Calculation No. H-1-AB-MDC-1854, Revision 1IR0
Main Steam Line Break Accident

CALC NO.: H-1-AB-MDC-1854 REVISION: 1IR0	CALCULATION COVER SHEET	Page 1 of 30

CALC. TITLE:	Main Steam Line Break Accident						
# SHTS (CALC):	30	# ATT / # SHTS:	1/1	# IDV/50.59 SHTS:	4/4/3	# TOTAL SHTS:	38

CHECK ONE:

☐ FINAL ☒ INTERIM (Proposed Plant Change) ☐ FINAL (Future Confirmation Req'd) ☐ VOID

SALEM OR HOPE CREEK: ☐ Q – LIST ☒ IMPORTANT TO SAFETY ☐ NON-SAFETY RELATED

HOPE CREEK ONLY: ☒Q ☐Qs ☐Qsh ☐F ☐R

☒ STATION PROCEDURES IMPACTED, IF SO CONTACT RELIABILITY ENGINEER

☒ CDs INCORPORATED (IF ANY): CD D506, PACKAGE NO. 80027981, CD D501, PACKAGE NOS. 80032110 AND 80033412

DESCRIPTION OF CALCULATION REVISION (IF APPL.):

Revised to include the EPU reactor coolant activity concentrations and TEDE dose criteria.

PURPOSE:

The purpose of this calculation is to determine the Exclusion Area Boundary (EAB), Low Population Zone (LPZ), and Control Room (CR) doses due to a Main Steam Line Break Accident (MSLBA) occurring outside containment using the Extended Power Uprate (EPU) reactor coolant activity concentrations and TEDE dose criteria. The thermal power level is expected to increase to 4,031 MW_t.

CONCLUSIONS:

The results of analysis in Section 8 indicate that the EAB, LPZ, and CR doses due to a MSLB accident are within their allowable TEDE dose limits. The results of a MSLBA indicate that CREF system initiation is not required during a MSLB accident.

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REVISION HISTORY

Revision	Revision Description
0	Initial Issue.
1	Revised to include the EPU reactor coolant activity concentrations and TEDE dose criteria. Updated control room volume is used IAW CD D506, Package No. 80027981. The CREF is not credited in the analysis and uprated coolant activity is used. Therefore, the discrepancies addressing the CREF operation and source term are considered resolved IAW CD D501, Package Numbers 80032110 and 80033412.

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1.0 PURPOSE:

The purpose of this calculation is to determine the Exclusion Area Boundary (EAB), Low Population Zone (LPZ), and Control Room (CR) doses due to a Main Steam Line Break Accident (MSLBA) occurring outside containment using the TEDE dose criteria and Extended Power Uprate (EPU) reactor coolant activity concentrations. The thermal power level is expected to increase to 4,031 MW_t.

2.0 BACKGROUND:

The consequences of a MSLBA are analyzed using the plant specific design and licensing bases inputs, which are compatible to the TEDE dose criteria. The MSLBA analysis is performed using the guidance in Regulatory Guide 1.183, Appendix D (Ref. 9.1) and Standard Review Plan 15.6.4 (Ref. 9.6). There are no specific ESF functions credited in the analysis, including initiation of the CR emergency filtration (CREF) system to mitigate the CR dose.

3.0 ANALYTICAL APPROACH:

This analysis uses Version 3.02 of the RADTRAD computer code to calculate the potential radiological consequences of the MSLBA. The RADTRAD code is documented in NUREG/CR-6604 (Ref. 9.2). The RADTRAD code is maintained as Software ID Number A-0-ZZ-MCS-0225, (Ref. 9.12).

Since no fuel damage occurs during the MSLBA at the Hope creek plant, the released activity is the maximum coolant activity allowed by technical specifications. The iodine concentration in the primary coolant is assumed corresponding to the following two cases in the standard technical specifications:

3.1. Pre-accident Iodine Spike

The reactor coolant activity concentration for this case is assumed to be at the maximum value of 4.0 µCi/gm Dose Equivalent (DE) I-131 permitted for a condition of a pre-accident spike (Ref. 9.11). The assumptions and design input parameters used for this release path are described in Sections 4.0 and 5.0. The iodine scaling factors for the pre-accident iodine spike and equilibrium iodine concentration cases are calculated in Table 2 based on the maximum iodine concentrations of 4.0 µCi/g and 0.2 µCi/g using the following definition of I-131 DE:

DOSE EQUIVALENT I-131 shall be that concentration of I-131, µCi/g, which alone would produce the same thyroid dose as the quantity and isotopic mixture of I-131, I-132, I-133, I-134, and I-135 actually present.

The thyroid dose conversion factors are calculated in Table 1 using Federal Guidance Report 12 (Ref. 9.8) and corresponding isotopic iodine concentrations are calculated in Tables 3 & 4.

The isotopic noble gas concentrations are calculated in Table 5 using the noble gas release rate at time t = 0 sec (Ref. 9.15, Table V) and the uprated steam mass flow rate (Ref. 9.3, Section 3.2.1). The isotopic noble gas concentrations based on 100/E-BAR are calculated in Table 6 and listed in Table 7 using the following 100/E-BAR definition:

E-BAR shall be the average, weighted in proportion to the concentration of each radionuclide in the reactor coolant at the time of sampling, of the sum of the average beta and gamma energies per disintegration, in MeV, for isotopes, with half lives greater than 15 minutes, making up at least 95% of the total non-iodine activity in the coolant.

