Attachment 8

CALCULATION NO: H-1-ZZ-MDC-1880

Post-LOCA EAB, LPZ, and CR Doses – Alternate Source Term Analysis.

CALC NO.: H-1-ZZ-MDC-1880 REVISION: 0IR2	CALCULATION COVER SHEET	Page 1 of 68
CALC. TITLE:	Post-LOCA EAB, LPZ, and CR Doses – Alternate Source Term Analysis	

# SHTS (CALC):	68	# ATT / # SHTS:	1	# IDV/50.59 SHTS:	12/0	# TOTAL SHTS:	82

2 TYP

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 SYSTEM MANAGER
☐ CDs INCORPORATED (IF ANY): ____________

DESCRIPTION OF CALCULATION REVISION (IF APPL.):

N/A

PURPOSE:
The purpose of this calculation is to determine the EAB, LPZ, and control room doses for Hope Creek Generating Station (HCGS) due to the increased CR unfiltered inleakage from 10 cfm to 900 cfm, the deletion of MSIV Sealing System (MSIVSS), and the increased MSIV leakage from 46 scfh to 250 scfh. The analysis is performed using the Alternate Source Term (AST), the guidance in the Regulatory Guide 1.183, and the TEDE dose criteria. The V&V of RADTRAD3.02 computer code is performed using the HABIT1.0 code, which is currently used for the licensing basis analyses at the Hope Creek and Salem plants.

The 10CFR50.59 evaluation for DCP 4EC-3513, Package No. 1 applies to this documentation which is CD P606.

CONCLUSIONS:
The results of analyses in Section 8 indicate that the main steam sealing system can be safely eliminated along with the increased MSIV leakage of 250 scfh and control room unfiltered inleakage of 900 cfm using the AST and guidance in the Regulatory guide 1.183. Adherence to guidance in the RG 1.183 and use of the specific values and limits contained in the technical specifications and as-built post-accident performance of safety grade ESF functions provide the assurance for sufficient safety margin, including a margin to account for analysis uncertainties in the proposed uses of an AST and the associated facility modifications and changes to procedures. The V&V of RADTRAD3.02 code demonstrates that RADTRAD produces the identical results within ± 2% margin of error compared to the HABIT1.0 results.

	Printed Name / Signature	Date
ORIGINATOR/COMPANY NAME:	Gopal J. Patel/NUCORE	08/01/01
PEER REVIEWER/COMPANY NAME:	N/A	N/A
VERIFIER/COMPANY NAME:	John Duffy/PSEG	08/01/01
PSEG SUPERVISOR APPROVAL:	Robert DeNight/PSEG	08/01/01

REVISION HISTORY

Revision	Issue Date	Revision Description
0IR0	5/7/01	Initial Issue.
0IR1	5/16/01	Revised due to incorporation of the preliminary plant-specific core inventory, which will be confirmed via Order No. 80028003. The CR inleakage value was reduced to 900 cfm from 1000 cfm to offset the impact of preliminary core inventory on the CR dose.
0IR2	8/01/01	Revised the aerosol removal rate in main steam piping, horizontal projected pipe surface area, and equation calculating the aerosol deposition. Incorporated the revised χ/Qs.

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2

CALC. NO.: H-1-ZZ-MDC-1880			REFERENCE:				
ORIGINATOR, DATE	REV:	G. Patel, 08/01/01	0				
REVIEWER/VERIFIER, DATE		J. Duffy, 08/01/01					

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4	0IR2	45	0IR0	Attachment D	0IR2
5	0IR1	46	0IR0	Attachment E	0IR2
6	0IR0	47	0IR0	Attachment F	0IR2
7	0IR0	48	0IR0	Attachment G	0IR2
8	0IR0	49	0IR0	Attachment H	0IR2
9	0IR0	50	0IR0	Attachment I	0IR2
10	0IR0	51	0IR0	Attachment J	0IR2
11	0IR0	52	0IR0	Attachment K	0IR2
12	0IR0	53	0IR0	Attachment L	0IR2
13	0IR1	54	0IR0	Attachment M	0IR2
14	0IR0	55	0IR0	Attachment N	0IR0
15	0IR0	56	0IR0	Attachment O	0IR0
16	0IR0	57	0IR0		
17	0IR2	58	0IR0		
18	0IR0	59	0IR0		
19	0IR0	60	0IR2		
20	0IR1	61	0IR0		
21	0IR2	62	0IR1		
22	0IR0	63	0IR2		
23	0IR0	64	0IR2		
24	0IR0	65	0IR1		
25	0IR2	66	0IR2		
26	0IR0	67	0IR2		
27	0IR2	68	0IR2		
28	0IR0				
29	0IR0				
30	0IR1				
31	0IR2				
32	0IR2				
33	0IR2				
34	0IR2				
35	0IR2				
36	0IR2				
37	0IR0				
38	0IR0				
39	0IR0				
40	0IR0				
41	0IR0				

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Calculation No: H-1-ZZ-MDC-1880

1.0 PURPOSE:

The purpose of this calculation is to evaluate the Exclusion Area Boundary (EAB), Low Population Zone (LPZ), and Control Room (CR) Post-LOCA doses for Hope Creek Generating Station due to:

- An assumed increase of CR unfiltered inleakage from 10 cfm to 900 cfm.
- The deletion of Main Steam Isolation Valve (MSIV) Sealing System (MSIVSS), and
- An allowable increase of MSIV leakage from 46 scfh to 250 scfh.

The final results of the analyses are shown in Section 8.0 of this calculation. The doses are calculated using the Alternate Source Term (AST), Regulatory Guide (RG) 1.183 requirements, NRC sponsored RADTRAD3.02 computer code, and Total Effective Dose Equivalent (TEDE) dose methodology. Additionally, the RADTRAD3.02 code is benchmarked using the HABIT1.0 code using the TID release models with the consistent source terms, transport mechanisms, and dose conversion factors to demonstrate the ability of RADTRAD code to produce consistent results with an accuracy of ±2%. The comparison of results is shown in Section 8 and computer runs are shown in Attachment O.

2.0 SCOPE:

The scope of this evaluation covers the anticipated dose consequences of a Post-LOCA scenario for the HCGS. This calculation is being performed in support of Design Change Package (DCP) 4EC-3513, MSIV Steam Sealing System Deletion. As part of this analysis, the following licensing basis post-LOCA release paths are analyzed:

1. Containment Leakage.
2. Engineered Safety Feature (ESF) Leakage.
3. Main Steam Isolation Valve (MSIV) Bypass Leakage.

3.0 ANALYTICAL APPROACH

The elimination of the MSIV sealing system (MSIVSS) is proposed based on the implementation of AST and TEDE dose criteria. The characteristics of the AST (different in magnitude, timing, and chemical forms) and the revised dose calculation methodology became incompatible with many of the analysis assumptions and methods currently used in the current licensing basis analyses for HCGS. Therefore, the existing design input parameters and assumptions were assessed to determine their compatibility for the AST and integrated radiological response of the plant. Additionally, the design input parameters are validated to represent as-built design of the plant and performance of the safety grade components credited in the analysis.

The RADTRAD3.02 computer code (Ref. 10.2) was developed for the U.S. Nuclear Regulatory Commission Office Of Nuclear Reactor Regulation for use in control room habitability assessments. The

RADTRAD code estimates transport and removal of radionuclides and doses at selected receptors. In addition, the code can account for a reduction in the quantity of radioactive material due to containment sprays, natural deposition, filters, and other natural engineered safety features. The EAB, LPZ, and CR doses are calculated using the release paths such as containment leakage, ESF leakage, and MSIV leakage using the as-built design inputs/assumptions and guidance in the Regulatory Guide 1.183 (Ref. 10.1). The structure, system, and components capable of performing their safety functions during and following a safe shutdown earthquake (SSE) are credited in the analysis.

4.0 ASSUMPTIONS

The following assumptions used in evaluating the offsite and control room doses resulting from a Loss of Coolant Accident (LOCA) are based on the requirements in the Regulatory Guide 1.183 (Ref. 10.1). These assumptions become the design inputs in Sections 5.3 through 5.7 and are incorporated in the analyses.

4.1 Source Term Assumptions

Acceptable assumptions regarding core inventory and the release of radionuclides from the fuel are provided in Regulatory Positions (RGP) 3.1 through 3.4 of Reference 10.1 as follows:

4.2 Core Inventory

The assumed inventory of fission products in the reactor core and available for release to the containment is based on the maximum power level of 3,458 MWt corresponding to current fuel enrichment and fuel burnup, which is 1.05 times the current licensed rated thermal power of 3,293 MWt for HCGS (Reference 10.6.9). The assumed core inventory is shown in Table 1 of Design Input 5.3.1.3.

4.3 Release Fractions and Timing

The core inventory release fractions, by radionuclide groups, for the gap release and early in-vessel damage for a Design Basis Accident (DBA) LOCA are listed in Table 3 of Design Input 5.3.1.5. These fractions are applied to the equilibrium core inventory described in Design Input 5.3.1.3 (Ref. 10.1, Tables 1 & 4).

4.4 Radionuclide Composition

The elements in each radionuclide group to be considered in design basis analyses are shown in Table 2 of Design Input 5.3.1.4 (Ref. 10.1, RGP 3.4).

4.5 Chemical Form

A pH value of 7.0 or greater for the suppression pool water inventory is assumed. Consequently, the chemical forms of radioiodine released to the containment can be assumed to be 95% cesium iodide (CsI), 4.85 percent elemental iodine, and 0.15 percent organic iodide (Ref. 10.1, RGP 3.5 and A.2). These are shown in Design Inputs 5.3.1.7. With the exception of elemental and organic iodine and noble gases, fission products are assumed to be in particulate form (Ref. 10.1, RGP 3.5 and A.2).

4.6 Assumptions on Activity Transport in Primary Containment

4.6.1 The radioactivity released from the fuel is assumed to mix instantaneously and homogeneously throughout the free air volume of the primary containment.

4.6.2 Reduction in airborne radioactivity in the containment by natural deposition within the containment is credited using the RADTRAD3.02 Powers model for aerosol removal coefficient with a 10-percentile probability (Ref. 10.1 RGP A.3.2 & 10.2).

4.6.3 The primary containment is assumed to leak at the allowable Technical Specification peak pressure leak rate for the first 24 hours (Ref. 10.1, RGP A.3.7). For HCGS, this leakage is reduced to 50% of its TS value after the first 24 hours based on the post-LOCA containment pressure (Ref. 10.15) as shown in design input 5.3.2.5.

4.6.4 The HCGS drywell and suppression chamber may be purged for up to 500 hrs per year (Ref. 10.6.18). Normally, the containment is purged at <25% power level before or during a drywell entry in an outage. Per RG 1.183, RGP A.7, the radiological consequences from post-LOCA primary containment purging as a combustible gas or pressure control measure should be analyzed. If the primary containment purging is required within 30 days of the LOCA, the results of this analysis should be combined with consequences postulated for other fission product release paths to determine the total calculated radiological consequences from the LOCA. However, HCGS has a safety grade hydrogen recombination system to control the post-accident combustible gas (Ref. 10.41 & 10.42). The post-LOCA containment pressure is reduced to less than 31 psia within a few days (Ref 10.15). Containment purging is not required for the combustible gas or pressure control measure within 30 days of the LOCA. Therefore, the release from containment purging is not analyzed.

4.7 Offsite Dose Consequences

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

4.7.1 The offsite dose is determined in the TEDE, which is the sum of the committed effective dose equivalent (CEDE) from inhalation and the deep dose equivalent (DDE) from external exposure from all radionuclides that are significant with regard to dose consequences and the released radioactivity (Ref. 10.1, RGP 4.1.1, Ref 10.7). The RADTRAD3.02 computer code (Ref. 10.2) performs this summation to calculate the TEDE.

4.7.2 The offsite dose analysis is performed using the RADTRAD3.02 code (Ref. 10.2), which uses the Committed Effective Dose (CED) Conversion Factors for inhalation. (Ref. 10 .1, RGP 4.1.2, Refs. 10.7 & 10.8).

4.7.3 Since RADTRAD3.02 calculates Deep Dose Equivalent (DDE) using whole body submergence in semi-infinite cloud with appropriate credit for attenuation by body tissue, the DDE can be assumed nominally equivalent to the effective dose equivalent (EDE) from external exposure. Therefore, the code uses DDE in lieu of EDE in determining TEDE (Ref. 10.1, RGP 4.1.4, and Ref 10.8).

4.7.4 The maximum EAB TEDE for any two-hour period following the start of the radioactivity release is determined and used in determining compliance with the dose acceptance criteria in 10 CFR 50.67 (Ref. 10.1, RGP 4.1.5 & RGP 4.4, and Ref. 10.4).

EAB Dose Acceptance Criteria: 25 Rem TEDE (50.67(b)(2)(i))

4.7.5 TEDE is determined for the most limiting receptor at the outer boundary of the low population zone (LPZ) and is used in determining compliance with the dose criteria in 10 CFR 50.67 (Refs. 10.1, RGP 4.1.6 and RGP 4.4 & Ref. 10.4).

LPZ Dose Acceptance Criteria: 25 Rem TEDE (50.67(b)(2)(ii))

4.7.6 No correction is made for depletion of the effluent plume by deposition on the ground (Ref. 10.1, RGP 4.1.7).

4.7.7 The breathing rates used for persons at offsite locations is given in Reference 10.1, RGPs 4.1.3 & 4.4. These rates are incorporated in design input 5.7.3.

4.8 Control Room Dose Consequences

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

4.8.1 The CR TEDE analysis considers the following sources of radiation that will cause exposure to control room personnel (Ref. 10.1, RGP 4.2.1). See applicable Design Inputs 5.6.1 through 5.6.13.

- Contamination of the control room atmosphere by the intake or infiltration of the radioactive material contained in the post-accident radioactive plume released from the facility (via CR air intake),
- Contamination of the control room atmosphere by the intake or infiltration of airborne radioactive material from areas and structures adjacent to the control room envelope (via CR unfiltered inleakage),
- Radiation shine from the external radioactive plume released from the facility (external airborne cloud),
- Radiation shine from radioactive material in the reactor containment (containment shine dose), and

- 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 (CR filter shine dose).

4.8.2 The radioactivity releases and radiation levels used for the control room dose is 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. 10.1, RGP 4.2.2).

4.8.3 The occupancy and breathing rate of the maximum exposed individual presents in the control room are incorporated in design inputs 5.6.12 & 5.6.13 (Ref. 10.1, RGP 4.2.6).

4.8.4 10 CFR 50.67 (Ref. 10.4) establishes the following radiological criterion for the control room. This criterion is stated for evaluating reactor accidents of exceedingly low probability of occurrence and low risk of public exposure to radiation, e.g., a large-break LOCA (Ref. 10.1, RGP 4.4).

CR Dose Acceptance Criteria: 5 Rem TEDE (50.67(b)(2)(iii))

4.8.5 Credit for engineered safety features that mitigate airborne activity within the control room is taken for control room isolation or pressurization, intake or recirculation filtration (Ref. 10.1, RGP 4.2.4). The control room design is often optimized for the DBA LOCA and the protection afforded for other accident sequences may not be as advantageous. In most designs, control room isolation is actuated by engineered safety feature (ESF) signals or radiation monitors (RMs). In some cases, the ESF signal is effective only for selected accidents, placing reliance on the RMs. Several aspects of RMs can delay the isolation, including the delay for activity to build up to concentrations equivalent to the alarm setpoint and the effects of different radionuclide accident isotopic mixes on monitor response. The CR emergency filtration system is conservatively assumed to isolate and initiate at 30 minutes after a LOCA per Design Input 5.6.5.

4.8.6 The CR unfiltered in leakage is conservatively assumed to be 500 cfm (Design Input 5.6.7) during the CFREF transition period of 30 minutes after a LOCA. A conservative model would consider the normal ventilation mode for the transition period, which is of short duration (less than two minutes) until the control room envelop is fully pressurized following CREF initiation. Such a model would result in total unfiltered inleakage of 6,600 ft^3 (3000 ft^3/min x 2 min 1.1 = 6,600 ft^3). The conservative assumption of 500 cfm unfiltered inleakage during the transition period would result in 15,000 ft^3 (500 ft^3/min x 30 min = 15,000 ft^3) unfiltered air, which is 2 times higher.

4.8.7 No credits for KI pills or respirators are taken (Ref. 10.1, RGP 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 assumptions and design inputs used in the analyses. The characteristics of the AST 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 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 requirements of the AST and the TEDE criteria.

5.1.2 Credit for Engineered Safety Features

Credit is taken only for those 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 single active component failure modeled in this calculation is an 'A' or 'B' EDG failure concurrent with a loss of offsite power (LOP) resulting in the MSIV release at the ground level instead of released through the south plant vent (SPV). The consequences of an EDG failure is translated throughout the calculation by assuming that only four out of six FRVS recirculation filtration trains are available and one out of four inboard MSIV fails open. Assumptions regarding the occurrence and timing of a LOP are selected for the CREF system with the objective of maximizing the postulated radiological consequences.

5.1.3 Assignment of Numeric Input Values

The numeric values that are chosen as inputs to analyses required by 10 CFR 50.67 are compatible to AST and TEDE dose criteria and selected with the objective of maximizing the postulated dose. As a conservative alternative, the limiting value applicable to each portion of the analysis is used in the evaluation of that portion. The use of containment, ESF, and MSIV leakage values higher than actually measured, use of 10% lower flow rates for the FRVS and CREFS recirculation systems, use of 10% higher flow rate for FRVS vent, 30 minutes delay in the CREF initiation time, and use of ground release χ/Qs demonstrate the inherent conservatisms in the plant design and post-accident response. Most of the design input parameter values used in the analysis are those specified in the Technical Specifications (Ref. 10.6).

