12 calculated the control room operator dose due to the design basis refueling accident. The results of this analysis determined that the dose for this accident is 1.211 Rem thyroid, 0.168 Rem whole body, and 1.650 Rem beta skin dose. Increase of these doses from Rev. 0 are due to changes in the source terms and in the modeling of the accident by the PADD code to produce more conservative results.

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Checked By: _____ NPPD Reviewer: David J. Kuehn

Date: _____ 19____ Date: July 16, 1994

Revision 1 incorporated comments from a third party review of ERIN calculation C122-93-01-01, Rev. 0, by Sargent & Lundy (Attachment C). The third party review identified several discrepancies between the assumptions for the calculation and the attached inputs and results for the calculation test cases. Upon validation of these discrepancies, ERIN re-performed all calculation test cases and re-issued the calculation as Revision 1. The following discrepancies were identified:

- Time line for meteorology conditions. Fumigation conditions should have been assumed for the first thirty minutes. Instead twenty minutes was used. Since the majority of the control room dose occurs during this first half hour, this underestimated the dose by approximately 50%. This has been corrected in Rev. 1 of the ERIN calculation.

- Mixing in the Reactor Building. Assumption 2 of the ERIN calculation states that no credit for mixing in the reactor building was to be considered. In actuality the ERIN calculation was mistakenly done using 100% mixing. This was modified in Rev. 1 and 2 of that calculation with all cases being corrected in Rev. 3. 2

- Iodine Source Term. Reg Guide 1.3 states that 25% of the core inventory of halogens (iodine) is available for leakage. The ERIN calculation mistakenly used 100% which overestimated the thyroid dose by approximately a factor of 4. This has been corrected in Rev. 1 of the ERIN calculation.

When modeling these same errors, the third party review calculated doses which were comparable to the results of Rev. 0 of the ERIN calculation (see Attachment C). Therefore, it can be concluded that the ERIN code PADD produces acceptable dose calculation results (depending upon the use of correct inputs).

Additional issues identified by the third party review which require discussion are the comments in 1.c and 1.d of Attachment C.

- Section 1.c discusses unfiltered inleakage. Since the CNS control room is pressurized by filtered make-up flow and is tested regularly to verify the pressurization, no unfiltered inleakage is assumed with the exception of 10 cfm for the possibility of contamination back flow into the control room from the opening and closing of doors.

- Section 1.d discusses the release point of the unfiltered exhaust from secondary containment during the assumed actuation time. The ERIN calculation (Rev. 0) assumed one minute of unfiltered release from the elevated release point to account for the time required to close isolation valves. In actuality, the release point for secondary containment before isolated is the reactor building roof. This release point would result in a much larger dose during that first minute. However, since the reactor building fans will trip immediately and SGT will start immediately, the assumption of an actuation delay is conservative. Also, since the actual activity released from primary containment in the first hour is only a small fraction of the total release (Ref. 9), it is

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Date: _____ 19____ Date: July 16, 1994

conservative to assume that the release point for the unfiltered flow is from the elevated release point.

Revision 1 of the ERIN calculation also changed the assumed 60 second secondary containment actuation time to 90 seconds to be consistent with the off-site dose calculations. Per CNS Surveillance Procedure 6.3.10.8.1, Rev. 0, the closing stroke time limit for the secondary containment isolation valves is 90 seconds. This was carried over into Revision 2 of the ERIN calculation.

Results

The following table shows the results of this calculation for design basis LOCA and Refueling accident (and additional sensitivity analysis cases) assuming a control room filter efficiency of 90%. (2)

Case #	Control Room Filtered Intake Flow Rate (CFM)	Control Room Unfiltered Inleakage (CFM)	Operator Thyroid Dose (Rem)	Operator Whole Body Dose (Rem)	Operator Beta Skin Dose (Rem)
1	375	10	11.39	0.043	0.422
2	666	10	12.24	0.056	0.508
3	1000	10	12.81	0.066	0.594
5	1500	10	13.00	0.075	0.686
7	2000	10	13.15	0.080	0.748
15	305	100	27.08	0.073	0.653
11	305	2000	29.75	0.084	0.775
12*	375	10	1.211	0.168	1.650

* - Case #12 is for Refueling accident.

Conclusion:

On the basis of this review, the ERIN calculation C122-93-01-01, Rev. 3 and 4, has been determined to be acceptable for calculation of the control room operator radiological dose due to intake and inleakage into the control room of an accident release cloud. The calculation provided results for both a LOCA and a refueling accident and the LOCA was determined to be the overall limiting accident with respect to control room dose. The doses calculated for a design basis LOCA are within the limits specified by 10CFR50, Appendix A, GDC 19 (specified by SRP 6.4 to be 30 Rem thyroid, 5 Rem whole body, 30 Rem beta skin). Therefore, the Control Room Habitability System, as currently configured, is acceptable. (2)

(For control room operator dose due to other sources see References 7 and 8.)