PREPARATION, REVIEW AND APPROVAL OF CALCULATIONS

CALCULATION TITLE PAGE

ComEd

BYRON STATION UNIT 1

Calculation No: ATD-0410

DESCRIPTION CODE: R01
DISCIPLINE CODE: M
SYSTEM CODE: RC, MS

TITLE: ALLOWABLE LEAKRATE CALCULATION FOR STEAM GENERATOR INTERIM PLUGGING CRITERIA

☒ Safety Related ☐ Augmented Quality ☐ Non-Safety Related

REFERENCE NUMBERS

Type	Number	Type	Number

COMPONENT EPN:

EPN	Compt Type
1RC01BA	B10 Steam Generator
1RC01BB	B10 Steam Generator
1RC01BC	B10 Steam Generator
1RC01BD	B10 Steam Generator

DOCUMENT NUMBERS:

Doc Type/SubType	Document Number
CALC/ENG	BYP97-332

REMARKS:

REV. NO.	REVISING ORGANIZATION	APPROVED PRINT/SIGN	DATE
0	ComEd C502	D. Palmer/ (See original for signature)	7/31/94
1	ComEd C502	W. Perchiazzi/ (See original for signature)	8/21/97
2	ComEd C502	W. Perchiazzi/ (See original for signature)	8/28/97
3	ComEd C502	K. Passmore/ (See original for signature)	9/22/97
4	ComEd C502	Kevin Passmore / K. Passmore	9/30/97

9710060318 971001
PDR ADOCK 05000454
P PDR

COMMONWEALTH EDISON COMPANY
CALCULATION REVISION PAGE

CALCULATION NO. ATD-0410 PAGE NO.: 2

REVISION SUMMARIES

REV: 3

REVISION SUMMARY:
Revise calculation to reflect changes to the iodine concentrations listed in UFSAR Table 15.0-9, per Westinghouse Letter CAE-97-185 dated 9/19/97. Revise to reflect changes to BYR97-332. See page 2.1 for more detail.

Electronic Calculation Data Files:
(Program Name, Version, File name ext/size/date/hour/: min)

J.Smith/ (See orignal for signature) 9/22/97

Prepared by: M. Marchionda/ (See orignal for signature) 9/22/97
Print/Sign Date

Reviewed by: G. Lahti/(See original for signature) 9/22/97
Print/Sign Date

Type of Review
[X] Detailed [ ] Alternate [ ] Test

DO ANY ASSUMPTIONS IN THIS CALCULATION REQUIRE LATER VERIFICATION [ ] YES [X] NO
Tracked by:______________________

REV: 4

REVISION SUMMARY:
This revision supersedes all previous revisions of this calculation. See page 2.2 for detail.

Electronic Calculation Data Files:
(Program Name, Version, File name ext/size/date/hour/: min)

J. Smith/ J. Smith 9/30/97

Prepared by: M. Marchionda/ M. Marchionda 9-30-97
Print/Sign Date

Reviewed by: G. Lahti/ Gerald P. Lahti 9-30-97
Print/Sign Date

Type of Review
[X] Detailed [ ] Alternate [ ] Test

DO ANY ASSUMPTIONS IN THIS CALCULATION REQUIRE LATER VERIFICATION [ ] YES [ ] NO
Tracked by:______________________

Revision Summary for Revision 3 (con't)

- Pages 5 and 6: Replaced Design Inputs 5 and 6 with Design Inputs 19 and 20. Renumbered remaining inputs accordingly.
- Page 6: Added Design Input 22.
- Pages 6 and 7: Deleted Reference 5 (BOP CV-17 And BOP CV-9). Renumbered remaining references accordingly.
- Page 7: Added References 23 and 24.
- Page 8, 10-18, 20, 22, 24: Revised Reference numbers.
- Page 8: Revised values in Table 1.a.
- Page 8: Added unit conversion factor.
- Page 9: Revised values in Table 1.b.
- Page 10: Revised values in Table 1.c and revised text accordingly.
- Page 16: Revised values in Table 2.f.3.
- Page 21: Revised values in Table 3.f.3.
- Pages 21, 22, 24 and 25: Revised values in equations and revised text accordingly.

COMMONWEALTH EDISON COMPANY

Revision Summary for Revision 4 (con't from p.2):

- Revise calculation to reflect total activity released with 12.8 gpm primary to secondary leak in the time period 0-2 hours to determine the low population zone thyroid dose.
- The letdown purification system parameters were revised to reflect UFSAR Table 11.1-1 instead of UFSAR Table 9.3-2.
- Revisions to Design Inputs, References, variable names and text for clarity and editorial purposes.

Exhibit D
NEP-12-02
Revision 5

COMMONWEALTH EDISON COMPANY
CALCULATION TABLE OF CONTENTS

CALCULATION NO. ATD-0410	REV. NO. 4	PAGE NO. 3
SECTION	PAGE NO.	SUB-PAGE NO.
TITLE PAGE	1	
REVISION SUMMARY	2	2.1, 2.2
TABLE OF CONTENTS	3	
PURPOSE/OBJECTIVE	4	
METHODOLOGY AND ACCEPTANCE CRITERIA	4	
ASSUMPTIONS	5	
DESIGN INPUT	5	
REFERENCES	6	
CALCULATIONS	8	
SUMMARY AND CONCLUSIONS	25	
ATTACHMENTS	n/a	

COMMONWEALTH EDISON COMPANY

PURPOSE AND OBJECTIVE:

The purpose of this calculation is to generate the maximum allowable primary to secondary steam generator tube leak rate during a postulated main steam line break using 24% plugging criteria design data. The evaluation was performed for both a pre-accident and accident initiated iodine spike. The release of iodine and the resulting thyroid dose at the Exclusion Area Boundary (EAB) and Low Population Zone (LPZ) were considered in the leak rate determination. Whole body dose due to noble gas immersion is less limiting than thyroid dose as documented in UFSAR Table 15.0-11. Given the large margin to the 25 rem whole body dose limit, whole body dose was not re-evaluated.

This calculation also determines the resulting thyroid dose at the Exclusion Area Boundary, Low Population Zone and Main Control Room for the actual predicted end-of-cycle 8 steam generator tube leakage during a postulated Main Steam Line Break.

METHODOLOGY AND ACCEPTANCE CRITERIA:

The Main Steam Line Break (MSLB) accident is evaluated because the event causes a sustained large pressure difference across the steam generator tubes providing a motive force for Reactor Coolant System (RCS) release. The dose attributed to a 1 gpm leak rate from the reactor coolant system was calculated. This value was then used to determine the allowable leak rate without exceeding the Standard Review Plan dose criteria.