5.1.4 Meteorology Considerations

Atmospheric dispersion factors (χ/Qs) for the onsite release points such as the FRVS vent for containment and ESF leakage release path and turbine building louvers for MSIV leakage release path are re-developed (Ref. 10.5) using the NRC sponsored computer code ARCON96 and guidance provided in Draft NEI 99-03, Appendix D (Ref. 10.34). The EAB and LPZ χ/Qs are reconstituted using the HCGS plant specific meteorology and appropriate regulatory guidance (Ref. 10.32). The site boundary χ/Qs reconstituted in Reference 10.32 were accepted by the staff in the 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 requirements of the AST and TEDE dose criteria and the assumptions are consistent with those identified in Regulatory Position 3 and Appendix A of RG 1.183 (Ref. 10.1). The design inputs and assumptions in the following sections represent the as-built design of the plant.

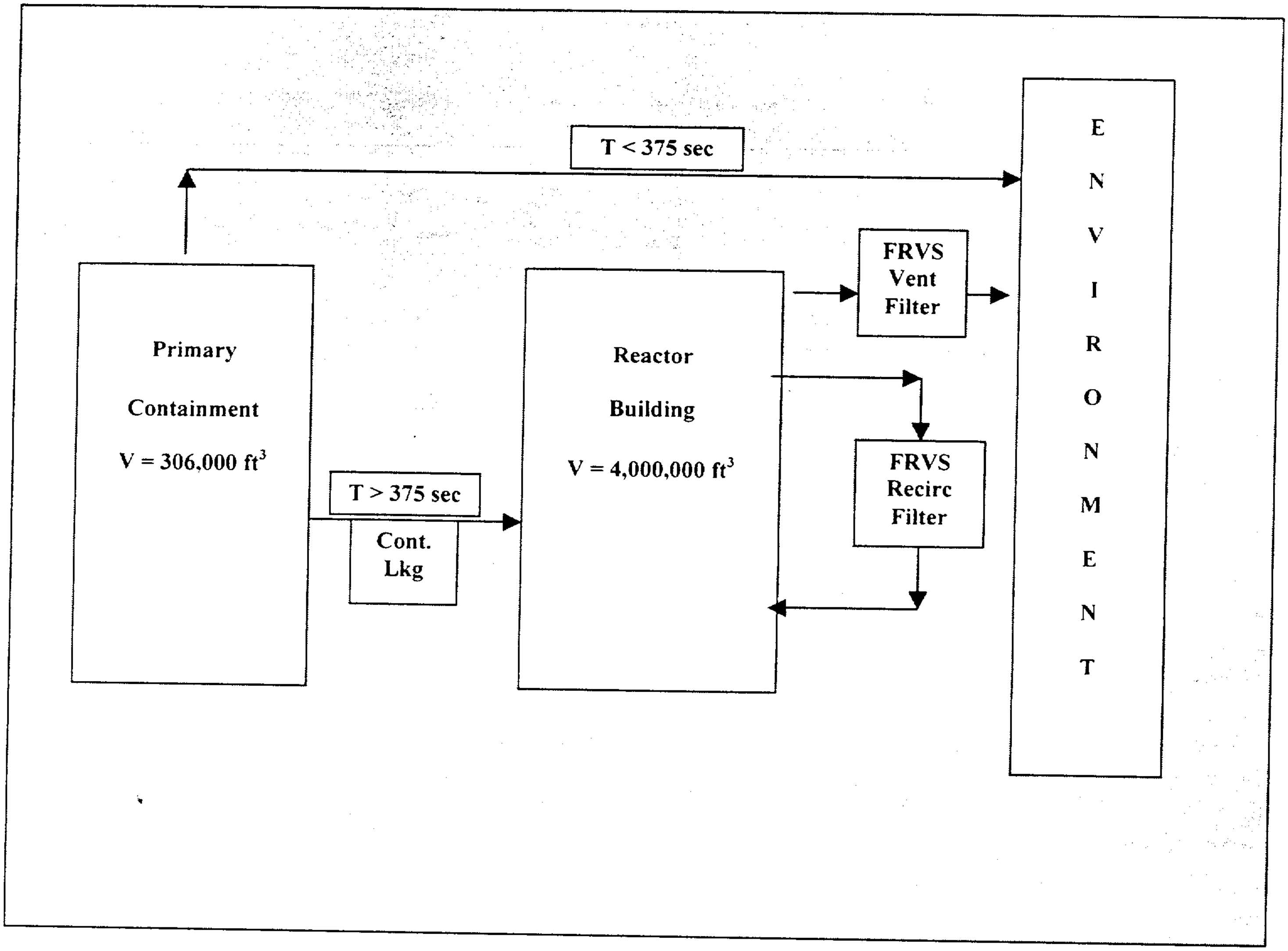


Figure 1: Containment Leakage RADTRAD Nodalization

CALC. NO.: H-1-ZZ-MDC-1880		REFERENCE:				
ORIGINATOR, DATE	REV:	G. Patel, 08/01/01	0			
REVIEWER/VERIFIER, DATE		J. Duffy, 08/02/01				

Design Input Parameter	Value Assigned	Reference
5.3 Containment Leakage Model Parameters		
5.3.1 Source Term		
5.3.1.1 Power Level	3293 x 1.05 = 3458 MWt	10.6.9
5.3.1.2 Post-LOCA Containment Condition (Ref. 10.15)		
0-0.5 hr (Cont. Pressure)	63 psia	10.15
0.5- 720 hr (Cont. Pressure)	31 psia	
5.3.1.3 Isotopic Core Inventory (Curie) (Ref. 10.45) See Below		

Table 1

Isotope	Activity	Isotope	Activity	Isotope	Activity
CO-58	5.287E+05	RU103	1.503E+08	CS136	5.122E+06
CO-60	6.328E+05	RU105	1.071E+08	CS137	1.363E+07
KR 85	1.157E+06	RU106	6.074E+07	BA139	1.745E+08
KR 85M	2.788E+07	RH105	9.970E+07	BA140	1.677E+08
RB 86	1.743E+05	SB127	1.034E+07	LA140	1.728E+08
KR 87	5.454E+07	SB129	3.080E+07	LA141	1.594E+08
KR 88	7.691E+07	TE127M	1.359E+06	LA142	1.554E+08
SR 89	9.386E+07	TE127	1.024E+07	CE141	1.573E+08
SR 90	9.213E+06	TE129M	4.517E+06	CE143	1.513E+08
SR 91	1.274E+08	TE129	3.030E+07	CE144	1.178E+08
SR 92	1.352E+08	TE131M	1.383E+07	PR143	1.456E+08
Y 90	9.555E+06	TE132	1.333E+08	ND147	6.294E+07
Y 91	1.184E+08	I131	9.406E+07	NP239	2.050E+09
Y 92	1.357E+08	I132	1.356E+08	PU238	3.658E+05
Y 93	1.533E+08	I133	1.917E+08	PU239	3.890E+04
ZR 95	1.566E+08	I134	2.122E+08	PU240	4.995E+04
ZR 97	1.599E+08	I135	1.792E+08	PU241	1.774E+07
NB 95	1.561E+08	XE133	1.869E+08	AM241	2.455E+04
MO 99	1.739E+08	XE135	5.420E+07	CM242	7.032E+06
TC 99M	1.522E+08	CS134	1.869E+07	CM244	5.764E+05

1

Design Input Parameter	Value Assigned	Reference
5.3.1.4 Radionuclide Composition		

Table 2

Group	Elements	
Noble Gases	Xe, Kr	10.1, RGP 3.4, Table 5
Halogens	I, Br	
Alkali Metals	Cs, Rb	
Tellurium Group	Te, Sb, Se, Ba, Sr	
Noble Metals	Ru, Rh, Pd, Mo, Tc, Co	
Lanthanides	La, Zr, Nd, Eu, Nb, Pm, Pr, Sm, Y, Cm, Am	
Cerium	Ce, Pu, Np	

5.3.1.5 Release Fraction (Ref 10.1, Tables 1)

Table 3

BWR Core Inventory Fraction Released Into Containment

4.9 Group	**Gap Release Phase**	**Early In-Vessel Release Phase**
Noble Gases	0.05	0.95
Halogens	0.05	0.25
Alkali Metals	0.05	0.20
Tellurium Metals	0.00	0.05
Ba, Sr	0.00	0.02
Noble Metals	0.00	0.0025
Cerium Group	0.00	0.0005
Lanthanides	0.00	0.0002

5.3.1.6 Timing of Release Phase (Ref. 10.1, Table 4)

Table 4

Phase	Onset	Duration
Gap Release	2-min	0.5 hr
Early In-Vessel Release	0.5 hr	1.5 hr

Design Input Parameter	Value Assigned	Reference
5.3.1.7 Iodine Chemical Form		
	Table 5	
Iodine Chemical Form	**%**	
Aerosol	95.0%	10.1, RGP 3.5
Elemental	4.85%	
Organic	0.15%	
5.3.1.8 Post-LOCA Drywell Temperature		
	Table 6	
Post-LOCA Time (Hr)	Temperature (^{0}F)	
0	340	Temperature values are bounding based on information in Reference 10.25, pages 35 through 45.
3	320	
6	250	
24	208	
96	180	
240	170	
480	150	
720		
5.3.2 Activity Transport in Primary Containment		
5.3.2.1 Primary Containment Parameters		
5.3.2.2 Drywell Air Volume	169000 ft^3	10.6.6 & 10.16
5.3.2.3 Suppression Chamber Air Volume	137000 ft^3	10.6.6 & 10.16
5.3.2.4 Containment Air Volume	306000 ft^3	DI 5.3.2.2 + DI 5.3.2.3
5.3.2.5 Containment Leak Rate		
0-24 hrs	0.5 v%/day	10.6.4 & 10.15
24-720 hrs	0.25 v%/day	10.1, RGP A.3.7 & 10.15
5.3.2.6 Draw Down Time	375 sec	10.6.8
5.3.2.7 Cont. Leakage Before Draw Down Time (< 375 sec)	Directly Released to Environment	10.1, RGP A.4.2
5.3.2.8 Cont. Leakage After Draw Down Time (>375 sec)	Directly Released to Reactor Building	10.1, RGP A.4.2

Design Input Parameter	Value Assigned	Reference
5.3.2.9 Reactor Building Volume	4,000,000 ft^3	10.6.7
5.3.2.10 Reactor Building Mixing	50%	10.1, RGP A.4.4
5.3.2.11 FRVS Vent Exhaust Rate Before Draw Down	9000 cfm ± 10%	10.6.3, & 10.20
5.3.2.12 FRVS Vent Exhaust Flow Rate After Draw Down	$3324 + 5676e^{-1.18t}$	Actual Eqn in Ref. 10.19, page 24 is $3324 + 5637e^{-1.18t}$
5.3.2.13 FRVS Vent Exhaust Filter Efficiency		
	Table 7	
Iodine Species	**Efficiency (%)**	
Elemental	99%	10.6.2 & 10.10, Table 2
Aerosol	99%	10.6.1 & 10.10, Table 2
Organic	99%	10.6.2 & 10.10, Table 2
5.3.2.14 Post Draw Down FRVS Exhaust Rates For 50% Mixing (using Design Input 5.3.2.12)		
	Table 8	
Post-LOCA Time (hr)	**Normal Flow Rate (cfm)** $A = 3324 + 5676e^{-1.18t}$	**50% Mixing Flow Rate (cfm) A x 1.1 x 2**
0	9000	19800
0.1042 (375 sec)	8343	18355
0.3333	7154	15739
2	3860	8492
4	3375	7425
8	3324	7313
24	3324	7313
96	3324	7313
5.3.2.15 FRVS Recirc Flow Rate	120000 cfm - 10% (or, 108,000 cfm)	10.6.12 &10.20
5.3.2.16 FRVS Recirc Filter Efficiency		
	Table 9	
Iodine Species	**Efficiency (%)**	
Elemental	80%	10.6.11
Aerosol	99%	10.6.10
Organic	80%	10.6.11

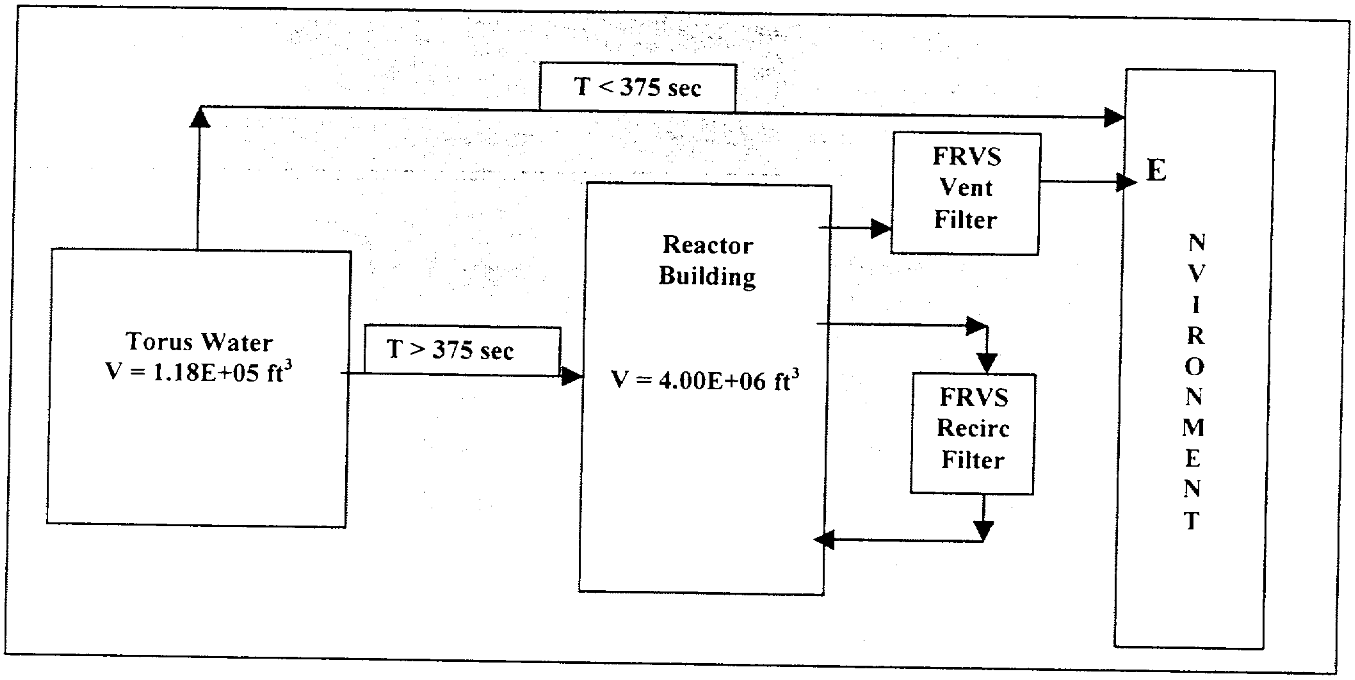


Figure 2: HCGS ESF Leakage RADTRAD Nodalization

Design Input Parameter	Value Assigned	Reference
5.4 ESF Leakage Model Parameters		
5.4.1 Sump Water Volume	118,000 ft^3	10.6.5 & 10.16
5.4.2 ESF Leakage	10 gpm	10.18, page 13
5.4.3 ESF Leakage Initiation Time	0 minute	Assumption
5.4.4 Suppression Pool Water pH	>7	10.1, RGP A.2, 10.43, page 11
5.4.5 Sump Water Activity (Ref. 10.1, RGP A.5.1, A.5.3 & Tables 1 & 4)		
	Table 10	
Group	Gap Release Phase	Early In-Vessel Release Phase
Timing Duration (Hrs)	2 min – 0.50 Hr	0.50 – 2.0 Hr
Halogen	0.05	0.25
5.4.6 Iodine Flashing Factor	10%	10.1, RGP A.5.5 and 10.25, page 35 through 45
5.4.7 Chemical Form Iodine In ESF Leakage		
Elemental	97%	10.1, RGP A.5.6
Organic	3%	

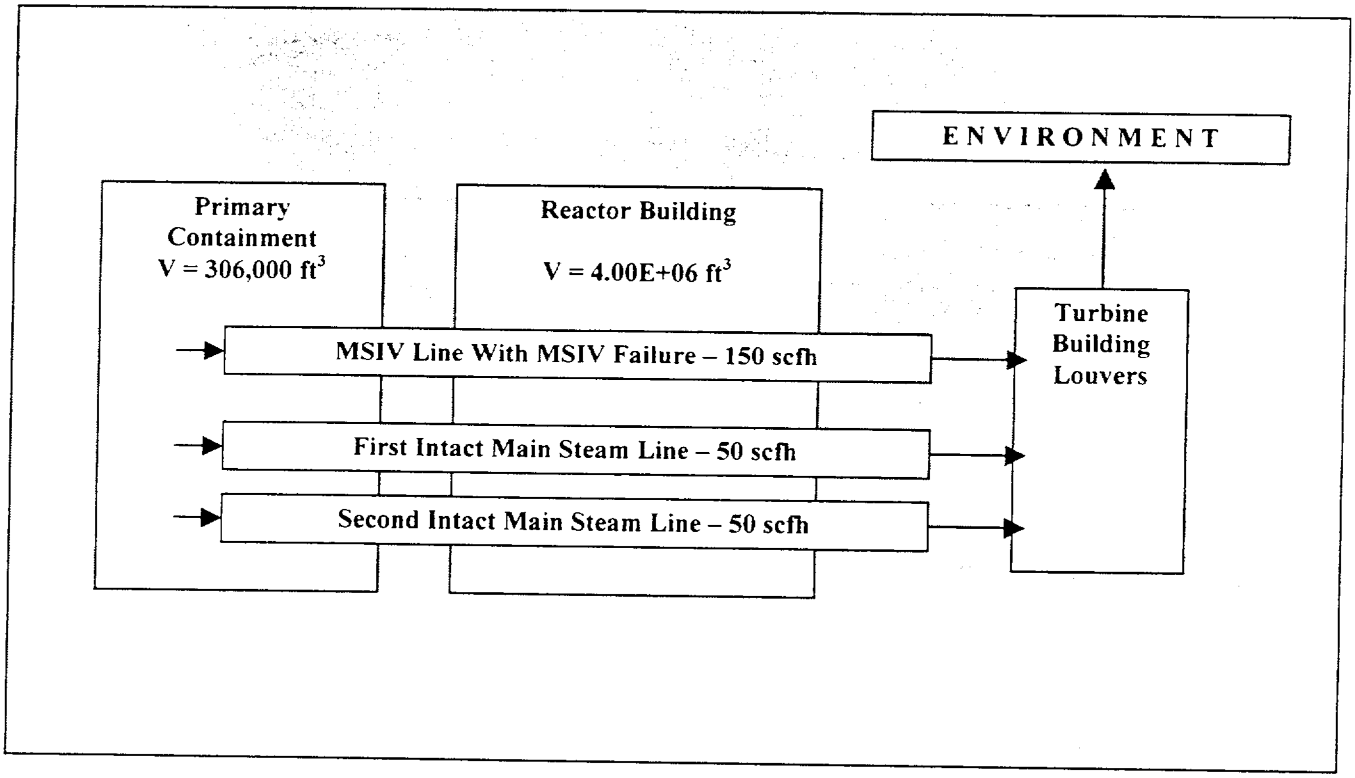


Figure 3: HCGS MSIV Leak RADTRAD Nodalization

Design Input Parameter	Value Assigned	Reference
5.5 MSIV Leakage Model Parameters		
5.5.1 Total MSIV Leak Rate Thru All Four Lines	≤ 250 scfh	Proposed Limit to TS 3.6.1.2.c
5.5.2 MSIV Leak Rate Through Line With MSIV Failed	150 scfh	Assumed
5.5.3 MSIV Leak Rate Through First Intact Line	50 scfh	Assumed
5.5.4 MSIV Leak Rate Through Second Intact Line	50 scfh	Assumed
5.5.5 Number of Steam Lines	4	10.11 & 10.12e
5.5.6 Diameter and Wall Thickness of Pipe Between RPV Nozzle & Inboard Isolation Valves HV F022A/B/C/D	Diameter = 26" Wall Thickness = 1.117"	10.13b 10.14c