The use of RADTRAD code requires a volume node for the source activity released from a MSLB accident. Therefore, a source volume of 100 ft^3 is introduced for a MSLBA release in a way that all activities released to environment in a single puff with a release rate of 2.0E+05 volume/day (see Figure 1). The reactor coolant mass of 140,000 pounds is assumed to release from the MSLB (Ref. 9.6, Section III.2.a). Although this release consists of two phase flow of water and steam mixture with different iodine concentrations in each phase, it is conservatively assumed that the reactor coolant iodine concentrations are appropriate for both phases. Similarly, the noble gas concentrations are assumed equal for both phases. The isotopic activities available for release to the environment are calculated in Table 8 for the pre-accident iodine spike case.

3.2. Maximum Equilibrium Iodine Activity

The reactor coolant concentration for this case is assumed to be at a value of 0.2 μCi/gm DE I-131 permitted for an equilibrium iodine activity for continued full power operation (Ref. 9.11). The specific release model, assumptions and design input parameters used in the analysis are same as those for the pre-accident iodine case (Sections 4.0 & 5.0) except the isotopic iodine concentrations are calculated based on 0.2 μCi/gm DE I-131 in Table 4 and listed in Table 9 with the noble gas 100/E-BAR isotopic concentrations.

The potential post-MSLBA release paths are the blow out panels, south plant vent, and turbine building louvers, which are shown in Reference 9.13 with respect to the CR air intake with its tornado missile barrier. Since the MSLBA is a high energy line break accident, the pressure sensitive blow out panels would break open immediately to relieve the high pressure steam release. The χ/Qs for these release paths are obtained from Reference 9.5 Section 8.0, and listed in the following table:

Time Interval (hr)	HCGS Control Room 95% Atmospheric Dispersion Factors (X/Qs) (s/m^3)		
	South Plant Vent	TBL (s/m^3)	Blow Out Panel (s/m^3)
0-2	5.75E-04	6.17E-04	1.20E-03
2-8	3.84E-04	4.00E-04	8.16E-04
8-24	1.40E-04	1.44E-04	3.08E-04
24-96	9.08E-05	1.00E-04	2.14E-04
96-720	7.01E-05	7.49E-05	1.63E-04

Comparison of χ/Qs in the above table indicates that the blow out panel release path is the most limiting release path for the post-MSLBA release. Therefore, the CR dose is calculated using the post-MSLBA release through blow out panels. Since the post-MSLBA activity is postulated to release instantaneously as a single puff, the CREF is not credited. The CR is assumed to be in the normal mode of operation for the entire duration of the accident.

The RADTRAD V3.02 (Ref. 9.2) default nuclide inventory file (NIF) Bwr_def. NIF is modified based on the activity releases to the environment from the MSLBA as shown in Tables 8 & 9. The plant-specific NIFs HEPU4MSLB_def.txt and HEPU2MSLB_def.txt are further modified to include Kr-83m, Xe-131m, Xe-133m, Xe-135m, and Xe-138 isotopes, which are critical for a puff release. The modified RADTRAD3.02 dose conversion factor (DCF) and Release Fraction and Timing (RFT) Files HEPUMSLB_FG11&12.txt and HEPUMSLB_RFT.txt are used for the MSLBA analysis.

The EAB, LPZ, and CR doses are shown for both cases in Section 7.0 and compared with the allowable dose limits.

4.0 ASSUMPTIONS:

Assumptions for Evaluating the Radiological Consequences of a MSLBA

The assumptions in these sections are acceptable to the NRC staff for evaluating the radiological consequences of a MSLBA. These assumptions supplement the guidance provided in Regulatory Guide 1.183, Appendix D (Ref. 9.1). These assumptions are incorporated as design inputs in Sections 5.3.1 through 5.3.4 for the MSLBA analysis.

SOURCE TERM

4.1 Per Reference 9.1, Appendix D, Section 2, since no or minimal fuel damage is postulated for the limiting event, the released activity is the maximum coolant activity allowed by technical specification. The iodine concentration in the primary coolant is assumed to correspond to the following two cases in the nuclear steam supply system vendor's standard technical specifications.

4.1.1 The maximum value of reactor coolant concentration typically permitted for an assumed pre-accident spike (Ref. 9.1, Appendix D, Section 2.1), which corresponds to 4.0 μCi/gm DE I-131 for the Hope Creek plant (Ref. 9.11), and

4.1.2 The maximum equilibrium value of reactor coolant concentration typically permitted for continued full power operation (Ref. 9.1, Appendix D, Section 2.2), which corresponds to 0.2 μCi/gm DE I-131 for the Hope Creek plant (Ref. 9.11).

4.1.3 Per Reference 9.1, Appendix D, Section 3, the activity released from the fuel is assumed to mix instantaneously and homogenously in the reactor coolant. Noble gases are assumed to enter the steam phase instantaneously.

TRANSPORT

4.2 The total mass of coolant released is assumed to be that amount in the steam line and connecting lines at the time of the break plus the amount that passes through the valves prior to closure (Ref. 9.1, Appendix D, Section 4.2). The reactor coolant mass of 140,000 lbs is assumed to be released to the environment (Ref. 9.6, Section III.2.a).

4.3 All the radioactivity in the released coolant is assumed to be released to the atmosphere instantaneously as a ground-level release. No credit is assumed for plateout, holdup, or dilution within facility buildings (Ref. 9.1, Appendix D, Section 4.3).

4.4 The iodine species released from the main steam line is assumed to be 95% CsI as an aerosol, 4.85% elemental, and 0.15% organic (Ref. 9.1, Appendix D, Section 4.4).

