N131-0994

Nebraska Public Power District
DESIGN CALCULATIONS COVER SHEET

Title Control Room Operator Dose due to Inleakage to Control Room	Calculation No. NEDC 94-071
System/Structure Control Room Habitability	Supersedes Calc. No. SWEC 13095.16 PR(D)-002 NEDC 94-172 / 4 DJR 1-19-95
Component Control Room Emergency Filter	Task Identification No. 89214
Classification: ☒ Essential	Design Change No. None
☐ Non-Essential	Discipline Mechanical
	*ASME Stress reports shall be approved by Registered P.E.

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.

(For references, attachments, and revision block for revisions 0 thru 2, see original coversheet on next sheet.)

Design Basis or References:

1. USAR
2. TECH. SPECS.
3. Consult. Calculation:
4. NED Calculation:

10. NEDC 94-172, Rev. 0 — 3 DJR 11-28-94
11. NEDC 94-157, Rev. 0
12. DC 93-257
13. STP 94-199 — 4 DJR 1-19-95

Attachments:

A.
B.
C.
D.

Rev. No.	Status	Revision Description	Prepared By/Date	Checked or Reviewed By/Date	Design Verification/Date	Approved By/Date
3	1, 3	Added Reference 10	ERIN	David J. Raabe / 11-28-94	N/A	[signature] 11/29/94
4	1	INCORPORATED REV 5 OF ERIN CALC C122-93-01-01	ERIN	David J. Raabe / 1-19-95	N/A	[signature] 1/19/95

Status Codes
1. As-Built
2. Information only
3. For Construction
4. Superseded or Deleted

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PDR ADOCK 05000298
P PDR

N131-1189

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DESIGN CALCULATIONS COVER SHEET

DOCUMENT (SET) START

Title Control Room Operator Dose due to Inleakage to Control Room	Calculation No. NEDC 94-071
System/Structure Control Room Habitability	Supersedes Calc. No. SWEC 13095.16 PR(D)-002
Component Control Room Emergency Filter	Task Identification No. 89214
Classification: ☒ Essential	Design Change No. None
☐ 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 (Companies Name) Date 4-26-94
Checked By ______ Date ______	NPPD Reviewed By David J Raabe Date 4-27-94
Design Verification By ______ Date ______	NPPD Approval [signature] 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.~~ △

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 △

Attachments:

A. ERIN Calculation C122-93-01-01, Rev. ~~4~~ 5
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. △

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;	ERIN	David J Raabe / 7-8-94	~~DJR / 7-8-94~~	[signature] 7/8/94
/	REPLACED ATT. A WITH REV. 2				
2	REPLACED ATT. A WITH REV. 4	ERIN	David J Raabe / 7-16-94	~~DJR / 7-16-94~~	[signature] 7/16/94

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DESIGN CALCULATION CROSS REFERENCE INDEX

NEDC 94-172 Prepared By: ERIN Checked/Reviewed By: David J. Raabe

Date: ______ 19 ____ Date: NOVEMBER 28, 1994

NEDC Rev. No.	SOURCE DOCUMENTS (Indicate A or D)*	Rev. No.	AFFECTED DOCUMENTS (Indicate C, A or D)*	Rev. No.	Tracking System**
3	(A) NEDC 94-172	0			
4	(D) NEDC 94-172	0	(A) NEDC 94-275	0	DC 94-102

* C = Change A = Addition D = Deletion

** Use modification document (DC, ESC, etc.) number when a calculation is associated with a modification. Otherwise, the CMDC database is normally specified.

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.

The purpose of Revision 4 (to NEDC 94-071) is to review changes made per Revision 5 to ERIN calculation C122-93-01-01. The revision is necessary to allow the calculation of a control room operator dose which more accurately represents the actual capabilities of the Control Room Habitability System and the Secondary Containment System. Specific items addressed by this revision include the following: 4 DR 1-14-95

- SGT filter efficiency
- Control room unfiltered inleakage
- Emergency Core Cooling Systems leakage into Secondary Containment
- MSIV leakage path to atmosphere
- Secondary Containment isolation delay time

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).