Design Input Parameter	Value Assigned	Reference
5.5.7 Diameter and Wall Thickness of Pipe Between Inboard & Outboard Isolation Valves HV F028A/B/C/D	Diameter = 26" Wall Thickness = 1.117"	10.12e 10.14c
5.5.8 Diameter and Wall Thickness of Pipe Between Outboard & 3rd Isolation Valves HV 3631A/B/C/D	Diameter = 26" Wall Thickness = 1.023	10.12e 10.14a
5.5.9 Diameter of Pipe Between 3rd Isolation & Turbine Stop Valves MSV1/2/3/4	Diameter = 28" Wall Thickness = 0.934"	10.12a 10.14b
5.5.10 Corrosion Allowance For Steam	0.12"	10.14

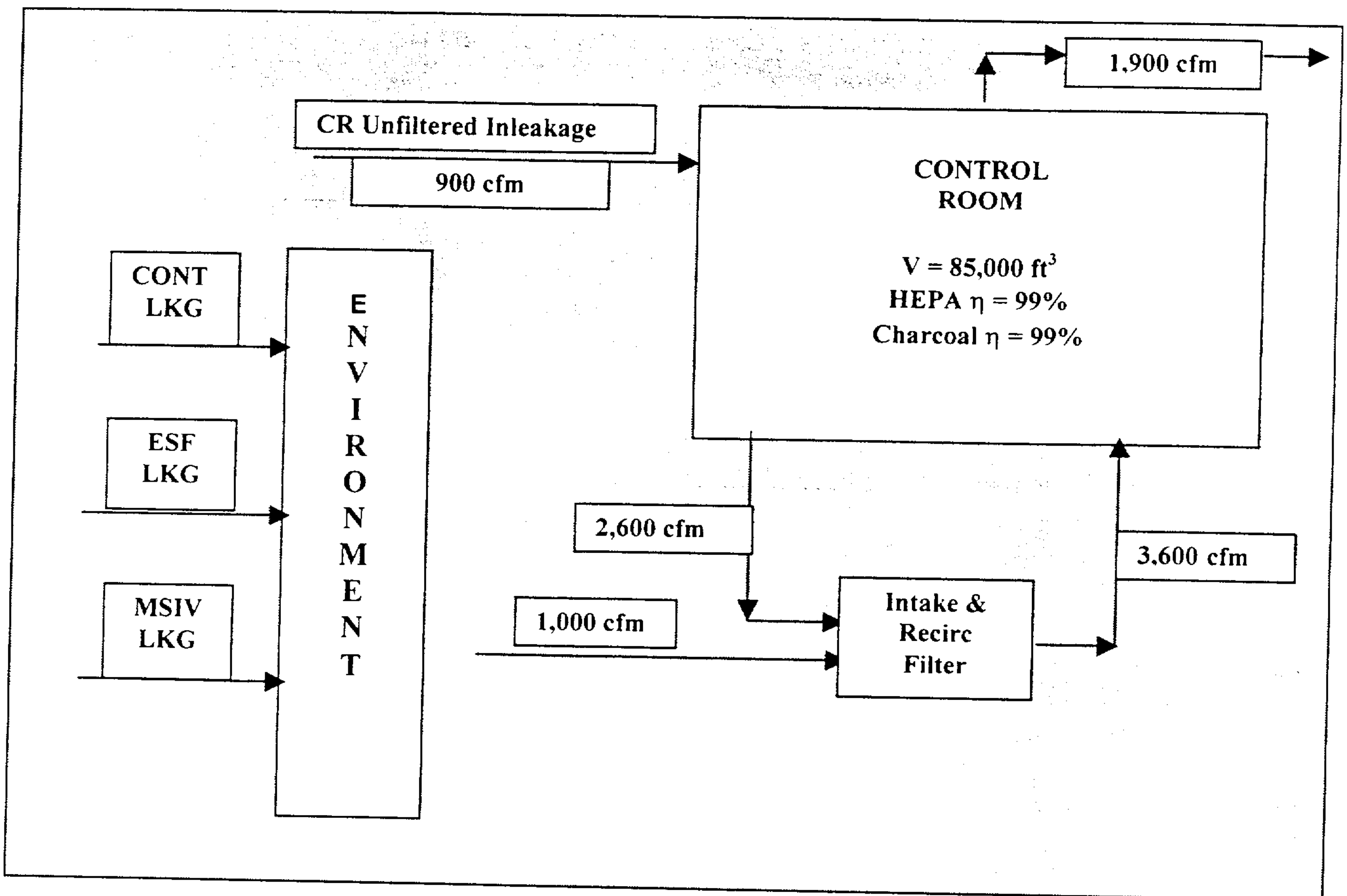


Figure 4 – HCGS Control Room RADTRAD Nodalization

Design Input Parameter	Value Assigned	Reference
5.6 Control Room Model Parameters		
5.6.1 CR Volume	85,000 ft^3	10.33, Page 10
5.6.2 CREF System Flow Rate	1,000 cfm	10.6.16
5.6.3 CR Minimum Recir Flow Rate	2,600 cfm	10.6.15
5.6.4 CR Unfiltered Inleakage	900 cfm	Assumed
5.6.5 CREV System Initiation Time After a LOCA	30 minutes	Assumption 4.8.5
5.6.6 CR Charcoal & HEPA Filter Efficiencies	99%	10.6.13 & 10.6.14

CALC. NO.: H-1-ZZ-MDC-1880		REFERENCE:				
ORIGINATOR, DATE	REV:	G. Patel, 08/01/01	0			
REVIEWER/VERIFIER, DATE		J. Duffy, 08/02/01				

Design Input Parameter	Value Assigned	Reference
5.6.7 CR Unfiltered Inleakage During Pressurization	500 cfm	10.40, page 6.4-8 & Assumption 4.8.6
5.6.8 CR Concrete Wall, Floor, and Ceiling Thickness		
Walls	>3 feet	10.27 through 10.31
Floor	>3 feet	
Total Roof Thickness	2'-10-1/2"	
Ceiling Above CR	1'-0"	10.29a & 10.29b
5.6.9 CR χ/Qs For Containment & ESF Leakage Release Via FRVS Vent Ground Level Release		
Table 11		
Time	**X/Q (sec/m^3)**	
0-2	1.25E-03	10.5, page 34
2-8	8.09E-04	
8-24	3.04E-04	
24-96	2.10E-04	
96-720	1.59E-04	
5.6.10 CR X/Qs For MSIV Leakage Release Via Turbine Building Louvers Ground Level Release		
Table 12		
Time	**X/Q (sec/m^3)**	
0-2	6.17E-04	10.5, page 35
2-8	4.00E-04	
8-24	1.44E-04	
24-96	1.00E-04	
96-720	7.49E-05	
5.6.11 CR Occupancy Factors		
Table 13		
Time (Hr)	%	
0-24	100	10.1, RGP 4.2.6
24-96	60	
96-720	40	

2 (revision marks in right margin)

Design Input Parameter	Value Assigned	Reference
5.6.12 CR Breathing Rate	3.5E-04 (m^3/sec)	10.1, RGP 4.2.6
5.6.13 Minimum Reactor Bldg Wall Thickness	1'-6"	10.35
5.7 Site Boundary Release Model Parameters		
5.7.1 EAB X/Q (0-2 Hrs)	1.9E-04 sec/m^3	10.32, pages 5 & 9
5.7.2 LPZ X/Qs (0-720 Hrs)		

Table 14

Time	X/Q (sec/m^3)	
0-2	1.9E-05	10.32, pages 5 & 9
2-4	1.2E-05	
4-8	8.0E-6	
8-24	4.0E-06	
24-96	1.7E-06	
96-720	4.7E-07	

5.7.3 Offsite Breathing Rate

Table 15

Time	(m^3/sec)	
0-8	3.5E-04	10.1, RGPs 4.1.3 & 4.4
8-24	1.8E-04	
24-720	2.3E-04	

5.7.4 CR Charcoal Filter Dimensions Approximated Conservatively		
5.7.4.1 Length	3 feet	10.38
5.7.4.2 Height	3 feet	
5.7.4.3 Width	4 feet	
5.7.5 Charcoal Density	0.70 g/cc	Assumed
5.7.6 Concrete Density	2.3 g/cc	Assumed
5.7.7 Dose Point Location	143'-0"	6' above EL 137'-0"

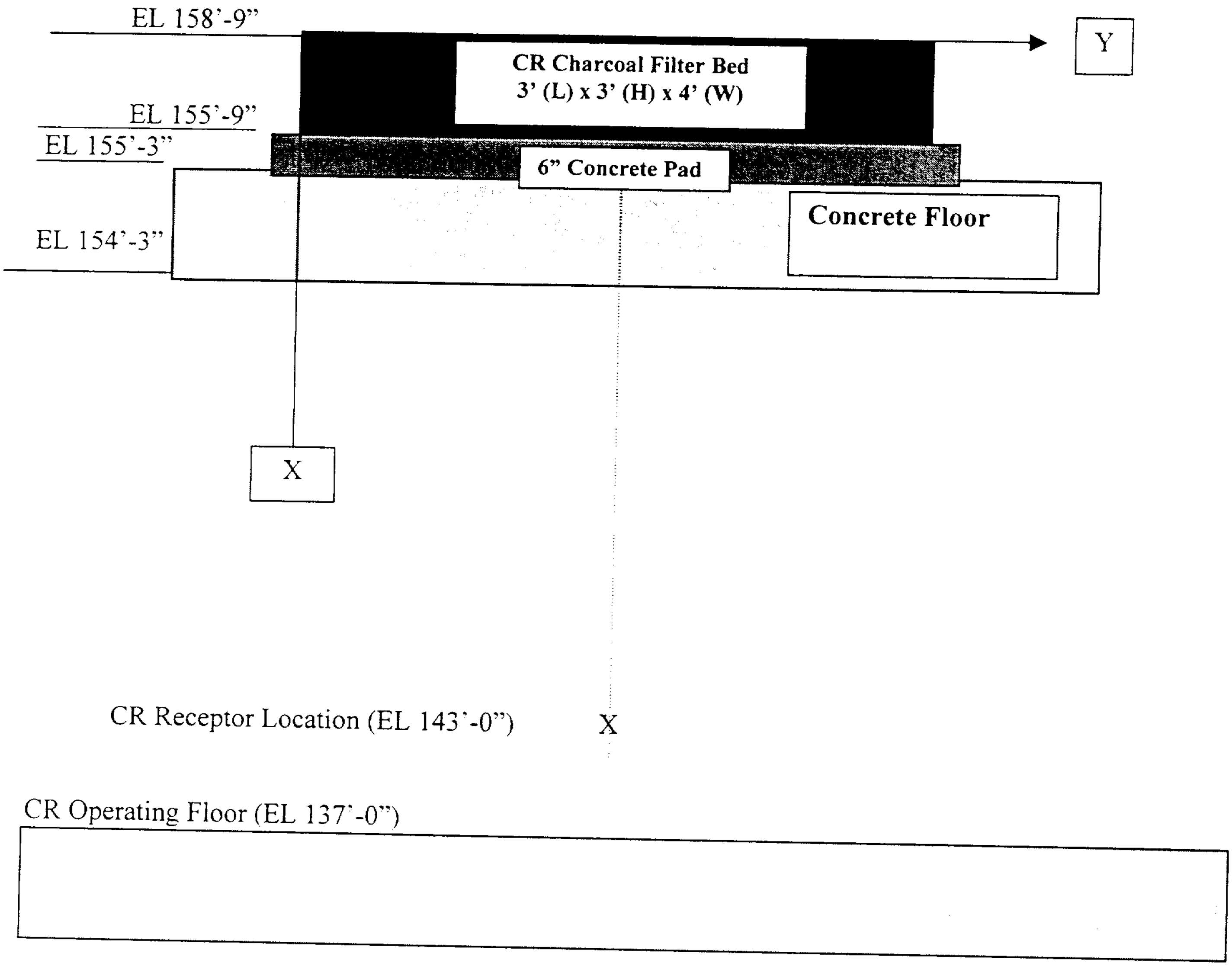
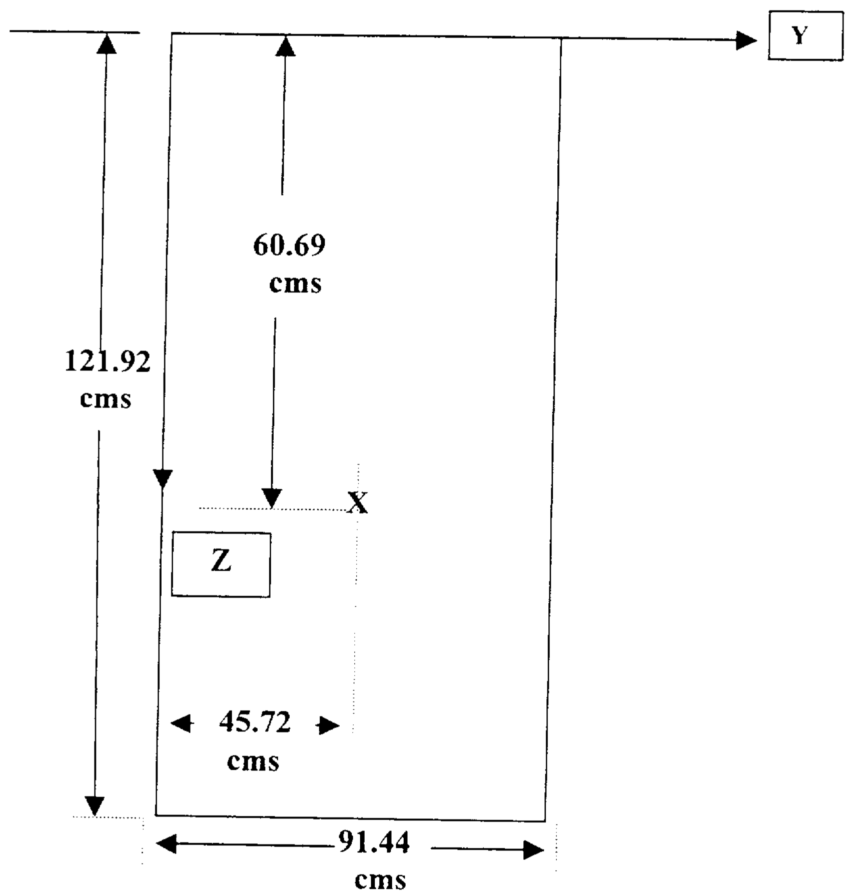


Figure 5 – CR Filter Shine Dose
(Elevation View)



X Indicates Dose Point Location

Figure 6 – CR Filter Shine Dose
(Plan View)

6.0 METHODOLOGY

The design basis accidents postulated were analyzed using a conservative set of assumptions and as-built design inputs to demonstrate the performance of one or more aspects of the facility design to protect the control room operator and the health and safety of the general public. The guidance in the Regulatory Guide 1.183 (Ref. 10.1) is followed line by line along with the plant-specific design input parameters computable for the AST and TEDE dose criteria. The numeric values of the post-accident performance of ESF components are conservatively selected to assure an appropriate and prudent safety margin against unpredicted events in the course of an accident and compensate for large uncertainties in facility parameters, accident progression, radioactive material transport, and atmospheric dispersion. Any deviations from the methodology of Regulatory Guide 1.183 were only performed for plant specific situations if an adequate justification/bases exist.

6.1 Post-LOCA Containment Leakage:

6.1.1 Source Term:

The post-LOCA containment leakage model is shown in Figure 1. The core inventory listed in the Table 1 above is released into the containment at the release timing and fractions shown in Tables 3 & 4 (Ref. 10.1, RGPs 3.2 & 3.3). Since the post-LOCA minimum suppression chamber water pH is calculated at a value greater than 7.0 (Ref. 10.43), the chemical form of radioiodine released into the containment is assumed to be 95% cesium iodide (CsI), 4.85 percent elemental iodine, and 0.15 percent organic iodide as shown in Table 5. With the exception of elemental and organic iodine and noble gases, the remaining fission products are assumed to be in particulate form (Ref 10.1, RGP 3.5). The RADTRAD plant-specific Nuclide Inventory File (NIF) is shown in Table 16. The isotopic Ci/MW_t is calculated in Table 16 and the RADTRAD NIF HCGSMHA_DEFis shown in Attachment A and used for the containment, ESF, and MSIV leakage paths. The source term design inputs are shown in Sections 5.3.1.1 through 5.3.1.8. 1

6.1.2 Transport In Primary Containment:

The radioactivity released from the fuel is assumed to mix instantaneously and homogeneously throughout the free air volume of the primary containment as it is released. The radioactivity release into the containment is assumed to terminate at the end of the early in-vessel phase, which occurs at the end of 2 hrs after the onset of a LOCA (see Table 4). The design inputs for the transport in the primary containment are shown in Sections 5.3.2.1 through 5.3.2.9.