Offsite Dose Consequences:

The following guidance is used in determining the TEDE for a maximum exposed individual at EAB and LPZ locations:

4.5 The maximum EAB TEDE for any two-hour period following the start of the radioactivity release is determined (Ref. 9.1, Section 4.1.5), and used in determining compliance with the dose acceptance criteria in Reference 9.1, Section 4.4, Table 6:

EAB Dose Acceptance Criterion (pre-accident spike case):	25 Rem TEDE
EAB Dose Acceptance Criterion (equilibrium iodine activity case):	2.5 Rem TEDE

4.6 The breathing rates for persons at offsite locations are given in Reference 9.1, Section 4.1.3, and are incorporated in Design Input 5.3.4.

4.7 The maximum Low Population Zone (LPZ) TEDE is determined for the most limiting receptor at the outer boundary of the LPZ (Ref. 9.1, Section 4.1.6), and used in determining compliance with the dose criteria in Reference 9.1, Section 4.4 Table 6"

LPZ Dose Acceptance Criterion (pre-accident spike case):	25 Rem TEDE
LPZ Dose Acceptance Criterion (equilibrium iodine activity case):	2.5 Rem TEDE

4.8 No correction is made for depletion of the effluent plume by deposition on the ground (Ref 9.1, Section 4.1.7).

Control Room Dose Consequences

The following guidance is used in determining the TEDE for maximum exposed individuals located in the control room:

4.9 The CR TEDE analysis considers the following sources of radiation that will cause exposure to control room personnel (Ref 9.1, Section 4.2.1):

- Contamination of the control room atmosphere by the intake or infiltration (i.e., filtered CR ventilation inflow via the CR air intake, and unfiltered inleakage) of the radioactive material contained in the post-accident radioactive plume released from the facility,
- Contamination of the control room atmosphere by the intake or infiltration (i.e., filtered CR ventilation inflow via the CR air intake, and unfiltered inleakage) of airborne radioactive material from areas and structures adjacent to the control room envelope,
- Radiation shine from the external radioactive plume released from the facility (i.e., external airborne cloud shine dose),
- Radiation shine from radioactive material in the reactor containment (i.e., containment shine dose; not applicable to a MSLB occurring outside containment),
- Radiation shine from radioactive material in systems and components inside or external to the control room envelope, e.g., radioactive material buildup in recirculation filters (i.e., CR filter shine dose).

Note: The external airborne cloud shine dose and the CR filter shine dose due to a MSLBA are insignificant compared to those due to a LOCA (see the core release fractions for LOCA and non-LOCA design basis accidents in Tables 1 and 3 of Reference 9.1). Therefore, these direct dose contributions are considered to be insignificant and are not evaluated for a MSLBA.

4.10 The radioactivity material releases and radiation levels used in the control room dose analysis are determined using the same source term, transport, and release assumptions used for determining the exclusion area boundary (EAB) and the low population zone (LPZ) TEDE values (Ref 9.1, Section 4.2.2).

4.11 The occupancy and breathing rate of the maximum exposed individual present in the control room are incorporated in Design Input 5.3 (Ref. 9.1, Section 4.2.6).

4.12 10 CFR 50.67 (Ref 9.4) establishes the following radiological criterion for the control room:

CR Dose Acceptance Criterion: 5 Rem TEDE

4.13 Although allowed by Reference 9.1, Section 4.2.4, credit is not taken for the engineered safety features of the CR emergency filtration (CREF) system that mitigate airborne activity within the control room.

4.14 No credits for KI pills or respirators are taken (Ref. 9.1, Section 4.2.5).

5.0 DESIGN INPUTS:

5.1 General Considerations

5.1.1 Applicability of Prior Licensing Basis

The implementation of an AST is a significant change to the design basis of the facility and to the assumptions and design inputs used in the analyses. The characteristics of the ASTs and the revised TEDE dose calculation methodology may be incompatible with many of the analysis assumptions and methods currently used in the facility's design basis analyses. The HCGS plant specific design inputs and assumptions used in the current TID-14844 analyses were assessed for their validity to represent the as-built condition of the plant and evaluated for their compatibility to meet the AST and TEDE methodology. The analysis in this calculation ensures that analysis assumptions, design inputs, and methods are compatible with the ASTs and the TEDE criteria.

5.1.2 Credit for Engineered Safety Features

Credit is taken only for accident mitigation features that are classified as safety-related, are required to be operable by technical specifications, are powered by emergency power sources, and are either automatically actuated or, in limited cases, have actuation requirements explicitly addressed in emergency operating procedures. The dose mitigation function of the CREF system is not credited in the analysis.

5.1.3 Assignment of Numeric Input Values

The numeric values that are chosen as inputs to the analyses required by 10 CFR 50.67 (Ref. 9.4) are compatible to AST and TEDE dose criteria and selected with the objective of producing conservative radiological consequences. For conservatism, the limiting values of reactor coolant iodine concentrations listed in the HCGS Technical Specification are used in the analysis.

5.1.4 Meteorology Considerations

The control room atmospheric dispersion factors (χ/Qs) for the blowout panel release point are developed (Ref. 9.5) using the NRC sponsored computer code ARCON96. The EAB and LPZ χ/Qs were reconstituted using the

HCGS plant specific meteorology and appropriate regulatory guidance (Ref. 9.9). The off-site χ/Qs reconstituted in Reference 9.9 were accepted by the staff in previous licensing proceedings.

