CALCULATION TITLE PAGE

ICCN NO./ PRELIM. CCN NO.	PAGE ___ OF ___
	CCN CONVERSION: CCN NO. CCN-

Calc. No. N-0720-014 DCP/FIDCN/FCN No. & Rev. ________

Subject Control Room and Offsite Doses Should CPIS, CRIS and FHIS Fail Sheet 1 of 252

System Number/Primary Station System Designator 1510 / GKA SONGS Unit 2 and 3 Q-Class II*

Tech. Spec./LCS Affecting? ☒ NO ☐ YES, Section No. ________ Equipment Tag No. ________

Site Programs/Procedure Impact? ☒ NO ☐ YES, AR No. ________

CONTROLLED COMPUTER PROGRAM/ DATABASE	☒ PROGRAM ☐ DATABASE	PROGRAM/DATABASE NAME(S) ☐ ALSO, LISTED BELOW NE-319 "LOCADOSE Code"	VERSION/RELEASE NO.(S) Version 3, on RISC 6000 AIX w/ Version 3.2.5 Op. System

RECORDS OF ISSUES

REV. DISC.	DESCRIPTION	TOTAL SHTS. LAST SHT.	PREPARED (Print name/sign/date)	APPROVED (Signature/date)	
0	A beyond design basis calculation in support of the PCN for DCP	252	ORIG. Mark Drucker Mark Drucker 8-15-97	FLS [signature] 8/21/97	Other
NFM	2&3 6926.01SJ (digital rad monitor upgrade)	252	IRE T Remick Tom Remick 8/19/97	Other	Other
			ORIG.	FLS	Other
			IRE	Other	Other
			ORIG.	FLS	Other
			IRE	Other	Other
			ORIG.	FLS	Other
			IRE	Other	Other

Space for RPE Stamp, identify use of an alternate calc., and notes as applicable.

This calculation was typed using WordPerfect 6.1 as an electronic typewriter. No mathematical calculations were made using WordPerfect.

* Q Class II designation is based on maintaining consistency with the UFSAR Chapter 15 accident analyses (e.g., Calculations N-4072-001, N-4072-002, N-4075-004, N-4077-001).

AUG 25 1997

SITE FILE COPY

This calc. was prepared for the identified DCP/FCN. DCP/FCN completion and turnover acceptance to be verified by receipt of a memorandum directing DCN Conversion. Upon receipt, this calc. represents the as-built condition. Memo date ________ by ________

SCE 26-121-1 REV 3/94 [REFERENCE: SO123-XXIV-7.15]

9710220326 971017
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Calc. rev. number and responsible supervisor initials and date	INPUTS These interfacing calculations and/or documents provide input to the subject calculation, and if revised may require revision of the subject calculation.		OUTPUTS Results and conclusions of the subject calculation are used in these interfacing calculations and/or documents.		Does the output interface calc/document require revision?	Identify output interface calc/document CCN, DCN TCN/Rev. or FIDCN
8/21/97	Calc/Document No.	Rev. No.	Calc/Document No.	Rev. No.	YES/NO	
0	Units 2&3 Calculation M-0073-041	7, CCN-1 → 7	DCP 2&3 6926.01SJ	0	Yes	Post Rev 0 activities for RW# 6926. Activity ID 692600765
	Units 2&3 Calculation M-0073-043	3, CCN-1, 4 → 6	Units 2&3 Calculation J-SPA-289	0	Yes	Action Request 970700095
	Units 2&3 Calculation M-0076-001	3, CCN-1 → 4				
	Units 2&3 Calculation N-0220-030	0, CCN-1				
	Units 2&3 Calculation N-1140-024	0				
	Units 2&3 Calculation N-4010-001	4				
	Units 2&3 Calculation N-4010-002	1				
	Units 2&3 Calculation N-4060-020	2, CCN-2 & 3				
	Units 2&3 Calculation N-4071-001	3, CCN-1				
	Units 2&3 Calculation N-4072-001	4, CCN-1 → 3				
	Units 2&3 Calculation N-4072-003	2, CCN-2				
	Units 2&3 Calculation N-4072-007	3, CCN-1				
	Units 2&3 Calculation N-4073-001	4, CCN-1 & 2				
	Units 2&3 Calculation N-4074-001	2				
	Units 2&3 Calculation N-4075-004	2				
	Units 2&3 Calculation N-4076-001	2, CCN-1				
	Units 2&3 Calculation N-4077-001	7, CCN-1				
	Units 2&3 Calculation N-4078-001	1, CCN-1				

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[illegible] 8/21/97	Calc/Document No.	Rev. No.	Calc/Document No.	Rev. No.	YES/NO	
0	Units 2&3 Calculation N-4080-026	0, CCN-1 & NT2				
	Units 2&3 Calculation N-4097-013	0, CCN-1				
	Units 2&3 Calculation N-4097-015	0				
	Units 2&3 Calculation C-257-01.06.01	1				
	Units 2&3 Calculation C-259-01.01.11	2, CCN-1 → 5				
	Units 2&3 Drawing 31394	17				
	Unit 2 Drawing 31395	16				
	Units 2&3 Drawing 40090	5, FCN F11497M FCN F11514M				
	Units 2&3 Drawing 40092	7				
	Units 2&3 Drawing 40096	14				
	Units 2&3 Drawing 40098	8				
	Unit 2 Drawing 40111A	33				
	Unit 3 Drawing 40111ASO3	31, DCN 38				
	Unit 2 Drawing 40117A	7				
	Unit 3 Drawing 40117ASO3	7				
	Unit 2 Drawing 40171A	24				
	Unit 3 Drawing 40171ASO3	21				
	Units 2&3 Drawing 40173A	17				

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	Calc/Document No.	Rev. No.	Calc/Document No.	Rev. No.	YES/NO	
0	Units 2&3 Drawing 40173C	14				
	Units 2&3 Drawing 41358	12, DCN-48→54 FCN F13531M				
	Units 2&3 Drawing 41366	11, DCN-40→42				
	Units 2&3 Drawing 716031	1				
	Units 2&3 Drawing 716032	1				
	Units 2&3 Drawing SO23-207-1-78	3, DCN 6				
	Units 2&3 Drawing SO23-410-1-1	13, DCN 2				
	Units 2&3 Drawing SO23-990-164	0				
	Procedure SO23-I-2.44	6, TCN 6-2				
	Procedure SO23-I-3.32	6, TCN 6-4				
	Procedure SO123-III-2.22.23	10				
	Procedure SO23-X-7.2	3				
	Unit 2 Technical Specifications	Am. 136				
	Unit 3 Technical Specifications	Am. 128				
	Unit 2 Licensee Controlled Specifications	3				
	Unit 3 Licensee Controlled Specifications	3				
	Units 2&3 UFSAR	12				
	Unit 2 Calculation N-5000-002	0				

SCE 26-424 REV. 1 6/94 [REFERENCE: SO123-XXIV-7.18]

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Calc. rev. number and responsible supervisor initials and date	INPUTS These interfacing calculations and/or documents provide input to the subject calculation, and if revised may require revision of the subject calculation.		OUTPUTS Results and conclusions of the subject calculation are used in these interfacing calculations and/or documents.		Does the output interface calc/document require revision?	Identify output interface calc/document CCN, DCN TCN/Rev. or FIDCN
[illegible] 8/21/97	Calc/Document No.	Rev. No.	Calc/Document No.	Rev. No.	YES/NO	
0	Unit 2 Drawing 40160A	26				
	Unit 3 Drawing 40160ASO3	23				
	DBD-SO23-360	4, DCNs 29, 30				
	Units 2&3 Calculation M-0073-095	3, CCN-1→ 3				
	Units 2&3 Calculation N-4060-027	0, CCN-1				

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	Mark Drucker	8/15/97	T. Remick	8/18/97					

REV ⇓

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REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	Mark Drucker	8/15/97	T. Remick	8/18/97					

1.0 PURPOSE

1.1 Task Description

This calculation determines the offsite and Control Room dose consequences should a common mode software defect cause an undetected failure of the Containment Purge Isolation Signal (CPIS), Control Room Isolation Signal (CRIS), and/or Fuel Handling Isolation Signal (FHIS) during an associated design basis accident, in response to a request by the NRC. The thyroid inhalation and whole body gamma and beta-skin immersion doses due to released materials (but not direct shine doses) are calculated.

This analysis supports Design Change Package DCP 2&3 6926.01SJ and its associated PCN, which changes the radiation monitors used in Engineered Safety Features Actuation Systems (ESFAS) from a totally analog system to a predominately digital design. The software design and procurement controls are intended to prevent any common mode failures that would disable all of the detectors. Since this calculation is originated in support of the PCN process, this analysis is considered as being beyond the design basis of Units 2 & 3. Realistic or best estimate values will therefore be used for selected parameters and times. As a result of the PCN process, licensing commitments may be necessary based on the results of this calculation.

This calculation will evaluate the UFSAR Chapter 15 accidents to ensure that the offsite and Control Room doses are acceptable should a common mode software failure cause the simultaneous, undetected, failure of CPIS, CRIS, and/or FHIS. Currently, Control Room doses are only evaluated for the most severe limiting faults. Because the delay in Control Room isolation may increase the operator doses, additional accidents that release significant amounts of radioactive material (such as the CEA ejection accident) may have their associated Control Room doses evaluated.

1.2 Criteria, Codes and Standards

1.2.1 The Control Room operator dose criteria are defined in the General Design Criteria of Appendix A to 10 CFR 50 (Reference 6.4a). General Design Criterion 19 states that the Control Room personnel must be able to occupy the Control Room during accident conditions without receiving radiation exposures in excess of 5 Rem whole body, or its equivalent to any part of the body, for the duration of the accident.

Section II of Standard Review Plan Section 6.4 (Reference 6.4n) clarifies the dose guidelines for evaluating the protection afforded by the Control Room by indicating that the dose to the Control Room personnel during the entire period of the postulated accident should not exceed:

Control Room (accident duration dose):	Whole body gamma dose of 5 Rem Thyroid dose of 30 Rem Beta-skin dose of 30 Rem

1.2.2 Per the exposure guidelines of 10 CFR 100, Section 100.11(a)(1) (Reference 6.4b), the dose at the exclusion area boundary is for the two hours immediately following onset of the postulated accident. Therefore, the EAB dose should not exceed:

EAB (2 hour dose):	Whole body gamma dose of 25 Rem Thyroid dose of 300 Rem

1.2.3 Per the exposure guidelines of 10 CFR 100, Section 100.11(a)(2), the dose at the outer boundary of the low population zone is for the entire period of the postulated accident. Therefore, the LPZ dose should not exceed:

LPZ (accident duration dose):	Whole body gamma dose of 25 Rem Thyroid dose of 300 Rem

1.2.4 For the Feedwater System Pipe Break accident, Standard Review Plan section 15.2.8 Section II (Reference 6.4x) states that doses should be "a small fraction" (which is defined as 10%) of the 10 CFR 100 limits specified in paragraphs 1.2.2 and 1.2.3.

1.2.5 For the CEA Ejection accident, the NUREG 75/087 Standard Review Plan Section 15.4.8 Appendix A Section II (Reference 6.4p-i) states that the doses should be on the order of 150 Rem to the thyroid and 20 Rem to the whole body, or less (for the first 2 hours at the EAB, and for the accident duration at the LPZ outer boundary). The NUREG-0800 Standard Review Plan section 15.4.8 Appendix A Section II (Reference 6.4p-ii), which is not the SONGS 2&3 licensing basis, reduced the dose criteria to "well within" (which is defined as 75 Rem for the thyroid and 6 Rem for the whole body) the 10 CFR 100 limits specified in paragraphs 1.2.2 and 1.2.3.

1.2.6 For the FHA, SFP Gate Drop, and SFP Boiling accidents, Standard Review Plan section 15.7.4 Section II (Reference 6.4s) states that doses should be "well within" the 10 CFR 100 limits specified in paragraphs 1.2.2 and 1.2.3.

1.2.7 For the Increased Main Steam Flow with a Single Active Failure infrequent incident, Section 5.1 of the NRC Safety Evaluation Report for SONGS PCN-201, 202, 203, 204, and 206 (Reference 6.4u) stated that the doses should be "well within" the 10 CFR 100 limits specified in paragraphs 1.2.2 and 1.2.3.

1.2.8 For the small break Loss of Coolant Accident, Standard Review Plan Section 15.6.5 Appendix A (Reference 6.4r) states that the doses should not exceed the 10 CFR 100 limits specified in paragraphs 1.2.2 and 1.2.3.

1.2.9 For the Inadvertent Opening of a Steam Generator Atmospheric Dump Valve with Single Active Failure event, the offsite dose limit is 0.5 Rem for the whole body based on the guidance of Regulatory Guide 1.26 (Reference 6.4v) and Regulatory Guide 1.29 (Reference 6.4w).

2.0 RESULTS/CONCLUSIONS AND RECOMMENDATIONS

2.1 Results/Conclusions

2.1.1 The beyond design basis Control Room doses for the analyzed accidents coincident with a single common mode failure of the DCP 2&3 6926.01SJ digital radiation monitor system are as follows. The doses meet the limits of General Design Criterion 19.

Accident	Control Room Doses in Rem		
	Thyroid	Beta-Skin	Whole Body
Criteria (Section 1.2)	30	30	5
CEA Ejection (Appendix A)	23.8	0.7	0.1
Feedwater System Pipe Break (Appendix B)*	7.9	<0.1	<0.1
Small Break Loss-of-Coolant Accident (Appendix C)*	≤ 4.9	<0.1	<0.1
FHA in FHB (Appendix D)*	20.4	0.4	<0.1
SFP Gate Drop (Appendix E)*	29.2	0.8	0.1
Increased Main Steam Flow with a Single Active Failure (Appendix F)*	5.1	3.7	0.7
Inadvertent Opening of a Steam Generator ADV with a Single Active Failure (Appendix G)	14.1	<0.1	<0.1
Spent Fuel Pool Boiling (Appendix H)	19.4	Not Evaluated (see App. H)	0.3

* The doses for these accidents assume manual operator actions to isolate the containment mini-purge system and/or to place the Control Room HVAC system into the high radiation isolation mode, per Assumption 3.1.

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	Mark Drucker	8/15/97	T. Remick	8/18/97					

2.1.2 The beyond design basis offsite doses for the analyzed accidents coincident with a single common mode failure of the DCP 2&3 6926.01SJ digital radiation monitor system are as follows.

Accident	EAB Doses in Rem			LPZ Doses in Rem		
	Thyroid	Beta-Skin	Whole Body	Thyroid	Beta-Skin	Whole Body
"Small Fraction" Criteria (10% of Section 1.2 Criteria)	30	N/A	2.5	30	N/A	2.5
Feedwater System Pipe Break (Appendix B)*	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
"Well within" Criteria (25% of Section 1.2 Criteria)	75	N/A	6	75	N/A	6
FHA in FHB (Appendix D)*	0.2	<0.1	<0.1	0.1	<0.1	<0.1
SFP Gate Drop (Appendix E)*	0.6	<0.1	<0.1	0.1	<0.1	<0.1
SFP Boiling (Appendix H)	<0.1	NA	<0.1	<0.1	NA	<0.1
Increased Main Steam Flow with SAF (Appendix F)*	0.2	<0.1	<0.1	0.2	<0.1	<0.1
Other Criteria	150	N/A	20	150	N/A	20
CEA Ejection (Appendix A)	1.0	<0.1	<0.1	0.9	<0.1	<0.1
Full 10CFR100 Criteria	300	N/A	25	300	N/A	25
SBLOCA (Appendix C)**	< 0.1	< 0.1	< 0.1	≤ 0.1	< 0.1	< 0.1
Regulatory Guides 1.26/1.29	N/A	N/A	0.5	N/A	N/A	0.5
IOSGADV/SAF (Appendix G)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

* The doses for these accidents assume manual operator actions to isolate the containment mini-purge system and/or to place the Control Room HVAC system into the high radiation isolation mode, per Assumption 3.1.

** The reported SBLOCA doses assume manual operator actions to isolate the containment mini-purge system at 30 minutes, per Assumption 3.1. However, per Section C5.14, no manual operator actions are required to ensure acceptable offsite dose consequences.

2.2 Recommendations

Some of the accidents evaluated in this calculation take credit for manual operator actions to isolate the containment mini-purge system and/or to place the Control Room HVAC system into the high radiation isolation mode (per Assumption 3.1). It is recommended that Calculation J-SPA-289 address the impact of these changes as they relate to Design Change Package DCP 2&3 6926.01SJ.

3.0 ASSUMPTIONS

NOTE: For those accidents analyzed in an appendix to this calculation, any accident specific assumptions are listed in the appendix.

3.1 The overall initial conditions for the analyses performed in this calculation are:

a. the plant is at steady state prior to the accident.
b. the reactor coolant iodine activity is at the Technical Specification 3.4.16 limit of 1.0 μCi/gm Dose Equivalent I-131.
c. the reactor coolant non-iodine activity is at the Technical Specification 3.4.16 limit of 100/E μCi/gm.
d. the secondary coolant activity profile is based on the iodine activity being at the Technical Specification 3.7.19 limit of 0.1 μCi/gm Dose Equivalent I-131.
e. primary to secondary leakage is at the Technical Specification 3.4.13 limit of 1 gallon per minute.
f. offsite power is not available, so plant cooldown is through the Atmospheric Dump Valves (ADVs) and steam driven Auxiliary Feedwater (AFW) pump.
g. for accidents which release radioactive material to containment, containment mini-purge is assumed to be in operation at the start of the accident. A pre-existing iodine spike at the Technical Specification 3.4.16 limit of 60 μCi/gm Dose Equivalent I-131 is also assumed.

Manual operator actions to isolate the containment mini-purge system, and/or to place the Control Room HVAC system into the high radiation isolation mode, are assumed to occur at the following times in this analysis:

a. FHA Inside Containment - Control Room isolation at 3 minutes (Section 8.1.3.1.7).
b. Feedwater System Pipe Break - Mini-purge isolation at 30 minutes (Appendix B)
c. Small Break LOCA - Control Room and mini-purge isolation at 30 minutes (Appendix C).
d. FHA in FHB - Control Room isolation at 30 minutes (Appendix D).
e. SFP Gate Drop - Control Room isolation at 20 minutes (Appendix E).
f. Increased Main Steam Flow with Single Active Failure - Control Room isolation at 30 minutes (Appendix F).

Except as follows, design basis assumptions are used in this calculation:

a. atmospheric dispersion factors are based on 50 % meteorology, as reported in UFSAR Table 15B-4.

b. during a fuel handling accident inside the containment, manual operator action is credited for isolating the control room within 3 minutes.

c. 9 days of decay occur prior to the start of the SFP gate drop accident.

3.2 When the Control Room is isolated, an unfiltered Control Room inleakage of 10 cfm is assumed to account for door opening, per Standard Review Plan 6.4 Section III.3.d (Reference 6.4n).

3.3 The effects of daughter products are considered in this analysis. The daughter products generated by the radioactive decay of the Iodine isotopes are noble gas isotopes. The daughter products generated by the radioactive decay of the noble gases are Rubidium, Cesium, Strontium and Barium. The Bechtel LOCADOSE computer program (NE-319 Reference 6.6a) places isotopes into groups. Rubidium and Cesium are in LOCADOSE isotope group 5, and Strontium and Barium are in LOCADOSE group 7. Per Table 2-17 "Particulate Release Rates from Gaseous Effluents", of NUREG-0017 (Reference 6.4m) these isotopes are particulates. Additionally, the isotopes in LOCADOSE groups 6 (Te, Sb), 8 (noble metals), and 9 (rare earths) are also listed as particulates. Therefore for this analysis, LOCADOSE Groups 5 to 9 are considered to consist of particulates and will be subject to High Efficiency Particulate Air (HEPA) filtration.

3.4 The breathing rates from Regulatory Guide 1.4 Section C.2.c (Reference 6.4c), which addresses the breathing rates of individuals present at offsite locations during a LOCA, will be used for all analyses. The breathing rate guidance varies as a function of time for the offsite individuals (at work and at rest). The LOCA at-work breathing rate will be assumed to apply to the Control Room operators. The LOCA offsite breathing rates will be assumed to apply to individuals at the EAB and LPZ. These breathing rates are:

Time Interval	CR (m^3/sec)	EAB (m^3/sec)	LPZ (m^3/sec)
0 to 2 hours	3.47×10^{-4}	3.47×10^{-4}	3.47×10^{-4}
2 to 8 hours	3.47×10^{-4}	Not Applicable	3.47×10^{-4}
8 to 24 hours	3.47×10^{-4}	Not Applicable	1.75×10^{-4}
1 to 30 days	3.47×10^{-4}	Not applicable	2.32×10^{-4}

3.5 For consistency with current methodology (such as ABB design analysis A-SG2-FE-0100, Reference 6.7h), an intact steam generator iodine partition coefficient of 0.01 will be used.

3.6 This calculation is based on the Unit 2 Cycle 9 configuration. Due to the symmetry between units, the results are expected to apply to Unit 3 also.

3.7 Shine doses from sources external to the Control Room will not be explicitly considered in this analysis. Per the Calculation N-4060-020 LOCA analysis (Reference 6.1i), approximately 44% of the Control Room whole body gamma dose is due to shine from sources external to the operating area. Of this 44%, approximately half is due to shine from sources external to the Auxiliary Building, and half is due to the shine from the Control Room HVAC filter units located inside the Auxiliary Building. To account for these shine doses, the Control Room whole body immersion dose calculated by LOCADOSE will be doubled. Not performing a detailed analysis of the shine doses does not affect the conclusions of this analysis, as the Control Room whole body doses are much less limiting than the thyroid doses (as shown in Section 2 of this calculation).

3.8 Unless otherwise justified, operator action to manually place the Control Room HVAC system in the high radiation isolation mode is assumed to take place no sooner than 20 minutes after the start of the accident. The 20 minute interval is addressed in Standard Review Plan Section 6.4, paragraph III.3.d(3) on page 6.4-10 (Reference 6.4n). The high radiation isolation mode of operation can be easily initiated from the Control Room by manual action.

3.9 The released secondary steam is assumed to be free of non-iodine particulates per Calculation N-4097-015 section II.2.1 (Reference 6.1v).

3.10 Since the steam released from the secondary side does not contain particulates (per Assumption 3.9), particulates which do not decay to iodines or noble gases will not be modeled in the Secondary Side.

3.11 The steam density in the secondary side is assumed to be 1.95 lbm/ft^3, which corresponds to saturated steam at approximately 850 psig. As shown in Section 5.4.6, the value used is not significant to the calculated results.

3.12 The iodine species fractions will be taken as 91% elemental, 4% organic, and 5% particulate. This is consistent with Regulatory Guide 1.4 (Reference 6.4c).

3.13 The reactor coolant system density chosen will be based on the hot leg conditions. As shown in Section 5.4.5, the RCS density should be minimized to maximize the calculated doses. The minimum RCS density (other than the pressurizer, which is not an area of concern) is found at the core exit/hot leg.

3.14 For the fuel handling accident inside Containment, operator action to manually place the Control Room HVAC system in the high radiation isolation mode within 3 minutes is assumed. This duration is reasonable, given the Licensee Controlled Specification (LCS) 3.9.102 (References 6.4j and 6.4k) requirement for continuous communications with the Control Room during fuel handling activities inside containment. The NRC concurred with this approach in the April 1996 meeting on the radiation monitor replacement project.

4.0 DESIGN INPUTS

NOTE: For those accidents analyzed in an appendix to this calculation, any specific design inputs are specified in the appendix.

4.1 The Control Room HVAC parameters during normal and high radiation isolation operation are as follows (the configuration is shown on References 6.2k and 6.2l). For conservatism, the high radiation isolation mode outside air intake flow rate was increased to the upper tolerance (per procedure SO23-I-2.44, Reference 6.5d), and the recirculation flowrate decreased to the lower tolerance (per procedure SO23-I-2.44). The SO23-I-2.44 tolerances are consistent with calculation M-0073-043 (Reference 6.1w) page 9 of 24 (±150 cfm for filtered intake) and page 20 of 24 (±10% for filtered recirculation). For the first 8 hours of the accident, two trains of emergency HVAC are in operation (consistent with UFSAR Appendix 15B, Reference 6.4l).

Parameter	CR Normal Operation		CR High Radiation Isolation Operation per Train	
	Value	Reference	Value	Reference
Filtered Intake	0 cfm	40096 (Ref. 6.2e)	2050 + 150 = 2200 cfm	40096 (Ref 6.2e) 40098 (Ref 6.2f) SO23-I-2.44 (6.5d)
Unfiltered Intake	5820 cfm	40096 (Ref. 6.2e)	0 cfm + 10 cfm per Assumption 3.2	40096 (Ref 6.2e) 40098 (Ref 6.2f)
Filtered Recirculation	0 cfm	40096 (Ref. 6.2e)	(35,705-10%)-2200 = 29,934.5 cfm*	40096 (Ref 6.2e) 40098 (Ref 6.2f) SO23-I-2.44 (6.5d)
Unfiltered Recirculation	29,885 cfm	40096 (Ref. 6.2e)	0 cfm	40096 (Ref. 6.2e) 40098 (Ref. 6.2f)

* conservatively rounded down to 29,934 cfm for single train operation

4.2 Per drawings 40096 (Reference 6.2e) and 40098 (Reference 6.2f), the makeup air entering the Control Room passes through both the EVS and EAC filter trains. However, per UFSAR Appendix 15B (Reference 6.4l), credit is only taken for the EAC charcoal filter. The recirculation air passes only through the EAC filter train. The EAC iodine filter efficiency is based on the charcoal filter depth of 2 inches (Reference 6.1k) and the corresponding charcoal filter efficiency values given in Regulatory Guide 1.52 Table 2 (Reference 6.4f). The EAC particulate efficiency is based on the

HEPA efficiencies given in Regulatory Guide 1.52 section C.5.c. Regulatory Guide 1.52 efficiencies are applicable since Technical Specification 5.5.2.12 (References 6.4h and 6.4i) tests the EAC filters to this Regulatory Guide. Per Regulatory Guide 1.52 this results in the following elemental, organic, and particulate iodine removal efficiencies for the LOCADOSE intake and recirculation filters.

Item Being Removed	EVS Removal Efficiency (A206/A207)	EAC Filter Efficiency (E418/E419)	LOCADOSE Intake Removal Efficiency	LOCADOSE Recirculation Removal Efficiency
Elemental Iodine	0%	95%	95%	95%
Organic Iodide	0%	95%	95%	95%
Particulates	0%	99%	99%	99%

4.3 Some of the analyses presented in this calculation model a Control Room net free volume of 244,398 ft^3 based on Calculation M-0073-041 page 7 (Reference 6.1c). Since first cited, Calculation M-0073-041 was revised in CCN-5 to calculate the Control Room gross volume rather than the net free volume. And, the control room net free volume has been revised based on more accurate physical data to be 266,920 ft^3 in Calculation M-0073-095 (Reference 6.1y, CCN-3). Calculation N-4060-027 (Reference 6.1z) assessed the impact of that revised volume on CR doses due to design basis accidents and concluded that the revised volume produces insignificant impacts on CR doses. Any subsequent revision to this calculation should use the revised volume 266,920 ft^3.

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CALCULATION SHEET

ICCN NO./ PRELIM. CCN NO.

PAGE ___ OF ___

Project or DCP/MMP DCP 2&3 6926.01SJ

Calc. No. N-0720-014

CCN CONVERSION: CCN NO. CCN --

Subject Control Room and Offsite Doses Should CPIS, CRIS, and FHIS Fail

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	Mark Drucker	8/15/97	T. Remick	8/18/97					

4.4 The occupancy factors for the Control Room are given in Standard Review Plan 6.4 Figure/Table 6.4-1 (Reference 6.4n). Per 10 CFR 100.11 (Reference 6.4b), the offsite post-accident doses are to be calculated for an individual who is exposed for the entire interval of interest (which means an occupancy factor of 1.0). Therefore, the occupancy factors are:

Exclusion Area Boundary	1.0 for 0 hour to 2 hours 0.0 for 2 hours to 720 hours
Low Population Zone Boundary	1.0 for 0 hour to 720 hours
Control Room	1.0 for 0 hours to 24 hours 0.6 for 24 hours to 96 hours 0.4 for 96 hours to 720 hours

4.5 The 50% meteorology atmospheric dispersion factors (χ/Q) for releases from the Containment to the locations of interest are as follows per Calculations N-4010-001 page 40 (Reference 6.1g) and N-4010-002 Revision 1 page 3 (Reference 6.1h). Because the Control Room χ/Qs include occupancy factors (N-4010-001 page 36 and 39), the values from N-4010-001 are modified as shown below to remove the impact of the occupancy factors (these values are also given in UFSAR Table 15B-4).

	50 Percentile χ/Q (sec/m^3)				
	0-2 Hours	2-8 Hours	8-24 Hours	24-96 Hours	96-720 Hours
Control Room	7.9×10^{-4} @	7.9×10^{-4} @	4.6×10^{-4} *	2.5×10^{-4} +	6.25×10^{-5} #
Exclusion Area Boundary	3.6×10^{-6}	NA	NA	NA	NA
Low Population Zone	9.24×10^{-7}	9.24×10^{-7}	6.03×10^{-7}	3.65×10^{-7}	3.28×10^{-7}

@ 7.9×10^{-4} from N-4010-001 ÷ occupancy factor of 1.0 from Design Input 4.4 = 7.9×10^{-4}

* 4.6×10^{-4} from N-4010-001 ÷ occupancy factor of 1.0 from Design Input 4.4 = 4.6×10^{-4}

\+ 1.5×10^{-4} from N-4010-001 ÷ occupancy factor of 0.6 from Design Input 4.4 = 2.5×10^{-4}

\# 2.5×10^{-5} from N-4010-001 ÷ occupancy factor of 0.4 from Design Input 4.4 = 6.25×10^{-5}

4.6 The core exit/hot leg conditions are 611°F and 2250 psia per drawings 40111A (Reference 6.2g) and 40111ASO3 (Reference 6.2h). Per the ASME steam tables, the specific volume at these conditions is 0.02371 ft³/lbm, with an equivalent density of 42.176 lbm/ft³. Per Assumption 3.13, these values will be used when converting RCS mass release rates to volumetric release rates.

4.7 The containment free volume is 2,305,000 ft³ per Calculation C-257-1.06.01 (Reference 6.1a, page 7).

4.8 The default dose conversion factors in the Bechtel LOCADOSE computer program (Reference 6.6a) will be used in this calculation. These dose conversion factors are shown in the LOCADOSE library files included in each analysis.

4.9 Per Calculation N-4097-015 (Reference 6.1v), the reactor coolant and secondary side activity concentrations are given in the following table, based on a burnup of 60 GWD/t. The reactor coolant activity is based on 1.0 μCi/gm Dose Equivalent I-131, and $100/\bar{E}$ for non-iodine isotopes.

The secondary side liquid activities are based on 0.1 μCi/gm Dose Equivalent I-131, with the same scaling factor used for non-iodine isotopes. The secondary side steam activities are based on an iodine partition factor of 0.01, a particulate partition factor of 0.002, and with the noble gas activity concentrations based on the normal primary to secondary leakage of 1440 lbm/day.

Per Assumptions 3.9 and 3.10 particulates are not required to be modeled unless calculation N-1140-024 (Reference 6.1f) determined that the particulate decays to a noble gas or iodine, or unless required by the specific accident being analyzed. Those isotopes required to be modeled are identified in bold in the following table.

Per Assumption 3.3, daughter products are included in the analysis. For this reason, the LOCADOSE Library files will also include isotopes (such as Rb-88 and Cs-135) that are not required per the preceding.

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CALCULATION SHEET

ICCN NO./ PRELIM. CCN NO.

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Project or DCP/MMP DCP 2&3 6926.01SJ Calc. No. N-0720-014

CCN CONVERSION: CCN NO. CCN --

Subject Control Room and Offsite Doses Should CPIS, CRIS, and FHIS Fail

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	Mark Drucker	8/15/97	T. Remick	8/18/97					

PRIMARY AND SECONDARY SYSTEM ACTIVITY CONCENTRATIONS

Isotope	RCS Activity (μCi/gm)	SG Liquid Activity (μCi/gm)	SG Steam Activity (μCi/gm)	Required per N-1140-024?	Particulate ?
I-131	8.03E-01	8.13E-02	8.13E-04	Yes	
I-132	2.25E-01	1.54E-02	1.54E-04	Yes	
I-133	9.90E-01	9.57E-02	9.57E-04	Yes	
I-134	9.85E-02	4.43E-03	4.43E-05	Yes	
I-135	4.36E-01	3.78E-02	3.78E-04	Yes	
Kr-85m	2.47E+00	0	8.19E-05	Yes	
Kr-85	1.08E+01	0	3.58E-04	Yes	
Kr-87	1.16E+00	0	3.84E-05	Yes	
Kr-88	3.74E+00	0	1.24E-04	Yes	
Xe-131m	2.51E+00	0	8.32E-05	Yes	
Xe-133	3.44E+02	0	1.14E-02	Yes	
Xe-135m	1.16E+00	0	3.84E-05	Yes	
Xe-135	1.07E+01	0	3.55E-04	Yes	
Xe-138	5.87E-01	0	1.95E-05	Yes	
H-3	3.22E+00	1.49E+03	2.98E+00	No	
Br-84	4.18E-02	1.54E-03	3.08E-06	Yes	
Rb-88	4.27E+00	1.13E-01	2.26E-04	No	Yes (NE-319 Group 5)
Sr-89	9.80E-03	1.74E-03	3.48E-06	No	Yes (NUREG-0017)
Sr-90	1.09E-03	1.95E-04	3.90E-07	No	Yes (NUREG-0017)
Y-90	1.49E-03	2.59E-04	5.18E-07	No	Yes (NE-319 Group 9)
Y-91	1.02E-01	1.81E-02	3.62E-05	No	Yes (NE-319 Group 9)
Y-91m	4.05E-03	2.37E-04	4.74E-07	No	Yes (NE-319 Group 9)
Sr-91	6.47E-03	9.76E-04	1.95E-06	No	Yes (NUREG-0017)
Mo-99	2.35E+00	4.09E-01	8.18E-04	No	Yes (NE-319 Group 8)
Ru-103	9.93E-03	1.76E-03	3.52E-06	No	Yes (NUREG-0017)
Ru-106	7.54E-04	1.34E-04	2.68E-07	No	Yes (NUREG-0017)
Te-129	5.24E-02	3.81E-03	7.62E-06	Yes	Yes (NE-319 Group 6)
Te-132	6.75E-01	1.19E-01	2.38E-04	Yes	Yes (NE-319 Group 6)
Cs-134	4.03E-01	7.21E-02	1.44E-04	No	Yes (NUREG-0017)
Cs-136	2.78E-02	4.95E-03	9.90E-06	No	Yes (NUREG-0017)
Cs-137	1.24E+00	2.23E-01	4.46E-04	No	Yes (NUREG-0017)
Ba-140	1.28E-02	2.27E-03	4.54E-06	No	Yes (NUREG-0017)
La-140	1.28E-02	2.19E-03	4.38E-06	No	Yes (NUREG-0017)
Pr-143	1.19E-02	2.11E-03	4.22E-06	No	Yes (NE-319 Group 9)
Ce-144	9.05E-03	1.61E-03	3.22E-06	No	Yes (NE-319 Group 9)
Cr-51	3.54E-03	6.30E-04	1.26E-06	No	Yes (NE-319 Group 9)
Mn-54	1.16E-03	2.05E-04	4.10E-07	No	Yes (NUREG-0017)
Zr-95	1.14E-02	2.04E-03	4.08E-06	No	Yes (NUREG-0017)
Co-60	7.44E-03	1.33E-03	2.66E-06	No	Yes (NUREG-0017)
Fe-59	1.85E-03	3.29E-04	6.58E-07	No	Yes (NUREG-0017)
Co-58	5.93E-01	1.06E-02	2.12E-05	No	Yes (NUREG-0017)

4.10 The Containment leak rate is 0.1% by volume per day for the first 24 hours of the accident per Technical Specification SR 3.6.1.1 (Reference 6.4h and 6.4i). Per Regulatory Guides 1.4 (Reference 6.4c) and 1.77 (Reference 6.4g), the leak rate is reduced by 50% after 24 hours. As shown below, this is equivalent to the following leakage rates (based on the Containment volume per Design Input 4.7):

$$Containment\ Leak\ Rate = (2.305E{+}06\,ft^3) \times \frac{0.001}{day} \times \frac{day}{24 \times 60\ min} = 1.6\ cfm$$

$$Containment\ Leak\ Rate = (2.305E{+}06\,ft^3) \times \frac{0.0005}{day} \times \frac{day}{24 \times 60\ min} = 0.8\ cfm$$

4.11 Technical Specification 3.4.13 (Reference 6.4h and 6.4i) limits primary to secondary leakage to 0.5 gpm per steam generator, with an overall limit of 1 gpm to both steam generators. This analysis will be based on the overall limit of 1 gpm. Per procedure SO123-III-2.22.23 step 6.4.1.6 (Reference 6.5b), leakage is evaluated after the sample has been cooled to a density of 8.34 lbm/gallon. Therefore, the primary to secondary leakage of 1 gpm is equivalent to 8.34 lbm/min. Per Assumption 3.13, this 8.34 lbm/min leakage will be converted to an equivalent flow rate at the Design Input 4.6 hot leg conditions.

$$\frac{8.34\ lbm}{min} \times \frac{0.02371\ ft^3}{lbm} = 0.198\ cfm$$

4.12 Per Calculation N-0220-030 (Reference 6.1e, sheets 14 and 24), the reactor coolant system (RCS) cold nominal volume (without the pressurizer) is 10,103 cubic feet. Applying the RCS expansion factor of 1.4 percent from CE Letter S-91-031 (Reference 6.31) yields the reactor coolant system hot nominal volume (not including the pressurizer liquid volume). Per Calculation N-0220-030 (sheets 14 and 23), the pressurizer water volume at the nominal operating point is 819 cubic feet. Based on these volumes, the reactor coolant system has a liquid volume of:

$$V_{RCS} = (V_{RCS\ w/o\ PZR} \times Expansion\ Factor) + V_{PZR,liquid}$$
$$V_{RCS} = (10{,}103\ ft^3 \times 1.014) + 819\ ft^3$$
$$V_{RCS} = 11{,}063\ ft^3$$

This volume will be conservatively rounded down to 11,000 ft^3, as discussed in Section 5.4.5.

4.13 Using the RCS volume (per Design Input 4.12), the activity (for the modeled isotopes) specified in Design Input 4.9, and the RCS density per Design Input 4.6, the total number of Curies in the RCS liquid (without an iodine spike) is:

$$Ci = \frac{\mu Ci}{gm} \times \frac{454\ gm}{lbm} \times \frac{42.176\ lbm}{ft^3} \times 11{,}000\ ft^3 \times \frac{Ci}{10^6\ \mu Ci}$$

$$Ci = 210.6 \times \frac{\mu Ci}{cc}$$

Therefore, the total activity present in the primary system is:

PRIMARY SYSTEM ACTIVITY INVENTORY (NO IODINE SPIKE)			
Isotope	DI 4.9 RCS Activity Concentration (μCi/gm)	× Scaling Factor	= RCS Activity (Ci)
I-131	8.03E-01	210.6	1.69E+02
I-132	2.25E-01	210.6	4.74E+01
I-133	9.90E-01	210.6	2.08E+02
I-134	9.85E-02	210.6	2.07E+01
I-135	4.36E-01	210.6	9.18E+01
Kr-85m	2.47E+00	210.6	5.20 E+02
Kr-85	1.08E+01	210.6	2.27E+03
Kr-87	1.16E+00	210.6	2.44E+02
Kr-88	3.74E+00	210.6	7.88E+02
Xe-131m	2.51E+00	210.6	5.29E+02
Xe-133	3.44E+02	210.6	7.24E+04
Xe-135m	1.16E+00	210.6	2.44E+02
Xe-135	1.07E+01	210.6	2.25E+03
Xe-138	5.87E-01	210.6	1.24E+02
H-3	3.22E+00	210.6	6.78E+02
Br-84	4.18E-02	210.6	8.80E+00
Te-129	5.24E-02	210.6	1.10E+01
Te-132	6.75E-01	210.6	1.42E+02

4.14 For those accidents where a pre-existing iodine spike (equivalent to 60 μCi/gm Dose Equivalent I-131 per Technical Specification 3.4.16, References 6.4h and 6.4i) is present, the iodine present in the RCS is increased by a factor of 60 over the 1.0 μCi/gm Dose Equivalent I-131 values in Design Input 4.13.

PRIMARY SYSTEM IODINE ACTIVITY INVENTORY (WITH PRE-EXISTING IODINE SPIKE)			
Isotope	DI 4.9 RCS Activity Concentration (μCi/gm)	× Scaling Factors	= RCS Activity (Ci)
I-131	8.03E-01	210.6 × 60	1.01E+04
I-132	2.25E-01	210.6 × 60	2.84E+03
I-133	9.90E-01	210.6 × 60	1.25E+04
I-134	9.85E-02	210.6 × 60	1.25E+03
I-135	4.36E-01	210.6 × 60	5.51E+03

4.15 The secondary system will be modeled as 1E+09 cubic feet of steam, with the steam activity (for the modeled isotopes) as specified in Design Input 4.9, at the Assumption 3.11 steam density. A large volume is used so that the steam releases (from the secondary system) do not appreciably affect the volume. The specific activity of the secondary system (from Design Input 4.9) can be converted to a total number of Curies in the 1E+09 ft^3 secondary system steam node as follows:

$$Ci = \frac{\mu Ci}{gm} \times (1.0x10^9 ft^3) \times \frac{1.95\ lbm}{ft^3} \times \frac{454\ gm}{lbm} \times \frac{Ci}{10^6\ \mu Ci}$$

$$Ci = 885{,}300 \times \frac{\mu Ci}{gm}$$

Therefore, the total activity present in the secondary system steam is:

SECONDARY SYSTEM STEAM ACTIVITY INVENTORY			
Isotope	DI 4.9 SG Steam Activity Concentration (μCi/gm)	× Scaling Factor	= Secondary Steam Activity (Ci)
I-131	8.13E-04	885,300	7.20E+02
I-132	1.54E-04	885,300	1.36E+02
I-133	9.57E-04	885,300	8.47E+02
I-134	4.43E-05	885,300	3.92E+01
I-135	3.78E-04	885,300	3.35E+02
Kr-85m	8.19E-05	885,300	7.25E+01
Kr-85	3.58E-04	885,300	3.17E+02
Kr-87	3.84E-05	885,300	3.40E+01
Kr-88	1.24E-04	885,300	1.10E+02
Xe-131m	8.32E-05	885,300	7.37E+01
Xe-133	1.14E-02	885,300	1.01E+04
Xe-135m	3.84E-05	885,300	3.40E+01
Xe-135	3.55E-04	885,300	3.14E+02
Xe-138	1.95E-05	885,300	1.73E+01
H-3	2.98E+00	885,300	2.64E+06
Br-84	3.08E-06	885,300	2.73E+00
Te-129	7.62E-06	885,300	6.75E+00
Te-132	2.38E-04	885,300	2.11E+02

4.16 Reactor Core Isotope Inventory

The average fuel rod inventory of noble gas and iodine isotopes for non-LOCA transients is calculated in design analysis A-SG-FE-0064 (Reference 6.7b, Table 4.1). The A-SG-FE-0064 fuel rod activities are based on a core power of 3390 MWt, an average power per fuel rod of 68.045 KW, fresh fuel enrichments up to 5 weight percent U-235, and burnups equal to 20 GWD/t, 30 GWD/t, and 40 GWD/t. The A-SG-FE-0064 Table 4-1 isotope-specific activities represent the highest isotopic inventory for each combination of burnup and enrichment. There were no refueling times assumed in achieving these burnups. Fission product activities beyond 40 GWD/t were not calculated because the relative power in a fuel rod with a burnup greater than 40 GWD/t is most likely less than unity, the fission rate would be dropping as the burnup increases, and consequently the high burnup fission product activities would be less than those at a 40 GWD/t burnup.

The A-SG-FE-0064 average fuel rod inventory is based on a core loading of 49,820 fuel rods and 1,392 shims. For conservatism, the core inventory used in this analysis will be based on having fuel (at the A-SG-FE-0064 average fuel rod inventory) in all 51,212 available locations (i.e., 217 assemblies × 236 potential locations per assembly).

CORE ACTIVITY INVENTORY			
Isotope	A-SG-FE-0064 Average Fuel Rod Activity Inventory (Ci/rod)	× Maximum Number of Fuel Rods in Core	= Core Activity Inventory (Ci)
I-131	1.859e+03	51212	9.520e+07
I-132	2.679e+03	51212	1.372e+08
I-133	3.762e+03	51212	1.927e+08
I-134	4.168e+03	51212	2.135e+08
I-135	3.514e+03	51212	1.800e+08
Kr-83m	2.619e+02	51212	1.341e+07
Kr-85m	5.833e+02	51212	2.987e+07
Kr-85	2.234e+01	51212	1.144e+06
Kr-87	1.147e+03	51212	5.874e+07
Kr-88	1.621e+03	51212	8.301e+07
Xe-131m	2.084e+01	51212	1.067e+06
Xe-133m	1.172e+02	51212	6.002e+06
Xe-133	3.666e+03	51212	1.877e+08
Xe-135m	7.438e+02	51212	3.809e+07
Xe-135	1.115e+03	51212	5.710e+07
Xe-138	3.247e+03	51212	1.663e+08

4.17 Per drawing 40092 (Reference 6.2d) the nominal flow rate through the Containment HVAC mini-purge system is 2000 cfm. For conservatism, this flow rate will be increased by 10% to 2200 cfm for use in this analysis.

4.18 Per calculation A-SG2-FE-0060 (Table 3.6-11, Reference 6.7a) the maximum 100% power Unit 2 cycle 9 peaking factor is 1.6935. To allow margin for future increases, a peaking factor of 1.73 will be used in this analysis.

5.0 METHODOLOGY

5.1 General Methodology

As discussed in Section 1.1, selected accidents will be evaluated for the beyond design basis case where a single common mode failure causes an undetected, concurrent failure of all the digital radiation monitors.

Depending on the accident sequence, a formal analysis may not be required. For these cases, a discussion will be provided. If a formal analysis is performed, it will be done using the LOCADOSE computer code (Reference 6.6a). This computer code is described in Section 5.2.

5.2 LOCADOSE Computer Code Description

The doses due to the accident activity release mechanisms will be evaluated through use Bechtel Standard Computer Program NE-319, LOCADOSE (Reference 6.6a). The LOCADOSE Code consists of three modules: an activity transport program, a dose calculation program, and a filter loading program. The first two modules will be used in this calculation.

The activity transport module calculates activities, integrated activities and releases over a time period using a multi-region model that can accommodate up to nine regions and fifty time steps. Daughter isotope activities, spray removal and LOCA during purge option can be performed by this program. Activities, integrated activities and releases are saved on a file for use by the other modules.

The dose calculation module uses the file generated by the activity transport program, the isotope library file and a user-generated data file to calculate dose rates and doses. Doses and dose rates can be obtained for all the regions used by the activity transport program and for up to twenty offsite locations.

The LOCADOSE code is executed on the Nuclear Fuel Management IBM-RISC 6000 workstation. Use of the LOCADOSE code on the IBM-RISC 6000 workstation has been verified and validated as detailed in the Software Installation Report (Reference 6.6b).

5.3 EAB, LPZ and Control Room Immersion and Inhalation Doses

5.3.1 General Methodology

This calculation determines the immersion and inhalation doses due to the airborne cloud at the EAB and LPZ and the cloud inside the Control Room. The LOCADOSE dose calculation program will be run using the appropriate assumptions and design inputs from both the main calculation and the associated Appendix for each analyzed accident. The model used for a particular accident is detailed in the Appendix for that accident.

5.3.2 Accidents Not Resulting in Fuel Failure

For those accidents which do not result in fuel failure, the radioactive material released to the various locations is simply the mass released times the specific activity of the released material (primary coolant, secondary coolant, or secondary steam).

5.3.3 Accidents Resulting in Fuel Failure

For those accidents which result in fuel failure, the radioactive material released to the various locations consists of:

a. The radioactive material originally present in the primary coolant, secondary coolant, or secondary steam (per Section 5.3.2).

b. The radioactive material released from the failed fuel that is transported to the environment.

The material released from the failed fuel into the reactor coolant system is based upon an assumption that the fuel that fails is operating at the highest peaking factor, that a limited amount of the fuel rod activity inventory is present in the fuel rod gap (if no fuel melting occurs), and that all of the material in the gap of all of the failed fuel is released to the RCS. For a given failed fuel percentage, the amount of material released to the primary coolant is thus:

$$\textit{Release to RCS} = \textit{Core Inventory (Ci)} \times \textit{Failed Fuel Fraction} \times \textit{Gap Activity Fraction} \times \textit{Peaking Factor}$$

The released material is assumed to be evenly diluted in the primary coolant, and then is released to the containment, secondary side, or environment at the applicable leak rate.

5.4 Mass Release to Volumetric Release Conversion

The LOCADOSE code is based on volumetric flow rates (cfm), while most of the accident release information from ABB/CE is given on a mass basis. The LOCADOSE code is also based on providing a node volume, and an activity inventory (in curies) for that node. This section addresses the methodology of the conversion of mass releases to volumetric releases. For clarity, some unit conversions (such as μCi to Ci) are not shown in the following sections.

5.4.1 Primary to Secondary Leakage Without Fuel Failure

The activity release rate due to primary to secondary leakage (not including the impact of failed fuel) is:

$$\mathring{A}_{P\text{-}S}\left(\frac{Ci}{min}\right) = \frac{A_{RCS}(Ci)}{V_{RCS}(ft^3)} \times Q_{P\text{-}S}\left(\frac{ft^3}{min}\right)$$

Where:

- $\mathring{A}_{P\text{-}S}$ activity release rate due to primary to secondary leakage
- A_{RCS} activity present in RCS in Curies
- V_{RCS} RCS volume in cubic feet
- $Q_{P\text{-}S}$ primary to secondary volumetric flow rate in cfm

A_{RCS} is calculated in Design Inputs 4.13 and 4.14 from the Design Input 4.9 concentrations (C_{RCS}) as follows:

$$A_{RCS}(Ci) = C_{RCS}\left(\frac{\mu Ci}{gm}\right) \times V_{RCS}(ft^3) \times Density_{RCS}\left(\frac{gm}{ft^3}\right) \times \textit{Iodine Spiking Factor}$$

$Q_{P\text{-}S}$ is calculated in Design Input 4.11 from the mass release rate ($M_{P\text{-}S}$) as follows:

$$Q_{P\text{-}S}\left(\frac{ft^3}{min}\right) = \frac{M_{P\text{-}S}\left(\frac{gm}{min}\right)}{Density_{RCS}\left(\frac{gm}{ft^3}\right)}$$

Substituting A_{RCS} and $Q_{P\text{-}S}$ into the original equation yields:

$$\mathring{A}_{P\text{-}S}\left(\frac{Ci}{min}\right) = \frac{C_{RCS}\left(\frac{\mu Ci}{gm}\right) \times V_{RCS}(ft^3) \times Density_{RCS}\left(\frac{gm}{ft^3}\right) \times IodineSpikingFactor}{V_{RCS}(ft^3)} \times \frac{M_{P\text{-}S}\left(\frac{gm}{min}\right)}{Density_{RCS}\left(\frac{gm}{ft^3}\right)}$$

As can be seen, V_{RCS} and $Density_{RCS}$ drop out of the above equation. This means that for a given C_{RCS}, Iodine Spiking Factor, and $M_{P\text{-}S}$, any V_{RCS} and $Density_{RCS}$ may be used without affecting the calculated primary to secondary activity release rate.

5.4.2 Primary Coolant Releases Without Fuel Failure

Primary coolant is released to the containment atmosphere during the CEA ejection and SBLOCA events. Provided that no fuel failure has occurred, the volumetric flow rate for this path follows the equations given in Section 5.4.1 (if fuel failure occurs, the activity release rate changes as described in Section 5.4.3). The P-S parameter would change to P-C for the primary to containment releases. Any V_{RCS} and $Density_{RCS}$ may be used without affecting the calculated primary to containment activity release rate.

5.4.3 Primary to Secondary Leakage With Fuel Failure

When fuel failure occurs, an additional activity release rate is present due to the activity released to the reactor coolant system from the failed fuel. The total activity release rate is:

$$\mathring{A}_{TOTAL}\left(\frac{Ci}{min}\right) = \mathring{A}_{P\text{-}S}\left(\frac{Ci}{min}\right) + \mathring{A}_{P\text{-}S,FF}\left(\frac{Ci}{min}\right)$$

$\mathring{A}_{P\text{-}S}$ is as described in section 5.4.1. $\mathring{A}_{P\text{-}S,FF}$ is:

$$\mathring{A}_{P\text{-}S,FF}\left(\frac{Ci}{min}\right) = \frac{A_{FF}(Ci)}{V_{RCS}(ft^3)} \times Q_{P\text{-}S}\left(\frac{ft^3}{min}\right)$$

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Where:

- $\mathring{A}_{P\text{-}S,FF}$ activity release rate from failed fuel due to primary to secondary leakage
- A_{FF} activity present in RCS from failed fuel in Curies
- V_{RCS} RCS volume in cubic feet
- $Q_{P\text{-}S}$ primary to secondary volumetric flow rate in cfm

$Q_{P\text{-}S}$ is calculated in Design Input 4.11 from the mass release rate ($M_{P\text{-}S}$) as follows:

$$Q_{P\text{-}S}\left(\frac{ft^3}{min}\right) = \frac{M_{P\text{-}S}\left(\frac{gm}{min}\right)}{Density_{RCS}\left(\frac{gm}{ft^3}\right)}$$

Substituting $Q_{P\text{-}S}$ into the original equation yields:

$$\mathring{A}_{P\text{-}S,FF}\left(\frac{Ci}{min}\right) = \frac{A_{FF}(Ci)}{V_{RCS}(ft^3)} \times \frac{M_{P\text{-}S}\left(\frac{gm}{min}\right)}{Density_{RCS}\left(\frac{gm}{ft^3}\right)}$$

As can be seen, neither V_{RCS} nor $Density_{RCS}$ drops out of the above equation. In order to maximize the activity release rate, V_{RCS} and $Density_{RCS}$ should be minimized (a smaller V_{RCS} and $Density_{RCS}$ results in a larger $A_{P\text{-}S,FF}$).

5.4.4 Primary Coolant Releases With Fuel Failure

Primary coolant is released to the containment atmosphere during the CEA ejection and SBLOCA events. The volumetric flow rate for this path follows the equations given in Section 5.4.1 and Section 5.4.3. The P-S parameter would change to P-C for the primary to containment releases. V_{RCS} and $Density_{RCS}$ should be minimized to maximize the activity release rate.

5.4.5 RCS Density and Volume

Per Sections 5.4.3 and 5.4.4, the values used for V_{RCS} and $Density_{RCS}$ should be minimized to conservatively maximize the activity release rate due to failed fuel. As shown in Sections 5.4.1 and 5.4.2, use of the minimized values for V_{RCS} and $Density_{RCS}$ does not affect the calculated activity release rate.

5.4.6 Secondary Steam Releases

The activity release rate from the secondary side (due to MSSV and ADV operation) is:

$$\mathring{A}_{SEC}(\frac{Ci}{min}) = \frac{A_{SEC,TS}(Ci)}{V_{SEC}(ft^3)} \times Q_{SEC}(\frac{ft^3}{min})$$

Where:

- $\mathring{A}_{SEC}$ activity release rate due to MSSV/ADV secondary team releases (at TS limits)
- $A_{SEC,TS}$ activity present in secondary side steam at Tech Spec limits in Curies
- V_{SEC} secondary side steam volume in cubic feet
- Q_{SEC} secondary side MSSV/ADV volumetric steam flow release rate in cfm

$A_{SEC,TS}$ is calculated in Design Input 4.15 from the Design Input 4.9 concentrations ($C_{SEC,TS}$) as follows:

$$A_{SEC,TS}(Ci) = C_{SEC,TS}(\frac{\mu Ci}{gm}) \times V_{SEC}(ft^3) \times Density_{SEC}(\frac{gm}{ft^3})$$

Q_{SEC} can be calculated from mass release rate (M_{SEC}) as follows:

$$Q_{SEC}(\frac{ft^3}{min}) = \frac{M_{SEC}(\frac{gm}{min})}{Density_{SEC}(\frac{gm}{ft^3})}$$

Substituting $A_{SEC,TS}$ and Q_{SEC} into the original equation yields:

$$\mathring{A}_{SEC}(\frac{Ci}{min}) = \frac{C_{SEC,TS}(\frac{\mu Ci}{gm}) \times V_{SEC}(ft^3) \times Density_{SEC}(\frac{gm}{ft^3})}{V_{SEC}(ft^3)} \times \frac{M_{SEC}(\frac{gm}{min})}{Density_{SEC}(\frac{gm}{ft^3})}$$

As can be seen, V_{SEC} and $Density_{SEC}$ drop out of the above equation. Thus, for a given $C_{SEC,TS}$ and M_{SEC}, any V_{SEC} and $Density_{SEC}$ may be used without affecting the calculated secondary steam activity release rate. Because the LOCADOSE models for each appendix transport the primary to secondary leakage directly to the environment (with appropriate filtration to model the steam generator partitioning) rather than into the Secondary Steam node, the presence of failed fuel does not affect the secondary steam activity release rate.

6.0 REFERENCES

6.1 SCE Calculations

6.1a Units 2&3 Calculation C-257-01.06.01, Revision 1, Containment Shell Analysis - Containment Passive Heat Sink.

6.1b Units 2&3 Calculation C-259-01.01.11, Revision 2 (CCN-1 to CCN-5), Evaluation of Spent Fuel Pool for Westinghouse High Density Racks.

6.1c Units 2&3 Calculation M-0073-041, Revision 7 (CCN-1 to CCN-7), Auxiliary Building - Control Area El-30' Control Room Complex - Heat Load Calculation Spec # SO23-410-1.

6.1d Units 2&3 Calculation M-0076-001, Revision 3 (CCN-1 to CCN-4), Fuel Handling Building - Normal Cooling System - Heat Load Calculation Spec# SO23-410-6.

6.1e Units 2&3 Calculation N-0220-030, Revision 0 (CCN-1), SONGS Units 2 and 3 Transient Analysis Model (TAM): Reactor Coolant System (RCS) Volumes.

6.1f Units 2&3 Calculation N-1140-024, Revision 0, Post-LOCA EQ Doses - ESF Pump Seal Failure Leakage with Temporarily Breached SEB Barriers.

6.1g Units 2&3 Calculation N-4010-001, Revision 4 (CCN-1), Control Room χ/Q Values.