The activity released to the environment due to a MSLB is analyzed in two distinct releases:

1. The release of the iodine activity that has been established in the secondary coolant prior to the accident, and

2. The release of the primary coolant iodine activity due to tube leakage.

The methodology used for calculating the Radiological Consequences of a MSLB with primary to secondary leakage is consistent with the Standard Review Plan (NUREG 0800), 15.1.5 Appendix A.

TID-14844 dose conversion factors were used to determine dose equivalent iodine concentrations for the RCS, which is the Technical Specification definition of dose equivalent iodine. The TID values are based on ICRP 2, "Permissible Dose for Internal Radiation, 1959."

The off-site dose assessment uses ICRP 30, "Limits for Intakes of Radionuclides by Workers, 1979" dose conversion factors. ICRP 30 is also the basis for Federal Guidance Report No. 11, "Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingection," dated 1988.

The dose Acceptance Criteria are based on the guidance of Standard Review Plan (NUREG-0800) Section 15.1.5, Appendix A. For a MSLB with a postulated pre-accident iodine spike, the calculated doses should not exceed the guideline values of 10CFR Part 100 Section 11. The numerical values used for these doses are 25 rem to the whole body and 300 rem to the thyroid from iodine exposure for 2 hours following the accident. For a MSLB with an accident initiated iodine spike, the calculated doses should not exceed a small fraction of the 10 CFR 100 guideline values, i.e. 2.5 rem and 30 rem respectively for the whole body and thyroid doses.

COMMONWEALTH EDISON COMPANY

ASSUMPTIONS:

1) The effect of boron on the RCS density is assumed to be negligible since the boron mass is less than 1% of the total RCS mass at the beginning of core life.

DESIGN INPUTS:

1. The total volume of the RCS is 12,062 ft^3. (Reference 1)

2. The full power RCS temperature and pressure are 586.2 °F and 2250 psia. (Ref 1 and 2)

3. The RCS specific volume at full power is 0.02258 ft^3/lbm. (Ref. 3)

4. Deleted

5. Letdown Purification System temperature is 130°F and 2300 psig. (Ref 1)

6. Letdown Purification System specific volume is 0.01613 ft^3/lbm. (Ref. 3)

7. Breathing rates are taken from B/B UFSAR Table 15A-1. (Ref. 5)

8. Atmospheric Dilution Factors, X/Q, are the fifth percentile values taken from UFSAR Table 15.0-13. (Ref.6)

9. RCS iodine concentrations are based on UFSAR Table 11.1-2. (Ref. 7)

10. The initial steam release from the defective and intact steam generators is taken from UFSAR Table 15.1-3. (Ref. 8)

11. The secondary side faulted steam generator has a partition coefficient of 1.0 and the intact steam generators have partition coefficients of 0.1. (Reference 14)

12. The half life for I-131 is 8.04 days, I-132 is 2.30 hrs, I-133 is 20.8 hrs, I-134 is 52.6 min, and I-135 is 6.61 hrs (λ_D=0.693/half life). (Ref.20)

13. The initial primary coolant activity for the pre-accident spike is 60 μCi/g DE I-131 and 1 μCi/g DE I-131 for the accident initiated spike. (Ref. 11 and 13)

14. The initial secondary coolant activity is 0.1 μCi/g DE I-131. (Ref. 11 and 13)

15. The duration of the spike is 2 hours. (Ref. 25)

16. No fuel failure is attributable to the accident since DNB design basis is met. (Ref. 11 and 26)

17. Iodine partition coefficients for all SGs are 1.0 for primary-to-secondary leakage. (Ref. 14)

COMMONWEALTH EDISON COMPANY

18. Normal letdown purification flow is 75 gpm. (Ref 1)

19. Demineralizer Decon Factor, DF, for iodine is 10. (Ref 1)

20. The iodine release rate spike factor is 500. (Ref 11)

21. The main control room MSLB thyroid dose is 7.4 rem for an 8 hour release. (Ref 21)

22. Dose conversion factors are based on ICRP 30 values using the significant digits from Federal Guidance Report No. 11. (Ref. 16 and 19)

23. The allowable primary to secondary leak rate is 150 gallons per day (0.1 gpm) per steam generator. (Ref. 13)

24. The total projected end-of-cycle 8 MSLB leak rate is 63.1 gpm at operating conditions. (Ref. 27)

REFERENCES:

1) B/B UFSAR Table 11.1-1, Revision 0 superseded by Westinghouse Letter CAE-97-185, "Byron and Braidwood Primary Coolant Source Term," dated September, 19, 1997

2) B/B UFSAR Table 5.1-1, Revision 0

3) ASME Steam Table, Fifth Edition

4) Deleted

5) B/B UFSAR Table 15A-1, Revision 0

6) B/B UFSAR Table 15.0-13, Revision 0

7) B/B UFSAR Table 11.1-2, Revision 0

8) B/B UFSAR Table 15.1-3, Revision 6

9) Introductory Nuclear Physics by Kenneth S. Krane, 1988

10) Deleted

11) Standard Review Plan (NUREG 0800), 15.1.5 Appendix A

12) Deleted

13) Technical Specifications 3.4.8 (Amendment 77), 3.7.1.4 (Original), 3.4.6.2 (Amendment 67)

14) WCAP 14046, "Braidwood 1 Technical Support for Cycle 5 Steam Generator Interim Plugging Criteria," dated May, 1994

COMMONWEALTH EDISON COMPANY

15) ICRP Publication 2, Report of Committee II on Permissible Dose for Internal Radiation, 1959

16) ICRP Publication 30, Limits for Intakes of Radionuclides by Workers, 1979

17) J.P. Adams and C.L. Atwood, "The Iodine Spike Release Rate During a Steam Generator Tube Rupture," Nuclear Technology, Vol. 94, pp 361-371, June 1991; and EGG-NERD-8648 Technical Report, "Probability of the Iodine Spike Release Rate During a SGTR," September 1989

18) Westinghouse Letter CAE 97-171, dated July 21,1997, pertaining to the Reactor Coolant Water Density Used in Determining Byron and Braidwood Alternate Tube Plugging Limit

19) Federal Guidance Report No.11, "Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors For Inhalation, Submersion, and Ingestion, 1988

20) Radioactive Decay Data Tables: A Handbook of Decay Data For Application to Radiation Dosimetry and Radiological Assessments, DOE/TIC-11026, 1981 by David C. Kocher

21) Byron Calculation BYR97-332, Revision 2

22) B/B UFSAR Table 6.4-1, Revision 0

23) B/B UFSAR Table 15.1-4a, Revision 6

24) B/B UFSAR Table 15.0-9, Revision 0, superseded by Westinghouse Letter CAE-97-185, "Byron and Braidwood Primary Coolant Source Term," dated September, 19, 1997