5.2 Accident-Specific Design Inputs/Assumptions

The design inputs/assumptions utilized in the EAB, LPZ, and CR habitability analyses are listed in the following sections. The design inputs are compatible with the AST and TEDE dose criteria and assumptions are consistent with those identified in Appendix D of RG 1.183 (Ref. 9.1). The design inputs and assumptions in the following sections represent the as-built design of the plant.

Design Input Parameter		Value Assigned		Reference	
5.3 Main Steam Line Break Accident Parameters					
5.3.1 Source Term					
5.3.1.1 Proposed extended power uprate level		4,031 MW_t		9.3, Section 3.2.1	
5.3.1.2.a Uprated Iodine Coolant Concentration (μCi/gm)				9.3, Appendix A	
Isotope	**Activity**	**Isotope**	**Activity**	**Isotope**	**Activity**
I-131	1.30E-02	I-132	1.20E-01	I-133	8.90E-02
I-134	2.40E-01	I-135	1.30E-01		
5.3.1.2.b Uprated Noble Gas Release Rate @ time t = 0 (μCi/sec)				9.15, Table V	
KR-83M	3.40E+03	KR-88	2.00E+04	XE-135M	2.60E+04
KR-85M	6.10E+03	XE-131M	1.50E+01	XE-135	2.20E+04
KR-85	2.00E+01	XE-133M	2.90E+02	XE-138	8.90E+04
Kr-87	2.00E+04	XE-133	8.20E+03		
5.3.1.3 Maximum reactor coolant iodine concentration for pre-accident spike		4.0 μCi/gm		9.11	
5.3.1.4 Maximum equilibrium reactor coolant iodine concentration for continued full power operation		0.2 μCi/gm		9.11	
5.3.1.5 Mass of reactor coolant released from MSLBA		140,000 lbs		9.6, Section III.2.a	
5.3.2 Activity Transport (see Figure 1)					
5.3.2.1 Activity release rate		2.0E+05 source volumes/day		Assumed to postulate a single puff	
5.3.2.2 Duration of release		Instantaneously in a single puff		9.1, Table 6 and Appendix D, Section 4.3	
5.3.2.3 Type of release to the atmosphere		Ground level release		9.1, Appendix D, Section 4.3	
5.3.2.4 Chemical form of Iodine in reactor coolant released from the main steam line					
Aerosol		95%		9.1, Appendix D, Section 4.4	
Elemental		4.85%			
Organic		0.15%			
5.3.2.5 Dilution or holdup within the facility building		Not credited		9.1, Appendix D, Section 4.3	
5.3.2.6 Source volume		100 ft^3		Assumed to facilitate RADTRAD nodalization	
5. 3.3 Control Room Parameters (see Figure 1)					
5.3.3.1 CR volume		85,000 ft^3		9.10, page 10	

Design Input Parameter	Value Assigned	Reference
5.3.3.2 CR normal air inflow rate during MSLBA	3,000 ± 10% cfm for 0-720 hrs (conservatively modeled as 3,300 cfm)	9.14 and Assumption 4.13
5.3.3.3 CR occupancy factors		
Time (Hr)	**%**	9.1, Section 4.2.6
0-24	100	
24-96	60	
96-720	40	
5.3.3.4 CR atmospheric dispersion factors for blowout panel release (X/Qs)		
Time (Hr)	**X/Q (sec/m^3)**	
0-2	1.20E-03	9.5, Section 8.8
2-8	8.16E-04	
8-24	3.08E-04	
24-96	2.14E-04	
96-720	1.63E-04	
5.3.3.5 CR breathing rate (m^3/sec)	3.5E-04	9.1, Section 4.2.6
5.3.4 Site Boundary Release Model Parameters		
5.3.4.1 EAB atmospheric dispersion factor (χ/Q) (sec/m^3)	1.9E-04	9.9, Pages 5 & 9
5.3.4.2 LPZ atmospheric dispersion factors (X/Qs)		
Time (Hr)	**X/Q (sec/m^3)**	
0-2	1.9E-05	9.9, Pages 5 & 9
2-4	1.2E-05	
4-8	8.0E-06	
8-24	4.0E-06	
24-96	1.7E-06	
96-720	4.7E-07	
5.3.4.3 EAB breathing rate (m^3/sec)	3.5E-04	9.1, Section 4.1.3
5.3.4.4 LPZ breathing rates (m^3/sec)		
Time (Hr)	**(m^3/sec)**	
0-8	3.5E-04	9.1, Section 4.1.3
8-24	1.8E-04	
24-720	2.3E-04	

6.0 CALCULATIONS:

Miscellaneous Conversion Factors

Steam Mass Flow Rate:

Uprated Steam Flow Rate

= 17,774,000.0 lb/hr (Ref. 9.3, Section 3.2.1) = 17,774,000.0 lb/hr x 453.6 g/lb x 1/3600 hr/sec

= 2,239,524.0 g/sec ≅ 2.24E+06 g/sec

This conversion factor is used to convert the noble gas release rates in μCi/sec to noble gas activity concentrations in μCi/g in Table 5.

Coolant Mass Release:

Coolant Mass Release From MSLB
= 140,000 lb (Ref. 9.6, Section III.2.a) = 140,000 lb x 453.6 g/lb = 6.35E+07 g
This conversion factor is used in Tables 8 & 9.