6.1h Units 2&3 Calculation N-4010-002, Revision 1, EAB and LPZ χ/Q Values.

6.1i Units 2&3 Calculation N-4060-020, Revision 2 (CCN-2 and CCN-3), Control Room, EAB, and LPZ Post-LOCA Doses.

6.1j Units 2&3 Calculation N-4071-001, Revision 3 (CCN-1), Gaseous Radwaste System Offsite Doses.

6.1k Units 2&3 Calculation N-4072-001, Revision 4 (CCN-1 to CCN-3), Fuel Handling Accident Inside the Fuel Handling Building.

6.1l Units 2&3 Calculation N-4072-003, Revision 2 (CCN-2), Fuel Handling Accident Inside Containment.

6.1m Units 2&3 Calculation N-4072-007, Revision 3 (CCN-1), Doses Due to Spent Fuel Pool Boiling.

6.1n Units 2&3 Calculation N-4073-001, Revision 4 (CCN-1 and CCN-2), Control Rod Ejection Accident - Offsite Doses.

6.1o Units 2&3 Calculation N-4074-001, Revision 2, Main Steam Line Break and Iodine Spike Analysis, Offsite Doses.

6.1p Units 2&3 Calculation N-4075-004, Revision 2, Doses For Revised Steam Generator Tube Rupture Event.

6.1q Units 2&3 Calculation N-4076-001, Revision 2 (CCN-1), Inadvertent Opening of a Steam Generator Atmospheric Dump Valve - Offsite Doses.

6.1r Units 2&3 Calculation N-4077-001, Revision 7 (CCN-1), Letdown Line Break - Offsite and Control Room Doses.

6.1s Units 2&3 Calculation N-4078-001, Revision 1 (CCN-1), Liquid Radwaste System Failure Offsite Doses.

6.1t Units 2&3 Calculation N-4080-026, Revision 0 (CCN-1 and CCN-NT2), Containment P-T Analysis for Design Basis LOCA.

6.1u Units 2&3 Calculation N-4097-013, Revision 0 (CCN-1), Spent Fuel Pool Rerack Activities and Source Strength Spectrums.

6.1v Units 2&3 Calculation N-4097-015, Revision 0, Primary and Secondary Side Activity Concentrations at Tech Spec Limits.

6.1w Units 2&3 Calculation M-0073-043, Revision 3 (CCN-1, CCN-4 to CCN-6), Auxiliary Building - Control Area El 30' Control Room Complex - Emergency Equipment Sizing Calculations.

6.1x Unit 2 Calculation N-5000-002, Revision 0, S2C9 Inadvertent Opening of a Steam Generator ADV.

6.1y Units 2&3 Calculation M-0073-095 Revision 3 (CCN-1 to -3), Infiltration into the Control Room Envelope from Surrounding Areas.

6.1z Units 2&3 Calculation N-4060-027, Revision 0 (CCN-1), Impact of Reduced CR Volume on CR Doses - OIR 92-085 and OIR 92-087.

6.2 Drawings

6.2a Units 2&3 Drawing 716031, Revision 1, Fuel Handling Building Cask Handling Crane Travel Path Requirements Plan.

6.2b Units 2&3 Drawing 716032, Revision 1, Fuel Handling Building Cask Crane Hook Height Requirements.

6.2c Units 2&3 Drawing 40090, Revision 5 (FCN F11497M and F11514M), Fuel Handling Building HV & AC Air Flow Diagram.

6.2d Units 2&3 Drawing 40092, Revision 7, Containment HV & AC Air Flow Diagram Normal System.

6.2e Units 2&3 Drawing 40096, Revision 14, Air Flow Diagram, Train B Control Building - El. 30'-0".

6.2f Units 2&3 Drawing 40098, Revision 8, Air Flow Diagram, Train A Control Building - El. 30'-0".

6.2g Unit 2 Drawing 40111A , Revision 33, P&I Diagram, Reactor Coolant System - System 1201.

6.2h Unit 3 Drawing 40111ASO3, Revision 31 (DCN-38), P&I Diagram, Reactor Coolant System - System 1201.

6.2i Unit 2 Drawing 40117A, Revision 7, P&I Diagram Sump and Drain Systems - System No. 2426.

6.2j Unit 3 Drawing 40117ASO3, Revision 7, P&I Diagram Sump and Drain Systems - System No. 2426.

6.2k Units 2 & 3 Drawing 40173A, Revision 17, P&I Diagram, Control Room Complex HVAC (Normal A.C.) - System No. 1510.

6.2l Units 2&3 Drawing 40173C, Revision 14, P&I Diagram, Control Room Complex HVAC (Emergency V.S. and A.C. Units) - System No. 1510.

EC&FS DEPARTMENT

CALCULATION SHEET

ICCN NO./ PRELIM. CCN NO.	PAGE ___ OF ___
	CCN CONVERSION: CCN NO. CCN --

Project or DCP/MMP DCP 2&3 6926.01SJ Calc. No. N-0720-014

Subject Control Room and Offsite Doses Should CPIS, CRIS, and FHIS Fail

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6.2m Units 2&3 Drawing 41358, Revision 12 (DCN 48 to DCN 54, and FCN F13531M), Area CA9 HV & AC Plan El. 50' to 30'.

6.2n Units 2&3 Drawing 41366, Revision 11 (DCN 40 to DCN 42), Area CA10 HV & AC Plan El. 50' to 30'.

6.2o Drawing SO23-207-1-78, Revision 3 (DCN 6), Fuel Handling Building Spent Fuel Pool Liner Bulkhead Gate sheet 3 (PX Engineering Company drawing 498A).

6.2p Drawing SO23-990-164, Revision 0, Fuel Bundle Assembly (ABB Supplier Drawing E-FSG-E000-A07, Revision 01).

6.2q Drawing SO23-410-1-1, Revision 13 (DCN-2), Control Room Emergency HV Unit (American Air Filter drawing R107D-160325-K).

6.2r Unit 2 Drawing 40171A, Revision 24, P&I Diagram - Containment HVAC System (Normal) - System 1501.

6.2s Unit 3 Drawing 40171ASO3, Revision 21, P&I Diagram - Containment HVAC System (Normal) - System 1501.

6.2t Units 2&3 Drawing 31394, Revision 17, Elementary Diagram - HVAC Plant Control Room Isolation System Train A.

6.2u Unit 2 Drawing 31395, Revision 16, Elementary Diagram - HVAC Plant Control Room Isolation System Channel B.

6.2v Unit 2 Drawing 40160A, Revision 26, [illegible]gram - Auxiliary Feedwater System - System No. 1305.

6.2w Unit 3 Drawing 40160ASO3, Revision 23, P&I Diagram - Auxiliary Feedwater System - System No. 1305.

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6.3 Vendor Documents

6.3a CE letter S-CE-2666, FSAR Accident Analysis for San Onofre 2 and 3, dated March 18, 1976 (CDM# C760318G-41-7-3).

6.3b CE Letter S-CE-3034, San Onofre 2 and 3 FSAR - Chapter 15 First Drafts (Partial), dated July 8, 1976 (CDM# C760708G-80-141-6).

6.3c CE Letter S-CE-3056, San Onofre 2 and 3 FSAR - Section 15 First and Revised First Drafts, dated September 7, 1976 (CDM# C760907G-58-307-4).

6.3d CE letter S-CE-3058, San Onofre 2 and 3 FSAR - Revised Steam Line Break Source Terms, dated July 15, 1976 (CDM# C760715G-29-7-2).

6.3e CE letter S-CE-3068, San Onofre 2 and 3 FSAR - Sections 7.3 and 15.7.4, dated July 19, 1976 (CDM # C760719G-47-3-4).

6.3f CE Letter S-CE-3124, San Onofre 2 and 3 FSAR - Reactor Coolant Pump Sheared Shaft and Inadvertent Opening of a Safety Valve Analyses Accident, dated August 2, 1976 (CDM# C760802G-9-8-1).

6.3g CE Letter S-CE-3379, San Onofre Units 2 and 3 FSAR - Input for Dose Calculations for Chapter 15 Infrequent Incidents, dated October 27, 1976 (CDM# C761027G-28-7-2).

6.3h CE Letter S-CE-4517, San Onofre Units 2 and 3 - Analysis of Letdown Line Breaks with Automatic Control Systems Operation, dated January 23, 1978 (CDM # C780123G-38-4).

6.3i CE Letter S-CE-3036, San Onofre 2 and 3 FSAR - Section 11.1 Revised First Draft, dated July 8, 1976 (CDM# C760708G-46-45-4 and C760708G-125-43-8).

6.3j CE Letter S-CE-5696, FSAR Change Package 159 - CEA Ejection Reanalysis, dated September 5, 1979 (CDM # C790905G-16-56).

6.3k CE Letter S2-CE-R-441, Assessment of Modified MSSV Flow Characteristics for SONGS 2 Cycle 5, dated September 26, 1989 (CDM # C910625-1266-22).

6.3l CE Letter S-91-031, Reactor Vessel Water Volume for SONGS 2/3, dated February 14, 1991 (CDM # K910623S5134-2).

6.3m ABB Letter ST-96-456, SONGS 2&3 SBLOCA Data for Radiation Monitor Replacement Project, dated September 10, 1996.

6.4 Regulatory Documents

6.4a 10 CFR Part 50, "Domestic Licensing of Production & Utilization Facilities", revised as of January 1, 1996.

6.4b 10 CFR Part 100, "Reactor Site Criteria", revised as of January 1, 1996.

6.4c Regulatory Guide 1.4, Revision 2, "Assumptions Used for Evaluating the Potential Radiological Consequences of a Loss of Coolant Accident for Pressurized Water Reactors", dated June 1974.

6.4d Regulatory Guide 1.11 (Safety Guide 11), "Instrument Lines Penetrating Primary Reactor Containment", dated March 10, 1971, including Supplement 1 dated February 17, 1972.

6.4e Regulatory Guide 1.25 (Safety Guide 25), "Assumptions Used for Evaluating the Potential Radiological Consequences of a Fuel Handling Accident in the Fuel Handling and Storage Facility for Boiling and Pressurized Water Reactors", dated March 23, 1972.

6.4f Regulatory Guide 1.52, Revision 2, "Design, Testing and Maintenance Criteria for Post Accident Engineered-Safety-Feature Atmosphere Cleanup System Air Filtration and Adsorption Units of Light-Water-Cooled Nuclear Power Plants", dated March 1978.

6.4g Regulatory Guide 1.77, Revision 0, "Assumptions Used for Evaluating a Control Rod Ejection Accident for Pressurized Water Reactors", dated May 1974.

6.4h Unit 2 Technical Specifications, up to and including Amendment 136 (through 7/17/97)

6.4i Unit 3 Technical Specifications, up to and including Amendment 128 (through 7/17/97)

6.4j Unit 2 Licensee Controlled Specifications, Revision 3 (through 6/30/97)

6.4k Unit 3 Licensee Controlled Specifications, Revision 3 (through 6/30/97)

6.4l SONGS 2&3 Updated Final Safety Analysis Report, Revision 12.

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6.4m NUREG-0017, Revision 1, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Pressurized Water Reactors (PWR-GALE Code)", published April 1985.

6.4n Standard Review Plan (SRP) Section 6.4, "Control Room Habitability System".

i NUREG 75/087, Revision 1, dated December 1978.
ii NUREG-0800, Revision 2, dated July 1981.

6.4o Standard Review Plan (SRP) Section 6.2.4 Branch Technical Position CSB 6-4, "Containment Purging During Normal Plant Operations".

i NUREG 75/087, Revision 1, dated May 1978.
ii NUREG-0800, Revision 2, dated July 1981.

6.4p Standard Review Plan (SRP) Section 15.4.8 Appendix A, "Radiological Consequences of Control Rod Ejection Accident (PWR)".

i NUREG-75/087, Revision 0, dated 11/24/75.
ii NUREG-0800, Revision 2, dated July 1981.

6.4q Standard Review Plan (SRP) Section 15.6.2, "Radiological Consequences of the Failure of Small Lines Carrying Primary Coolant Outside Containment".

i NUREG 75/087, Revision 1, dated July 1978.
ii NUREG-0800, Revision 2, dated July 1981.

6.4r Standard Review Plan (SRP) Section 15.6.5 Appendix A, "Radiological Consequences of a Design Basis Loss-of-Coolant Accident: Containment Leakage Contribution".

i NUREG 75/087, Revision 0, dated 11/24/75
ii NUREG-0800, Revision 1, dated July 1981.

6.4s Standard Review Plan (SRP) Section 15.7.4, "Radiological Consequences of Fuel Handling Accidents".

i NUREG 75/087, Revision 0, dated 11/24/75
ii NUREG-0800, Revision 1, dated July 1981.

6.4t Standard Review Plan (SRP) Section 15.7.5, "Spent Fuel Cask Drop Accidents".

- i NUREG 75/087, Revision 1, dated December 1978.
- ii NUREG-0800, Revision 2, dated July 1981.

6.4u NRC Safety Evaluation by the Office of Nuclear Reactor Regulation Supporting Amendment No. 47 to NPF-10 and Amendment No. 36 to NPF-15, dated May 16, 1986. This SER was for PCN-201, PCN-202, PCN-203, PCN-204, and PCN-206, and applied to both Units 2 and 3.

6.4v Regulatory Guide 1.26, Revision 3, "Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants," dated February 1976.

6.4w Regulatory Guide 1.29, Revision 3, "Seismic Design Classification," dated September 1978.

6.4x Standard Review Plan (SRP) Section 15.2.8, "Feedwater System Pipe Breaks Inside and Outside Containment (PWR)".

- i NUREG 75/087, Revision 0, dated 11/24/75.
- ii NUREG-0800, Revision 1, dated July 1981.

6.5 **Procedures**

6.5a Maintenance Procedure SO23-I-3.32, Revision 6 (TCN 6-4), Crane - Cask Handling Crane Checkout and Operation.

6.5b Chemistry Procedure SO123-III-2.22.23, Revision 10, Units 2/3 Steam Generator Leak Rate Determination.

6.5c Site Technical Services Procedure SO23-X-7.2, Revision 3, Nuclear Fuel Movement for Refueling Cycles.

6.5d Maintenance Procedure SO23-I-2.44, Revision 6 (TCN 6-2), CREACUS - Control Room Emergency Air Clean Up System Operation and Operability Test Surveillance.

6.6 Other Documents

6.6a LOCADOSE Code, Bechtel Standard Computer Program NE-319, Release 3.

6.6b Software Installation Report, LOCADOSE (NE-319) Version 3.0, RISC 6000 Computer System - Device ID D026748, Operating System AIX Version 3.2.5, Approved June 30, 1995.

6.6c DBD-SO23-360, Revision 4 (DCNs 29 and 30), Reactor Coolant System Design Basis Document.

6.6d Memorandum from Allen Evinay, "Pre and Post Trip SLB SIAS Timing", dated September 10, 1996 (included as Attachment 1).

6.6e Interoffice Correspondence SG3-FE-0069, Revision 02, SONGS-3 Cycle 9 Groundrules Document (SCE Document RGR-U3-C9), authored by U. Decher, dated August 29, 1996.

6.6f Interoffice Correspondence SG2-FE-0073, Revision 02, SONGS-2 Cycle 9 Reload Analysis Ground Rules (SCE Document RGR-U2-C9), authored by U. Decher, dated August 29, 1996.

6.6g Memorandum for File, "San Onofre Nuclear Generating Station, Basis for UFSAR Section 15.6.3.4.5 - Inadvertent Opening of a Pressurizer Safety Valve Dose Consequences", authored by Tom Remick, dated May 2, 1997.

6.7 ABB/CE Calculations

The following ABB/CE calculations were used for this calculation. These documents are not available through CDM, and are therefore not listed on the Calculation Cross Index.

6.7a Unit 2 Calculation A-SG2-FE-0060, Revision 01, SONGS-2 Cycle 9 Design Parameters, F_r Versus Power.

6.7b Units 2&3 Calculation A-SG-FE-0064, Revision 00, SONGS Units 2 and 3 Non-LOCA Source Term.

6.7c Unit 2 Calculation A-SG2-FE-0081, Revision 00, SONGS-2 Cycle 9 Excess Load with LOAC.

6.7d Unit 2 Calculation A-SG2-FE-0088, Revision 00, SONGS 2 Cycle 9 CEA Ejection Analysis.

6.7e Unit 2 Calculation A-SG2-FE-0089, Revision 00, SONGS Unit 2 Cycle 9 Post-Trip Steam Line Break Analysis.

6.7f Unit 2 Calculation A-SG2-FE-0090, Revision 00, SONGS-2 Cycle 9 Pre-Trip Steam Line Break Analysis.

6.7g Unit 2 Calculation A-SG2-FE-0093, Revision 00, SONGS-2 Cycle 9 Sheared Shaft/Seized Rotor Fuel Failure Analysis.

6.7h Unit 2 Calculation A-SG2-FE-0100, Revision 01, SONGS-2 Cycle 9 RAR Dose Assessment.

6.7i Units 2/3 Calculation 1370-CPE-009/1470-CPE-005, Revision 00, SONGS 2 and 3 Decreased Auxiliary Feedwater Analysis.

6.7j Unit 2 Calculation 1370-DT-003, Revision 1, Southern California Edison - Excess Load Analysis.

6.7k Unit 2 Calculation 1370-DT-005, Revision 1, San Onofre FSAR Steam Line Break Analysis.

6.7l Units 2&3 Calculation 1370-DT-010, Revision 3, SCE SONGS 2&3 FSAR Loss of Load Analysis.

6.7m Unit 2 Calculation 1370-DT-011, Revision 0, Excess Heat Removal Due to Feedwater System Malfunction for SCE.

6.7n Unit 2 Calculation 1370-DT-013, Revision 0, SCE FSAR Total Loss of Flow Analysis.

6.7o Unit 2 Calculation 1370-DT-018, Revision 1, SCE Loss of Feedwater Flow.

6.7p Unit 2 Calculation 1370-DT-037, Revision 0, Reanalysis of Feedwater Line Break for SCE and Responses to NRC Round Two Questions.

6.7q Unit 2 Calculation 1370-TS-004, Revision 1, Radiological Releases for SONGS 2 ECP Transient Analysis.

6.7r Units 2/3 Calculation 1370-TS-109/1470-TS-051, Revision 0, SONGS Units 2&3 Steam Generator Tube Rupture Analysis for Extended Blowdown of Steam Generator Safety Valves

6.7s Unit 2 Calculation 1370-DT-004, Revision 0, SCE - Loss of All Non-Emergency AC Power.

6.7t Unit 2 Calculation 1370-PSAE-057/9270-PSAE-034, Revision 0, Waterford/SONGS CEA Ejection Peak Pressure Reanalysis.

6.7u Unit 2 Calculation A-SG2-FE-0114, Revision 0, SONGS-2 Cycle 9 Feedwater System Pipe Break.

7.0 NOMENCLATURE

ABB:	Asea Brown Boveri
ADV:	Atmospheric Dump Valve
AFW:	Auxiliary Feedwater
CE:	Combustion Engineering
CEA:	Control Element Assembly
CEA-ej:	Control Element Assembly Ejection
CPIS:	Containment Purge Isolation Signal
CR:	Control Room
CREACUS:	Control Room Emergency Air Cleanup System
CRIS:	Control Room Isolation Signal
CVCS:	Chemical and Volume Control System
EAB:	Exclusion Area Boundary
EAC:	Control Room Emergency Air Conditioner
ECCS:	Emergency Core Cooling System
EVS:	Control Room Emergency Ventilation Supply
FHA:	Fuel Handling Accident
FHA-FHB:	Fuel Handling Accident Inside Fuel Handling Building
FHA-IC:	Fuel Handling Accident Inside Containment
FHB:	Fuel Handling Building
FHIS:	FHB Isolation Signal
FWSPB:	Feedwater System Pipe Break
GDA:	(SFP) Gate Drop Accident
HVAC:	Heating, Ventilating and Air Conditioning
IFWF:	Increase in Feedwater Flow
IMSF:	Increased Main Steam Flow
IOSGADV:	Inadvertent Opening of a Steam Generator Atmospheric Dump Valve
LCO:	Technical Specification Limiting Condition for Operation
LCS:	Licensee Controlled Specifications
LLB:	Letdown Line Break
LNFWF:	Loss of Normal Feedwater Flow
LOAC:	Loss of Normal AC Power
LOCA:	Loss of Coolant Accident
LOCV:	Loss of Condenser Vacuum
LPZ:	Low Population Zone
MSSV:	Main Steam Safety Valve
PAU:	FHB Post Accident Cleanup Filter Unit
PSV:	Pressurizer Safety Valve

RCS:	Reactor Coolant System
SAF:	Single Active Failure
SBLOCA:	Small Break Loss of Coolant Accident
SFPB:	Spent Fuel Pool Boiling
SG:	Steam Generator
SGTR:	Steam Generator Tube Rupture
SLB:	Steam Line Break
SLB-IC:	Steam Line Break Inside Containment
SLB-OC:	Steam Line Break Outside Containment
SRP:	Standard Review Plan (NUREG 75/087 and NUREG-0800)
SFP:	Spent Fuel Pool
TS:	Technical Specifications
UFSAR:	Updated Final Safety Analysis Report
X/Q:	Atmospheric Dispersion Factor
μCi:	microCurie (1 Ci = 1,000,000 μCi)

8.0 COMPUTATIONS

8.1 Determination of Accidents to be Evaluated

This calculation evaluates the UFSAR Chapter 15 events that credit CPIS, FHIS, or CRIS to ensure that the offsite and control room doses are acceptable. In this section the various accident events detailed in UFSAR Chapter 15 are individually reviewed to determine if the events credit these isolation signals, and consequently if reanalysis is warranted. Section 8.1.1 presents the review of moderate frequency incidents. Section 8.1.2 presents the review of infrequent incidents. Section 8.1.3 presents the review of limiting faults.

A Safety Injection Actuation Signal (SIAS) is capable of initiating containment minipurge valve closure (per drawings 40171A and 40171ASO3, References 6.2r and 6.2s). A SIAS also generates a Control Room Isolation Signal (CRIS) per drawings 31394 (Reference 6.2t) and 31395 (Reference 6.2u), which causes control room normal HVAC isolation and essential HVAC operation.

8.1.1 Determination of Moderate Frequency Incidents to be Evaluated

Moderate frequency incidents are those events which may occur during a calendar year for a particular plant. The moderate frequency incidents may release radioactivity to the environment. Table 8.1-1 summarizes the moderate frequency incidents addressed in the UFSAR.

Table 8.1-1 notes the airborne activity release locations for each moderate frequency incident. The determination of event release locations was made with engineering judgement based on the UFSAR event descriptions and a review of the reload transient analyses. Irrespective of the release location, any release of radioactivity could be dispersed via the atmosphere to the control room and offsite locations. Currently, control room doses are not evaluated for any moderate frequency incident.

Table 8.1-1 notes that none of the moderate frequency incidents generates a SIAS, although the inadvertent operation of the ECCS during power operation event addressed in UFSAR Section 15.5.1.2 is postulated to be caused by a spurious SIAS. The determination as to whether an event generates a SIAS was made with engineering judgement based on the UFSAR event descriptions and a review of the reload transient analyses.

Many of the moderate frequency incidents yield consequences that are enveloped by another more severe event. Table 8.1-1 notes these occurrences. The following subsections determine that in the absence of CPIS, FHIS and CRIS, the radiological consequences of the moderate frequency incidents are less severe than the infrequent incident of an Inadvertent Opening of a Steam Generator Atmospheric Dump Valve with a Single Active Failure (IOSGADV/SAF). Therefore, there is no need for this calculation to evaluate dose consequences for any moderate frequency incident.

TABLE 8.1-1 SUMMARY OF MODERATE FREQUENCY INCIDENTS

UFSAR Section	Moderate Frequency Incident Description	Airborne Activity Release Location (SEE NOTES 1, 2, 3, 4)					SIAS initiated	Other Event that Bounds Dose Consequences with no CPIS-FHIS-CRIS
		Inside Ctmt.	Inside Fuel Bldg.	MSSV prior to 30 min	ADV 30 min to SDC	Other		
15.1.1.1	Decrease in Feedwater Temperature	N	N	N	N	N	N	no dose consequences
15.1.1.2	Increase in Feedwater Flow	N	N	N	N	N	N	no dose consequences
15.1.1.3	Increased Main Steam Flow [referred to by ABB/CE as an Excess Load event]	N	N	N	N	N	N	no dose consequences
15.1.1.4	Inadvertent Opening of a Steam Generator Atmospheric Dump Valve (IOSGADV)	N	N	N	Yes (See Note 6)	N	N	Infrequent Incident--IOSGADV/SAF
15.2.1.1	Loss of External Load	N (See Note 5)	N	Yes	N	N	N	IOSGADV, LOCV or LOAC
15.2.1.2	Turbine Trip	N (See Note 5)	N	Yes	N	N	N	IOSGADV, LOCV or LOAC
15.2.1.3	Loss of Condenser Vacuum (LOCV)	N (See Note 5)	N	Yes	Yes	N	N	Infrequent Incident--IOSGADV/SAF
15.2.1.4	Loss of Normal AC Power (LOAC)	N (See Note 5)	N	Yes	Yes	N	N	Infrequent Incident--IOSGADV/SAF
15.3.1.1	Partial Loss of Forced Reactor Coolant Flow	N	N	Yes	N	N	N	IOSGADV, LOCV or LOAC

TABLE 8.1-1 SUMMARY OF MODERATE FREQUENCY INCIDENTS

UFSAR Section	Moderate Frequency Incident Description	Airborne Activity Release Location (SEE NOTES 1, 2, 3, 4)					SIAS initiated	Other Event that Bounds Dose Consequences with no CPIS-FHIS-CRIS
		Inside Ctmt	Inside Fuel Bldg.	MSSV prior to 30 min	ADV 30 min to SDC	Other		
15.4.1.1	Uncontrolled CEA Withdrawal from a Subcritical or Low Power Condition	N (See Note 5)	N	Yes	N	N	N	IOSGADV, LOCV or LOAC
15.4.1.2	Uncontrolled CEA Withdrawal at Power	N	N	Yes	N	N	N	IOSGADV, LOCV or LOAC
15.4.1.3	Control Element Assembly Misoperation	N	N	Yes	N	N	N	IOSGADV, LOCV or LOAC
15.4.1.4	CVCS Malfunction (Inadvertent Boron Dilution)	N	N	N	N	N	N	no dose consequences
15.4.1.5	Startup of an Inactive Reactor Coolant System Pump	N	N	N	N	N	N	no dose consequences
15.5.1.1	Chemical and Volume Control System Malfunction	N	N	Yes	N	N	N	IOSGADV, LOCV or LOAC
15.5.1.2	Inadvertent Operation of the ECCS During Power Operation	N	N	N	N	N	Y	no dose consequences

(1) If an event does not release radioactivity into the containment building, then the failure of the CPIS will not affect the radiological dose consequences of that event.

(2) If an event does not release radioactivity into the fuel handling building, then the failure of the FHIS will not affect the radiological dose consequences of that event.

(3) UFSAR Chapter 15 dose analyses typically assume that main steam safety valve (MSSV) steam releases continue until the valves either reseat on decreasing secondary side pressure, or until Operator Action is taken at time 30 minutes to close the MSSVs by operation of the ADVs.

(4) UFSAR Chapter 15 dose analyses typically assume that atmospheric dump valve (ADV) steam releases are initiated by Operator Action 30 minutes into the event, and that the ADVs are isolated (i.e., end of the accident scenario) when shutdown cooling mode is initiated.

(5) This event releases primary coolant activity via the pressurizer safety valves (PSVs). The radioactivity flowing past the PSVs is directed into the Pressurizer Relief (Quench) Tank, which is designed to prevent normal discharges from the PSVs from being released to the containment atmosphere.

(6) The IOSGADV event is characterized by an ADV that has inadvertently opened at time zero. It is assumed that Operator Action isolates the ADV steam releases at time 30 minutes.

8.1.1.1 Airborne Activity Releases Inside Containment

Table 8.1-1 identifies five events that could potentially release activity into the containment building. Per Combustion Engineering Letters S-CE-3056 (Reference 6.3c, Sections 15.2.1.1 through 15.2.1.4), and S-CE-3034 (Reference 6.3b, Section 15.4.1.1), these five events increase the reactor coolant system pressure and eventually lift the Pressurizer Safety Valves (PSVs). When the PSVs lift there is an activity release to the Pressurizer Relief (Quench) Tank via the PSV discharge piping. A rupture disc venting to the containment atmosphere is provided for Quench Tank overpressure protection. UFSAR Section 5.4.11.1 (Reference 6.4l) indicates that the Quench Tank and associated blowdown systems are designed to receive and condense the normal discharges from the PSVs and to prevent the discharge from being released to containment. Per Reactor Coolant System Design Basis Document DBD-SO23-360 (Reference 6.6c, Section 4.7.1), the Quench Tank volume is sized to more than accommodate, without challenging the rupture disk, the discharge from the PSVs from two consecutive occurrences.

Based on the preceding discussion, none of the moderate frequency incidents will release radioactivity into the containment building. Consequently, the failure of the CPIS will not affect the radiological consequences of any moderate frequency incident.

8.1.1.2 Airborne Activity Releases Inside Fuel Handling Building

Table 8.1-1 identifies no moderate frequency incident that could potentially release activity into the fuel handling building. Consequently, the failure of the FHIS will not affect the radiological consequences of any moderate frequency incident.

8.1.1.3 Airborne Activity Releases Directly to the Outside Environment

Since there are no inside containment or fuel handling building activity releases, the single event that bounds the radiological consequences of all moderate frequency incidents is that which releases the maximum airborne activity directly to the outside environment.

Table 8.1-1 identifies numerous events that could potentially release activity directly to the outside environment. One event, the Inadvertent Opening of a Steam Generator Atmospheric Dump Valve (IOSGADV) event, releases activity via an atmospheric dump valve (ADV) that inadvertently opens. The opened ADV allows a release of contaminated secondary side steam to the outside environment until Operator Action is taken at time 30 minutes to isolate the release path. Once the opened ADV is closed, the main condenser is used to facilitate entry into the shutdown cooling mode.

Other moderate frequency incidents increase the steam generator and main steam system pressures and eventually lift the main steam safety valves (MSSVs). The opened MSSVs allow a release of contaminated secondary side steam to the outside environment until the valves either reseat on decreasing secondary side pressure, or until Operator Action is taken at time 30 minutes to isolate the release path. The majority of these moderate frequency incidents that lift the MSSVs have the condenser available to cool the plant and to facilitate entry into the shutdown cooling mode. In these cases the activity releases to the outside environment end at time 30 minutes with the Operator Action to close the MSSVs by operation of the ADVs. However, the condenser is unavailable in the Loss of Condenser Vacuum (LOCV) and Loss of Normal AC Power (LOAC) events, and consequently a need exists for Operator Action to open one or more ADVs at time 30 minutes to facilitate entry into the shutdown cooling mode.

Based on these release scenarios, the moderate frequency incident with the most severe radiological consequences is either the IOSGADV (with its pre-30 minute ADV release), or the LOCV or LOAC event (with their MSSV and post-30 minute ADV releases). In comparison, the infrequent incident of an IOSGADV with a Single Active Failure (IOSGADV/SAF) is essentially an IOSGADV concurrent with a LOCV and a LOAC, in which it is necessary to cool down the reactor coolant system using the ADV from the unaffected steam generator. Consequently, in the absence of CPIS, FHIS and CRIS, the IOSGADV/SAF event will release more radioactive steam and generate more severe radiological consequences than the IOSGADV, LOCV or LOAC event, or any other moderate frequency incident. Therefore, there is no need for this calculation to evaluate dose consequences for any moderate frequency incident.

8.1.2 Determination of Infrequent Incidents to be Evaluated

Infrequent incidents are those events which may occur during the lifetime of a particular plant. The infrequent incidents may release radioactivity to the environment. Table 8.1-2 summarizes the infrequent incidents addressed in the UFSAR.

Table 8.1-2 notes the airborne activity release locations for each infrequent incident. The determination of event release locations was made with engineering judgement based on the UFSAR event descriptions and a review of the reload transient analyses. Irrespective of the release location, any release of radioactivity could be dispersed via the atmosphere to the control room and offsite locations. Currently, control room doses are not evaluated for any infrequent incident.

Table 8.1-2 notes that none of the infrequent incidents generates a SIAS. The determination as to whether an event generates a SIAS was made with engineering judgement based on the UFSAR event descriptions and a review of the reload transient analyses.

Many of the infrequent incidents yield consequences that are enveloped by another more severe event. Table 8.1-2 notes these occurrences. The following subsections determine that in the absence of CPIS, FHIS and CRIS, the Increased Main Steam Flow with a Single Active Failure (IMSF/SAF) is the most severe infrequent incident. The IMSF/SAF event is also the only infrequent incident characterized by fuel failure. In the absence of fuel failure (and in the absence of CPIS, FHIS, and CRIS), the Inadvertent Opening of a Steam Generator Atmospheric Dump Valve with a Single Active Failure (IOSGADV/SAF) is the most severe infrequent incident. As concluded in the following subsections, the radiological consequences of the remaining infrequent incidents are less severe than the IOSGADV/SAF event.

The following subsections also determine that since the IMSF/SAF and IOSGADV/SAF events do not initiate a SIAS, the control room doses due to an IMSF/SAF or IOSGADV/SAF will not be mitigated by a CRIS. Consequently, it is necessary for this calculation to evaluate dose consequences of both the IMSF/SAF and IOSGADV/SAF infrequent incidents. Since the radiological consequences of the IMSF/SAF and IOSGADV/SAF bound those of all other infrequent incidents, there is no need for this calculation to evaluate dose consequences for any other infrequent incident.

TABLE 8.1-2 SUMMARY OF INFREQUENT INCIDENTS

UFSAR Section	Infrequent Incident Description	Airborne Activity Release Location (SEE NOTES 1, 2, 3,4)					SIAS initiated	Other Event that Bounds Dose Consequences with no CPIS-FHIS-CRIS
		Inside Ctmt.	Inside Fuel Bldg.	MSSV prior to 30 min	ADV 30 min to SDC	Other		
15.1.2.1	Decrease in Feedwater Temperature with a Single Active Failure	N	N	N	N	N	N	no dose consequences
15.1.2.2	Increase in Feedwater Flow with a Single Active Failure (IFWF/SAF)	N	N	Yes	Yes	N	N	IOSGADV/SAF
15.1.2.3	Increased Main Steam Flow with a Single Active Failure (IMSF/SAF) [referred to by ABB/CE as an Excess Load with a Single Active Failure event]	N	N	Yes	Yes	N	N	No **THIS EVENT MUST BE EVALUATED**
15.1.2.4	Inadvertent Opening of a Steam Generator Atmospheric Dump Valve with a Single Active Failure (IOSGADV/SAF)	N	N	N	Yes (See Note 6)	N	N	No **THIS EVENT MUST BE EVALUATED**
15.2.2.1	Loss of External Load with a Single Active Failure	N (See Note 5)	N	Yes	N	N	N	IOSGADV/SAF
15.2.2.2	Turbine Trip with a Single Active Failure	N (See Note 5)	N	Yes	N	N	N	IOSGADV/SAF
15.2.2.3	Loss of Condenser Vacuum with a Single Active Failure (LOCV/SAF)	N (See Note 5)	N	Yes	Yes	N	N	IOSGADV/SAF
15.2.2.4	Loss of Normal AC Power with a Single Active Failure (LOAC/SAF)	N	N	Yes	Yes	N	N	IOSGADV/SAF
15.2.2.5	Loss of Normal Feedwater Flow (LNFWF)	N	N	Yes	Yes	N	N	IOSGADV/SAF
15.3.2.1	Total Loss of Forced Reactor Coolant Flow	N	N	Yes	N	N	N	IOSGADV/SAF
15.3.2.2	Partial Loss of Forced Reactor Coolant Flow with a Single Active Failure	N	N	Yes	N	N	N	IOSGADV/SAF

TABLE 8.1-2 SUMMARY OF INFREQUENT INCIDENTS

UFSAR Section	Infrequent Incident Description	Airborne Activity Release Location (SEE NOTES 1, 2, 3,4)					SIAS initiated	Other Event that Bounds Dose Consequences with no CPIS-FHIS-CRIS
		Inside Cmt.	Inside Fuel Bldg.	MSSV prior to 30 min	ADV 30 min to SDC	Other		
15.5.2.1	Chemical and Volume Control System Malfunction with a Single Active Failure	N	N	N	N	N	N	no dose consequences

(1) If an event does not release radioactivity into the containment building, then the failure of the CPIS will not affect the radiological dose consequences of that event.

(2) If an event does not release r-dioactivity into the fuel handling building, then the failure of the FHIS will not affect the radiological dose consequences of that event.

(3) UFSAR Chapter 15 dose analyses typically assume that main steam safety valve steam releases continue until the valves either reseat on decreasing secondary side pressure, or until Operator Action is taken at time 30 minutes to close the MSSVs by operation of the ADVs.

(4) UFSAR Chapter 15 dose analyses typically assume that atmospheric dump valve steam releases are initiated by Operator Action 30 minutes into the event, and that the ADVs are isolated (i.e., end of the accident scenario) when shutdown cooling mode is initiated.

(5) This event releases primary coolant activity via the pressurizer safety valves. The radioactivity flowing past the PSVs is directed into the Pressurizer Relief (Quench) Tank, which is designed to prevent normal discharges from the PSVs from being released to the containment atmosphere.

(6) The IOSGADV/SAF event is characterized by an ADV that has inadvertently opened at time zero. It is assumed that Operator Action at time 30 minutes isolates the affected main steam line loop ADV steam releases, and initiates intact main steam line loop ADV steam releases to achieve shutdown cooling.

8.1.2.1 Airborne Activity Releases Inside Containment

Table 8.1-2 identifies three events that could potentially release activity into the containment building. Per Combustion Engineering Letter S-CE-3056 (Reference 6.3c, Sections 15.2.2.1 through 15.2.2.3), these three events increase the reactor coolant system pressure and eventually lift the Pressurizer Safety Valves. When the PSVs lift there is an activity release to the Pressurizer Relief (Quench) Tank via the PSV discharge piping. A rupture disc venting to the containment atmosphere is provided for Quench Tank overpressure protection. UFSAR Section 5.4.11.1 (Reference 6.4l) indicates that the Quench Tank and associated blowdown systems are designed to receive and condense the normal discharges from the PSVs and to prevent the discharge from being released to containment. Per Reactor Coolant System Design Basis Document DBD-SO23-360 (Reference 6.6c, Section 4.7.1), the Quench Tank volume is sized to more than accommodate, without challenging the rupture disk, the discharge from the PSVs from two consecutive occurrences.

Based on the preceding discussion, none of the infrequent incidents will release radioactivity into the containment building. Consequently, the failure of the CPIS will not affect the radiological consequences of any infrequent incident.

8.1.2.2 Airborne Activity Releases Inside Fuel Handling Building

Table 8.1-2 identifies no infrequent incidents that could potentially release activity into the fuel handling building. Consequently, the failure of the FHIS will not affect the radiological consequences of any infrequent incident.

8.1.2.3 Airborne Activity Releases Directly to the Outside Environment

Since there are no inside containment or fuel handling building activity releases, the event that bounds the radiological consequences of all infrequent incidents is that which releases the maximum airborne activity directly to the outside environment.

Table 8.1-2 identifies numerous events that could potentially release activity directly to the outside environment. One event, the Inadvertent Opening of a Steam Generator Atmospheric Dump Valve with Single Active Failure (IOSGADV/SAF) event, releases activity via an ADV that inadvertently opens. The opened ADV allows a release of contaminated secondary side steam to the outside environment until Operator Action is taken at time 30 minutes to isolate the release path. With the affected main steam line loop ADV closed, Operator Action is taken at time 30 minutes to open one or more intact main steam line loop ADVs to facilitate entry into the shutdown cooling mode.

Many of the remaining infrequent incidents increase the steam generator and main steam system pressures and eventually lift the main steam safety valves. As Table 8.1-2 indicates, the opened MSSVs allow a release of contaminated secondary side steam to the outside environment until the valves either reseat on decreasing secondary side pressure, or until Operator Action is taken at time 30 minutes to isolate the release path. The majority of these infrequent incidents that lift the MSSVs have the condenser available to cool the plant and to facilitate entry into the shutdown cooling mode. In these cases the activity releases to the outside environment end at time 30 minutes with the Operator Action to close the MSSVs by operation of the ADVs. However, Table 8.1-2 identifies several infrequent incidents that model the condenser as unavailable, and with a need for Operator Action to open one or more atmospheric dump valves at time 30 minutes to facilitate entry into the shutdown cooling mode. These events include the Increase in Feedwater Flow with a Single Active Failure

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(IFWF/SAF), the Increased Main Steam Flow with a Single Active Failure (IMSF/SAF), the Loss of Condenser Vacuum with a Single Active Failure (LOCV/SAF), the Loss of Normal AC Power with a Single Active Failure (LOAC/SAF), and the Loss of Normal Feedwater Flow (LNFWF). The radiological consequences of these latter events (with their MSSV and post-30 minute ADV releases) bound the radiological consequences of those events with only MSSV releases.

Based on the preceding release scenario discussion, the infrequent incident with the most severe radiological consequences is either the IOSGADV/SAF (with its pre and post-30 minute ADV releases) or the IMSF/SAF, IFWF/SAF, LOCV/SAF, LOAC/SAF, or LNFW event (with their pre-30 minute MSSV and post-30 minute ADV releases). Table 8.1-3 documents a comparison of these infrequent incidents to assist in the determination of the most severe event.

TABLE 8.1-3: COMPARISON OF INFREQUENT INCIDENT ACTIVITY RELEASE CHARACTERISTICS

Parameter	IFWF/SAF	IMSF/SAF	IOSGADV/ SAF	LOCV/SAF	LOAC/SAF	LNFWF
Fuel Failure (percent of the core)	0	< 25	0	0	0	0
Primary to Secondary Mass Release Rate (gallon/minute)	1.0	1.0	1.0	1.0	1.0	1.0
Secondary Side Steam Mass Releases:						
0 to 30 minutes (lbm)	< 249,040	249,040	289,300	99,100	77,000	20,000
30 minutes to end of event (lbm)	< 668,000	668,000	866,000	660,000	861,012	715,000
Total Event Duration (lbm)	< 917,040	917,040	1,150,000	759,100	938,012	735,000

Table 8.1-3 shows that only one infrequent incident, the IMSF/SAF event, is characterized by fuel failure. The determination as to whether an event experiences fuel failure was made with engineering judgement based on the UFSAR event descriptions and a review of the reload transient analyses, including a review of the Unit 2 Cycle 9 Reload Analysis Report dose assessment by ABB/CE design analysis A-SG2-FE-0100 (Reference 6.7h).

Table 8.1-3 shows that each infrequent incident is characterized by a 1.0 gallon/minute primary to secondary leakage rate. The determination of this leakage rate was made with engineering judgement based on the UFSAR event descriptions and a review of the reload transient analyses, including a review of ABB/CE design analysis A-SG2-FE-0100.

Table 8.1-3 shows mass release to atmosphere data per the following references:

The IFWF/SAF mass release data are described in CE Calculation 1370-DT-011 (Reference 6.7m, page 5) as having "smaller cooldown rates" than that of the excess load event (i.e., the increased main steam flow event).

The IMSF/SAF mass release data are documented in ABB/CE design analysis A-SG2-FE-0100 (pages E-6 and E-7), which utilizes data determined in CE Calculation 1370-DT-003 (Reference 6.7j, pages 66 and 70).

The IOSGADV/SAF mass release data are documented in Calculation N-4076-001 (Reference 6.1q, pages 22 and 37), which utilizes data determined in CE Calculation 1370-DT-003 (Reference 6.7j, pages 67 and 69).

The LOCV/SAF mass release data are determined in CE Calculation 1370-DT-010 (Reference 6.7l, page 17).

The LOAC/SAF mass release data are determined in CE Calculation 1370-DT-004 (Reference 6.7s, pages 19 and 21).

The LNFWF mass release data are documented in UFSAR Section 15.2.2.5.4.3. No CE Calculation with equivalent mass release data has been found.

Per the Table 8.1-3 listing of events without fuel failure, the IOSGADV/SAF mass release bounds the IFWF/SAF, LOCV/SAF, LOAC/SAF, and LNFW mass releases. Since more steam is released during the IOSGADV/SAF, and since the steam release of each event is characterized by the absence of fuel failure, the radiological consequences of the IFWF/SAF, LOCV/SAF, LOAC/SAF and LNFW events are bounded by the radiological consequences of the IOSGADV/SAF event.

Per Tables 8.1-2 and 8.1-3, the IOSGADV/SAF and IMSF/SAF events are similar in that both feature a 1 gpm primary to secondary leakage rate, both feature only secondary side releases, and neither event initiates a SIAS. However, per Table 8.1-3, although the IOSGADV/SAF mass release bounds the IMSF/SAF mass release, the IMSF/SAF event has fuel failure. Based on this comparison, the true indicator as to which of these events is radiologically bounding rests upon a comparison of their offsite dose consequences. Per Calculation N-4076-001 (page 41), the IOSGADV/SAF event results in EAB thyroid and whole body gamma immersion doses of 1.91 Rem and 1.71e-3 Rem, respectively. Per ABB/CE design analysis A-SG2-FE-0100 (pages 11 and E-5), the IMSF/SAF event results in EAB thyroid and whole body gamma immersion doses of 17.0 rem and 2.6 rem, respectively. Therefore, the radiological consequences of the IMSF/SAF event bound the radiological consequences of all other infrequent incidents, including the IOSGADV/SAF, IFWF/SAF, LOCV/SAF, LOAC/SAF, and LNFW events.

Since the IMSF/SAF and IOSGADV/SAF events do not initiate a SIAS, the control room doses due to an IMSF/SAF or IOSGADV/SAF will not be mitigated by a CRIS. Since the IMSF/SAF event has fuel failure, it is reasonable to assume that high control room radiation levels will alert the Operators to a need to manually place the control room HVAC system into the high radiation isolation mode. Since the IOSGADV/SAF event and all other infrequent incidents have no fuel failure, there may not be any indication in the control room that an incident with radiological consequences has occurred and, hence, the control room HVAC system may not be manually placed into the high radiation mode. Consequently, it is necessary for this calculation to evaluate dose consequences of both the IMSF/SAF and IOSGADV/SAF infrequent incidents. Since the radiological consequences of an IMSF/SAF and IOSGADV/SAF bound those of all other infrequent incidents, in the absence of CPIS, FHIS, and CRIS, there is no need for this calculation to evaluate dose consequences for any other infrequent incident.

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8.1.3 Determination of Limiting Faults to be Evaluated

Limiting faults are those events which are not expected to occur but are postulated because their consequences would include the potential for the release of significant amounts of radioactive material. Limiting faults may release radioactivity to the environment from various plant locations, including the containment building and the fuel handling building. Table 8.1-4 summarizes the limiting faults addressed in the UFSAR.

Table 8.1-4 notes the airborne activity release locations for each limiting fault. The determination of event release locations was made with engineering judgement based on the UFSAR event descriptions and a review of the reload transient analyses. Irrespective of the release location, any release of radioactivity could be dispersed via the atmosphere to the control room and offsite locations. Currently, control room doses are only evaluated for selected severe limiting fault accidents.

Table 8.1-4 notes that some of the limiting faults generate a SIAS. The determination as to whether an event generates a SIAS was made with engineering judgement based on the UFSAR event descriptions and a review of the reload transient analyses.

Many of the limiting faults have radiological consequences that are not impacted by the absence of CPIS, FHIS and CRIS. Many of the remaining limiting faults yield consequences that are enveloped by another more severe event. Table 8.1-4 notes these occurrences. The following subsections determine that in the absence of CPIS, FHIS and CRIS the following limiting faults are among the most severe events:

Feedwater System Pipe Breaks (FWSPB)
Control Element Assembly Ejection (CEA-ej)
Small Break Loss of Coolant Accident (SBLOCA)
Design Basis Fuel Handling Accident Inside Fuel Building (FHA-FHB)
Spent Fuel Pool Gate Drop Accident (GDA)
Spent Fuel Pool Boiling Accident (SFPB)

The following subsections determine that these events and the infrequent incidents of Increased Main Steam Flow with a Single Active Failure (IMSF/SAF) and Inadvertent Opening of a Steam Generator Atmospheric Dump Valve with a Single Active Failure (IOSGADV/SAF) bound the radiological consequences of other limiting faults affected by the absence of CPIS, FHIS and CRIS. Section 8.1.2 identifies the IMSF/SAF and IOSGADV/SAF as events that needs to be evaluated in this calculation.

The following subsections also determine that since the FWSPB, CEA-ej, SBLOCA, FHA-FHB, GDA, and SFPB events do not necessarily initiate a SIAS, the control room and/or offsite doses due to these events will not be mitigated by a CPIS and/or CRIS. Consequently, it is necessary for this calculation to evaluate these seven limiting faults. Since the radiological consequences of these seven limiting faults and the IMSF/SAF and IOSGADV/SAF infrequent incidents bound those of all other limiting faults affected by the absence of CPIS, FHIS and CRIS, there is no need for this calculation to evaluate dose consequences for any other limiting fault.

TABLE 8.1-4 SUMMARY OF LIMITING FAULTS

UFSAR Section	Limiting Fault Description	Airborne Activity Release Location (SEE NOTES 1, 2, 3,4)					SIAS initiated	Other Event that Bounds Dose Consequences with no CPIS-FHIS-CRIS
		Inside Ctmt.	Inside Fuel Bldg.	MSSV prior to 30 min	ADV 30 min to SDC	Other		
15.1.3.1A	Pre-Trip Steam Line Break, Outside Containment	N	N	Yes	Yes	Yes	Yes	No (See Note 7)
	Pre-Trip Steam Line Break, Inside Containment	Yes	N	Yes	Yes	N	Yes	No (See Note 7)
15.1.3.1B	Post-Trip Return-to-Power Steam Line Break	N	N	N	Yes	Yes	Yes	No (See Note 7)
15.2.3.1	Feedwater System Pipe Breaks	Yes	N	Yes	Yes	N	N	No **THIS EVENT MUST BE EVALUATED**
15.2.3.2	Loss of Normal Feedwater Flow with an Active Failure in the Turbine Steam Bypass System	N	N	N	Yes	N	Yes	Post-Trip SLB
15.3.3.1	Single Reactor Coolant Pump Shaft Seizure	N	N	Yes	Yes	N	N	Single RCP Sheared Shaft
15.3.3.2	Single Reactor Coolant Pump Sheared Shaft	N	N	Yes	Yes	N	N	Infrequent Incident--IMSF/SAF
15.3.3.3	Total Loss of Forced Reactor Coolant Flow with Single Active Failure	N	N	Yes	N	N	N	Single RCP Sheared Shaft

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TABLE 8.1-4 SUMMARY OF LIMITING FAULTS

UFSAR Section	Limiting Fault Description	Airborne Activity Release Location (SEE NOTES 1, 2, 3,4)					SIAS initiated	Other Event that Bounds Dose Consequences with no CPIS-FHIS-CRIS
		Inside Cmt.	Inside Fuel Bldg.	MSSV prior to 30 min	ADV 30 min to SDC	Other		
15.4.3.1	Inadvertent Loading of a Fuel Assembly into the Improper Position	N	N	N	N	N	N	no dose consequences
15.4.3.2	Control Element Assembly Ejection (CEA-ej)	Yes	N	Yes	Yes	N	Not credited	No **THIS EVENT MUST BE EVALUATED**
15.6.3.1	Primary Sample or Instrument Line Break [referred to as a Letdown Line Break (LLB)]	N	N	N	Yes	Yes	N	No (See Note 9)
15.6.3.2	Steam Generator Tube Rupture	N	N	Yes	Yes	N	Yes	No (See Note 7)
15.6.3.3	Small Break Loss of Coolant Accident (SBLOCA)	Yes	N	Yes	Yes	N	Yes and No (See Note 6)	No **THIS EVENT MUST BE EVALUATED**
	Large Break Loss of Coolant Accident	Yes	N	Yes	Yes	Yes	Yes	No (See Note 7)
15.6.3.4	Inadvertent Opening of a Pressurizer Safety Valve (IOPSV)	Yes (See Note 5)	N	Yes	Yes	N	Yes	SBLOCA
15.7.3.1	Radioactive Waste Gas System Leak or Failure	N	N	Yes	Yes	N	N	Single RCP Sheared Shaft
15.7.3.2	Radioactive Waste System Leak or Failure (Release to Atmosphere)	N	N	Yes	Yes	N	N	Single RCP Sheared Shaft
15.7.3.3	Postulated Radioactive Releases due to Liquid Tank Failures	N	N	N	N	N	N	no dose consequences
15.7.3.4	Design Basis Fuel Handling Accident Inside Fuel Building (FHA-FHB)	N	Yes	N	N	N	N	No **THIS EVENT MUST BE EVALUATED**

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0	Mark Drucker	8/15/97	T. Remick	8/18/97					

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TABLE 8.1-4 SUMMARY OF LIMITING FAULTS

UFSAR Section	Limiting Fault Description	Airborne Activity Release Location (SEE NOTES 1, 2, 3,4)					SIAS initiated	Other Event that Bounds Dose Consequences with no CPIS-FHIS-CRIS
		Inside Ctmt.	Inside Fuel Bldg.	MSSV prior to 30 min	ADV 30 min to SDC	Other		
15.7.3.5.1	Spent Fuel Cask Drop into Spent Fuel Pool	N	N (See Note 8)	N	N	N	N	no dose consequences
15.7.3.5.2	Spent Fuel Cask Drop to Flat Surface	N	N (See Note 8)	N	N	N	N	no dose consequences
15.7.3.6	Spent Fuel Pool Gate Drop Accident (GDA)	N	Yes	N	N	N	N	No **THIS EVENT MUST BE EVALUATED**
15.7.3.7	Test Equipment Drop	N	Yes	N	N	N	N	no dose consequences
15.7.3.8	Spent Fuel Pool Boiling Accident	N	Yes	N	N	N	N	No **THIS EVENT MUST BE EVALUATED**
15.7.3.9	Design Basis Fuel Handling Accident Inside Containment	Yes	N	N	N	N	N	No (See Note 7)
15.7.3.10.1	Spent Fuel Assembly Drop onto Reconstitution Station	N	N (See Note 8)	N	N	N	N	no dose consequences
15.7.3.10.2	Spent Fuel Assembly Drop onto CEA Bearing Spent Fuel Assemblies	N	N (See Note 8)	N	N	N	N	no dose consequences
15.7.3.11	Use of Miscellaneous Equipment Under 2000 lbs	N	N (See Note 8)	N	N	N	N	no dose consequences

TABLE 8.1-4 SUMMARY OF LIMITING FAULTS

UFSAR Section	Limiting Fault Description	Airborne Activity Release Location (SEE NOTES 1, 2, 3,4)					SIAS initiated	Other Event that Bounds Dose Consequences with no CPIS-FHIS-CRIS
		Inside Cmt.	Inside Fuel Bldg.	MSSV prior to 30 min	ADV 30 min to SDC	Other		

(1) If an event does not release radioactivity into the containme. building, then the failure of the CPIS will not affect the radiological dose consequences of that event.

(2) If an event does not release radioactivity into the fuel handling building, then the failure of the FHIS will not affect the radiological dose consequences of that event.

(3) UFSAR Chapter 15 dose analyses typically assume that main steam safety valve steam releases continue until the valves either reseat on decreasing secondary side pressure, or until Operator Action is taken at time 30 minutes to close the MSSVs by operation of the ADVs.

(4) UFSAR Chapter 15 dose analyses typically assume that atmospheric dump valve steam releases are initiated by Operator Action 30 minutes into the event, and that the ADVs are isolated (i.e., end of the accident scenario) when shutdown cooling mode is initiated.

(5) This event releases primary coolant activity via the pressurizer safety valves. The radioactivity flowing past the PSVs is directed into the Pressurizer Relief (Quench) Tank, which is designed to prevent normal discharges from the PSVs from being released to the containment atmosphere. In the IOPSV event, the magnitude of the PSV mass release causes a breach of the Quench Tank rupture disk and a subsequent release to the containment atmosphere.

(6) The small break LOCA event represents a spectrum of break sizes. SBLOCA break sizes smaller than 0.01 ft^2 may not generate a SIAS.

(7) Although the radiological consequences of this event are not bounded by the consequences of any other event, for reasons discussed in Sections 8.1.3.1 through 8.1.3.3, the failure of the CPIS and/or CRIS will not affect the radiological dose consequences of this event.

(8) Although this event occurs in the Fuel Handling Building, for reasons discussed in Section 8.1.3.2, the failure of the FHIS and/or CRIS will not affect the radiological dose consequences of this event.

(9) Although the radiological consequences of this event are not bounded by the consequences of any other event, as discussed in Section 8.1.3.3.8, an evaluation which does not credit control room isolation and the subsequent initiation of CREACUS has been performed in the analysis of record. The evaluation determined that even without a CRIS, the control room doses meet GDC 19 dose criteria.

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0	Mark Drucker	8/15/97	T. Remick	8/18/97					

8.1.3.1 Airborne Activity Releases Inside Containment

Table 8.1-4 identifies the following seven limiting faults which could potentially release activity into the containment building:

- Pre-Trip Steam Line Break Inside Containment (SLB-IC)
- Feedwater System Pipe Break (FWSPB)
- Control Element Assembly Ejection (CEA-ej)
- Small Break Loss of Coolant Accident (SBLOCA)
- Large Break Loss of Coolant Accident (LBLOCA)
- Inadvertent Opening of a Pressurizer Safety Valve (IOPSV)
- Design Basis Fuel Handling Accident Inside Containment (FHA-IC)

The following subsections determine that many of the limiting faults that could potentially release activity into the containment building have radiological consequences that are not impacted by the absence of CPIS and CRIS. Of the remaining limiting faults, the CEA-ej and SBLOCA limiting faults and the infrequent incident of an Increased Main Steam Flow with a Single Active Failure (IMSF/SAF) bound the radiological consequences of other limiting faults that could potentially release activity into the containment building and be affected by the absence of CPIS and CRIS. Section 8.1.2 identifies the IMSF/SAF infrequent incident as an event that need be evaluated in this calculation.

The following subsections determine that since the spectrum of CEA-ej and SBLOCA events do not always initiate a SIAS, the control room and/or offsite doses due to these events will not always be mitigated by a CPIS and/or CRIS. Consequently, it is necessary for this calculation to evaluate these two limiting faults. Since the radiological consequences of these two limiting faults and the IMSF/SAF infrequent incident bound those of all other limiting faults that could potentially release activity into the containment building and be affected by the absence of CPIS and CRIS, there is no need for this calculation to evaluate dose consequences for any other limiting fault that could potentially release activity into the containment building.