6.1.3 Reduction In Airborne Activity Inside Containment

The airborne iodine and aerosol are removed from the reactor building environment by the FRVS recirculation system, which re-circulates air at a design rate of 108,000 cfm or 1.62 vol/hr (108,000

ft^3/min x 60 min/hr x (4.00E+06 $ft^3)^{-1}$ = 1.62 vol/hr). Although, the FRVS recirc provides a good mixing of activity in the reactor building (RB), the airborne activity is conservatively assumed to mix with only 50% of the RB volume (Ref. 10.1, RGP A.4.4.). To simulate the 50% mixing in the RB, the exhaust rate of FRVS vent system is doubled as shown in Design Input 5.3.2.14. The FRVS vent exhaust rate varies with time as shown by the equation in Design Input 5.3.2.12. Table 8 provides the FRVS exhaust flow rates at 100% and 50% mixings. The airborne activity in the RB is removed by both the FRVS recirculation and FRVS vent filtration system before it released to environment. The charcoal and HEPA filtration efficiencies are shown in Section 5.3.2.16.

6.1.4 Dual Containment:

Leakage from the primary containment is assumed to be released directly to the environment prior to draw down time during which the RB does not maintain a negative pressure as defined in technical specifications (Ref 10.1, RGP A.4.2). 50% mixing is credited for dilution of the activity in the RB (Ref. 10.1, RGP A.4.4). The containment leakage RADTRAD input and output files are listed in the Attachments B and C and the EAB, LPZ, and CR TEDE doses are shown in the Section 8.0.

6.1.5 Containment Purging:

The HCGS containment is not purged for combustible gas or pressure control measure within 30 days of the LOCA. Therefore, the release containment purging is not analyzed per RG 1.183, RGP A.7.

6.2 Post-LOCA ESF Leakage:

The post-LOCA ESF leakage release model is shown in Figure 2. The ESF systems that recirculate suppression pool water outside of the primary containment are assumed to leak during their intended operation. This release source includes leakage through valve packing glands; pump shaft seals, flanged connections, and other similar components. The radiological consequences from the postulated leakage is analyzed and combined with consequences from other fission product release paths to determine the total calculated radiological consequences from the LOCA (see Section 8.0 of this calc). The ESF components are located in the RB.

6.2.1 Source Term:

With the exception of noble gases, all the fission products released from the fuel to the containment (as defined in Sections 5.3.1.3 & 5.3.1.5) are assumed to instantaneously and homogeneously mix in the suppression pool water at the time of release from the core. The total ESF leakage from all components in the ESF recirculation systems is 10 gpm. This ESF leakage is doubled (Ref 10.1, RGP A.5.2) and assumed to start at time t=0.0 minute after onset of a LOCA. With the exception of iodine, all remaining fission products in the recirculating liquid are assumed to be retained in the liquid phase. The design inputs for the ESF leakage are shown in Sections 5.4.1 through 5.4.6.

6.2.3 Chemical Form

The radioiodine that is postulated to be available for release to the environment is assumed to be 97% elemental and 3% organic (Ref. 10.1, RGP A.5.6) based on the Regulatory Position A.5.6. The reduction in ESF leakage activity by dilution in the RB and removal by FRVS recirc and FRVS vent filtration systems are credited.

The ESF leakage RADTRAD inputs and outputs files are listed in the Attachments D & F and the EAB, LPZ, and CR TEDE doses are shown in the Section 8.0.

6.3 Post-LOCA MSIV Leakage:

The main steam isolation valves (MSIVs) have design leakage that may result in a radioactivity release. The radiological consequences from postulated MSIV leakage are analyzed and combined with consequences postulated for other fission product release paths to determine the total calculated radiological consequences from the LOCA. The following assumptions are acceptable for evaluating the consequences of MSIV leakage.

6.3.1 Source Term

For the purpose of this analysis, the activity available for release via MSIV leakage is assumed to be that activity released in the drywell for evaluating containment leakage.

A total of 250 scfh (the maximum proposed allowable leakage limit) is assumed to occur as follows:

(1) 150 scfh through the steam line with the failed MSIV. The plate out of activity and holdup time are not credited in the steam line between the inboard and outboard valves. The plateout and holdup are credited in the steam lines from the RPV to inboard isolation valve, outboard isolation valve to turbine block valve, which is conservative. 2

(2) 50 scfh through a first intact steam line. The plate out of activity and holdup time are credits in the entire steam line from the RPV nozzle to turbine stop valve.

(3) 50 scfh through a second intact steam line. The plate out of activity and holdup time are credits in the entire steam line from the RPV nozzle to turbine stop valve.

The MSIV leakage is assumed to continue for entire duration of the accident. Per RG 1.183, RGP A.6.2 (Ref. 10.1), the MSIV leakage is to reduce to a value 50% of the maximum leak rate after the first 24 hours, based on the post-LOCA drywell pressure (Ref. 10.15).

Reduction of the amount of released aerosol radioactivity by gravitational deposition on the pipe surface is calculated in Section 7.4 using the NRC staff Monte Carlo analysis to determine the distribution of settling velocity in well mixed flow in the steam line (Ref 10.22). The analysis in Section 7.4.1 takes the credit of pipe surface areas upstream and down stream of inboard isolation valves because the steam lines from the RPV nozzle to turbine stop valve are seismically designed and supported for Safe Shutdown Earthquake (SSE) (Ref 10.26 & 10.37). The analysis in Section 7.4.1 determines that all airborne aerosol (100%) in MSIV leakage will be deposited on the steam pipe surface.

The reduction in elemental iodine activity in the MSIV leakage is calculated in Section 7.4.2 using the staff recommended guidance on acceptable method in Reference 10.23 (Reference A-9 of RG 1.183). Both, the temperature dependent elemental iodine deposition and resuspension rates, net iodine deposition rates, and iodine removal efficiencies are calculated in Tables 18 through 24 using J.E. Cline method (Ref 10.23). The remaining airborne activity in the MSIV leakage after removal by deposition (aerosol) and plateout (elemental) mechanisms is directly released to the environment as a ground level release through the turbine building louvers.

The holdup times for each MSIV leakage release path (MSIV failed and intact steam lines) are calculated in Sections 7.2 and 7.3 based on the leakage rates and well-mixed steam piping volumes. These parameters calculated in Sections 7.2, 7.3, & 7.4 are input in the RADTRAD MSIV release model to calculate EAB, LPZ, and CR doses, which are listed in Section 8.0. The design inputs for the MSIV leakage are shown in Sections 5.5.1 through 5.5.8.

6.4 Control Room Model

The post-LOCA control room RADTRAD nodalization is shown in Figure 4 with the design input parameters. The post-LOCA radioactive releases that contribute the CR TEDE dose are as follows:

- Post-LOCA Containment Leakage
- Post-LOCA ESF Leakage
- Post-LOCA MSIV Leakage

The radioactivity from the above sources are assumed to be released into the atmosphere and transported to the CR air intake, where it may leak into the CR envelope or be filtered by the CR intake and recirculation filtration system and distributed in the CR envelope. There are four major radioactive sources, which contribute to the CR TEDE dose are:

- Post-LOCA airborne activity inside the CR
- Post-LOCA airborne cloud external to CR
- Post-LOCA containment shine to CR
- Post-LOCA CREF filter shine

6.4.1 Post-LOCA Airborne Activity Inside CR

The post-LOCA radioactive releases from various sources are discussed in Sections 6.1 through 6.3 above and shown in Figure 4. The activities releases from the various sources are diluted by the atmospheric dispersions and carried to the CR air intake. The atmospheric dispersion factors are shown in Sections 5.6.9 & 5.6.10 for the containment/ESF and MSIV leakages. The containment and ESF leakages have the same release point (FRVS vent) and X/Qs. The RADTRAD release models are developed for each release path using appropriate design inputs from Sections 5.3, 5.4, and 5.5. The CR dose model is developed using the design input parameters in Sections 5.6.1 through 5.6.13. The CR airborne TEDE dose contributions from the above post-LOCA sources are calculated and tabulated in Section 8.0.

6.4.2 Post-LOCA Airborne Cloud External to CR

The radioactive plumes released from various post-LOCA sources are carried over the CR building, submerging the CR in the radioactive cloud. The CR operator is exposed to direct radiation from the radioactive cloud external to the CR structure. The review of control building concrete structure drawings (Ref. 10.27 through 10.31) indicate that the CR is surrounded by at least 2'-10-1/2" (1' ceiling @ EL 155'-3" and 1'-10-1/2" roof @ EL 172'0") concrete shielding with a minimum distance of 29 feet from the least shielding (172'-0" – (137'-0" + 6'-0" tall person)). This minimum-shielding configuration provides an adequate protection to the CR operator to reduce the CR operator external cloud dose to negligible amount.

6.4.3 Post-LOCA Containment Shine to CR

The post-LOCA airborne activity in the containment is released to reactor building via containment leakage through the penetrations and openings and gets uniformly distributed inside the RB. The airborne activity confined in the dome space of the RB contributes direct shine dose to CR operator. The review of the containment building concrete structure drawing (Ref. 10.35) indicates that the minimum dome concrete thickness is 1'-6". The CR minimum roof/ceiling concrete shielding is 2'-10-1/2". The combined concrete shielding of 4'-4-1/2" (1'-6" + 2'-10-1/2" = 4'-4-1/2") provides ample shielding to reduce the CR operator containment shine dose to an insignificant amount.

6.4.4 Post-LOCA CREF Filter Shine

The two trains of CREF charcoal and HEPA filters are located above the CR operating floor at elevation 155'-3" (Refs. 10.28, 10.29, & 10.39). The CR operating floor is located at elevation 137'-0" (Ref. 10.28c). The concrete floor at EL 155'-3" is 1 feet thick (Ref. 10.29). The filter assembly is placed on 6" concrete pad (Ref. 10.39c, Section DD), which provides the total concrete shielding of 1'-6" between the CR operator and charcoal/HEPA filter. The receptor location is assumed to be located at 6 feet above the CR operating floor right below the center of charcoal filter. The iodine and aerosol activities are conservatively collected on the charcoal bed. The dimensions of charcoal filter housing are obtained from Reference 10.38 and conservatively approximated to 3' (L) x 3' (H) x 4' (W) as shown in Figure 5 with dose point location.

Post-LOCA Activity

The RADTRAD3.02 code does not provide the post-LOCA iodine and aerosol activities accumulated on charcoal and HEPA filters. Therefore the iodine and aerosol activities are conservatively calculated as follows:

1. The time dependent isotopic iodine and aerosol integrated activities in the CR due to the post-LOCA containment leakage are calculated without taking the credits for charcoal and HEPA filters (RADTRAD File HAST1000CL03.psf). The time dependent integrated activities are shown in Table 26. 1

2. The time dependent isotopic iodine and aerosol integrated activities in the CR due to the post-LOCA containment leakage are calculated with the credit of charcoal and HEPA filters credit (RADTRAD File HAST1000CL02.psf). The time dependent integrated activities are shown in Table 25. 1

3. The total isotopic iodine and aerosol activities on the CR filters due to the containment leakage are calculated in Table 27 (Case 1 – Case 2).

4. Similarly, the time dependent isotopic iodine and aerosol integrated activities in the CR due to the post-LOCA MSIV and ESF leakages are calculated in Tables 28 – 29 and Tables 30 – 31 respectively.

5. The total iodine and aerosol integrated activities on the CR filters are shown in Table 32.

6. The total isotopic activities are input into the MicroShield Computer code (Ref. 10.9) with the source geometry, dimension, and detector location to compute the direct dose rate from the CR filter. The direct dose from the CR filter shine is calculated in Section 7.6 using the CR occupancy factors.

6.5 CR & FRVS Charcoal/HEPA Filter Efficiencies

The CR, FRVS vent, and FRVS recirculation charcoal and HEPA filters are tested to comply with Generic Letter 99-02 requirements (Refs. 10.3 & 10.6). The in-place penetration testing acceptance requirements are given in Hope Creek Technical Specifications (Ref. 10.6). The filter efficiencies credited in this analysis are calculated in Section 7.7 based on the testing criteria in Reference 10.6 and GL 99-02 (Ref. 10.3).

7.0 CALCULATIONS

7.1 HCGS Plant Specific Nuclide Inventory File (NIF) For RADTRAD3.02 Input

The RADTRAD nuclide inventory file Bwr_def_NIF establishes the power dependent radionuclide activity in Ci/MW_t for the reactor core source term. Since these core radionuclide activities are dependent on the core thermal power level, reload design, and burnup, the NIF is modified based on the plant-specific core information. The Ci/MW_t for the core radionuclides are calculated in Table 14 below and the NIF for RADTRAD input is modified accordingly as shown in Appendix A.

7.2 Main Steam Line Volumes & Surface Area For Plateout of Activity

7.2.1 MSIV Line Between RPV Nozzle & Inboard Isolation Valve

Piping Class = DLA (Ref. 10.13b)

Pipe Diameter = 26" (Ref. 10.13b)

Minimum Wall Thickness = 1.117" (Ref. 10.14c)

Corrosion Allowance For Steam = 0.12" (Ref. 10.14c)

Total Minimum Thickness = 1.117" + 0.12" = 1.237"

26" Pipe ID = OD – (2 x Min Wall Thickness) = 26" – 2 x 1.237" = 23.526" = 1.961'

Shortest Length of Pipe Between RPV Nozzle & Inboard Isolation Valves ≡ 91 ' (Ref. 10.13)

Length of Vertical Pipe = 170-1-1/2" (Ref. 10.13i) – 107'-0" (Ref. 10.12e) = 63.125'

Length of Horizontal Pipe = 91.0 – 63.125 = 27.875' 2

Volume of Pipe Between RPV Nozzle & Inboard Isolation Valves

$= \pi r^2 L = \pi (1.961/2)^2 \times 91' =$ **274.84 ft^3 = 7.79 m^3**

Projected Pipe Surface Area = D L = 1.961 x 27.875 = **54.66 ft^2 = 5.08 m^2** 2

7.2.2 MSIV Line Between Inboard & Outboard Isolation Valves

Piping Class = DLA (Ref. 10.13b)

Pipe Diameter = 26" (Ref. 10.13b)

Minimum Wall Thickness = 1.117" (Ref. 10.14c)

Corrosion Allowance For Steam = 0.12" (Ref. 10.14c)

Total Minimum Thickness = 1.117" + 0.12" = 1.237"

26" Pipe ID = OD – (2 x Min Wall Thickness) = 26" – 2 x 1.237" = 23.526" = 1.961'

Length of Pipe Between Inboard & Outboard Isolation Valves = 25.67' (Ref. 10.13)

Length of Vertical Pipe = 0.0' (Ref 10.11) 2

Volume of Pipe Between Inboard & Outboard Isolation Valves

$= \pi r^2 L = \pi (1.961/2)^2 \times 25.67 =$ **77.53 ft^3 = 2.2 m^3**

Projected Pipe Surface Area = D L = 1.961 x 25.67 = **50.34 ft^2 = 4.68 m^2** 2

7.2.3 MSIV Line Between Outboard & Third Isolation Valves

Piping Class = DBB (Ref. 10.11 & 10.12e)

Pipe Diameter = 26" (Ref. 10.12e)

Minimum Wall Thickness = 1.023" (Ref. 10.14a)

Corrosion Allowance For Steam = 0.12" (Ref. 10.14a)

Total Minimum Thickness = 1.023" + 0.12" = 1.143"

26" Pipe ID = OD – (2 x Min Wall Thickness) = 26" – 2 x 1.143" = 23.714" = 1.976'

Length of Pipe Between Outboard & Third Isolation Valves = 41.33' (Ref. 10.12e)

Length of Vertical Pipe = 19'-6-1/2" = 19.542' (Ref. 10.11 & 10.12e)

Length of Horizontal Pipe = 41.33 – 19.542 = 21.79' 2

Volume of Pipe Between Outboard & Third Isolation Valves

$= \pi r^2 L = \pi (1.976/2)^2 \times 41.33' =$ **126.74 ft^3 = 3.59 m^3**

Projected Pipe Surface Area = D L = 1.976 x 21.79 = **43.06 ft^2 = 4.00 m^2** 2

7.2.4 MSIV Line Between Third Isolation Valve and Turbine Stop Valve

Piping Class = DBC (Ref. 10.11 & 10.12a)

Pipe Diameter = 28" (Ref. 10.12a)

Minimum Wall Thickness = 0.934" (Ref. 10.14b)

Corrosion Allowance For Steam = 0.12" (Ref. 10.14b)

Total Minimum Thickness =0.934" + 0.12" = 1.054"

28" Pipe ID = OD – (2 x Min Wall Thickness) = 28" – 2 x 1.054" = 25.892" = 2.158'

Length of Pipe Between Third Isolation Valve & Turbine Stop Valve = 272.6' (Ref. 10.12a)

Length of Vertical Pipe = 0.0' (Ref. 10.11)

Length of Horizontal Pipe = 272.6' 2

Volume of Pipe Between Third Isolation Valve & Turbine Stop Valve

$= \pi r^2 L = \pi (2.158/2)^2 \times 272.6' =$ **997.05 ft³ = 28.26 m³**

Projected Pipe Surface Area = D L = 2.158 ft x 272.6 ft = **588.27 ft² = 54.68 m²** 2

7.2.5 <u>Surface Area & Volume of Failed MSIV Steam Line</u>

Total Volume of MSIV Leakage Path For MSIV Failed Steam Line

$= 274.84\ ft^3 + 126.74\ ft^3 + 997.05\ ft^3$

= **1,398.63 ft³ = 39.58 m³**

Total Projected Pipe Surface Area of MSIV Leakage Path For MSIV Failed Steam Line

$= 54.66\ ft^2 + 43.06\ ft^2 + 588.27\ ft^2$ 2

= **685.99 ft² = 63.76 m²**

7.2.6 <u>Surface Area & Volume of Intact Steam Lines</u> 2

Total Volume of MSIV Leakage Path For Intact Steam Lines

$= 274.84\ ft^3 + 77.53\ ft^3 + 126.74\ ft^3 + 997.05\ ft^3$

= **1,476.16 ft³ = 41.83 m³**

Total Projected Pipe Surface Area of MSIV Leakage Path For Intact Steam Lines

$= 54.66\ ft^2 + 50.34\ ft^2 + 43.06\ ft^2 + 588.27\ ft^2$ 2

= **736.33 ft² = 68.44 m²**

7.3 Holdup Times

MSIV Leak Rate of 250 scfh

Holdup Time for MSIV Leakage of 150 scfh for each of two MSIV Failed Line

$= 1{,}398.63\ ft^3 / 150\ ft^3/hr = 9.32$ hrs

Holdup Time for MSIV Leakage of 50 scfh/MSIV For MSIV Intact Lines

$= 1{,}476.16\ ft^3 / 50\ ft^3/hr = 29.52$ hrs

MSIV Leak Rate For MSIV Failed Line = 150 $ft^3/hr \times 1/60$ hr/min = 2.50 cfm

MSIV Leak Rate For MSIV Intact Lines = 50 $ft^3/hr \times 1/60$ hr/min = 0.8334 cfm

MSIV leakage rate is halved after 24 hours

7.4 Plateout of Activity in Main Steam Lines

7.4.1 Aerosol Deposition

Reference 10.37 indicates that the HCGS main steam piping from the reactor pressure vessel (RPV) nozzle to the turbine stop valve is seismically analyzed to assure the piping wall integrity during and after a seismic event (SSE). The Hope Creek turbine building is classified as Non-seismic, however, codes and criteria similar to those for Seismic Category I structure, were used for the structure design of the entire building (Ref. 10.26, Section 1.2). The turbine building was dynamically analyzed and design to accommodate an SSE event (Ref. 10.37, page 1-2) so that it does not collapse on, or interact with, adjacent seismic Cat I structures for SSE. 10 CFR Part 100 requires that the structures, systems, and components necessary to ensure the capability of mitigating the radiological consequences of an accident that could result in exposures comparable to the does guideline of Part 100 be designed to remain functional during and following a safe-shutdown earthquake. The main steam lines and housing structures are qualified to meet Part 100 requirements; therefore, the main steam lines are credited for the aerosol deposition and holdup for MSIV leakage path.