7.0 RESULTS SUMMARY:

7.1 The results of the MSLBA analysis with the pre-accident iodine spike are summarized in the following table:

	Main Steam Line Break Accident with Pre-accident Iodine Spike TEDE Dose (rem)		
	Receptor Location		
	Control Room	**EAB**	**LPZ**
Calculated Dose	3.60E+00	9.42E-01 (0.0 hr)	9.45E-02
Allowable TEDE Limit	**5.0E+00**	**2.5E+01**	**2.5E+01**
	RADTRAD Computer Run No.		
	HEPU4MSLBA00	HEPU4MSLB00	HEPU4MSLB00

Significant assumptions used in this analysis:

- Maximum iodine concentration = 4.0 µCi/gm DE I-131
- Post-MSLBA activity is released to the environment in a single puff at ground level through blowout panels.
- CREF system is not credited.
- Core thermal power = 4,031 MW_t

7.2 The results of the MSLBA analysis with the maximum equilibrium iodine concentration permitted for continued full power operation are summarized in the following table:

	Main Steam Line Break Accident with Maximum Equilibrium Iodine Concentration for Continued Full Power Operation TEDE Dose (rem)		
	Receptor Location		
	Control Room	**EAB**	**LPZ**
Calculated Dose	1.81E-01	5.61E-02 (0.0 hr)	5.63E-03
Allowable TEDE Limit	**5.0E+00**	**2.5E+00**	**2.5E+00**
	RADTRAD Computer Run No.		
	HEPU2MSLB00	HEPU2MSLB00	HEPU2MSLB00

Significant assumptions used in this analysis:

- Maximum iodine concentration = 0.2 µCi/gm DE I-131
- Post-MSLBA activity is released to the environment in a single puff at ground level through blowout panels
- CREF system is not credited.
- Core thermal power = 4,031 MW_t

8.0 CONCLUSIONS:

The results of MSLB accident analyses in Section 7.0 indicate that the EAB, LPZ, and CR doses due to a MSLB accident are within their allowable limits and CREF system actuation is not required during a MSLB accident.

9.0 REFERENCES:

1. U.S. NRC Regulatory Guide 1.183, Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors, July 2000
2. S.L. Humphreys et al., "RADTRAD: A Simplified Model for Radionuclide Transport and Removal and Dose Estimation," NUREG/CR-6604, USNRC, April 1998
3. GE-NE-0000-0008-3534-02, DRF 0000-0004-6923, Revision 0, Class III, November 2002, Project Task Report T0807 Draft, Coolant Radiation Sources
4. 10 CFR 50.67, "Accident Source Term."
5. Calculation No. H-1-ZZ-MDC-1879, Rev 1, Control Room & Technical Support Center χ/Qs Using ARCON96 Code
6. NUREG-0800, Standard Review Plan 15.6.4, Revision 2, "Radiological Consequences of Main Steam Line Failure Outside Containment (BWR)," July 1981.
7. Federal Guidance Report 11, EPA-520/1-88-020, Environmental Protection Agency
8. Federal Guidance Report 12, EPA-402-R-93-081, Environmental Protection Agency
9. Calculation No. H-1-ZZ-MDC-1820, Rev 0, Offsite Atmospheric Dispersion Factors
10. Calculation No. H-1-ZZ-MDC-1882, Rev 0, Control Room Envelope Volume
11. HCGS Technical Specification 3/4.4.5, "Specific Activity" Limiting Condition for Operation
12. Critical Software Package Identification No. A-0-ZZ-MCS-0225, Rev 0, RADTRAD Computer Code.
13. HCGS General Arrangement Drawings:
    a. P-0006-0, Rev 7, Plan EL 153'-0" & EL 162'-0"
    b. P-0007-0, Rev 7, Plan EL 171'-0" & EL 201'-0"
    c. P-0010-0, Rev 6, Sections A-A & B-B
    d. P-0011-0, Rev 5, Sections C-C & D-D
14. HCGS Air Flow Diagram No. M-78-1, Rev 21, "Aux Bldg Control Area Air Flow Diagram."
15. GE Specification Document No. 22A2703F, Rev 3, Radiation Sources.

10.0 TABLES:

Table 1
Iodine Isotopic Dose Conversion Factors

Isotope	Isotopic Dose Conversion Factor (Sv/Bq) A	Conversion Factor (rem/Ci/Sv/Bq) B	Iodine Dose Conversion Factor (rem/Ci) C=AxB
I-131	2.920E-07	3.700E+12	1.080E+06
I-132	1.740E-09	3.700E+12	6.438E+03
I-133	4.860E-08	3.700E+12	1.798E+05
I-134	2.880E-10	3.700E+12	1.066E+03
I-135	8.460E-09	3.700E+12	3.130E+04

A From Reference 9.7, Page 136

Table 2
Iodine Scaling Factors
Pre-accident Iodine Spike & Equilibrium Iodine Concentration

Isotope	Normal Iodine Activity Concentration µCi/g A	Iodine Dose Conversion Factor (rem/Ci) B	Product µCi.rem/Ci.g (rem) (A x B)
I-131	1.300E-02	1.080E+06	1.404E+04
I-132	1.200E-01	6.438E+03	7.726E+02
I-133	8.900E-02	1.798E+05	1.600E+04
I-134	2.400E-01	1.066E+03	2.558E+02
I-135	1.300E-01	3.130E+04	4.069E+03
Total			3.514E+04

A From Reference 9.3, Appendix A

I-131 DE Based on Normal Iodine Concentration	3.254E-02

Iodine Scaling Factor Based on 4 µCi/g DE I-131	1.229E+02
Iodine Scaling Factor Based on 0.2 µCi/g DE I-131	6.147E+00