8.1.3.1.1 UFSAR §15.1.3.1A -- Pre-Trip Steam Line Break Inside Containment

UFSAR Section 15.1.3.1A presents the evaluation of a Pre-Trip Power Excursion Analysis of a Main Steam Line Break Inside Containment (pre-trip SLB-IC). The pre-trip SLB-IC releases radioactivity into the containment building as steam via the rupture point, and to the outside environment via MSSV and ADV steam releases. The radiological dose consequences of this limiting fault were recently evaluated in the Unit 2 Cycle 9 Reload Analysis Report dose assessment by ABB/CE design analysis A-SG2-FE-0100 (Reference 6.7h, Appendix B).

In ABB/CE design analysis A-SG2-FE-0100 (Section B3.7), the activity introduced into the containment building as a result of the pre-trip SLB-IC was modeled as being gradually released to the outside environment at a 0.1 volume percent per day containment leakage rate. The containment minipurge was implicitly assumed to be out of service during the event; consequently, there was no modeling of a CPIS.

A Safety Injection Actuation Signal is capable of initiating containment minipurge valve closure, control room normal HVAC isolation, and control room essential HVAC operation. ABB/CE Unit 2 Cycle 9 pre-trip steam line break design analysis A-SG2-FE-0090 (Reference 6.7f) ends its transient evaluation prior to confirmation that a SIAS has been generated. However, per Reference 6.6d, engineering judgement predicts that the pre-trip SLB-IC would have generated a SIAS within approximately 30 seconds. Therefore, the SIAS provides a backup if the digital radiation monitors experience a common mode software failure.

8.1.3.1.2 UFSAR §15.2.3.1 -- Feedwater System Pipe Breaks

UFSAR Section 15.2.3.1 presents the evaluation of a Feedwater System Pipe Break (FWSPB); however, no radiological dose consequences are presented for this event. A FWSPB releases radioactivity into the containment building as a consequence of steam generator liquid blowdown via the inside containment break location, and to the outside environment via MSSV and ADV steam releases.

An FWSPB event may not provide indication in the control room that an accident with radiological consequences has occurred and, hence, the control room may not be isolated by operator action. For this reason, it is necessary for this calculation to evaluate the limiting fault of a FWSPB event.

8.1.3.1.3 UFSAR §15.4.3.2 -- Control Element Assembly Ejection (CEA-ej)

UFSAR Section 15.4.3.2 presents the evaluation of a Control Element Assembly Ejection (CEA-ej). In a CEA-ej event it is possible for fuel damage to occur, and for primary reactor coolant carrying failed fuel activity to be released into the containment building. The radiological dose consequences of this limiting fault are evaluated in Calculation N-4073-001 (Reference 6.1n).

Per Calculation N-4073-001 (Appendix A page A5), the failed fuel activity released during a CEA-ej was modeled as being immediately released from the RCS to the Containment, and then gradually released to the outside environment at a 0.1 volume percent per day containment leakage rate. The containment minipurge was implicitly assumed to be out of service during the event; consequently, there was no modeling of a CPIS.

No Safety Injection Actuation Signal was assumed to be generated during the CEA-ej event. As such, the offsite and control room dose consequences of the CEA-ej event cannot be assumed to be mitigated by SIAS initiated containment minipurge valve closure, control room normal HVAC isolation, and control room essential HVAC operation. For this reason, it is necessary for this calculation to evaluate the limiting fault of a CEA-ej event.

8.1.3.1.4 UFSAR §15.6.3.3 -- Small Break Loss of Coolant Accident

UFSAR Section 15.6.3.3 presents the evaluation for a spectrum of Small Break Loss of Coolant Accidents (SBLOCAs). However, no radiological dose consequences are presented in the UFSAR for these events. In a SBLOCA event it is possible for fuel damage to occur, and for primary reactor coolant carrying failed fuel activity to be released into the containment building.

A Safety Injection Actuation Signal can be generated by sufficiently low pressurizer pressure or high containment pressure. However, several of the SBLOCA event scenarios are small enough such that they would not generate a SIAS within 30 minutes. As such, the offsite and control room dose consequences of several SBLOCA event scenarios will not be mitigated by SIAS initiated containment minipurge valve closure, control room normal HVAC isolation, and control room essential HVAC operation. For this reason, it is necessary for this calculation to evaluate the limiting fault of a SBLOCA.

8.1.3.1.5 UFSAR §15.6.3.3 -- Large Break Loss of Coolant Accident

UFSAR Section 15.6.3.3 presents the evaluation for a Large Break Loss of Coolant Accident (LBLOCA). In a LBLOCA event fuel damage would occur, and primary reactor coolant carrying failed fuel activity would be released into the containment building. In addition, during a LBLOCA other outside containment release paths are postulated, including

Engineered Safety Feature (ESF) and Post Accident Sampling System leakage. The radiological dose consequences of this limiting fault are summarized in Calculation N-4060-020 (Reference 6.1i).

A Safety Injection Actuation Signal is capable of initiating containment minipurge valve closure, control room normal HVAC isolation, and control room essential HVAC operation. Per Technical Specification Limiting Condition for Operation 3.3.5 and its Table 3.3.5-1 (References 6.4h and 6.4i), a SIAS is generated if the containment pressure exceeds 3.7 psig. Per Calculation N-4080-026 (Reference 6.1t, Supplement A page A-45) -- the Containment Pressure/Temperature analysis for the design basis LOCA -- the containment pressure rises to 6.68 psig within one second of a LBLOCA. Consequently, a SIAS will be generated for a LBLOCA event within one second of the event start time. Engineering judgement dictates that this time to SIAS is sufficiently short such that the SIAS will provide an adequate backup if the digital radiation monitors experience a common mode software failure.

8.1.3.1.6 UFSAR §15.6.3.4 -- Inadvertent Opening of a Pressurizer Safety Valve

UFSAR Section 15.6.3.4 presents the evaluation of an Inadvertent Opening of a Pressurizer Safety Valve (IOPSV). An IOPSV releases radioactivity into the containment building, and to the outside environment via MSSV and ADV steam releases. No radiological dose consequences are presented in the UFSAR for this event; UFSAR Section 15.6.3.4.5 currently states that the radiological consequences of the IOPSV event are less severe than those of the Inadvertent Opening of a Steam Generator Atmospheric Dump Valve with a Single Active Failure (IOSGADV/SAF).

By definition, the IOPSV event is characterized by the failure of a pressurizer safety valve resulting in the discharge of large amounts of steam into the Pressurizer Relief (Quench) Tank via the PSV discharge piping. A rupture disc venting to the containment atmosphere is provided for Quench Tank overpressure protection. Per CE Letter S-CE-3124 (Reference 6.3f), the rupture disk on the Quench Tank would fail after 1300 lbm of steam is discharged. Per engineering judgement, during an IOPSV event the rupture disk will fail, resulting in a release of radioactivity into the containment building. Therefore, the IOPSV is actually a small break LOCA.

A May 2, 1997 memorandum for file (Reference 6.6g) compares the IOPSV and SBLOCA event dose consequences. The memorandum concludes that the 0.025 ft^2 SBLOCA releases to containment and through the MSSVs are larger than the similar IOPSV releases, and that the ADV cooldown doses are the same for both events. The memorandum concludes that the

0.025 ft^2 SBLOCA dose consequences bound the IOPSV dose consequences. UFSAR change request SAR 23-544 has been originated to revise the UFSAR Section 15.6.3.4.5 text to compare the IOPSV event to the SBLOCA event, rather than to IOSGADV/SAF event.

8.1.3.1.7 UFSAR §15.7.3.9 -- Design Basis Fuel Handling Accident Inside Containment

UFSAR Section 15.7.3.9 presents the evaluation for a Design Basis Fuel Handling Accident Inside Containment (FHA-IC). In a FHA-IC event it is possible for the gaseous isotopes in the damaged spent fuel rod gap space to be released into the containment building. The radiological dose consequences of this limiting fault are evaluated in Calculation N-4072-003 (Reference 6.1l).

Per Calculation N-4072-003, the activity introduced into the containment building as a result of the FHA-IC was modeled as being rapidly released to the outside environment at a flow rate of 82,000 cfm for the duration of the accident. This flow rate effectively evacuated the containment air space within the first two hours of the event as required by Regulatory Guide 1.25 (Reference 6.4e, Position C.1.i). Since this exhaust flow rate is in excess of the of 40,000 cfm purge system flow rate shown by Drawing 40092 (Reference 6.2d), a failure of CPIS would not affect the doses calculated in the current analysis of record.

Operator Action is capable of initiating containment minipurge valve closure, control room normal HVAC isolation, and control room essential HVAC operation. Per Licensee Controlled Specification 3.9.102 (References 6.4j and 6.4k), continuous communication with the control room is required when performing fuel handling activities inside containment. Therefore, the control room Operators will be immediately notified should an FHA-IC occurs. This allows for prompt Operator Action to place the control room HVAC system in the high radiation isolation mode. The current analysis of record (Calculation N-4072-003) assumes that control room isolation occurs 3 minutes after the start of the FHA. Based on the operators performing the manual action to isolate the Control Room within 3 minutes, the FHA-IC analysis remains valid for the case where the CRIS from the digital radiation monitors fails.

8.1.3.2 Airborne Activity Releases Inside Fuel Handling Building

Table 8.1-4 identifies the following nine events which occur inside the fuel handling building and which could potentially release activity into the fuel handling building:

- Design Basis Fuel Handling Accident Inside Fuel Handling Building (FHA-FHB)
- Spent Fuel Cask Drop into Spent Fuel Pool
- Spent Fuel Cask Drop to Flat Surface
- Spent Fuel Pool Gate Drop Accident (GDA)
- Test Equipment Drop
- Spent Fuel Pool Boiling Accident
- Spent Fuel Assembly Drop onto Reconstitution Station
- Spent Fuel Assembly Drop onto CEA Bearing Spent Fuel Assemblies
- Use of Miscellaneous Equipment Under 2000 lbs

The following subsections determine that many of the limiting faults that could potentially release activity into the fuel handling building have radiological consequences that are not impacted by the absence of FHIS and CRIS. Of the remaining limiting faults, the FHA-FHB and GDA limiting faults bound the radiological consequences of other limiting faults that could potentially release activity into the fuel handling building and be affected by the absence of FHIS and CRIS.

The following subsections determine that since the FHA-FHB and GDA events do not initiate a Safety Injection Actuation Signal, the control room doses due to these events will not be mitigated by a CRIS. Consequently, it is necessary for this calculation to evaluate these two limiting faults. Since the radiological consequences of these two limiting faults bound those of all other limiting faults that could potentially release activity into the fuel handling building and be affected by the absence of FHIS and CRIS, there is no need for this calculation to evaluate dose consequences for any other limiting fault that could potentially release activity into the fuel handling building.

8.1.3.2.1 UFSAR §15.7.3.4 -- Design Basis Fuel Handling Accident Inside Fuel Handling Building

UFSAR Section 15.7.3.4 presents the evaluation for a Design Basis Fuel Handling Accident Inside the Fuel Handling Building (FHA-FHB). In a FHA-FHB event it is possible for the gaseous isotopes in the damaged spent fuel rod gap space to be released into the fuel handling building air space. The radiological dose consequences of this limiting fault are evaluated in Calculation N-4072-001 (Reference 6.1k).

Per Calculation N-4072-001, the activity introduced into the fuel handling building as a result of the FHA-FHB was modeled as being released to the outside environment at a flow rate of 26,365 cfm. This flow rate effectively evacuated the fuel handling building air space within the first two hours of the event as required by Regulatory Guide 1.25 (Reference 6.4e, Position C.1.i). This exhaust flow rate is equivalent to the normal operation FHB HVAC intake flow rate shown by Drawing 40090 (Reference 6.2c). Therefore, a failure of FHIS would not affect the doses calculated in the current analysis of record.

No Safety Injection Actuation Signal is generated during the FHA-FHB event. As such, the control room dose consequences of the FHA-FHB event will not be mitigated by SIAS initiated control room normal HVAC isolation and control room essential HVAC operation. For this reason, a failure of CRIS would affect the doses calculated in the current analysis of record, and it is necessary for this calculation to evaluate the limiting fault of a FHA-FHB.

8.1.3.2.2 UFSAR §15.7.3.5.1 -- Spent Fuel Cask Drop into Spent Fuel Pool

UFSAR Sections 15.7.3.5.1 and 9.1.4 address the potential for a Spent Fuel Cask Drop into the Spent Fuel Pool. As noted in the UFSAR, the cask handling crane is prohibited from traveling over the spent fuel pool or any unprotected safety-related equipment. The fuel handling building layout and design are shown on Drawing 716031 (Reference 6.2a). Per this drawing and UFSAR Section 9.1.4, positive protection against dropping the spent fuel shipping cask into the spent fuel storage pool is provided by the basic layout of the spent fuel storage pool, fuel transfer system, and fuel handling arrangement which make it impossible to pass the cask over the spent fuel storage racks. Thus, an accident with radiological consequences resulting from dropping a cask or other major load into the spent fuel pool is not credible.

8.1.3.2.3 UFSAR §15.7.3.5.2 -- Spent Fuel Cask Drop to Flat Surface

NUREG-0800 Standard Review Plan 15.7.5 (Reference 6.4t, Section II) states that the plant design with regard to spent fuel cask drop accidents is acceptable without calculation of radiological consequences if potential cask drop distances are less than 30 feet and appropriate impact limiting devices are employed during cask movements.

UFSAR Sections 15.7.3.5.2 and 9.1.4 address the potential for a Spent Fuel Cask Drop to a Flat Surface. Plant design as shown on Drawing 716032 (Reference 6.2b) and administrative controls limit the potential drop of a spent fuel cask to less than an equivalent 30-foot drop onto a flat, essentially unyielding, horizontal surface. The administrative controls that implement this limitation are addressed in Procedure SO123-I-3.32 (Reference 6.5a, Attachment 1, Administrative Control 13, and Attachment 4).

Administrative controls also include the requirement for placing a 3-foot high railcar in the railcar bay to serve as an impact energy absorber should a spent fuel cask drop through the open receiving/shipping hatch to the railcar. The railcar represents a yielding surface that mitigates the consequences of a potential 34-foot drop to plant grade. The administrative control that implements this limitation is addressed in Procedure SO123-I-3.32 (Attachment 1, Administrative Control 15).

Since the guidelines of Standard Review Plan 15.7.5 are met, there are no radiological consequences that need be evaluated for a spent fuel cask drop accident to a flat surface.

8.1.3.2.4 UFSAR §15.7.3.6 – Spent Fuel Pool Gate Drop Accident

UFSAR Section 15.7.3.6 presents the evaluation for a Spent Fuel Pool Gate Drop Accident Inside the Fuel Handling Building (GDA). In a GDA event it is possible for fuel damage to occur, and for gaseous isotopes in the spent fuel rod gap space to be released into the fuel handling building air space. The radiological dose consequences of this limiting fault are evaluated in Calculation N-4072-001 (Reference 6.1k).

Per Calculation N-4072-001 (Assumption 3.6 and Design Input 4.5), the activity introduced into the fuel handling building as a result of the GDA was modeled as being released to the outside environment at a flow rate of 26,365 cfm. This flow rate effectively evacuated the fuel handling building air space within the first two hours of the event as required by Regulatory Guide 1.25 (Reference 6.4e, Position C.1.i). This exhaust flow rate is equivalent to the normal operation FHB HVAC intake flow rate shown by Drawing 40090 (Reference 6.2c). Therefore, a failure of FHIS would not affect the doses calculated in the current analysis of record.

No Safety Injection Actuation Signal is generated during the GDA event. As such, the control room dose consequence of the GDA event will not be mitigated by SIAS initiated control room normal HVAC isolation and control room essential HVAC operation. For this reason, it is necessary for this calculation to evaluate the limiting fault of a GDA.

8.1.3.2.5 UFSAR §15.7.3.7 -- Test Equipment Drop

UFSAR Section 15.7.3.7 addresses the scenario of a Test Equipment Skid Drop Inside the Fuel Handling Building. As noted in the UFSAR, administrative controls will be implemented to ensure that the radiological consequences for a test equipment drop will be bounded by the radiological consequences for a spent fuel pool gate drop accident. The administrative controls listed in the UFSAR, and the procedure steps that implement these controls, are as follows:

A. "The height above the pool floor that the skid may be carried over rack cells which contain Unit 1 fuel assemblies shall be limited to 47 feet (elevation 64 feet 6 inches)."
-- Implemented by Procedure SO23-X-7.2, Step 4.18.2 (Reference 6.5c).

B. "When it [the skid] is lowered, it shall be lowered over empty racks or rack cells containing Unit 1 fuel assemblies only."
-- Implemented by Procedure SO23-I-3.32, Precaution 4.16 (Reference 6.5a).

C. "The maximum height that the skid will travel horizontally over the racks shall be 72 inches (elevation 39 feet 10 inches). A drop from this height will not damage Units 2 and 3 fuel assemblies."
-- Implemented by Procedure SO23-X-7.2, Step 4.18.2.

D. "All CEA's are to be removed from the test equipment skid impact zone, 10 by 12 cells, prior to lifting or lowering the skid over the high density spent fuel storage racks."
-- Implemented by Procedure SO23-X-7.2, Step 4.18.1.

E. "The test equipment skid shall be maintained 11 inches or less above the top of the racks when passing over CEA bearing SONGS Units 2 and 3 spent fuel assemblies in the high density spent fuel storage racks."
-- Implemented by Procedure SO23-X-7.2, Step 4.18.3.

F. "The test equipment skid shall not be lifted or transported over the reconstitution station or adjacent spent fuel storage locations when spent fuel assemblies are in the reconstitution station on the rack spacers."
-- Implemented by Procedure SO23-X-7.2, Step 4.18.4.

Having these controls in place will ensure that the fuel assemblies are not damaged since the depth of penetration will not impact the racks at the level where the Unit 1 or Units 2 and 3 fuel assemblies are located. Although the UFSAR correctly states that radiological consequences of this accident are bounded by those of the gate drop accident, there will be, in fact, no radiological consequences. Hence, operator action to isolate the control room is not necessary in order to meet the dose criteria of GDC 19.

8.1.3.2.6 UFSAR §15.7.3.8 -- Spent Fuel Pool Boiling Accident

UFSAR Section 15.7.3.8 addresses the scenario of a loss of spent fuel pool cooling flow resulting in a Spent Fuel Pool (SFP) Boiling Accident. In a SFP boiling accident it is possible for gaseous isotopes in the spent fuel rod gap space to be released into the fuel handling building air space. The radiological dose consequences of this limiting fault are evaluated in Calculation N-4072-007 (Reference 6.1m).

In Calculation N-4072-007 (Assumption 5 and Section 8.1B on sheet 24), no credit was taken for the FHIS as the activity released into the fuel handling building as a result of the SFP boiling accident was modeled as being instantaneously released to the outside environment. Calculation N-4072-007 predicts EAB whole body and thyroid doses of less than 0.05 rem, which is bounded by the doses for a design basis fuel handling accident in the fuel handling building (FHA-FHB). However, the SFP boiling accident is still evaluated (Appendix H) because, unlike the FHA-FHB, it may not provide indication in the control room that an accident with radiological consequences has occurred and, hence, the control room may not be isolated by operator action.

8.1.3.2.7 UFSAR §15.7.3.10.1 -- Spent Fuel Assembly Drop onto Reconstitution Station

UFSAR Section 15.7.3.10.1 addresses the scenario of a Spent Fuel Assembly Drop onto a Reconstitution Station Inside the Fuel Handling Building. As noted in the UFSAR, two administrative controls have been implemented to prevent the occurrence of this type of accident. The administrative controls listed in the UFSAR, and the procedure steps that implement these controls, are as follows:

A. "No spent fuel assembly shall be moved over any spent fuel assembly in the reconstitution station or over adjacent storage locations when spent fuel assemblies are in the reconstitution station on the rack spacers."
-- Implemented by Procedure SO23-X-7.2 (Reference 6.5c), Step 4.7.3.

B. "No CEA bearing spent fuel assemblies shall be placed atop rack spacers in the reconstitution station."
-- Implemented by Procedure SO23-X-7.2, Step 4.7.1.

These administrative controls ensure that an accident with radiological consequences resulting from a spent fuel assembly drop onto a reconstitution station is not credible.

8.1.3.2.8 UFSAR §15.7.3.10.2 -- Spent Fuel Assembly Drop onto CEA Bearing Spent Fuel Assemblies

UFSAR Section 15.7.3.10.2 addresses the scenario of a Spent Fuel Assembly Drop onto a CEA Bearing Spent Fuel Assembly Inside the Fuel Handling Building. As noted in the UFSAR, this type of accident will not damage either the dropped assembly or the target CEA bearing spent fuel assembly in the high density spent fuel storage racks. As such there are no radiological consequences for a spent fuel assembly drop onto a CEA bearing spent fuel assembly.

8.1.3.2.9 UFSAR §15.7.3.11 -- Use of Miscellaneous Equipment Under 2000 lbs

UFSAR Section 15.7.3.11 addresses the scenario of miscellaneous equipment weighing under 2,000 pounds dropping onto the high density spent fuel storage racks during refueling and normal spent fuel pool maintenance. Procedure SO23-X-7.2 (Reference 6.5c) Step 4.20.1 has been implemented to implement the 2,000 pound value as a load restriction. As noted in the UFSAR, the dropping of equipment weighing under 2,000 pounds will not damage fuel impacted by the dropped equipment. As such there are no radiological consequences for miscellaneous equipment weighing under 2,000 pounds dropping onto the high density spent fuel storage racks during refueling and normal spent fuel pool maintenance.

8.1.3.3 Airborne Activity Releases Directly to the Outside Environment

Table 8.1-4 identifies the following twelve events that could potentially release activity solely to the outside environment. Events that could also release activity into the containment or fuel handling buildings are addressed in Sections 8.1.3.1 and 8.1.3.2, respectively.

- Pre-Trip Steam Line Break Outside Containment
- Post-Trip Return-to-Power Steam Line Break
- Loss of Normal Feedwater Flow with an Active Failure in the Turbine Steam Bypass System
- Single Reactor Coolant Pump Snaft Seizure
- Single Reactor Coolant Pump Sheared Shaft
- Total Loss of Forced Reactor Coolant Flow with a Single Active Failure
- Inadvertent Loading of a Fuel Assembly into the Improper Location
- Primary Sample or Instrument Line Break (LLB)
- Steam Generator Tube Rupture
- Radioactive Waste Gas System Leak or Failure
- Radioactive Waste System Leak or Failure (Release to Atmosphere)
- Postulated Radioactive Releases due to Liquid Tank Failures

The following subsections determine that many of the limiting faults that could potentially release activity solely to the outside environment have radiological consequences that are not impacted by the absence of CRIS. Of the remaining limiting faults, the LLB limiting fault and the infrequent incident of an Increased Main Steam Flow with a Single Active Failure (IMSF/SAF) bound the radiological consequences of other limiting faults that could potentially release activity solely to the outside environment and be affected by the absence of CRIS. Section 8.1.2 identifies the IMSF/SAF infrequent incident as an event that need be evaluated in this calculation.

The following subsections determine that since the LLB event does not initiate a Safety Injection Actuation Signal, the control room doses due to this event will not be mitigated by a CRIS. Since the radiological consequences of the LLB limiting fault and the IMSF/SAF infrequent incident bound those of all other limiting faults that could potentially release activity solely to the outside environment and be affected by the absence of CRIS, there is no need for this calculation to evaluate dose consequences for any other limiting fault that could potentially release activity solely to the outside environment.

8.1.3.3.1 UFSAR §15.1.3.1A -- Pre-Trip Steam Line Break Outside Containment

UFSAR Section 15.1.3.1A presents the evaluation of a Pre-trip Power Excursion Analysis of a Main Steam Line Break Outside Containment (pre-trip SLB-OC). The pre-trip SLB-OC releases radioactivity to the outside environment as steam via the rupture point, and via MSSV and ADV steam releases. The EAB radiological dose consequences of this limiting fault were recently evaluated in the Unit 2 Cycle 9 Reload Analysis Report dose assessment by ABB/CE design analysis A-SG2-FE-0100 (Reference 6.7h, Appendix C).

ABB/CE Unit 2 Cycle 9 design analysis A-SG2-FE-0090 (Reference 6.7f) ends its pre-trip steam line break transient evaluation prior to confirmation that a SIAS has been generated. However, per Reference 6.6d, engineering judgement predicts that the pre-trip SLB-OC would have generated a SIAS within approximately 30 seconds. Therefore, the SIAS provides a backup if the digital radiation monitors experience a common mode software failure.

8.1.3.3.2 UFSAR §15.1.3.1B -- Post-Trip Steam Line Break

UFSAR Section 15.1.3.1B presents the evaluation of a Post-Trip Return-to-Power Analysis of a Main Steam Line Break (post-trip RTP SLB). The RTP SLB can occur either inside or outside containment. The EAB radiological dose consequences of this limiting fault were recently evaluated in the Unit 2 Cycle 9 Reload Analysis Report dose assessment by ABB/CE design analysis A-SG2-FE-0089 (Reference 6.7e).

Per ABB/CE design analysis A-SG2-FE-0089 (Section 4.2), the Post-Trip Return-to-Power Steam Line Break Outside Containment (post-trip RTP SLB-OC) represents a more direct activity release path to the environment than the Post-Trip Return-to-Power Steam Line Break Inside Containment (post-trip RTP SLB-IC). The post-trip RTP SLB-OC event releases radioactivity to the outside environment as steam via the rupture point, and via ADV steam releases. The absence of activity dilution and hold-up within the containment building justifies the fact that UFSAR Section 15.1.3.1B only addresses the radiological consequences of the post-trip RTP SLB-OC. The radiological dose consequences of this limiting fault were recently evaluated in Calculation N-4074-001 (Reference 6.1o).

Per ABB/CE design analysis A-SG2-FE-0089 (Tables 7.1.5b-3 through 7.1.5b-6), the post-trip RTP SLB-IC event results in low pressurizer pressure that generates a SIAS 21.34 seconds after the piping failure. Per ABB/CE design analysis A-SG2-FE-0089 (Section 4.2), the pre-trip RTP SLB-OC transient analysis results are bounded by the pre-trip RTP SLB-IC results. For this reason, engineering judgement dictates that the post-trip RTP SLB-IC SIAS time is characteristic of the post-trip RTP SLB-OC event. Engineering judgement also dictates that this time to SIAS is sufficiently short such that the SIAS will provide an adequate backup if the digital radiation monitors experience a common mode software failure.

8.1.3.3.3 UFSAR §15.2.3.2 -- Loss of Normal Feedwater Flow with an Active Failure in the Turbine Steam Bypass System

UFSAR Section 15.2.3.2 presents the evaluation of a loss of normal feedwater flow with an active failure in the turbine steam bypass system. The Loss of Normal Feedwater Flow with this Single Active Failure (LNFWF/SAF) releases radioactivity to the outside environment via ADV steam releases. No radiological dose consequences are presented in the UFSAR for this event.

The LNFWF/SAF transient analysis was recently evaluated in ABB/CE design analysis 1370-CPE-009/1470-CPE-005 (Reference 6.7i). Per ABB/CE design analysis 1370-CPE-009/1470-CPE-005 (Hand Calculation #8b, page 53), the LNFWF/SAF event results in low pressurizer pressure that generates a SIAS 72.85 seconds after the termination of all feedwater flow to the steam generators. Engineering judgement dictates that this time to SIAS is sufficiently short such that the SIAS will provide an adequate backup if the digital radiation monitors experience a common mode software failure.

Per ABB/CE design analysis 1370-CPE-009/1470-CPE-005 (Section III, page 10), the radiological consequences of the LNFWF/SAF event are less severe than other limiting faults. This conclusion is consistent with UFSAR Section 15.2.3.2.5, which states that the radiological consequences of the LNFWF/SAF event are less severe than the consequences of the Post-trip Return-to-Power Steam Line Break Outside Containment (post-trip RTP SLB-OC). This conclusion is also supported by a comparison of the LNFWF/SAF and post-trip RTP SLB-OC event characteristics as presented in Table 8.1-6.

TABLE 8.1-6: COMPARISON OF LNFWF/SAF and POST-TRIP RTP SLB-OC EVENT CHARACTERISTICS

Parameter	Loss of Normal Feedwater Flow with a Single Active Failure	Post-Trip Return-to-Power Steam Line Break Outside Containment
Fuel Failure	0 percent	0 percent
Primary to Secondary Mass Release Rate	1.0 gpm	1.0 gpm
Secondary Side Liquid Mass Releases	0 lbm	308,571.1 lbm
Secondary Side Steam Mass Releases		
0 to 30 minutes	0 lbm	0 lbm
30 minutes to end of event	700,000 lbm	1,120,392 lbm
Total Event Duration	700,000 lbm	1,120,392 lbm

No fuel failure is predicted for either the LNFWF/SAF or the post-trip RTP SLB-OC. The determination as to whether an event experiences fuel failure was made with engineering judgement based on the UFSAR event descriptions and a review of the reload transient analyses.

Each event is characterized by a 1.0 gallon/minute primary to secondary leakage rate. The determination of this leakage rate was made with engineering judgement based on the UFSAR event descriptions and a review of the reload transient analyses.

The steam mass release data during a LNFWF/SAF is documented in CE Calculation 1370-DT-018 (Reference 6.7o, page 21). The liquid and steam mass releases to atmosphere during a post-trip RTP SLB-OC are documented in Calculation N-4074-001 (Reference 6.1o, pages 12 and 13), which cites CE Letter S-CE-3058 (Reference 6.3d). CE Letter S-CE-3058 is partially based on mass release rate and accident duration data determined in CE Calculation 1370-DT-005 (Reference 6.7k, Revision 0 page 83).

Per Table 8.1-6, the LNFWF/SAF mass release is bounded by the post-trip RTP SLB-OC mass release. Since more steam and liquid mass are released during the post-trip RTP SLB-OC, and since each event is characterized by the absence of fuel failure, the radiological consequences of the LNFWF/SAF are bounded by the radiological consequences of the post-trip RTP SLB-OC.

8.1.3.3.4 UFSAR §15.3.3.1 – Single Reactor Coolant Pump Shaft Seizure

UFSAR Section 15.3.3.1 presents the evaluation of a Single Reactor Coolant Pump Shaft Seizure (also known as a Seized Rotor event [RCP/SR]). No radiological dose consequences are presented for this event; UFSAR Section 15.3.3.1 currently states that the radiological consequences of the RCP/SR are less severe than those of the Single Reactor Coolant Pump Sheared Shaft (RCP/SS).

The RCP/SR and RCP/SS transient analyses were recently evaluated in ABB/CE Unit 2 Cycle 9 design analysis A-SG2-FE-0093 (Reference 6.7g). Per ABB/CE design analysis A-SG2-FE-0093 (Section 7.3.3.2), the consequences of the RCP/SS event are more limiting than the RCP/SR event because of the delay in generating the RCP/SS trip (relative to the RCP/SR trip), and the consequential increase in RCP/SS fuel failure (relative to the RCP/SR fuel failure).

Engineering judgement dictates that the mass release for the RCP/SR and RCP/SS events will be virtually identical, representing the MSSV and ADV steam releases associated with a loss of AC power event. The steam release consists of secondary side activity plus failed fuel induced primary side activity introduced by primary-to-secondary leakage. Since the RCP/SS event has greater fuel failure than the RCP/SR event, the radiological consequences of the RCP/SR are bounded by the radiological consequences of the RCP/SS.

8.1.3.3.5 UFSAR §15.3.3.2 – Single Reactor Coolant Pump Sheared Shaft

UFSAR Section 15.3.3.2 presents the evaluation of a Single Reactor Coolant Pump Sheared Shaft (RCP/SS). The RCP/SS transient analysis was recently evaluated in ABB/CE Unit 2 Cycle 9 design analysis A-SG2-FE-0093 (Reference 6.7g). Per ABB/CE design analysis A-SG2-FE-0093 (Section IV), the RCP/SS event is characterized by a fuel failure of 8.05 percent. The RCP/SS releases radioactivity to the outside environment via MSSV and ADV steam releases. The radiological dose consequences of this limiting fault were recently evaluated in the Unit 2 Cycle 9 Reload Analysis Report dose assessment by ABB/CE design analysis A-SG2-FE-0100 (Reference 6.7h, Appendix D).

Similar to the RCP/SS limiting fault, the infrequent incident of an Increased Main Steam Flow with a Single Active Failure (IMSF/SAF) is also characterized by fuel failure and both MSSV and ADV steam releases. Per ABB/CE design analysis A-SG2-FE-0081 (Reference 6.7c, Section 4.1), the IMSF/SAF event is characterized by a fuel failure of 18.4 percent.

As with the RCP/SS limiting fault, the EAB radiological dose consequences of the IMSF/SAF infrequent incident were recently evaluated in the Unit 2 Cycle 9 Reload Analysis Report dose assessment by ABB/CE design analysis A-SG2-FE-0100 (Appendix E). Primarily because of the difference in fuel failure, ABB/CE design analysis A-SG2-FE-0100 shows that the IMSF/SAF infrequent incident has radiological consequences that are more severe than those of the RCP/SS limiting fault. As noted in Section 8.1.2, this calculation will evaluate the infrequent incident of an IMSF/SAF.

8.1.3.3.6 UFSAR §15.3.3.3 -- Total Loss of Forced Reactor Coolant Flow with a Single Active Failure

UFSAR Section 15.3.3.3 presents the evaluation of a Total Loss of Forced Reactor Coolant Flow with a Single Active Failure (TLOF/SAF). The TLOF/SAF releases radioactivity to the outside environment via MSSV steam releases. No radiological dose consequences are presented for this event; UFSAR Section 15.3.3.3 currently states that the radiological consequences of the TLOF/SAF are less severe than those of the Reactor Coolant Pump Sheared Shaft (RCP/SS). This conclusion is also supported by a comparison of the TLOF/SAF and RCP/SS event characteristics as presented in Table 8.1-7.

TABLE 8.1-7: COMPARISON OF TLOF/SAF and RCP/SS EVENT CHARACTERISTICS

Parameter	Total Loss of Forced Reactor Coolant Flow with a Single Active Failure	Single Reactor Coolant Pump Sheared Shaft
Fuel Failure	2.12 percent	8.05 percent
Primary to Secondary Mass Release Rate	1.0 gpm	1.0 gpm
Secondary Side Steam Mass Releases		
0 to 30 minutes	3235 lbm	84,700 lbm
30 minutes to 2 hours	0 lbm	492,604 lbm
Total: 0 to 2 hours	3235 lbm	577,304 lbm

Per CE Calculation 1370-DT-013 (Reference 6.7n, pages 5 and 17), the TLOF/SAF limiting fault is characterized by 2.12 percent fuel failure and a MSSV steam release of only 3235 lbm.

Per ABB/CE design analysis A-SG2-FE-0093 (Reference 6.7g, Section IV), the RCP/SS event is characterized by a fuel failure of 8.05 percent. The steam and liquid mass release data during a RCP/SS are documented in ABB/CE design analysis A-SG2-FE-0100 (Reference 6.7h, Appendix D pages D6 and D7), based on data determined in CE Calculation 1370-TS-004 (Reference 6.7q, Revision 00, pages 12 and 13).

Each event is characterized by a 1.0 gallon/minute primary to secondary leakage rate. The determination of this leakage rate was made with engineering judgement based on the UFSAR event descriptions and a review of the reload transient analyses.

Per Table 8.1-7, the TLOF/SAF fuel failure and mass release are both bounded by the RCP/SS. Therefore, the radiological consequences of the TLOF/SAF are bounded by the radiological consequences of the RCP/SS.

8.1.3.3.7 UFSAR §15.4.3.1 -- Inadvertent Loading of a Fuel Assembly into the Improper Position

UFSAR Section 15.4.3.1 presents the evaluation of an inadvertent loading of a fuel assembly into the improper position. Two accidents are considered, (1) the misloading of fuel pellets or fuel pins of different enrichment in a fuel assembly, and (2) the incorrect placement or orientation of fuel assemblies.

As noted in the UFSAR, the likelihood of an error in assembly, fabrication, or core loading is considered to be extremely remote because of the extensive quality control and quality surveillance programs employed during the fabrication process as well as the strict procedural control used during core loading. However, even if the core were to have incorrectly placed fuel rods or assemblies, these would either be detectable from the results of the startup or would lead to a minimal number of rods with excessive power during full power operation. These precautions and administrative procedural controls ensure that an accident with radiological consequences resulting from an inadvertent loading of a fuel assembly into the improper position is not credible.

8.1.3.3.8 UFSAR §15.6.3.1 -- Primary Sample or Instrument Line Break

UFSAR Section 15.6.3.1 presents the evaluation of a Primary Sample or Instrument (i.e., Letdown) Line Break (LLB). In the LLB primary reactor coolant is released into the auxiliary building air space, from which it is dispersed to the outside environment.

Additionally, due to the postulated loss of normal AC power, the process of cooling down the plant results in secondary steam releases from the ADVs. The radiological dose consequences of this limiting fault were recently evaluated in Calculation N-4077-001 (Reference 6.1r).

No Safety Injection Actuation Signal is generated during the limiting LLB event (where the non-safety pressurizer control systems remain in operation). As such, the control room dose consequences of the LLB event will not be mitigated by SIAS initiated control room normal HVAC isolation and control room essential HVAC operation. Calculation N-4077-001 evaluates a case (Case B-N) which does not credit control room isolation and the subsequent initiation of CREACUS. This evaluation determined that the Case B-N control room doses meet the dose criteria of 10 CFR Part 50 Appendix A General Design Criterion 19. The initial conditions of Case B-N are consistent with, or conservative to, those of this analysis. Therefore, Case B-N is applicable to this calculation and its assumed high radiation induced CRIS failure.

8.1.3.3.9 UFSAR §15.6.3.2 -- Steam Generator Tube Rupture

UFSAR Section 15.6.3.2 presents the evaluation of a Steam Generator Tube Rupture (SGTR). The SGTR event releases radioactivity to the outside environment via the condenser air ejectors, MSSV and ADV steam releases. The radiological dose consequences of this limiting fault were recently evaluated in Calculation N-4075-004 Revision 2 (Reference 6.1p).

The SGTR transient analysis was evaluated in CE Calculation 1370-TS-109/1470-TS-051 (Reference 6.7r). Per CE Calculation 1370-TS-109/1470-TS-051 (Table III.D.1), the SGTR event results in low pressurizer pressure that generates a SIAS 1010.2 seconds (about 16.8 minutes) after the tube rupture. The SIAS is capable of initiating control room normal HVAC isolation and control room essential HVAC operation.

Calculation N-4075-004 evaluates a pre-existing primary reactor coolant system iodine spike case [Case P30] in which credit for the SIAS induced CRIS and CREACUS operation is not taken until 30 minutes after the start of the SGTR event. This evaluation determined that even with this delay in the SIAS start time, the control room doses meet the dose criteria of 10 CFR Part 50 Appendix A General Design Criterion 19.

8.1.3.3.10 UFSAR §15.7.3.1 -- Radioactive Waste Gas System Leak or Failure

UFSAR Section 15.7.3.1 presents the evaluation of a radioactive waste gas system leak or failure. The evaluation specifically addresses a failure of a gaseous radwaste system (GRS) decay tank and the release of contaminants into the auxiliary building air space and eventually to the outside environment within two hours.

Calculation N-4071-001 (Reference 6.1j) is the analysis of record for the GRS decay tank failure. Per Calculation N-4071-001, the activity released to the outside environment consists of the iodine and noble gas present in one reactor coolant system volume, with consideration given for an iodine partition factor of 0.001. The resultant activity profile for the isotopes released to the environment is as shown in UFSAR Table 15.7-2. This activity release profile is less severe than that determined in other limiting faults, including the activity release profile determined for the Reactor Coolant Pump Sheared Shaft (RCP/SS) event. The activity profile for the RCP/SS event is documented in the Unit 2 Cycle 9 Reload Analysis Report dose assessment by ABB/CE design analysis A-SG2-FE-0100 (Reference 6.7h, Appendix D, page D-22). Therefore, the radiological consequences of the GRS decay tank failure are bounded by the radiological consequences of the RCP/SS.

8.1.3.3.11 UFSAR §15.7.3.2 -- Radioactive Waste System Leak or Failure

UFSAR Section 15.7.3.2 presents the evaluation of a radioactive waste system leak or failure. The evaluation specifically addresses a failure of a liquid radwaste system (LRS) primary or secondary tank, and the release of contaminants into the auxiliary building air space and eventually to the outside environment within two hours.

Calculation N-4078-001 (Reference 6.1s) is the analysis of record for the LRS primary and secondary tank failures. Per Calculation N-4078-001, the activity released to the outside environment consists of the iodine and noble gas present in a tank volume, with consideration given for an iodine partition factor of 0.001. The resultant activity profile for the isotopes released to the environment is as shown in UFSAR Table 15.7-4. This activity release profile is less severe than that determined in other limiting faults, including the activity release profile determined for the Reactor Coolant Pump Sheared Shaft (RCP/SS) event. The activity profile for the RCP/SS event is documented in the Unit 2 Cycle 9 Reload Analysis Report dose assessment by ABB/CE design analysis A-SG2-FE-0100 (Reference 6.7h, Appendix D, page D-22). Therefore, the radiological consequences of the LRS primary or secondary tank failure are bounded by the radiological consequences of the RCP/SS.

8.1.3.3.12 UFSAR §15.7.3.3 -- Postulated Radioactive Releases due to Liquid Tank Failures

UFSAR Section 15.7.3.3 presents the evaluation of a postulated radioactive release due to a liquid tank failure, and refers the reviewer to UFSAR Sections 2.4.12 and 2.4.13 for discussions of the effects of a postulated radioactive liquid tank failure on surface water and groundwater.

UFSAR Section 2.4.12 addresses the effects of a postulated radioactive liquid tank failure on surface water. Since this is not an airborne release path, there is no radiological consequences either offsite or in the control room that would be mitigated by a CPIS, FHIS or CRIS. Therefore, it is not necessary for this calculation to evaluate this event.

UFSAR Section 2.4.13 addresses the effects of a postulated radioactive liquid tank failure on groundwater. Since this is not an airborne release path, there is no radiological consequences either offsite or in the control room that would be mitigated by a CPIS, FHIS or CRIS. Therefore, it is not necessary for this calculation to evaluate this event.

8.2 Control Element Assembly Ejection

The analysis of the Control Element Assembly (CEA) Ejection limiting fault is provided in Appendix A. The calculated doses are listed in the appendix, and meet the criteria of Section 1.2.

8.3 Feedwater System Pipe Break

The analysis of the Feedwater System Pipe Break (FWSPB) infrequent incident is provided in Appendix B. The calculated doses are listed in the appendix, and meet the criteria of Section 1.2.

8.4 Small Break LOCA

The analysis of the Small Break LOCA limiting fault is provided in Appendix C. The calculated doses are listed in the appendix, and meet the criteria of Section 1.2.

8.5 Fuel Handling Accident in the Fuel Handling Building

The analysis of the Fuel Handling Accident (FHA) in the Fuel Handling Building (FHB) limiting fault is provided in Appendix D. The calculated doses are listed in the appendix, and meet the criteria of Section 1.2.

8.6 Spent Fuel Pool Gate Drop Accident

The analysis of the Spent Fuel Pool (SFP) Gate Drop the Fuel Handling Building (FHB) limiting fault is provided in Appendix E. The calculated doses are listed in the appendix, and meet the criteria of Section 1.2. Per Design Input E4.4, normal movement of the Spent Fuel Pool gate can not result in any damage to the fuel stored in the Spent Fuel Pool. The gate is only lifted to perform maintenance activities on the gate.

8.7 Increased Main Steam Flow with a Single Active Failure

The analysis of the Increased Main Steam Flow with a Single Active Failure infrequent incident is provided in Appendix F. The calculated doses are listed in the appendix, and meet the criteria of Section 1.2.

8.8 Inadvertent Opening of a SG ADV w/ SAF

The analysis of the Inadvertent Opening of a Steam Generator Atmospheric Dump Valve (SG ADV) with a Single Active Failure (SAF) infrequent incident is provided in Appendix G. The calculated doses are listed in the appendix, and meet the criteria of Section 1.2.

8.9 Spent Fuel Pool Boiling

The analysis of the Spent Fuel Pool Boiling infrequent incident is provided in Appendix H. The calculated doses are listed in the appendix, and meet the criteria of Section 1.2.

9.0 COMPUTER FILES

The following computer files were created for this calculation. Copies of the LOCADOSE library, input, and dose output files for each analysis are included in the associated appendix.

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drwxr-sr-x  11 sys      sys          512 Jun 11 09:03 ../
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EC&FS DEPARTMENT

CALCULATION SHEET

ICCN NO./ PRELIM. CCN NO.	PAGE __ OF __
	CCN CONVERSION: CCN NO. CCN –

Project or DCP/MMP DCP 2&3 6926.01SJ Calc. No. N-0720-014

Subject Control Room and Offsite Doses Should CPIS, CRIS, and FHIS Fail

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	Mark Drucker	8/15/97	T. Remick	8/18/97					

The Appendix C parametric evaluation files are:

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-rw-r--r--   1 remickta nf010    62686 Sep 11 13:03 sloca1.trn

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-rw-r--r--   1 remickta nf010    73572 Sep 11 13:03 sloca_1.to
-rw-r--r--   1 remickta nf010    62686 Sep 11 13:03 sloca_1.trn

-rw-r-----   1 remickta nf010      845 Sep 11 13:01 slocap01.di
-rw-r--r--   1 remickta nf010    23394 Sep 11 13:04 slocap01.do
-rw-r-----   1 remickta nf010     3645 Sep 11 13:01 slocap01.ti
-rw-r--r--   1 remickta nf010    73572 Sep 11 13:04 slocap01.to
-rw-r--r--   1 remickta nf010    62686 Sep 11 13:04 slocap01.trn
```

APPENDIX A CEA EJECTION

A1.0 CEA EJECTION METHODOLOGY

Following a Control Element Assembly (CEA) Ejection there are three main radioactive material release mechanisms. First, as the CEA ejection is based on a breach of the reactor coolant pressure boundary (at the failed CEA drive vessel penetration) the reactor coolant released to Containment leaks to the environment at the Containment leak rate or at the mini-purge flow rate. Second, the process of cooling down the reactor results in the release of secondary side activity to the atmosphere through the Atmospheric Dump Valves (ADV) and Main Steam Safety Valves (MSSV) as the assumed loss of power makes the condenser unavailable. Third, steam generator tube leakage is assumed to be at the design basis value of 1 gpm, resulting in the reactor coolant leakage being released from the secondary side to the atmosphere with the flow through the ADV/MSSVs. The released radioactive material is dispersed into the atmosphere, and from there to the Control Room, EAB and LPZ.

The immersion and inhalation doses are due to the airborne cloud at the EAB and LPZ and the cloud inside the Control Room. The LOCADOSE dose calculation program will be run using the appropriate assumptions and design inputs from Sections 3 and 4 to calculate the immersion and inhalation doses in the CR and at the EAB and LPZ. Figures A-1 and A-2 show the LOCADOSE models used.

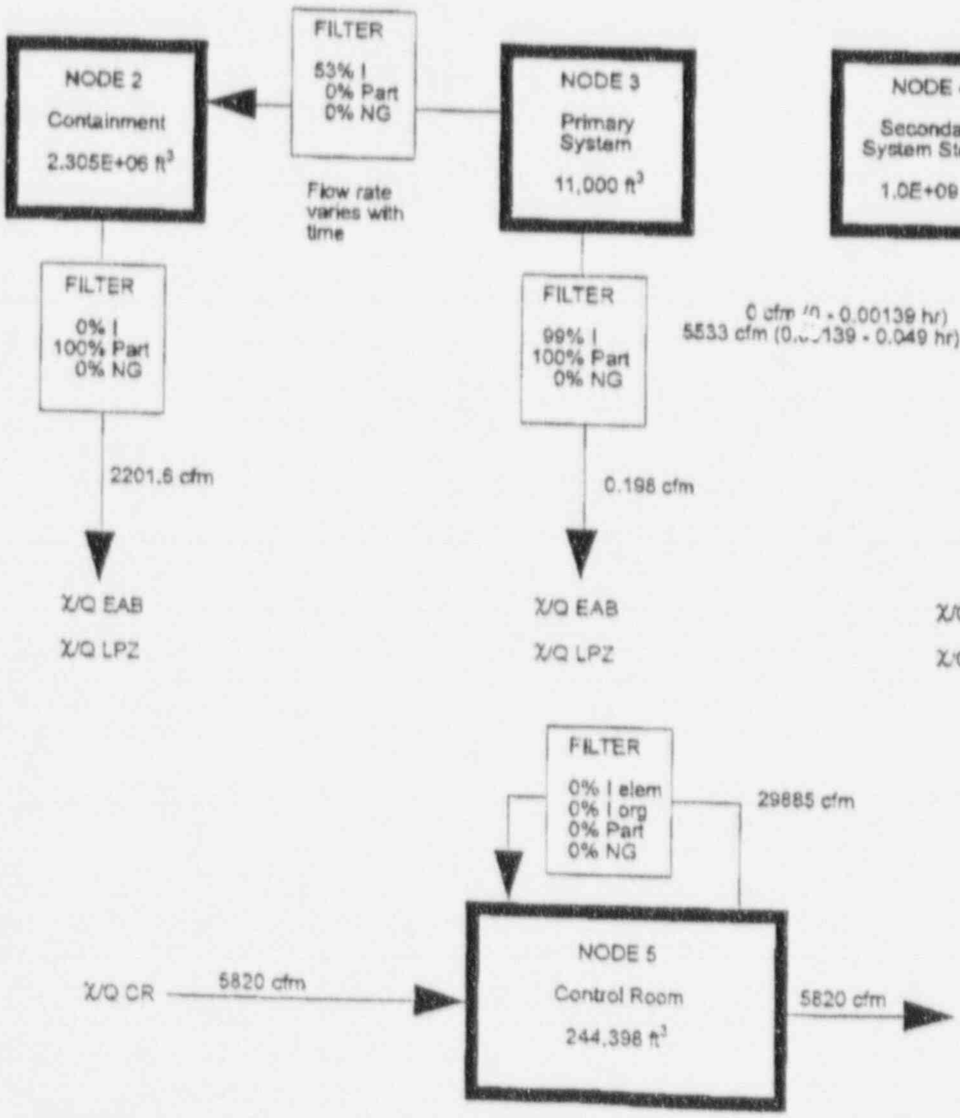
1. Figure A-1 represents the initial configuration, with containment mini-purge in operation.

2. Figure A-2 represents the configuration once the CR HVAC system has been placed into the high radiation isolation mode, and the containment mini-purge system has been isolated.

A2.0 CEA EJECTION LOCADOSE MODEL

Figure A-1

CEA Ejection LOCADOSE Model
CR HVAC In Normal Mode
Containment Mini-purge in Operation



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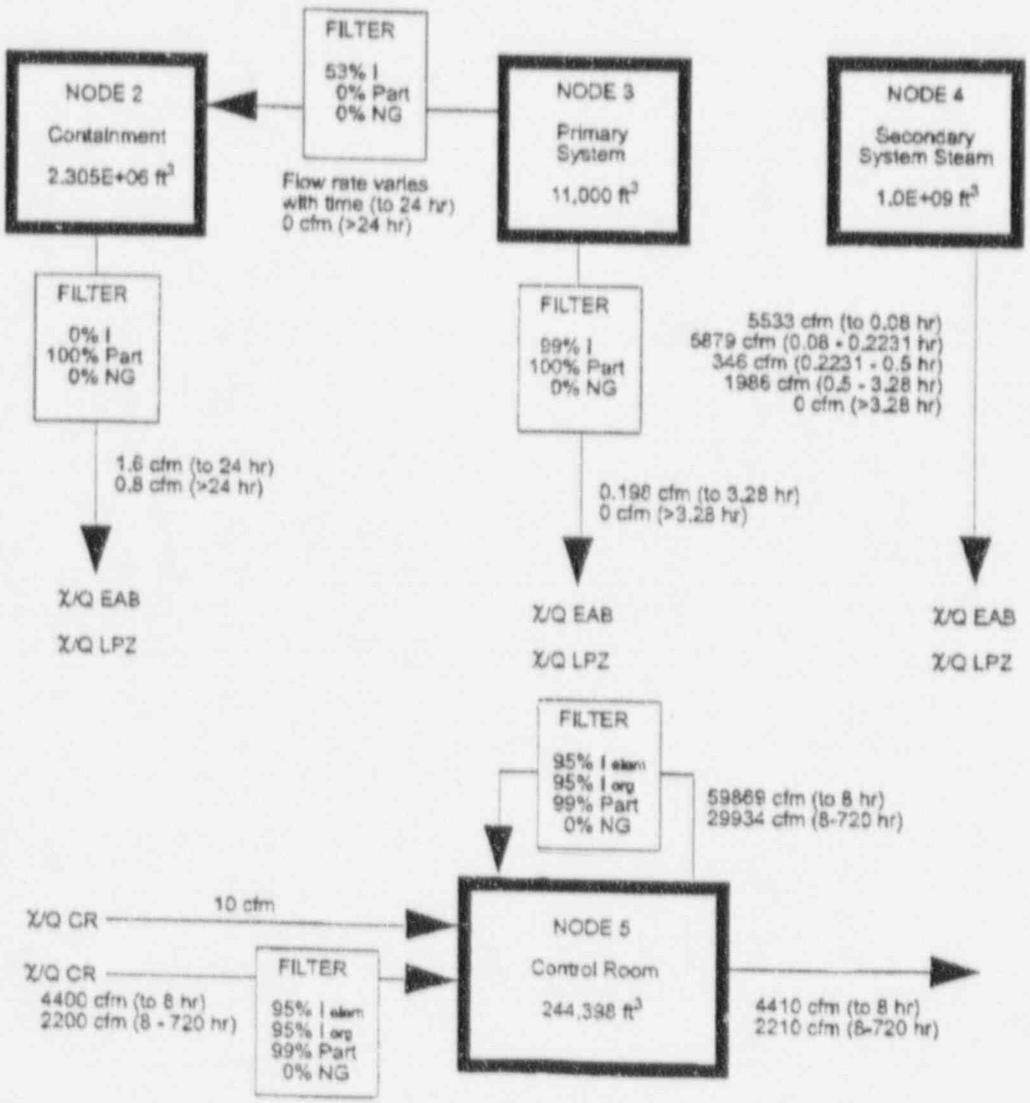
0	Mark Drucker	8/15/97	T. Remick	8/18/97					

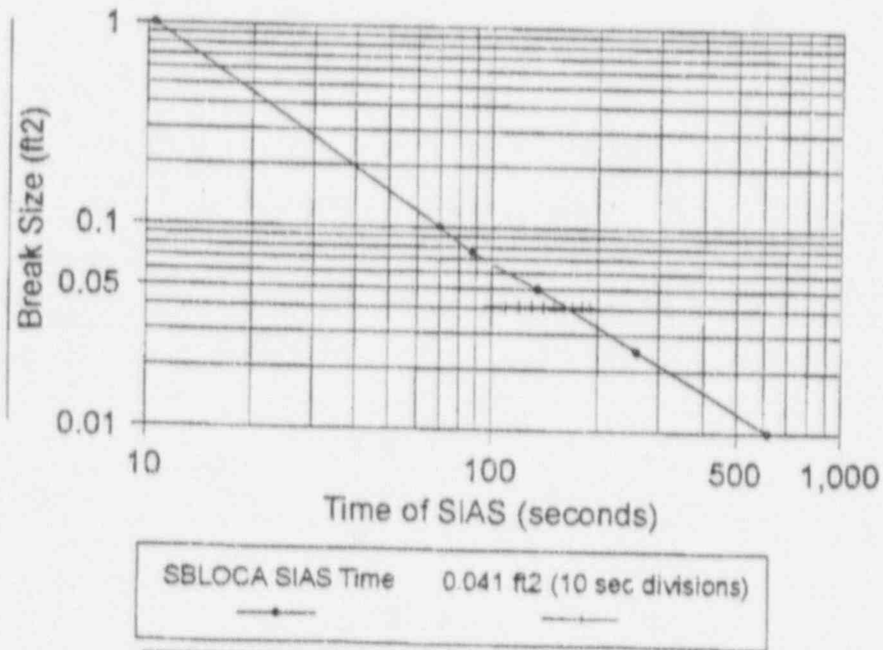
Figure A-2

CEA Ejection LOCADOSE Model
CR HVAC In High Radiation Isolation Mode
Containment Mini-purge Isolated



A3.0 CEA EJECTION ASSUMPTIONS

A3.1 Per CE Letter S-CE-5696 (Reference 6.3j), the analyses of record for the CEA Ejection did not consider the impact of the break in the RCS boundary. This was done to conservatively maximize the RCS overpressurization transient. Based on engineering judgement, a SIAS would have been generated had the break been considered. Per S-CE-5696, the CEA Ejection has a break size of 0.041ft^2. ABB Letter ST-96-456 (Reference 6.3m) provides a listing of the SIAS time for the various SBLOCA sizes. This data is plotted in the following chart. Based on the chart, this analysis will assume that for the 0.041 ft^2 CEA Ejection a SIAS will be generated by 165 seconds. The SIAS will cause the Control Room HVAC to shift to the high radiation isolation mode, and the Containment mini-purge system to isolate.



A3.2 The RCS mass release to Containment information from the 0.05 ft^2 SBLOCA will be assumed to apply to the CEA ejection. Since the CEA ejection break size is 0.041 ft^2, this is reasonable. Per ABB Letter ST-96-456, the 0.05 ft^2 SBLOCA break flow rate data is:

<u>0.05 ft² SBLOCA</u>

0 - 2.25 min (0.0375 hr):	121,000 lbm (equivalent to 1275 cfm)
2.25 - 30 min:	316,880 lbm (equivalent to 271 cfm)
30 - 50 min (end):	75,770 lbm (equivalent to 90 cfm)

The volumetric flow rate for each of the time intervals has been calculated as follows, using the Design Input 4.6 RCS specific volume:

$$Flow\ rate\ (cfm) = \frac{Interval\ release\ (lbm)}{Interval\ duration\ (min)} \times \frac{0.02371\ ft^3}{lbm}$$

For the first time interval, a sample calculation is:

$$\frac{121{,}000\ lbm}{2.25\ min} \times \frac{0.02371\ ft^3}{lbm} = 1275\ cfm$$

The flow rate from 50 minutes to 24 hours will be assumed to be equal to the flow rate at 50 minutes. The flow rate after 24 hours will be assumed to be 0 cfm (as the RCS is assumed to be depressurized, stopping the leak).

A3.3 It will be assumed that 1% of the iodine present in that portion of the RCS leakage that does not flash will also become airborne. The value of 1% is consistent with the iodine partition coefficient used for the steam generators.

A3.4 Because this evaluation is based on having the containment mini-purge system in service at the start of the accident, a pre-existing reactor coolant iodine spike of 60 μCi/gm Dose Equivalent I-131 will be assumed. This is per Standard Review Plan Section 6.2.4 Branch Technical Position 6-4 item B.5.a (Reference 6.4o).

A3.5 Because this analysis assumes that only the iodine present in the leaking reactor coolant that flashes to steam becomes airborne in containment, no credit will be taken for iodine removal by containment spray or plate out.

A3.6 Once the SIAS is initiated, it is assumed that the Control Room HVAC system dampers take 10 seconds to shift to the high radiation isolation mode. This time is conservative to the value of 6 seconds used in calculation N-4072-001 (Reference 6.1k).

A3.7 Once the SIAS is initiated, it is assumed that the Containment mini-purge system takes 10 seconds to isolate. This time is conservative to the Licensee Controlled Specification 3.6.101 Table 3.6.101-1B (References 6.4j and 6.4k) stroke time limit of 5 seconds.

A4.0 CEA EJECTION DESIGN INPUTS

A4.1 Per CE Letter S-CE-5696 Table 15.4-30 (Reference 6.3j) as verified by calculation 1370-PSAE-057 (Reference 6.7t), the sequence of events for a CEA Ejection is as follows:

5 seconds:	steam generator safety valves (MSSV) open
288 seconds:	emergency feedwater initiated
803 seconds:	steam generator safety valves closed
1800 seconds:	operator opens atmospheric dump valves (ADV) to initiate cooldown
11801 seconds:	shutdown cooling is initiated, ADV and AFW secured

A4.2 Per CE Letter S-CE-5696 (Reference 6.3j) as verified by calculation 1370-PSAE-057 (Reference 6.7t), the following mass releases occur:

steam released through MSSVs:	103,500 lbm
steam released from steam driven AFW pump (288 - 1800 sec):	17,000 lbm
steam released through ADVs and AFW pump (1800 - 11801 sec):	645,500 lbm

A4.3 Per CE Letter S2-CE-R-441 (Reference 6.3k), an additional MSSV mass release of 40,000 lbm occurs due to the change in the MSSV blowdown parameters.

A4.4 Per A-SG2-FE-0088 Sections VII and XII.7.4.6.4 (SONGS 2 Cycle 9 CEA Ejection Analysis, Reference 6.7d), the design basis CEA ejection does not result in any cladding failure, or fuel melting. This analysis will conservatively model 10% cladding failure, and 0% fuel melting.

A4.5 Per Regulatory Guide 1.77 Appendix B item 1.b (Reference 6.4g), 100% of the gaseous activity present in the fuel rod gap (per Design Input A4.6) is released to the reactor coolant system

A4.6 Per Regulatory Guide 1.77 Appendix B item 1.c (Reference 6.4g), the activity present in the fuel rod gap is 10% of the core iodines and 10% of the core noble gases.

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Subject Control Room and Offsite Doses Should CP S, CRIS, and FHIS Fail

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0	Mark Drucker	8/15/97	T. Remick	8/18/97					

A5.0 CEA EJECTION COMPUTATIONS

A5.1 Primary System Activity Inventory

The activity present in the primary system has two sources. The first source is the normal reactor coolant activity (per Design Inputs 4.13 and 4.14) with an iodine spike (per Assumption A3.4), and the second is the activity released from the failed fuel (Design Input A4.4). Per Section 5.3.3, the failed fuel activity release to the RCS is:

$$\textit{Release to RCS} = \textit{Core Inventory (Ci)} \times \textit{Gap Activity Fraction} \times \textit{Failed Fuel Fraction} \times \textit{Peaking Factor}$$

CEA EJECTION RCS ACTIVITY							
	A	B	C	D	E=AxBxCxD	F	G=E+F
Isotope	DI 4.16 Core Inventory (Ci)	DI A4.6 Gap Fraction	DI A4.4 Failed Fuel Fraction	DI 4.18 Peaking Factor	Activity From Failed Fuel (Ci)	DI 4.13/4.14 Normal RCS Activity (Ci)	Total RCS Activity (Ci)
I-131	9.520e+07	0.1	0.1	1.73	1.647e+06	10,100	1.657e+06
I-132	1.372e+08				2.374e+06	2840	2.377e+06
I-133	1.927e+08				3.334e+06	12,500	3.347e+06
I-134	2.135e+08				3.694e+06	1250	3.695e+06
I-135	1.800e+08				3.114e+06	5510	3.120e+06
Kr-83m	1.341e+07				2.320e+05	N/A	2.320e+05
Kr-85m	2.987e+07				5.168e+05	520	5.173e+05
Kr-85	1.144e+06				1.979e+04	2270	2.206e+04
Kr-87	5.874e+07				1.016e+06	244	1.016e+06
Kr-88	8.301e+07				1.436e+06	788	1.437e+06
Xe-131m	1.067e+06				1.846e+04	529	1.899e+04
Xe-133m	6.002e+06				1.038e+05	N/A	1.038e+05
Xe-133	1.877e+08				3.247e+06	72,400	3.319e+06
Xe-135m	3.809e+07				6.590e+05	244	6.592e+05
Xe-135	5.710e+07				9.878e+05	2250	9.901e+05
Xe-138	1.663e+08				2.877e+06	124	2.877e+06
H-3	N/A				0	678	678
Br-84	N/A				0	8.80	8.80
Te-129	N/A				0	11.0	11.0
Te-132	N/A				0	142	142

A sample calculation for I-131 is:

$$(9.52e{+}07 \times 0.1 \times 0.1 \times 1.73) + 10{,}100 = 1.657e{+}06$$

A5.2 Reactor Coolant Iodine Flashing

The reactor coolant being released is initially at the hot leg conditions of 611°F and 2250 psia (per Design Input 4.6). Per Assumption A3.5, the iodine present in the portion of the leaking reactor coolant that flashes to steam will become airborne. To find the flashing fraction, the mass and enthalpy balance equations will be solved simultaneously.

Terminology (all enthalpies are from the ASME Steam Tables):

- m_c = mass of coolant released to containment
- m_L = released coolant mass that remains a liquid in containment
- m_g = released coolant mass that flashes to a gas in containment
- h_c = coolant enthalpy (compressed liquid at 611°F and 2250 psia, 629.3 BTU/lbm)
- h_L = liquid enthalpy (saturated liquid at 14.7 psia, 180.17 BTU/lbm)
- h_g = gas enthalpy (saturated vapor at 14.7 psia, 1150.5 BTU/lbm)

$$m_c h_c = m_L h_L + m_g h_g$$

$$m_c = m_L + m_g$$

Substituting $m_L = m_c - m_g$ yields:

$$m_c h_c = (m_c - m_g) h_L + m_g h_g$$

$$m_c h_c = m_c h_L - m_g h_L + m_g h_g$$

$$m_c (h_c - h_L) = m_g (h_g - h_L)$$

$$\frac{m_g}{m_c} = \frac{h_c - h_L}{h_g - h_L}$$

$$\frac{m_g}{m_c} = \frac{629.3 - 180.17}{1150.5 - 180.17} = 46.3\%$$

Per Assumption A3.3, an additional 0.537% (1% of the iodine present in the 53.7% of the liquid that does not flash) is also assumed to be released. The total flashing plus partitioning percentage of 46.837% (46.3% + 0.537%) will be conservatively modeled as 47% in this calculation. The flashing will be modeled in LOCADOSE by assuming a 53% efficient iodine filter is on the flowpath of the leaking reactor coolant from the RCS to the containment volume. No filtration will be used on the noble gases or particulates leaking from the RCS to the containment volume.

A5.3 Secondary Side MSSV Releases

Per Design Input A4.1, the MSSV mass release starts at 5 seconds, and ends at 803 seconds.

Per Design Inputs A4.2 and A4.3 the mass release through the MSSVs is:

103,500 lbm + 40,000 lbm = 143,500 lbm

Using a steam density of 1.95 lbm/ft^3 per Assumption 3.11, this results in the following MSSV flow rate:

$$MSSV\ flow\ rate = \frac{143{,}500\ lbm}{(803 - 5\ seconds)} \times \frac{60\ seconds}{min} \times \frac{ft^3}{1.95\ lbm} = 5533\ cfm$$

A5.4 Secondary Side AFW Releases Prior to 30 Minutes

Per Design Input A4.1, the AFW mass release starts at 288 seconds, and is still in operation at 1800 seconds.

Per Design Input A4.2 the steam release from the AFW turbine (up to 1800 seconds) is 17,000 lbm.

Using a steam density of 1.95 lbm/ft^3 per Assumption 3.11, this results in the following AFW flow rate for the first 30 minutes:

$$AFW\ flow\ rate = \frac{17{,}000\ lbm}{(1800 - 288\ seconds)} \times \frac{60\ seconds}{min} \times \frac{ft^3}{1.95\ lbm} = 346\ cfm$$

A5.5 Secondary Side ADV and AFW Releases After 30 Minutes

Per Design Input A4.1, the combined ADV/AFW mass release starts at 1800 seconds, and continues to 11801 seconds.

Per Design Input A4.2 the combined steam release from the ADVs and AFW turbine (from 1800 seconds to the end of the accident) is 645,500 lbm.

Using a steam density of 1.95 lbm/ft^3 per Assumption 3.11, this results in the following ADV/AFW flow rate after 30 minutes:

$$ADV/AFW\ flow\ rate = \frac{645{,}500\ lbm}{(11801 - 1800\ seconds)} \times \frac{60\ seconds}{min} \times \frac{ft^3}{1.95\ lbm} = 1986\ cfm$$

A5.6 Total Secondary System Releases

The total release rate from the secondary side is the total of the release rates from the MSSV, the AFW turbine, and the ADVs. The totals, per time interval, are:

	0 sec (0 hr) – 5 sec (1.39E-03 hr)	5 sec (1.39E-03 hr) – 288 sec (0.08 hr)	288 sec (0.08 hr) – 803 sec (0.2231 hr)	803 sec (0.2231 hr) – 1800 sec (0.5 hr)	1800 sec (0.5 hr) – 11801 sec (3.28 hr)
MSSV		5533 cfm	5533 cfm		
AFW			346 cfm	346 cfm	
ADV/AFW					1986 cfm
Total	0 cfm	5533 cfm	5879 cfm	346 cfm	1986 cfm

A5.7 Primary to Secondary Leakage

Per Design Input 4.11, the primary to secondary leakage is 0.198 cfm. This leakage will be assumed to start at time zero, and stop once shutdown cooling is placed in service. Once shutdown cooling is placed in service, there is no longer a release path from the Steam Generator to the atmosphere (i.e., MSSV or ADV open). A filter (99% effective for iodine, 100% for particulates, 0% for noble gases) will be used on this flow path, to model the steam generator partition coefficient of 0.01 (per Assumption 3.5).

A5.8 Containment Releases to Atmosphere

Prior to the SIAS, the flow rate out of containment is the 2200 cfm from the mini-purge system (per Design Input 4.17) plus 1.6 cfm of containment leakage (per Design Input 4.10). Once the isolation of the mini-purge system initiated by the SIAS is completed (10 seconds after the generation of the SIAS per Assumption A3.7), the flow rate out of containment is equal to the Design Input 4.10 containment leak rate.

A5.9 CEA Ejection LOCADOSE Code Time Steps

The time steps entered into the LOCADOSE Code were chosen to model the times at which parameters important to the analysis are changed (e.g., HVAC changes, secondary system release changes). The analysis will be done for a duration of 30 days.

Time Step (hours after start of event)	Significance of the Time Step
0 hrs	Beginning of CEA ejection limiting fault
0.00139 hr (5 seconds)	MSSV open
0.0375 hr (2.25 minutes)	Change in break flow rate
165 seconds	SIAS generated per A3.1
0.049 hr (175 seconds)	Control Room HVAC transferred to high radiation isolation mode (10 seconds after SIAS per A3.6) Containment mini-purge system isolated (10 seconds after SIAS per A3.7)
0.080 hr (288 seconds)	AFW in service, releasing secondary steam from the AFW turbine exhaust
0.2231 hr (803 seconds)	MSSV closed
0.5 hr	ADV open Change in break flow rate
2 hr	End of EAB dose analysis
3.28 hr (11801 seconds)	Shutdown cooling in service, ADV closed and AFW secured (stopping the release path allowing the primary to secondary leakage to reach the atmosphere)
8 hr	Control Room HVAC placed in single train operation CR χ/Q changes LPZ χ/Q changes LPZ breathing rate changes
24 hr	Change in break flow rate Change in containment leakage rate CR occupancy factor changes CR χ/Q changes LPZ χ/Q changes LPZ breathing rate changes
96 hr	CR occupancy factor changes CR χ/Q changes LPZ χ/Q changes
720 hr	End of analysis

A5.10 CEA Ejection Dose Results

Per Section A6.5, the dose consequences of this accident are as follows. The Control Room whole body doses are doubled per Assumption 3.7.

CEA Ejection - Mini-purge in Operation, SIAS at 165 Seconds	
Location	Dose (Rem)
CR:	
Thyroid	23.8
Beta Skin	0.7
Whole Body	0.1
EAB:	
Thyroid	1.0
Beta Skin	<0.1
Whole Body	<0.1
LPZ:	
Thyroid	0.9
Beta Skin	<0.1
Whole Body	<0.1

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0	Mark Drucker	8/15/97	T. Remick	8/18/97						

A6.0 CEA EJECTION COMPUTER FILES

A6.1 CEA Ejection LOCADOSE Library File (cea-mini.lib)