The Brockmann model for aerosol deposition (Ref. 10.2, Section 2.2.6.1) provides the following equation for deposition efficiency:

$$\eta_g = 1 - \exp(- U_g A_s / \pi Q)$$

Where
η_g = aerosol deposition efficiency
U_g = gravitational deposition velocity (m/s) = U_s = gravitational settling velocity (m/s)
A = settling area = projected pipe surface area (D x L) = m^2
D = diameter of pipe (m)
L = length of horizontal pipe
Q = pipe gas flow (m^3/s)

2

And $$U_s = \frac{\rho . d_e^2 . g. C_s}{18 . \mu . k}$$ (Ref. 10.22, Equation 5)

Where ρ = aerosol density
d_e = aerosol diameter
g = gravitational acceleration
C_s = Cunningham slip factor
μ = viscosity
k = shape factor

The values of aerosol density, diameter, and shape factor during a design basis LOCA have some uncertainty. Therefore, the staff performed a Monte Carlo analysis to determine the distribution of settling velocities in the main steam line during the in-vessel release phase. The results of Monte Carlo analysis for settling velocity in the main steam line is as follows:

Percentile	Settling Velocity (m/sec)	Removal Rate Constant (hr^{-1})
60th (average)	0.00148	11.43
50th (median)	0.00117	9.04
40th	0.00081	6.26
10th	0.00021	1.62

The 40 percentile settling velocity is selected to calculate the aerosol removal rate and efficiency using the Hope Creek plant specific piping parameters.

Settling velocity υ_s = 0.00081 m/sec = U_g
Settling area A = 63.76 m^2 (Section 7.5.2)
Q for failed MSIV line = 150 scfh = 150 ft^3/hr x $(3600 \text{ sec/hr})^{-1}$ x $(3.28 \text{ ft/m})^{-3}$ = 0.00118 m^3/sec

η_g **= 1 - exp (- 0.00081 m/s x 63.76 m^2 / π x 0.00118 m^3/s)**
= 1 – exp(-13.93) = 1 – (8.92E-07) = 0.999999 ≈ 1 or 100%

It means that all aerosols in the MSIV leakage will deposit on the large surface area of the main steam line. The aerosol being heavier in comparison to elemental iodine, it will get fixed on the surface. The settling velocity in the above analysis is a gravitational deposition velocity. Additional conservatisms include additional deposition by thermophoresis, diffusiophoresis, hydroscopicity, flow irregularities, and possible plugging of the leaking MSIV by aerosols.

7.4.2 Elemental Iodine

Gaseous iodine tends to deposit on the piping surface by chemical adsorption. The elemental iodine being the most reactive has the highest deposition rate. The iodine deposited on the surface undergoes both physical and chemical changes and can be re-emitted as an airborne gas (re-suspension) or permanently fixed to the surface (fixation). The RGP A.6.5 (Ref. 10.1) indicates that Reference A-9 provides acceptable models for deposition of iodine on the pipe surface. Reference 10.23, which is Reference A-9 of Regulatory Guide 1.183 is used to determine the deposition and resuspension rates of elemental iodine as follows:

d_i = elemental iodine vapor deposition velocity (cm/s) = $\mathbf{e}^{(2809/T - 12.80 (\pm 0.33))} = \mathbf{e}^{(2809/T - 12.5)}$ (Ref. 10.23, pages 4 & 12).

Where T = gas temperature (^{0}K)

This equation is same as equation 30 in Bixler Model in the RADTRAD3.02 code (Ref. 10.2, page 212).

The elemental iodine deposition velocities are calculated in Table 17 based the post-LOCA drywell temperature shown in Design Input 5.3.1.8.

The elemental iodine deposition rate λ_{ed} (hr^{-1}) $= \frac{d_i * S * 3600}{V}$ (Ref. 10.23, page 4)

Where d_i = deposition velocity (m/sec)
S = surface area of deposition (m^2)
V = volume (m^3)

The deposition velocity in cm/sec, which is converted into m/sec and elemental iodine deposition rates at various drywell temperatures are calculated in Tables 18 & 19 for the MSIV failed and intact steam lines respectively.

The portion of elemental iodine deposited on the pipe surface will be resuspended as an airborne gas (organic iodine). Since the CR filtration efficiencies are same for all iodine spices, the resuspension of elemental iodine will produce the same thyroid organ dose irrespective of the form of iodine.

Resuspension rate of elemental iodine (sec^{-1})

$$= \mathbf{2.32\ (\pm 2.00) \times 10^{-5}\ e^{-600/T} = 4.32 \times 10^{-5}\ e^{-600/T}}$$

Resuspension rate of elemental iodine λ_{er} (hr^{-1})

$$= \mathbf{4.32 \times 3600 \times 10^{-5}\ e^{-600/T}}$$

The resuspension rates of elemental iodine at various drywell temperatures are calculated in Table 20.

The net deposition of elemental iodine on the pipe surface is the difference of deposition rate and resuspension rate. The net elemental iodine deposition rates at various drywell temperatures are calculated in Tables 21 and 22.

Net Deposition Rate of Elemental Iodine $\lambda_e = \lambda_{ed} - \lambda_{er}$

$1/DF = 1 - \eta = \exp^{(-\lambda e * t)}$ (Ref 10.2, Equations 4 & 5, page 196)

Where DF = decontamination factor
η = filter efficiency for elemental iodine

λe = elemental iodine removal rate (hr^{-1})
t = time (hr)

Therefore, Elemental Iodine Filter Efficiency = $\mathbf{1 - e^{-(\lambda e * t)}}$

The values net elemental iodine deposition rates (λe) are obtained from Table 20 and the corresponding filter efficiencies at various drywell temperatures are calculated in Tables 23 & 24 for the MSIV failed and intact steam lines respectively. The conservative values are used for each time step in RADTRAD model rather than using average values for each time step.

The elemental iodine removal efficiencies at various drywell temperatures are used along with aerosol removal efficiency (Section 7.4.1) in the RADTRAD3.02 MSIV release model.

7.5 ESF Leak Rates

The design basis ESF leakage is 10 gpm, which is doubled and converted into cfm as follows:

10 gallon/min x 2 x 1/7.481 ft^3/gallon = 2.673 cfm

10% of ESF leakage becomes airborne = 0.10 x 2.673 = 0.2673 cfm

7.6 CR Direct Dose From Filter Shine

CR Filter Shine Dose Rate = 7.754E-03 mRem/hr

CR Operator Exposure Time = 1 x (24 hr) + 0.60 (96 hr – 24 hr) + 0.40 (720 hr – 96 hr)

= 24 hr + 0.60 (72 hr) + 0.40 (624 hr) = 316.8 hr

Total CR Dose From Filter Shine

= 7.754E-03 mRem/hr x 1/1000 Rem/mRem x 316.8 hr = 2.4565E-03 Rem

7.7 FRVS Vent & Recirc and CR Charcoal/HEPA Filters Efficiencies

HEPA Filter:

In-place penetration testing acceptance criteria for the safety related HEPA filters are as follows:

FRVS Vent HEPA Filter – in-laboratory testing penetration < 0.05% (Ref. 10.6.1)

FRVS Recirc HEPA Filter – in-laboratory testing penetration < 0.05% (Ref. 10.6.10)

CREF HEPA Filter – in-laboratory testing penetration < 0.05% (Ref. 10.6.13)

GL 99-02 (Ref 10.3) requires a safety factor of at least 2 should be used to determine the filter efficiencies to be credited in the design basis accident.

Testing penetration (%) = (100% - η)/safety factor = (100% - η)/2

Where η = HEPA filter efficiency to be credited in the analysis

$0.05\% = (100\% - \eta)/2$

$0.1\% = (100\% - \eta)$

$\eta = 100\% - 0.1\% = 99.9\%$

Conservatively, the HEPA filter efficiency of 99% is credited in the analysis

Charcoal Filter

In-place penetration testing acceptance criteria for the safety related Charcoal filters are as follows:

FRVS Vent Charcoal Filter – in-laboratory testing methyl iodide penetration < 2.5% (Ref. 10.6.2)

FRVS Recirc Charcoal Filter – in- laboratory testing methyl iodide penetration < 10% (Ref. 10.6.11)

CREF Recirc Charcoal Filter – in- laboratory testing methyl iodide penetration < 0.5% (Ref. 10.6.14)

Testing methyl iodide penetration (%) = $(100\% - \eta)$/safety factor = $(100\% - \eta)/2$

Where η = charcoal filter efficiency to be credited in the analysis

FRVS Recirc Charcoal Filter

$10\% = (100\% - \eta)/2$

$20\% = (100\% - \eta)$

$\eta = 100\% - 20\% = 80\%$

FRVS Vent Charcoal Filter

$2.5\% = (100\% - \eta)/2$

$5\% = (100\% - \eta)$

$\eta = 100\% - 5\% = 95\%$

Since the FRVS recirc and FRVS vent are in series (Ref. 41), the combined charcoal filter efficiency would be:

$\eta = [1 - (1 - 0.80)(1 - 0.95)] \times 100\% = [1 - (0.2 \times 0.05)] \times 100\% = [1 - 0.01] \times 100\% = 99\%$

CR Charcoal Filter

$0.5\% = (100\% - \eta)/2$

$1\% = (100\% - \eta)$

$\eta = 100\% - 1\% = 99\%$

Safety Grade Filter	Filter Efficiency Credited (%)		
	Aerosol	Elemental	Organic
FRVS Vent	99	99	99
FRVS Recirc	99	80	80
Control Room	99	99	99

Table 16
HCGS RADTRAD Nuclide Inventory File

Isotope	Core Activity (Ci) A	Core Thernal Power (MWt) B	Core Activity (Ci/MWt) A/B	Isotope	Core Activity (Ci) A	Core Thernal Power (MWt) B	Core Activity (Ci/MWt) A/B
CO-58*	5.287E+05	3458	.1529E+03	TE-131M	1.383E+07	3458	.3999E+04
CO-60*	6.328E+05	3458	.1830E+03	TE-132	1.333E+08	3458	.3855E+05
KR-85	1.157E+06	3458	.3346E+03	I-131	9.406E+07	3458	.2720E+05
KR-85M	2.788E+07	3458	.8063E+04	I-132	1.356E+08	3458	.3920E+05
KR-87	5.454E+07	3458	.1577E+05	I-133	1.917E+08	3458	.5543E+05
KR-88	7.691E+07	3458	.2224E+05	I-134	2.122E+08	3458	.6136E+05
RB-86	1.743E+05	3458	.5040E+02	I-135	1.792E+08	3458	.5181E+05
SR-89	9.386E+07	3458	.2714E+05	XE-133	1.869E+08	3458	.5406E+05
SR-90	9.213E+06	3458	.2664E+04	XE-135	5.420E+07	3458	.1567E+05
SR-91	1.274E+08	3458	.3684E+05	CS-134	1.869E+07	3458	.5406E+04
SR-92	1.352E+08	3458	.3910E+05	CS-136	5.122E+06	3458	.1481E+04
Y-90	9.555E+06	3458	.2763E+04	CS-137	1.363E+07	3458	.3943E+04
Y-91	1.184E+08	3458	.3423E+05	BA-139	1.745E+08	3458	.5046E+05
Y-92	1.357E+08	3458	.3924E+05	BA-140	1.677E+08	3458	.4850E+05
Y-93	1.533E+08	3458	.4433E+05	LA-140	1.728E+08	3458	.4998E+05
ZR-95	1.566E+08	3458	.4528E+05	LA-141	1.594E+08	3458	.4611E+05
ZR-97	1.599E+08	3458	.4623E+05	LA-142	1.554E+08	3458	.4493E+05
NB-95	1.561E+08	3458	.4515E+05	CE-141	1.573E+08	3458	.4549E+05
MO-99	1.739E+08	3458	.5028E+05	CE-143	1.513E+08	3458	.4374E+05
TC-99M	1.522E+08	3458	.4402E+05	CE-144	1.178E+08	3458	.3408E+05
RU-103	1.503E+08	3458	.4345E+05	PR-143	1.456E+08	3458	.4210E+05
RU-105	1.071E+08	3458	.3098E+05	ND-147	6.294E+07	3458	.1820E+05
RU-106	6.074E+07	3458	.1757E+05	NP-239	2.050E+09	3458	.5928E+06
RH-105	9.970E+07	3458	.2883E+05	PU-238	3.658E+05	3458	.1058E+03
SB-127	1.034E+07	3458	.2989E+04	PU-239	3.890E+04	3458	.1125E+02
SB-129	3.080E+07	3458	.8908E+04	PU-240	4.995E+04	3458	.1444E+02
TE-127	1.024E+07	3458	.2961E+04	PU-241	1.774E+07	3458	.5129E+04
TE-127M	1.359E+06	3458	.3930E+03	AM-241	2.455E+04	3458	.7099E+01
TE-129	3.030E+07	3458	.8764E+04	CM-242	7.032E+06	3458	.2034E+04
TE-129M	4.517E+06	3458	.1306E+04	CM-244	5.764E+05	3458	.1667E+03

* CO-58 & CO-60 activities are obtained from RADTRAD User's Manual, Table 1.4.3.2-3 (Ref. 10.2)

Table 17

Elemental Iodine Deposition Velocity - MSIV Leakage

Time	Temp Degree* F	Temp Degree K	(2809/T) -12.5	Deposition Velocity cm/sec	Deposition Velocity m/sec
0	340	444.26	-6.18	0.002076	2.076E-05
3	320	433.15	-6.01	0.002442	2.442E-05
6	250	394.26	-5.38	0.004630	4.630E-05
24	208	370.93	-4.93	0.007248	7.248E-05
96	180	355.37	-4.60	0.010096	1.010E-04
240	170	349.82	-4.47	0.011446	1.145E-04
480	150	338.71	-4.21	0.014896	1.490E-04
720					

* From Design Input 5.3.1.8, Table 6

Table 18

Elemental Iodine Deposition Rate - MSIV Failed Line

Time Hr	Deposition Velocity m/sec A	Main Steam Line Total Surface Area (m^2) B	Main Steam Line Total Volume (m^3) C	Elemental Iodine Removal Rate (hr^{-1}) (AxB)x3600/C
0	2.076E-05	247.77	39.58	0.4679
3	2.442E-05	247.77	39.58	0.5503
6	4.630E-05	247.77	39.58	1.0433
24	7.248E-05	247.77	39.58	1.6333
96	1.010E-04	247.77	39.58	2.2752
240	1.145E-04	247.77	39.58	2.5796
480	1.490E-04	247.77	39.58	3.3570
720				

A From Table 17

B & C From Section 7.2.5

Table 19

Elemental Iodine Deposition Rate - MSIV Intact Lines

Time	Deposition Velocity	Main Steam Line		Elemental Iodine Removal Rate
		Total Surface Area	Total Volume	
Hr	m/sec	(m^2)	(m^3)	(hr^{-1})
	A*	B	C	(AxB)x3600/C
0	2.076E-05	262.46	41.83	0.4690
3	2.442E-05	262.46	41.83	0.5516
6	4.630E-05	262.46	41.83	1.0457
24	7.248E-05	262.46	41.83	1.6371
96	1.010E-04	262.46	41.83	2.2805
240	1.145E-04	262.46	41.83	2.5855
480	1.490E-04	262.46	41.83	3.3647
720				