Table 3

Iodine Concentrationn Based On Pre-accident Iodine Spike

Isotope	Normal Iodine Activity Concentration µCi/g A	Iodine Scaling Factor B	Iodine Activity Concentration µCi/g C = A x B
I-131	1.300E-02	1.229E+02	1.598E+00
I-132	1.200E-01	1.229E+02	1.475E+01
I-133	8.900E-02	1.229E+02	1.094E+01
I-134	2.400E-01	1.229E+02	2.951E+01
I-135	1.300E-01	1.229E+02	1.598E+01

A From Reference 9.3, Appendix A

B Scaling Factor Based on 4 µCi/g DE I-131 From Table 2

Table 4

Iodine Concentration Based On Equilibrium Iodine Concentration

Isotope	Normal Iodine Activity Concentration µCi/g A	Iodine Scaling Factor B	Iodine Activity Concentration µCi/g C = A x B
I-131	1.300E-02	6.147E+00	7.991E-02
I-132	1.200E-01	6.147E+00	7.376E-01
I-133	8.900E-02	6.147E+00	5.471E-01
I-134	2.400E-01	6.147E+00	1.475E+00
I-135	1.300E-01	6.147E+00	7.991E-01

A From Reference 9.3, Appendix A

B Scaling Factor Based on 0.2 µCi/g DE I-131 From Table 2

Table 5
Normal Noble Gas Concentration

Isotope	Noble Gas Release Rate At t=0 (µCi/sec) A	Uprated Steam Mass Flow Rate (g/sec) B	Normal Noble Gas Activity Concentration (µCi/g) C= A/B
Kr-83m	3.400E+03	2.240E+06	1.518E-03
Kr-85m	6.100E+03	2.240E+06	2.724E-03
Kr-85	2.000E+01	2.240E+06	8.931E-06
Kr-87	2.000E+04	2.240E+06	8.931E-03
Kr-88	2.000E+04	2.240E+06	8.931E-03
Xe-131m	1.500E+01	2.240E+06	6.698E-06
Xe-133m	2.900E+02	2.240E+06	1.295E-04
Xe-133	8.200E+03	2.240E+06	3.662E-03
Xe-135m	2.600E+04	2.240E+06	1.161E-02
Xe-135	2.200E+04	2.240E+06	9.824E-03
Xe-137	1.500E+05	2.240E+06	6.698E-02
Xe-138	8.900E+04	2.240E+06	3.974E-02

A From Reference 9.15, Table V

B = 17774000 lb/hr x 453.6 g/lb x 1/3600 hr/sec = 2.240E+06 g/sec

Table 6
HCGS Reactor Coolant Concentration Based on 100/E-BAR

Isotope	Normal EPU Activity Concentration µCi/g Ai	Average Energy Mev/Dis Beta Bi	Gamma Ci	Total Di = Bi + Ci	Weighted Energy E-Bar Mev.µCi/dis.g Ei = Ai * Di
Br-83	1.50E-02	0.321	0.008	0.329	0.0049
Br-84	2.70E-02	1.229	1.788	3.017	0.0815
Kr-83m	1.52E-03	0.039	0.003	0.042	0.0001
Kr-85m	2.72E-03	0.255	0.158	0.413	0.0011
Kr-85	8.93E-06	0.251	0.002	0.253	0.0000
KR 87	8.93E-03	1.324	0.793	2.117	0.0189
KR 88	8.93E-03	0.364	1.955	2.319	0.0207
Xe-131m	6.70E-06	0.144	0.020	0.164	0.0000
Xe-133m	1.29E-04	0.192	0.041	0.233	0.0000
Xe-133	3.66E-03	0.136	0.046	0.182	0.0007
Xe-135m	1.16E-02	0.098	0.429	0.527	0.0061
Xe-135	9.82E-03	0.317	0.249	0.566	0.0056
Sr-89	3.10E-03	0.583	0.000	0.583	0.0018
Sr-90	2.30E-04	0.196	0.000	0.196	0.0000
Sr-91	6.90E-02	0.656	0.697	1.353	0.0934
Sr-92	1.10E-01	0.196	1.339	1.535	0.1689
Zr-95	4.00E-05	0.116	0.739	0.855	0.0000
Zr-97	3.20E-05	0.700	0.179	0.879	0.0000
Nb-95	4.20E-05	0.044	0.766	0.810	0.0000
Mo-99	2.20E-02	0.392	0.150	0.542	0.0119
Tc-99m	2.80E-01	0.016	0.126	0.142	0.0396
Ru-103	1.90E-05	0.075	0.469	0.544	0.0000
Ru-106	2.60E-06	0.010	0.000	0.010	0.0000
Te-129m	4.00E-05	0.260	0.038	0.298	0.0000
Te-132	4.90E-02	0.102	0.234	0.336	0.0165
Cs-134	1.60E-04	0.164	1.555	1.719	0.0003
Cs-136	1.10E-04	0.139	2.166	2.305	0.0003
Cs-137	2.40E-04	0.187	0.000	0.187	0.0000
Cs-138	1.90E-01	1.207	2.361	3.568	0.6779
Ba-139	1.60E-01	0.898	0.043	0.941	0.1506
Ba-140	9.00E-03	0.313	0.183	0.496	0.0045