```
Version 1.0   Thyroid    Lung       Bone   Beta Skin Whole Body
I--131 2.[illegible]3E+04 9.976E-07 1.490E+06 2.073E+04 3.150E+03 3.170E-02 8.720E-02  1
1 21  0  0  0  0  0
 1.100E-02 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00  1 1.817E-01 3.789E-01
I--131 2.508E+04 9.976E-07 1.490E+06 2.073E+04 3.150E+03 3.170E-02 8.720E-02  2
1 21  0  0  0  0  0
 1.100E-02 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00  2 1.817E-01 3.789E-01
I--131 2.508E+04 9.976E-07 1.490E+06 2.073E+04 3.150E+03 3.170E-02 8.720E-02  3
1 21  0  0  0  0  0
 1.100E-02 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00  3 1.817E-01 3.789E-01
I--132 3.806E+04 8.425E-05 1.430E+04 8.879E+02 1.450E+02 1.320E-01 5.130E-01  1
0  0  0  0  0  0  0
 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 34 4.824E-01 3.559E+00
I--132 3.806E+04 8.425E-05 1.430E+04 8.879E+02 1.450E+02 1.320E-01 5.130E-01  2
0  0  0  0  0  0  0
 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 35 4.824E-01 3.559E+00
I--132 3.806E+04 8.425E-05 1.430E+04 8.879E+02 1.450E+02 1.320E-01 5.130E-01  3
0  0  0  0  0  0  0
 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 36 4.824E-01 3.559E+00
I--133 5.622E+04 9.211E-06 2.690E+05 5.064E+03 1.080E+03 7.350E-02 1.550E-01  1
2 23 22  0  0  0  0
 9.710E-01 2.900E-02 0.000E+00 0.000E+00 0.000E+00 0.000E+00  4 4.067E-01 6.047E-01
I--133 5.622E+04 9.211E-06 2.690E+05 5.064E+03 1.080E+03 7.350E-02 1.550E-01  2
2 23 22  0  0  0  0
 9.710E-01 2.900E-02 0.000E+00 0.000E+00 0.000E+00 0.000E+00  5 4.067E-01 6.047E-01
I--133 5.622E+04 9.211E-06 2.690E+05 5.064E+03 1.080E+03 7.350E-02 1.550E-01  3
2 23 22  0  0  0  0
 9.710E-01 2.900E-02 0.000E+00 0.000E+00 0.000E+00 0.000E+00  6 4.067E-01 6.047E-01
I--134 6.575E+04 2.200E-04 3.730E+03 3.627E+02 8.050E+01 9.230E-02 5.320E-01  1
0  0  0  0  0  0  0
 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00  7 6.052E-01 2.620E+00
I--134 6.575E+04 2.200E-04 3.730E+03 3.627E+02 8.050E+01 9.230E-02 5.320E-01  2
0  0  0  0  0  0  0
 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00  8 6.052E-01 2.620E+00
I--134 6.575E+04 2.200E-04 3.730E+03 3.627E+02 8.050E+01 9.230E-02 5.320E-01  3
0  0  0  0  0  0  0
 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00  9 6.052E-01 2.620E+00
I--135 5.103E+04 2.912E-05 5.600E+04 1.971E+03 3.350E+02 1.290E-01 4.210E-01  1
2 25 24  0  0  0  0
 8.450E-01 1.550E-01 0.000E+00 0.000E+00 0.000E+00 0.000E+00 10 3.691E-01 1.617E+00
I--135 5.103E+04 2.912E-05 5.600E+04 1.971E+03 3.350E+02 1.290E-01 4.210E-01  2
2 25 24  0  0  0  0
 8.450E-01 1.550E-01 0.000E+00 0.000E+00 0.000E+00 0.000E+00 11 3.691E-01 1.617E+00
I--135 5.103E+04 2.912E-05 5.600E+04 1.971E+03 3.350E+02 1.290E-01 4.210E-01  3
2 25 24  0  0  0  0
 8.450E-01 1.550E-01 0.000E+00 0.000E+00 0.000E+00 0.000E+00 12 3.691E-01 1.617E+00
KR-83M 4.152E+03 1.052E-04 0.000E+00 5.190E-01 0.000E+00 0.000E+00 2.396E-06  4
0  0  0  0  0  0  0
 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 13 0.000E+00 4.610E-04
KR-85M 1.297E+04 4.297E-05 0.000E+00 2.910E+00 0.000E+00 4.626E-02 3.708E-02  4
1 18  0  0  0  0  0
 2.100E-01 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 14 2.902E-01 1.610E-01
KR--85 4.102E+02 2.054E-09 0.000E+00 2.410E+0[illegible] 0.000E+00 4.246E-02 5.102E-04  4
0  0  0  0  0  0  0
 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 15 2.505E-01 2.236E-03
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Project or DCP/MMP DCP 2&3 6926.01SJ Calc. No. N-0720-014

Subject Control Room and Offsite Doses Should CPIS, CRIS, and FHIS Fail

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	Mark Drucker	8/15/97	T. Remick	8/18/97					

```
KR--87 2.335E+04 1.514E-04 0.000E+00 1.530E+01 0.000E+00 3.083E-01 1.876E-01  4
0  0  0  0  0  0  0
 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 16 1.324E+00 8.032E-01
KR--88 3.200E+04 6.731E-05 0.000E+00 3.130E+01 0.000E+00 7.510E-02 4.658E-01  4
1 31  0  0  [illegible]  0  0
 1.000E+00 [illegible].000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 17 3.587E-01 1.981E+00
XE131M 2.595E+02 6.815E-07 0.000E+00 1.400E+00 0.000E+00 1.508E-02 2.899E-03  4
0  0  0  0  0  0  0
 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.00[illegible]+00 18 0.000E+0[illegible] [illegible].116E-03
XE133M 1.384E+03 3.663E-06 0.000E+00 1.890E+00 0.000E+00 3.150E-02 7.954E-03  4
1 23  0  0  0  0  0
 1.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 19 0.[illegible]00E+00 2.332E-02
XE-133 5.622E+04 1.528E-06 0.000E+00 1.570E+00 0.000E+00 9.697E-03 9.316E-03  4
0  0  0  0  0  0  0
 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 20 1.004E-01 2.997E-02
XE135M 1.557E+04 7.380E-04 0.000E+00 2.220E+00 0.000E+00 2.253E-02 9.887E-02  4
1 25  0  0  0  0  0
 1.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 21 3.000E-01 4.266E-01
XE-135 5.363E+04 2.115E-05 0.000E+00 4.050E+00 0.000E+00 5.894E-02 5.736E-02  4
1 32  0  0  0  0  0
 1.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 22 3.028E-01 2.466E-01
XE-138 4.775E+04 8.151E-04 0.000E+00 2.440E+01 0.000E+00 1.309E-01 2.798E-01  4
1 33  0  0  0  0  0
 1.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 23 6.140E-01 1.241E+00
H----3 1.848E+01 1.780E-09 1.580E+02 1.580E+02 5.570E+01 0.000E+00 0.000E+00 10
0  0  0  0  0  0  0
 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 24 5.685E-03 0.000E+00
BR--84 5.394E+03 3.632E-04 0.000E+00 4.675E+02 0.000E+00 2.700E-01 4.480E-01 11
0  0  0  0  0  0  0
 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 25 1.230E+00 1.779E+00
TE-129 8.727E+03 1.662E-04 4.870E-03 2.420E+02 6.220E-03 1.010E-01 1.280E-02  6
3 34 35 36  0  0  0
 9.100E-01 4.000E-02 5.000E-02 0.000E+00 0.000E+00 0.000E+00 26 5.224E-01 5.981E-02
TE-132 3.841E+04 2.462E-06 2.370E+01 3.600E+04 3.250E-01 3.060E-03 5.280E-02  6
3  4  5  6  0  0  0
 9.100E-01 4.000E-02 5.000E-02 0.000E+00 0.000E+00 0.000E+00 27 5.940E-02 2.123E-01
RB--88 0.000E+00 6.496E-04 0.000E+00 2.908E+02 0.000E+00 4.790E-01 1.55[illegible]E-01  5
0  0  0  0  0  0  0
 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 28 2.072E+00 6.365E-01
CS-135 0.000E+00 7.449E-15 7.480E+03 1.570E+03 1.460E+04 2.730E-03 0.000E+00  5
0  0  0  0  0  0  0
 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 29 5.630E-02 0.000E+00
CS-138 0.000E+00 3.587E-04 0.000E+00 6.070E+00 4.140E+01 2.810E-01 5.530E-01  5
0  0  0  0  0  0  0
 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 30 1.218E+00 2.330E+00
I--129 0.000E+00 1.400E-15 5.540E+06 9.015E+04 2.480E+03 3.710E-04 3.024E-03  1
0  0  0  0  0  0  0
 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 31 4.090E-02 2.820E-03
I--129 0.000E+00 1.400E-15 5.540E+06 9.015E+04 2.480E+03 3.710E-04 3.024E-03  2
0  0  0  0  0  0  0
 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 32 4.090E-02 2.820E-03
I--129 0.000E+00 1.400E-15 5.540E+06 9.015E+04 2.480E+03 3.710E-04 3.024E-03  3
0  0  0  0  0  0  0
 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 33 4.090E-02 2.820E-03
```

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CALCULATION SHEET

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Subject Control Room and Offsite Doses Should CPIS, CRIS, and FHIS Fail Sheet 107 of 252

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇩
0	Mark Drucker	8/15/97	T. Remick	8/18/97						

A6.2 CEA Ejection LOCADOSE Activity Transport Input File (cea-mini.ti)

```
CEA Ejection (10% Failed Fuel)-Minipurge & CR Isol @ 175 sec
Tom Remick
SONGS UNITS 2&3
cea-mini.ti
N-720-013  0
           1
   3   12  36   1   1   0
 0 0  0.00000E+00  0.00000E+00  2  0  0
CFM  CUFT CURIES
   1  1  1  1  1  1  1  1  1  1  1
   0.91 0.04 0.05
CONTAINMNT_RCS      SEC_STEAM
0.00000E+00 0.00139E+00  1  1  1  1
  1  0  1
0 1.657E+06  720      <I-131
0 1.657E+06  720      <I-131
0 1.657E+06  720      <I-131
0 2.377E+06  136      <I-132
0 2.377E+06  136      <I-132
0 2.377E+06  136      <I-132
0 3.347E+06  847      <I-133
0 3.347E+06  847      <I-133
0 3.347E+06  847      <I-133
0 3.695E+06  39.2     <I-134
0 3.695E+06  39.2     <I-134
0 3.695E+06  39.2     <I-134
0 3.120E+06  335      <I-135
0 3.120E+06  335      <I-135
0 3.120E+06  335      <I-135
0 2.320E+05  0        <Kr-83m
0 5.173E+05  72.5     <Kr-85m
0 2.206E+04  317      <Kr-85
0 1.016E+06  34.0     <Kr-87
0 1.437E+06  110      <Kr-88
0 1.899E+04  73.7     <Xe-131m
0 1.038E+05  0        <Xe-133m
0 3.319E+06  10100    <Xe-133
0 6.592E+05  34.0     <Xe-135m
0 9.901E+05  314      <Xe-135
0 2.877E+06  17.3     <Xe-138
0 678        2.64e+06 <H-3
0 8.80       2.73     <Br-84
0 11.0       6.75     <Te-129
0 142        211      <Te-132
0 0          0        <Rb-88
0 0          0        <Cs-135
0 0          0        <Cs-138
0 0          0        <I-129
0 0          0        <I-129
0 0          0        <I-129
2.305E+06 11000  1.0E+09
  3  2  1275  0
   53  53  53  0  0 0 0 0 0 0 0
  2  1  2201.6  0
   0  0  0  0  100 100 100 100 100 100 100
  3  1  0.198  0
   99  99  99  0  100 100 100 100 100 100 100
 -1,0,0,0
```

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CCN CONVERSION: CCN NO. CCN --	

Project or DCP/MMP DCP 2&3 6926.01SJ Calc No. N-0720-014

Subject Control Room and Offsite Doses Should CPIS, CRIS, and FHIS Fail

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	Mark Drucker	8/15/97	T. Remick	8/18/97					

```
-1,0,0,0
          1    7.900000E-04
244398  0  5820  29885  5820
    0   0   0   0   0   0   0   0   0   0   0
    0   0   0   0   0   0   0   0   0   0   0
0.00139E+00 0.0375E+00  1  1  1  1
 0  0  0
 4  1  0   5533
  0  0  0  0  0  0  0  0  0  0  0
-1,0,0,0
-1,0,0,0
          0    7.900000E-04
0.0375E+00 0.049E+00  1  1  1  1
 0  0  0
 3  2  271   0
    53   53   53   0   0   0   0   0   0   0   0
-1,0,0,0
-1,0,0,0
          0    7.900000E-04
0.049E+00 0.08E+00  1  1  1  1
 0  0  0
 2  1  1.6  0
  0  0  0  0  100 100 100 100 100 100 100
-1,0,0,0
-1,0,0,0
          1    7.900000E-04
244398  4400   10  59869  4410
    95  95  99   0  99  99  99  99  99   99   99
    95  95  99   0  99  99  99  99  99   99   99
0.08E+00  0.2231E+00  1  1  1  1
 0  0  0
 4  1  0   5879
  0  0  0  0  0  0  0  0  0  0  0
-1,0,0,0
-1,0,0,0
          0    7.900000E-04
0.2231E+00 0.5E+00  1  1  1  1
 0  0  0
 4  1  0  346
  0  0  0  0  0  0  0  0  0  0  0
-1,0,0,0
-1,0,0,0
          0    7.900000E-04
0.50000E+00 2.00000E+00  1  1  1  1
 0  0  0
 3  2  90   0
    53   53   53   0   0   0   0   0   0   0   0
 4  1  0  1986
  0  0  0  0  0  0  0  0  0  0  0
-1,0,0,0
-1,0,0,0
          0    7.900000E-04
2.00000E+00 3.28000E+00  1  1  1  0
 0  0  0
-1,0,0,0
-1,0,0,0
          0    7.900000E-04
3.28000E+00 8.00000E+00  1  1  1  1
 0  0  0
 3  1  1.0E-9  0
 100  100  100  100  100 100 100 100 100 100 100
```

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
0	Mark Drucker	8/15/97	T. Remick	6/18/97						

```
  4  1  1.0E-9  0
  100  100  100  100  100 100 100 100 100 100 100
 -1,0,0,0
 -1,0,0,0
          0    7.900000E-04
 8.00000E+00 2.40000E+01  1  1  1  1
  0  0  0
 -1,0,0,0
 -1,0,0,0
          1    4.600000E-04
 244398  2200   10  29934  2210
    95  95  99   0  99  99  99  99  99   99   99
    95  95  99   0  99  99  99  99  99   99   99
2.40000E+01 9.60000E+01  1  1  1  1
  0  0  0
  2  1  0.8  0
   0  0  0  0  100 100 100 100 100 100 100
  3  2  1E-09  0
   100  100  100  100  100 100 100 100 100 100 100
-1,0,0,0
 -1,0,0,0
          0    2.50000E-04
 9.60000E+01 7.20000E+02  1  1  1  0
  0  0  0
 -1,0,0,0
 -1,0,0,0
          0    6.2500000E-05
```

A6.3 CEA Ejection LOCADOSE Dose Calculation Input File (cea-mini.di)

```
CEA Ejection (10% Failed Fuel)-Minipurge & CR Isol @ 175 sec
Tom Remick
SONGS UNITS 2&3
cea-mini.di
N720-13  0
           1
DORDOF
   2   5   4   3   1   0   0
REM  REM/HR
  3.6000E-06  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
  3.4700E-04  0.0000E+00  0.0000E+00  0.0000E+00
  9.2400E-07  9.2400E-07  6.0300E-07  3.6500E-07  3.2800E-07
  3.4700E-04  3.4700E-04  1.7500E-04  2.3200E-04
  2.0000E+00  8.0000E+00  2.4000E+01  9.6000E+01  7.2000E+02
  2.0000E+00  8.0000E+00  2.4000E+01  7.2000E+02
  1.0000E+00  1.0000E+00
  1.0000E+00  1.0000E+00   1.0000E+00
  3.4700E-04
  1.0000E+00  1.0000E+00   1.0000E+00
  3.4700E-04
  1.0000E+00  1.0000E+00   1.0000E+00
  3.4700E-04
  1.0000E+00  0.6000E+00   0.4000E+00
  3.4700E-04
  2.4000E+01  9.6000E+01   7.2000E+02
  7.2000E+02
  1.0000E+00  1.0000E+00  1.0  1.0
```

A6.4 CEA Ejection LOCADOSE Activity Transport Output File (cea-mini.to)

As this is not a design basis calculation, no output file is included.

A6.5 CEA Ejection LOCADOSE Dose Calculation Output File (cea-mini.do)

```
Bechtel Standard Computer Program        LOCADOSE, NE319  Version 3.0
(c) 1989 SCE AIX Version. 2 Feb 1995             Calc No. N720-13    Rev No. 0
Originator Tom Remick                 Date 10 Sep 1996
Project SONGS UNITS 2&3           Job No. cea-mini.di            Sheet No.    12
Subject CEA Ejection (10% Failed Fuel)-Minipurge & CR Isol @ 175 sec
==========================================================================

NE319 Doses Within Regions Summary

        Doses in REM for region  5 Cont Room
```

Time Interval (hr) From - to	Thyroid	Lung	Bone	Beta Skin	Whole Body
0.0000E+00-1.3900E-03	1.322E-04	2.310E-06	3.874E-07	1.424E-06	1.734E-07
1.3900E-03-3.7500E-02	2.151E+00	3.670E-02	6.309E-03	6.410E-03	9.459E-04
3.7500E-02-4.9000E-02	2.491E+00	4.245E-02	7.299E-03	7.032E-03	1.046E-03
4.9000E-02-8.0000E-02	6.598E+00	1.126E-01	1.933E-02	2.146E-02	3.046E-03
8.0000E-02- .2231	9.787E+00	1.696E-01	2.872E-02	7.476E-02	8.804E-03
.2231 - .5000	1.270E+00	2.831E-02	3.879E-03	1.033E-01	1.039E-02
.5000 - 2.000	1.084E-01	2.091E-02	4.625E-04	2.554E-01	2.470E-02
2.000 - 3.280	7.943E-02	8.348E-03	2.250E-04	8.848E-02	8.819E-03
3.280 - 8.000	2.867E-01	8.849E-03	7.689E-04	5.648E-02	5.431E-03
8.000 - 24.00	5.487E-01	9.932E-03	1.380E-03	3.090E-02	2.000E-03
24.00 - 96.00	2.986E-01	4.669E-03	6.732E-04	8.654E-03	4.433E-04
96.00 - 720.0	1.388E-01	2.052E-03	2.941E-04	2.395E-03	1.105E-04
Total	2.376E+01	4.444E-01	6.934E-02	6.553E-01	6.573E-02

```
Bechtel Standard Computer Program        LOCADOSE, NE319  Version 3.0
(c) 1989 SCE AIX Version. 2 Feb 1995             Calc No. N720-13    Rev No. 0
Originator Tom Remick                 Date 10 Sep 1996
Project SONGS UNITS 2&3           Job No. cea-mini.di            Sheet No.    14
Subject CEA Ejection (10% Failed Fuel)-Minipurge & CR Isol @ 175 sec
==========================================================================

NE319 Offsite Dose Summary

        Doses in REM for distance  1
```

Time Interval (hr) From - to	Thyroid	Lung	Bone	Beta Skin	Whole Body
0.0000E+00-1.3900E-03	8.763E-04	1.319E-05	2.567E-06	7.244E-06	1.604E-05
1.3900E-03-3.7500E-02	5.428E-01	9.254E-03	1.591E-03	1.530E-03	4.087E-03
3.7500E-02-4.9000E-02	3.278E-01	5.580E-03	9.594E-04	8.730E-04	2.360E-03
4.9000E-02-8.0000E-02	1.838E-03	4.052E-05	7.239E-06	7.919E-05	1.593E-04
8.0000E-02- .2231	8.969E-03	1.925E-04	3.530E-05	2.948E-04	5.949E-04
.2231 - .5000	1.893E-02	3.382E-04	5.588E-05	3.572E-04	7.309E-04
.5000 - 2.000	1.129E-01	1.990E-03	3.526E-04	7.713E-04	1.666E-03
2.000 - 3.280	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
3.280 - 8.000	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
8.000 - 24.00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
24.00 - 96.00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
96.00 - 720.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Total	1.014E+00	1.741E-02	3.004E-03	3.913E-03	9.614E-03

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	CCN CONVERSION: CCN NO. CCN --

Project or DCP/MMP DCP 2&3 6926.01SJ Calc. No. N-0720-014

Subject Control Room and Offsite Doses Should CPIS, CRIS, and FHIS Fail Sheet 112 of 252

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV
0	Mark Drucker	8/15/97	T. Remick	8/18/97						

```
Bechtel Standard Computer Program        LOCADOSE, NE319  Version 3.0
(c) 1989 SCE AIX Version. 2 Feb 1995           Calc No. N720-13   Rev No. 0
Originator Tom Remick                Date 10 Sep 1996
Project SONGS UNITS 2&3        Job No. cea-mini.di            Sheet No.   16
Subject CEA Ejection (10% Failed Fuel)-Minipurge & CR Isol @ 175 sec
==========================================================================
```

NE319 Offsite Dose Summary

Doses in REM for distance 2

Time Interval (hr) From - to	Thyroid	Lung	Bone	Beta Skin	Whole Body
0.0000E+00-1.3900E-03	2.249E-04	3.900E-06	6.589E-07	1.859E-06	4.117E-06
1.3900E-03-3.7500E-02	1.393E-01	2.375E-03	4.083E-04	3.927E-04	1.049E-03
3.7500E-02-4.9000E-02	8.412E-02	1.432E-03	2.462E-04	2.241E-04	6.058E-04
4.9000E-02-8.0000E-02	4.717E-04	1.040E-05	1.858E-06	2.033E-05	4.089E-05
8.0000E-02- .2231	2.302E-03	4.941E-05	9.061E-06	7.567E-05	1.527E-04
.2231 - .5000	4.859E-03	8.681E-05	1.434E-05	9.168E-05	1.876E-04
.5000 - 2.000	2.898E-02	5.108E-04	9.050E-05	1.980E-04	4.275E-04
2.000 - 3.280	2.582E-02	4.413E-04	7.861E-05	7.607E-05	1.750E-04
3.280 - 8.000	9.299E-02	1.468E-03	2.493E-04	7.292E-05	1.826E-04
8.000 - 24.00	9.568E-02	1.445E-03	2.406E-04	8.904E-05	1.821E-04
24.00 - 96.00	1.280E-01	1.830E-03	2.886E-04	4.170E-05	7.345E-05
96.00 - 720.0	3.224E-01	4.490E-03	6.831E-04	6.091E-05	1.078E-04
Total	9.252E-01	1.414E-02	2.311E-03	1.345E-03	3.188E-03

APPENDIX B FEEDWATER SYSTEM PIPE BREAK

B1.0 FWSPB PURPOSE

A feedwater system pipe break (FWSPB) is postulated to occur as a result of a pipe failure in the main feedwater system. This may produce a total loss of normal feedwater and a very rapid blowdown of one steam generator (SG). If normal plant electrical power is lost, this superimposes a loss of primary coolant flow, turbine load, pressurizer pressure and control, and steam bypass control. This would cause a rapid decrease in the heat transfer capability of both steam generators and eventual elimination of one steam generator's heat transfer capability. The result would be an RCS heatup and pressurization.

The FWSPB is postulated to release activity via the following pathways:

1. Primary coolant leakage to the secondary system and eventually to the outside environment.
2. Secondary system liquid releases through the break to the containment and eventually to the outside environment.
3. Secondary system steam releases directly to the outside environment.

The objective of this appendix is to calculate the doses from a FWSPB at the Exclusion Area Boundary (EAB) and the Low Population Zone (LPZ) as well as inside the Control Room assuming CRIS failure.

B2.0 FWSPB RESULTS

The resulting doses are as follows, based on Table B-22:

	DOSE (Rem)		
	Thyroid	Beta Skin	Whole Body
Exclusion Area Boundary	<0.1	<0.1	<0.1
Low Population Zone	<0.1	<0.1	<0.1
Control Room	7.9	<0.1	<0.1

All doses meet the acceptance criteria of Sections 1.2.1 and 1.2.4.

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	Mark Drucker	8/15/97	T. Remick	8/18/97					

B3.0 FWSPB ASSUMPTIONS

B3.1 The break is assumed to occur between the steam generator and the feedwater line check valve, rendering the check valve ineffective at terminating the blowdown of the affected steam generator, per Calculation 1370-DT-037 (Reference 6.7p, Sheet 72).

B3.2 It is assumed that main feedwater flow to both steam generators is terminated instantaneously following the break, per Calculation 1370-DT-037 (Reference 6.7p, Sheet 45). The absence of subcooled feedwater flow to the generators results in a gradual heatup of the primary and secondary systems.

B3.3 The most limiting single failure is assumed to be the failure of one of the electric driven auxiliary feedwater pumps, per Calculation 1370-DT-037 (Reference 6.7p, Sheet 44). This failure leads to larger radiological releases through the steam generator safety valves due to the relatively higher steam generator pressure which results with only one-half the auxiliary feedwater flow available.

B3.4 All releases of activity into the containment are assumed to be mixed in 50% of the containment volume. This is conservative as a smaller volume results in a higher airborne activity concentration inside the containment.

B3.5 It is assumed that after 30 minutes the operator isolates the containment mini-purge system and begins a controlled cooldown via the atmospheric dump valves until the shutdown cooling system can be initiated, thereby terminating the accident. No credit is taken for automatic or manual CRIS actuation.

B3.6 It is conservatively assumed that 100% of the iodines introduced into the affected steam generator via primary-to-secondary leakage will be released to the containment (i.e., an iodine partition factor of 1.0).

B3.7 All fluid releases into the containment are conservatively assumed to be have an iodine partition factor of 1.0, thereby maximizing the amount of iodine released to the environment.

B4.0 FWSPB DESIGN INPUTS

B4.1 The FWSPB event increases the reactor coolant system pressure and eventually lifts the pressurizer safety valves. The pressurizer safety valves release 2325 lb steam to the quench tank (Reference 6.7p, Sheet 46), which is then released to the containment following the actuation of the quench tank rupture disk.

B4.2 Secondary side liquid mass release from the affected steam generator into the containment is 151,033 lbm, per Calculation 1370-DT-037 (Reference 6.7p, Sheet 46).

B4.3 Main feedwater flowing towards the affected steam generator is released through the break at a maximum flow rate of 21.9E6 lbm/hr (per Cycle 9 reload ground rules, Reference 6.6e, 6.6f, Item V.003) until isolated following a main steam isolation signal (MSIS). MSIS is initiated at 265.4 sec per Calculation A-SG2-FE-0114 (Reference 6.7u, Page [illegible]2, case of degraded secondary and 1000 SG tubes plugged) while the main feedwater isolation valve response time is 10.9 sec, per LCS 3.3.100 Table 3.3.100-2.5 (Reference 6.4j, 6.4k). An isolation time of 300 sec will conservatively be used for the feedwater valves.

B4.4 Secondary side steam mass releases to the atmosphere are as follows, per Calculation 1370-DT-037 (Reference 6.7p, Sheets 37 and 46):

TIME	MASS RELEASE (lbm)
0 - 30 min	74,800
30 min - 3.7 hr	934,000
Total	1,008,800

B4.5 The shutdown cooling system is initiated at 13,300 sec (or 222 min or 3.7 hr), thereby terminating the accident, per Calculation 1370-DT-037 (Reference 6.7p, Sheet 49).

B5.0 FWSPB METHODOLOGY & COMPUTATIONS

B5.1 Methodology

A FWSPB releases activity into the containment building and eventually to the environment. For each radioactive fluid release (primary liquid, secondary liquid, secondary steam), the following equation is used to calculate the inhalation dose due to a given isotope:

$$D_{Inh} = (AR)(\chi/Q)(BR)(DCF_{Inh})(OF)$$

where:

AR is the integrated activity released (Ci)
χ/Q is the atmospheric dispersion factor (sec/m^3)
BR is the breathing rate (m^3/sec)
DCF_{Inh} is the inhalation dose conversion factor (Rem/Ci)
OF is the occupancy factor (unitless)

The immersion dose is calculated as follows:

$$D_{Imm} = (AR)(\chi/Q)(DCF_{Imm})(OF)$$

where DCF_{Imm} is the immersion dose conversion factor (Rem-m^3/Ci-sec) and the other parameters are as defined above.

Control room doses are calculated at the CR HVAC intake louvers. No credit is taken for dilution within the CR HVAC envelope, nor for CREACUS filtration.

B5.2 Primary System Liquid

Once the SG has boiled dry due to lack of feedwater, the primary to secondary leakage will be released to containment with no iodine partitioning. Since the SG boils dry in under 40 sec (per Calculation 1370-DT-037, Reference 6.7p, Sheet 48), the entire 0.5 gpm of primary to secondary leakage into the affected main steam line loop (per Design Input 4.11) will be assumed to be released to containment with no partitioning. Over the 222 min duration of the accident (per Design Input B4.5), the primary to secondary leakage into the affected SG is:

$$\left(\frac{0.5\ gal}{min}\right)\left(\frac{8.34\ lbm}{gal}\right)(222\ min)\left(\frac{454\ gm}{lbm}\right) = 4.20E{+}5\ gm$$

Per Design Input B4.1, 2325 lbm or 1.056E+6 gm of primary coolant is released via the pressurizer quench tank rupture disk. The total release of primary system fluid into the containment is:

$$m_{prim\text{-}cmt} = (4.20E{+}5\ gm) + (1.056E{+}6\ gm) = 1.476E{+}6\ gm$$

With the mini-purge system in operation for 30 minutes (per Assumption B3.5), the following amount of containment air is released to the environment, based on the purge rate from Design Input 4.17:

$$(2200\ ft^3/min)(30\ min) = 6.60E{+}4\ ft^3$$

Once the mini-purge system is secured, the following amount of containment air leaks (per Design Input 4.10) to the environment for the remaining duration of the 222 min accident (per Design Input B4.5):

$$(1.6\ ft^3/min)(222\ min - 30\ min) = 3.07E{+}2\ ft^3$$

Assuming the primary coolant to be mixed in half of the containment volume (Assumption B3.4), the following release fraction is obtained (per Design Input 4.7):

$$\frac{6.60E{+}4\ ft^3 + 3.07E{+}2\ ft^3}{(0.5)(2.305E{+}6\ ft^3)} = 5.75E{-}2$$

Hence, the mass of primary coolant released to the outside environment via the containment is:

$$m_{cmt\text{-}env} = (1.476E{+}6\ gm)(5.75E{-}2) = 8.49E{+}4\ gm$$

Like the 0.5 gpm primary to secondary leakage into the affected SG, per Design Input 4.11 there is also 0.5 gpm primary to secondary leakage into the intact SG. As with the affected SG, this leakage also totals 4.20E+5 gm over the 222-minute accident duration. However, this leakage has an iodine partition factor of 0.01 (per Assumption 3.5) and is not diluted by the containment volume before being released to the outside environment. The total effective mass of primary coolant containing iodine that is released to the outside environment is obtained by adding this direct release from the intact steam generator to the release diluted by the containment:

$$m_{iod-env} = (4.20E{+}5\ gm)(0.01) + (8.49E{+}4\ gm) = 8.91E{+}4\ gm$$

The total mass of primary coolant containing noble gases and tritium that is released to the outside environment is obtained by adding the direct release from the intact steam generator to the release diluted by the containment:

$$m_{NG/H\text{-}3-env} = (4.20E{+}5\ gm) + (8.49E{+}4\ gm) = 5.05E{+}5\ gm$$

Design Input 4.9 lists the primary coolant activity concentrations by isotope. Multiplying the concentration (µCi/gm) by the mass released (gm) yields the activity released. The equations from Section B5.1 can then be used to calculate the doses. This is done in Tables B-1 to B-7 with the results summarized in Table B-22. Sample calculations are shown below.

The EAB whole body dose from Xe-133 due to immersion is calculated as follows:

$$AR = \left(3.44E{+}2\ \frac{\mu Ci}{gm}\right)(5.05E{+}5\ gm)\left(1E{-}6\ \frac{Ci}{\mu Ci}\right) = 1.74E{+}2\ Ci$$

$$D_{Imm} = (1.74E{+}2\ Ci)\left(3.6E{-}6\ \frac{sec}{m^3}\right)\left(9.32E{-}3\ \frac{Rem\text{-}m^3}{Ci\text{-}sec}\right)(1.0) = 5.8E{-}6\ Rem$$

Using a pre-existing spiking factor of 60, the following EAB thyroid dose due to inhalation is calculated for I-131:

$$AR = \left(8.03E{-}1\ \frac{\mu Ci}{gm}\right)(8.91E{+}4\ gm)\left(1E{-}6\ \frac{Ci}{\mu Ci}\right)(60) = 4.29\ Ci$$

$$D_{Inh} = (4.29\ Ci)\left(3.6E-6\ \frac{sec}{m^3}\right)\left(3.47E-4\ \frac{m^3}{sec}\right)\left(1.49E+6\ \frac{Rem}{Ci}\right)(1.0) = 8.0E-3\ Rem$$

B5.3 Secondary System Liquid

Per Design Input B4.3, the feedwater entering the containment towards the affected steam generator is released through the break as follows:

$$\left(\frac{21.9E+6\ lbm}{3600\ sec}\right)\left(\frac{454\ gm}{lbm}\right)(300\ sec) = 8.29E+8\ gm$$

Per Design Input B4.2, the total release from the affected steam generator to the containment is 151,033 lbm or 6.86E+7 gm. The total release of secondary system liquid is:

(8.29E+8 gm) + (6.86E+7 gm) = 8.98E+8 gm

Since this release is into the containment, it is multiplied by the containment air release fraction, as is done with the primary system liquid in Section B5.2:

(8.98E+8 gm)(5.75E-2) = 5.16E+7 gm

Doses are calculated based on this mass release using the equations from Section B5.1, as is done in Section B5.2 for the primary system. These calculations are shown in Tables B-8 to B-14 with the results summarized in Table B-22.

B5.4 Secondary System Steam

Per Design Input B4.4, the total mass of steam released from the secondary system is 1.0088E+6 lbm or 4.58E+8 gm. This release is assumed to be directly to the outside environment. Tables B-15 through B-21 show the doses from this release, calculated using the dose equations from Section B5.1, with the results summarized in Table B-22.

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	Mark Drucker	8/15/97	T. Remick	8/18/97					

Table B-1. Primary Coolant Activities Released to Outside Environment

ISOTOPE	MASS RELEASE (gm)	ACTIVITY (μCi/g)	ACTIVITY (Ci)
I-131	8.91e+04	4.82e+01	4.29e+00
I-132	8.91e+04	1.35e+01	1.20e+00
I-133	8.91e+04	5.94e+01	5.29e+00
I-134	8.91e+04	5.91e+00	5.27e-01
I-135	8.91e+04	2.62e+01	2.33e+00
Kr-85m	5.05e+05	2.47e+00	1.25e+00
Kr-85	5.05e+05	1.08e+01	5.45e+00
Kr-87	5.05e+05	1.16e+00	5.86e-01
Kr-88	5.05e+05	3.74e+00	1.89e+00
Xe-131m	5.05e+05	2.51e+00	1.27e+00
Xe-133	5.05e+05	3.44e+02	1.74e+02
Xe-135m	5.05e+05	1.16e+00	5.86e-01
Xe-135	5.05e+05	1.07e+01	5.40e+00
Xe-138	5.05e+05	5.87e-01	2.96e-01
H-3	5.05e+05	3.22e+00	1.63e+00

Note 1: Ci values obtained by multiplying μCi/gm values by gm value and 1E-6 Ci/μCi. Concentrations are from Design Input 4.9, with the iodine values multiplied by a spiking factor of 60 (per Design Input 4.14). Mass releases are per Section B5.2.

Note 2: This table was prepared using a spreadsheet software with internal calculations performed using more digits than shown; hence, hand calculations may yield slightly different results due to roundoff.

Table B-2. EAB Thyroid Dose due to Primary System Releases

ISOTOPE	ACTIVITY (Ci)	DCF (Rem/Ci)	DOSE (Rem)
I-131	4.29e+00	1.49e+06	8.0e-03
I-132	1.20e+00	1.43e+04	2.1e-05
I-133	5.29e+00	2.69e+05	1.8e-03
I-134	5.27e-01	3.73e+03	2.5e-06
I-135	2.33e+00	5.60e+04	1.6e-04
H-3	1.63e+00	1.58e+02	3.2e-07
Total			1.0e-02

Note 1: Dose calculated using D_{inh} equation from Section B5.1 with a χ/Q of 3.6E-6 sec/m^3 (per Design Input 4.5), a breathing rate of 3.47E-4 m^3/sec (per Assumption 3.4), inhalation DCFs per Design Input 4.8, and an occupancy factor of 1.0 (per Design Input 4.4).

Note 2: This table was prepared using a spreadsheet software with internal calculations performed using more digits than shown; hence, hand calculations may yield slightly different results due to roundoff.

Table B-3. EAB Immersion Doses due to Primary System Releases

ISOTOPE	ACTIVITY (Ci)	DCF (Rem-m³/Ci-sec)		DOSE (Rem)	
		B. Skin	W. Body	B. Skin	W. Body
I-131	4.29e+00	3.17e-02	8.72e-02	4.9e-07	1.3e-06
I-132	1.20e+00	1.32e-01	5.13e-01	5.7e-07	2.2e-06
I-133	5.29e+00	7.35e-02	1.55e-01	1.4e-06	3.0e-06
I-134	5.27e-01	9.23e-02	5.32e-01	1.7e-07	1.0e-06
I-135	2.33e+00	1.29e-01	4.21e-01	1.1e-06	3.5e-06
Kr-85m	1.25e+00	4.63e-02	3.71e-02	2.1e-07	1.7e-07
Kr-85	5.45e+00	4.25e-02	5.10e-04	8.3e-07	1.0e-08
Kr-87	5.86e-01	3.08e-01	1.88e-01	6.5e-07	4.0e-07
Kr-88	1.89e+00	7.51e-02	4.66e-01	5.1e-07	3.2e-06
Xe-131m	1.27e+00	1.51e-02	2.90e-03	6.9e-08	1.3e-08
Xe-133	1.74e+02	9.70e-03	9.32e-03	6.1e-06	5.8e-06
Xe-135m	5.86e-01	2.25e-02	9.89e-02	4.8e-08	2.1e-07
Xe-135	5.40e+00	5.89e-02	5.74e-02	1.1e-06	1.1e-06
Xe-138	2.96e-01	1.31e-01	2.80e-01	1.4e-07	3.0e-07
H-3	1.63e+00	0.00e+00	0.00e+00	0.0e+00	0.0e+00
Total				1.3e-05	2.2e-05

Note 1: Dose calculated using D_{Imm} equation from Section B5.1 with a χ/Q `3.6E-6 sec/m³ (per Design Input 4.5), immersion DCFs per Design Input 4.8, and an occupancy factor of 1.0 (per Design Input 4.4).

Note 2: This table was prepared using a spreadsheet software with internal calculations performed using more digits than shown; hence, hand calculations may yield slightly different results due to roundoff.

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REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV
0	Mark Druckar	8/15/97	T. Remick	8/18/97						

Table B-4. LPZ Thyroid Dose due to Primary System Releases

ISOTOPE	ACTIVITY (Ci)	DCF (Rem/Ci)	DOSE (Rem)
I-131	4.29e+00	1.49e+06	2.1e-03
I-132	1.20e+00	1.43e+04	5.5e-06
I-133	5.29e+00	2.69e+05	4.6e-04
I-134	5.27e-01	3.73e+03	6.3e-07
I-135	2.33e+00	5.60e+04	4.2e-05
H-3	1.63e+00	1.58e+02	8.2e-08
Total			2.6e-03

Note 1: Dose calculated using D_{Inh} equation from Section B5.1 with a χ/Q of 9.24E-7 sec/m^3 (per Design Input 4.5), a breathing rate of 3.47E-4 m^3/sec (per Assumption 3.4), inhalation DCFs per Design Input 4.8, and an occupancy factor of 1.0 (per Design Input 4.4).

Note 2: This table was prepared using a spreadsheet software with internal calculations performed using more digits than shown; hence, hand calculations may yield slightly different results due to roundoff.

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	Mark Drucker	8/15/97	T. Remick	8/18/97					

Table B-5. LPZ Immersion Doses due to Primary System Releases

ISOTOPE	ACTIVITY (Ci)	DCF (Rem-m^3/Ci-sec)		DOSE (Rem)	
		B. Skin	W. Body	B. Skin	W. Body
I-131	4.29e+00	3.17e-02	8.72e-02	1.3e-07	3.5e-07
I-132	1.20e+00	1.32e-01	5.13e-01	1.5e-07	5.7e-07
I-133	5.29e+00	7.35e-02	1.55e-01	3.6e-07	7.6e-07
I-134	5.27e-01	9.23e-02	5.32e-01	4.5e-08	2.6e-07
I-135	2.33e+00	1.29e-01	4.21e-01	2.8e-07	9.1e-07
Kr-85m	1.25e+00	4.63e-02	3.71e-02	5.3e-08	4.3e-08
Kr-85	5.45e+00	4.25e-02	5.10e-04	2.1e-07	2.6e-09
Kr-87	5.86e-01	3.08e-01	1.88e-01	1.7e-07	1.0e-07
Kr-88	1.89e+00	7.51e-02	4.66e-01	1.3e-07	8.1e-07
Xe-131m	1.27e+00	1.51e-02	2.90e-03	1.8e-08	3.4e-09
Xe-133	1.74e+02	9.70e-03	9.32e-03	1.6e-06	1.5e-06
Xe-135m	5.86e-01	2.25e-02	9.89e-02	1.2e-08	5.4e-08
Xe-135	5.40e+00	5.89e-02	5.74e-02	2.9e-07	2.9e-07
Xe-138	2.96e-01	1.31e-01	2.80e-01	3.6e-08	7.7e-08
H-3	1.63e+00	0.00e+00	0.00e+00	0.0e+00	0.0e+00
Total				3.4e-06	5.7e-06

Note 1: Dose calculated using $D_{\gamma im}$ equation from Section B5.1 with a χ/Q of 9.24E-7 sec/m^3 (per Design Input 4.5), immersion DCFs per Design Input 4.8, and an occupancy factor of 1.0 (per Design Input 4.4).

Note 2: This table was prepared using a spreadsheet software with internal calculations performed using more digits than shown; hence, hand calculations may yield slightly different results due to roundoff.

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
0	Mark Drucker	8/15/97	T. Remick	8/18/97						

Table B-6. Control Room Thyroid Dose due to Primary System Releases

ISOTOPE	ACTIVITY (Ci)	DCF (Rem/Ci)	DOSE (Rem)
I-131	4.29e+00	1.49e+06	1.8e+00
I-132	1.20e+00	1.43e+04	4.7e-03
I-133	5.29e+00	2.69e+05	3.9e-01
I-134	5.27e-01	3.73e+03	5.4e-04
I-135	2.33e+00	5.60e+04	3.6e-02
H-3	1.63e+00	1.58e+02	7.0e-05
Total			2.2e+00

Note 1: Dose calculated using D_{inh} equation from Section B5.1 with a χ/Q of 7.9E-4 sec/m^3 (per Design Input 4.5), a breathing rate of 3.47E-4 m^3/sec (per Assumption 3.4), inhalation DCFs per Design Input 4.8, and an occupancy factor of 1.0 (per Design Input 4.4).

Note 2: This table was prepared using a spreadsheet software with internal calculations performed using more digits than shown; hence, hand calculations may yield slightly different results due to roundoff.

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REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	Mark Drucker	8/15/97	T. Remick	8/18/97					

Table B-7. Control Room Immersion Doses due to Primary System Releases

ISOTOPE	ACTIVITY (Ci)	DCF (Rem-m^3/Ci-sec)		DOSE (Rem)	
		B. Skin	W. Body	B. Skin	W. Body
I-131	4.29e+00	3.17e-02	8.72e-02	1.1e-04	5.9e-04
I-132	1.20e+00	1.32e-01	5.13e-01	1.3e-04	9.7e-04
I-133	5.29e+00	7.35e-02	1.55e-01	3.1e-04	1.3e-03
I-134	5.27e-01	9.23e-02	5.32e-01	3.8e-05	4.4e-04
I-135	2.33e+00	1.29e-01	4.21e-01	2.4e-04	1.6e-03
Kr-85m	1.25e+00	4.63e-02	3.71e-02	4.6e-05	7.3e-05
Kr-85	5.45e+00	4.25e-02	5.10e-04	1.8e-04	4.4e-06
Kr-87	5.86e-01	3.08e-01	1.88e-01	1.4e-04	1.7e-04
Kr-88	1.89e+00	7.51e-02	4.66e-01	1.1e-04	1.4e-03
Xe-131m	1.27e+00	1.51e-02	2.90e-03	1.5e-05	5.8e-06
Xe-133	1.74e+02	9.70e-03	9.32e-03	1.3e-03	2.6e-03
Xe-135m	5.86e-01	2.25e-02	9.89e-02	1.0e-05	9.2e-05
Xe-135	5.40e+00	5.89e-02	5.74e-02	2.5e-04	4.9e-04
Xe-138	2.96e-01	1.31e-01	2.80e-01	3.1e-05	1.3e-04
H-3	1.63e+00	0.00e+00	0.00e+00	0.0e+00	0.0e+00
Total				2.9e-03	9.8e-03

Note 1: Dose calculated using D_{imm} equation from Section B5.1 with a χ/Q of 7.9E-4 sec/m^3 (per Design Input 4.5), immersion DCFs per Design Input 4.8, and an occupancy factor of 1.0 (per Design Input 4.4). Whole body doses have been doubled per Assumption 3.7.