A From Table 17

B & C From Section 7.2.6

Table 20

Elemental Iodine Resuspension Rate - MSIV Leakage

Post-LOCA Time (hr)	**Temp Degree F**	**Temp Degree K**	**-600/T**	**Resuspension Rate (hr^{-1})**
0	340	444.26	-1.35	0.0403
3	320	433.15	-1.39	0.0389
6	250	394.26	-1.52	0.0340
24	208	370.93	-1.62	0.0309
96	180	355.37	-1.69	0.0287
240	170	349.82	-1.72	0.0280
480	150	338.71	-1.77	0.0265
720				

Resuspension Rate $(sec)^{-1}$ = $2.32\ (2.00) \times 10^{-5}\ e^{-600/T} = 4.32 \times 10^{-5}\ e^{-600/T}$

Resuspension Rate $(hr)^{-1}$ = $4.32 \times 3600 \times 10^{-5}\ e^{-600/T}$

Table 21

Net Elemental Iodine Removal Rate - MSIV Failed Line

Post-LOCA Time (hr)	Temp Degree F	Iodine Removal Rate A (hr-1)	Iodine Resuspension Rate B (hr-1)	Net Iodine Removal Rate λ_f = A - B (hr-1)
0	340	0.4679	0.0403	0.4276
3	320	0.5503	0.0389	0.5114
6	250	1.0433	0.0340	1.0094
24	208	1.6333	0.0309	1.6024
96	180	2.2752	0.0287	2.2465
240	170	2.5796	0.0280	2.5516
480	150	3.3570	0.0265	3.3305
720				

A From Table 18
B From Table 20

Table 22

Net Elemental Iodine Removal Rate - Intact Lines

Post-LOCA Time (hr)	Temp Degree F	Iodine Removal Rate A (hr-1)	Iodine Resuspension Rate B (hr-1)	Net Iodine Removal Rate $\lambda_i = A - B$ (hr-1)
0	340	0.4690	0.0403	0.4287
3	320	0.5516	0.0389	0.5127
6	250	1.0457	0.0340	1.0118
24	208	1.6371	0.0309	1.6062
96	180	2.2805	0.0287	2.2518
240	170	2.5855	0.0280	2.5575
480	150	3.3647	0.0265	3.3383
720				

A From Table 19
B From Table 20

Table 23

Elemental Iodine Removal Efficiency - MSIV Failed Line

Post-LOCA Time (hr)	Temp Degree F	Net Iodine Removal Rate λ_f (hr-1)	Elemental Iodine Removal Efficiency B (%)
0	340	0.4276	34.79
3	320	0.5114	40.03
6	250	1.0094	63.56
24	208	1.6024	79.86
96	180	2.2465	89.42
240	170	2.5516	92.20
480	150	3.3305	96.42
720			

λ_f From Table 21

$B = 1-e^{-\lambda_f}$

Table 24

Elemental Iodine Removal Efficiency - Intact Lines

Post-LOCA Time (hr)	Temp Degree F	Net Iodine Removal Rate λ_i (hr-1)	Elemental Iodine Removal Efficiency B (%)
0	340	0.4287	34.87
3	320	0.5127	40.11
6	250	1.0118	63.64
24	208	1.6062	79.94
96	180	2.2518	89.48
240	170	2.5575	92.25
480	150	3.3383	96.45
720			

A From Table 22
$B = 1-e^{-\lambda_i}$

Table 25

Post-LOCA Containment Leakage Activity in CR With Charcoal/HEPA Filters

(Ci)

Isotope	0-0.33	0.33-0.5	0.5-2	2-4	4-8	8-24	24-96	96-720	Total
Co-58	0.00E+00	0.00E+00	2.94E-08	7.97E-09	3.00E-10	0.00E+00	0.00E+00	0.00E+00	3.76E-08
Co-60	0.00E+00	0.00E+00	3.52E-08	9.55E-09	3.61E-10	5.75E-14	0.00E+00	0.00E+00	4.51E-08
Kr-85	3.31E-05	4.77E-05	1.21E-02	2.31E-02	4.82E-02	3.67E-02	1.43E-02	9.79E-03	1.44E-01
Kr-85m	1.14E-03	1.61E-03	3.23E-01	4.52E-01	5.08E-01	3.25E-02	1.84E-07	0.00E+00	1.32E+00
Kr-87	1.83E-03	2.40E-03	2.69E-01	1.73E-01	4.07E-02	5.05E-06	0.00E+00	0.00E+00	4.87E-01
Kr-88	2.73E-03	3.77E-03	6.63E-01	7.77E-01	6.10E-01	9.35E-03	0.00E+00	0.00E+00	2.07E+00
Rb-86	1.48E-06	1.40E-06	3.08E-07	6.99E-08	2.60E-09	0.00E+00	0.00E+00	0.00E+00	3.26E-06
Sr-89	0.00E+00	0.00E+00	4.26E-05	1.16E-05	4.35E-07	6.88E-11	5.94E-12	2.69E-12	5.46E-05
Sr-90	0.00E+00	0.00E+00	3.02E-06	8.20E-07	3.09E-08	4.94E-12	4.44E-13	2.87E-13	3.87E-06
Sr-91	0.00E+00	0.00E+00	4.79E-05	1.12E-05	3.17E-07	0.00E+00	0.00E+00	0.00E+00	5.95E-05
Sr-92	0.00E+00	0.00E+00	3.47E-05	5.65E-06	7.67E-08	0.00E+00	0.00E+00	0.00E+00	4.04E-05
Y-90	0.00E+00	0.00E+00	3.16E-08	8.41E-09	3.04E-10	0.00E+00	0.00E+00	0.00E+00	4.03E-08
Y-91	0.00E+00	0.00E+00	5.20E-07	1.41E-07	5.32E-09	8.42E-13	0.00E+00	0.00E+00	6.67E-07
Y-92	0.00E+00	0.00E+00	3.93E-07	7.21E-08	1.24E-09	0.00E+00	0.00E+00	0.00E+00	4.66E-07
Y-93	0.00E+00	0.00E+00	5.76E-07	1.36E-07	3.91E-09	0.00E+00	0.00E+00	0.00E+00	7.17E-07
Zr-95	0.00E+00	0.00E+00	6.85E-07	1.86E-07	7.00E-09	1.11E-12	0.00E+00	0.00E+00	8.78E-07
Zr-97	0.00E+00	0.00E+00	6.50E-07	1.63E-07	5.21E-09	0.00E+00	0.00E+00	0.00E+00	8.18E-07
Nb-95	0.00E+00	0.00E+00	6.47E-07	1.76E-07	6.60E-09	1.04E-12	0.00E+00	0.00E+00	8.29E-07
Mo-99	0.00E+00	0.00E+00	9.15E-06	2.43E-06	8.81E-08	1.19E-11	0.00E+00	0.00E+00	1.17E-05
Tc-99m	0.00E+00	0.00E+00	6.41E-06	1.38E-06	3.29E-08	0.00E+00	0.00E+00	0.00E+00	7.82E-06
Ru-103	0.00E+00	0.00E+00	7.09E-06	1.92E-06	7.23E-08	1.14E-11	9.72E-13	0.00E+00	9.08E-06
Ru-105	0.00E+00	0.00E+00	3.46E-06	6.87E-07	1.39E-08	0.00E+00	0.00E+00	0.00E+00	4.16E-06
Ru-106	0.00E+00	0.00E+00	1.93E-06	5.23E-07	1.97E-08	3.14E-12	2.81E-13	1.74E-13	2.47E-06
Rh-105	0.00E+00	0.00E+00	3.39E-06	8.86E-07	3.09E-08	0.00E+00	0.00E+00	0.00E+00	4.31E-06
Sb-127	0.00E+00	0.00E+00	8.80E-06	2.36E-06	8.63E-08	1.22E-11	1.22E-11	0.00E+00	1.12E-05
Sb-129	0.00E+00	0.00E+00	2.25E-05	4.43E-06	8.81E-08	0.00E+00	0.00E+00	0.00E+00	2.70E-05
Te-127	0.00E+00	0.00E+00	7.46E-06	1.75E-06	4.90E-08	0.00E+00	0.00E+00	0.00E+00	9.25E-06
Te-127m	0.00E+00	0.00E+00	1.16E-06	3.16E-07	1.19E-08	1.89E-12	2.10E-13	0.00E+00	1.49E-06
Te-129	0.00E+00	0.00E+00	8.81E-06	7.24E-07	2.50E-09	0.00E+00	0.00E+00	0.00E+00	9.54E-06
Te-129m	0.00E+00	0.00E+00	7.64E-06	2.07E-06	7.79E-08	1.23E-11	1.04E-12	0.00E+00	9.79E-06

Table 25 (Cont'd)

Post-LOCA Containment Leakage Activity in CR With Charcoal/HEPA Filters (Ci)									
Isotope	0-0.333	0.33-0.5	0.5-2	2-4	4-8	8-24	24-96	96-720	Total
Te-131m	0.00E+00	0.00E+00	1.40E-05	3.64E-06	1.25E-07	0.00E+00	0.00E+00	0.00E+00	1.78E-05
Te-132	0.00E+00	0.00E+00	1.41E-04	3.76E-05	1.37E-06	1.90E-10	9.02E-12	0.00E+00	1.80E-04
I-131	2.72E-03	2.58E-03	6.72E-04	1.75E-04	3.15E-05	9.83E-06	2.69E-06	1.97E-07	6.19E-03
I-132	3.62E-03	3.26E-03	5.45E-04	7.83E-05	4.27E-06	1.14E-08	0.00E+00	0.00E+00	7.51E-03
I-133	5.65E-03	5.33E-03	1.33E-03	3.27E-04	5.21E-05	1.01E-05	3.25E-07	0.00E+00	1.27E-02
I-134	4.81E-03	3.99E-03	3.20E-04	1.73E-05	1.33E-07	0.00E+00	0.00E+00	0.00E+00	9.14E-03
I-135	5.20E-03	4.84E-03	1.08E-03	2.31E-04	2.77E-05	1.71E-06	3.18E-10	0.00E+00	1.14E-02
Xe-133	7.16E-03	1.03E-02	2.59E+00	4.89E+00	9.98E+00	6.96E+00	1.82E+00	4.04E-02	2.63E+01
Xe-135	1.66E-03	2.36E-03	5.35E-01	8.76E-01	1.35E+00	3.03E-01	4.86E-04	0.00E+00	3.06E+00
Cs-134	4.46E-04	4.23E-04	9.33E-05	2.12E-05	7.92E-07	1.26E-10	1.13E-11	7.16E-12	9.84E-04
Cs-136	1.20E-04	1.13E-04	2.49E-05	5.64E-06	2.09E-07	3.21E-11	2.47E-12	0.00E+00	2.64E-04
Cs-137	2.67E-04	2.53E-04	5.58E-05	1.27E-05	4.74E-07	7.56E-11	6.80E-12	4.40E-12	5.89E-04
Ba-139	0.00E+00	0.00E+00	2.81E-05	2.79E-06	1.41E-08	0.00E+00	0.00E+00	0.00E+00	3.09E-05
Ba-140	0.00E+00	0.00E+00	7.54E-05	2.04E-05	7.63E-07	1.17E-10	8.96E-12	1.78E-12	9.66E-05
La-140	0.00E+00	0.00E+00	7.47E-07	1.96E-07	6.91E-09	0.00E+00	0.00E+00	0.00E+00	9.50E-07
La-141	0.00E+00	0.00E+00	5.02E-07	9.58E-08	1.79E-09	0.00E+00	0.00E+00	0.00E+00	5.99E-07
La-142	0.00E+00	0.00E+00	2.79E-07	3.09E-08	1.75E-08	0.00E+00	0.00E+00	0.00E+00	3.28E-07
Ce-141	0.00E+00	0.00E+00	1.72E-06	4.65E-07	1.75E-08	2.75E-12	1.62E-13	0.00E+00	2.20E-06
Ce-143	0.00E+00	0.00E+00	1.61E-06	4.18E-07	1.45E-08	0.00E+00	0.00E+00	0.00E+00	2.04E-06
Ce-144	0.00E+00	0.00E+00	1.12E-06	3.03E-07	1.14E-08	1.82E-12	2.04E-13	9.88E-14	1.43E-06
Pr-143	0.00E+00	0.00E+00	6.53E-07	1.77E-07	6.61E-09	0.00E+00	0.00E+00	0.00E+00	8.36E-07
Nd-147	0.00E+00	0.00E+00	2.91E-07	7.87E-08	2.94E-09	0.00E+00	0.00E+00	0.00E+00	3.73E-07
Np-239	0.00E+00	0.00E+00	2.13E-05	5.64E-06	2.03E-07	2.66E-11	0.00E+00	0.00E+00	2.71E-05
Pu-238	0.00E+00	0.00E+00	1.52E-09	4.12E-10	1.56E-11	2.48E-15	0.00E+00	0.00E+00	1.95E-09
Pu-239	0.00E+00	0.00E+00	3.85E-10	1.05E-10	3.95E-12	6.29E-16	5.66E-17	3.67E-17	4.93E-10
Pu-240	0.00E+00	0.00E+00	4.82E-10	1.31E-10	4.94E-12	7.88E-16	7.08E-17	4.59E-17	6.18E-10
Pu-241	0.00E+00	0.00E+00	8.29E-08	2.25E-08	8.50E-10	1.36E-13	1.22E-14	7.87E-15	1.06E-07
Am-241	0.00E+00	0.00E+00	3.37E-11	9.16E-12	3.46E-13	0.00E+00	0.00E+00	0.00E+00	4.32E-11
Cm-242	0.00E+00	0.00E+00	8.90E-09	2.42E-09	9.12E-11	0.00E+00	0.00E+00	0.00E+00	1.14E-08
Cm-244	0.00E+00	0.00E+00	4.81E-10	1.31E-10	4.93E-12	0.00E+00	0.00E+00	0.00E+00	6.16E-10

From RADTRAD Computer Run HAST1000CL02

Table 26

Post-LOCA Containment Leakage Activity in CR Without Charcoal/HEPA Filters (Ci)									
Isotope	0-0.333	0.33-0.5	0.5-2	2-4	4-8	8-24	24-96	96-720	Total
Co-58	0.00E+00	0.00E+00	9.30E-08	4.69E-08	2.18E-09	0.00E+00	0.00E+00	0.00E+00	1.42E-07
Co-60	0.00E+00	0.00E+00	1.11E-07	5.62E-08	2.61E-09	3.37E-13	2.34E-14	1.50E-14	1.70E-07
Kr-85	3.31E-05	4.77E-05	1.21E-02	2.31E-02	4.82E-02	3.67E-02	1.43E-02	9.79E-03	1.44E-01
Kr-85m	1.14E-03	1.61E-03	3.23E-01	4.52E-01	5.08E-01	3.25E-02	1.84E-07	0.00E+00	1.32E+00
Kr-87	1.83E-03	2.40E-03	2.69E-01	1.73E-01	4.07E-02	5.05E-06	0.00E+00	0.00E+00	4.87E-01
Kr-88	2.73E-03	3.77E-03	6.63E-01	7.77E-01	6.10E-01	9.35E-03	0.00E+00	0.00E+00	2.07E+00
Rb-86	1.48E-06	1.40E-06	1.17E-06	4.34E-07	1.89E-08	2.36E-12	0.00E+00	0.00E+00	4.50E-06
Sr-89	0.00E+00	0.00E+00	1.35E-04	6.80E-05	3.15E-06	4.03E-10	2.69E-11	1.22E-11	2.06E-04
Sr-90	0.00E+00	0.00E+00	9.56E-06	4.82E-06	2.24E-07	2.89E-11	2.01E-12	1.30E-12	1.46E-05
Sr-91	0.00E+00	0.00E+00	1.52E-04	6.61E-05	2.30E-06	9.21E-11	0.00E+00	0.00E+00	2.20E-04
Sr-92	0.00E+00	0.00E+00	1.10E-04	3.32E-05	5.56E-07	0.00E+00	0.00E+00	0.00E+00	1.44E-04
Y-90	0.00E+00	0.00E+00	1.00E-07	4.94E-08	2.20E-09	0.00E+00	0.00E+00	0.00E+00	1.52E-07
Y-91	0.00E+00	0.00E+00	1.65E-06	8.30E-07	3.85E-08	4.93E-12	0.00E+00	0.00E+00	2.52E-06
Y-92	0.00E+00	0.00E+00	1.24E-06	4.24E-07	9.01E-09	0.00E+00	0.00E+00	0.00E+00	1.68E-06
Y-93	0.00E+00	0.00E+00	1.82E-06	8.02E-07	2.83E-08	0.00E+00	0.00E+00	0.00E+00	2.65E-06
Zr-95	0.00E+00	0.00E+00	2.17E-06	1.09E-06	5.07E-08	6.49E-12	4.37E-13	0.00E+00	3.31E-06
Zr-97	0.00E+00	0.00E+00	2.06E-06	9.56E-07	3.77E-08	0.00E+00	0.00E+00	0.00E+00	3.05E-06
Nb-95	0.00E+00	0.00E+00	2.05E-06	1.03E-06	4.78E-08	6.09E-12	0.00E+00	0.00E+00	3.13E-06
Mo-99	0.00E+00	0.00E+00	2.90E-05	1.43E-05	6.38E-07	6.95E-11	0.00E+00	0.00E+00	4.39E-05
Tc-99m	0.00E+00	0.00E+00	2.03E-05	8.12E-06	2.38E-07	0.00E+00	0.00E+00	0.00E+00	2.86E-05
Ru-103	0.00E+00	0.00E+00	2.24E-05	1.13E-05	5.24E-07	6.67E-11	4.40E-12	1.80E-12	3.42E-05
Ru-105	0.00E+00	0.00E+00	1.09E-05	4.04E-06	1.01E-07	0.00E+00	0.00E+00	0.00E+00	1.51E-05
Ru-106	0.00E+00	0.00E+00	6.10E-06	3.07E-06	1.43E-07	1.84E-11	1.27E-12	7.86E-13	9.31E-06
Rh-105	0.00E+00	0.00E+00	1.07E-05	5.21E-06	2.24E-07	2.11E-11	0.00E+00	0.00E+00	1.62E-05
Sb-127	0.00E+00	0.00E+00	2.79E-05	1.38E-05	6.25E-07	7.14E-11	0.00E+00	0.00E+00	4.23E-05
Sb-129	0.00E+00	0.00E+00	7.12E-05	2.61E-05	6.38E-07	0.00E+00	0.00E+00	0.00E+00	9.79E-05
Te-127	0.00E+00	0.00E+00	2.36E-05	1.03E-05	3.55E-07	0.00E+00	0.00E+00	0.00E+00	3.42E-05
Te-127m	0.00E+00	0.00E+00	3.68E-06	1.86E-06	8.63E-08	1.11E-11	7.56E-13	4.15E-13	5.63E-06
Te-129	0.00E+00	0.00E+00	2.79E-05	4.26E-06	1.81E-08	0.00E+00	0.00E+00	0.00E+00	3.22E-05
Te-129m	0.00E+00	0.00E+00	2.42E-05	1.22E-05	5.64E-07	7.17E-11	4.69E-12	1.78E-12	3.69E-05