Table 6 (Con'd)
HCGS Reactor Coolant Concentration Based on 100/E-BAR

Isotope	Normal EPU Activity Concentration µCi/g Ai	Average Energy Mev/Dis			Weighted Energy E-Bar Mev.µCi/dis.g
		Beta Bi	Gamma Ci	Total Di = Bi + Ci	Ei = Ai * Di
Ba-141	1.70E-01	0.901	0.845	1.746	0.2968
Ce-141	3.90E-05	0.171	0.076	0.247	0.0000
Ce-143	3.50E-05	0.433	0.282	0.715	0.0000
Ce-144	3.50E-05	0.092	0.021	0.113	0.0000
Pr-143	3.80E-05	0.314	0.000	0.314	0.0000
Nd-147	1.40E-05	0.270	0.140	0.410	0.0000
Np-239	2.40E-01	0.260	0.173	0.433	0.1039
Na-24	2.00E-03	0.554	4.121	4.675	0.0094
P-32	2.00E-05	0.695	0.000	0.695	0.0000
Cr-51	5.00E-04	0.004	0.033	0.036	0.0000
Mn-54	4.00E-05	0.004	0.836	0.840	0.0000
Mn-56	5.00E-02	0.830	1.692	2.522	0.1261
Co-58	5.00E-03	0.034	0.976	1.009	0.0050
Co-60	5.00E-04	0.097	2.504	2.601	0.0013
Fe-59	8.00E-05	0.118	1.189	1.307	0.0001
Ni-65	3.00E-04	0.017	0.000	0.017	0.0000
Zn-65	2.00E-06	0.007	0.584	0.591	0.0000
Zn-69m	3.00E-05	0.022	0.417	0.439	0.0000
Ag-110m	6.00E-05	0.072	2.751	2.823	0.0002
W-187	3.00E-03	0.312	0.481	0.793	0.0024
F-18	4.00E-03	0.250	1.022	1.272	0.0051
Total	**1.46E+00**			**Total**	**1.86E+00**

Ai From Reference 9.15, Tables III & IV

Bi & Ci From Reference 9.8, Appendix A for isotope having half life > 15 minutes

E-BAR = SUM (Weighted E-Bar)/Sum (Ai)	1.273
100/E-BAR Coolant Concentration	78.571
Percent Fuel Defect Based on E-BAR = (100/E-BAR)/Sum (Ai)	53.887

Table 7
Normal Noble Gas Concentration Based on 100/E-BAR

Isotope	Normal Noble Gas Activity Concentration (µCi/g) A	Noble Gas Scaling Factor Based On 100/E-BAR B	Noble Gas Concentration Based On 100/E-BAR (µCi/g) C= A x B
Kr-83m	1.518E-03	5.389E+01	8.181E-02
Kr-85m	2.724E-03	5.389E+01	1.468E-01
Kr-85	8.931E-06	5.389E+01	4.812E-04
Kr-87	8.931E-03	5.389E+01	4.812E-01
Kr-88	8.931E-03	5.389E+01	4.812E-01
Xe-131m	6.698E-06	5.389E+01	3.609E-04
Xe-133m	1.295E-04	5.389E+01	6.978E-03
Xe-133	3.662E-03	5.389E+01	1.973E-01
Xe-135m	1.161E-02	5.389E+01	6.256E-01
Xe-135	9.824E-03	5.389E+01	5.294E-01
Xe-138	3.974E-02	5.389E+01	2.142E+00

A From Table 5

Table 8
Post-MSLB Activity Release - Pre-accident Iodine Spike

Isotope	Iodine & Noble Gas Activity Concentration µCi/g A	Post-MSLB Coolant Mass Release (g) B	Post-MSLB Activity Release (Ci) C=AxB/1E6
I-131	1.598E+00	6.350E+07	.1015E+03
I-132	1.475E+01	6.350E+07	.9368E+03
I-133	1.094E+01	6.350E+07	.6948E+03
I-134	2.951E+01	6.350E+07	.1874E+04
I-135	1.598E+01	6.350E+07	.1015E+04
Kr-83m	8.181E-02	6.350E+07	.5195E+01
Kr-85m	1.468E-01	6.350E+07	.9320E+01
Kr-85	4.812E-04	6.350E+07	.3056E-01
Kr-87	4.812E-01	6.350E+07	.3056E+02
Kr-88	4.812E-01	6.350E+07	.3056E+02
Xe-131m	3.609E-04	6.350E+07	.2292E-01
Xe-133m	6.978E-03	6.350E+07	.4431E+00
Xe-133	1.973E-01	6.350E+07	.1253E+02
Xe-135m	6.256E-01	6.350E+07	.3973E+02
Xe-135	5.294E-01	6.350E+07	.3361E+02
Xe-138	2.142E+00	6.350E+07	.1360E+03

A - Iodine Activity Concentration From Table 3
A - Noble Gas Activity Concentration From Table 7

Table 9
Post-MSLB Activity Release - Equilibrium Iodine Concentration

Isotope	Iodine & Noble Gas Activity Concentration µCi/g A	Post-MSLB Coolant Mass Release (g) B	Post-MSLB Activity Release (Ci) C=AxB/1E6
I-131	7.991E-02	6.350E+07	.5074E+01
I-132	7.376E-01	6.350E+07	.4684E+02
I-133	5.471E-01	6.350E+07	.3474E+02
I-134	1.475E+00	6.350E+07	.9368E+02
I-135	7.991E-01	6.350E+07	.5074E+02
Kr-83m	8.181E-02	6.350E+07	.5195E+01
Kr-85m	1.468E-01	6.350E+07	.9320E+01
Kr-85	4.812E-04	6.350E+07	.3056E-01
Kr-87	4.812E-01	6.350E+07	.3056E+02
Kr-88	4.812E-01	6.350E+07	.3056E+02
Xe-131m	3.609E-04	6.350E+07	.2292E-01
Xe-133m	6.978E-03	6.350E+07	.4431E+00
Xe-133	1.973E-01	6.350E+07	.1253E+02
Xe-135m	6.256E-01	6.350E+07	.3973E+02
Xe-135	5.294E-01	6.350E+07	.3361E+02
Xe-138	2.142E+00	6.350E+07	.1360E+03