25) B/B UFSAR Section 15.1.5.3, Revision 6

26) B/B UFSAR Section 15.1.5.1, Revision 4

27) Byron Operability Assessment 97-044, dated July 22, 1997

28) TID-14844, "Calculation of Distance Factors for Power and Test Reactor Sites," March 23, 1962

VARIABLE AND CONSTANT DEFINITIONS:

M	RCS mass [g]
M_{stm}	Steam Generator steam release mass [lb]
V	RCS volume [ft^3]
v	RCS specific volume [ft^3/lbm]
λ_{lr}	RCS leak rate constant [sec^{-1}]
λ_{fuel}	Fuel Release constant [Ci/sec]
λ_d	Isotope Decay Constant [sec^{-1}]
λ_{LD}	Letdown Purification Removal Constant [sec^{-1}]
λ_t	Total Iodine Removal Rate [sec^{-1}]
t	Time [sec]
A_i	RCS iodine activity [Ci]

COMMONWEALTH EDISON COMPANY

C_i	Iodine Concentration [Ci/g or μCi/g]
C_o	Initial Iodine Concentration [Ci/g or μCi/g]
F_p	Letdown Purification Flow [g/sec]
R_i	Activity Released of nuclide, i [Ci]
D	Thyroid Inhalation Dose [rem]
B	Breathing Rate [m^3/sec]
X/Q	Atmospheric Dilution Factor [sec/m^3]
W_i	DCF Weighted Activity [Rem]
DE I-131	Dose Equivalent Iodine 131

DEFINE UNITS:

μCi = 1E-6 Ci
1 lbm = 454 g
1 ft^3 = 7.48 gal
1 min = 60 sec
1 Sv/Bq = 3.7E12 Rem/Ci

1. CALCULATION OF DOSE DUE TO STEADY STATE ACTIVITY IN SECONDARY SIDE

The first dose component to be calculated will be the dose from the secondary side. The secondary side activity is conservatively taken as the Technical Specification limit of 0.1 μCi/g (Design Input 14). This value is the same for both the pre-accident and accident initiated events. The steam release for the faulted steam generator (SG) is 96,000 lbs (Design Input 10) which is the entire initial SG water mass. The faulted SG is assumed to steam dry in 10-15 minutes so all of the iodine is available for release. The combined 0-2 hr steam release for the three intact steam generators is 406,716 lbs (Design Input 10). The combined 2-8 hr steam release for the three intact SGs is 939,604 lbs (Design Input 10). For the three intact SGs, a partition coefficient of 0.1 is used (Design Input 11).

a. The iodine concentrations are obtained from Reference 24 and are converted to Ci/lb, since the steam release is defined in lbs.

$$C_i\left[\frac{Ci}{lb}\right] = C_o\left[\frac{\mu Ci}{g}\right] \times 454\left[\frac{g}{lb}\right] \times 1E-6\left[\frac{Ci}{\mu Ci}\right] \quad \text{Equation 1.a}$$

TABLE 1.a

Nuclide	Iodine Concentration, C_o, (Reference 24) [μCi/g]	Iodine Concentration, C_i, (Equation 1.a) [Ci/lb]
I-131	0.0645	2.93E-5
I-132	0.0723	3.28E-5
I-133	0.1032	4.69E-5
I-134	0.0155	7.04E-6
I-135	0.0567	2.57E-5

COMMONWEALTH EDISON COMPANY

b. The iodine concentration for each nuclide, C_i from Table 1.a, is multiplied by the mass of steam released (96,000 lbs for the faulted SG and 406,716 lbs for the three intact SGs) and then multiplied by the partition coefficient (1.0 for faulted steam generator and 0.1 for intact steam generators) to obtain the total curies released, R_i, for 0-2 hours.

$$R_i^{faulted}[Ci] = C_i\left[\frac{Ci}{lb}\right] \times M_{stm}^{faulted}[lb] \times 1.0 \quad \text{Equation 1.b.1}$$

$$R_i^{intact}[Ci] = C_i\left[\frac{Ci}{lb}\right] \times M_{stm}^{intact}[lb] \times 0.1 \quad \text{Equation 1.b.2}$$

TABLE 1.b

Nuclide	Activity Released from Faulted SG, $R_i^{Faulted}$, (Equation 1.b.1) [Ci]	Activity Released from Intact SGs (0-2 hrs), R_i^{intact}, (Equation 1.b.2) [Ci]
I-131	2.81E0	1.19E0
I-132	3.15E0	1.33E0
I-133	4.50E0	1.91E0
I-134	6.76E-1	2.86E-1
I-135	2.47E0	1.05E0

c. The activity released, R_i determined above, is multiplied by the ICRP-30 Dose Conversion Factor, DCF_i, (Design Input 22) for each iodine isotope and then summed separately for the faulted SG and intact SGs. The DCF weighted activity released is:

$$W_i^{Faulted}[rem] = R_i^{Faulted}[Ci] \times DCF_i\left[\frac{rem}{Ci}\right] \quad \text{Equation 1.c.1}$$

$$W_i^{intact}[rem] = R_i^{intact}[Ci] \times DCF_i\left[\frac{rem}{Ci}\right] \quad \text{Equation 1.c.2}$$

TABLE 1.c

Nuclide	ICRP-30 Dose Conversion Factor, DCF_i, (Design Input 22) [rem/Ci]	Weighted Activity from Faulted SG, $W^{Faulted}$, (Equation 1.c.1) [rem]	Weighted Activity from Intact SGs, W^{intact}, (0-2 hrs) (Equation 1.c.2) [rem]
I-131	1.08E6	3.03E6	1.29E6
I-132	6.44E3	2.03E4	8.57E3
I-133	1.80E5	8.10E5	3.44E5
I-134	1.07E3	7.23E2	3.06E2
I-135	3.13E4	7.73E4	3.29E4
	Total $\Sigma(R_i x DCF_i)$	3.94E6	1.68E6

The 0-2 hour weighted activity released from the faulted and the three intact SGs is 5.62E6 rem (3.94E6 + 1.68E6 rem). This total weighted activity can also be defined as $\Sigma(R_i x DCF_i)$.

The DE I-131 activity released from the faulted and intact steam generators is the total weighted activity from Table 1.c divided by the I-131 dose conversion factor. Numerically this is 5.20 Ci DE I-131 (5.62E6 rem/1.08E6 rem/Ci)

d. The off-site thyroid inhalation dose at the exclusion area boundary, D_{EAB}, is calculated in accordance with UFSAR equation 15A-2. The low population zone dose for both the preaccident and accident initiated iodine spike cases includes the activity released from the secondary side and is calculated in steps 2.f and 3.f, respectively. The breathing rate is based on the 0-8 hour time period.