Table 26 (Cont'd)

Post-LOCA Containment Leakage Activity in CR Without Charcoal/HEPA Filters (Ci)

Isotope	0-0.33	0.33-0.5	0.5-2	2-4	4-8	8-24	24-96	96-720	Total
Te-131m	0.00E+00	0.00E+00	4.44E-05	2.14E-05	9.07E-07	8.08E-11	0.00E+00	0.00E+00	6.67E-05
Te-132	0.00E+00	0.00E+00	4.47E-04	2.21E-04	9.93E-06	1.11E-09	4.08E-11	0.00E+00	6.78E-04
I-131	2.72E-03	2.58E-03	2.48E-03	1.03E-03	1.58E-04	4.45E-05	1.22E-05	8.93E-07	9.02E-03
I-132	3.62E-03	3.26E-03	2.01E-03	4.59E-04	2.14E-05	5.15E-08	0.00E+00	0.00E+00	9.37E-03
I-133	5.65E-03	5.33E-03	4.90E-03	1.92E-03	2.61E-04	4.58E-05	1.47E-06	0.00E+00	1.81E-02
I-134	4.81E-03	3.99E-03	1.18E-03	1.01E-04	6.67E-07	0.00E+00	0.00E+00	0.00E+00	1.01E-02
I-135	5.20E-03	4.84E-03	4.00E-03	1.36E-03	1.38E-04	7.74E-06	1.44E-09	0.00E+00	1.55E-02
Xe-133	7.16E-03	1.03E-02	2.59E+00	4.89E+00	9.98E+00	6.96E+00	1.82E+00	4.04E-02	2.63E+01
Xe-135	1.66E-03	2.36E-03	5.35E-01	8.76E-01	1.35E+00	3.03E-01	4.86E-04	0.00E+00	3.06E+00
Cs-134	4.46E-04	4.23E-04	3.53E-04	1.32E-04	5.77E-06	7.39E-10	5.13E-11	3.24E-11	1.36E-03
Cs-136	1.20E-04	1.13E-04	9.43E-05	3.50E-05	1.52E-06	1.88E-10	1.12E-11	1.83E-12	3.64E-04
Cs-137	2.67E-04	2.53E-04	2.11E-04	7.87E-05	3.45E-06	4.43E-10	3.08E-11	1.99E-11	8.13E-04
Ba-139	0.00E+00	0.00E+00	8.89E-05	1.64E-05	1.02E-07	0.00E+00	0.00E+00	0.00E+00	1.05E-04
Ba-140	0.00E+00	0.00E+00	2.39E-04	1.20E-04	5.52E-06	6.87E-10	4.06E-11	6.40E-12	3.64E-04
La-140	0.00E+00	0.00E+00	2.36E-06	1.15E-06	5.00E-08	0.00E+00	0.00E+00	0.00E+00	3.57E-06
La-141	0.00E+00	0.00E+00	1.59E-06	5.63E-07	1.29E-08	0.00E+00	0.00E+00	0.00E+00	2.16E-06
La-142	0.00E+00	0.00E+00	8.85E-07	1.82E-07	1.40E-09	0.00E+00	0.00E+00	0.00E+00	1.07E-06
Ce-141	0.00E+00	0.00E+00	5.43E-06	2.74E-06	1.27E-07	1.61E-11	1.05E-12	0.00E+00	8.30E-06
Ce-143	0.00E+00	0.00E+00	5.08E-06	2.46E-06	1.05E-07	0.00E+00	0.00E+00	0.00E+00	7.65E-06
Ce-144	0.00E+00	0.00E+00	3.53E-06	1.78E-06	8.27E-08	1.07E-11	7.36E-13	4.48E-13	5.39E-06
Pr-143	0.00E+00	0.00E+00	2.07E-06	1.04E-06	4.79E-08	5.96E-12	0.00E+00	0.00E+00	3.15E-06
Nd-147	0.00E+00	0.00E+00	9.23E-07	4.63E-07	2.13E-08	2.63E-12	0.00E+00	0.00E+00	1.41E-06
Np-239	0.00E+00	0.00E+00	6.74E-05	3.32E-05	1.47E-06	1.56E-10	0.00E+00	0.00E+00	1.02E-04
Pu-238	0.00E+00	0.00E+00	4.81E-09	2.42E-09	1.13E-10	1.45E-14	1.01E-15	0.00E+00	7.34E-09
Pu-239	0.00E+00	0.00E+00	1.22E-09	6.15E-10	2.86E-11	3.68E-15	2.56E-16	1.66E-16	1.86E-09
Pu-240	0.00E+00	0.00E+00	1.53E-09	7.69E-10	3.58E-11	4.61E-15	3.21E-16	2.08E-16	2.33E-09
Pu-241	0.00E+00	0.00E+00	2.63E-07	1.32E-07	6.16E-09	7.94E-13	5.52E-14	3.57E-14	4.01E-07
Am-241	0.00E+00	0.00E+00	1.07E-10	5.39E-11	2.50E-12	3.23E-16	0.00E+00	0.00E+00	1.63E-10
Cm-242	0.00E+00	0.00E+00	2.82E-08	1.42E-08	6.60E-10	0.00E+00	0.00E+00	0.00E+00	4.31E-08
Cm-244	0.00E+00	0.00E+00	1.52E-09	7.67E-10	3.57E-11	4.60E-15	0.00E+00	0.00E+00	2.32E-09

From RADTRAD Computer Run HAST1000CL03

Table 27

Containment Leakage Total Activity on CR Charcoal/HEPA Filter (Ci)			
Isotope	**0-720**	**Isotope**	**0-720**
Co-58	1.04E-07	Te-131m	4.89E-05
Co-60	1.25E-07	Te-132	4.98E-04
Kr-85	0.00E+00	I-131	2.83E-03
Kr-85m	0.00E+00	I-132	1.86E-03
Kr-87	0.00E+00	I-133	5.41E-03
Kr-88	0.00E+00	I-134	9.44E-04
Rb-86	1.24E-06	I-135	4.15E-03
Sr-89	1.51E-04	Xe-133	0.00E+00
Sr-90	1.07E-05	Xe-135	0.00E+00
Sr-91	1.61E-04	Cs-134	3.75E-04
Sr-92	1.03E-04	Cs-136	1.00E-04
Y-90	1.11E-07	Cs-137	2.24E-04
Y-91	1.85E-06	Ba-139	7.45E-05
Y-92	1.21E-06	Ba-140	2.68E-04
Y-93	1.94E-06	La-140	2.62E-06
Zr-95	2.43E-06	La-141	1.56E-06
Zr-97	2.23E-06	La-142	7.40E-07
Nb-95	2.30E-06	Ce-141	6.10E-06
Mo-99	3.22E-05	Ce-143	5.61E-06
Tc-99m	2.08E-05	Ce-144	3.96E-06
Ru-103	2.52E-05	Pr-143	2.32E-06
Ru-105	1.09E-05	Nd-147	1.03E-06
Ru-106	6.85E-06	Np-239	7.49E-05
Rh-105	1.19E-05	Pu-238	5.40E-09
Sb-127	3.11E-05	Pu-239	1.37E-09
Sb-129	7.09E-05	Pu-240	1.71E-09
Te-127	2.50E-05	Pu-241	2.95E-07
Te-127m	4.14E-06	Am-241	1.20E-10
Te-129	2.26E-05	Cm-242	3.16E-08
Te-129m	2.71E-05	Cm-244	1.71E-09

Table 28

Post-LOCA MSIV Leakage Activity in CR With Charcoal/HEPA Filters (Ci)							
Isotope	**0-24**	**24-29.52**	**29.52--96**	**96-240**	**240-480**	**480-720**	**Total**
Kr-85	4.06E-02	1.37E-02	2.24E-02	1.65E-02	1.49E-02	1.35E-02	1.22E-01
Kr-85m	3.60E-02	5.18E-03	2.89E-07	0.00E+00	0.00E+00	0.00E+00	4.12E-02
Kr-87	5.60E-06	9.33E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.69E-06
Kr-88	1.04E-02	9.10E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.13E-02
I-131	4.89E-03	9.50E-04	1.22E-03	3.15E-04	9.62E-05	2.26E-05	7.50E-03
I-132	5.66E-06	2.13E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.87E-06
I-133	5.03E-03	8.29E-04	1.48E-04	5.26E-07	1.28E-10	0.00E+00	6.01E-03
I-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
I-135	8.51E-04	9.45E-05	1.45E-07	0.00E+00	0.00E+00	0.00E+00	9.45E-04
Xe-133	7.71E+00	2.53E+00	2.86E+00	9.53E-01	2.31E-01	5.58E-02	1.43E+01
Xe-135	3.35E-01	7.43E-02	7.64E-04	9.57E-09	0.00E+00	0.00E+00	4.10E-01

From RADTRAD Computer Run HAST1000MS02

Table 29

Post-LOCA MSIV Leakage Activity in CR Without Charcoal/HEPA Filters (Ci)								Total Activity C/HEPA Fltr (Ci)
Isotope	0-24	24-29.52	29.52--96	96-240	240-480	480-720	Total	
Kr-85	4.06E-02	1.37E-02	2.24E-02	1.65E-02	1.49E-02	1.35E-02	1.22E-01	0.00E+00
Kr-85m	3.60E-02	5.18E-03	2.89E-07	0.00E+00	0.00E+00	0.00E+00	4.12E-02	0.00E+00
Kr-87	5.60E-06	9.33E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.69E-06	0.00E+00
Kr-88	1.04E-02	9.10E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.13E-02	0.00E+00
I-131	2.21E-02	4.31E-03	5.53E-03	1.43E-03	4.36E-04	1.02E-04	3.39E-02	2.64E-02
I-132	2.56E-05	9.64E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.66E-05	2.07E-05
I-133	2.28E-02	3.76E-03	6.68E-04	2.38E-06	5.79E-10	5.79E-10	2.72E-02	2.12E-02
I-134	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
I-135	3.85E-03	4.28E-04	6.55E-07	0.00E+00	0.00E+00	0.00E+00	4.28E-03	3.33E-03
Xe-133	7.71E+00	2.53E+00	2.86E+00	9.53E-01	2.31E-01	5.58E-02	1.43E+01	0.00E+00
Xe-135	3.35E-01	7.43E-02	7.64E-04	9.57E-09	0.00E+00	0.00E+00	4.10E-01	0.00E+00

From RADTRAD Computer Run HAST1000MS03

Table 30

Post-LOCA ESF Leakage Activity in CR With Charcoal/HEPA Filters (Ci)									
Isotope	**0-0.33**	**0.33-0.5**	**0.5-2**	**2-4**	**4-8**	**8-24**	**24-96**	**96-720**	**Total**
I-131	1.78E-03	1.69E-03	5.43E-04	3.76E-04	3.41E-04	1.28E-04	7.01E-05	5.04E-06	4.93E-03
I-132	2.37E-03	2.13E-03	4.40E-04	1.68E-04	4.62E-05	1.49E-07	0.00E+00	0.00E+00	5.16E-03
I-133	3.70E-03	3.49E-03	1.07E-03	7.01E-04	5.63E-04	1.32E-04	8.47E-06	0.00E+00	9.66E-03
I-134	3.15E-03	2.61E-03	2.58E-04	3.71E-05	1.44E-06	0.00E+00	0.00E+00	0.00E+00	6.06E-03
I-135	3.40E-03	3.17E-03	8.76E-04	4.95E-04	2.99E-04	2.23E-05	8.30E-09	0.00E+00	8.26E-03

From RADTRAD Run HAST1000ESF02

Table 31

Post-LOCA ESF Leakage Activity in CR Without Charcoal/HEPA Filters (Ci)										Total Activity C/HEPA Fltr (Ci)
Isotope	**0-0.33**	**0.33-0.5**	**0.5-2**	**2-4**	**4-8**	**8-24**	**24-96**	**96-720**	**Total**	
I-131	1.78E-03	1.69E-03	1.95E-03	1.67E-03	1.54E-03	5.82E-04	3.17E-04	2.28E-05	9.55E-03	4.62E-03
I-132	2.37E-03	2.13E-03	1.58E-03	7.45E-04	2.09E-04	6.73E-07	0.00E+00	0.00E+00	7.03E-03	1.88E-03
I-133	3.70E-03	3.49E-03	3.85E-03	3.11E-03	2.55E-03	5.98E-04	3.84E-05	0.00E+00	1.73E-02	7.67E-03
I-134	3.15E-03	2.61E-03	9.27E-04	1.65E-04	6.53E-06	0.00E+00	0.00E+00	0.00E+00	6.86E-03	8.01E-04
I-135	3.40E-03	3.17E-03	3.14E-03	2.20E-03	1.36E-03	1.01E-04	3.76E-08	0.00E+00	1.34E-02	5.10E-03

From RADTRAD Run HAST1000ESF03

Table 32

Post-LOCA Total Iodine & Aerosol Activity in CR Charcoal/HEPA Filters (Ci)				
Isotope	Containment Leakage 0-720	MSIV Leakage 0-720	ESF Leakage 0-720	Total Iodine & Aerosol
Co-58	1.04E-07	0.00E+00	0.00E+00	1.04E-07
Co-60	1.25E-07	0.00E+00	0.00E+00	1.25E-07
Kr-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Kr-85m	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Kr-87	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Kr-88	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Rb-86	1.24E-06	0.00E+00	0.00E+00	1.24E-06
Sr-89	1.51E-04	0.00E+00	0.00E+00	1.51E-04
Sr-90	1.07E-05	0.00E+00	0.00E+00	1.07E-05
Sr-91	1.61E-04	0.00E+00	0.00E+00	1.61E-04
Sr-92	1.03E-04	0.00E+00	0.00E+00	1.03E-04
Y-90	1.11E-07	0.00E+00	0.00E+00	1.11E-07
Y-91	1.85E-06	0.00E+00	0.00E+00	1.85E-06
Y-92	1.21E-06	0.00E+00	0.00E+00	1.21E-06
Y-93	1.94E-06	0.00E+00	0.00E+00	1.94E-06
Zr-95	2.43E-06	0.00E+00	0.00E+00	2.43E-06
Zr-97	2.23E-06	0.00E+00	0.00E+00	2.23E-06
Nb-95	2.30E-06	0.00E+00	0.00E+00	2.30E-06
Mo-99	3.22E-05	0.00E+00	0.00E+00	3.22E-05
Tc-99m	2.08E-05	0.00E+00	0.00E+00	2.08E-05
Ru-103	2.52E-05	0.00E+00	0.00E+00	2.52E-05
Ru-105	1.09E-05	0.00E+00	0.00E+00	1.09E-05
Ru-106	6.85E-06	0.00E+00	0.00E+00	6.85E-06
Rh-105	1.19E-05	0.00E+00	0.00E+00	1.19E-05
Sb-127	3.11E-05	0.00E+00	0.00E+00	3.11E-05
Sb-129	7.09E-05	0.00E+00	0.00E+00	7.09E-05
Te-127	2.50E-05	0.00E+00	0.00E+00	2.50E-05
Te-127m	4.14E-06	0.00E+00	0.00E+00	4.14E-06
Te-129	2.26E-05	0.00E+00	0.00E+00	2.26E-05
Te-129m	2.71E-05	0.00E+00	0.00E+00	2.71E-05

Table 32 (Cont'd)

Post-LOCA Total Iodine & Aerosol Activity in CR Charcoal/HEPA Filters (Ci)

Isotope	Containment Leakage 0-720	MSIV Leakage 0-720	ESF Leakage 0-720	Total Iodine & Aerosol
Te-131m	4.89E-05	0.00E+00	0.00E+00	4.89E-05
Te-132	4.98E-04	0.00E+00	0.00E+00	4.98E-04
I-131	2.83E-03	2.64E-02	4.62E-03	3.39E-02
I-132	1.86E-03	2.07E-05	1.88E-03	3.76E-03
I-133	5.41E-03	2.12E-02	7.67E-03	3.43E-02
I-134	9.44E-04	0.00E+00	8.01E-04	1.75E-03
I-135	4.15E-03	3.33E-03	5.10E-03	1.26E-02
Xe-133	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Xe-135	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cs-134	3.75E-04	0.00E+00	0.00E+00	3.75E-04
Cs-136	1.00E-04	0.00E+00	0.00E+00	1.00E-04
Cs-137	2.24E-04	0.00E+00	0.00E+00	2.24E-04
Ba-139	7.45E-05	0.00E+00	0.00E+00	7.45E-05
Ba-140	2.68E-04	0.00E+00	0.00E+00	2.68E-04
La-140	2.62E-06	0.00E+00	0.00E+00	2.62E-06
La-141	1.56E-06	0.00E+00	0.00E+00	1.56E-06
La-142	7.40E-07	0.00E+00	0.00E+00	7.40E-07
Ce-141	6.10E-06	0.00E+00	0.00E+00	6.10E-06
Ce-143	5.61E-06	0.00E+00	0.00E+00	5.61E-06
Ce-144	3.96E-06	0.00E+00	0.00E+00	3.96E-06
Pr-143	2.32E-06	0.00E+00	0.00E+00	2.32E-06
Nd-147	1.03E-06	0.00E+00	0.00E+00	1.03E-06
Np-239	7.49E-05	0.00E+00	0.00E+00	7.49E-05
Pu-238	5.40E-09	0.00E+00	0.00E+00	5.40E-09
Pu-239	1.37E-09	0.00E+00	0.00E+00	1.37E-09
Pu-240	1.71E-09	0.00E+00	0.00E+00	1.71E-09
Pu-241	2.95E-07	0.00E+00	0.00E+00	2.95E-07
Am-241	1.20E-10	0.00E+00	0.00E+00	1.20E-10
Cm-242	3.16E-08	0.00E+00	0.00E+00	3.16E-08
Cm-244	1.71E-09	0.00E+00	0.00E+00	1.71E-09

8.0 RESULTS SUMMARY

The results of AST analyses are summarized in the following sections:

8.1 Licensing Basis Analysis

The results of analyses, which establish licensing basis for the deletion of MSIVSS, increased MSIV, and CR unfiltered inleakage, are summarized in the following table:

Post-LOCA Activity Release Path	Post-LOCA TEDE Dose (Rem)		
	Receptor Location		
	Control Room	**EAB**	**LPZ**
Containment Leakage	4.29E-01	3.41E-01 (3.2 hr)	1.10E-01
ESF Leakage	2.64E-01	3.51E-02 (0 hr)	1.19E-02
MSIV Leakage	3.40E+00	1.92E+00 (9.3 hr)	3.67E-01
Containment Purge	0.00E+00	0.00E+00	0.00E+00
Containment Shine	0.00E+00	0.00E+00	0.00E+00
External Cloud	0.00E+00	0.00E+00	0.00E+00
CR Filter Shine	2.46E-03*	0.00E+00	0.00E+00
Total	**4.10E+00**	**2.30E+00**	**4.89E-01**
Allowable TEDE Limit	**5.00E+00**	**2.50E+01**	**2.50E+01**
	RADTRAD Computer Run No.		
Containment Leakage	HAST900CL01	HAST900CL01	HAST900CL01
ESF Leakage	HAST900ESF01	HAST900ESF01	HAST900ESF01
MSIV Leakage	HAST900MS01	HAST900MS01	HAST900MS01

* CR filter shine dose due to the CR unfiltered inleakage of 1000 cfm with the RADTRAD default nuclide inventory file (NIF) will bound that due to the CR unfiltered inleakage of 900 cfm with the plant-specific NIF.