A - Iodine Activity Concentration From Table 4
A - Noble Gas Activity Concentration From Table 7

CALC. NO.: H-1-AB-MDC-1854			REFERENCE: DCP 80048085				
ORIGINATOR, DATE	REV:	G. Patel, 11/27/02	1				
REVIEWER/VERIFIER, DATE		Mark Drucker, 11/29/02					

11.0 FIGURES:

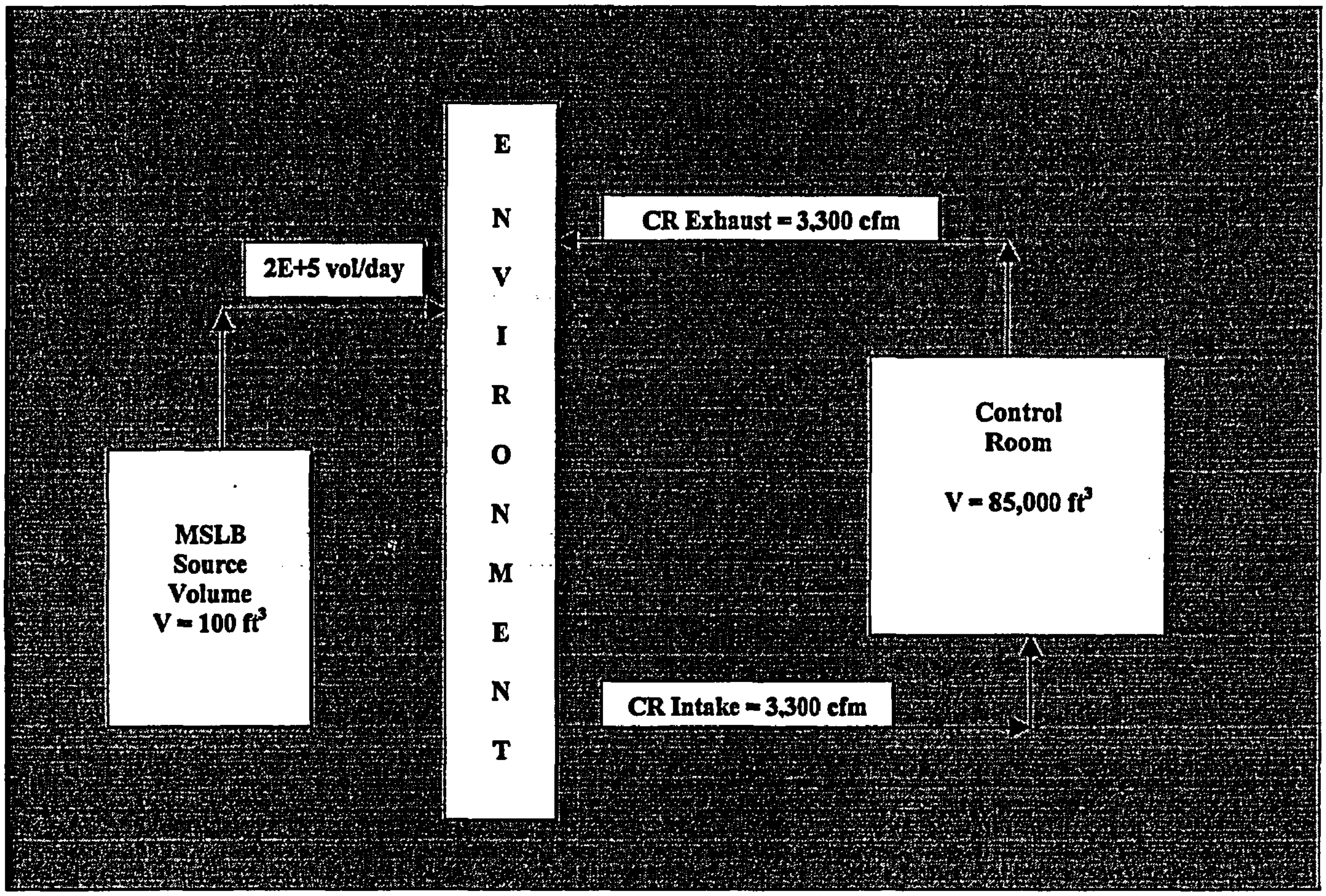

Figure 1: RADTRAD Nodalization For MSLBA Release

12.0 AFFECTED DOCUMENTS:

Upon approval of Licensing Change Request LCR H02-01 and implementation of DCP 80048085, the following documents will be either superseded or revised:

Document to be superseded

Engineering Evaluation H-1-ZZ-MDC-1854, Rev 0

Documents to be revised:

UFSAR Section 15.6.4

UFSAR Table 15.6.-7

UFSAR Table 15.6.-9

13.0 ATTACHMENTS:

Attachment A : 2 Diskettes with the following electronic files:

Calculation No: H-1-AB-MDC-1854, Rev 1.
Peer Review Comment Resolutions – Mark Drucker
Nuclide Inventory File HEPU4MSLB_def
Nuclide Inventory File HEPU2MSLB_def
Nuclide Release Fraction & Timing File HEPUMSLB_rft
Dose Conversion File HEPUMSLB_FG11&12
RADTRAD Input File HEPU4MSLB00.psf
RADTRAD Output File HEPU4MSLB00.o0
RADTRAD Input File HEPU2MSLB00.psf
RADTRAD Output File HEPU2MSLB00.o0