<u>Exclusion Area Boundary Dose (0-2 hours) Due to Secondary Side Release</u>

$$D_{EAB}[rem] = \left(\frac{X}{Q}\right)_{EAB} \times B \times \sum_i (R_i \times DCF_i) \quad \text{Equation 1.d.1}$$

$$= 5.7E-4\left[\frac{sec}{m^3}\right] \times 3.47E-4\left[\frac{m^3}{sec}\right] \times 5.62E6[rem]$$

$$= 1.11\,[rem]$$

COMMONWEALTH EDISON COMPANY

2. **CALCULATION OF DOSE DUE TO PRIMARY-TO-SECONDARY LEAKAGE DURING PRE-ACCIDENT INITIATED SPIKE**

In accordance with Reference 11, the pre-accident case occurs when the reactor is operating at the maximum value permitted by the Technical Specifications prior to the postulated MSLB. The radioactive isotopes are assumed to be evenly distributed throughout the RCS. The iodine activity changes over time due to radioactive decay and the rate at which activity leaves the RCS due to primary-to-secondary tube leakage.

a. The RCS mass inventory, M, will be calculated given the hot full power volume and specific volume.

RCS Volume:	$V=12062\ ft^3$	(Design Input 1)
RCS specific volume	$\nu=0.02258\ ft^3/lbm$	(Design Input 3)

$$M[g] = \frac{V[ft^3]}{\nu\left[\frac{ft^3}{lbm}\right]} \times 454\left[\frac{g}{lbm}\right] \quad \text{Equation 2.a}$$

$$= \frac{12062[ft^3]}{0.02258\left[\frac{ft^3}{lbm}\right]} \times 454\left[\frac{g}{lbm}\right]$$

$$= 2.42E8\ [g]$$

b. The RCS activity needs to be calculated for 60 μCi/g DE I-131. UFSAR Table 11.1-2 is used to obtain RCS activity, which is based on 1% fuel clad defects per UFSAR Table 11.1-1. The total initial RCS activity is calculated by multiplying the initial concentration by the RCS mass. The initial DE I-131 activity is then determined by multiplying each isotope's activity by its dose conversion factor, summing the values for each nuclide and dividing the sum by the I-131 dose conversion factor to normalize the activity to I-131. This DE I-131 activity is the contribution due to 1% fuel clad defects. To determine the activity at 1 μCi/g DE I-131, the fraction of each isotopes contribution to the DE I-131 is calculated and then multiplied by the RCS mass to obtain the corrected total activity in the RCS at 1 μCi/g DE I-131. To obtain the total activity at 60 μCi/g DE I-131, each isotope activity is multiplied by 60.

COMMONWEALTH EDISON COMPANY

$$A_i[Ci] = C_o\left[\frac{Ci}{g}\right] \times M[g] \quad \text{Equation 2.b.1}$$

$$W_i[rem] = A_i[Ci] \times DCF_i\left[\frac{rem}{Ci}\right] \quad \text{Equation 2.b.2}$$

$$DE\ I131[Ci] = \frac{\sum_i W_i[rem]}{DCF_{I131}\left[\frac{rem}{Ci}\right]} = \frac{1.39E9[rem]}{1.48E6\left[\frac{rem}{Ci}\right]} = 939.2\ [Ci]$$

$$\text{Nuclide Concentration at } 1\,\frac{\mu Ci}{g} = \frac{A_i[Ci]}{DE\ I131[Ci]} \quad \text{Equation 2.b.3}$$

$$\text{RCS Activity at } 1\,\frac{\mu Ci}{g}[Ci] = \text{Equation 2.b.3} \times M[g] \times 1\left[\frac{\mu Ci}{g}\right] \times \left[\frac{1\ Ci}{1E6\ \mu Ci}\right] \quad \text{Equation 2.b.4}$$

$$\text{RCS Activity at } 60\,\frac{\mu Ci}{g}[Ci] = \text{Equation 2.b.4}[Ci] \times 60 \quad \text{Equation 2.b.5}$$

TABLE 2.b

Nuclide	RCS Concent., C_o (UFSAR Table 11.1-2) [Ci/g]	RCS Activity, A_i (Eq. 2.b.1) [Ci]	ICRP-2 Dose Conversion Factor DCF_i [rem/Ci] (Ref. 28)	Weighted Activity, W_i (Eq. 2.b.2) [rem]	Nuclide Concent. at 1 μCi/g (Eq. 2.b.3)	RCS Total Activity at 1 μCi/g (Eq. 2.b.4) [Ci]	RCS Total Activity at 60 μCi/g (Eq. 2.b.5) [Ci]
I-131	2.5E-6	605	1.48E6	8.95E8	0.645	156.1	9.36E3
I-132	2.8E-6	678	5.35E4	3.63E7	0.722	174.8	1.05E4
I-133	4.0E-6	968	4.00E5	3.87E8	1.032	249.7	1.50E4
I-134	6.0E-7	145	2.50E4	3.63E6	0.155	37.5	2.25E3
I-135	2.2E-6	532	1.24E5	6.60E7	0.566	137.3	8.23E3
			ΣW_i	1.39E9			

COMMONWEALTH EDISON COMPANY

c. The two removal mechanisms for this accident are due to decay and leak rate to the secondary side of 1 gpm. The time dependent activity after two hours with the removal constants can be calculated using the basic decay equation methodology (Reference 9).

$$\frac{dA(t)}{dt} = -\lambda_d A(t) - \lambda_{lr} A(t)$$

$$\int_{A_o}^{A} \frac{dA(t)}{A(t)} = \int_0^t (-\lambda_d - \lambda_{lr})dt$$

$$A(t) = A_o e^{\ \ \ -\lambda_{lr})}$$

Where : $t = 2 \text{ hours} = 7200 \text{ sec}$

$$\lambda_{lr} = \frac{1 \text{ gpm}}{\text{Volume of RCS}}$$

$$\lambda_{lr} = \frac{1\left[\frac{gal}{min}\right]}{12062\left[ft^3\right]} \times \left[\frac{1\left[ft^3\right]}{7.48\left[gal\right]}\right] \times \left[\frac{1\left[min\right]}{60\left[sec\right]}\right]$$

$$= 1.85E - 7 \left[sec^{-1}\right]$$

d. Since the isotope activity is assumed to remain evenly distributed throughout the RCS volume, then the rate at which the isotope activity leaks from the RCS, R(t), is simply the RCS leak rate times the activity. The total activity released during a given time interval is the integration of the release rate over that interval, in this case, 2 hours.