Note 2: This table was prepared using a spreadsheet software with internal calculations performed using more digits than shown; hence, hand calculations may yield slightly different results due to roundoff.

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	Mark Drucker	8/15/97	T. Remick	8/18/97					

Table B-8. Secondary System Liquid Activities

ISOTOPE	ACTIVITY (µCi/g)	ACTIVITY (Ci)
I-131	8.13E-02	4.20E+00
I-132	1.54E-02	7.95E-01
I-133	9.57E-02	4.94E+00
I-134	4.43E-03	2.29E-01
I-135	3.78E-02	1.95E+00
H-3	1.49E+03	7.69E+04
Total		1.21E+01

Note: Ci values obtained by multiplying µCi/g values by 5.16E+7 gm (per Section B5.3) and 1E-6 Ci/µCi. Concentrations are from Design Input 4.9.

Precision Note: This table was prepared using a spreadsheet software with internal calculations performed using more digits than shown; hence, hand calculations may yield slightly different results due to roundoff.

Table B-9. EAB Thyroid Dose due to Secondary Liquid Releases

ISOTOPE	ACTIVITY (Ci)	DCF (Rem/Ci)	DOSE (Rem)
I-131	4.20E+00	1.49E+06	7.8E-03
I-132	7.95E-01	1.43E+04	1.4E-05
I-133	4.94E+00	2.69E+05	1.7E-03
I-134	2.29E-01	3.73E+03	1.1E-06
I-135	1.95E+00	5.60E+04	1.4E-04
H-3	7.69E+04	1.58E+02	1.5E-02
Total			2.5E-02

Note 1: Dose calculated using D_{inh} equation from Section B5.1 with a χ/Q of 3.6E-6 sec/m^3 (per Design Input 4.5), a breathing rate of 3.47E-4 m^3/sec (per Assumption 3.4), inhalation DCFs per Design Input 4.8, and an occupancy factor of 1.0 (per Design Input 4.4).

Note 2: This table was prepared using a spreadsheet software with internal calculations performed using more digits than shown; hence, hand calculations may yield slightly different results due to roundoff.

Table B-10. EAB Immersion Doses due to Secondary Liquid Releases

ISOTOPE	ACTIVITY (Ci)	DCF (Rem-m^3/Ci-sec)		DOSE (Rem)	
		B. Skin	W. Body	B. Skin	W. Body
I-131	4.20E+00	3.17E-02	8.72E-02	4.8E-07	1.3E-06
I-132	7.95E-01	1.32E-01	5.13E-01	3.8E-07	1.5E-06
I-133	4.94E+00	7.35E-02	1.55E-01	1.3E-06	2.8E-06
I-134	2.29E-01	9.23E-02	5.32E-01	7.6E-08	4.4E-07
I-135	1.95E+00	1.29E-01	4.21E-01	9.1E-07	3.0E-06
H-3	7.69E+04	0.00E+00	0.00E+00	0.0E+00	0.0E+00
Total				3.1E-06	8.9E-06

Note 1: Dose calculated using D_{Imm} equation from Section B5.1 with a χ/Q of 3.6E-6 sec/m^3 (per Design Input 4.5), immersion DCFs per Design Input 4.8, and an occupancy factor of 1.0 (per Design Input 4.4).

Note 2: This table was prepared using a spreadsheet software with internal calculations performed using more digits than shown; hence, hand calculations may yield slightly different results due to roundoff.

Table B-11. LPZ Thyroid Dose due to Secondary Liquid Releases

ISOTOPE	ACTIVITY (Ci)	DCF (Rem/Ci)	DOSE (Rem)
I-131	4.20E+00	1.49E+06	2.0E-03
I-132	7.95E-01	1.43E+04	3.6E-06
I-133	4.94E+00	2.69E+05	4.3E-04
I-134	2.29E-01	3.73E+03	2.7E-07
I-135	1.95E+00	5.60E+04	3.5E-05
H-3	7.69E+04	1.58E+02	3.9E-03
Total			6.4E-03

Note 1: Dose calculated using D_{Inh} equation from Section B5.1 with a χ/Q of 9.24E-7 sec/m^3 (per Design Input 4.5), a breathing rate of 3.47E-4 m^3/sec (per Assumption 3.4), inhalation DCFs per Design Input 4.8, and an occupancy factor of 1.0 (per Design Input 4.4).

Note 2: This table was prepared using a spreadsheet software with internal calculations performed using more digits than shown; hence, hand calculations may yield slightly different results due to roundoff.

Table B-12. LPZ Immersion Doses due to Secondary Liquid Releases

ISOTOPE	ACTIVITY (Ci)	DCF (Rem-m³/Ci-sec)		DOSE (Rem)	
		B. Skin	W. Body	B. Skin	W. Body
I-131	4.20E+00	3.17E-02	8.72E-02	1.2E-07	3.4E-07
I-132	7.95E-01	1.32E-01	5.13E-01	9.7E-08	3.8E-07
I-133	4.94E+00	7.35E-02	1.55E-01	3.4E-07	7.1E-07
I-134	2.29E-01	9.23E-02	5.32E-01	1.9E-08	1.1E-07
I-135	1.95E+00	1.29E-01	4.21E-01	2.3E-07	7.6E-07
H-3	7.69E+04	0.00E+00	0.00E+00	0.0E+00	0.0E+00
Total				8.1E-07	2.3E-06

Note 1: Dose calculated using D_{Imm} equation from Section B5.1 with a χ/Q of 9.24E-7 sec/m³ (per Design Input 4.5), immersion DCFs per Design Input 4.8, and an occupancy factor of 1.0 (per Design Input 4.4).

Note 2: This table was prepared using a spreadsheet software with internal calculations performed using more digits than shown; hence, hand calculations may yield slightly different results due to roundoff.

Table B-13. Control Room Thyroid Dose due to Secondary Liquid Releases

ISOTOPE	ACTIVITY (Ci)	DCF (Rem/Ci)	DOSE (Rem)
I-131	4.20E+00	1.49E+06	1.7E+00
I-132	7.95E-01	1.43E+04	3.1E-03
I-133	4.94E+00	2.69E+05	3.6E-01
I-134	2.29E-01	3.73E+03	2.3E-04
I-135	1.95E+00	5.60E+04	3.0E-02
H-3	7.69E+04	1.58E+02	3.3E+00
Total			5.4E+00

Note 1: Dose calculated using D_{Inh} equation from Section B5.1 with a χ/Q of 7.9E-4 sec/m^3 (per Design Input 4.5), a breathing rate of 3.47E-4 m^3/sec (per Assumption 3.4), inhalation DCFs per Design Input 4.8, and an occupancy factor of 1.0 (per Design Input 4.4).

Note 2: This table was prepared using a spreadsheet software with internal calculations performed using more digits than shown; hence, hand calculations may yield slightly different results due to roundoff.

Table B-14. Control Room Immersion Doses due to Secondary Liquid Releases

ISOTOPE	ACTIVITY (Ci)	DCF (Rem-m^3/Ci-sec)		DOSE (Rem)	
		B. Skin	W. Body	B. Skin	W. Body
I-131	4.20E+00	3.17E-02	8.72E-02	1.1E-04	5.8E-04
I-132	7.95E-01	1.32E-01	5.13E-01	8.3E-05	6.4E-04
I-133	4.94E+00	7.35E-02	1.55E-01	2.9E-04	1.2E-03
I-134	2.29E-01	9.23E-02	5.32E-01	1.7E-05	1.9E-04
I-135	1.95E+00	1.29E-01	4.21E-01	2.0E-04	1.3E-03
H-3	7.69E+04	0.00E+00	0.00E+00	0.0E+00	0.0E+00
Total				6.9E-04	3.9E-03

Note 1: Dose calculated using D_{imm} equation from Section B5.1 with a χ/Q of 7.9E-4 sec/m^3 (per Design Input 4.5), immersion DCFs per Design Input 4.8, and an occupancy factor of 1.0 (per Design Input 4.4). Whole body doses have been doubled per Assumption 3.7.

Note 2: This table was prepared using a spreadsheet software with internal calculations performed using more digits than shown; hence, hand calculations may yield slightly different results due to roundoff.

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	Mark Drucker	8/15/97	T. Remick	8/18/97					

Table B-15. Secondary System Steam Activities

ISOTOPE	ACTIVITY (μCi/g)	ACTIVITY (Ci)
I-131	8.13E-04	3.72E-01
I-132	1.54E-04	7.05E-02
I-133	9.57E-04	4.38E-01
I-134	4.43E-05	2.03E-02
I-135	3.78E-04	1.73E-01
Kr-85m	8.19E-05	3.75E-02
Kr-85	3.58E-04	1.64E-01
Kr-87	3.84E-05	1.76E-02
Kr-88	1.24E-04	5.68E-02
Xe-131m	8.32E-05	3.81E-02
Xe-133	1.14E-02	5.22E+00
Xe-135m	3.84E-05	1.76E-02
Xe-135	3.55E-04	1.63E-01
Xe-138	1.95E-05	8.93E-03
H-3	2.98E+00	1.36E+03

Note 1: Ci values obtained by multiplying μCi/gm values by 4.58E+8 gm (per Section B5.4) and 1E-6 Ci/μCi.

Note 2: This table was prepared using a spreadsheet software with internal calculations performed using more digits than shown; hence, hand calculations may yield slightly different results due to roundoff.

Table B-16. EAB Thyroid Dose due to Secondary Steam Releases

ISOTOPE	ACTIVITY (Ci)	DCF (Rem/Ci)	DOSE (Rem)
I-131	3.72E-01	1.49E+06	6.9E-04
I-132	7.05E-02	1.43E+04	1.3E-06
I-133	4.38E-01	2.69E+05	1.5E-04
I-134	2.03E-02	3.73E+03	9.5E-08
I-135	1.73E-01	5.60E+04	1.2E-05
H-3	1.36E+03	1.58E+02	2.7E-04
Total			1.1E-03

Note 1: Dose calculated using D_{inh} equation from Section B5.1 with a χ/Q of 3.6E-6 sec/m^3 (per Design Input 4.5), a breathing rate of 3.47E-4 m^3/sec (per Assumption 3.4), inhalation DCFs per Design Input 4.8, and an occupancy factor of 1.0 (per Design Input 4.4).

Note 2: This table was prepared using a spreadsheet software with internal calculations performed using more digits than shown; hence, hand calculations may yield slightly different results due to roundoff.

Table B-17. EAB Immersion Doses due to Secondary Steam Releases

ISOTOPE	ACTIVITY (Ci)	DCF (Rem-m³/Ci-sec)		DOSE (Rem)	
		B. Skin	W. Body	B. Skin	W. Body
I-131	3.72E-01	3.17E-02	8.72E-02	4.2E-08	1.2E-07
I-132	7.05E-02	1.32E-01	5.13E-01	3.4E-08	1.3E-07
I-133	4.38E-01	7.35E-02	1.55E-01	1.2E-07	2.4E-07
I-134	2.03E-02	9.23E-02	5.32E-01	6.7E-09	3.9E-08
I-135	1.73E-01	1.29E-01	4.21E-01	8.0E-08	2.6E-07
Kr-85m	3.75E-02	4.63E-02	3.71E-02	6.2E-09	5.0E-09
Kr-85	1.64E-01	4.25E-02	5.10E-04	2.5E-08	3.0E-10
Kr-87	1.76E-02	3.08E-01	1.88E-01	2.0E-08	1.2E-08
Kr-88	5.68E-02	7.51E-02	4.66E-01	1.5E-08	9.5E-08
Xe-131m	3.81E-02	1.51E-02	2.90E-03	2.1E-09	4.0E-10
Xe-133	5.22E+00	9.70E-03	9.32E-03	1.8E-07	1.8E-07
Xe-135m	1.76E-02	2.25E-02	9.89E-02	1.4E-09	6.3E-09
Xe-135	1.63E-01	5.89E-02	5.74E-02	3.4E-08	3.4E-08
Xe-138	8.93E-03	1.31E-01	2.80E-01	4.2E-09	9.0E-09
H-3	1.36E+03	0.00E+00	0.00E+00	0.0E+00	0.0E+00
Total				5.7E-07	1.1E-06

Note 1: Dose calculated using D_{Imm} equation from Section B5.1 with a χ/Q of 3.6E-6 sec/m³ (per Design Input 4.5), immersion DCFs per Design Input 4.8, and an occupancy factor of 1.0 (per Design Input 4.4).

Note 2: This table was prepared using a spreadsheet software with internal calculations performed using more digits than shown; hence, hand calculations may yield slightly different results due to roundoff.

Table B-18. LPZ Thyroid Dose due to Secondary Steam Releases

ISOTOPE	ACTIVITY (Ci)	DCF (Rem/Ci)	DOSE (Rem)
I-131	3.72E-01	1.49E+06	1.8E-04
I-132	7.05E-02	1.43E+04	3.2E-07
I-133	4.38E-01	2.69E+05	3.8E-05
I-134	2.03E-02	3.73E+03	2.4E-08
I-135	1.73E-01	5.60E+04	3.1E-06
H-3	1.36E+[illegible]	1.58E+02	6.9E-05
Total			2.9E-04

Note 1: Dose calculated using D_{inh} equation from Section B5.1 with a χ/Q of 9.24E-7 sec/m^3 (per Design Input 4.5), a breathing rate of 3.47E-4 m^3/sec (per Assumption 3.4), inhalation DCFs per Design Input 4.8, and an occupancy factor of 1.0 (per Design Input 4.4).

Note 2: This table was prepared using a spreadsheet software with internal calculations performed using more digits than shown; hence, hand calculations may yield slightly different results due to roundoff.

Table B-19. LPZ Immersion Doses due to Secondary Steam Releases

ISOTOPE	ACTIVITY (Ci)	DCF (Rem-m³/Ci-sec)		DOSE (Rem)	
		B. Skin	W. Body	B. Skin	W. Body
I-131	3.72E-01	3.17E-02	8.72E-02	1.1E-08	3.0E-08
I-132	7.05E-02	1.32E-01	5.13E-01	8.6E-09	3.3E-08
I-133	4.38E-01	7.35E-02	1.55E-01	3.0E-08	6.3E-08
I-134	2.03E-02	9.23E-02	5.32E-01	1.7E-09	1.0E-08
I-135	1.73E-01	1.29E-01	4.21E-01	2.1E-08	6.7E-08
Kr-85m	3.75E-02	4.63E-02	3.71E-02	1.6E-09	1.3E-09
Kr-85	1.64E-01	4.25E-02	5.10E-04	6.4E-09	7.7E-11
Kr-87	1.76E-02	3.08E-01	1.88E-01	5.0E-09	3.0E-09
Kr-88	5.68E-02	7.51E-02	4.66E-01	3.9E-09	2.4E-08
Xe-131m	3.81E-02	1.51E-02	2.90E-03	5.3E-10	1.0E-10
Xe-133	5.22E+00	9.70E-03	9.32E-03	4.7E-08	4.5E-08
Xe-135m	1.76E-02	2.25E-02	9.89E-02	3.7E-10	1.6E-09
Xe-135	1.63E-01	5.89E-02	5.74E-02	8.9E-09	8.6E-09
Xe-138	8.93E-03	1.31E-01	2.80E-01	1.1E-09	2.3E-09
H-3	1.36E+03	0.00E+00	0.00E+00	0.0E+00	0.0E+00
Total				1.5E-07	2.9E-07

Note 1: Dose calculated using D_{imm} equation from Section B5.1 with a χ/Q of 9.24E-7 sec/m³ (per Design Input 4.5), immersion DCFs per Design Input 4.8, and an occupancy factor of 1.0 (per Design Input 4.4).

Note 2: This table was prepared using a spreadsheet software with internal calculations performed using more digits than shown; hence, hand calculations may yield slightly different results due to roundoff.

Table B-20. Control Room Thyroid Dose due to Secondary Steam Releases

ISOTOPE	ACTIVITY (Ci)	DCF (Rem/Ci)	DOSE (Rem)
I-131	3.72E-01	1.49E+06	1.5E-01
I-132	7.05E-02	1.43E+04	2.8E-04
I-133	4.38E-01	2.69E+05	3.2E-02
I-134	2.03E-02	3.73E+03	2.1E-05
I-135	1.73E-01	5.60E+04	2.7E-03
H-3	1.36E+03	1.58E+02	5.9E-02
Total			2.5E-01

Note 1: Dose calculated using D_{inh} equation from Section B5.1 with a χ/Q of 7.9E-4 sec/m^3 (per Design Input 4.5), a breathing rate of 3.47E-4 m^3/sec (per Assumption 3.4), inhalation DCFs per Design Input 4.8, and an occupancy factor of 1.0 (per Design Input 4.4).

Note 2: This table was prepared using a spreadsheet software with internal calculations performed using more digits than shown; hence, hand calculations may yield slightly different results due to roundoff.

Table B-21. Control Room Immersion Doses due to Secondary Steam Releases

ISOTOPE	ACTIVITY (Ci)	DCF (Rem-m^3/Ci-sec)		DOSE (Rem)	
		B. Skin	W. Body	B. Skin	W. Body
I-131	3.72E-01	3.17E-02	8.72E-02	9.3E-06	5.1E-05
I-132	7.05E-02	1.32E-01	5.13E-01	7.4E-06	5.7E-05
I-133	4.38E-01	7.35E-02	1.55E-01	2.5E-05	1.1E-04
I-134	2.03E-02	9.23E-02	5.32E-01	1.5E-06	1.7E-05
I-135	1.73E-01	1.29E-01	4.21E-01	1.8E-05	1.2E-04
Kr-85m	3.75E-02	4.63E-02	3.71E-02	1.4E-06	2.2E-06
Kr-85	1.64E-01	4.25E-02	5.10E-04	5.5E-06	1.3E-07
Kr-87	1.76E-02	3.08E-01	1.88E-01	4.3E-06	5.2E-06
Kr-88	5.68E-02	7.51E-02	4.66E-01	3.4E-06	4.2E-05
Xe-131m	3.81E-02	1.51E-02	2.90E-03	4.5E-07	1.7E-07
Xe-133	5.22E+00	9.70E-03	9.32E-03	4.0E-05	7.7E-05
Xe-135m	1.76E-02	2.25E-02	9.89E-02	3.1E-07	2.7E-06
Xe-135	1.63E-01	5.89E-02	5.74E-02	7.6E-06	1.5E-05
Xe-138	8.93E-03	1.31E-01	2.80E-01	9.2E-07	3.9E-06
H-3	1.36E+03	0.00E+00	0.00E+00	0.0E+00	0.0E+00
Total				1.3E-04	5.0E-04

Note 1: Dose calculated using D_{imm} equation from Section B5.1 with a χ/Q of 7.9E-4 sec/m^3 (per Design Input 4.5), immersion DCFs per Design Input 4.8, and an occupancy factor of 1.0 (per Design Input 4.4). Whole body doses have been doubled per Assumption 3.7.

Note 2: This table was prepared using a spreadsheet software with internal calculations performed using more digits than shown; hence, hand calculations may yield slightly different results due to roundoff.

Table B-22. Dose Summary

	DOSE (Rem)		
	Thyroid	Beta Skin	Whole Body
Exclusion Area Boundary			
Primary Liquid	1.0E-02	1.3E-05	2.2E-05
Secondary Liquid	2.5E-02	3.1E-06	8.9E-06
Secondary Steam	1.1E-03	5.7E-07	1.1E-06
Total	3.6E-02	1.7E-05	3.2E-05
Low Population Zone			
Primary Liquid	2.6E-03	3.4E-06	5.7E-06
Secondary Liquid	6.4E-03	8.1E-07	2.3E-06
Secondary Steam	2.9E-04	1.5E-07	2.9E-07
Total	9.3E-03	4.4E-06	8.3E-06
Control Room			
Primary Liquid	2.2E+00	2.9E-03	9.8E-03
Secondary Liquid	5.4E+00	6.9E-04	3.9E-03
Secondary Steam	2.5E-01	1.3E-04	5.0E-04
Total	7.9E+00	3.8E-03	1.4E-02

Note: This table was prepared using a spreadsheet software with internal calculations performed using more digits than shown; hence, hand calculations may yield slightly different results due to roundoff.

APPENDIX C SMALL BREAK LOCA

C1.0 SBLOCA METHODOLOGY

Following a Small Break Loss-of-Coolant Accident (SBLOCA) there may be four main radioactive material release mechanisms. First, as the SBLOCA is a breach of the reactor coolant pressure boundary (at an unspecified location) the reactor coolant released to Containment leaks to the environment at the Containment leak rate or at the mini-purge flow rate. Second, for some of the SBLOCA events Main Steam Safety Valves (MSSV) actuate to control secondary side pressure with a corresponding release of secondary side activity to the environment. Third, the process of cooling down the reactor results in the release of secondary side activity to the atmosphere through the Atmospheric Dump Valves (ADV) as the assumed loss of power makes the condenser unavailable. Fourth, steam generator tube leakage is assumed to be at the design basis value of 1 gpm, resulting in the reactor coolant leakage being released from the secondary side to the atmosphere with the flow through the ADVs or MSSVs. The released radioactive material is dispersed into the atmosphere, and from there to the Control Room, EAB and LPZ.

The immersion and inhalation doses are due to the airborne cloud at the EAB and LPZ and the cloud inside the Control Room. The LOCADOSE dose calculation program will be run using the appropriate assumptions and design inputs from Sections 3 and 4 to calculate the immersion and inhalation doses in the CR and at the EAB and LPZ. Figures C-1 and C-2 show the LOCADOSE models used.

1. Figure C-1 represents the initial configuration, with containment mini-purge system in operation.

2. Figure C-2 represents the configuration once the CR HVAC system has been placed into the high radiation isolation mode and the containment mini-purge system has been isolated.

Due to the wide variation in break flow rates and SIAS generation times caused by the differing SBLOCA break sizes, a parametric evaluation will first be performed to determine which SBLOCA is limiting. The limiting SBLOCA will then be evaluated for the offsite and Control Room doses.

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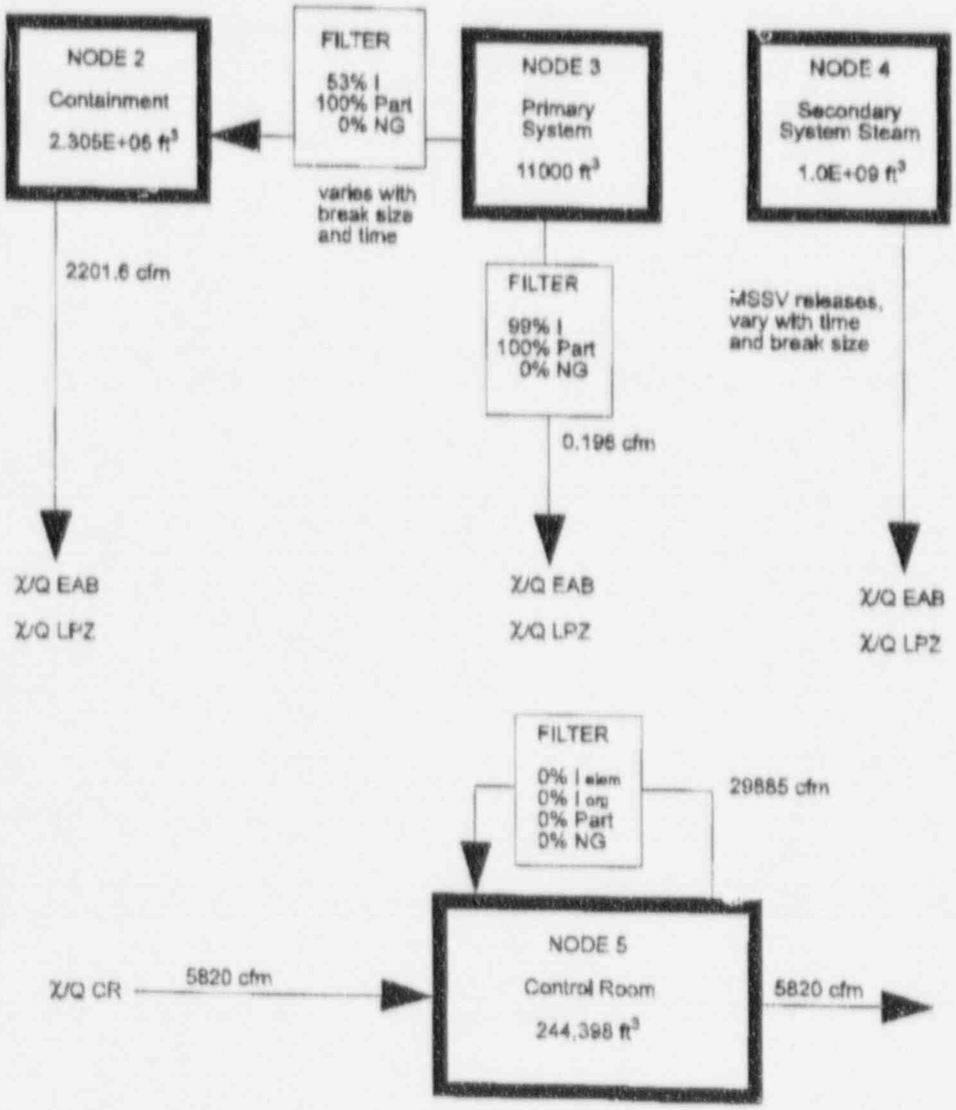
0	Mark Drucker	8/15/97	T. Remick	8/18/97					

C2.0 SBLOCA LOCADOSE MODEL

Figure C-1

SBLOCA LOCADOSE Model
CR HVAC In Normal Mode, Containment Mini-Purge in Operation



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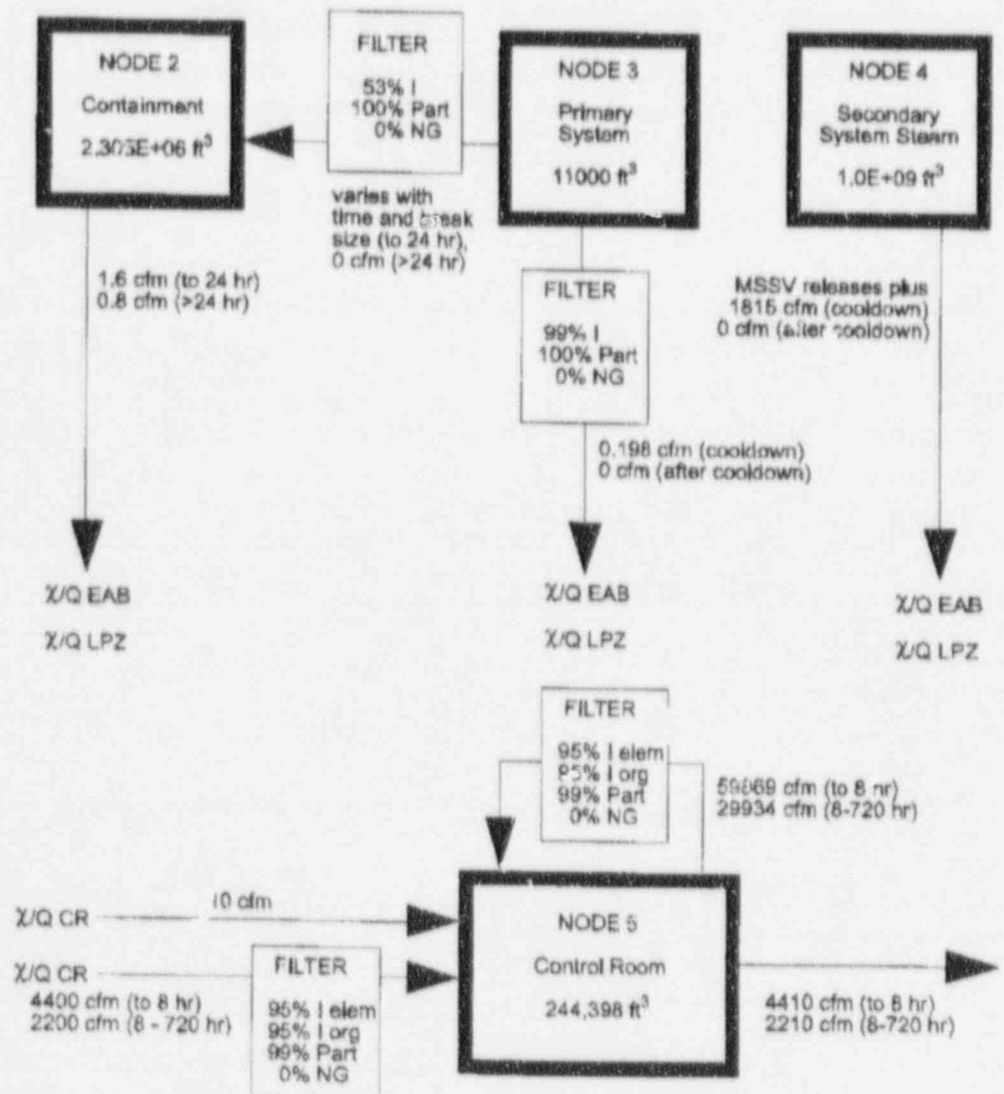
0	Mark Drucker	8/15/97	T. Remick	8/18/97					

Figure C-2

SBLOCA LOCADOSE Model
CR HVAC In High Radiation Isolation Mode, Containment Mini-Purge Secured



C3.0 SBLOCA ASSUMPTIONS

C3.1 No specific cooldown information is provided for this accident. The entire secondary side mass releases from an Inadvertent Opening of a Steam Generator Atmospheric Dump Valve with a Single Active Failure (IOSGADV/SAF) will be used to provide a reasonable approximation of the cooldown mass releases. The IOSGADV/SAF has a cooldown duration of 16,950 seconds (283 minutes or 4.71 hours) and a total secondary steam mass release of 1,155,300 lbm (from S-CE-3379, Reference 6.3g; with the data from pages 67 and 69 of calculation 1370-DT-003, Reference 6.7j). For conservatism, the secondary system mass release will be rounded up to 1,300,000 lbm for this analysis.

C3.2 Because this evaluation is based on having the containment mini-purge system in service at the start of the accident, a pre-existing iodine spike will be assumed. This is per Standard Review Plan 6.2.4 Branch Technical Position 6-4 (Reference 6.4o).

C3.3 This analysis assumes that the iodine present in the leaking reactor coolant that flashes to steam will become airborne in containment. Therefore, no additional credit will be taken for iodine removal by containment spray or plate out.

C3.4 It will be assumed that 1% of the iodine present in that portion of the RCS leakage that does not flash will also become airborne. The value of 1% is consistent with the iodine partition coefficient used for the steam generators.

C3.5 Per ABB Letter ST-96-456 (Reference 6.3m) no fuel failure results from small break LOCAs at the beginning of core life, and any fuel failures at the end of cycle will occur after the SIAS has been generated (and therefore after the containment mini-purge system and the Control Room have been isolated).

C3.6 It is assumed that the leakage from the RCS to containment continues until 24 hours after the start of the accident, when the RCS is assumed to be depressurized (stopping the leak).

C3.7 Since the ABB/CE mass release information in Design Input C4.3 does not go to 24 hours, the mass release rate calculated from the last ABB/CE time interval will be assumed to apply from the end of the ABB/CE analysis to 24 hours.

C3.8 To bound SBLOCAs smaller than 0.01 ft^2, the 0.01 ft^2 SBLOCA evaluation will not credit the SIAS (per Design Input C4.1). This is because smaller SBLOCAs may not generate a SIAS prior to 30 minutes, due to makeup from the CVCS. Instead, operator action to manually isolate the containment mini-purge system and place the Control Room HVAC system in the high radiation isolation mode is assumed to take place 30 minutes after the start of the accident. This 30 minute interval is conservative relative to the 20 minute manual action interval permitted by Standard Review Plan Section 6.4, paragraph III.3.d(3), page 6.4-10 (Reference 6.4n). The operators would be alerted to the leak through safety related instrumentation such as the 2(3)-LT-5853-2 containment sump inflow leak detection (with associated Control Room annunciator), or by the Critical Function Monitoring System computer, or by observation of the increase in containment sump level on 2(3)-LI-5853-1 or 2(3)-LR-5853-2 (References 6.2i and 6.2j).

C3.9 Secondary side mass release time information is not available. The parametric analysis will assume that of the 1,300,000 lbm secondary release (per Assumption C3.1), 400,000 lbm is released in the first 30 minutes through the MSSVs. This 0 to 30 minute value is conservatively larger than the actual MSSV release (per Design Input C4.3). The remaining 900,000 lbm of the assumed secondary release is through the MSSVs, ADVs, and/or the steam driven Auxiliary Feedwater pump during the remainder of the event.

C3.10 Once the SIAS is initiated, it is assumed that the Control Room HVAC system dampers take 10 seconds to shift to the high radiation isolation mode. This time is conservative to the value of 6 seconds used in calculation N-4072-001 (Reference 6.1k).

C3.11 Once the SIAS is initiated, it is assumed that the Containment mini-purge system takes 10 seconds to isolate. This time is conservative to the Licensee Controlled Specification 3.6.101 Table 3.6.101-1B (References 6.4j and 6.4k) stroke time limit of 5 seconds.

C3.12 The entire Design Input C4.3 MSSV release for the 0.01 ft^2 SBLOCA will be assumed to occur in the first 30 minutes. Per ABB Letter ST-96-456 (Reference 6.3m), the MSSVs for the broken loop actually close at 1936 seconds (32.3 minutes), and the MSSVs for the intact loop close at 2040 seconds (34 minutes). Modeling the flowpath isolation at 30 minutes is slightly conservative, as the entire release therefore occurs prior to isolation of the Control Room.

C4.0 SBLOCA DESIGN INPUTS

C4.1 Per ABB Letter ST-96-456 (Reference 6.3m) the SIAS and MSSV actuations occur at the following times for the given break size. An entry of N/A indicates that the event did not occur.

Break Size (ft^2)	SIAS (sec)	MSSVs Open (sec)	Last MSSVs Closed (sec)
0.01	620	150	2040
0.025	260	110	5440
0.05	135	140	2500
0.075	88	92	440
0.10	70	70	314
1.0	10.5	N/A	N/A

C4.2 Per ST-96-456 the mass releases for the various sized SBLOCAs are as follows.

0.01 ft^2 SBLOCA

0 - 10.33 min (620 sec or 0.172 hr):	116,960 lbm (equivalent to 268 cfm)
10.33 - 30 min:	102,590 lbm (equivalent to 124 cfm)
30 - 60 min:	156,320 lbm (equivalent to 124 cfm)
60 - 83.3 min (end):	40,030 lbm (equivalent to 41 cfm)
total (0 to 83.3 min):	415,900 lbm

0.025 ft^2 SBLOCA

0 - 4.33 min (260 sec or 0.072 hr):	119,090 lbm (equivalent to 652 cfm)
4.33 - 30 min:	239,830 lbm (equivalent to 222 cfm)
30 - 60 min:	114,110 lbm (equivalent to 90 cfm)
60 - 100 min (end):	123,250 lbm (equivalent to 73 cfm)
total (0 to 100 min):	596,280 lbm

0.05 ft^2 SBLOCA

0 - 2.25 min (135 sec or 0.038 hr):	121,000 lbm (equivalent to 1275 cfm)
2.25 - 30 min:	316,880 lbm (equivalent to 271 cfm)
30 - 50 min (end):	75,770 lbm (equivalent to 90 cfm)
total (0 to 50 min):	513,650 lbm

0.075 ft² SBLOCA

0 - 1.47 min (88 sec or 0.024 hr):	117,350 lbm (equivalent to 1893 cfm)
1.47 - 30 min:	354,560 lbm (equivalent to 295 cfm)
30 - 33.3 min (end):	14,690 lbm (equivalent to 106 cfm)
total (0 to 33.3 min):	486,600 lbm

0.1 ft² SBLOCA

0 - 1.17 min (70 sec or 0.019 hr):	121,710 lbm (equivalent to 2466 cfm)
1.17 - 16.7 min (end):	300,750 lbm (equivalent to 459 cfm)
total (0 to 16.7 min):	422,460 lbm

1.0 ft² SBLOCA

0 - 0.175 min (10.5 sec or 0.003 hr):	157,220 lbm (equivalent to 21300 cfm)
0.175 - 1.1 min (end):	251,940 lbm (equivalent to 6458 cfm)
total (0 to 1.1 min):	409,160 lbm

The volumetric flow rate for each of the time intervals has been calculated as follows, using the Design Input 4.6 RCS specific volume:

$$\textit{Flow rate (cfm)} = \frac{\textit{Interval release (lbm)}}{\textit{Interval duration (min)}} \times \frac{0.02371\,ft^3}{lbm}$$

For the 0.05 ft² first time interval, a sample calculation is:

$$\frac{121{,}000\,lbm}{2.25\,min} \times \frac{0.02371\,ft^3}{lbm} = 1275\,cfm$$

C4.3 Per ST-96-456 the MSSV releases for the various sized breaks are as follows.

0.01 ft² SBLOCA

150 - 620 seconds:	95,373 lbm (broken loop, prior to SIAS)
150 - 620 seconds:	94,238 lbm (intact loop, prior to SIAS)
620 - 1936 seconds:	49,347 lbm (broken loop, after SIAS)
620 - 2040 seconds:	74,442 lbm (intact loop, after SIAS)
total:	313,400 lbm (both loops)

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<u>0.025 ft^2 SBLOCA</u>

110 - 260 seconds:	11,043 lbm (broken loop, prior to SIAS)
110 - 260 seconds:	10,520 lbm (intact loop, prior to SIAS)
260 - 5440 seconds:	135,057 lbm (broken loop, after SIAS)
260 - 5440 seconds:	105,950 lbm (intact loop, after SIAS)
total:	262,570 lbm (both loops)

<u>0.05 ft^2 SBLOCA</u>

140 - 2500 seconds:	68,008 lbm (broken loop, all after SIAS)
140 - 920 seconds:	48,264 lbm (intact loop, all after SIAS)
total:	116,272 lbm (both loops)

<u>0.075 ft^2 SBLOCA</u>

92 - 440 seconds:	39,209 lbm (broken loop, all after SIAS)
92 - 435 seconds:	36,392 lbm (intact loop, all after SIAS)
total:	75,601 lbm (both loops)

<u>0.1 ft^2 SBLOCA</u>

70 - 314 seconds:	30,894 lbm (broken loop, all after SIAS)
70 - 314 seconds:	28,834 lbm (intact loop, all after SIAS)
total:	59,728 lbm (both loops)

<u>1.0 ft^2 SBLOCA</u>

no MSSV actuation

C5.0 SBLOCA COMPUTATIONS

C5.1 Primary System Activity Inventory

The primary system contains the normal reactor coolant activity (per Design Inputs 4.13 and 4.14) with an iodine spike (per Assumption C3.2). Use of this initial source term, without a production term, means that this analysis is valid for those cases which generate a reactor trip.

C5.2 Reactor Coolant Iodine Flashing

Per Assumption C3.3, the iodine present in the portion of the leaking reactor coolant that flashes to steam will become airborne. To find the flashing fraction, the mass and enthalpy balance equations will be solved simultaneously. The break location is not specified, so the temperature and pressure of the released fluid is not known. To maximize the amount of liquid that flashes, this analysis will be done for the hot leg conditions of 611°F and 2250 psia (per Design Input 4.6).

Terminology (all enthalpies are from the ASME Steam Tables):

m_c = mass of coolant released to containment
m_L = released coolant mass that remains a liquid in containment
m_g = released coolant mass that flashes to a gas in containment
h_c = coolant enthalpy (compressed liquid at 611°F and 2250 psia, 629.3 BTU/lbm)
h_L = liquid enthalpy (saturated liquid at 14.7 psia, 180.17 BTU/lbm)
h_g = gas enthalpy (saturated vapor at 14.7 psia, 1150.5 BTU/lbm)

$$m_c h_c = m_L h_L + m_g h_g$$

$$m_c = m_L + m_g$$

Substituting $m_L = m_c - m_g$ yields:

$$m_c h_c = (m_c - m_g) h_L + m_g h_g$$

$$m_c h_c = m_c h_L - m_g h_L + m_g h_g$$

$$m_c (h_c - h_L) = m_g (h_g - h_L)$$

$$\frac{m_g}{m_c} = \frac{h_c - h_L}{h_g - h_L}$$

$$\frac{m_g}{m_c} = \frac{629.3 - 180.17}{1150.5 - 180.17} = 46.3\%$$

Per Assumption C3.4, an additional 0.537% (1% of the iodine [illegible]ent in the 53.7% of the liquid that does not flash) is also assumed to be released. The total flashing percentage of 46.837% (46.3% + 0.537%) will be conservatively modeled as 47% in this calculation. The flashing will be modeled in LOCADOSE by assuming a 53% efficient iodine filter is on the flowpath of the leaking reactor coolant from the RCS to the containment volume. No filtration will be used on the noble gases or particulates leaking from the RCS to the containment volume.

C5.3 SBLOCA Primary to Secondary Leakage

Per Design Input 4.11, the primary to secondary leakage is 0.198 cfm. The radioactive material in this leakage is only released when there is a flow path from the Steam Generator to the atmosphere (i.e., MSSV or ADV open). For conservatism, this will be assumed to be from the start of the accident to the point when shutdown cooling is in operation. A filter (99% effective for iodine, 100% for particulates, 0% for noble gases) will be used on this flow path, to model the steam generator partition coefficient of 0.01 (per Assumption 3.5).

C5.4 SBLOCA MSSV Releases Prior to 30 Minutes for Parametric Evaluation

Per Assumption C3.9 the MSSV steam release from the secondary side during the first 30 minutes is 400,000 lbm. For the purposes of the parametric evaluation, this release will be modeled as starting at 0 seconds. Using a steam density of 1.95 lbm/ft^3 per Assumption 3.11, this results in the following MSSV mass flow rate:

$$MSSV\,flow\,rate = \frac{400{,}00\ lbm}{30\ min} \times \frac{ft^3}{1.95\ lbm} = 6838\ cfm$$

Use of this value for all size SBLOCAs will tend to over predict the Control Room doses for the larger SBLOCAs. As shown in Design Input C4.1, the SIAS has already been generated (and thus the Control Room isolation initiated) for the 0.075 ft^2, 0.1 ft^2, and 1.0 ft^2 SBLOCAs

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before the MSSVs open. This over conservatism does not affect the conclusions of the parametric evaluation, since as shown in Section C5.8 the doses actually decrease with increasing break size (due to the smaller duration for the mini-purge release path).

C5.5 SBLOCA Secondary Side Cooldown Releases for Parametric Evaluation

Per Assumption C3.9 the steam release from the secondary side during the cooldown is 900,000 lbm, and the duration is 283 minutes. Using a steam density of 1.95 lbm/ft^3 per Assumption 3.11, this results in the following cooldown mass flow rate:

$$Cooldown\ flow\ rate = \frac{900,00\ lbm}{283\ min} \times \frac{ft^3}{1.95\ lbm} = 1631\ cfm$$

C5.6 Containment Releases to Atmosphere

Prior to the SIAS, the flow rate out of containment is the 2200 cfm from the mini-purge system (per Design Input 4.17) plus 1.6 cfm of containment leakage (per Design Input 4.10). Once the isolation of the mini-purge system initiated by the SIAS is completed (10 seconds after the generation of the SIAS per Assumption A3.7), the flow rate out of containment is equal to the Design Input 4.10 containment leak rate.

C5.7 SBLOCA LOCADOSE Code Time Steps for Parametric Evaluation

The time steps entered into the LOCADOSE Code were chosen to model the times at which parameters important to the analysis are changed (e.g., HVAC changes, secondary system release changes). The analysis will be done for a duration of 30 days. To simplify the modeling, the break flow rate for the 0 to SIAS time interval will be modeled as continuing for the additional 10 seconds necessary for the Control Room and mini-purge isolations to occur (per Assumption C3.10).

Time Step (hours after start of event)	Significance of the Time Step
0 hrs	Containment mini-purge system in operation Beginning of SBLOCA limiting fault
variable (per C4.1)	SIAS generated Change in break flow for 0.01 ft^2 SBLOCA
variable + 10 seconds (per C4.1 and C3.10)	Containment mini-purge and Control Room isolated (except for 0.01 ft^2 SBLOCA per Assumption C3.8) Change in break flow (except for 0.01 ft^2 SBLOCA)
0.5 hours	Start of plant cooldown Change in break flow Containment mini-purge and Control Room isolated for 0.01 ft^2 SBLOCA per C3.8
1 hr	Change in break flow
2 hr	End of EAB dose analysis
5.21 hr	(4.71 hr cooldown + 0.5 hr start time = 5.21 hr) Shutdown cooling in service, ADV closed and AFW secured (also stopping the release path for the primary to secondary leakage).
8 hr	Control Room HVAC placed in single train operation CR χ/Q changes LPZ χ/Q changes LPZ breathing rate changes
24 hr	Leakage from RCS to Containment assumed to be isolated CR occupancy factor changes CR χ/Q changes LPZ χ/Q changes LPZ breathing rate changes
96 hr	CR occupancy factor changes CR χ/Q changes LPZ χ/Q changes
720 hr	End of analysis

C5.8 SBLOCA Dose Results for Parametric Evaluation

The Control Room and EAB thyroid doses for the various sized SBLOCAs are as follows, based on the Section C6.2 and C6.5 input files:

Break Size	CR Thyroid Dose (Rem)	EAB Thyroid Dose (Rem)
0.01 ft^2	4.91	0.076
0.025 ft^2	0.17	0.007
0.05 ft^2	0.09	0.005
0.075 ft^2	0.06	0.004
0.1 ft^2	0.05	0.003
1.0 ft^2	0.03	0.003

Based on the parametric evaluation, the 0.01 ft^2 SBLOCA is the most limiting. The following sections will detail the 0.01 ft^2 accident specific LOCADOSE input parameters (which differ slightly from the generic values used in the parametric evaluation).

C5.9 0.01 ft^2 SBLOCA MSSV Releases

Per Design Input C4.1 the MSSV steam release from the secondary side starts at 150 seconds. Per Design Input C4.3 the release totals 313,400 lbm, which will be rounded up to 314,000 lbm for this analysis. Per Assumption C3.12 this entire release will be assumed to occur during the first 30 minutes of the accident. Using a steam density of 1.95 lbm/ft^3 per Assumption 3.11, this results in the following MSSV mass flow rate:

$$MSSV\ flow\ rate = \frac{314{,}000\ lbm}{30\ min - 2.5\ min} \times \frac{ft^3}{1.95\ lbm} = 5855\ cfm$$

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CALCULATION SHEET

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Project or DCP/MMP DCP 2&3 6926.01SJ Calc. No. N-0720-014

CCN CONVERSION: CCN NO. CCN --

Subject Control Room and Offsite Doses Should CPIS, CRIS, and FHIS Fail

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0	Mark Drucker	8/15/97	T. Remick	8/18/97					

C5.10 0.01 ft^2 SBLOCA Secondary Side Cooldown Releases

Per Assumption C3.9 the steam release from the secondary side during the cooldown is 900,000 lbm, and the duration is 283 minutes. Using a steam density of 1.95 lbm/ft^3 per Assumption 3.11, this results in the following cooldown mass flow rate:

$$Cooldown\ flow\ rate = \frac{900{,}00\ lbm}{283\ min} \times \frac{ft^3}{1.95\ lbm} = 1631\ cfm$$

C5.11 0.01 ft^2 SBLOCA LOCADOSE Code Time Steps

The time steps entered into the LOCADOSE Code were chosen to model the times at which parameters important to the analysis are changed (e.g., HVAC changes, secondary system release changes). Per Assumption C3.8, no credit will be taken for the SIAS initiating the isolation of the Control Room or the Containment mini-purge system, in order to bound smaller SBLOCAs (where the SIAS may not occur prior to 30 minutes). The analysis will be done for a duration of 30 days.

Time Step (hours after start of event)	Significance of the Time Step
0 hrs	Containment mini-purge system in operation Beginning of SBLOCA limiting fault Containment leakage begins at 0.1 volume percent per day
0.042 hr (150 seconds)	MSSVs open
0.172 hr (620 seconds)	SIAS generated (but not credited, per Assumption C3.8) Change in break flow
0.5 hours	Containment mini-purge isolated (per Assumption C3.8) Control Room isolated (per Assumption C3.8) Start of plant cooldown MSSVs closed (per Assumption C3.12)
2 hr	End of EAB dose analysis
5.21 hr	(4.71 hr cooldown + 0.5 hr start time = 5.21 hr) Shutdown cooling in service, ADV closed and AFW secured (also stopping the release path for the primary to secondary leakage).
8 hr	Control Room HVAC placed in [illegible]eration CR χ/Q changes LPZ χ/Q changes LPZ breathing rate changes
24 hr	Leakage from RCS to Containment assumed to be isolated Containment leakage reduced to 0.05 volume percent per day CR occupancy factor changes CR χ/Q changes LPZ χ/Q changes LPZ breathing rate changes
96 hr	CR occupancy factor changes CR χ/Q changes LPZ χ/Q changes
720 hr	End of analysis

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C5.12 0.01 ft^2 SBLOCA Dose Results

Per Section C4.2, the 0.01 ft^2 break size is characterized by an average 30 minute leak rate of approximately 1300 gpm:

LR (0.01 ft^2) = [116,920 lbm + 102,590 lbm] / [(30 min)(42.176 lbm/min)(0.13368 ft^3/gal)]
LR (0.01 ft^2) = 1300 gpm

Per Section C6.7 the dose consequences of this 0.01 ft^2 break size SBLOCA are as follows. The Control Room whole body doses are doubled per Assumption 3.7.

Table C5.12-1
0.01 ft^2 SBLOCA, Mini-Purge and CR Isolated at 30 Minutes

Location	Dose (Rem)
Control Room	
Thyroid Inhalation	4.9
Beta Skin Immersion	<0.1
Whole Body Gamma Immersion	<0.1
EAB:	
Thyroid Inhalation	0.1
Beta Skin Immersion	<0.1
Whole Body Gamma Immersion	<0.1
LPZ:	
Thyroid Inhalation	<0.1
Beta Skin Immersion	<0.1
Whole Body Gamma Immersion	<0.1

C5.13 40 gpm RCS Leak Dose Results

This section evaluates a small RCS leak which is at the capacity of a single charging pump (i.e., 40 gallons/minute per Technical Specification LCO 3.5.2 (References 6.4h and 6.4i), assuming that Operator Actions are taken at 30 minutes to isolate the containment mini-purge system and to place the Control Room HVAC system into the high radiation isolation mode.

The analysis is based on a LOCADOSE code run for an RCS leak rate of 40 gpm. The leak rate is assumed to occur with an reactor coolant density of 42.176 lbm/ft^3 corresponding to the core exit/hot leg conditions of 611°F and 2250 psia (per Design Input 4.6). Use of this density ensures consistency between the leak rate and the primary reactor coolant activity concentrations modeled in the LOCADOSE code runs (per Design Inputs 4.13 and 4.14). Based on a 0.13368 ft^3/gallon volumetric conversion factor and a reactor coolant density of 42.176 lbm/ft^3, the 40 gpm volumetric leak rate is equivalent to a mass leak rate of:

$$LR = (40 \text{ gallons/minute})(0.13368 \text{ ft}^3\text{/gallon})(42.176 \text{ lbm/ft}^3) = 225.5 \text{ lbm/minute}$$

The LOCADOSE code run for the 40 gpm RCS leak is presented in Section C6.8. The significant characteristics of this run are:

1. Per Assumption C3.2, the primary reactor coolant system iodine activity concentration at the start of the RCS leak is modeled at the Technical Specification 3.4.16 short-term full power pre-existing iodine spike limit of 60 µci/gram dose equivalent Iodine-131. This iodine spike is assumed to decay (at the half-lives of the various isotopes) from time zero.

2. The RCS leak continues unabated during the 30 day RCS leak event duration. This model conservatively omits consideration of any Operator Action that would be taken to mitigate the release into the containment air space.

3. Per Design Input 4.10, the containment leak rate is 0.1% by volume per day (1.6 cfm) for the first 24 hours of the accident per Tech Spec 3.6.1.1, and reduced by 50% to 0.8 cfm after 24 hours. Containment mini-purge is assumed to be in operation at 2200 cfm (per Design Input 4.17) at the start of the event.

4. MSSV and ADV cooldown steam releases are not considered in this evaluation. Engineering judgement dictates that should the MSSVs lift, then Operator Action would be taken to identify the cause and initiate a cooldown to shutdown cooling which would terminate these activity releases within a matter of hours. As such,

Engineering judgement dictates that the secondary side steam activity release will be minimal in comparison to the primary coolant (with pre-existing iodine spike) activity released to the environment.

5. Simultaneous manual Operator Actions occur to isolate the containment mini-purge system, place the Control Room HVAC system into the high radiation isolation mode, and start a single train of the control room essential HVAC system.

The LOCADOSE input files for the 40 gpm case utilize the activity release rates determined in Table C5.13-1. These activity release rates were calculated by scaling the Design Input 4.9 RCS activity profile with the Design Input 4.6 RCS density and the assumed RCS 40 gpm leak rate. The iodine isotopes were additionally scaled by the Design Input 4.14 RCS pre-existing iodine spiking factor of 60 and the Section C5.2 47 percent RCS to containment air flashing fraction. Sample calculations are provided in Table C5.13-1 footnotes "b" and "c".

The containment airborne activity release mechanism and the control room model are depicted in Figures C-3 and C-4. Table C5.13-2 presents the LOCADOSE Code time steps employed in this evaluation.

Per Section C6.8 the dose consequences of this 40 gpm break size SBLOCA are as presented in Table C5.13-3. The Control Room whole body doses are doubled per Assumption 3.7.

Engineering judgement dictates that the secondary side steam activity release will be minimal in comparison to the primary coolant (with pre-existing iodine spike) activity released to the environment.

5. Simultaneous manual Operator Actions occur to isolate the containment mini-purge system, place the Control Room HVAC system into the high radiation isolation mode, and start a single train of the control room essential HVAC system.

The LOCADOSE input files for the 40 gpm case utilize the activity release rates determined in Table C5.13-1. These activity release rates were calculated by scaling the Design Input 4.9 RCS activity profile with the Design Input 4.6 RCS density and the assumed RCS 40 gpm leak rate. The iodine isotopes were additionally scaled by the Design Input 4.14 RCS pre-existing iodine spiking factor of 60 and the Section C5.2 47 percent RCS to containment air flashing fraction. Sample calculations are provided in Table C5.13-1 footnotes "b" and "c".

The containment airborne activity release mechanism and the control room model are depicted in Figures C-3 and C-4. Table C5.13-2 presents the LOCADOSE Code time steps employed in this evaluation.

Per Section C6.8 the dose consequences of this 40 gpm break size SBLOCA are as presented in Table C5.13-3. The Control Room whole body doses are doubled per Assumption 3.7.