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.

Case #5 is for the design basis LOCA which models the design condition of the Control Room Habitability System. The design filtered intake flow rate is 1000 cfm per DC 93-257 (currently in the installation phase). The control room unfiltered inleakage is assumed to be 100 cfm based upon an actual inleakage measurement of 45 cfm ± 26 cfm per STP 94-199. (The 100 cfm value includes the 10 cfm inleakage for opening and closing of doors as used in previous revisions.) 4 DJR 1-14-95

The case #5 results supersede the previous control room thyroid dose calculation by Stone & Webster (Attachment B). The ERIN calculation has 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, MSIV leak path was changed to assume a delayed release through the condenser and the turbine building instead of secondary containment, and control room and primary containment volumes were increased to be 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 93.84% and 90% respectively, control room unfiltered inleakage was increased from 10 cfm to 100 cfm, and ECCS leakage was included as an additional source of activity in secondary containment. Overall, the ERIN calculation resulted in increasing the control room operator thyroid dose from the 1.09 Rem that was calculated in Attachment B.

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Case #s 1, 3, 7, 9, and 11 show the effects of changing the filtered and unfiltered control room flow rates. In general, an increase in filtered flow rate will cause a decrease in thyroid dose and an increase in whole body 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 activity leaving the room, thereby decreasing the activities residence time and resulting in a decrease in dose. An increase in unfiltered inleakage will result in an increase in all dose.

Case #15 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 1.69 Rem thyroid, 0.267 Rem whole body, and 2.53 Rem beta skin dose.

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:

- <u>Time line for meteorology conditions.</u> 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.

- <u>Mixing in the Reactor Building.</u> 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.

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

Changes made per revision 4 of NEDC 94-071 result in the following estimated dose adjustments: 4 DJR 1-14-95

SGT filter efficiency decreased from 95% to 93.84% resulting in thyroid dose increasing by a factor of 1.232. [(1-.9384)/(1-.95)=1.232]

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Date: 19 Date: January 14 1995

Unfiltered control room inleakage increased from 10 cfm to 100 cfm based upon results of STP 94-199. Results from Reference 10 and revision 3 of this calculation show that such an increase will cause the thyroid dose to increase by approximately a factor of 1.145. [14.67Rem/12.81Rem=1.145]

ECCS water leakage of 1000 ml/min added to the existing activity in secondary containment will increase the thyroid dose by a factor of 1.017. [0.646% per day/0.635% per day =1.017]

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MSIV leak path changed from a release to secondary containment with 95% filtering to a release to the condenser with a dose reduction factor of 10 due to hold-up and plateout in the main steam piping and a 0.5% condenser volume leak rate per day. The leak path through the condenser more accurately models the actual leakage. Comparisons of the contributions of MSIV leakage to the thyroid doses determined by revisions 3 and 4 of this calculation indicate that the thyroid dose is decreased by a factor of 0.93 by the change in leak path.

Secondary containment isolation delay time decreased from 90 to 0 seconds. This change more accurate models the actual LOCA sequence of events since secondary containment will be isolated by a Group 6 signal before activity is released from primary containment. The refueling accident secondary containment isolation delay remains at 90 seconds. This change results in a decrease in LOCA dose. The effect upon the dose is estimated by considering the above dose adjustment factors and the change in dose from revision 3 of this calculation (for 1000 cfm filtered flow). LOCA dose is estimated to decrease by a factor of 0.22.

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%.

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	100	5.37	0.042	0.408
5*	1000	100	3.91	0.061	0.550
9	2000	100	3.29	0.070	0.677
15**	1000	100	1.69	0.267	2.53

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* - Case #5 is the design basis LOCA dose.
** - Case #15 is for Refueling accident.

Conclusion:

On the basis of this review, the ERIN calculation C122-93-01-01, Rev. 5, 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 more limiting accident with respect to control room dose. (Main steam line break accident dose is calculated by Reference 11.) 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. 4

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