$$R(t) = \lambda_{lr} \times A(t)$$

$$R(t) = \lambda_{lr} \times A_o e^{-t(\lambda_d + \lambda_{lr})}$$

$$\int_0^t R(t)dt = \int_0^t \lambda_{lr} A_o e^{-t(\lambda_d + \lambda_{lr})} dt$$

$$= \frac{\lambda_{lr} A_o}{-(\lambda_d + \lambda_{lr})} \int_0^t (\lambda_d + \lambda_{lr}) e^{-t(\lambda_d + \lambda_{lr})} dt$$

$$R = \frac{\lambda_{lr} A_o}{\lambda_d + \lambda_{lr}} \left(1 - e^{-t(\lambda_d + \lambda_{lr})}\right) \quad \text{Equation 2.d}$$

COMMONWEALTH EDISON COMPANY

TABLE 2.d

Nuclide	RCS Activity at 60 μCi/g (Table 2.b) [Ci]	Isotope Decay Constant, λ_d (Design Input 12) [sec^{-1}]	Activity Released, R_i (Equation 2.d) [Ci]
I-131	9.36E3	9.97E-7	1.24E1
I-132	1.05E4	8.37E-5	1.05E1
I-133	1.50E4	9.25E-6	1.93E1
I-134	2.25E3	2.20E-4	1.50E0
I-135	8.23E3	2.91E-5	9.88E0

e. Calculate the 0-2 hour thyroid inhalation dose at the Exclusion Area Boundary (EAB) in accordance with UFSAR equation 15A-2.

TABLE 2.e

Nuclide	Activity Released, R_i (Table 2.d) [Ci]	ICRP-30 Dose Conversion Factor, DCF_i, (Design Input 22) [rem/Ci]	Weighted Activity Released $R_i \times DCF_i$ [rem]
I-131	1.24E1	1.08E6	1.34E7
I-132	1.05E1	6.44E3	6.76E4
I-133	1.93E1	1.80E5	3.47E6
I-134	1.50E0	1.07E3	1.60E3
I-135	9.88E0	3.13E4	3.09E5
		Total $\Sigma(R_i x DCF_i)_{EAB}$	1.72E7

The total DE I-131 activity released is the total weighted activity from Table 2.e divided by the I-131 dose conversion factor. Numerically this is 15.9 Ci (1.72E7 rem/1.08E6 rem/Ci). The breathing rate is based on the 0-8 hour time period.

<u>Exclusion Area Boundary Dose for 0-2 hours for a 1 gpm Leak Rate</u>

$$D_{EAB}[rem] = \left(\frac{X}{Q}\right)_{EAB} \times B \times \sum_i (R_i \times DCF_i)_{EAB} \quad \text{Equation 2.e.1}$$

$$= 5.7E-4\left[\frac{sec}{m^3}\right] \times 3.47E-4\left[\frac{m^3}{sec}\right] \times 1.72E7[rem]$$

$$= 3.40\ [rem]$$

COMMONWEALTH EDISON COMPANY

f. Calculate the thyroid inhalation dose at the Low Population Zone (LPZ) using the equation from UFSAR Section 15A.4. The activity released during the accident from 2-40 hours was obtained from UFSAR Table 15.1-4a. This activity includes the dose contribution from 12.8 gpm primary to secondary leakage and the secondary side release.

TABLE 2.f.1

Nuclide	RCS Iodine Activity Released, R_i (UFSAR Table 15.1-4a) [Ci]	ICRP-30, Dose Conversion Factor, DCF_i (Design Input 22) [rem/Ci]	2-40 Hour Weighted Activity Released, $R_i \times DCF_i$ [rem]
I-131	2.4E3	1.08E6	2.59E9
I-132	5.1E1	6.44E3	3.28E5
I-133	2.3E3	1.80E5	4.14E8
I-134	5.1E0	1.07E3	5.46E3
I-135	5.0E2	3.13E4	1.57E7
		Total $\Sigma(R_i \times DCF_i)$	3.02E9

The total 2-40 hour weighted activity calculated above in Table 2.f.1 is separated into specific time periods of 2-8 hrs, 8-24 hrs, 24-40 hrs. This is based on scaling the total 2-40 hour weighted activity by the fraction of steam released during the same time period. The 2-40 hour steam release was obtained from UFSAR Table 15.1-3.

TABLE 2.f.2

Time Period	Steam Release, (UFSAR Table 15.1-3) [lb]	Fraction of Total Steam Release for Time Period	Total 2-40 Hr Weighted Activity Released (Table 2.f.1) [rem]	Weighted Activity Released in Time Period [rem]
2-8 hr	939,604	0.30	3.02E9	9.06E8
8-24 hr	1,234,515	0.39	3.02E9	1.18E9
24-40 hr	980,806	0.31	3.02E9	9.36E8
Total Steam Release	3,154,925		Total Weighted Activity Released	3.02E9

The atmospheric dilution factors (X/Q) for 0-8 hrs, 8-24 hrs, and 24-40 hrs were obtained from UFSAR Table 15.0-13. The breathing rates for 0-8 hrs, 8-24 hrs and 24-40 hrs were obtained from UFSAR Table15A-1. Calculate the thyroid inhalation dose at the Low Population Zone (LPZ) using the equation from UFSAR Section 15A.4.

$$D_{LPZ}\,[\text{rem}] = \left(\frac{X}{Q}\right)_{LPZ} \times B \times \sum (R_i \times DCF_i) \quad \text{Equation 2.f.1}$$

TABLE 2.f.3

Time Period	Atmos. Dispersion Factor, X/Q, (UFSAR Table 15.0-13) [sec/m^3]	Breathing Rate, B, (UFSAR Table 15A-1) [m^3/sec]	Weighted Activity Released, Σ(RxDCF) (Table 2.f.2) [rem]	LPZ Dose, D_{LPZ}, w/ 12.8 gpm Leak rate (Equation 2.f.1) [rem]
0-2 hr	1.70E-5	3.47E-4	2.26E8*	1.33
2-8 hr	1.70E-5	3.47E-4	9.06E8	5.34
8-24	2.4E-6	1.75E-4	1.18E9	0.50
24-40	1.1E-6	2.32E-4	9.36E8	0.24
			Total LPZ Dose w/ 12.8 gpm Leak rate [rem]	7.41

* From Tables 2.e and 1.c [(12.8x1.72E7) + (3.94E6+1.68E6) =2.26E8]