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Table C5.13-1

ACTIVITY RELEASE RATES INTO CONTAINMENT FOR A 40 GPM RCS LEAK

Isotope	RCS Activity [DI 4.9] (μci/gm)	RCS Iodine Spiking Factor [DI 4.14] (unitless)	RCS Density [DI 4.6] (lbm/cf)	Fraction Flashing into Ctmt. [Sect. C5.2] (unitless)	RCS Leak Rate [assumed] (gal/min)	Conversion Factor (see note a)	Activity Release Rate into Ctmt. (see note b) (Ci/hr)
I-131	8.03e-01	60	42.176	0.47	40	3.638e-03	1.39e+02
I-132	2.25e-01	60	42.176	0.47	40	3.638e-03	3.89e+01
I-133	9.90e-01	60	42.176	0.47	40	3.638e-03	1.71e+02
I-134	9.85e-02	60	42.176	0.47	40	3.638e-03	1.70e+01
I-135	4.36e-01	60	42.176	0.47	40	3.638e-03	7.55e+01
Kr-83m	0.00e+00	1	42.176	1	40	3.638e-03	0.00e+00
Kr-85m	2.47e+00	1	42.176	1	40	3.638e-03	1.52e+01
Kr-85	1.08e+01	1	42.176	1	40	3.638e-03	6.63e+01
Kr-87	1.16e+00	1	42.176	1	40	3.638e-03	7.12e+00
Kr-88	3.74e+00	1	42.176	1	40	3.638e-03	2.30e+01
Xe-131m	2.51e+00	1	42.176	1	40	3.638e-03	1.54e+01
Xe-133m	0.00e+00	1	42.176	1	40	3.638e-03	0.00e+00
Xe-133	3.44e+02	1	42.176	1	40	3.638e-03	2.11e+03
Xe-135m	1.16e+00	1	42.176	1	40	3.638e-03	7.12e+00
Xe-135	1.07e+01	1	42.176	1	40	3.638e-03	6.57e+01
Xe-138	5.87e-01	1	42.176	1	40	3.638e-03	3.60e+00
H-3	3.22e+00	1	42.176	1	40	3.638e-03	1.98e+01
Br-84	4.18e-02	1	42.176	1	40	3.638e-03	2.57e-01
Te-129	5.24e-02	1	42.176	1	40	3.638e-03	3.22e-01
Te-132	6.75e-01	1	42.176	1	40	3.638e-03	4.14e+00
Rb-88	4.27e+00	1	42.176	1	40	3.638e-03	2.62e+01
Cs-135	0.00e+00	1	42.176	1	40	3.638e-03	0.00e+00
Cs-138	0.00e+00	1	42.176	1	40	3.638e-03	0.00e+00
I-129	0.00e+00	60	42.176	0.47	40	3.638e-03	0.00e+00

(a) CF = (453.5924 gm/lbm)(0.13368 cf/gal)(1e-6 Ci/μCi)(60 min/hr) = 3.638e-3 gm-cf-Ci-min / lbm-gal-μCi-hr

(b) Sample calculation for Iodine-131:
Release Rate = (0.803 μCi/gm)(60)(42.176 lbm/cf)(0.47)(40 gal/min)(3.638e-3 gm-cf-Ci-min / lbm-gal-μCi-hr)
Release Rate = 139 Ci/hr

(c) Sample calculation for Krypton-85m:
Release Rate = (2.47 μCi/gm)(42.176 lbm/cf)(40 gal/min)(3.638e-3 gm-cf-Ci-min / lbm-gal-μCi-hr) = 15.2 Ci/hr

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	Mark Drucker	8/15/97	T. Remick	8/18/97					

Figure C-3
40 gpm SBLOCA LOCADOSE Model
CR HVAC in Normal Mode, Containment Mini-Purge in Operation

Node 2
Containment
2.306E+06 ft^3

↓

Containment Purge + Leakage Flow = 2201.6 cfm

↓

X/Q Atmospheric Dispersion to Control Room

↓

Unfiltered Inflow = 5820 cfm

↓

Node 3
Control Room
266,920 ft^3

Exhaust Flow = 5820 cfm

Recirc. Flow= 29885 cfm

→ → → →

Recirculation Filter
0% I elemental
0% I organic
0% Particulates
0% Noble Gases

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0	Mark Drucker	8/15/97	T. Remick	8/18/97					

REV ⇓

Figure C-4
40 gpm SBLOCA LOCADOSE Model
CR HVAC in Emergency Mode, Containment Mini-Purge Isolated

Node 2
Containment
2.306E+06 ft^3

↓

Leakage Flow = 1.6 cfm (prior to 24 hours)
Leakage Flow = 0.8 cfm (after 24 hours)

↓

X/Q Atmospheric Dispersion to Control Room

↓

Unfiltered Inflow = 10 cfm
Filtered Inflow = 2200 cfm (95% I elem., 95% I org., 99% partic., 0% noble gases)

↓

Node 3
Control Room
266,920 ft^3

↓ Exhaust Flow = 2210 cfm ↓

↓ Recirc. Flow= 29934 cfm ↓ ↓ → → → →

↑ ↑ ↑

Recirculation Filter
95% I elemental
95% I organic
99% Particulates
0% Noble Gases

TABLE C5.13-2
40 GPM RCS LEAKAGE SEQUENCE OF EVENTS

Time Step (hours after start of event)	Significance of the Time Step
0 hrs	Containment mini-purge system in operation Beginning of 40 gpm RCS leakage Containment leakage begins at 0.1 volume percent per day
0.5 hours	Containment mini-purge isolated Control Room isolated, with Control Room HVAC placed in single train operation
2 hr	End of EAB dose analysis
8 hr	CR χ/Q changes LPZ χ/Q changes LPZ breathing rate changes
24 hr	Containment leakage reduced to 0.05 volume percent per day CR occupancy factor changes CR χ/Q changes LPZ χ/Q changes LPZ breathing rate changes
96 hr	CR occupancy factor changes CR χ/Q changes LPZ χ/Q changes
720 hr	End of analysis

TABLE C5.13-2
40 GPM RCS LEAKAGE SEQUENCE OF EVENTS

Time Step (hours after start of event)	Significance of the Time Step
0 hrs	Containment mini-purge system in operation Beginning of 40 gpm RCS leakage Containment leakage begins at 0.1 volume percent per day
0.5 hours	Containment mini-purge isolated Control Room isolated, with Control Room HVAC placed in single train operation
2 hr	End of EAB dose analysis
8 hr	CR χ/Q changes LPZ χ/Q changes LPZ breathing rate changes
24 hr	Containment leakage reduced to 0.05 volume percent per day CR occupancy factor changes CR χ/Q changes LPZ χ/Q changes LPZ breathing rate changes
96 hr	CR occupancy factor changes CR χ/Q changes LPZ χ/Q changes
720 hr	End of analysis

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0	Mark Drucker	8/15/97	T. Remick	8/18/97					

TABLE C5.13-3
40 GPM RCS LEAKAGE,
MINI-PURGE AND CR ISOLATED AT 30 MINUTES

Location	Dose (Rem)
Control Room:	
Thyroid Inhalation	0.2
Beta Skin Immersion	<0.1
Whole Body Gamma Immersion	<0.1
EAB:	
Thyroid Inhalation	<0.1
Beta Skin Immersion	<0.1
Whole Body Gamma Immersion	<0.1
LPZ:	
Thyroid Inhalation	<0.1
Beta Skin Immersion	<0.1
Whole Body Gamma Immersion	<0.1

C5.14 Offsite Doses without Manual Isolation of Containment

This section determines the offsite 2-hour EAB and 30-day LPZ doses due to an unmitigated 1 gpm RCS leakage rate. These doses will be scaled up to the post-LOCA offsite dose criteria to determine the maximum RCS leakage rate that can be tolerated without initiating manual isolation of the containment mini-purge system. The LOCADOSE code run for the 1 gpm RCS leak rate case is presented in Section C6.9. The significant characteristics of this run are:

1. Per Assumption C3.2, the primary reactor coolant system iodine activity concentration at the start of the RCS leak is modeled at the Technical Specification 3.4.16 short-term full power pre-existing iodine spike limit of 60 μci/gram dose equivalent Iodine-131. This iodine spike and the normal reactor coolant activity are assumed to decay (at the half-lives of the various isotopes) from time zero. Per engineering judgement, the non-conservatism introduced by decaying the initial normal reactor coolant activity is insignificant compared to the dose contribution from the high initial iodine concentration and the conservatism inherent in not taking credit for CVCS cleanup of the RCS.

2. The RCS leak continues unabated during the 30 day RCS leak event duration. This model conservatively omits consideration of any Operator Action that would be taken to mitigate the release into the containment air space.

3. Per Design Input 4.10, the containment leak rate is 0.1% by volume per day (1.6 cfm) for the first 24 hours of the accident per Tech Spec 3.6.1.1, and reduced by 50% to 0.8 cfm after 24 hours. Containment mini-purge is assumed to be in operation at 2200 cfm (per Design Input 4.17) at the start of the event.

4. MSSV and ADV cooldown steam releases are not considered in this evaluation. Engineering judgement dictates that should the MSSVs lift, then Operator Action would be taken to identify the cause and initiate a cooldown to shutdown cooling which would terminate these activity releases within a matter of hours. As such, Engineering judgement dictates that the secondary side steam activity release will be minimal in comparison to the primary coolant (with pre-existing iodine spike) activity released to the environment.

5. No manual Operator Actions occur to isolate the containment mini-purge system.

The LOCADOSE input files for the 1.0 gpm case utilize the activity release rates determined in Tables C5.14-1. These activity release rates were calculated by scaling the Design Input 4.9

RCS activity profile with the Design Input 4.6 RCS density and the assumed RCS leak rate. The iodine isotopes were additionally scaled by the Design Input 4.14 RCS pre-existing iodine spiking factor of 60 and the Section C5.2 47 percent RCS to containment air flashing fraction. Sample calculations are provided in Table C5.14-1 footnotes "b" and "c".

The containment airborne activity release mechanism and the control room model are identical to that modeled in Section C5.13. Table C5.14-2 presents the LOCADOSE Code time steps employed in this evaluation.

This LOCADOSE Code run for the 1 gpm RCS leak rate allows determination that a RCS leak rate as high as 342,857 gpm would yield acceptable offsite 2-hour EAB thyroid inhalation and whole body gamma immersion doses without the need for manual operator action to isolate the containment mini-purge system. This determination, documented in Table C5.14-3, was made by dividing the EAB thyroid inhalation and whole body gamma immersion dose criteria (per Section 1.2.8) by the calculated 0 to 2-hour EAB doses per unit leak rate (per Section C6.9.3):

LR (EAB, thyroid inhalation) = (300 rem) / (8.750e-4 rem/1.0 gpm) = 342,857 gpm
LR (EAB, WB gamma immersion) = (25 rem) / (1.141e-6 rem/1.0 gpm) = 21,910,605 gpm

Similarly it can be determined that a RCS leak rate as high as 2950 gpm would yield acceptable 30-day offsite LPZ thyroid inhalation and whole body gamma immersion doses without the need for manual operator action to isolate the containment mini-purge system. This determination, documented in Table C5.14-3, was made by dividing the LPZ thyroid inhalation and whole body gamma immersion dose criteria (per Section 1.2.8) by the calculated 0 to 30-day LPZ doses per unit leak rate (per Section C6.9.3):

LR (LPZ, thyroid inhalation) = (300 rem) / (1.017e-1 rem/1.0 gpm) = 2950 gpm
LR (LPZ, WB gamma immersion) = (25 rem) / (6.421e-5 rem/1.0 gpm) = 389,347 gpm

Per Section C4.1, a SIAS is expected for SBLOCA leak rates equivalent to those associated with a 0.01 ft^2 break size or larger. Per Section C5.12, the 0.01 ft^2 break size is characterized by an average 30 minute leak rate of approximately 1300 gpm. Since the need for manual operator action to isolate the containment mini-purge system is not required until a leak rate of either 342,857 gpm (for EAB dose criteria satisfaction) or 2950 gpm (for LPZ dose criteria satisfaction) and since a SIAS will initiate CPIS for leak rates in excess of 1300 gpm, there is never a need for manual operator actions to ensure acceptable offsite doses for 30 days following either an RCS leak rate of up to 40 gpm or a SBLOCA for the non-design basis initial conditions of this calculation.

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Table C5.14-1
ACTIVITY RELEASE RATES INTO CONTAINMENT FOR A 1 GPM RCS LEAK

Isotope	RCS Activity [DI 4.9] (uci/gm)	RCS Iodine Spiking Factor [DI 4.14] (unitless)	RCS Density [DI 4.6] (lbm/cf)	Fraction Flashing into Ctmt. [Sect. C5.2] (unitless)	RCS Leak Rate [assumed] (gal/min)	Conversion Factor (see note a)	Activity Release Rate into Ctmt. (notes b,c) (Ci/hr)
I-131	8.03e-01	60	42.176	0.47	1	3.638e-03	3.47e+00
I-132	2.25e-01	60	42.176	0.47	1	3.638e-03	9.74e-01
I-133	9.90e-01	60	42.176	0.47	1	3.638e-03	4.28e+00
I-134	9.85e-02	60	42.176	0.47	1	3.638e-03	4.26e-01
I-135	4.36e-01	60	42.176	0.47	1	3.638e-03	1.89e+00
Kr-83m	0.00e+00	1	42.176	1	1	3.638e-03	0.00e+00
Kr-85m	2.47e+00	1	42.176	1	1	3.638e-03	3.79e-01
Kr-85	1.08e+01	1	42.176	1	1	3.638e-03	1.66e+00
Kr-87	1.16e+00	1	42.176	1	1	3.638e-03	1.78e-01
Kr-88	3.74e+00	1	42.176	1	1	3.638e-03	5.74e-01
Xe-131m	2.51e+00	1	42.176	1	1	3.638e-03	3.85e-01
Xe-133m	0.00e+00	1	42.176	1	1	3.638e-03	0.00e+00
Xe-133	3.44e+02	1	42.176	1	1	3.638e-03	5.28e+01
Xe-135m	1.16e+00	1	42.176	1	1	3.638e-03	1.78e-01
Xe-135	1.07e+01	1	42.176	1	1	3.638e-03	1.64e+00
Xe-138	5.87e-01	1	42.176	1	1	3.638e-03	9.01e-02
H-3	3.22e+00	1	42.176	1	1	3.638e-03	4.94e-01
Br-84	4.18e-02	1	42.176	1	1	3.638e-03	6.41e-03
Te-129	5.24e-02	1	42.176	1	1	3.638e-03	8.04e-03
Te-132	6.75e-01	1	42.176	1	1	3.638e-03	1.04e-01
Rb-88	4.27e+00	1	42.176	1	1	3.638e-03	6.55e-01
Cs-135	0.00e+00	1	42.176	1	1	3.638e-03	0.00e+00
Cs-138	0.00e+00	1	42.176	1	1	3.638e-03	0.00e+00
I-129	0.00e+00	60	42.176	0.47	1	3.638e-03	0.00e+00

(a) CF = (453.5924 gm/lbm)(0.13368 cf/gal)(1e-6 Ci/μCi)(60 min/hr) = 3.638e-3 gm-cf-Ci-min / lbm-gal-μci-hr

(b) Sample calculation for Iodine-131:
Release Rate = (0.803 μCi/gm)(60)(42.176 lbm/cf)(0.47)(1 gal/min)(3.638e-3 gm-cf-Ci-min / lbm-gal-μci-hr)
Release Rate = 3.47 Ci/hr

(c) Sample calculation for Krypton-85m:
Release Rate = (2.47 μCi/gm)(42.176 lbm/cf)(1 gal/min)(3.638e-3 gm-cf-Ci-min / lbm-gal-μci-hr) = 0.379 Ci/hr

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0	Mark Drucker	8/15/97	T. Remick	8/18/97					

TABLE C5.14-2
1 GPM RCS LEAKAGE SEQUENCE OF EVENTS

Time Step (hours after start of event)	Significance of the Time Step
0 hrs	Containment mini-purge system in operation Beginning of 1 gpm RCS leakage Containment leakage begins at 0.1 volume percent per day
2 hr	End of EAB dose analysis
8 hr	CR χ/Q changes LPZ χ/Q changes LPZ breathing rate changes
24 hr	Containment leakage reduced to 0.05 volume percent per day CR occupancy factor changes CR χ/Q changes LPZ χ/Q changes LPZ breathing rate changes
96 hr	CR occupancy factor changes CR χ/Q changes LPZ χ/Q changes
720 hr	End of analysis

Table C5.14-3

Dose Receptor	Dose Limit (rem)	Dose per unit of RCS leakage (rem/gpm)	Allowable RCS leakage (gpm)
2-hour EAB - Thyroid Inhalation	300	8.750e-4	342,857
2-hour EAB - WB Gamma Immersion	25	1.141e-6	21,910,605
30-day LPZ - Thyroid Inhalation	300	1.017e-1	2950
30-day LPZ - WB Gamma Immersion	25	6.421e-5	389,347

C6.0 SBLOCA COMPUTER FILES

C6.1 SBLOCA LOCADOSE Library File (sloca.lib)

This library file was used for all of the LOCADOSE evaluations.

```
Version 1.0   Thyroid    Lung       Bone   Beta Skin Whole Body
I--131 2.508E+04 9.976E-07 1.490E+06 2.073E+04 3.150E+03 3.170E-02 8.720E-02  1
1 21  0  0  0  0  0
 1.100E-02 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00  1 1.817E-01 3.789E-01
I--131 2.508E+04 9.976E-07 1.490E+06 2.073E+04 3.150E+03 3.170E-02 8.720E-02  2
1 21  0  0  0  0  0
 1.100E-02 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00  2 1.817E-01 3.789E-01
I--131 2.508E+04 9.976E-07 1.490E+06 2.073E+04 3.150E+03 3.170E-02 8.720E-02  3
1 21  0  0  0  0  0
 1.100E-02 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00  3 1.817E-01 3.789E-01
I--132 3.806E+04 8.425E-05 1.430E+04 8.879E+02 1.450E+02 1.320E-01 5.130E-01  1
0  0  0  0  0  0  0
 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 34 4.824E-01 3.559E+00
I--132 3.806E+04 8.425E-05 1.430E+04 8.879E+02 1.450E+02 1.320E-01 5.130E-01  2
0  0  0  0  0  0  0
 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 35 4.824E-01 3.559E+00
I--132 3.806E+04 8.425E-05 1.430E+04 8.879E+02 1.450E+02 1.320E-01 5.130E-01  3
0  0  0  0  0  0  0
 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 36 4.824E-01 3.559E+00
I--133 5.622E+04 9.211E-06 2.690E+05 5.064E+03 1.080E+03 7.350E-02 1.550E-01  1
2 23 22  0  0  0  0
 9.710E-01 2.900E-02 0.000E+00 0.000E+00 0.000E+00 0.000E+00  4 4.067E-01 6.047E-01
I--133 5.622E+04 9.211E-06 2.690E+05 5.064E+03 1.080E+03 7.350E-02 1.550E-01  2
2 23 22  0  0  0  0
 9.710E-01 2.900E-02 0.000E+00 0.000E+00 0.000E+00 0.000E+00  5 4.067E-01 6.047E-01
I--133 5.622E+04 9.211E-06 2.690E+05 5.064E+03 1.080E+03 7.350E-02 1.550E-01  3
2 23 22  0  0  0  0
 9.710E-01 2.900E-02 0.000E+00 0.000E+00 0.000E+00 0.000E+00  6 4.067E-01 6.047E-01
I--134 6.575E+04 2.200E-04 3.730E+03 3.627E+02 8.050E+01 9.230E-02 5.320E-01  1
0  0  0  0  0  0  0
 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00  7 6.052E-01 2.620E+00
I--134 6.575E+04 2.200E-04 3.730E+03 3.627E+02 8.050E+01 9.230E-02 5.320E-01  2
0  0  0  0  0  0  0
 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00  8 6.052E-01 2.620E+00
I--134 6.575E+04 2.200E-04 3.730E+03 3.627E+02 8.050E+01 9.230E-02 5.320E-01  3
0  0  0  0  0  0  0
 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00  9 6.052E-01 2.620E+00
I--135 5.103E+04 2.912E-05 5.600E+04 1.971E+03 3.350E+02 1.290E-01 4.210E-01  1
2 25 24  0  0  0  0
 8.450E-01 1.550E-01 0.000E+00 0.000E+00 0.000E+00 0.000E+00 10 3.691E-01 1.617E+00
I--135 5.103E+04 2.912E-05 5.600E+04 1.971E+03 3.350E+02 1.290E-01 4.210E-01  2
2 25 24  0  0  0  0
 8.450E-01 1.550E-01 0.000E+00 0.000E+00 0.000E+00 0.000E+00 11 3.691E-01 1.617E+00
I--135 5.103E+04 2.912E-05 5.600E+04 1.971E+03 3.350E+02 1.290E-01 4.210E-01  3
2 25 24  0  0  0  0
 8.450E-01 1.550E-01 0.000E+00 0.000E+00 0.000E+00 0.000E+00 12 3.691E-01 1.617E+00
KR-83M 4.152E+03 1.052E-04 0.000E+00 5.190E-01 0.000E+00 0.000E+00 2.396E-06  4
0  0  0  0  0  0  0
 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 13 0.000E+00 4.610E-04
KR-85M 1.297E+04 4.297E-05 0.000E+00 2.910E+00 0.000E+00 4.626E-02 3.708E-02  4
1 18  0  0  0  0  0
 2.100E-01 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 14 2.902E-01 1.610E-01
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0	Mark Drucker	8/15/97	T. Remick	8/18/97					

```
KR--85 4.102E+02 2.054E-09 0.000E+00 2.410E+00 0.000E+00 4.246E-02 5.102E-04  4
0  0  0  0  0  0  0
 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 15 2.505E-01 2.236E-03
KR--87 2.335E+04 1.514E-04 0.000E+00 1.530E+01 0.000E+00 3.083E-01 1.876E-01  4
0  0  0  0  0  0  0
 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 16 1.324E+00 8.032E-01
KR--88 3.200E+04 6.731E-05 0.000E+00 3.130E+01 0.000E+00 7.510E-02 4.658E-01  4
1 31  0  0  0  0  0
 1.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 17 3.587E-01 1.981E+00
XE131M 2.595E+02 6.815E-07 0.000E+00 1.400E+00 0.000E+00 1.508E-02 2.899E-03  4
0  0  0  0  0  0  0
 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 18 0.000E+00 3.116E-03
XE133M 1.384E+03 3.663E-06 0.000E+00 1.890E+00 0.000E+00 3.150E-02 7.954E-03  4
1 23  0  0  0  0  0
 1.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 19 0.000E+00 2.332E-02
XE-133 5.622E+04 1.528E-06 0.000E+00 1.570E+00 0.000E+00 9.697E-03 9.316E-03  4
0  0  0  0  0  0  0
 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 20 1.004E-01 2.997E-02
XE135M 1.557E+04 7.380E-04 0.000E+00 2.220E+00 0.000E+00 2.253E-02 9.887E-02  4
1 25  0  0  0  0  0
 1.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 21 3.000E-01 4.266E-01
XE-135 5.363E+04 2.115E-05 0.000E+00 4.050E+00 0.000E+00 5.894E-02 5.736E-02  4
1 32  0  0  0  0  0
 1.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 22 3.028E-01 2.466E-01
XE-138 4.775E+04 8.151E-04 0.000E+00 2.440E+01 0.000E+00 1.309E-01 2.798E-01  4
1 33  0  0  0  0  0
 1.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 23 6.140E-01 1.241E+00
H----3 1.848E+01 1.780E-09 1.580E+02 1.580E+02 5.570E+01 0.000E+00 0.000E+00 10
0  0  0  0  0  0  0
 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 24 5.685E-03 0.000E+00
BR--84 5.394E+03 3.632E-04 0.000E+00 4.675E+02 0.000E+00 2.700E-01 4.480E-01 11
0  0  0  0  0  0  0
 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 25 1.230E+00 1.779E+00
TE-129 8.727E+03 1.662E-04 4.870E-03 2.420E+02 6.220E-03 1.010E-01 1.280E-02  6
3 34 35 36  0  0  0
 9.100E-01 4.000E-02 5.000E-02 0.000E+00 0.000E+00 0.000E+00 26 5.224E-01 5.981E-02
TE-132 3.841E+04 2.462E-06 2.370E+01 3.600E+04 3.250E+01 3.060E-03 5.280E-02  6
3  4  5  6  0  0  0
 9.100E-01 4.000E-02 5.000E-02 0.000E+00 0.000E+00 0.000E+00 27 5.940E-02 2.123E-01
RB--88 0.000E+00 6.496E-04 0.000E+00 2.908E+02 0.000E+00 4.790E-01 1.550E-01  5
0  0  0  0  0  0  0
 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 28 2.072E+00 6.365E-01
CS-135 0.000E+00 7.449E-15 7.480E+03 1.570E+03 1.460E+04 2.730E-03 0.000E+00  5
0  0  0  0  0  0  0
 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 29 5.630E-02 0.000E+00
CS-138 0.000E+00 3.587E-04 0.000E+00 6.070E+00 4.140E+01 2.810E-01 5.530E-01  5
0  0  0  0  0  0  0
 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 30 1.218E+00 2.330E+00
I--129 0.000E+00 1.400E-15 5.540E+06 9.015E+04 2.480E+03 3.710E-04 3.024E-03  1
0  0  0  0  0  0  0
 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 31 4.090E-02 2.820E-03
I--129 0.000E+00 1.400E-15 5.540E+06 9.015E+04 2.480E+03 3.710E-04 3.024E-03  2
0  0  0  0  0  0  0
 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 32 4.090E-02 2.820E-03
I--129 0.000E+00 1.400E-15 5.540E+06 9.015E+04 2.480E+03 3.710E-04 3.024E-03  3
0  0  0  0  0  0  0
 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 33 4.090E-02 2.820E-03
```

C6.2 SBLOCA LOCADOSE Activity Transport Input Files for Parametric Evaluation

The generic file shown in section C6.2.1, modified as indicated for each break size, was used for the parametric evaluations of Control Room and EAB thyroid doses. Because the SIAS is not credited in the 0.01 ft^2 SBLOCA (per Assumption C3.8), the slightly different input file given in section C6.2.2 was used for that parametric evaluation. The file names for the various break sizes are:

0.01 ft^2 SBLOCA	slocap01.ti
0.025 ft^2 SBLOCA	sloca_02.ti
0.05 ft^2 SBLOCA	sloca_05.ti
0.075 ft^2 SBLOCA	sloca_07.ti
0.1 ft^2 SBLOCA	sloca_1.ti
1.0 ft^2 SBLOCA	sloca1.ti

C6.2.1 Parametric Evaluation of SBLOCAs Other Than 0.01 ft^2

```
____ ft2 SBLOCA, Minipurge in Operation, I-spike
Tom Remick
SONGS UNITS 2&3
sloca_01.ti
N-720-013  0
           1
  3   9  36   1   1   0
 0 0  0.00000E+00  0.00000E+00  2  0  0
CFM  CUFT CURIES
  1   1   1   1   1   1   1   1   1   1
  0.91 0.04 0.05
CONTNMT  RCS        SEC_STEAM
 0.00000E+00  VALUE_A  1  1  1  1
```

SBLOCA	0.025 ft^2	0.05 ft^2	0.075 ft^2	0.1 ft^2	1 ft^2
VALUE_A (hr)	0.075	0.040	0.027	0.022	0.006

```
  1  0  1
0   10100     720     <I-131
0   10100     720     <I-131
0   10100     720     <I-131
0   2840     136      <I-132
0   2840     136      <I-132
0   2840     136      <I-132
0   12500     847     <I-133
0   12500     847     <I-133
0   12500     847     <I-133
0   1250     39.2     <I-134
0   1250     39.2     <I-134
0   1250     39.2     <I-134
0   5510     335      <I-135
0   5510     335      <I-135
```

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
0	Mark Drucker	8/15/97	T. Remick	8/18/97						

```
0  5510     335       <I-135
0  0        0         <Kr-83m
0  520      72.5      <Kr-85m
0  2270     317       <Kr-85
0  244      34.0      <Kr-87
0  788      110       <Kr-88
0  529      73.7      <Xe-131m
0  0        0         <Xe-133m
0  72400    10100     <Xe-133
0  244      34.0      <Xe-135m
0  2250     314       <Xe-135
0  124      17.3      <Xe-138
0  678      2.64e+06  <H-3
0  8.8      2.73      <Br-84
0  11.0     6.75      <Te-129
0  142      211       <Te-132
0  0        0         <Rb-88
0  0        0         <Cs-135
0  0        0         <Cs-138
0  0        0         <I-129
0  0        0         <I-129
0  0        0         <I-129
2.305E+06   11000  1.0E+09
  2  1  2201.6  0
    0   0   0   0   100   100   100   100   100   100   100
  3  1  0.198  0
    99   99   99   0   100   100   100   100   [illegible]   100   100
  3  2 VALUE_B  0
```

SBLOCA	0.025 ft^2	0.05 ft^2	0.075 ft^2	0.1 ft^2	1 ft^2
VALUE_B (cfm)	652	1275	1893	2466	21300

```
  53  53   53   0   0   0   0   0   0   0   0
 4  1  6838  0
    0   0   0   0   100   100   100   100   100   100   100
-1,0,0,0
-1,0,0,0
           1     7.9000E-04
244398  0  5820  29885  5820
    0   0   0   0   0   0   0   0   0   0   0
    0   0   0   0   0   0   0   0   0   0   0
VALUE_A 0.50000E+00  1  1  1  1
```

see earlier VALUE_A table

```
 0  0  0
 2  1  1.6  0
    0   0   0   0   100   100   100   100   100   100   100
 3  2 VALUE_C  0
```

SBLOCA	0.025 ft^2	0.05 ft^2	0.075 ft^2	0.1 ft^2	1 ft^2
VALUE_C (cfm)	222	271	295	459	6458

```
   53  53   53   0   0   0   0   0   0   0   0
-1,0,0,0
-1,0,0,0
           1     7.900000E-04
244398  4400  10  59869  4410
```

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Subject Control Room and Offsite Doses Should CPIS, CRIS, and FHIS Fail Sheet 174 of 252

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	Mark Drucker	8/15/97	T. Remick	8/18/97					

```
     95  95  99   0  99  99  99  99  99   0   0
     95  95  99   0  99  99  99  99  99   0   0
0.5E+00 1.0000E+00  1  1  1  1
  0  0  0
  3  2 VALUE_D  0
```

SBLOCA	0.025 ft²	0.05 ft²	0.075 ft²	0.1 ft²	1 ft²
VALUE_D (cfm)	90	90	106	459	6458

```
     53  53   53   0   0   0   0   0   0   0   0
  4  1  1631  0
     0   0   0   0  100   100   100   100   100   100   100
 -1,0,0,0
 -1,0,0,0
              0     7.900000E-04
1.0E+00 2.0000E+00  1  1  1  1
  0  0  0
  3  2 VALUE_E  0
```

SBLOCA	0.025 ft²	0.05 ft²	0.075 ft²	0.1 ft²	1 ft²
VALUE_E (cfm)	73	90	106	459	6458

```
    53  53   53   0   0   0   0   0   0   0   0
  4  1  1631  0
     0   0   0   0  100   100   100   100   100   100   100
 -1,0,0,0
 -1,0,0,0
              0     7.900000E-04
2.00000E+00 5.21000E+00  1  1  1  *
  0  0  0
 -1,0,0,0
 -1,0,0,0
              0     7.900000E-04
5.21000E+00 8.00000E+00  1  1  1  0
  0  0  0
   3  1  1.0E-09  0
    100  100   100   100   100   100   100   100   100   100   100
   4  1  1.0E-09  0
    100  100   100   100   100   100   100   100   100   100   100
 -1,0,0,0
 -1,0,0,0
              0     7.900000E-04
8.00000E+00 2.40000E+01  1  1  1  1
  0  0  0
 -1,0,0,0
 -1,0,0,0
              1     4.600000E-04
 244398  2200    10  29934  2210
     95  95  99   0  99  99  99  99  99   0   0
     95  95  99   0  99  99  99  99  99   0   0
2.40000E+01 9.60000E+01  1  1  1  0
  0  0  0
  2  1  0.8  0
     0   0   0   0  100   100   100   100   100   100   100
  3  2  1.0E-09  0
     100  100  100  100  100  100  100  100  100  100  100
 -1,0,0,0
 -1,0,0,0
              0     2.500000E-04
```

```
9.60000E+01 7.20000E+02  1  1  1  0
  0  0  0
 -1,0,0,0
 -1,0,0,0
           0    6.25000UE-05
```

C6.2.2 Parametric Evaluation of 0.01 ft^2 SBLOCA (slocap01.ti)

```
0.01 ft2 SBLOCA, Minipurge in Operation, I-spike
Tom Remick
SONGS UNITS 2&3
slocap01.ti
N-720-013  0
           1
   3   9  36   1   1   0
 0 0  0.00000E+00  0.00000E+00  2  0  0
CFM  CUFT CURIES
   1   1   1   1   1   1   1   1   1   1   1
   0.91 0.04 0.05
CONTNMT  RCS      SEC_STEAM
 0.00000E+00 0.172  1  1  1  1
  1  0  1
0    10100   720        <I-131
0    10100   720        <I-131
0    10100   720        <I-131
0    2840    136        <I-132
0    2840    136        <I-132
0    2840    136        <I-132
0    12500   847        <I-133
0    12500   847        <I-133
0    12500   847        <I-133
0    1250    39.2       <I-134
0    1250    39.2       <I-134
0    1250    39.2       <I-134
0    5510    335        <I-135
0    5510    335        <I-135
0    5510    335        <I-135
0    0       0          <Kr-83m
0    520     72.5       <Kr-85m
0    2270    317        <Kr-85
0    244     34.0       <Kr-87
0    788     110        <Kr-88
0    529     73.7       <Xe-131m
0    0       0          <Xe-133m
0    72400   10100      <Xe-133
0    244     34.0       <Xe-135m
0    2250    314        <Xe-135
0    124     17.3       <Xe-138
0    678     2.64e+06   <H-3
0    8.8     2.73       <Br-84
0    11.0    6.75       <Te-129
0    142     211        <Te-132
0    0       0          <Rb-88
0    0       0          <Cs-135
0    0       0          <Cs-138
0    0       C          <I-129
0    0       0          <I-129
0    0       0          <I-129
```

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Subject Control Room and Offsite Doses Should CPIS, CRIS, and FHIS Fail Sheet 176 of 252

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	Mark Drucker	8/15/97	T. Remick	8/18/97					

```
2.305E+06   11000   1.0E+09
  2  1  2201.6  0
     0   0   0   0   100   100   100   100   100   100   100
  3  1  0.198  0
    99   99   99   0   100   100   100   100   100   100   100
  3  2 268  0
  53  53   53   0   0   0   0   0   0   0
  4  1  6838  0
     0   0   0   0   100   100   100   100   100   100   100
 -1,0,0,0
 -1,0,0,0
          1    7.9000E-04
 244398  0  5820  29885  5820
     0   0   0   0   0   0   0   0   0   0   0
     0   0   0   0   0   0   0   0   0   0   0
0.172   0.50000E+00  1  1  1  1
  0  0  0
  3  2 124  0
   53  53   53   0   0   0   0   0   0   0   0
 -1,0,0,0
 -1,0,0,0
          0    7.900000E-04
0.5E+00 1.0000E+00  1  1  1  1
  0  0  0
  2  1  1.6  0
     0   0   0   0   100   100   100   100   100   100   100
  3  2 124  0
    53  53   53   0   0   0   0   0   0   0   0
  4  1  1631  0
     0   0   0   0   100   100   100   100   100   100   100
 -1,0,0,0
 -1,0,0,0
          1    7.900000E-04
 244398  4400  10  59869  4410
    95  95  99   0  99  99  99  99  99   0   0
    95  95  99   0  99  99  99  99  99   0   0
1.0E+00 2.0000E+00  1  1  1  1
  0  0  0
  3  2 41  0
   53  53   53   0   0   0   0   0   0   0   0
  4  1  1631  0
     0   0   0   0   100   100   100   100   100   100   100
 -1,0,0,0
 -1,0,0,0
          0    7.900000E-04
2.00000E+00 5.21000E+00  1  1  1  1
  0  0  0
 -1,0,0,0
 -1,0,0,0
          0    7.900000E-04
5.21000E+00 8.00000E+00  1  1  1  0
  0  0  0
   3  1  1.0E-09  0
    100  100  100  100  100  100  100  100  100  100  100
   4  1  1.0E-09  0
    100  100  100  100  100  100  100  100  100  100  100
 -1,0,0,0
 -1,0,0,0
          0    7.900000E-04
8.00000E+00 2.40000E+01  1  1  1  1
  0  0  0
```

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	Mark Drucker	8/15/97	T. Remick	8/18/97					

```
 -1,0,0,0
 -1,0,0,0
           1    4.600000E-04
 244398  2200   10  29934  2210
    95  95  99   0  99  99  99  99  99   0   0
    95  95  99   0  99  99  99  99  99   0   0
2.40000E+01 9.60000E+01  1  1  1  0
  0  0  0
  2  1  0.8  0
     0   0   0   0   100   100   100   100   100   100   100
  3  2  1.0E-09  0
     100  100  100  100  100  100  100  100  100  100  100
 -1,0,0,0
 -1,0,0,0
           0    2.500000E-04
9.60000E+01 7.20000E+02  1  1  1  0
  0  0  0
 -1,0,0,0
 -1,0,0,0
           0    6.250000E-05
```

C6.3 SBLOCA LOCADOSE Dose Calculation Input File for Parametric Evaluation

The Dose Calculation input file given in Section C6.5, with the title modified for each break size, was used for the parametric evaluation of Control Room and EAB thyroid doses. The file names for the various break sizes are:

0.01 ft^2 SBLOCA	slocap01.di
0.025 ft^2 SBLOCA	sloca_02.di
0.05 ft^2 SBLOCA	sloca_05.di
0.075 ft^2 SBLOCA	sloca_07.di
0.1 ft^2 SBLOCA	sloca_1.di
1.0 ft^2 SBLOCA	sloca1.di

C6.4 SBLOCA LOCADOSE Activity Transport Input File (sloca_01.ti)

```
0.01 ft2 SBLOCA, Minipurge in Operation, I-spike
Tom Remick
SONGS UNITS 2&3
sloca_01.ti
N-720-013  0
           1
   3   10  36   1   1   0
 0 0  0.00000E+00  0.00000E+00  2  0  0
CFM  CUFT CURIES
   1   1   1   1   1   1   1   1   1   1   1
   0.91 0.04 0.05
CONTMMT  RCS       SEC_STEAM
 0.00000E+00 0.042  1  1  1  1
   1  0  1
0   10100   720       <I-131
```

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REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV
0	Mark Drucker	8/15/97	T. Remick	8/18/97						

```
0  10100   720       <I-131
0  10100   720       <I-131
0  2840    136       <I-132
0  2840    136       <I-132
0  2840    136       <I-132
0  12500   847       <I-133
0  12500   847       <I-133
0  12500   847       <I-133
0  1250    39.2      <I-134
0  1250    39.2      <I-134
0  1250    39.2      <I-134
0  5510    335       <I-135
0  5510    335       <I-135
0  5510    335       <I-135
0  0       0         <Kr-83m
0  520     72.5      <Kr-85m
0  2270    317       <Kr-85
0  244     34.0      <Kr-87
0  788     110       <Kr-88
0  529     73.7      <Xe-131m
0  0       0         <Xe-133m
0  72400   10100     <Xe-133
0  244     34.0      <Xe-135m
0  2250    314       <Xe-135
0  124     17.3      <Xe-138
0  678     2.64e+06  <H-3
0  8.8     2.73      <Br-84
0  11.0    6.75      <Te-129
0  142     211       <Te-132
0  0       0         <Rb-88
0  0       0         <Cs-135
0  0       0         <Cs-138
0  0       0         <I-129
0  0       0         <I-129
0  0       0         <I-129
2.305E+06   11000   1.0E+09
  2  1  2201.6  0
     0   0   0   0   100   100   100   100   100   100   100
  3  1  0.198  0
     99   99   99   0   100   100   100   100   100   100   100
  3  2 268  0
  53  53   53   0   0   0   0   0   0   0   0
 -1,0,0,0
 -1,0,0,0
           1    7.9000E-04
 244398  0  5820  29885  5820
     0   0   0   0   0   0   0   0   0   0   0
     0   0   0   0   0   0   0   0   0   0   0
0.042   0.172  1  1  1  1
  0  0  0
  4  1  5855  0
     0   0   0   0   100   100   100   100   100   100   100
 -1,0,0,0
 -1,0,0,0
           0    7.900000E-04
0.172   0.50000E+00  1  1  1  1
  0  0  0
  3  2 124  0
    53  53   53   0   0   0   0   0   0   0   0
 -1,0,0,0
 -1,0,0,0
```

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Subject Control Room and Offsite Doses Should CPIS, CRIS, and FHIS Fail

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	Mark Drucker	8/15/97	T. Remick	8/18/97					

```
             0    7.900000E-04
0.5E+00 1.0000E+00  1  1  1  1
 0  0  0
 2  1  1.6  0
    0   0   0   0   100   100   100   100   100   100   100
 3  2 124  0
   53  53   53   0   0   0   0   0   0   0   0
 4  1  1631  0
    0   0   0   0   100   100   100   100   100   100   100
 -1,0,0,0
 -1,0,0,0
             1    7.900000E-04
 244398  4400  10  59869  4410
    95  95  99   0  99  99  99  99  99   0   0
    95  95  99   0  99  99  99  99  99   0   0
1.0E+00 2.0000E+00  1  1  1  1
 0  0  0
 3  2 41  0
   53  53   53   0   0   0   0   0   0   0
 4  1  1631  0
    0   0   0   0   100   100   100   100   100   100   100
 -1,0,0,0
 -1,0,0,0
             0    7.900000E-04
2.00000E+00 5.21000E+00  1  1  1  1
 0  0  0
 -1,0,0,0
 -1,0,0,0
             0    7.900000E-04
5.21000E+00 8.00000E+00  1  1  1  0
 0  0  0
  3  1  1.0E-09  0
   100  100   100   100   100   100   100   100   100   100   100
  4  1  1.0E-09  0
   100  100   100   100   100   100   100   100   100   100   100
 -1,0,0,0
 -1,0,0,0
             0    7.900000E-04
8.00000E+00 2.40000E+01  1  1  1  1
 0  0  0
 -1,0,0,0
 -1,0,0,0
             1    4.600000E-04
 244398  2200   10  29934  2210
    95  95  99   0  99  99  99  99  99   0   0
    95  95  99   0  99  99  99  99  99   0   0
2.40000E+01 9.60000E+01  1  1  1  0
 0  0  0
 2  1  0.8  0
    0   0   0   0   100   100   100   100   100   100   100
 3  2  1.0E-09  0
    100  100  100  100  100  100  100  100  100  100  100
 -1,0,0,0
 -1,0,0,0
             0    2.500000E-04
9.60000E+01 7.20000E+02  1  1  1  0
 0  0  0
 -1,0,0,0
 -1,0,0,0
             0    6.250000E-05
```

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	Mark Drucker	8/15/97	T. Remick	8/18/97					

C6.5 SBLOCA LOCADOSE Dose Calculation Input File (sloca_01.di)

```
0.01 ft2 SBLOCA, Minipurge in Operation, I-spike
Tom Remick
SONGS UNITS 2&3
sloca_01.di
N-0720-13  0
           1
DORDOF
   2   5   4   3   1   0   0
REM  REM/HR
  3.6000E-06  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
  3.4700E-04  0.0000E+00  0.0000E+00  0.0000E+00
  9.2400E-07  9.2400E-07  6.0300E-07  3.6500E-07  3.2800E-07
  3.4700E-04  3.4700E-04  1.7500E-04  2.3200E-04
  2.0000E+00  8.0000E+00  2.4000E+01  9.6000E+01  7.2000E+02
  2.0000E+00  8.0000E+00  2.4000E+01  7.2000E+02
  1.0000E+00  1.0000E+00
  1.0000E+00  1.0000E+00  1.0000E+00
  3.4700E-04
  1.0000E+00  1.0000E+00  1.0000E+00
  3.4700E-04
  1.0000E+00  1.0000E+00  1.0000E+00
  3.4700E-04
  1.0000E+00  0.6000E+00  0.4000E+00
  3.4700E-04
  2.4000E+01  9.6000E+01  7.2000E+02
  7.2000E+02
  1.0000E+00  1.0000E+00  1.0  1.0
```

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CCN CONVERSION: CCN NO. CCN --	

Project or DCP/MMP DCP 2&3 6926.01SJ Calc. No. N-0720-014

Subject Control Room and Offsite Doses Should CPIS, CRIS, and FHIS Fail Sheet 181 of 252

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV
0	Mark Drucker	8/15/97	T. Remick	8/18/97						

C6.6 SBLOCA LOCADOSE Activity Transport Output File (sloca_01.to)

As this is not a design basis calculation, no output file is needed. However, to support Section 8.1.3.1.2, the page showing the activity that has been released to containment for the 0 to 2.5 minute interval is included.

```
Bechtel Standard Computer Program        LOCADCSE, NE319  Version 3.0
(c) 1989 SCE AIX Version. 2 Feb 1995                Calc No. N-720-013 Rev No.   0
Originator Tom Remick              Date 11 Sep 1996
Project SONGS UNITS 2&3      Job No. sloca_01.ti           Sheet No.    7
Subject 0.01 ft2 SBLOCA, Minipurge in Operation, I-spike
==========================================================================

****Results for Activity Computation at the end of  4.2000E-02 hours

                     Distribution of Instantaneous Activity in CURIES
```

	CONTNMT	RCS	SEC_STEAM	Cont Room
I--131	2.823E+02	9.497E+03	7.199E+02	7.396E-04
I--132	7.846E+01	2.639E+03	1.369E+02	2.055E-04
I--133	3.489E+02	1.174E+04	8.458E+02	9.143E-04
I--134	3.380E+01	1.137E+03	3.792E+01	8.856E-05
I--135	1.533E+02	5.159E+03	3.335E+02	4.018E-04
KR-83M	0.000E+00	0.000E+00	0.000E+00	0.000E+00
KR-85M	3.073E+01	4.858E+02	7.203E+01	1.273E-04
KR--85	1.350E+02	2.135E+03	3.170E+02	5.595E-04
KR--87	1.418E+01	2.243E+02	3.323E+01	5.878E-05
KR--88	4.639E+01	7.335E+02	1.089E+02	1.923E-04
XE131M	3.146E+01	4.974E+02	7.369E+01	1.304E-04
XE133M	8.734E-03	1.886E-01	1.359E-02	2.944E-08
XE-133	4.305E+03	6.807E+04	1.010E+04	1.784E-02
XE135M	1.687E+01	2.898E+02	3.588E+01	6.685E-05
XE-135	1.341E+02	2.124E+03	3.140E+02	5.552E-04
XE-138	6.520E+00	1.031E+02	1.529E+01	2.702E-05
H----3	4.032E+01	6.376E+02	2.640E+06	2.200E-33
BR--84	4.954E-01	7.833E+00	2.584E+00	0.000E+00
TE-129	6.380E-01	1.009E+01	6.582E+00	0.000E+00
TE-132	8.442E+00	1.335E+02	2.109E+02	0.000E+00
RB--88	4.358E+00	6.897E+01	1.024E+01	7.259E-06
CS-135	1.509E-10	2.388E-09	3.536E-10	2.468E-16
CS-138	3.657E-01	5.789E+00	8.588E-01	5.898E-07
I--129	1.007E-13	2.162E-12	1.413E-12	1.791E-19
Total	5.672E+03	1.057E+05	2.653E+06	2.192E-02

C6.7 SBLOCA LOCADOSE Dose Calculation Output File (sloca_01.do)

```
Bechtel Standard Computer Program        LOCADOSE, NE319  Version 3.0
(c) 1989 SCE AIX Version. 2 Feb 1995            Calc No. N-0720-13 Rev No.   0
Originator Tom Remick               Date 11 Sep 1996
Project SONGS UNITS 2&3       Job No. sloca_01.di          Sheet No.    12
Subject 0.01 ft2 SBLOCA, Minipurge in Operation, I-spike
==============================================================================

NE319 Doses Within Regions Summary

     Doses in REM for region  5 Cont Room
```

Time Interval (hr) From	to	Thyroid	Lung	Bone	Beta Skin	Whole Body
0.0000E+00	4.2000E-02	3.531E-03	5.403E-05	8.968E-06	3.760E-06	3.798E-07
4.2000E-02	.1720	2.151E-01	3.287E-03	5.459E-04	1.761E-04	1.942E-05
.1720	.5000	3.481E+00	5.312E-02	8.816E-03	2.697E-03	2.954E-04
.5000	1.000	1.195E+00	1.834E-02	3.022E-03	3.184E-03	2.377E-04
1.000	2.000	1.051E-03	1.636E-04	2.651E-06	2.649E-03	1.567E-04
2.000	5.210	1.381E-03	1.279E-04	3.421E-06	2.002E-03	1.126E-04
5.210	8.000	8.268E-04	2.591E-05	2.021E-06	2.677E-04	1.403E-05
8.000	24.00	2.974E-03	5.754E-05	7.032E-06	2.865E-04	1.398E-05
24.00	96.00	1.750E-03	3.231E-05	3.857E-06	1.520E-04	6.963E-06
96.00	720.0	8.367E-04	1.449E-05	1.772E-06	7.118E-05	2.164E-06
	Total	4.904E+00	7.522E-02	1.241E-02	1.149E-02	8.593E-04

```
Bechtel Standard Computer Program        LOCADOSE, NE319  Version 3.0
(c) 1989 SCE AIX Version. 2 Feb 1995            Calc No. N-0720-13 Rev No.   0
Originator Tom Remick               Date 11 Sep 1996
Project SONGS UNITS 2&3       Job No. sloca_01.di          Sheet No.    14
Subject 0.01 ft2 SBLOCA, Minipurge in Operation, I-spike
==============================================================================

NE319 Offsite Dose Summary

     Doses in REM for distance  1
```

Time Interval (hr) From	to	Thyroid	Lung	Bone	Beta Skin	Whole Body
0.0000E+00	4.2000E-02	8.071E-04	1.234E-05	2.050E-06	7.694E-07	1.438E-06
4.2000E-02	.1720	1.182E-02	1.806E-04	3.001E-05	9.135E-06	1.844E-05
.1720	.5000	6.188E-02	9.440E-04	1.568E-04	4.551E-05	9.199E-05
.5000	1.000	2.521E-04	3.884E-06	6.349E-07	1.263E-06	1.593E-06
1.000	2.000	5.266E-04	8.054E-06	1.320E-06	1.956E-06	2.466E-06
2.000	5.210	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
5.210	8.000	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
8.000	24.00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
24.00	96.00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
96.00	720.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
	Total	7.529E-02	1.149E-03	1.908E-04	5.863E-05	1.159E-04

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Project or DCP/MMP DCP 2&3 6926.01SJ Calc. No N-0720-014

Subject Control Room and Offsite Doses Should CPIS, CRIS, and FHIS Fail Sheet 183 of 252

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	Mark Drucker	8/15/97	T. Remick	8/18/97					

```
Bechtel Standard Computer Program        LOCADOSE, NE319  Version 3.0
(c) 1989 SCE AIX Version. 2 Feb 1995               Calc No. N-0720-13 Rev No.   0
Originator Tom Remick               Date 11 Sep 1996
Project SONGS UNITS 2&3       Job No. sloca_01.di           Sheet No.   16
Subject 0.01 ft2 SBLOCA, Minipurge in Operation, I-spike
================================================================================

NE319 Offsite Dose Summary

         Doses in REM for distance  2
```

Time Interval (hr) From - to	Thyroid	Lung	Bone	Beta Skin	Whole Body
0.0000E+00-4.2000E-02	2.071E-04	3.168E-06	5.261E-07	1.975E-07	3.691E-07
4.2000E-02- .1720	3.035E-03	4.636E-05	7.702E-06	2.345E-06	4.732E-06
.1720 - .5000	1.588E-02	2.423E-04	4.023E-05	1.168E-05	2.361E-05
.5000 - 1.000	6.472E-05	9.970E-07	1.629E-07	3.243E-07	4.089E-07
1.000 - 2.000	1.352E-04	2.067E-06	3.388E-07	5.020E-07	6.329E-07
2.000 - 5.210	4.482E-04	6.777E-06	1.111E-06	1.086E-06	1.347E-06
5.210 - 8.000	2.653E-04	3.952E-06	6.486E-07	1.524E-07	2.523E-07
8.000 - 24.00	5.192E-04	7.594E-06	1.228E-06	5.189E-07	7.640E-07
24.00 - 96.00	7.509E-04	1.064E-05	1.654E-06	4.552E-07	5.712E-07
96.00 - 720.0	1.944E-03	2.709E-05	4.116E-06	1.102E-06	1.007E-06
Total	2.325E-02	3.509E-04	5.772E-05	1.836E-05	3.370E-05

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV
0	Mark Drucker	8/15/97	T. Remick	8/18/97						

C6.8 RCS Leak LOCADOSE File (40 gpm w/ CR & Containment isolation at 30 min)

C6.8.1 RCS Leak LOCADOSE Activity Transport Input File (sb40_30m.ti)

```
40.0 gpm SBLOCA w/ 1 spike, CR & minipurge isolated @ 30 min
MARK DRUCKER
SONGS UNITS 2&3
sb40_30m.ti
N-0720-14  0
           1
  1   8  36   1   1   0
 0 0  0.00000E+00  0.00000E+00  2  0  0
CFM  CUFT CURIES
  1   1   1   1   1   1   1   1   1   1   1
  0.91 0.04 0.05
CONTMNT
 0.00000E+00 0.50000E+00  1  1  1  1
  1  1  1
   0   <I-131   initial containment inventory
   0   <I-131   initial containment inventory
   0   <I-131   initial containment inventory
   0   <I-132   initial containment inventory
   0   <I-132   initial containment inventory
   0   <I-132   initial containment inventory
   0   <I-133   initial containment inventory
   0   <I-133   initial containment inventory
   0   <I-133   initial containment inventory
   0   <I-134   initial containment inventory
   0   <I-134   initial containment inventory
   0   <I-134   initial containment inventory
   0   <I-135   initial containment inventory
   0   <I-135   initial containment inventory
   0   <I-135   initial containment inventory
   0   <Kr-83m  initial containment inventory
   0   <Kr-85m  initial containment inventory
   0   <Kr-85   initial containment inventory
   0   <Kr-87   initial containment inventory
   0   <Kr-88   initial containment inventory
   0   <Xe-131m initial containment inventory
   0   <Xe-133m initial containment inventory
   0   <Xe-133  initial containment inventory
   0   <Xe-135m initial containment inventory
   0   <Xe-135  initial containment inventory
   0   <Xe-138  initial containment inventory
   0   <H-3     initial containment inventory
   0   <Br-84   initial containment inventory
   0   <Te-129  initial containment inventory
   0   <Te-132  initial containment inventory
   0   <Rb-88   initial containment inventory
   0   <Cs-135  initial containment inventory
   0   <Cs-138  initial containment inventory
   0   <I-129   initial containment inventory
   0   <I-129   initial containment inventory
   0   <I-129   initial containment inventory
 139.      <I-131   ci/hour leaked into containment
 139.      <I-131   ci/hour leaked into containment
 139.      <I-131   ci/hour leaked into containment
  38.9     <I-132   ci/hour leaked into containment
  38.9     <I-132   ci/hour leaked into containment
```

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Project or DCP/MMP DCP 2&3 6926.01SJ   Calc. No. N-0720-014

CCN CONVERSION: CCN NO. CCN --

Subject Control Room and Offsite Doses Should CPIS, CRIS, and FHIS Fail   Sheet 185 of 252

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	Mark Drucker	8/15/97	T. Remick	8/18/97					

```
   38.9     <I-132   ci/hour leaked into containment
  171.      <I-133   ci/hour leaked into containment
  171.      <I-133   ci/hour leaked into containment
  171.      <I-133   ci/hour leaked into containment
   17.0     <I-134   ci/hour leaked into containment
   17.0     <I-134   ci/hour leaked into containment
   17.0     <I-134   ci/hour leaked into containment
   75.5     <I-135   ci/hour leaked into containment
   75.5     <I-135   ci/hour leaked into containment
   75.5     <I-135   ci/hour leaked into containment
    0       <Kr-83m  ci/hour leaked into containment
   15.2     <Kr-85m  ci/hour leaked into containment
   66.3     <Kr-85   ci/hour leaked into containment
    7.12    <Kr-87   ci/hour leaked into containment
   23.0     <Kr-88   ci/hour leaked into containment
   15.4     <Xe-131m ci/hour leaked into containment
    0       <Xe-133m ci/hour leaked into containment
 2110.      <Xe-133  ci/hour leaked into containment
    7.12    <Xe-135m ci/hour leaked into containment
   65.7     <Xe-135  ci/hour leaked into containment
    3.60    <Xe-138  ci/hour leaked into containment
   19.8     <H-3     ci/hour leaked into containment
    0.257   <Br-84   ci/hour leaked into containment
    0.322   <Te-129  ci/hour leaked into containment
    4.14    <Te-132  ci/hour leaked into containment
   26.2     <Rb-88   ci/hour leaked into containment
    0       <Cs-135  ci/hour leaked into containment
    0       <Cs-138  ci/hour leaked into containment
    0       <I-129   ci/hour leaked into containment
    0       <I-129   ci/hour leaked into containment
    0       <I-129   ci/hour leaked into containment
 2.305E+06
   2  1  2201.6  0
     0   0   0   0  100  100  100  100  100  0  0
  -1,0,0,0
  -1,0,0,0
           1    7.900000E-04
  266920  0  5820  29885  5820
     0  0  0  0  0  0  0  0  0  0  0
     0  0  0  0  0  0  0  0  0  0  0
 0.50000E+00 1.00000E+00  1  1  1  1
   0  0  0
   2  1  1.6  0
     0   0   0   0  100  100  100  100  100  0  0
  -1,0,0,0
  -1,0,0,0
           1    7.900000E-04
  266920  2200   10  29934  2210
    95  95  99   0  99  99  99  99  99  0  0
    95  95  99   0  99  99  99  99  99  0  0
 1.00000E+00 2.00000E+00  1  1  1  1
   0  0  0
  -1,0,0,0
  -1,0,0,0
           0    7.900000E-04
 2.00000E+00 4.00000E+00  1  1  1  1
   0  0  0
  -1,0,0,0
  -1,0,0,0
           0    7.900000E-04
 4.00000E+00 8.00000E+00  1  1  1  1
```

```
  0  0  0
 -1,0,0,0
 -1,0,0,0
           0    7.900000E-04
8.00000E+00 2.40000E+01  1  1  1  1
  0  0  0
 -1,0,0,0
 -1,0,0,0
           0    4.600000E-04
2.40000E+01 9.60000E+01  1  1  1  1
  0  0  0
  2  1  0.8  0
     0    0    0    0   100   100   100   100   100   0   0
 -1,0,0,0
 -1,0,0,0
           0    2.500000E-04
9.60000E+01 7.20000E+02  1  1  1  1
  0  0  0
 -1,0,0,0
 -1,0,0,0
           0    6.250000E-05
```

C6.8.2 RCS Leak LOCADOSE Dose Input File (sb40_30m.di)

```
40.0 gpm SBLOCA w/ I spike, CR & minipurge isolated @ 30 min
MARK DRUCKER
SONGS UNITS 2&3
sb40_30m.di
N-0720-14  0
           1
DORDOFDRRDRO
   2   5   4   3   1   0   0
REM REM/HR
  3.6000E-06  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
  3.4700E-04  0.0000E+00  0.0000E+00  0.0000E+00
  9.2400E-07  9.2400E-07  6.0300E-07  3.6500E-07  3.2800E-07
  3.4700E-04  3.4700E-04  1.7500E-04  2.3200E-04
  2.0000E+00  8.0000E+00  2.4000E+01  9.6000E+01  7.2000E+02
  2.0000E+00  8.0000E+00  2.4000E+01  7.2000E+02
  1.0000E+00  1.0000E+00
  1.0000E+00  1.0000E+00  1.0000E+00
  3.4700E-04
  1.0000E+00  0.6000E+00  0.4000E+00
  3.4700E-04
  2.4000E+01  9.6000E+01  7.2000E+02
  7.2000E+02
  1.0000E+00  1.0000E+00
```

C6.8.2 RCS Leak LOCADOSE Dose Output Input File (sb40_30m.do)

```
Bechtel Standard Computer Program       LOCADOSE, NE319  Version 3.0
(c) 1989 SCE AIX Version, 2 Feb 1995          Calc No. N-0720-14 Rev No.   0
Originator MARK DRUCKER            Date  7 Aug 1997
Project SONGS UNITS 2&3      Job No. sb40_30m.di        Sheet No.    7
Subject 40.0 gpm SBLOCA w/ I spike, CR & minipurge isolated @ 30 min
==========================================================================

NE319 Dose Rate Within Regions Summary

          Dose rates in REM/HR for region  3 Cont Room
```

Time (hr)	Thyroid	Lung	Bone	Beta Skin	Whole Body
0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
5.000E-01	5.303E-01	8.085E-03	1.342E-03	3.889E-04	4.403E-05
1.000E+00	1.674E-02	2.683E-04	4.392E-05	1.579E-04	1.013E-05
2.000E+00	3.986E-05	8.923E-06	1.184E-06	8.804E-05	5.122E-06
4.000E+00	4.218E-05	3.886E-06	5.306E-07	3.312E-05	1.789E-06
8.000E+00	8.089E-05	2.038E-06	3.262E-07	8.951E-06	4.641E-07
2.400E+01	1.268E-04	2.746E-06	4.532E-07	9.305E-06	4.537E-07
9.600E+01	9.839E-05	2.266E-06	3.973E-07	7.443E-06	3.367E-07
7.200E+02	2.820E-05	1.479E-06	4.108E-07	3.461E-06	4.825E-08

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Subject Control Room and Offsite Doses Should CPIS, CRIS, and FHIS Fail Sheet 188 of 252

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	Mark Drucker	8/15/97	T. Remick	8/18/97					

R E V ⇓