8.2 V&V of RADTRAD V3.02 Code

The comparison of results of RADTRAD3.02 and HABIT1.0 codes are shown in the following table:

Comparison of Control Room Doses - Licensing Basis Case					
Dose ID	Post-LOCA Control Room Dose (Rem)				Dose Variation (%)
	HABIT	RADTRAD			
	Cont+ESF+MSIV	Cont+MSIV	ESF	Total	
Thyroid	3.3634E-01	2.2593E-01	1.1570E-01	3.4163E-01	+1.57%
Whole Body	2.3027E-02	2.3392E-02	6.0348E-06	2.3398E-02	+1.61%
Comparison of Exclusion Area Boundary Doses - Licensing Basis Case					
Dose ID	Post-LOCA Exclusion Area Boundary Dose (Rem)				Dose Variation (%)
	HABIT	RADTRAD			
	Cont+ESF+MSIV	Cont+MSIV	ESF	Total	
Thyroid	1.2500E+02	9.1537E+01	3.3431E+01	1.2497E+02	-0.02%
Whole Body	1.3480E+00	1.2283E+00	1.4366E-01	1.3720E+00	+1.78%
Comparison of Low Population Zone Doses - Licensing Basis Case					
Dose ID	Post-LOCA Low Population Zone Dose (Rem)				Dose Variation (%)
	HABIT	RADTRAD			
	Cont+ESF+MSIV	Cont+MSIV	ESF	Total	
Thyroid	1.6820E+01	1.1796E+01	5.0355E+00	1.6832E+01	+0.07%
Whole Body	2.4120E-01	2.3056E-01	1.5273E-02	2.4583E-01	+1.92%

9.0 CONCLUSIONS/RECOMMENDATIONS

9.1 CONCLUSIONS:

The results of analyses in Section 8 above indicate that the main steam isolation valve sealing system (MSIVSS) can be safely eliminated along with the increased MSIV leakage of 250 scfh and control room unfiltered inleakage of 900 cfm using the AST and guidance in the Regulatory Guide 1.183. Adherence to guidance in the RG 1.183 and use of the specific values and limits contained in the technical specifications and as-built post-accident performance of safety grade ESF functions provide the assurance of sufficient safety margin, including a margin to account for analysis uncertainties in the proposed uses of an AST and the associated facility modifications and changes to procedures. 1

The verification & validation of RADTRAD3.02 computer code (Section 8.2) demonstrates that the RADTRAD3.02 code produces the identical results within ± 2% margin of error compared to HABIT1.0 code for the same source terms, release mechanisms, and dose conversion factors. RADTRAD has been developed and tested by NRC in accordance with the requirements of ANSI/ANS-10.4-1987 in Reference 10.2, in Section 3, "Quality Assurance." In addition to the use of these programming standards, various program elements were tested and examined to insure program quality and ability to produce accurate and consistent results with HABIT 1.1 code.

10.0 REFERENCES

10.1 U.S. NRC Regulatory Guide 1.183, Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors, July 2000.

10.2 S.L. Humphreys et al., "RADTRAD V3.02: A Simplified Model for Radionuclide Transport and Removal and Dose Estimation," NUREG/CR-6604, USNRC, April 1998.

10.3 USNRC, "Laboratory Testing of Nuclear-Grade Activated Charcoal," NRC Generic Letter 99-02, June 3, 1999.

10.4 10 CFR 50.67, "Alternate Source Term."

10.5 Calculation No. H-1-ZZ-MDC-1879, Rev 0IR2, Control Room χ/Qs For FRVS Vent, RB Truck Bay, TB Louvers, and SPV Using ARCON96 Code. 2

10.6 HCGS Technical Specifications:

- 10.6.1 Specification 4.6.5.3.1.c.1, FRVS Vent HEPA Filter Testing Criterion
- 10.6.2 Specification 4.6.5.3.1.c.2, FRVS Vent Charcoal Filter Testing Criterion
- 10.6.3 Specification 4.6.5.3.1.c.3, FRVS Vent HEPA/Charcoal Filter Flow Rate Testing Criterion
- 10.6.4 Specification 6.8.4.f, Primary Containment Leak Rate Testing Program
- 10.6.5 Bases ¾.6.2, Depressurization Systems
- 10.6.6 Specification 5.2.1, Containment Configuration
- 10.6.7 Specification 5.2.3, Secondary Containment
- 10.6.8 Specification 4.6.5.1, Secondary Containment Integrity
- 10.6.9 Specification 1.35, Rated Thermal Power.
- 10.6.10 Specification 4.6.5.3.2.c.1, FRVS Recirc HEPA Filter Testing Criterion
- 10.6.11 Specification 4.6.5.3.2.c.2, FRVS Recirc Charcoal Filter Testing Criterion
- 10.6.12 Specification 4.6.5.3.2.c.3, FRVS Recirc HEPA/Charcoal Filter Flow Rate Testing Criterion
- 10.6.13 Specification 4.7.2.c.1, Control Room Emergency Filtration System Surveillance Requirements
- 10.6.14 Specification 4.7.2.c.2, Control Room Emergency Filtration System Surveillance Requirements
- 10.6.15 Specification 4.7.2.c.3, Control Room Emergency Filtration System Surveillance Requirements

10.6.16 Specification 4.7.2.e.3, Control Room Emergency Filtration System Surveillance Requirements

10.6.17 Specification 3.6.1.2.c, Primary Containment Leakage Limiting Condition For Operation

10.6.18 Specification 3.6.1.8, Drywell and Suppression Chamber Purge System

10.6.19 HCGS Technical Specification Table 3.6.3-1, Primary Containment Isolation Valves.

10.7 Federal Guidance Report 11, EPA-5201/1-88-020, Environmental Protection Agency.

10.8 Federal Guidance Report 12, EPA-402- R-93-081, Environmental Protection Agency.

10.9 MicroShield Computer Code, V&V Version 5.05, Grove Engineering.

10.10 Draft Safety Evaluation by the Office of Nuclear Reactor Regulation Related to Facility Operating License No. NPF-57. Subject: Increase of Allowable Main Steam Isolation Valve (MSIV) Leak Rate and Deletion of MSIV Sealing System (TAC No. MA9978).

10.11 Drawing No. 1-P-AB-01, Rev 18, System Isometric / Turbine Building Main Steam Lead.

10.12 Fabrication Isometric Main Steam Lead – Turbine Building Unit #1 Drawings:

a. 1-P-AB-001, Rev 11
b. 1-P-AB-002, Rev 9
c. 1-P-AB-003, Rev 9
d. 1-P-AB-004, Rev 9
e. 1-P-AB-011, Rev 11

10.13 Piping Area Drawings:

a. P-1703-1, Rev 3, Reactor Building Area 17, Plan EL 100'-2".
b. P-1704-1, Rev 2, Reactor Building Area 17, Plan EL 112'-0".
c. P-1705-1, Rev 2, Reactor Building Area 17, Plan EL 121'-7-1/2".
d. P-1712-1, Rev 2, Reactor Building Area 17, Section B17 – B17.
e. P-1713-1, Rev 4, Reactor Building Area 17, Section C17 – C17.
f. P-1403-1, Rev 2, Reactor Building Area 14, Plan At EL 102'-0".
g. P-1414-1, Rev 1, Reactor Building Area 14, Section D14 – D14.
i. P-1711-1, Rev 2, Reactor Building Area 17, Section A17 – A17. 2

10.14 Piping Class Sheet Drawing No. 10855-P-0500::

10.14.a Sheet 16, Rev 9, Class DBB

10.14.b Sheet 17, Rev 7, Class DBC

10.14.c Sheet 24, Rev 7, Class DLA

10.15 GE-NE-T2300759-00-02, HCGS Containment Analysis With 100 ^{0}F SACS Temperature, September 1998.

10.16 Calculation No. 12-0025, Rev 3, "Drywell Volume & Torus Air & Water Volumes."

10.17 Specification 10855-M-786 (Q), Rev 11, Technical Specification For HVAC Air Filter Systems, Seismic Category I For The Hope Creek Generating Station.

10.18 Procedure HC.RA-AP.ZZ-0051(Q), Rev. 1, Leakage Reduction Program

10.19 Calculation No. GU-0013, Rev. 4, Filtration Recirculation and Ventilation System Exhaust Rate

10.20 Drawing M-76-1, Rev. 18, P&ID Reactor Building Air Flow Diagram

10.21 CR961030231 Act. 0010 Response, Secondary Containment

10.22 NRC Report AEB-98-03, " Assessment of Radiological Consequences For the Perry Pilot Plant Application Using the Revised (NUREG-1465) Source Term.

10.23 MSIV Leakage Iodine Transport Analysis By J.E. Cline & Associates, March 26, 1991, Contract NRC-03-87-029, Task Order 75

10.24 NUREG/CR-2713, Vapor Deposition Velocity Measurements and Correlations for I_2 and CsI, May 1982.

10.25 Calculation No. No. H-1-ZZ-MDC-0364, Rev 0, Drywell Temperature After Recirculation Line Break.. 1

10.26 EQE International, Inc., Report No. 200235-R-01, November 12, 1998, Hope Creek Nuclear Plant Main Steam Isolation System Alternate Leakage Treatment Pathway Seismic Evaluation.

10.27 General Arrangement Drawings:

- 10.27.a P-0006-0, Rev 7, Plan EL 153'-0" and 162'-0"
- 10.27.b P-0011-0, Rev 5, Sections C-C & D-D

10.28 Equipment Location Drawings:

- 10.28.a P-0035-0, Rev 10, Service & Radwaste Area Plan EL 137'-0"
- 10.28.b P-0036-0, Rev 16, Service & Radwaste Area Plan EL 153'-0" & 155'-3"
- 10.28.c P-0055-0, Rev 15, Control & D/G Area, Plan EL 137'-0" & EL 146'-0" & EL 150'-0"
- 10.28.d P-0056-0, Rev 16, Control & D/G Area, Plan EL 155'-3" & EL 163'-6"

10.29 Auxiliary Bldg – Control Area Drawings:

- 10.29.a C-1317-0, Rev 22, Floor Plan EL 155'-3" Area 25
- 10.29.b C-1319-0, Rev 12, Floor Plan EL 155'-3" Area 26
- 10.29.c C-1321-0, Rev 5, Roof Plan EL 172-0" Area 25
- 10.29.d C-1323-0, Rev 4, Roof Plan EL 172-0" Area 26

10.30 Auxiliary Bldg – Control Area Drawings:

10.30.a C-1313-0, Rev 11, Floor Plan EL 137'-0" Area 25

10.30.b C-1315-0, SH 2, Rev 3, Floor Plan EL 137'-0" Area 26

10.31 Auxiliary Bldg – Diesel Generator Area Drawings:

10.31.a C-1413-0, Rev 20, Floor Plan EL 146'-0", EL 150'-0", EL 155'-3" Area 27

10.31.b C-1415-0, Rev 22, Floor Plan EL 146'-0", EL 150'-0", EL 155'-3" Area 28

10.32 Calculation No. H-1-ZZ-MDC-1820, Rev 0, Offsite Atmospheric Dispersion Factors.

10.33 Calculation No. H-1-ZZ-MDC-1882, Rev 0, Control Room Envelope Volume.

10.34 Draft NEI 99-03, Control Room Habitability Guidance, February 2001.

10.35 Drawing No. C-0738-0, Rev 6, Reactor Building Dome Reinforcement Plan Section & Details.

10.36 NRC Safety Evaluation for Amendment No. 30.

10.37 Specification No 10855-P-0501, Rev 34, Line Index For The Hope Creek Generating Station.

10.38 American Air Filter Drawing No. M786(Q)-5(1), Rev 10, Housing Assy Filter (Control Room Emergency Filter).

10.39 HVAC Area Drawings:

10.39.a P-9266-1, Rev 25, Aux Bldg Area 26, Plan At EL 155'-3''& 163'-6"

10.39.b P-9256-1, Rev 24, Aux Bldg Area 25, Plan At EL 155'-3''& 175'-0"

10.39.c P-9267-1, Sheet 1 of 4, Rev 17, Aux Building Area 25 & 26 Sections

10.40 U.S. NRC Standard Review Plan 6.4, Control Room Habitability System.

10.41 P&ID M-57-1, Rev 36, Containment Atmosphere Control.

10.42 P&ID M-78-1, Rev 9, Containment Hydrogen Recombination System.

10.43 Calculation No. H-1-ZZ-MDC-1886, Hope Creek Post-Accident pH. 2

10.44 Order No. 80028003, Confirmatory Inputs For H-1-ZZ-MDC-1880.

10.45 HCGS Core Inventory by Westinghouse, Hope Creek Calculation No. (Later)

11.0 Tracking of Items Required Confirmation

Some of critical design inputs are used in this analysis with bounding value assumptions, which required to be confirmed as soon as design input information is available. The following Orders will track the completion of required actions:

11.1 Order No.80028003

The isotopic core inventory used in this analysis is obtained from the RADTRAD nuclide inventory file and shown in the Design Input 5.3.1.3, Table 1 and Table 16 of this calculation. This isotopic core inventory should be compared with the plant-specific isotopic core inventory to determine the validity of Design Input 5.3.1.3.

The core inventories in Table 1 and Table 16 are confirmed to be HCGS plant-specific inventory per Reference 10.45 2

11.2 Order No. 80028003

A pH value of 7.0 or greater is assumed for the suppression pool water inventory to take a credit of the chemical forms of radioiodine released to the containment to be 95% cesium iodide (CsI), 4.85 percent elemental iodine, and 0.15 percent organic iodide (Assumption 4.5). The pH of suppression pool water should be compared with the plant-specific pool water pH to determine the validity of pH assumption.

The assumption of suppression pool water pH greater than 7 is confirmed per Calculation No. H-1-ZZ-MDC-1866, Rev 0, Hope Creek Post-Accident pH, page 11. 2

12.0 ATTACHMENTS

2 Diskettes with the following electronic files:

Calculation No: H-1-ZZ-MDC-1880, Rev OIR1.
Comment Resolution Form 2 – John F. Duffy
ATTACHMENT A: HCGSMHA_DEF.txt For Cont., ESF, & MSIV Leakages
ATTACHMENT B: Cont. Leakage RADTRAD Input File HAST900CL01.PSF
ATTACHMENT C: Cont. Leakage RADTRAD Output File HAST900CL01.o0
ATTACHMENT D: ESF Leakage RADTRAD Input File HAST900ESF01.PSF
ATTACHMENT E: ESF Leakage RADTRAD Output File HAST900ESF01.o0
ATTACHMENT F: MSIV Leakage RADTRAD Input File HAST900MS01.PSF
ATTACHMENT G: MSIV Leakage RADTRAD Output File HAST900MS01.o0
ATTACHMENT H: Cont. LKG Without CR Filter Input/Output File HAST1000CL02
ATTACHMENT I: Cont. LKG Without CR Filter Input/Output File HAST1000CL03
ATTACHMENT J: ESF LKG Without CR Filter Input/Output File HAST1000ESF02
ATTACHMENT K: ESF LKG Without CR Filter Input/Output File HAST1000ESF03
ATTACHMENT L: MSIV LKG Without CR Filter Input/Output File HAST1000MS02
ATTACHMENT M: MSIV LKG Without CR Filter Input/Output File HAST1000MS03
ATTACHMENT N: CR Filter Shine Dose MicroShield Input/Output File
ATTACHMENT O: RADTRAD/HABIT1.0 V&V Files

99%oa.DSG	HCI30ESF00.O0
99%oacb.INP	HCI30ESF00.PSF
99%oacb.SPD	HCGSTID_DEF
99%oat5a.INP	HCCLI30MS00.PSF
99%oat5a.NUC	
99%oat5a.TAB	
99%xxx.DSG	
99%xxxcb.INP	
99%xxxcb.SPD	
99%xxx5a.INP	
99%xxxt5a.NUC	
99%xxxt5a.TAB	
HCCLI30MS00.O0	

2 Diskettes With Various Electronic Files