3. <u>CALCULATION OF DOSE DUE TO PRIMARY TO SECONDARY LEAKAGE DURING ACCIDENT INITIATED SPIKE</u>

The accident initiated spike model is the same as the pre-accident model except an additional iodine appearance rate term is added for fuel release rate into the RCS. In accordance with the Standard Review Plan, the reactor trip and/or primary system depressurization associated with the MSLB creates an iodine spike in the primary system. The spiking model assumes that the iodine release rate from the fuel rods to the primary coolant increases to a value 500 times greater than the Technical Specification limit. This factor adds an additional release rate factor for iodine activity, λ_{fuel}.

a. Calculate the total removal rate of iodine, λ_t, through letdown purification and radioactive decay. Equation 2 of Reference 17 defines this total as:

$$\lambda_t\left[sec^{-1}\right] = \lambda_{LD}\left[sec^{-1}\right] + \lambda_d\left[sec^{-1}\right] \quad \text{Equation 3.a.1}$$

$$\text{Where:} \quad \lambda_{LD}\left[sec^{-1}\right] = \frac{F_p\left[\frac{g}{sec}\right]}{M[g]} \times \left(1 - \frac{1}{DF}\right) \quad \text{Equation 3.a.2}$$

The 75 gpm letdown purification flow, F_p, is converted from gpm to grams/sec at letdown design parameters (Design Inputs 5 and 6).

$$F_p\left[\frac{g}{sec}\right] = 75\left[\frac{gal}{min}\right] \times \left[\frac{1\ ft^3}{7.48\ gal}\right] \times \left[\frac{1\ lb}{0.01613\ ft^3}\right] \times \left[\frac{454\ g}{lb}\right] \times \left[\frac{1\ min}{60\ sec}\right]$$

$$= 4704\left[\frac{g}{sec}\right]$$

Substituting the values of F_p, M and DF int o Equation 3.a.2 gives:

$$\lambda_{LD}\left[sec^{-1}\right] = \frac{4704\left[\frac{g}{sec}\right]}{2.42E8[g]} \times \left(1 - \frac{1}{10}\right)$$

$$= 1.75E-5\left[sec^{-1}\right]$$

TABLE 3.a

Nuclide	Letdown Purif. Removal Constant, λ_{LD}, (Equation 3.a.2) [sec^{-1}]	Isotope Decay Constant, λ_d (Design Input 12) [sec^{-1}]	Total Iodine Removal Rate, λ_t Equation 3.a.1 [sec^{-1}]
I-131	1.75E-5	9.97E-7	1.85E-5
I-132	1.75E-5	8.37E-5	1.01E-4
I-133	1.75E-5	9.25E-6	2.67E-5
I-134	1.75E-5	2.20E-4	2.38E-4
I-135	1.75E-5	2.91E-5	4.66E-5

b. The equilibrium fuel release rate, λ_{fuel}, is defined as the product of the RCS activity at 1 μCi/g DE I-131 (from Table 2.b) and the total iodine removal rate for each isotope:

λ_{fuel} [Ci/sec] = A_i [Ci] x λ_t [sec^{-1}] Equation 3.b

COMMONWEALTH EDISON COMPANY

Each equilibrium fuel release rate is multiplied by 500 (Design Input 20) to obtain the spiked release rate.

TABLE 3.b

Nuclide	Total Iodine Removal Rate, λ_t (Table 3.a) [sec^{-1}]	Fuel Release Rate, λ_{fuel} (Equation 3.b) [Ci/sec]	Spiked Release Rate 500 x λ_{fuel} [Ci/sec]
I-131	1.85E-5	2.89E-3	1.45
I-132	1.01E-4	1.77E-2	8.85
I-133	2.67E-5	6.67E-3	3.34
I-134	2.38E-4	8.92E-3	4.46
I-135	4.66E-5	6.39E-3	3.20

c. Neglecting the loss terms (radiodecay, leakage, and letdown), the time dependent RCS activity due to the accident initiated spike may be written as:

$$\frac{dA(t)}{dt} = 500\lambda_{fuel}$$

$$\int_{A_o}^{A} dA(t) = \int_0^t 500\lambda_{fuel} dt$$

$$A(t) = A_o + 500\lambda_{fuel} t \quad \text{Equation 3.c}$$

d. Since the isotope activity, A(t) is assumed to remain evenly distributed throughout the RCS volume, then the rate at which the isotope activity leaks from the RCS, R(t), is the RCS leak rate constant, λ_{lr}, multiplied by the activity determined by Equation 3.c. The total activity released during the event is calculated by integrating the release rate over the time interval.

$$R(t) = \lambda_{lr} A(t)$$

$$= \lambda_{lr}(A_o + 500\lambda_{fuel} t)$$

$$\int_0^t R(t)dt = \int_0^t \lambda_{lr}(A_o + 500\lambda_{fuel} t)dt$$

$$R = \lambda_{lr}\left(A_o t + \frac{500\lambda_{fuel} t^2}{2}\right) \quad \text{Equation 3.d}$$

COMMONWEALTH EDISON COMPANY

TABLE 3.d

Nuclide	RCS Activity at 1 μCi/g, A_o (Table 2.b) [Ci]	Spiked Release Rate (Table 3.b) [Ci/sec]	0-2 hour Activity Released, R_i (Equation 3.d) [Ci]
I-131	156.1	1.45	7.16
I-132	174.8	8.85	4.27E1
I-133	249.7	3.34	1.63E1
I-134	37.5	4.46	2.14E1
I-135	137.3	3.20	1.55E1

e. Calculate the thyroid inhalation dose at the Exclusion Area Boundary and Low Population Zone in accordance with UFSAR equation 15A-2.

TABLE 3.e

Nuclide	0-2 hour Activity Released, R_i (Table 3.d) [Ci]	DCF_i [rem/Ci]	$R_i x DCF_i$ [rem]
I-131	7.16	1.08E6	7.73E6
I-132	4.27E1	6.44E3	2.75E5
I-133	1.63E1	1.80E5	2.93E6
I-134	2.14E1	1.07E3	2.29E4
I-135	1.55E1	3.13E4	4.85E5
		$\Sigma(R_i x DCF_i)$	1.14E7

The total DE I-131 activity released in 0-2 hours is the total weighted activity released, Σ (R_i x DCF_i), from Table 3.e divided by the I-131 dose conversion factor. Numerically this is 10.6 Ci DE I-131 released in the first two hours (1.14E7 rem/1.08E6 rem/Ci). The breathing rate is based on the 0-8 hour time period.