```
Bechtel Standard Computer Program        LOCADOSE, NE319  Version 3.0
(c) 1989 SCE AIX Version. 2 Feb 1995          Calc No. N-0720-14 Rev No.   0
Originator MARK DRUCKER          Date  7 Aug 1997
Project SONGS UNITS 2&3      Job No. sb40_30m.di          Sheet No.   10
Subject 40.0 gpm SBLOCA w/ I spike, CR & minipurge isolated @ 30 min
==========================================================================
```

NE319 Doses Within Regions Summary

Doses in REM fo. region 3 Cont Room

Time Interval (hr) From	to	Thyroid	Lung	Bone	Beta Skin	Whole Body
0.0000E+00	.5000	9.331E-02	1.423E-03	2.363E-04	6.843E-05	7.818E-06
.5000	1.000	7.429E-02	1.137E-03	1.885E-04	1.138E-04	9.731E-06
1.000	2.000	2.437E-03	4.796E-05	7.526E-06	1.176E-04	7.064E-06
2.000	4.000	6.753E-05	1.127E-05	1.567E-06	1.092E-04	6.225E-06
4.000	8.000	2.460E-04	9.695E-06	1.498E-06	6.444E-05	3.468E-06
8.000	24.00	1.406E-03	3.109E-05	5.101E-06	1.111E-04	5.517E-06
24.00	96.00	2.926E-03	6.690E-05	1.148E-05	2.286E-04	1.061E-05
96.00	720.0	6.684E-03	2.551E-04	6.399E-05	6.310E-04	1.455E-05
	Total	1.814E-01	2.983E-03	5.160E-04	1.444E-03	6.498E-05

```
Bechtel Standard Computer Program        LOCADOSE, NE319  Version 3.0
(c) 1989 SCE AIX Version. 2 Feb 1995          Calc No. N-0720-14 Rev No.   0
Originator MARK DRUCKER          Date  7 Aug 1997
Project SONGS UNITS 2&3      Job No. sb40_30m.di          Sheet No.   11
Subject 40.0 gpm SBLOCA w/ I spike, CR & minipurge isolated @ 30 min
==========================================================================
```

NE319 Doses Within Regions Summary

Cumulative doses in REM for region 3 Cont Room

Time (hr)	Thyroid	Lung	Bone	Beta Skin	Whole Body
5.000E-01	9.331E-02	1.423E-03	2.363E-04	6.843E-05	7.818E-06
1.000E+00	1.676E-01	2.561E-03	4.249E-04	1.822E-04	1.755E-05
2.000E+00	1.700E-01	2.609E-03	4.324E-04	2.998E-04	2.461E-05
4.000E+00	1.701E-01	2.620E-03	4.339E-04	4.090E-04	3.084E-05
8.000E+00	1.704E-01	2.630E-03	4.354E-04	4.734E-04	3.431E-05
2.400E+01	1.718E-01	2.661E-03	4.405E-04	5.845E-04	3.982E-05
9.600E+01	1.747E-01	2.728E-03	4.520E-04	8.131E-04	5.043E-05
7.200E+02	1.814E-01	2.983E-03	5.160E-04	1.444E-03	6.498E-05

EC&FS DEPARTMENT

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Project or DCP/MMP DCP 2&3 6926.01SJ Calc. No. N-0720-014

Subject Control Room and Offsite Doses Should CPIS, CRIS, and FHIS Fail Sheet 189 of 252

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	Mark Drucker	8/15/97	T. Remick	8/18/97					

```
Bechtel Standard Computer Program       LOCADOSE, NE319  Version 3.0
(c) 1989 SCE AIX Version. 2 Feb 1995            Calc No. N-0720-14 Rev No.   0
Originator MARK DRUCKER          Date  7 Aug 1997
Project SONGS UNITS 2&3        Job No. sb40_30m.di          Sheet No.   12
Subject 40.0 gpm SBLOCA w/ 1 spike, CR & minipurge isolated @ 30 min
================================================================================
```

NE319 Offsite Dose Rate Summary

Dose rates in REM/HR for distance 1

Time (hr)	Thyroid	Lung	Bone	Beta Skin	Whole Body
0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
5.000E-01	9.052E-03	1.380E-04	2.292E-05	6.406E-06	1.295E-05
1.000E+00	1.318E-05	2.004E-07	3.325E-08	9.008E-09	1.777E-08
2.000E+00	2.617E-05	3.961E-07	6.560E-08	1.695E-08	3.207E-08
4.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
8.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2.400E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
9.600E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
7.200E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

```
Bechtel Standard Computer Program       LOCADOSE, NE319  Version 3.0
(c) 1989 SCE AIX Version. 2 Feb 1995            Calc No. N-0720-14 Rev No.   0
Originator MARK DRUCKER          Date  7 Aug 1997
Project SONGS UNITS 2&3        Job No. sb40_30m.di          Sheet No.   13
Subject 40.0 gpm SBLOCA w/ 1 spike, CR & minipurge isolated @ 30 min
================================================================================
```

NE319 Offsite Dose Rate Summary

Dose rates in REM/HR for distance 2

Time (hr)	Thyroid	Lung	Bone	Beta Skin	Whole Body
0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
5.000E-01	2.323E-03	3.542E-05	5.884E-06	1.644E-06	3.323E-06
1.000E+00	3.383E-06	5.144E-08	8.535E-09	2.312E-09	4.560E-09
2.000E+00	6.718E-06	1.017E-07	1.684E-08	4.350E-09	8.230E-09
4.000E+00	1.319E-05	1.981E-07	3.269E-08	7.905E-09	1.401E-08
8.000E+00	2.545E-05	3.780E-07	6.192E-08	1.384E-08	2.245E-08
2.400E+01	2.230E-05	3.229E-07	5.168E-08	2.007E-08	2.799E-08
9.600E+01	2.538E-05	3.565E-07	5.476E-08	1.414E-08	1.676E-08
7.200E+02	2.533E-05	3.563E-07	5.480E-08	2.060E-08	1.090E-08

EC&FS DEPARTMENT

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Project or DCP/MMP DCP 2&3 6926.01SJ Calc. No. N-0720-014

Subject Control Room and Offsite Doses Should CPIS, CRIS, and FHIS Fail Sheet 190 of 252

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
0	Mark Drucker	8/15/97	T. Remick	8/18/97						

```
Bechtel Standard Computer Program       LOCADOSE, NE319  Version 3.0
(c) 1989 SCE AIX Version. 2 Feb 1995            Calc No. N-0720-14 Rev No.   0
Originator MARK DRUCKER          Date  7 Aug 1997
Project SONGS UNITS 2&3       Job No. sb40_30m.di          Sheet No.   14
Subject 40.0 gpm SBLOCA w/ I spike, CR & minipurge isolated @ 30 min
=====================================================================
```

NE319 Offsite Dose Summary

Doses in REM for distance 1

Time Interval (hr) From	to	Thyroid	Lung	Bone	Beta Skin	Whole Body
0.0000E+00	- .5000	2.276E-03	3.472E-05	5.768E-06	1.620E-06	3.288E-06
.5000	- 1.000	4.941E-06	7.521E-08	1.248E-08	3.421E-09	6.810E-09
1.000	- 2.000	1.969E-05	2.985E-07	4.947E-08	1.300E-08	2.499E-08
2.000	- 4.000	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
4.000	- 8.000	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
8.000	- 24.00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
24.00	- 96.00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
96.00	- 720.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
	Total	2.301E-03	3.509E-05	5.829E-06	1.636E-06	3.320E-06

```
Bechtel Standard Computer Program       LOCADOSE, NE319  Version 3.0
(c) 1989 SCE AIX Version. 2 Feb 1995            Calc No. N-0720-14 Rev No.   0
Originator MARK DRUCKER          Date  7 Aug 1997
Project SONGS UNITS 2&3       Job No. sb40_30m.di          Sheet No.   15
Subject 40.0 gpm SBLOCA w/ I spike, CR & minipurge isolated @ 30 min
=====================================================================
```

NE319 Offsite Dose Summary

Cumulative doses in REM for distance 1

Time (hr)	Thyroid	Lung	Bone	Beta Skin	Whole Body
5.000E-01	2.276E-03	3.472E-05	5.768E-06	1.620E-06	3.288E-06
1.000E+00	2.281E-03	3.479E-05	5.780E-06	1.623E-06	3.295E-06
2.000E+00	2.301E-03	3.509E-05	5.829E-06	1.636E-06	3.320E-06
4.000E+00	2.301E-03	3.509E-05	5.829E-06	1.636E-06	3.320E-06
8.000E+00	2.301E-03	3.509E-05	5.829E-06	1.636E-06	3.320E-06
2.400E+01	2.301E-03	3.509E-05	5.829E-06	1.636E-06	3.320E-06
9.600E+01	2.301E-03	3.509E-05	5.829E-06	1.636E-06	3.320E-06
7.200E+02	2.301E-03	3.509E-05	5.829E-06	1.636E-06	3.320E-06

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Project or DCP/MMP DCP 2&3 6926.01SJ Calc. No. N-0720-014

Subject Control Room and Offsite Doses Should CPIS, CRIS, and FHIS Fail Sheet 191 of 252

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	Mark Drucker	8/15/97	T. Remick	8/18/97					

```
Bechtel Standard Computer Program        LOCADOSE, NE319  Version 3.0
(c) 1989 SCE AIX Version. 2 Feb 1995          Calc No. N-0720-14 Rev No.   0
Originator MARK DRUCKER           Date  7 Aug 1997
Project SONGS UNITS 2&3       Job No. sb40_30m.di          Sheet No.   16
Subject 40.0 gpm SBLOCA w/ 1 spike, CR & minipurge isolated @ 30 min
================================================================================
```

NE319 Offsite Dose Summary

Doses in REM for distance 2

Time Interval (hr) From	to	Thyroid	Lung	Bone	Beta Skin	Whole Body
0.0000E+00-	.5000	5.841E-04	8.911E-06	1.480E-06	4.158E-07	8.439E-07
.5000	- 1.000	1.268E-06	1.930E-08	3.204E-09	8.780E-10	1.748E-09
1.000	- 2.000	5.053E-06	7.661E-08	1.270E-08	3.338E-09	6.415E-09
2.000	- 4.000	1.993E-05	3.002E-07	4.960E-08	1.229E-08	2.234E-08
4.000	- 8.000	7.741E-05	1.154E-06	1.896E-07	4.357E-08	7.304E-08
8.000	- 24.00	2.470E-04	3.604E-06	5.811E-07	2.338E-07	3.400E-07
24.00	- 96.00	1.256E-03	1.775E-05	2.749E-06	7.293E-07	5.974E-07
96.00	- 720.0	1.522E-02	2.133E-04	3.265E-05	9.717E-06	7.259E-06
	Total	1.741E-02	2.451E-04	3.772E-05	1.116E-05	9.444E-06

```
Bechtel Standard Computer Program        LOCADOSE, NE319  Version 3.0
(c) 1989 SCE AIX Version. 2 Feb 1995          Calc No. N-0720-14 Rev No.   0
Originator MARK DRUCKER           Date  7 Aug 1997
Project SONGS UNITS 2&3       Job No. sb40_30m.di          Sheet No.   17
Subject 40.0 gpm SBLOCA w/ 1 spike, CR & minipurge isolated @ 30 min
================================================================================
```

NE319 Offsite Dose Summary

Cumulative doses in REM for distance 2

Time (hr)	Thyroid	Lung	Bone	Beta Skin	Whole Body
5.000E-01	5.841E-04	8.911E-06	1.480E-06	4.158E-07	8.439E-07
1.000E+00	5.854E-04	8.930E-06	1.484E-06	4.167E-07	8.457E-07
2.000E+00	5.905E-04	9.007E-06	1.496E-06	4.200E-07	8.521E-07
4.000E+00	6.104E-04	9.307E-06	1.546E-06	4.323E-07	8.744E-07
8.000E+00	6.878E-04	1.046E-05	1.735E-06	4.759E-07	9.474E-07
2.400E+01	9.349E-04	1.406E-05	2.317E-06	7.096E-07	1.287E-06
9.600E+01	2.191E-03	3.181E-05	5.065E-06	1.439E-06	2.185E-06
7.200E+02	1.741E-02	2.451E-04	3.772E-05	1.116E-05	9.444E-06

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Subject Control Room and Offsite Doses Should CPIS, CRIS, and FHIS Fail Sheet 192 of 252

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	Mark Drucker	8/15/97	T. Remick	8/18/97					

C6.9 RCS Leak LOCADOSE Files (1 gpm with no CR or Containment Isolation)

C6.9.1 RCS Leak LOCADOSE Activity Transport Input File (sb1_720.ti)

```
1.0 gpm SBLOCA w/o isolat'n, Minipurge in Operation, I-spike
MARK DRUCKER
SONGS UNITS 2&3
sb1_720.ti
N-0720-14  0
           1
   1   8  36   1   1   0
 0 0  0.00000E+00  0.00000E+00  2  0  0
CFM  CUFT CURIES
   1   1   1   1   1   1   1   1   1   1   1
   0.91 0.04 0.05
CONTNMT
 0.00000E+00 0.50000E+00  1  1  1  1
  1  1  1
  0    <I-131    initial containment inventory
  0    <I-131    initial containment inventory
  0    <I-131    initial containment inventory
  0    <I-132    initial containment inventory
  0    <I-132    initial containment inventory
  0    <I-132    initial containment inventory
  0    <I-133    initial containment inventory
  0    <I-133    initial containment inventory
  0    <I-133    initial containment inventory
  0    <I-134    initial containment inventory
  0    <I-134    initial containment inventory
  0    <I-134    initial containment inventory
  0    <I-135    initial containment inventory
  0    <I-135    initial containment inventory
  0    <I-135    initial containment inventory
  0    <Kr-83m   initial containment inventory
  0    <Kr-85m   initial containment inventory
  0    <Kr-85    initial containment inventory
  0    <Kr-87    initial containment inventory
  0    <Kr-88    initial containment inventory
  0    <Xe-131m  initial containment inventory
  0    <Xe-133m  initial containment inventory
  0    <Xe-133   initial containment inventory
  0    <Xe-135m  initial containment inventory
  0    <Xe-135   initial containment inventory
  0    <Xe-138   initial containment inventory
  0    <H-3      initial containment inventory
  0    <Br-84    initial containment inventory
  0    <Te-129   initial containment inventory
  0    <Te-132   initial containment inventory
  0    <Rb-88    initial containment inventory
  0    <Cs-135   initial containment inventory
  0    <Cs-138   initial containment inventory
  0    <I-129    initial containment inventory
  0    <I-129    initial containment inventory
  0    <I-129    initial containment inventory
  3.47     <I-131    ci/hour leaked into containment
  3.47     <I-131    ci/hour leaked into containment
  3.47     <I-131    ci/hour leaked into containment
  0.974    <I-132    ci/hour leaked into containment
  0.974    <I-132    ci/hour leaked into containment
```

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Project or DCP/MMP DCP 2&3 6926.01SJ   Calc. No. N-0720-014

Subject Control Room and Offsite Doses Should CPIS, CRIS, and FHIS Fail   Sheet 193 of 252

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
0	Mark Drucker	8/15/97	T. Remick	8/18/97						

```
   0.974   <I-132   ci/hour leaked into containment
   4.28    <I-133   ci/hour leaked into containment
   4.28    <I-133   ci/hour leaked into containment
   4.28    <I-133   ci/hour leaked into containment
   0.426   <I-134   ci/hour leaked into containment
   0.426   <I-134   ci/hour leaked into containment
   0.426   <I-134   ci/hour leaked into containment
   1.89    <I-135   ci/hour leaked into containment
   1.89    <I-135   ci/hour leaked into containment
   1.89    <I-135   ci/hour leaked into containment
   0       <Kr-83m  ci/hour leaked into containment
   0.379   <Kr-85m  ci/hour leaked into containment
   1.66    <Kr-85   ci/hour leaked into containment
   0.178   <Kr-87   ci/hour leaked into containment
   0.574   <Kr-88   ci/hour leaked into containment
   0.385   <Xe-131m ci/hour leaked into containment
   0       <Xe-133m ci/hour leaked into containment
  52.8     <Xe-133  ci/hour leaked into containment
   0.178   <Xe-135m ci/hour leaked into containment
   1.64    <Xe-135  ci/hour leaked into containment
   0.0901  <Xe-138  ci/hour leaked into containment
   0.494   <H-3     ci/hour leaked into containment
   0.00641 <Br-84   ci/hour leaked into containment
   0.00804 <Te-129  ci/hour leaked into containment
   0.104   <Te-132  ci/hour leaked into containment
   0.655   <Rb-88   ci/hour leaked into containment
   0       <Cs-135  ci/hour leaked into containment
   0       <Cs-138  ci/hour leaked into containment
   0       <I-129   ci/hour leaked into containment
   0       <I-129   ci/hour leaked into containment
   0       <I-129   ci/hour leaked into containment
 2.305E+06
   2  1  2201.6  0
     0   0   0   0   100   100   100   100   100   0   0
  -1,0,0,0
  -1,0,0,0
           1    7.9000E-04
  266920  0  5820  29885  5820
     0   0   0   0   0   0   0   0   0   0   0
     0   0   0   0   0   0   0   0   0   0   0
 0.50000E+00 1.00000E+00  1  1  1  1
   0  0  0
  -1,0,0,0
  -1,0,0,0
           0    7.900000E-04
 1.00000E+00 2.00000E+00  1  1  1  1
   0  0  0
  -1,0,0,0
  -1,0,0,0
           0    7.900000E-04
 2.00000E+00 4.00000E+00  1  1  1  1
   0  0  0
  -1,0,0,0
  -1,0,0,0
           0    7.900000E-04
 4.00000E+00 8.00000E+00  1  1  1  1
   0  0  0
  -1,0,0,0
  -1,0,0,0
           0    7.900000E-04
 8.00000E+00 2.40000E+01  1  1  1  1
```

```
  0  0  0
 -1,0,0,0
 -1,0,0,0
            0    4.600000E-04
2.40000E+01 9.60000E+01  1  1  1  1
  0  0  0
  2  1  2200.8  0
     0    0    0    0   100   100   100   100   100   0   0
 -1,0,0,0
 -1,0,0,0
            0    2.500000E-04
9.60000E+01 7.20000E+02  1  1  1  1
  0  0  0
 -1,0,0,0
 -1,0,0,0
            0    6.250000E-05
```

C6.9.2 RCS Leak LOCADOSE Dose Input File (sb1_720.di)

```
1.0 gpm SBLOCA w/o isolat'n, Minipurge in Operation, I-spike
MARK DRUCKER
SONGS UNITS 2&3
sb1_720.di
N-0720-14  0
           1
DORDOFDRRDRO
  2  5  4  3  1  0  0
REM REM/HR
  3.6000E-06  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
  3.4700E-04  0.0000E+00  0.0000E+00  0.0000E+00
  9.2400E-07  9.2400E-07  6.0300E-07  3.6500E-07  3.2800E-07
  3.4700E-04  3.4700E-04  1.7500E-04  2.3200E-04
  2.0000E+00  8.0000E+00  2.4000E+01  9.6000E+01  7.2000E+02
  2.0000E+00  8.0000E+00  2.4000E+01  7.2000E+02
  1.0000E+00  1.0000E+00
  1.0000E+00  1.0000E+00  1.0000E+00
  3.4700E-04
  1.0000E+00  0.6000E+00  0.4000E+00
  3.4700E-04
  2.4000E+01  9.6000E+01  7.2000E+02
  7.2000E+02
  1.0000E+00  1.0000E+00
```

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Subject Control Room and Offsite Doses Should CPIS, CRIS, and FHIS Fail   Sheet 195 of 252

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	Mark Drucker	8/15/97	T. Remick	8/18/97					

C6.9.3 RCS Leak LOCADOSE Dose Output Input File (sb1_720.do)

```
Bechtel Standard Computer Program       LOCADOSE, NE319  Version 3.0
(c) 1989 SCE AIX Version. 2 Feb 1995            Calc No. N-0720-14 Rev No.   0
Originator MARK DRUCKER           Date  7 Aug 1997
Project SONGS UNITS 2&3       Job No. sb1_720.di          Sheet No.    7
Subject 1.0 gpm SBLOCA w/o isolat'n, Minipurge in Operation, I-spike
==========================================================================

NE319 Dose Rate Within Regions Summary

         Dose rates in REM/HR for region  3 Cont Room

           Time        Thyroid      Lung         Bone       Beta Skin    Whole Body
           (hr)

         0.000E+00    0.000E+00   0.000E+00   0.000E+00   0.000E+00   0.000E+00
         5.000E-01    1.324E-02   2.020E-04   3.353E-05   9.727E-06   1.102E-06
         1.000E+00    4.334E-02   6.593E-04   1.094E-04   3.140E-05   3.429E-06
         2.000E+00    1.223E-01   1.852E-03   3.065E-04   8.429E-05   8.787E-06
         4.000E+00    2.855E-01   4.289E-03   7.073E-04   1.786E-04   1.769E-05
         8.000E+00    5.526E-01   8.205E-03   1.344E-03   3.072E-04   2.831E-05
         2.400E+01    6.230E-01   9.029E-03   1.446E-03   2.837E-04   2.300E-05
         9.600E+01    3.505E-01   4.944E-03   7.641E-04   1.340E-04   9.435E-06
         7.200E+02    2.976E-02   4.163E-04   6.358E-05   1.127E-05   5.806E-07
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0	Mark Drucker	8/15/97	T. Remick	8/18/97					

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Bechtel Standard Computer Program        LOCADOSE, NE319  Version 3.0
(c) 1989 SCE AIX Version. 2 Feb 1995              Calc No. N-0720-14 Rev No.   0
Originator MARK DRUCKER           Date  7 Aug 1997
Project SONGS UNITS 2&3        Job No. sb1_720.di            Sheet No.   10
Subject 1.0 gpm SBLOCA w/o isolat'n, Minipurge in Operation, I-spike
==========================================================================
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NE319 Doses Within Regions Summary

Doses in REM for region 3 Cont Room

Time Interval (hr) From	to	Thyroid	Lung	Bone	Beta Skin	Whole Body
0.0000E+00	- .5000	2.331E-03	3.555E-05	5.905E-06	1.712E-06	1.956E-07
.5000	- 1.000	1.368E-02	2.083E-04	3.456E-05	9.986E-06	1.105E-06
1.000	- 2.000	8.173E-02	1.240E-03	2.054E-04	5.757E-05	6.101E-06
2.000	- 4.000	4.099E-01	6.177E-03	1.020E-03	2.679E-04	2.698E-05
4.000	- 8.000	1.701E+00	2.538E-02	4.169E-03	9.904E-04	9.385E-05
8.000	- 24.00	8.144E+00	1.189E-01	1.919E-02	3.928E-03	3.314E-04
24.00	- 96.00	1.513E+01	2.143E-01	3.333E-02	5.962E-03	4.310E-04
96.00	- 720.0	7.900E+00	1.106E-01	1.690E-02	2.989E-03	1.585E-04
	Total	3.338E+01	4.768E-01	7.485E-02	1.421E-02	1.049E-03

```
Bechtel Standard Computer Program        LOCADOSE, NE319  Version 3.0
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Originator MARK DRUCKER           Date  7 Aug 1997
Project SONGS UNITS 2&3        Job No. sb1_720.di            Sheet No.   11
Subject 1.0 gpm SBLOCA w/o isolat'n, Minipurge in Operation, I-spike
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NE319 Doses Within Regions Summary

Cumulative doses in REM for region 3 Cont Room

Time (hr)	Thyroid	Lung	Bone	Beta Skin	Whole Body
5.000E-01	2.331E-03	3.555E-05	5.905E-06	1.712E-06	1.956E-07
1.000E+00	1.601E-02	2.438E-04	4.046E-05	1.170E-05	1.301E-06
2.000E+00	9.774E-02	1.484E-03	2.459E-04	6.926E-05	7.402E-06
4.000E+00	5.076E-01	7.661E-03	1.266E-03	3.371E-04	3.438E-05
8.000E+00	2.209E+00	3.304E-02	5.435E-03	1.328E-03	1.282E-04
2.400E+01	1.035E+01	1.519E-01	2.462E-02	5.255E-03	4.596E-04
9.600E+01	2.548E+01	3.662E-01	5.795E-02	1.122E-02	8.906E-04
7.200E+02	3.338E+01	4.768E-01	7.485E-02	1.421E-02	1.049E-03

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REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	Mark Drucker	8/15/97	T. Remick	8/18/97					

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Bechtel Standard Computer Program       LOCADOSE, NE319  Version 3.0
(c) 1989 SCE AIX Version. 2 Feb 1995           Calc No. N-0720-14 Rev No.   0
Originator MARK DRUCKER           Date  7 Aug 1997
Project SONGS UNITS 2&3        Job No. sb1_720.di           Sheet No.   12
Subject 1.0 gpm SBLOCA w/o isolat'n, Minipurge in Operation, I-spike
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NE319 Offsite Dose Rate Summary

Dose rates in REM/HR for distance 1

Time (hr)	Thyroid	Lung	Bone	Beta Skin	Whole Body
0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
5.000E-01	2.261E-04	3.448E-06	5.728E-07	1.603E-07	3.239E-07
1.000E+00	4.434E-04	6.743E-06	1.119E-06	3.035E-07	5.987E-07
2.000E+00	8.530E-04	1.291E-05	2.139E-06	5.533E-07	1.047E-06
4.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
8.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2.400E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
9.600E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
7.200E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

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Bechtel Standard Computer Program       LOCADOSE, NE319  Version 3.0
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Originator MARK DRUCKER           Date  7 Aug 1997
Project SONGS UNITS 2&3        Job No. sb1_720.di           Sheet No.   13
Subject 1.0 gpm SBLOCA w/o isolat'n, Minipurge in Operation, I-spike
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NE319 Offsite Dose Rate Summary

Dose rates in REM/HR for distance 2

Time (hr)	Thyroid	Lung	Bone	Beta Skin	Whole Body
0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
5.000E-01	5.803E-05	[illegible]850E-07	1.470E-07	4.113E-08	8.315E-08
1.000E+00	1.138E-04	[illegible]31E-06	2.872E-07	7.791E-08	1.537E-07
2.000E+00	2.189E-04	[illegible].314E-06	5.489E-07	1.420E-07	2.687E-07
4.000E+00	4.060E-04	6.098E-06	1.006E-06	2.437E-07	4.319E-07
8.000E+00	7.026E-04	1.044E-05	1.710E-06	3.825E-07	6.212E-07
2.400E+01	4.195E-04	6.084E-06	9.752E-07	3.800E-07	5.338E-07
9.600E+01	3.434E-04	4.845E-06	7.490E-07	1.970E-07	2.398E-07
7.200E+02	1.047E-04	1.465E-06	2.237E-07	5.940E-08	5.289E-08

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0	Mark Drucker	8/15/97	T. Remick	8/18/97						

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Originator MARK DRUCKER Date 7 Aug 1997
Project SONGS UNITS 2&3 Job No. sb1_720.di Sheet No. 14
Subject 1.0 gpm SBLOCA w/o isolat'n, Minipurge in Operation, I-spike

NE319 Offsite Dose Summary

Doses in REM for distance 1

Time Interval (hr) From	to	Thyroid	Lung	Bone	Beta Skin	Whole Body
0.0000E+00	.5000	5.684E-05	8.673E-07	1.441E-07	4.053E-08	8.226E-08
.5000	1.000	1.677E-04	2.553E-06	4.238E-07	1.163E-07	2.315E-07
1.000	2.000	6.505E-04	9.863E-06	1.635E-06	4.304E-07	8.272E-07
2.000	4.000	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
4.000	8.000	0.000E+00	0.000E+00	0.000E+00	0.000E+C0	0.000E+00
8.000	24.00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
24.00	96.00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
96.00	720.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
	Total	8.750E-04	1.328E-05	2.203E-06	5.872E-07	1.141E-06

Bechtel Standard Computer Program LOCADOSE, NE319 Version 3.0
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Originator MARK DRUCKER Date 7 Aug 1997
Project SONGS UNITS 2&3 Job No. sb1_720.di Sheet No. 15
Subject 1.0 gpm SBLOCA w/o isolat'n, Minipurge in Operation, I-spike

NE319 Offsite Dose Summary

Cumulative doses in REM for distance 1

Time (hr)	Thyroid	Lung	Bone	Beta Skin	Whole Body
5.000E-01	5.684E-05	8.673E-07	1.441E-07	4.053E-08	8.226E-08
1.000E+00	2.245E-04	3.420E-06	5.679E-07	1.568E-07	3.138E-07
2.000E+00	8.750E-04	1.328E-05	2.203E-06	5.872E-07	1.141E-06
4.000E+00	8.750E-04	1.328E-05	2.203E-06	5.872E-07	1.141E-06
8.000E+00	8.750E-04	1.328E-05	2.203E-06	5.872E-07	1.141E-06
2.400E+01	8.750E-04	1.328E-05	2.203E-06	5.872E-07	1.141E-06
9.600E+01	8.750E-04	1.328E-05	2.203E-06	5.872E-07	1.141E-06
7.200E+02	8.750E-04	1.328E-05	2.203E-06	5.872E-07	1.141E-06

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0	Mark Drucker	8/15/97	T. R .mick	8/18/97					

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Originator MARK DRUCKER          Date  7 Aug 1997
Project SONGS UNITS 2&3        Job No. sb1_720.di          Sheet No.   16
Subject 1.0 gpm SBLOCA w/o isolat'n, Minipurge in Operation, I-spike
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NE319 Offsite Dose Summary

Doses in REM for distance 2

Time Interval (hr) From	to	Thyroid	Lung	Bone	Beta Skin	Whole Body
0.0000E+00	- .5000	1.459E-05	2.226E-07	3.699E-08	1.040E-08	2.111E-08
.5000	- 1.000	4.304E-05	6.552E-07	1.088E-07	2.984E-08	5.942E-08
1.000	- 2.000	1.670E-04	2.532E-06	4.196E-07	1.105E-07	2.123E-07
2.000	- 4.000	6.290E-04	9.476E-06	1.566E-06	3.886E-07	7.062E-07
4.000	- 8.000	2.243E-03	3.345E-05	5.496E-06	1.264E-06	2.120E-06
8.000	- 24.00	5.450E-03	7.957E-05	1.284E-05	5.177E-06	7.560E-06
24.00	- 96.00	2.450E-02	3.471E-04	5.397E-05	1.446E-05	1.802E-05
96.00	- 720.0	6.863E-02	9.605E-04	1.468E-04	3.890E-05	3.551E-05
	Total	1.017E-01	1.433E-03	2.212E-04	6.033E-05	6.421E-05

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Bechtel Standard Computer Program        LOCADOSE, NE319  Version 3.0
(c) 1989 SCE AIX Version. 2 Feb 1995            Calc No. N-0720-14 Rev No.   0
Originator MARK DRUCKER          Date  7 Aug 1997
Project SONGS UNITS 2&3        Job No. sb1_720.di          Sheet No.   17
Subject 1.0 gpm SBLOCA w/o isolat'n, Minipurge in Operation, I-spike
==========================================================================
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NE319 Offsite Dose Summary

Cumulative doses in REM for distance 2

Time (hr)	Thyroid	Lung	Bone	Beta Skin	Whole Body
5.000E-01	1.459E-05	2.226E-07	3.699E-08	1.040E-08	2.111E-08
1.000E+00	5.763E-05	8.778E-07	1.458E-07	4.025E-08	8.053E-08
2.000E+00	2.246E-04	3.409E-06	5.654E-07	1.507E-07	2.928E-07
4.000E+00	8.536E-04	1.289E-05	2.131E-06	5.393E-07	9.990E-07
8.000E+00	3.096E-03	4.634E-05	7.628E-06	1.803E-06	3.119E-06
2.400E+01	8.547E-03	1.259E-04	2.047E-05	6.980E-06	1.068E-05
9.600E+01	3.305E-02	4.730E-04	7.444E-05	2.144E-05	2.870E-05
7.200E+02	1.017E-01	1.433E-03	2.212E-04	6.033E-05	6.421E-05

APPENDIX D FHA in FHB

D1.0 FHA in FHB METHODOLOGY

Following a Fuel Handling Accident (FHA) in the Fuel Handling Building (FHB), activity is released into the Spent Fuel Pool, and then disperses into the FHB atmosphere, and from there to the Control Room, EAB and LPZ.

The immersion and inhalation doses are due to the airborne cloud at the EAB and LPZ and the cloud inside the Control Room. The LOCADOSE dose calculation program will be run using the appropriate assumptions and design inputs from Sections 3 and 4 to calculate the immersion and inhalation doses in the CR and at the EAB and LPZ. Figures D-1 and D-2 show the LOCADOSE models used. The figures relate to each other as follows:

1. Figure D-1 represents the initial configuration.

2. Figure D-2 represents the configuration once the CR HVAC system has been placed into the high radiation isolation mode.

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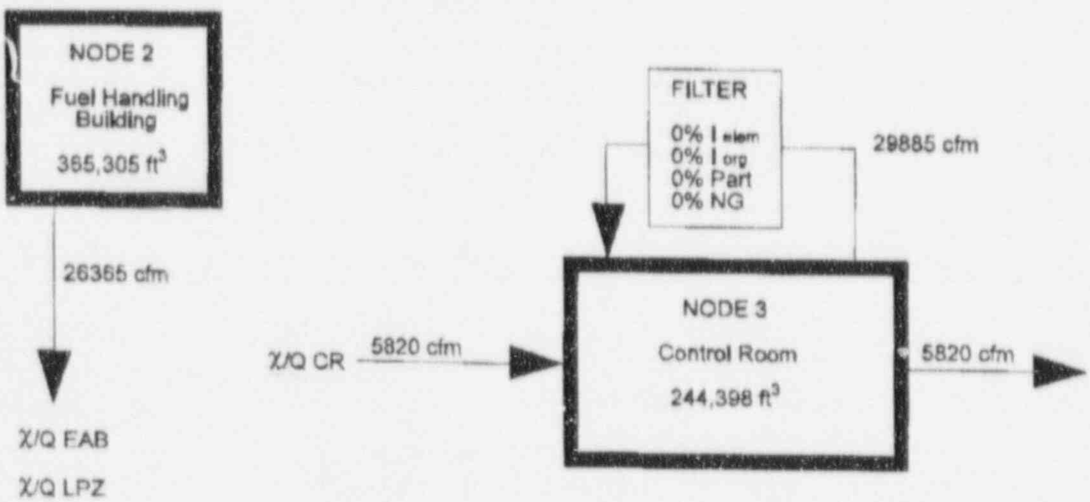
0	Mark Drucker	8/15/97	T. Remick	8/18/97						

D2.0 FHA in FHB LOCADOSE MODEL

Figure D-1

FHA in FHB LOCADOSE Model
CR HVAC In Normal Mode, FHB HVAC In Normal Mode



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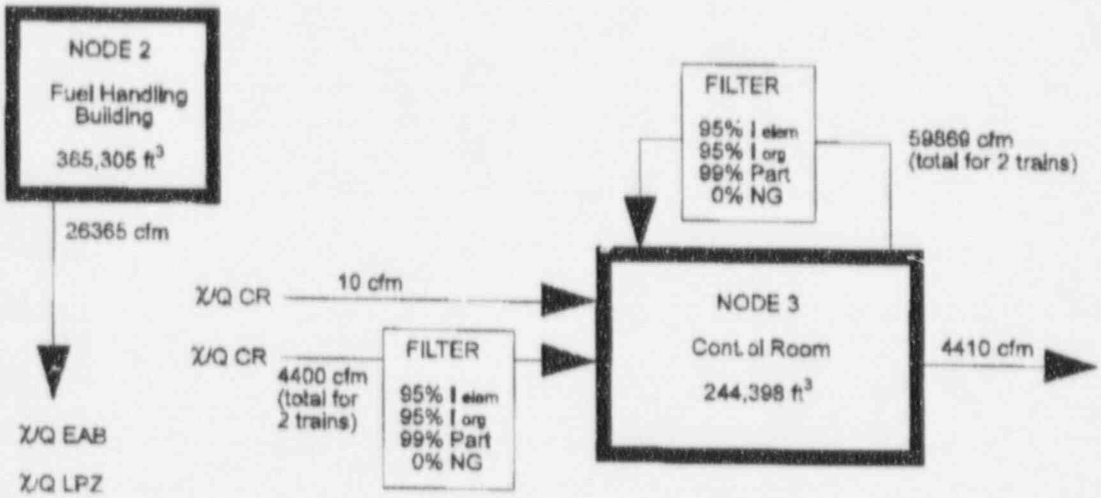
0	Mark Drucker	8/15/97	T. Remick	8/18/97					

Figure D-2

FHA in FHB LOCADOSE Model
2 Trains of CR HVAC In High Radiation Isolation Mode, FHB HVAC In Normal Mode



REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	Mark Drucker	8/15/97	T. Remick	8/18/97					

D3.0 FHA in FHB ASSUMPTIONS

D3.1 In accordance with Regulatory Guide 1.25 (Reference 6.4e), it is assumed that the fuel has at least 72 hours of decay prior to the accident. This time is based on Licensee Control Specification 3.9.101 (References 6.4j and 6.4k). Regulatory Guide 1.25 Section C.1.a states that the accident will be assumed to occur at a time after shutdown identified by the Technical Specifications as the earliest time irradiated fuel handling operations may begin.

D3.2 In accordance with Regulatory Guide 1.25 Section C.1.i, all of the radioactive material in the FHB atmosphere is assumed to be released to the environment over a 2 hour interval.

D3.3 Manual operator action is assumed to occur at 30 minutes to place the Control Room HVAC in the high radiation isolation mode. Because personnel must be in the FHB moving fuel for the FHA to occur, it is reasonable to assume that the Control Room receives prompt notification of the accident. The chosen interval allows adequate time for the personnel to stop fuel movement and exit the FHB prior to notifying the Control Room.

D3.4 Per Regulatory Guide 1.25 position C.1.f, elemental and particulate iodine are indistinguishable, and treated only as inorganic iodine. Treating the particulate iodine as elemental iodine is conservative, since the CR recirculation filter is more efficient at removing particulate iodine.

D3.5 The atmospheric dispersion factors for Containment releases (given in Design Input 4.5) are assumed to apply to FHB releases also. The normal FHB HVAC discharges to the Continuous Exhaust Plenum, which is the discharge point for containment leakage into most of the plant buildings. Use of the Containment χ/Q is reasonable, since the FHB is essentially adjacent to the Containment. For the EAB and LPZ, this means that the distance to the EAB and LPZ, and the terrain features, are very similar. For the Control Room, the FHB is further away from the outside air makeup (per drawings 41358 and 41366, References 6.2m and 6.2n), making the distance, and terrain features, conservative with respect to the Containment.

D3.6 This analysis does not take any credit for FHB Post Accident Cleanup Units S2(3)-1504-M-E370 or E371.

D4.0 FHA in FHB DESIGN INPUTS

D4.1 CE letters S-CE-2666 (Reference 6.3a) and S-CE-3068 (Reference 6.3e) provide the gap activity released from one fuel pin during an FHA (with a peaking factor of 1.65 and 72 hours of decay after reactor shutdown). To account for operating with fuel discharge burnup extended from 33 GWD/T to 60 GWD/T, Calculation N-4097-013 (Reference 6.1u) determined activity change factors to be used to account for the change in burnup. In the table below, the CE activities are adjusted by the N-4097-013 Table 8.1-1 change factor. Where the change factor is less than 1.0, no changes were made to the CE inventory. In accordance with N-4097-013 page 8, a change factor of 1 was used for Xe-133m (with its 2.19 day half-life). The daughter isotopes of the CE inventory (as determined by the LOCADOSE Code library file) are listed with a zero initial activity.

ISOTOPE	N-4097-013 Change Factor	S-CE-3068 Inventory (Ci/Peak Rod)	Adjusted Inventory (Ci/Peak Rod)
I-131	1.00	2.10e+02	2.10e+02
I-133	0.98	5.56e+01	5.56e+01
I-135	0.98	3.47e-01	3.47e-01
KR-85	2.00	1.46e+01	2.92e+01
XE131M	1.00	3.58e+00	3.58e+00
XE-133	0.98	5.12e+02	5.12e+02
XE133M	1.00	1.07e+01	1.07e+01
XE-135	1.10	6.63e+00	7.29e+00
XE135M	1.00	0.00e+00	0.00e+00
CS-135	2.00	0.00e+00	0.00e+00

D4.2 The FHB HVAC parameters during normal operation are as follows:

Parameter	FHB Normal Operation	
	Value	Reference
Filtered Intake	0 cfm	40090 (Ref. 6.2c)
Unfiltered Intake (includes infiltration)	26,365 cfm	40090 (Ref. 6.2c)
Exhaust Rate	26,365 cfm	40090 (Ref 6.2c)
Filtered Recirculation	0 cfm	40090 (Ref. 6.2c)
Unfiltered Recirculation	0 cfm	40090 (Ref. 6.2c)

D4.3 The FHB volume served by the normal FHB HVAC system is 365,305 ft^3 per Calculation M-0076-001 sheet 5 (Reference 6.1d).

D4.4 Per Section C.1.h of Regulatory Guide 1.25 (Reference 6.4e), the noble gas activity released to the Spent Fuel Pool is not subject to clean-up due to pool scrubbing. The retention of noble gases in the pool is negligible (i.e., a decontamination factor of one). For iodine, the iodine being released from the fuel pin gap space is assumed to be 99.75% particulate and elemental, and 0.25% organic per Regulatory Guide 1.25 sections C.1.f and C.1.g. The SFP decontamination factor for elemental/particulate iodine is 1/133, and 1 for organic iodine. These values are based on having 23 feet of water above the top of the fuel.

D4.5 This calculation will model 236 fuel rods in a fuel bundle assembly per drawing SO23-990-164 (Reference 6.2p).

D4.6 Per S-CE-2666 (Reference 6.3a) no more than all of the fuel pins in four rows parallel to one assembly face (corresponding to 60 pins) are damaged.

D5.0 FHA in FHB COMPUTATIONS

D5.1 Spent Fuel Pool Iodine Removal

As discussed in Design Input D4.4, the iodine gap activity released to the spent fuel pool water is subject to clean-up due to pool scrubbing. Regulatory Guide 1.25 gives pool decontamination factors for situations where there is at least 23 feet of water above the rods. Per Technical Specification LCO 3.7.16 (References 6.4h and 6.4i), the Spent Fuel Pool water level above the spent fuel stored in the fuel racks must be greater than or equal to 23 feet during fuel movement. Per CE letter S-CE-2666 (Reference 6.3a) the release occurs after the dropped bundle has hit the fuel pool floor. Since this means that the top of the bundle is below the top of the stored fuel, at least 23 feet of water are above the damaged bundle. Therefore, this calculation may take credit for iodine removal by the spent fuel pool.

Per Design Input D4.4, the activity profile modeled assumes that the iodine gap inventory of Design Input D4.1 is composed of 99.75 percent inorganic species (i.e., elemental and particulate iodine), and 0.25 percent organic species (i.e., organic iodide). Per Regulatory Guide 1.25, the pool decontamination factors for the inorganic iodine and organic iodide species are 133 and 1, respectively. Per Assumption D3.4, particulate iodine will be treated as elemental iodine. This results in the following iodine activity inventories becoming airborne in the FHB:

Iodine Species	Initial Pin Gap Inventory (Ci)	Fraction of Total Iodine	Decontamination Factor for SFP	Airborne Activity (Ci)
	A	B	C	A × B ÷ C
I-131 elemental	210	0.9975	133	1.575
I-131 organic	210	0.0025	1	0.525
I-133 elemental	55.6	0.9975	133	0.417
I-133 organic	55.6	0.0025	1	0.139
I-135 elemental	0.347	0.9975	133	0.0026025
I-135 organic	0.347	0.0025	1	0.0008675

As a sample calculation, the I-131 elemental airborne activity is:

$$\frac{210\ Ci \times 0.9975}{133} = 1.575\ Ci$$

D5.2 FHB Exhaust Flowrate

As discussed in Assumption D3.2, the analysis should assume that all of the radioactivity is released from the FHB over a 2 hour interval (120 minutes). The FHB exhaust flowrate (per Design Input D4.2), and the FHB volume (per Design Input D4.3) result in removing all but the following amount of the activity in the 2 hour period of interest:

$$\frac{Activity_{time\ t}}{Activity_{Initial}} = \frac{Activity_{Initial} \times e^{-\lambda \times t}}{Activity_{Initial}} = e^{-\lambda \times t}$$

$$\lambda = \frac{FHB\ Flowrate}{FHB\ Volume} = \frac{26{,}365\ ft^3/min}{365{,}305\ ft^3}$$

$$\lambda = 0.0722\ min^{-1}$$

$$\frac{Activity_{2\ hr}}{Activity_{Initial}} = e^{(-0.0722\ min^{-1}) \times (120\ min)} = 0.0002,\ or\ 0.02\%$$

Based on engineering judgement, the impact of not removing 0.02% of the FHB activity within the 2 hours will have negligible impact on the resulting doses. Use of the normal FHB HVAC exhaust flow rate in the analysis will meet the Regulatory Guide 1.25 2 hour removal requirement.

D5.3 FHA in FHB LOCADOSE Code Time Steps

The time steps entered into the LOCADOSE Code were chosen to model the times at which parameters important to the analysis are changed (e.g., HVAC changes). While the accident ends at 2 hours per Regulatory Guide 1.25, the analysis will go until 8 hours to ensure that all of the activity is removed from the FHB (due to the exponential equation used in determining the FHB exhaust flowrate in Section D5.2). This also ensures that the activity entering the Control Room has had sufficient time to either be exhausted back to the environment, decayed, or be removed by the CR EAC recirculation filters.

Time After Reactor Shutdown	LOCADOSE Time Step (hours)	Significance of the Time Step
0	N/A	Reactor shutdown
3 days	0 hrs	Beginning of FHA
3 days + 30 min	0.5 hr	Control Room HVAC manually isolated
3 days + 2 hrs	2 hrs	End of EAB analysis
3 days + 8 hrs	8 hrs	End of analysis

D5.5 FHA in FHB Dose Results

The number of fuel pins that fail is per Assumption D4.6. The doses for a single failed pin are from Section D6.5. The Control Room whole body doses are doubled per Assumption 3.7.

FHA - CR and FHB HVAC in Normal Operation at Start of FHA, CR Isolates at 30 Minutes			
Location	Single Pin Dose (Rem)	Total Dose	
		Pins Failed	Dose (Rem)
CR:			
Thyroid	3.406E-01	60	20.4
Beta Skin	6.508E-03	60	0.4
Whole Body	2.798E-04	60	<0.1
EAB:			
Thyroid	4.090E-03	60	0.2
Beta Skin	2.562E-05	60	<0.1
Whole Body	1.999E-05	60	<0.1
LPZ:			
Thyroid	1.050E-03	60	0.1
Beta Skin	6.577E-06	60	<0.1
Whole Body	5.133E-06	60	<0.1

EC&FS DEPARTMENT

CALCULATION SHEET

ICCN NO./ PRELIM. CCN NO.	PAGE ___ OF ___
	CCN CONVERSION: CCN NO. CCN --

Project or DCP/MMP DCP 2&3 6926.01SJ Calc. No. N-0720-014

Subject Control Room and Offsite Doses Should CPIS, CRIS, and FHIS Fail

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
0	Mark Drucker	8/15/97	T. Remick	8/18/97						

D6.0 FHA in FHB COMPUTER FILES

D6.1 FHA in FHB LOCADOSE Library File (fha_fhb.lib)

```
Version 1.0   Thyroid    Lung       Bone   Beta Skin Whole Body
I--131 2.508E+04 9.976E-07 1.490E+06 2.073E+04 3.150E+03 3.170E-02 8.720E-02  1
1 11  0  0  0  0  0
 1.100E-02 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00  1 1.817E-01 3.789E-01
I--131 2.508E+04 9.976E-07 1.490E+06 2.073E+04 3.150E+03 3.170E-02 8.720E-02  2
1 11  0  0  0  0  0
 1.100E-02 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00  2 1.817E-01 3.789E-01
I--131 2.508E+04 9.976E-07 1.490E+06 2.073E+04 3.150E+03 3.170E-02 8.720E-02  3
1 11  0  0  0  0  0
 1.100E-02 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00  3 1.817E-01 3.789E-01
I--133 5.622E+04 9.211E-06 2.690E+05 5.064E+03 1.080E+03 7.350E-02 1.550E-01  1
2 13 12  0  0  0  0
 9.710E-01 2.900E-02 0.000E+00 0.000E+00 0.000E+00 0.000E+00  4 4.067E-01 6.047E-01
I--133 5.622E+04 9.211E-06 2.690E+05 5.064E+03 1.080E+03 7.350E-02 1.550E-01  2
2 13 12  0  0  0  0
 9.710E-01 2.900E-02 0.000E+00 0.000E+00 0.000E+00 0.000E+00  5 4.067E-01 6.047E-01
I--133 5.622E+04 9.211E-06 2.690E+05 5.064E+03 1.080E+03 7.350E-02 1.550E-01  3
2 13 12  0  0  0  0
 9.710E-01 2.900E-02 0.000E+00 0.000E+00 0.000E+00 0.000E+00  6 4.067E-01 6.047E-01
I--135 5.103E+04 2.912E-05 5.600E+04 1.971E+03 3.350E+02 1.290E-01 4.210E-01  1
2 14 15  0  0  0  0
 8.450E-01 1.550E-01 0.000E+00 0.000E+00 0.000E+00 0.000E+00  7 3.691E-01 1.617E+00
I--135 5.103E+04 2.912E-05 5.600E+04 1.971E+03 3.350E+02 1.290E-01 4.210E-01  2
2 14 15  0  0  0  0
 8.450E-01 1.550E-01 0.000E+00 0.000E+00 0.000E+00 0.000E+00  8 3.691E-01 1.617E+00
I--135 5.103E+04 2.912E-05 5.600E+04 1.971E+03 3.350E+02 1.290E-01 4.210E-01  3
2 14 15  0  0  0  0
 8.450E-01 1.550E-01 0.000E+00 0.000E+00 0.000E+00 0.000E+00  9 3.691E-01 1.617E+00
KR--85 4.102E+02 2.054E-09 0.000E+00 2.410E+00 0.000E+00 4.246E-02 5.102E-04  4
0  0  0  0  0  0  0
 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 10 2.505E-01 2.236E-03
XE131M 2.595E+02 6.815E-07 0.000E+00 1.400E+00 0.000E+00 1.508E-02 2.899E-03  4
0  0  0  0  0  0  0
 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 11 0.000E+00 3.116E-03
XE133M 1.384E+03 3.663E-06 0.000E+00 1.890E+00 0.000E+00 3.150E-02 7.954E-03  4
1 13  0  0  0  0  0
 1.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 12 0.000E+00 2.332E-02
XE-133 5.622E+04 1.528E-06 0.000E+00 1.570E+00 0.000E+00 9.697E-03 9.316E-03  4
0  0  0  0  0  0  0
 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 13 1.004E-01 2.997E-02
XE-135 5.363E+04 2.115E-05 0.000E+00 4.050E+00 0.000E+00 5.894E-02 5.736E-02  4
1 16  0  0  0  0  0
 1.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 15 3.028E-01 2.466E-01
XE135M 0.000E+00 7.380E-04 0.000E+00 2.220E+00 0.000E+00 2.253E-02 9.887E-02  4
1 14  0  0  0  0  0
 1.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 14 3.000E-01 4.266E-01
CS-135 0.000E+00 7.449E-15 7.480E+03 1.570E+03 1.460E+04 2.730E-03 0.000E+00  5
0  0  0  0  0  0  0
 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 16 5.630E-02 0.000E+00
```

D6.2 FHA in FHB LOCADOSE Activity Transport Input File (fha_fhb.ti)

```
FHA In Fuel Bldg, CR Isolated at 30 minutes
Tom Remick
SONGS UNITS 2&3
fha_fhb.ti
N-720-013  0
           1
   1   3  16   1   1   0
 0 0  0.00000E+00  0.00000E+00  2  0  0
CFM  CUFT CURIES
   1   1   1   1   1   1   1   1   1   1   1
       1   1   0
FUEL BLDG
 0.00000E+00 0.5E+00  1  1  1  1
  1  0  1
1.575      <I-131 elemental
0.525      <I-131 organic
0          <I-131 particulate
0.417      <I-133 elemental
0.139      <I-133 organic
0          <I-133 particulate
0.0026025 <I-135 elemental
0.0008675 <I-135 organic
0          <I-135 particulate
29.2       <Kr-85
3.58       <Xe-131m
10.7       <Xe-133m
512        <Xe-133
7.29       <Xe-135
0          <Xe-135m
0          <Cs-135
365305
  2  1  0  26365
     0   0   0   0   0   0   0   0   0   0   0
 -1,0,0,0
 -1,0,0,0
           1    7.900000E-04
 244398  0  5820  29885  5820
     0   0   0   0   0   0   0   0   0   0   0
     0   0   0   0   0   0   0   0   0   0   0
 0.5E+00 2.00000E+00  1  1  1  1
  0  0  0
 -1,0,0,0
 -1,0,0,0
           1    7.900000E-04
 244398  4400  10  59869  4410
    95  95  99   0  99  99  99  99  99   0   0
    95  95  99   0  99  99  99  99  99   0   0
2.00000E+00 8.00000E+00  1  1  1  0
  0  0  0
 -1,0,0,0
 -1,0,0,0
           0    7.900000E-04
```

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	Mark Drucker	8/15/97	T. Remick	8/18/97					

D6.3 FHA in FHB LOCADOSE Dose Calculation Input File (fha_fhb.di)

```
FHA In Fuel Bldg, CR Isolated at 30 minutes
Tom Remick
SONGS UNITS 2&3
fha_fhb.di
N-720-013  0
           1
DCRDOF
   2   2   1   1   1   0   0
REM  REM/HR
  3.6000E-06  0.0000E+00
  3.4700E-04
  9.2400E-07  9.2400E-07
  3.4700E-04
  2.0000E+00  5.0000E+00
  8.0000E+00
  1.0000E+00  1.0000E+00
  1.0000E+00
  3.4700E-04
  1.0000E+00
  3.4700E-04
  8.0000E+00
  8.0000E+00
  1.0000E+00  1.0000E+00
```

D6.4 FHA in FHB LOCADOSE Activity Transport Output File (fha_fhb.to)

As this is not a design basis calculation, no output file is included.

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	Mark Drucker	8/15/97	T. Remick	8/18/97					

D6.5 FHA in FHB LOCADOSE Dose Calculation Output File (fha_fhb.do)

```
Bechtel Standard Computer Program        LOCADOSE, NE319  Version 3.0
(c) 1989 SCE AIX Version. 2 Feb 1995                 Calc No. N-720-013 Rev No.   0
Originator Tom Remick              Date  9 Sep 1996
Project SONGS UNITS 2&3       Job No. fha_fhb.di           Sheet No.    8
Subject FHA In Fuel Bldg, CR Isolated at 30 minutes
=============================================================================

NE319 Doses Within Regions Summary

          Doses in REM for region  3 Cont Room

          Time Interval (hr)        Thyroid     Lung       Bone      Beta Skin   Whole Body
            From        to
          0.0000E+00- .5000        2.926E-01  4.219E-03  6.437E-04  1.832E-03  8.074E-05
           .5000      - 2.000      4.799E-02  8.494E-04  1.056E-04  3.727E-03  1.589E-04
           2.000      - 8.000      8.117E-07  4.374E-05  1.782E-09  9.488E-04  4.020E-05
                       Total       3.406E-01  5.112E-03  7.493E-04  6.508E-03  2.798E-04

Bechtel Standard Computer Program        LOCADOSE, NE319  Version 3.0
(c) 1989 SCE AIX Version. 2 Feb 1995                 Calc No. N-720-013 Rev No.   0
Originator Tom Remick              Date  9 Sep 1996
Project SONGS UNITS 2&3       Job No. fha_fhb.di           Sheet No.   10
Subject FHA In Fuel Bldg, CR Isolated at 30 minutes
=============================================================================

NE319 Offsite Dose Summary

          Doses in REM for distance  1

          Time Interval (hr)        Thyroid     Lung       Bone      Beta Skin   Whole Body
            From        to
          0.0000E+00- .5000        3.623E-03  5.224E-05  7.973E-06  2.270E-05  1.772E-05
           .5000      - 2.000      4.675E-04  6.740E-06  1.028E-06  2.922E-06  2.278E-06
           2.000      - 8.000      0.000E+00  0.000E+00  0.000E+00  0.000E+00  0.000E+00
                       Total       4.090E-03  5.898E-05  9.001E-06  2.562E-05  1.999E-05

Bechtel Standard Computer Program        LOCADOSE, NE319  Version 3.0
(c) 1989 SCE AIX Version. 2 Feb 1995                 Calc No. N-720-013 Rev No.   0
Originator Tom Remick              Date  9 Sep 1996
Project SONGS UNITS 2&3       Job No. fha_fhb.di           Sheet No.   12
Subject FHA In Fuel Bldg, CR Isolated at 30 minutes
=============================================================================