<u>Exclusion Area Boundary Dose for a 1 gpm Leak Rate:</u>

$$D_{EAB}[\text{rem}] = \left(\frac{X}{Q}\right)_{EAB} \times B \times \sum_i (R_i \times DCF_i) \quad \text{Equation 3.e.1}$$

$$= 5.7E-4\left[\frac{\text{sec}}{\text{m}^3}\right] \times 3.47E-4\left[\frac{\text{m}^3}{\text{sec}}\right] \times 1.14E7[\text{rem}]$$

$$= 2.25\ [\text{rem}]$$

COMMONWEALTH EDISON COMPANY

f. Calculate the thyroid inhalation dose at the Low Population Zone (LPZ) using the equation from UFSAR Section 15A.4. The activity released during the accident from 2-40 hours was obtained from UFSAR Table 15.1-4a. This activity includes the dose contribution from a 12.8 gpm primary to secondary leakage and secondary side release.

TABLE 3.f.1

Nuclide	RCS Iodine Activity Released, R_i, (UFSAR Table 15.1-4a) [Ci]	ICRP-30, Dose Conversion Factor, DCF_i, (Design Input 22) [rem/Ci]	2-40 Hour Weighted Activity Released $R_i \times DCF_i$ [rem]
I-131	2.7E3	1.08E6	2.92E9
I-132	1.4E3	6.44E3	9.02E6
I-133	3.8E3	1.80E5	6.84E8
I-134	1.8E2	[illegible]7E3	1.93E5
I-135	1.6E3	3.[illegible]3E4	5.01E7
		Total $\Sigma(R_i \times DCF_i)$	3.66E9

The total 2-40 hour weighted activity released calculated above in Table 3.f.1 is separated into specific time periods of 2-8 hrs, 8-24 hrs, and 24-40 hrs. This is based on scaling the total 2-40 hour weighted activity released by the fraction of steam released during the same time period. The 2-40 hour steam release was obtained from UFSAR Table 15.1-3.

TABLE 3.f.2

Time Period	Steam Release, (UFSAR Table 15.1-3) [lb]	Fraction of Total Steam Release for Time Period	Total 2-40 Hr Weighted Activity Released (Table 3.f.1) [rem]	Weighted Activity Released For Time Period [rem]
2-8 hr	939,604	0.30	3.66E9	1.10E9
8-24 hr	1,234,515	0.39	3.66E9	1.43E9
24-40 hr	980,806	0.31	3.66E9	1.13E9
Total Steam Release	3,154,925		**Total Weighted Activity Released**	3.66E9

The atmospheric dilution factors (X/Q) for 0-8 hrs, 8-24 hrs, and 24-40 hrs were obtained from UFSAR Table 15.0-13. The breathing rates for 0-8 hrs, 8-24 hrs and 24-40 hrs were obtained from UFSAR Table15A-1. Calculate the thyroid inhalation dose at the Low Population Zone (LPZ) using the equation from UFSAR Section 15A.4.

COMMONWEALTH EDISON COMPANY

$$D_{LPZ}[\text{rem}] = \left(\frac{X}{Q}\right)_{LPZ} \times B \times \sum(R_i \times DCF_i) \quad \text{Equation 3.f.1}$$

TABLE 3.f.3

Time Period	Atmos. Dispersion Factor, X/Q, (UFSAR Table 15.0-13) [sec/m^3]	Breathing Rate, B, (UFSAR Table 15A-1) [m^3/sec]	Weighted Activity Release Σ(RxDCF) (Table 3.f.2) [rem]	LPZ Dose, D_{LPZ}, w/ a 12.8 gpm Leak Rate (Equation 3.f.1) [rem]
0-2 hr	1.7E-5	3.47E-4	1.52E8*	0.90
2-8 hr	1.7E-5	3.47E-4	1.10E9	6.49
8-24	2.4E-6	1.75E-4	1.43E9	0.60
24-40	1.1E-6	2.32E-4	1.13E9	0.29
			Total LPZ Dose w/ a 12.8 Leak Rate [rem]	8.28

* From Tables 3.e and 1.c [(12.8x1.14E7) + (3.94E6+1.68E6) =1.52E8]

4. CALCULATION OF SITE ALLOWABLE LEAK RATE

a. Results of the Pre-Accident Iodine Spike Model

The total EAB dose due to a 12.8 gpm leak rate and secondary side activity is 44.63 rem [(12.8x3.40)+1.11]. The total LPZ dose calculated in Table 2.f.3 is 7.41 rem. Therefore, the EAB dose is more limiting.

The thyroid dose due to the release of activity in the secondary side of all four steam generators is 1.11 rem (page 10). The dose due to 1 gpm primary to secondary leakage in 4 steam generators with a concentration of 60 μCi/g is 3.40 rem (page 14). Given that the dose limit in the Standard Review Plan is 300 rem for the pre-accident model, the maximum allowable leak rate without exceeding 300 rem is:

$$\text{Allowable Leak Rate} = \left(\frac{300\ \text{rem} - 1.11\ \text{rem}}{3.40\ \frac{\text{rem}}{\text{gpm}}}\right)$$

$$= 87.91\ \text{gpm}$$

Consequently, the total EAB dose due to a 87.91 gpm leak during a MSLB is 300 rem. Allowing 0.1 gpm room temperature leakage per each of the three intact steam generators leaves 87.49 gpm (87.91-0.3x1.406) for the faulted loop.

Note that the 87.91 gpm allowable leak rate is calculated at RCS operating conditions. Should the allowable leak rate be desired to be expressed at room temperature conditions, the 87.91 gpm must be divided by 1.406 (Reference 18) to account for RCS density differences. Therefore, the room temperature allowable leak rate is 62.52 gpm.

b. Results of the Accident Initiated Iodine Spike Model

The EAB dose due to a 12.8 gpm leak rate and secondary side activity is 29.9 rem [(12.8x2.25)+1.11]. The total LPZ dose calculated in Table 3.f.3 is 8.28 rem. Therefore, the EAB dose is more limiting.

The thyroid dose due to the release of activity in the secondary side of all four steam generators is 1.11 rem (page 10). The dose due to 1 gpm primary to secondary leakage in 4 steam generators with a concentration of 1 μCi/g is 2.25 rem (page 19). Given that the dose limit in the Standard Review Pla is 30 rem for the accident initiated spike model, the maximum allowable leak rate without exceeding 30 rem is:

$$\text{Allowable Leak Rate} = \left(\frac{30\ \text{rem} - 1.11\ \text{rem}}{2.25\ \frac{\text{rem}}{\text{gpm}}} \right)$$

$$= 12.84\ \text{gpm}$$

Allowing 0.1 gpm room temperature leakage per each of the three intact steam generators leaves 12.42 gpm (12.84-0.3x1.406) for the faulted loop.

Note that the 12.84 gpm allowable leak rate is calculated at RCS operating conditions. Should the allowable leak rate be desired to be expressed at room temperature conditions, the 12.84 gpm must be divided by 1.406 (Reference 18) to account for RCS density differences. Therefore, the room temperature allowable leak rate is 9.13 gpm.

COMMONWEALTH EDISON COMPANY

5. CALCULATION OF END-OF-CYCLE 8 PREDICTED DOSES

In accordance with the requirements for the Byron Unit 1 voltage based repair criteria (IPC) for outer diameter stress corrosion cracking at tube support plates, the potential tube leakage during a MSLB event with containment bypass must be predicted at the end of the next operating period. In addition to the predicted IPC leakage, the MSLB leakage contribution from circumferential cracking at the top of the tubesheet must also be factored into the end-of-cycle leakage assessment. This combined predicted leak rate must be compared to and shown to be less than the maximum site allowable leak rate determined in Section 4 above.

Via a January 31, 1997, transmittal to the NRC, Byron Station requested a Technical Specification change to lower the RCS Dose Equivalent Iodine-131 limit to 0.2 μCi/g. As documented in Section 3, the site allowable leak rate of 12.8 gpm is based on an RCS DE I-131 limit of 1 μCi/g. The site allowable leak rate can be increased proportional to a reduction in RCS DE I-131. Therefore, by reducing the RCS DE I-131 limit to 0.2 μCi/g, the allowable leak rate is increased to 64 gpm (12.8 gpm/0.2). This amendment request is currently being reviewed by the NRC.

The Byron Unit 1 Attachment C Operability Assessment 97-044, which was transmitted to the NRC on July 30, 1997, via Byron letter 97-0184, determined that the total predicted end-of cycle 8 leakage is 63.1 gpm operating conditions. This predicted leakage includes leakage due to IPC, circumferential indications and operational leakage (0.1 gpm) from each of the three intact SGs. This is bounded by the requested 64 gpm site allowable leakage limit at operating conditions. The end-of-cycle date used in the evaluation is the scheduled Unit 1 shutdown date of 11/07/97.

This section of the calculation determines the EAB, LPZ, and main control room thyroid dose for the predicted end-of-cycle leakage of 63.1 gpm to validate that the current operating conditions are bounded by existing calculations. The EAB and LPZ dose is bounded by Section 3 of this document, which showed that the accident initiated spike is the limiting accident.

a. The most restrictive EAB thyroid dose limit is 30 rem per Section 4.b (page 22). This dose limit corresponds to an allowable leak rate of 12.8 gpm at an RCS DE I-131 concentration of 1 μCi/g. The calculated EAB dose remains the same when allowable leakage is increased to 64 gpm because RCS DE I-131 is reduced a proportional amount. The EAB dose, X_{EAB}, due to current cycle projected leakage of 63.1 gpm is calculated by performing a ratio of calculated values to projected values.

$$\frac{63.1\text{ gpm}}{64\text{ gpm}} = \frac{X_{EAB}}{30\text{ rem}}$$

$$X_{EAB}(64\text{ gpm}) = (63.1\text{ gpm})(30\text{ rem})$$

$$X_{EAB} = 29.6\text{ rem} \quad \text{at a } 0.2\ \mu\text{Ci/g RCS DE I} - 131\text{ concentration}$$

COMMONWEALTH EDISON COMPANY

Therefore, the end-of-cycle 8 predicted EAB dose is within the 30 rem dose limit under end-of-cycle 8 operating conditions.

b. The LPZ calculated thyroid dose is 8.28 rem per Section 3.f (page 21). This dose value corresponds to an allowable leak rate of 12.8 gpm at an RCS DE I-131 concentration of 1 μCi/g, which again remains the same under the proposed allowable leak rate of 64 gpm because DE I-131 was reduced to 0.2μCi/g DE I-131. The LPZ dose for projected end-of-cycle conditions, X_{LPZ}, is calculated by performing a ratio of calculated values to projected values.

$$\frac{63.1\text{ gpm}}{64\text{ gpm}} = \frac{X_{LPZ}}{8.28\text{ rem}}$$

$$(X_{LPZ})(64\text{ gpm}) = (63.1\text{ gpm})(8.28\text{ rem})$$

$$X_{LPZ} = 8.16\text{ rem} \quad \text{at a } 0.2\mu\text{Ci/g RCS DE I} - 131\text{ concentration}$$

Therefore, the end-of-cycle 8 predicted LPZ dose is within the 30 rem dose limit under end-of-cycle 8 operating conditions.

c. The control room dose methodology follows the same strategy as 5.a and 5.b above.

Calculation BYR97-332 (Reference 21) estimates the MSLB control room dose for an 8 hour release. The dose was calculated by comparing the LOCA 8 hour release and corresponding dose to the MSLB event. The control room dose was determined to be 7.4 rem, which is less than the LOCA control room dose of 8.27 rem.

To ensure the control room dose, X_{MCR}, with a projected leak rate of 63.1 gpm is bounded by the control room dose calculation, BYR97-332, the calculated values are ratio'd to the projected end-of-cycle values.

$$\frac{63.1\text{ gpm}}{64\text{ gpm}} = \frac{X_{MCR}}{7.4\text{ rem}}$$

$$X_{MCR}(64\text{ gpm}) = (63.1\text{ gpm})(7.4\text{rem})$$

$$X_{MCR} = 7.3\text{ rem}$$

Therefore, the end-of-cycle main control room dose remains bounded by the LOCA control room dose as presented UFSAR Table 6.4-1 and is less than the calculated dose in BYR97-332, revision 2.

COMMONWEALTH EDISON COMPANY

SUMMARY AND CONCLUSIONS

It is concluded from Section 4 that the accident initiated spike is more limiting, therefore the maximum site allowable SG leak rate during a postulated MSLB is 12.8 gpm at RCS operating conditions (9.1 gpm at room temperature) with a RCS DE I-131 concentration of 1 μCi/g. This value includes the 0.1 gpm contribution from each of the three intact SGs.

Section 5 determined that the Unit 1end-of-cycle 8 predicted MSLB tube leakage results in off-site thyroid doses that are less than a small fraction (10%) of 10CFR100 limits. The resulting EAB and LPZ doses, with a 0.2 μCi/g RCS DE I-131 limit, are 29.6 rem and 8.16 rem, respectively, which are less than the 30 rem limit for the limiting accident initiated spike case. The control room dose resulting from the predicted end-of-cycle 8 MSLB leakage, 7.3 rem, is continued to be bounded by the LOCA control room dose case.

- FINAL -