NE319 Offsite Dose Summary

          Doses in REM for distance  2

          Time Interval (hr)        Thyroid     Lung       Bone      Beta Skin   Whole Body
            From        to
          0.0000E+00- .5000        9.299E-04  1.341E-05  2.046E-06  5.826E-06  4.547E-06
           .5000      - 2.000      1.200E-04  1.730E-06  2.639E-07  7.501E-07  5.848E-07
           2.000      - 8.000      1.802E-07  2.596E-09  3.956E-10  1.122E-09  8.726E-10
                       Total       1.050E-03  1.514E-05  2.311E-06  6.577E-06  5.133E-06
```

APPENDIX E SPENT FUEL POOL GATE DROP

E1.0 SFP GATE DROP METHODOLOGY

Following a Spent Fuel Pool (SFP) gate drop in the Fuel Handling Building (FHB), activity is released into the Spent Fuel Pool, and then disperses into the FHB atmosphere, and from there to the Control Room, EAB and LPZ. The SFP Gate Drop damages 236 fuel pins. This analysis is based on the gate being dropped onto spent fuel with a total of 9 days of decay.

The immersion and inhalation doses are due to the airborne cloud at the EAB and LPZ and the cloud inside the Control Room. The LOCADOSE dose calculation program will be run using the appropriate assumptions and design inputs from Sections 3 and 4 to calculate the immersion and inhalation doses in the CR and at the EAB and LPZ.

E2.0 SFP GATE DROP LOCADOSE MODEL

The Appendix D LOCADOSE model, modified to use the time steps given in Section E5.2, is used for this analysis.

E3.0 SFP GATE DROP ASSUMPTIONS

E3.1 Assumptions D3.1 to D3.6 of Appendix D are used in the analysis of the Spent Fuel Pool gate drop accident.

E3.2 Manual operator action is assumed to occur at 20 minutes to place the Control Room HVAC in the high radiation isolation mode. Because personnel must be in the FHB lifting the gate for the gate drop to occur, it is reasonable to assume that the Control Room receives prompt notification of the accident. The chosen interval allows adequate time for the personnel to exit the FHB prior to notifying the Control Room.

E3.3 A total of 9 days of decay following reactor shutdown are assumed to occur prior to the start of the SFP gate drop accident.

E4.0 SFP GATE DROP DESIGN INPUTS

E4.1 The design inputs of Appendix D are used in the analysis of the Spent Fuel Pool gate drop accident.

E4.2 The design basis Spent Fuel Pool gate drop accident damages all of the 236 fuel pins in one fuel assembly per CCN-2 to Calculation C-259-1.01.11 (Reference 6.1b).

E4.3 To model 9 days of decay prior to the start of the SFP gate drop accident, the LOCADOSE model includes a delay of 144 hours (6 days) prior to the start of the accident. When combined with the 72 hours (3 days) of decay included in the CE source term (Design Input D4.1), a total of 216 hours (9 days) of decay are present prior to the start of the accident.

E4.4 During routine opening and closing of the SFP Gates, the gates slide on a rail system that includes horizontal restraints (Drawing SO23-207-1-78, Reference 6.2o). These restraints preclude the gate from dropping onto stored fuel during routine gate operation. The only time the SFP Gates can actually drop are when the gates are lifted up by a crane.

E5.0 SFP GATE DROP COMPUTATIONS

E5.1 SFP Gate Drop Calculation Method

The analysis for the SFP gate drop uses the same model as the FHA in the FHB (Appendix D), except that the time steps are modified to include a total of 9 days of decay prior to the start of the accident. Refer to Appendix D for the details of the LOCADOSE model.

E5.2 SFP Gate Drop LOCADOSE Code Time Steps

The time steps entered into the LOCADOSE Code were chosen to model the times at which parameters important to the analysis are changed (e.g., HVAC changes). While the accident ends at 146 hours per Regulatory Guide 1.25 (2 hours after the start of the accident), the analysis will go until 152 hours to ensure that all of the activity is removed from the FHB (due to the exponential equation used in determining the FHB exhaust flowrate in Section D5.2). This also ensures that the activity entering the Control Room has had sufficient time to either be exhausted back to the environment, decay, or be removed by the CR EAC recirculation filters.

Time After Reactor Shutdown	LOCADOSE Time Step (hours)	Significance of the Time Step
0	N/A	Reactor shutdown
3 days	0	Start of additional decay beyond the 72 hours used in DI D4.1
9 days	144 hrs	Beginning of SFP gate drop event
9 days + 20 min	144.33 hr	Control Room HVAC manually isolated
9 days + 2 hrs	146 hrs	End of EAB analysis
9 days + 8 hrs	152 hrs	End of analysis

E5.3 SFP Gate Drop Dose Results

The number of fuel pins that fail is per Design Input E4.2. The doses for a single failed pin are from Section E6.5. The Control Room whole body doses are doubled per Assumption 3.7.

SFP Gate Drop at 9 Days of Decay, CR Isolates at 20 Minutes			
Location	Single Pin Dose (Rem)	Total Dose	
		Pins Failed	Dose (Rem)
CR:			
Thyroid	1.237E-01	236	29.2
Beta Skin	3.357E-03	236	0.8
Whole Body	1.175E-04	236	0.1
EAB:			
Thyroid	2.330E-03	236	0.6
Beta Skin	1.309E-05	236	<0.01
Whole Body	8.366E-06	236	<0.01
LPZ:			
Thyroid	5.981E-04	236	0.1
Beta Skin	3.359E-06	236	<0.01
Whole Body	2.148E-06	236	<0.01

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	CCN CONVERSION: CCN NO. CCN –

Project or DCP/MMP DCP 2&3 6926.01SJ Calc. No. N-0720-014

Subject Control Room and Offsite Doses Should CPIS, CRIS, and FHIS Fail Sheet 217 of 252

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
0	Mark Drucker	8/15/97	T. Remick	8/18/97						

E6.0 SFP GATE DROP COMPUTER FILES

E6.1 SFP Gate Drop LOCADOSE Library File (gatedrop.lib)

```
Version 1.0   Thyroid    Lung       Bone    Beta Skin Whole Body
I--131 2.508E+04 9.976E-07 1.490E+06 2.073E+04 3.150E+03 3.170E-02 8.720E-02  1
1 11  0  0  0  0  0
 1.100E-02 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00  1 1.817E-01 3.789E-01
I--131 2.508E+04 9.976E-07 1.490E+06 2.073E+04 3.150E+03 3.170E-02 8.720E-02  2
1 11  0  0  0  0  0
 1.100E-02 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00  2 1.817E-01 3.789E-01
I--131 2.508E+04 9.976E-07 1.490E+06 2.073E+04 3.150E+03 3.170E-02 8.720E-02  3
1 11  0  0  0  0  0
 1.100E-02 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00  3 1.817E-01 3.789E-01
I--133 5.622E+04 9.211E-06 2.690E+05 5.064E+03 1.080E+03 7.350E-02 1.550E-01  1
2 13 12  0  0  0  0
 9.710E-01 2.900E-02 0.000E+00 0.000E+00 0.000E+00 0.000E+00  4 4.067E-01 6.047E-01
I--133 5.622E+04 9.211E-06 2.690E+05 5.064E+03 1.080E+03 7.350E-02 1.550E-01  2
2 13 12  0  0  0  0
 9.710E-01 2.900E-02 0.000E+00 0.000E+00 0.000E+00 0.000E+00  5 4.067E-01 6.047E-01
I--133 5.622E+04 9.211E-06 2.690E+05 5.064E+03 1.080E+03 7.350E-02 1.550E-01  3
2 13 12  0  0  0  0
 9.710E-01 2.900E-02 0.000E+00 0.000E+00 0.000E+00 0.000E+00  6 4.067E-01 6.047E-01
I--135 5.103E+04 2.912E-05 5.600E+04 1.971E+03 3.350E+02 1.290E-01 4.210E-01  1
2 14 15  0  0  0  0
 8.450E-01 1.550E-01 0.000E+00 0.000E+00 0.000E+00 0.000E+00  7 3.691E-01 1.617E+00
I--135 5.103E+04 2.912E-05 5.600E+04 1.971E+03 3.350E+02 1.290E-01 4.210E-01  2
2 14 15  0  0  0  0
 8.450E-01 1.550E-01 0.000E+00 0.000E+00 0.000E+00 0.000E+00  8 3.691E-01 1.617E+00
I--135 5.103E+04 2.912E-05 5.600E+04 1.971E+03 3.350E+02 1.290E-01 4.210E-01  3
2 14 15  0  0  0  0
 8.450E-01 1.550E-01 0.000E+00 0.000E+00 0.000E+00 0.000E+00  9 3.691E-01 1.617E+00
KR--85 4.102E+02 2.054E-09 0.000E+00 2.410E+00 0.000E+00 4.246E-0[illegible] 5.102E-04  4
0  0  0  0  0  0  0
 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 10 2.505E-01 2.236E-03
XE131M 2.595E+02 6.815E-07 0.000E+00 1.400E+00 0.000E+00 1.508E-02 2.899E-03  4
0  0  0  0  0  0  0
 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 11 0.000E+00 3.116E-03
XE133M 1.384E+03 3.663E-06 0.000E+00 1.890E+00 0.000E+00 3.150E-02 7.954E-[illegible]  4
1 13  0  0  0  0  0
 1.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 12 0.000E+00 2.332E-02
XE-133 5.622E+04 1.528E-06 0.000E+00 1.570E+00 0.000E+00 9.697E-03 9.316E-03  4
0  0  0  0  0  0  0
 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 13 1.004E-01 2.997E-02
XE-135 5.363E+04 2.115E-05 0.000E+00 4.050E+00 0.000E+00 5.[illegible]94E-02 5.736E-02  4
1 16  0  0  0  0  0
 1.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 15 3.028E-01 2.466E-01
XE135M 0.000E+00 7.380E-04 0.000E+00 2.220E+00 0.000E+00 2.253E-02 9.807E-02  4
1 14  0  0  0  0  0
 1.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 14 3.000E-01 4.266E-01
CS-135 0.000E+00 7.449E-15 7.480E+03 1.570E+03 1.460E+04 2.730E-03 0.000E+00  5
0  0  0  0  0  0  0
 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 16 5.[illegible]0E-02 0.000E+00
```

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0	Mark Drucker	8/15/97	T. Remick	8/18/97					

E6.2 SFP Gate Drop LOCADOSE Activity Transport Input File (gatedrop.ti)

```
SFP Gate Drop @ 9 Days, CR Isol @ 20 minutes
Tom Remick
SONGS UNITS 2&3
gatedrop.ti
N-720-013  0
            1
   1    4  16   1    1    0
 0 0   0.00000E+00   0.00000E+00   2  0  0
CFM   CUFT  CURIES
   1    1    1    1    1    1    1    1    1    1    1
          1    1    0
FUEL BLDG
 0 144   1   1   1   1
  1  0  1
1.575       <I-131 elemental
0.525       <I-131 organic
0           <I-131 particulate
0.417       <I-133 elemental
0.139       <I-133 organic
0           <I-133 particulate
0.0026025  <I-135 elemental
0.0008675  <I-135 organic
0           <I-135 particulate
29.2        <Kr-85
3.58        <Xe-131m
10.7        <Xe-133m
512         <Xe-133
7.29        <Xe-135
0           <Xe-135m
0           <Cs-135
365305
  2  1  0  0
     0    0    0    0    0    0    0    0    0    0    0
 -1,0,0,0
 -1,0,0,0
            1      7.900000E-04
244398  0  5820   29885   5820
     0    0    0    0    0    0    0    0    0    0    0
     0    0    0    0    0    0    0    0    0    0    0
144  144.33   1   1   1   1
 0  0  0
 2  1  0   26365
     0    0    0    0    0    0    0    0    0    0    0
 -1,0,0,0
 -1,0,0,0
            0      7.900000E-04
144.33 146   1   1   1   1
 0  0  0
 -1,0,0,0
 -1,0,0,0
            1      7.900000E-04
244398  4400   10   59869   4410
   95   95   99    0   99   99   99   99   99    0    0
   95   95   99    0   99   99   99   99   99    0    0
146  152   1   1   1   0
 0  0  0
 -1,0,0,0
 -1,0,0,0
```

```
          0    7.900000E-04
```

E6.3 SFP Gate Drop LOCADOSE Dose Calculation Input File (gatedrop.di)

```
SFP Gate Drop @ 9 Days, CR Isol @ 20 minutes
Tom Remick
SONGS UNITS 2&3
gatedrop.di
N-720-013  0
           1
DORDOF
   2   2   1   1   1   0   0
REM  REM/HR
  3.600E-06  0.0000E+00
  3.4700E-04
  9.2400E-07  9.2400E-07
  3.4700E-04
  146  152
  152
  1.0000E+00  1.0000E+00
  1.0000E+00
  3.4700E-04
  1.0000E+00
  3.4700E-04
  152
  152
  1.0000E+00  1.0000E+00
```

E6.4 SFP Gate Drop LOCADOSE Activity Transport Output File (gatedrop.to)

As this is not a design basis calculation, no output file is included.

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	Mark Drucker	8/15/97	T. Remick	8/18/97					

E6.5 SFP Gate Drop LOCADOSE Dose Calculation Output File (gatedrop.do)

Bechtel Standard Computer Program   LOCADOSE, NE319 Version 3.0
(c) 1989 SCE AIX Version. 2 Feb 1995   Calc No. N-720-013 Rev No. 0
Originator Tom Remick   Date 9 Sep 1996
Project SONGS UNITS 2&3   Job No. gatedrop.di   Sheet No. 8
Subject SFP Gate Drop @ 9 Days, CR Isol @ 20 minutes
==

NE319 Doses Within Regions Summary

Doses in REM for region 3 Cont Room

Time Interval (hr) From	to	Thyroid	Lung	Bone	Beta Skin	Whole Body
0.0000E+00-	144.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
144.0	- 144.3	9.542E-02	1.351E-03	2.018E-04	5.360E-04	1.935E-05
144.3	- 146.0	2.831E-02	4.935E-04	5.988E-05	2.326E-03	8.100E-05
146.0	- 152.0	4.635E-07	2.120E-05	9.804E-10	4.957E-04	1.716E-05
	Total	1.237E-01	1.865E-03	2.617E-04	3.357E-03	1.175E-04

Bechtel Standard Computer Program   LOCADOSE, NE319 Version 3.0
(c) 1989 SCE AIX Version. 2 Feb 1995   Calc No. N-720-013 Rev No. 0
Originator Tom Remick   Date 9 Sep 1996
Project SONGS UNITS 2&3   Job No. gatedrop.di   Sheet No. 10
Subject SFP Gate Drop @ 9 Days, CR Isol @ 20 minutes
==

NE319 Offsite Dose Summary

Doses in REM for distance 1

Time Interval (hr) From	to	Thyroid	Lung	Bone	Beta Skin	Whole Body
0.0000E+00-	144.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
144.0	- 144.3	1.773E-03	2.509E-05	3.750E-06	9.957E-06	6.366E-06
144.3	- 146.0	5.571E-04	7.885E-06	1.178E-06	3.129E-06	1.999E-06
146.0	- 152.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
	Total	2.330E-03	3.297E-05	4.928E-06	1.30[illegible]E-05	8.366E-06

Bechtel Standard Computer Program   LOCADOSE, NE319 Version 3.0
(c) 1989 SCE AIX Version. 2 Feb 1995   Calc No. N-720-013 Rev No. 0
Originator Tom Remick   Date 9 Sep 1996
Project SONGS UNITS 2&3   Job No. gatedrop.di   Sheet No. 12
Subject SFP Gate Drop @ 9 Days, CR Isol @ 20 minutes
==

NE319 Offsite Dose Summary

Doses in REM for distance [illegible]

Time Interval (hr) From	to	Thyroid	Lung	Bone	Beta Skin	Whole Body
0.0000E+00-	144.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
144.0	- 144.3	4.550E-04	6.440E-06	9.624E-07	2.556E-06	[illegible]534E-06
144.3	- 146.0	1.430E-04	2.024E-06	3.025E-07	8.031E-07	5.132E-07
146.0	- 152.0	1.029E-07	1.456E-09	2.176E-10	5.778E-10	3.681E-10
	Total	5.981E-04	8.465E-06	1.265E-06	3.359E-06	2.148E-06

APPENDIX F INCREASED MAIN STEAM FLOW w/SAF

F1.0 IMSF w/SAF METHODOLOGY

Following an Increased Main Steam Flow with a Single Active Failure (IMSF w/SAF) there are three main radioactive material release mechanisms. First, the reactor transient results in opening the Main Steam Safety Valves (MSSVs), resulting in the release of secondary side activity to the atmosphere. Second, the process of cooling down the reactor results in the release of secondary side activity to the atmosphere through the Atmospheric Dump Valves (ADV) as the assumed loss of power makes the condenser unavailable. Third, steam generator tube leakage is assumed to be at the design basis value of 1 gpm, resulting in the reactor coolant leakage being released from the secondary side to the atmosphere with the flow through the MSSVs or ADVs. The released radioactive material is dispersed into the atmosphere, and from there to the Control Room, EAB and LPZ.

The immersion and inhalation doses are due to the airborne cloud at the EAB and LPZ and the cloud inside the Control Room. The LOCADOSE dose calculation program will be run using the appropriate assumptions and design inputs from Sections 3 and 4 to calculate the immersion and inhalation doses in the CR and at the EAB and LPZ. Figures F-1 and F-2 show the LOCADOSE models used.

1. Figure F-1 represents the initial configuration.

2. Figure F-2 represents the configuration once the CR HVAC system has been placed into the high radiation isolation mode.

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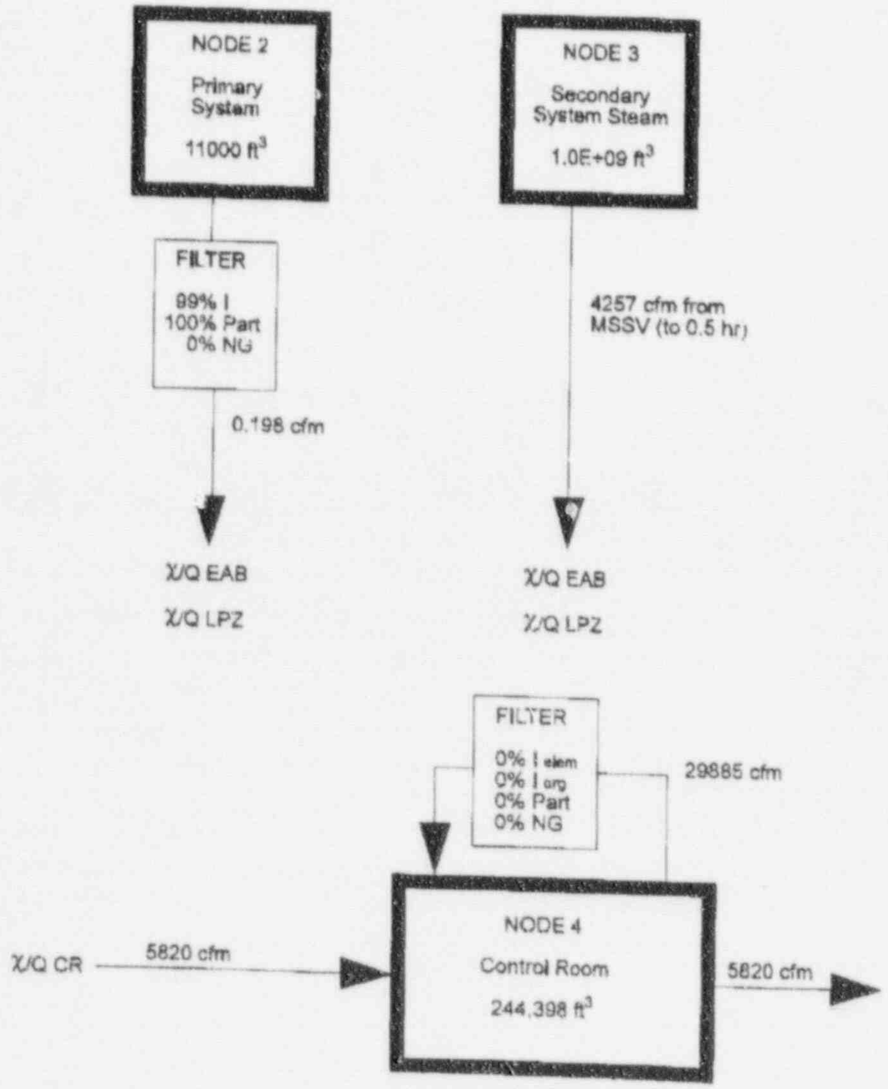
REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	Mark Drucker	8/15/97	T. Remick	8/18/97					

F2.0 IMSF w/SAF LOCADOSE MODEL

Figure F-1

IMSF w/SAF LOCADOSE Model
CR HVAC In Normal Mode



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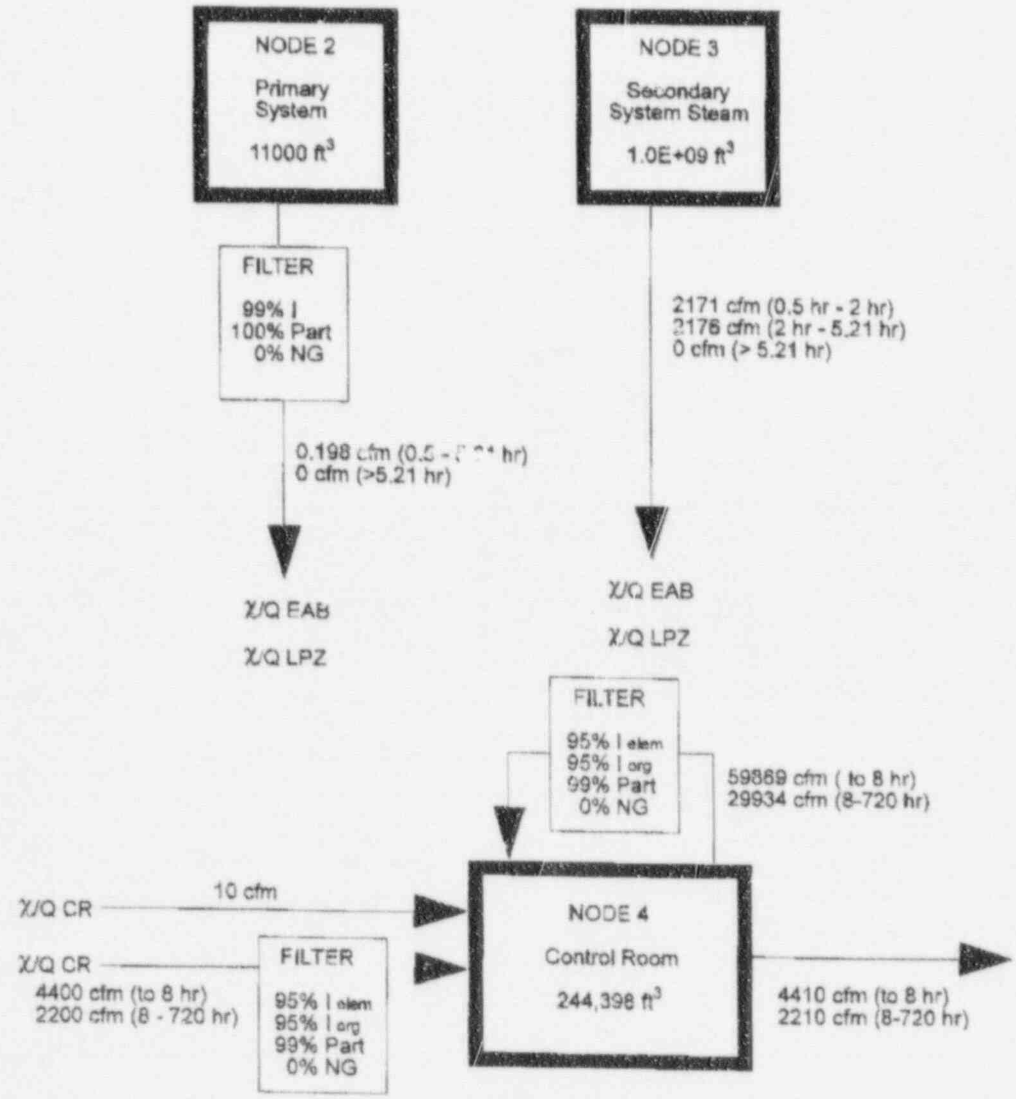
0	Mark Drucker	8/15/97	T. Remick	8/18/97						

Figure F-2

IMSF w/SAF LOCADOSE Model
CR HVAC In High Radiation Isolation Mode



F3.0 IMSF w/SAF ASSUMPTIONS

F3.1 No specific cooldown mass release information after 2 hours is provided for an IMSF w/SAF in calculation 1370-TS-004 (Reference 6.7q). The mass releases from an Inadvertent Opening of a Steam Generator Atmospheric Dump Valve with a Single Failure (IOSGADV/SAF) will be used to provide a reasonable approximation of the cooldown mass releases. The IOSGADV/SAF has a cooldown duration of 16,950 seconds (283 minutes or 4.71 hours) and a total secondary steam mass release of 1,155,300 lbm (from S-CE-3379, Reference 6.3g; with the data from pages 67 and 69 of calculation 1370-DT-003, Reference 6.7j). For conservatism, a cooldown duration of 283 minutes and a cooldown secondary system mass release of 1,200,000 lbm will be used in this analysis.

Per Design Input F4.2 the 30 minute to 2 hour ADV cooldown mass release is 381,010 lbm. Therefore, the cooldown mass release after 2 hours is:

$$\textit{Cooldown Mass Release}_{2\,hr\,to\,end} = 1{,}200{,}000\ lbm - 381{,}010\ lbm = 818{,}990\ lbm$$

F3.2 No specific information regarding the amount of activity present in the fuel rod gap is available. Therefore, the gap activity of 10% iodine, 30% Kr-85, and 10% for the remaining noble gases specified in Regulatory Guide 1.25 (Reference 6.4e) will be used for this analysis.

F3.3 For conservatism, a pre-existing reactor coolant iodine spike of 60 μCi/gm Dose Equivalent I-131 will be assumed to be present at the start of the accident.

F3.4 Manual operator action to place the Control Room HVAC system into the high radiation isolation mode is assumed to occur at 30 minutes.

F4.0 IMSFw/SAF DESIGN INPUTS

F4.1 This calculation will be analyzed for 25% failed fuel. This conservatively bounds the 18.4% failed fuel calculated in Calculation A-SG2-FE-0081 (Reference 6.7c, Section 4.1). This value is consistent with the failed fuel percentage used in calculation A-SG2-FE-0100 (Reference 6.7h).

F4.2 Per Calculation 1370-TS-004 (Reference 6.7q) the secondary side steam releases are:

0 to 30 minute MSSV release:	249,040 lbm
30 minute to 2 hour ADV release:	381,010 lbm

F5.0 IMSF w/SAF COMPUTATIONS

F5.1 Primary System Activity Inventory

The activity present in the primary system has two sources. The first source is the activity released from the failed fuel (Design Input F4.1) and the second is the normal reactor coolant activity (per Design Inputs 4.13 and 4.14) with an iodine spike (per Assumption F3.3). Per Section 5.3.3, the failed fuel activity release to the RCS is:

$$\textit{Release to RCS} = \textit{Core Inventory (Ci)} \times \textit{Gap Activity Fraction} \times \textit{Failed Fuel Fraction} \times \textit{Peaking Factor}$$

IMSF w/SAF RCS ACTIVITY							
	A	B	C	D	E=AxBxCxD	F	G=E+F
Isotope	DI 4.16 Core Inventory (Ci)	Assumption F3.2 Gap Fraction	DI F4.1 Failed Fuel Fraction	DI 4.18 Peaking Factor	Activity From Failed Fuel (Ci)	DI 4.13/4.14 Normal RCS Activity (Ci)	Total RCS Activity (Ci)
I-131	9.520e+07	0.1	0.25	1.73	4.117e+06	10,100	4.127e+06
I-132	1.372e+08				5.934e+06	2840	5.937e+06
I-133	1.927e+08				8.334e+06	12,500	8.347e+06
I-134	2.135e+08				9.234e+06	1250	9.235e+06
I-135	1.800e+08				7.785e+06	5510	7.791e+06
Kr-83m	1.341e+07				5.800e+05	N/A	5.800e+05
Kr-85m	2.987e+07				1.292e+06	520	1.293e+06
Kr-85	1.144e+06	0.3	0.25	1.73	1.484e+05	2270	1.507e+05
Kr-87	5.874e+07	0.1	0.25	1.73	2.541e+06	244	2.541e+06
Kr-88	8.301e+07				3.590e+06	788	3.591e+06
Xe-131m	1.067e+06				4.615e+04	529	4.668e+04
Xe-133m	6.002e+06				2.596e+05	N/A	2.596e+05
Xe-133	1.877e+08				8.118e+06	72,400	8.190e+06
Xe-135m	3.809e+07				1.647e+06	244	1.647e+06
Xe-135	5.710e+07				2.470e+06	2250	2.472e+06
Xe-138	1.663e+08				7.192e+06	124	7.192e+06
H-3	N/A	0	0.25	1.73	0	678	678
Br-84	N/A				0	8.80	8.80
Te-129	N/A				0	11.0	11.0
Te-132	N/A				0	142	142

F5.2 Primary Coolant Releases

The primary to secondary leakage will be assumed as going directly from the RCS to the environment at 0.198 cfm per Design Input 4.11. A filter (99% effective for iodine, 100% effective for particulates, 0% for noble gases) will be used on this flow path, to model the steam generator iodine partition coefficient of 0.01 (per Assumption 3.5).

F5.3 Secondary Side MSSV Release

Per Design Input F4.2, the MSSV release for the first 30 minutes is:

$$MSSV\ flow\ rate = \frac{249{,}040\ lbm}{30\ minutes} \times \frac{ft^3}{1.95\ lbm} = 4257\ cfm$$

F5.4 Secondary Side ADV Releases

Per Design Input F4.2, the ADV release for 30 minutes to 2 hours is:

$$ADV\ flow\ rate_{0.5\ to\ 2\ hours} = \frac{381{,}010\ lbm}{(120\ minutes - 30\ minutes)} \times \frac{ft^3}{1.95\ lbm} = 2171\ cfm$$

Per Assumption F3.1 the steam release from the secondary side during the remainder of the cooldown (283 minute total duration less the 90 minutes of cooldown that occur prior to 2 hours) is 818,990 lbm. This is a flow rate of:

$$ADV\ flow\ rate_{2\ hours\ to\ end} = \frac{818{,}990\ lbm}{(283\ minutes - 90\ minutes)} \times \frac{ft^3}{1.95\ lbm} = 2176\ cfm$$

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0	Mark Drucker	8/15/97	T. Remick	8/18/97					

R E V ⇓

F5.5 IMSF w/SAF LOCADOSE Code Time Steps

The time steps entered into the LOCADOSE Code were chosen to model the times at which parameters important to the analysis are changed (e.g., HVAC changes, secondary system release changes). The analysis will be done for a duration of 30 days.

Time Step (hours after start of event)	Significance of the Time Step
0 hrs	Beginning of IMSF w/SAF Start of MSSV release
0.5 hr (1800 seconds)	End of MSSV release Control Room HVAC manually transferred to high radiation isolation mode Initiate plant cooldown, start of ADV and AFW releases from secondary side
2 hr	End of EAB dose analysis
5.21 hr	Shutdown cooling in service, ADV closed and AFW secured (also stopping the release path for the primary to secondary leakage) (4.71 hr + 0.5 hr = 5.21 hr)
8 hr	Control Room HVAC placed in single train operation CR χ/Q changes LPZ χ/Q changes LPZ breathing rate changes
24 hr	CR occupancy factor changes CR χ/Q changes LPZ χ/Q changes LPZ breathing rate changes
96 hr	CR occupancy factor changes CR χ/Q changes LPZ χ/Q changes
720 hr	End of analysis

F5.6 IMSF w/SAF Dose Results

Per Section F6.5, the dose consequences of this accident are as follows. The Control Room whole body doses are doubled per Assumption 3.7.

Increase in Main Steam Flow w/SAF, CR Isolated at 30 Minutes	
Location	Dose (Rem)
CR:	
Thyroid	5.1
Beta Skin	3.7
Whole Body	0.7
EAB:	
Thyroid	0.2
Beta Skin	<0.1
Whole Body	<0.1
LPZ:	
Thyroid	0.2
Beta Skin	<0.1
Whole Body	<0.1

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Subject Control Room and Offsite Doses Should CPIS, CRIS, and FHIS Fail Sheet 230 of 252

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	Mark Drucker	8/15/97	T. Remick	8/18/97					

F6.0 IMSF w/SAF COMPUTER FILES

F6.1 IMSF w/SAF LOCADOSE Library File (imsf.lib)

```
Version 1.0   Thyroid    Lung       Bone   Beta Skin Whole Body
I--131 2.508E+04 9.976E-07 1.490E+06 2.073E+04 3.150E+03 3.170E-02 8.720E-02  1
1 21  0  0  0  0  0
 1.100E-02 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00  1 1.817E-01 3.789E-01
I--131 2.508E+04 9.976E-07 1.490E+06 2.073E+04 3.150E+03 3.170E-02 8.720E-02  2
1 21  0  0  0  0  0
 1.100E-02 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00  2 1.817E-01 3.789E-01
I--131 2.508E+04 9.976E-07 1.490E+06 2.073E+04 3.150E+03 3.170E-02 8.720E-02  3
1 21  0  0  0  0  0
 1.100E-02 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00  3 1.817E-01 3.789E-01
I--132 3.806E+04 8.425E-05 1.430E+04 8.879E+02 1.450E+02 1.320E-01 5.130E-01  1
0  0  0  0  0  0  0
 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 34 4.824E-01 3.559E+00
I--132 3.806E+04 8.425E-05 1.430E+04 8.879E+02 1.450E+02 1.320E-01 5.130E-01  2
0  0  0  0  0  0  0
 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 35 4.824E-01 3.559E+00
I--132 3.806E+04 8.425E-05 1.430E+04 8.879E+02 1.450E+02 1.320E-01 5.130E-01  3
0  0  0  0  0  0  0
 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 36 4.824E-01 3.559E+00
I--133 5.622E+04 9.211E-06 2.690E+05 5.064E+03 1.080E+03 7.350E-02 1.550E-01  1
2 23 22  0  0  0  0
 9.710E-01 2.900E-02 0.000E+00 0.000E+00 0.000E+00 0.000E+00  4 4.067E-01 6.047E-01
I--133 5.622E+04 9.211E-06 2.690E+05 5.064E+03 1.080E+03 7.350E-02 1.550E-01  2
2 23 22  0  0  0  0
 9.710E-01 2.900E-02 0.000E+00 0.000E+00 0.000E+00 0.000E+00  5 4.067E-01 6.047E-01
I--133 5.622E+04 9.211E-06 2.690E+05 5.064E+03 1.080E+03 7.350E-02 1.550E-01  3
2 23 22  0  0  0  0
 9.710E-01 2.900E-02 0.000E+00 0.000E+00 0.000E+00 0.000E+00  6 4.067E-01 6.047E-01
I--134 6.575E+04 2.200E-04 3.730E+03 3.627E+02 8.050E+01 9.230E-02 5.320E-01  1
0  0  0  0  0  0  0
 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00  7 6.052E-01 2.620E+00
I--134 6.575E+04 2.200E-04 3.730E+03 3.627E+02 8.050E+01 9.230E-02 5.320E-01  2
0  0  0  0  0  0  0
 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00  8 6.052E-01 2.620E+00
I--134 6.575E+04 2.200E-04 3.730E+03 3.627E+02 8.050E+01 9.230E-02 5.320E-01  3
0  0  0  0  0  0  0
 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00  9 6.052E-01 2.620E+00
I--135 5.103E+04 2.912E-05 5.600E+04 1.971E+03 3.350E+02 1.290E-01 4.210E-01  1
2 25 24  0  0  0  0
 8.450E-01 1.550E-01 0.000E+00 0.000E+00 0.000E+00 0.000E+00 10 3.691E-01 1.617E+00
I--135 5.103E+04 2.912E-05 5.600E+04 1.971E+03 3.350E+02 1.290E-01 4.210E-01  2
2 25 24  0  0  0  0
 8.450E-01 1.550E-01 0.000E+00 0.000E+00 0.000E+00 0.000E+00 11 3.691E-01 1.617E+00
I--135 5.103E+04 2.912E-05 5.600E+04 1.971E+03 3.350E+02 1.290E-01 4.210E-01  3
2 25 24  0  0  0  0
 8.450E-01 1.550E-01 0.000E+00 0.000E+00 0.000E+00 0.000E+00 12 3.691E-01 1.617E+00
KR-83M 4.152E+03 1.052E-04 0.000E+00 5.190E-01 0.000E+00 0.000E+00 2.396E-06  4
0  0  0  0  0  0  0
 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 13 0.000E+00 4.610E-04
KR-85M 1.297E+04 4.297E-05 0.000E+00 2.910E+00 0.000E+00 4.626E-02 3.708E-02  4
1 18  0  0  0  0  0
 2.100E-01 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 14 2.902E-01 1.610E-01
KR--85 4.102E+02 2.054E-09 0.000E+00 2.410E+00 0.000E+00 4.246E-02 5.102E-04  4
0  0  0  0  0  0  0
 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 15 2.505E-01 2.236E-03
```

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
0	Mark Drucker	8/15/97	T. Remick	8/18/97						

```
KR--87 2.335E+04 1.514E-04 0.000E+00 [illegible].530E+01 0.000E+00 3.083E-01 1.876E-01  4
0  0  0  0  0  0  0
 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 16 1.324E+00 8.032E-01
KR--88 3.200E+04 6.731E-05 0.000E+00 3.130E+01 0.000E+00 7.510E-02 4.658E-01  4
1 31  0  0  0  0  0
 1.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 17 3.587E-01 1.981E+00
XE131M 2.595E+02 6.815E-07 0.000E+00 1.400E+00 0.000E+00 1.508E-02 2.899E-03  4
0  0  0  0  0  0  0
 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 18 0.000E+00 3.116E-03
XE133M 1.384E+03 3.663E-06 0.000E+00 1.890E+00 0.000E+00 3.150E-02 7.954E-03  4
1 23  0  0  0  0  0
 1.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 19 0.000E+00 2.332E-02
XE-133 5.622E+04 1.528E-06 0.000E+00 1.570E+00 0.000E+00 9.697E-03 9.316E-03  4
0  0  0  0  0  0  0
 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 20 1.004E-01 2.997E-02
XE135M 1.557E+04 7.380E-04 0.000E+00 2.220E+00 0.000E+00 2.253E-02 9.887E-02  4
1 25  0  0  0  0  0
 1.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 21 3.000E-01 4.266E-01
XE-135 5.363E+04 2.115E-05 0.000E+00 4.050E+00 0.000E+00 5.894E-02 5.736E-02  4
1 32  0  0  0  0  0
 1.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 22 3.028E-01 2.466E-01
XE-138 4.775E+04 8.151E-04 0.000E+00 2.440E+01 0.000E+00 1.309E-01 2.798E-01  4
1 33  0  0  0  0  0
 1.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 23 6.140E-[illegible] 1.241E+00
H----3 1.848E+01 1.780E-09 1.580E+02 1.580E+02 5.570E+01 0.000E+00 0.000E+00 10
0  0  0  0  0  0  0
 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+[illegible] 24 5.685E-03 [illegible].000E+00
BR--84 5.394E+03 3.632E-04 0.000E+00 4.675E+02 0.000E+00 [illegible].700E-01 4.480E-0[illegible] 11
0  0  0  0  0  0  0
 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 25 1.230E+00 1.779E+00
TE-129 8.727E+03 1.662E-04 4.870E-03 2.420E+02 6.220E-03 1.010E-01 1.280E-02  6
3 34 35 36  0  0  0
 9.100E-01 4.000E-02 5.000E-02 0.000E+00 0.000E+00 0.000E+00 26 5.224E-01 5.981E-02
TE-132 3.841E+04 2.462E-06 2.370E+01 3.600E+04 3.250E+01 3.060E-03 5.280E-02  6
3  4  5  6  0  0  0
 9.100E-01 4.000E-02 5.000E-02 0.000E+00 0.000E+00 0.000E+00 27 5.940E-02 2.123E-01
RB--88 0.000E+00 6.496E-04 0.000E+00 2.908E+02 0.000E+00 4.790E-01 1.550E-01  5
0  0  0  0  0  0  0
 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 28 2.072E+00 6.365E-01
CS-135 0.000E+00 7.449E-15 7.480E+03 1.570E+03 1.460E+04 2.730E-03 0.000E+00  5
0  0  0  0  0  0  0
 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 29 5.630E-02 0.000E+00
CS-138 0.000E+00 3.587E-04 0.000E+00 6.070E+00 4.140E+01 2.810E-01 5.530E-01  5
0  0  0  0  0  0  0
 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 30 1.218E+00 2.330E+00
I--129 0.000E+00 1.400E-15 5.540E+06 9.015E+04 2.480E+03 3.710E-04 3.024E-03  1
0  0  0  0  0  0  0
 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 31 4.090E-02 2.820E-03
I--129 0.000E+00 1.400E-15 5.540E+06 9.015E+04 2.480E+03 3.710E-04 3.024E-03  2
0  0  0  0  0  0  0
 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 32 4.090E-02 2.820E-03
I--129 0.000E+00 1.400E-15 5.540E+06 9.015E+04 2.480E+03 3.710E-04 3.024E-03  3
0  0  0  0  0  0  0
 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 33 4.090E-02 2.820E-03
```

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Project or DCP/MMP DCP 2&3 6926.01SJ Calc. No. N-0720-014

Subject Control Room and Offsite Doses Should CPIS, CRIS, and FHIS Fail Sheet 232 of 252

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	Mark Drucker	8/15/97	T. Remick	8/18/97					

F6.2 IMSF w/SAF LOCADOSE Activity Transport Input File (imsf.ti)

```
Inc Main Steam Flow w/SAF, CR Isol @ 30 min, I-spike, 25% FF
Tom Remick
SONGS UNITS 2&3
imsf.ti
N-720-013  0
           1
  2   7  36   1   1   0
 0 0  0.00000E+00  0.00000E+00  2  0  0
CFM  CUFT CURIES
   1   1   1   1   1   1   1   1   1   1   1
   0.91 0.04 0.05
RCS       SEC_STEAM
 0.00000E+00 0.5E+00  1  1  1  1
  1  0  1
4.127e+06      720       <I-131
4.127e+06      720       <I-131
4.127e+06      720       <I-131
5.937e+06      136       <I-132
5.937e+06      136       <I-132
5.937e+06      136       <I-132
8.347E+06      847       <I-133
8.347e+06      847       <I-133
8.347e+06      847       <I-13_
9.235e+06      39.2      <I-134
9.235e+06      39.2      <I 134
9.235e+06      39.2      <I-134
7.791e+06      335       <I-135
7.791e+06      335       <I-135
7.791e+06      335       <I-135
5.800e+05      0         <Kr-83m
1.293e+06      72.5      <Kr-85m
1.507e+06      317       <Kr-85
2.541e+06      34.0      <Kr-87
3.591e+06      110       <Kr-88
4.668e+04      73.7      <Xe-131m
2.596e+05      0         <Xe-133m
8.190e+06      10100     <Xe-133
1.647e+06      34        <Xe-135m
2.?72e+06      314       <Xe-135
7.192e+06      17.3      <Xe-138
678            2.64e+06  <H-3
8.80           2.73      <Br-84
11.0           6.75      <Te-129
142            211       <Te-132
0              0             <Rb-88
0              0             <Cs-135
0              0             <Cs-138
0              0             <I-129
0              0             <I-129
0              0             <I-129
11000   1.0E+09
  2  1  0.198  0
      99  99  99   0   100  100  100  100  100  100  100
  3  1  4257  0
      0  0  0   0   100   100   100   100   100  100  100
 -1,0,0,0
 -1,0,0,0
            1    7.900000E-04
```

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Project or DCP/MMP DCP 2&3 6926.01SJ Calc. No. N-0720-014

Subject Control Room and Offsite Doses Should CPIS, CRIS, and FHIS Fail Sheet 233 of 252

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	Mark Drucker	8/15/97	T. Remick	8/18/97					

```
244398  0  5820  29885  5820
    0   0   0   0   0   0   0   0   0   0   0
    0   0   0   0   0   0   0   0   0   0   0
0.5E+00 2.00000E+00  1  1  1  1
  0  0  0
  3  1  2171   0
    0   0   0   0  100   100   100   100   100   100  100
 -1,0,0,0
 -1,0,0,0
          1    7.900000E-04
 244398  4400  10  59869  4410
    95  95  99   0  99  99  99  99  99   0   0
    95  95  99   0  99  99  99  99  99   0   0
2.00000E+00 5.21000E+00  1  1  1  1
  0  0  0
  3  1  2176   0
    0   0   0   0   100   100   100   100   100  0  0
 -1,0,0,0
 -1,0,0,0
          0    7.900000E-04
5.21000E+00 8.00000E+00  1  1  1  1
  0  0  0
   2  1  1.0E-09  0
   100   100   100  100  100  100  100  100  100  100  100
   3  1  1.0E-09  0
   100   100   100  100  100  100  100  100  100  100  100
 -1,0,0,0
 -1,0,0,0
          0    7.900000E-04
8.00000E+00 2.40000E+01  1  1  1  1
  0  0  0
 -1,0,0,0
 -1,0,0,0
          1    4.600000E-04
 244398  220[illegible]  10  29934  2210
    95  95  99   0  99  99  99  99  99   0   0
    95  95  99   0  99  99  99  99  99   0   0
2.40000E+01 9.60000E+01  1  1  1  0
  0  0  0
 -1,0,0,0
 -1,0,0,0
          0    2.500000E-04
9.60000E+01 7.20000E+02  1  1  1  0
  0  0  0
 -1,0,0,0
 -1,0,0,0
          0    6.250000E-05
```

F6.3 IMSF w/SAF LOCADOSE Dose Calculation Input File (imsf.di)

```
Inc Main Steam Flow w/SAF, CR Isol @ 30 min, I-spike, 25% FF
Tom  Remick
SONGS UNITS 2&3
imsf.di
N-720-013 0
1
DORDOF
   2   5   4   3   1   0   0
REM  REM/HR
  3.6000E-06  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
  3.4700E-04  0.0000E+00  0.0000E+00  0.0000E+00
  9.2400E-07  9.2400E-07  6.0300E-07  3.6500E-07  3.2800E-07
  3.4700E-04  3.4700E-04  1.7500E-04  2.3200E-04
  2.0000E+00  8.0000E+00  2.4000E+01  9.6000E+01  7.2000E+02
  2.0000E+00  8.0000E+00  2.4000E+01  7.2000E+02
  1.0000E+00  1.0000E+00
  1.0000E+00  1.0000E+00  1.0000E+00
  3.4700E-04
  1.0000E+00  1.0000E+00  1.0000E+00
  3.4700E-04
  1.0000E+00  0.6000E+00  0.4000E+00
  3.4700E-04
  2.4000E+01  9.6000E+01  7.2000E+02
  7.2000E+02
  1.0000E+00  1.0000E+00  1.0
```

F6.4 IMSF w/SAF LOCADOSE Activity Transport Output File (imsf.to)

As this is not a design basis calculation, no output file is included.

F6.5 IMSF w/SAF LOCADOSE Dose Calculation Output File (imsf.do)

```
Bechtel Standard Computer Program        LOCADOSE, NE319  Version 3.0
 (c) 1989 SCE AIX Version. 2 Feb 1995          Calc No. N-720-013 Rev No.  0
 Originator Tom  Remick            Date 11 Sep 1996
 Project SONGS UNITS 2&3       Job No. imsf.di             Sheet No.   10
 Subject Inc Main Steam Flow w/SAF, CR Isol @ 30 min, I-spike, 25% FF
===============================================================================

 NE319 Doses Within Regions Summary

        Doses in REM for region  4 Cont Room

       Time Interval (hr)        Thyroid      Lung        Bone      Beta Skin   Whole Body
         From         to
       0.0000E+00- .5000       3.768E+00   8.506E-02   1.196E-02   2.820E-01   2.569E-02
        .5000    - 2.000       1.023E+00   9.731E-02   3.440E-03   1.108E+00   1.018E-01
       2.000     - 5.210       3.218E-01   1.726E-01   1.296E-02   1.882E+00   1.693E-01
       5.210     - 8.000       1.849E-02   3.712E-02   4.493E-03   3.820E-01   3.015E-02
       8.000     - 24.00       1.299E-03   3.026E-03   4.580E-04   2.873E-02   1.747E-03
       24.00     - 96.00       1.324E-0[illegible]   1.840E-07   4.667E-08   1.[illegible]5E-06   5.034E-08
       96.00     - 720.0       9.553E-25   1.181E-24   3.368E-25   6.444E-2[illegible]   1.5[illegible]2E-25
                  Total        5.133E+00   3.9[illegible]1E-01   3.332E-02   3.682E+00   [illegible].287E-01
```

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Project or DCP/MMP DCP 2&3 6926.01SJ Calc. No. N-0720-014

Subject Control Room and Offsite Doses Should CPIS, CRIS, and FHIS Fail Sheet 235 of 252

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	Mark Drucker	8/15/97	T. Remick	8/18/97					

R E V ⇓

```
Bechtel Standard Computer Program        LOCADOSE, NE319  Version 3.0
(c) 1989 SCE AIX Version. 2 Feb 1995          Calc No. N-720-013 Rev No.  0
Originator Tom  Remick              Date 11 Sep 1996
Project SONGS UNITS 2&3       Job No. imsf.di             Sheet No.   12
Subject Inc Main Steam Flow w/SAF, CR Isol @ 30 min, I-spike, 25% FF
================================================================================
```

NE319 Offsite Dose Summary

Doses in REM for distance 1

Time Interval (hr) From	to	Thyroid	Lung	Bone	Beta Skin	Whole Body
0.0000E+00	.5000	6.025E-02	1.195E-03	1.751E-04	3.613E-03	6.959E-03
.5000	2.000	1.768E-01	3.198E-03	5.014E-04	6.003E-03	1.148E-02
2.000	5.210	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
5.210	8.000	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
8.000	24.00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
24.00	96.00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
96.00	720.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
	Total	2.370E-01	4.393E-03	6.765E-04	9.617E-03	1.844E-02

```
Bechtel Standard Computer Program        LOCADOSE, NE319  Version 3.0
(c) 1989 SCE AIX Version. 2 Feb 1995          Calc No. N-720-013 Rev No.  0
Originator Tom  Remick              Date 11 Sep 1996
Project SONGS UNITS 2&3       Job No. imsf.di             Sheet No.   14
Subject Inc Main Steam Flow w/SAF, CR Isol @ 30 min, I-spike, 25% FF
================================================================================
```

NE319 Offsite Dose Summary

Doses in REM for distance 2

Time Interval (hr) From	to	Thyroid	Lung	Bone	Beta Skin	Whole Body
0.0000E+00	.5000	1.546E-02	3.066E-04	4.494E-05	9.274E-04	1.786E-03
.5000	2.000	4.537E-02	8.208E-04	1.287E-04	1.541E-03	2.948E-03
2.000	5.210	9.319E-02	1.648E-03	2.747E-04	2.121E-03	3.933E-03
5.210	8.000	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
8.000	24.00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
24.00	96.00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
96.00	720.0	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
	Total	1.540E-01	2.776E-03	4.483E-04	4.589E-03	8.6[illegible]7E-03

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	Mark Drucker	8/15/97	T. Remick	8/18/97					

```
Bechtel Standard Computer Program        LOCADOSE, NE319  Version 3.0
(c) 1989 SCE AIX Version. 2 Feb 1995                  Calc No. N-720-013 Rev No.  0
Originator Tom  Remick              Date 11 Sep 1996
Project SONGS UNITS 2&3       Job No. imsf.di                Sheet No     15
Subject Inc Main Steam Flow w/SAF, CR Isol @ 30 min, I-spike, 25% FF
==========================================================================
```

NE319 Offsite Dose Summary

Cumulative doses in REM for distance 2

Time (hr)	Thyroid	Lung	Bone	Beta Skin	Whole Body
5.000E-01	1.546E-02	3.066E-04	4.494E-05	9.274E-04	1.786E-03
2.000E+00	6.084E-02	1.127E-03	1.736E-04	2.468E-03	4.734E-03
5.210E+00	1.540E-01	2.776E-03	4.483E-04	4.589E-03	8.667E-03
8.000E+00	1.540E-01	2.776E-03	4.483E-04	4.589E-03	8.667E-03
2.400E+01	1.540E-01	2.776E-03	4.483E-04	4.589E-03	8.667E-03
9.600E+01	1.540E-01	2.776E-03	4.483E-04	4.589E-03	8.667E-03
7.200E+02	1.540E-01	2.776E-03	4.483E-04	4.589E-03	8.667E-03

APPENDIX G INADVERTENT OPENING of a SG ADV w/SAF

G1.0 IOSGADV/SAF PURPOSE

The steam generator atmospheric dump valve (ADV) may be inadvertently opened by either a valve failure or operator error. Concurrent with the opening of the ADV, the single active failure (SAF) considered limiting for this accident is the loss of normal AC power. This SAF renders the condenser unavailable and leaves the ADV of the unaffected steam generator as the only means of heat removal by the secondary system, thereby releasing additional steam into the atmosphere.

Per Calculation N-4076-001 (Reference 6.1q, CCN-1, Section A5), the only radioactivity available for release to the environment during the IOSGADV/SAF event is the activity initially present in the steam generator mass, and the activity introduced into the secondary side by primary-to-secondary leakage occurring during the event. All of the activity initially present in the intact and affected steam generators is assumed to be released at time zero. The primary-to-secondary leakage is assumed to occur at 1 gpm for the duration of the IOSGADV/SAF event. The IOSGADV/SAF event is assumed to continue until the Shutdown Cooling System is initiated at 12 hours, thereby terminating the accident.

The objective of this appendix is to calculate the doses from the IOSGADV/SAF at the Exclusion Area Boundary (EAB) and the Low Population Zone (LPZ) as well as inside the Control Room assuming CRIS failure.

G2.0 IOSGADV/SAF RESULTS

The resulting doses are as follows:

	DOSE (Rem)		
	Thyroid	Beta Skin	Whole Body
Exclusion Area Boundary	<0.1	<0.1	<0.1
Low Population Zone	<0.1	<0.1	<0.1
Control Room	14.1	<0.1	<0.1

All doses meet the acceptance criteria of Sections 1.2.1 and 1.2.9.

G3.0 IOSGADV/SAF ASSUMPTIONS

G3.1 Operator Action is assumed within 30 minutes of the initiation of the event to terminate steam releases via the inadvertently opened atmospheric dump valve.

G3.2 Operator Action is assumed at 30 minutes to provide auxiliary feedwater flow to the intact steam generator and to open the atmospheric dump valve of the intact steam generator to facilitate heat removal, as the condenser is unavailable.

G3.3 It is conservatively assumed that 100% of the iodines either introduced via primary-to-secondary leakage or initially present in the secondary side liquid of the intact steam generator will be transported to the secondary side steam, i.e. an iodine partition factor of 1.0.

G3.4 It is conservatively assumed that 100% of the noble gases and tritium present in the intact steam generator liquid will be transported to the secondary side steam, i.e. a partition factor of 1.0 for each.

G3.5 It is conservatively assumed that all iodines, noble gases, and tritium present in the affected steam generator liquid will be transported to the secondary side steam and released via the inadvertently opened atmospheric dump valve (i.e., a partition factor of 1.0 for each).

G3.6 Based on engineering judgement, it is assumed that none of the particulate isotopes present in the liquid of both steam generators (affected and intact) will be transported to the secondary side steam, i.e. a partition factor of 0. This judgement is supported by NUREG-0017 (Reference 6.4m, Section 2.2.15.2), which notes that releases of radioactive particulates from the turbine building are negligible.

G3.7 Per P&IDs 40160A and 40160ASO3 (Reference 6.2v and 6.2w), the auxiliary feedwater pumps, which supply feedwater to the intact steam generator, draw water from the Condensate Storage Tanks. It is assumed that the water in these tanks is free of radioactive contamination. Hence, the only radioactivity available for release to the environment is that initially present in the steam generator secondary side and that introduced into the secondary side via primary-to-secondary leakage during the accident.

G3.8 It is conservatively assumed that the total activity expected to be released over the duration of the accident is released at time zero, i.e. no credit is taken for decay.

G4.0 IOSGADV/SAF DESIGN INPUTS

G4.1 Per Calculation N-5000-002 (Reference 6.1x, page 5), it is anticipated that the reactor coolant temperature will have decreased to 350°F and the Shutdown Cooling System will be initiated within twelve (12) hours of the start of the accident, thereby terminating the accident.

G4.2 Per Calculation N-5000-002 (Reference 6.1x, page 5), the maximum mass of water and steam in each steam generator is 350,000 lbm.

G4.3 Design basis IOSGADV/SAF doses and atmospheric dispersion factors (χ/Qs) are as follows per Calculation N-4076-001 (Reference 6.1q, CCN-1 Table A2-2 on Page 76):

	EAB	LPZ
χ/Q (sec/m^3)	2.72E-4	7.72E-6
DOSE (Rem)		
Thyroid	4.55E+0	1.38E-1
Beta Skin	2.16E-3	1.58E-4
Whole Body	5.00E-3	2.60E-4

G4.4 Per Calculation N-4076-001 (Reference 6.1q, CCN-1 Assumption A3.17), although the IOSGADV/SAF event is terminated at 12 hours, subsequent to the LPZ χ/Q term being reduced, the 0 to 8 hour LPZ χ/Q term of 7.72E-6 sec/m is conservatively applied to the 0 to 12 hour activity release duration. This same conservative assumption is employed in this Appendix G.

G5.0 IOSGADV/SAF METHODOLOGY & COMPUTATIONS

G5.1 Methodology

Design basis IOSGADV/SAF doses have been previously calculated in Calculation N-4076-001 (Reference 6.1x) based on the assumptions and design inputs presented in Sections G3.0 and G4.0 as well as applicable items in Sections 3.0 and 4.0. The only difference between Calculation N-4076-001 and the present analysis is that the former used atmospheric dispersion factors (χ/Q) based on 5 percentile meteorology while the present analysis uses 50 percentile meteorology.

50 percentile χ/Q doses can be obtained by applying χ/Q ratios to the 5 percentile doses. The following equation is utilized:

$$D_{New} = D_{Design}\left(\frac{(\chi/Q)_{New}}{(\chi/Q)_{Design}}\right)$$

where "Design" refers to Calculation N-4076-001 (5 percentile χ/Q) and "New" refers to the present analysis (50 percentile χ/Q).

In Calculation N-4076-001, LPZ doses were calculated for the duration of the accident (12 hours). The LPZ χ/Qs for 0-8 hours were conservatively used for 0-12 hours. In using the above equation to calculate LPZ and control room doses (see below) for the present calculation, the control room 0-8 hour 50 percentile χ/Qs are also conservatively used for the 12-hour accident duration. Calculation N-4076-001 used the maximum breathing rate of 3.47E-4 m^3/sec for the duration of the accident in calculating LPZ doses. Hence, no correction for breathing rates is required when utilizing the LPZ doses to determine control room doses.

G5.2 Computations

The following table shows the doses obtained by applying χ/Q ratios. The formula shown above is used. For example, the EAB thyroid dose for 50 percentile χ/Q is calculated as follows, using the data in Sections 4.5 and G4.3:

$$D_{New} = (4.55\ Rem)\left(\frac{3.60E{-}6\ sec/m^3}{2.72E{-}4\ sec/m^3}\right) = 6.02E{-}2\ Rem$$

Although no control room doses were previously calculated, they are calculated at the control room air intake for the 50 percentile case by applying the χ/Q ratios to the 5 percentile LPZ doses. This is appropriate since both doses are for 12 hours (duration of accident). It is conservative to apply the dose at the air intake to personnel within the control room as no credit is taken for the finite volume of the control room. Also, per Assumption 3.7, the control room whole body dose is doubled.

	χ/Q (sec/m^3)	DOSE (Rem)		
		Thyroid	Beta Skin	Whole Body
Calc N-4076-001				
EAB	2.72E-04	4.55E+00	2.16E-03	5.00E-03
LPZ	7.72E-06	1.38E-01	1.58E-04	2.60E-04
This Calculation				
EAB	3.60E-06	6.02E-02	2.86E-05	6.62E-05
LPZ	9.24E-07	1.65E-02	1.89E-05	3.11E-05
Control Room	7.90E-04	1.41E+01	1.62E-02	5.32E-02

APPENDIX H SPENT FUEL POOL BOILING

H1.0 SFP BOILING PURPOSE

Loss of cooling flow to the spent fuel pool (SFP) can result in the boiling of the pool. The boiling leads to elevated fuel temperatures, thereby increasing the migration of spent fuel radioisotopes into the SFP water with the gaseous isotopes partitioning into the Fuel Handling Building (FHB) air space and being transported to the outside environment. SFP boiling also results in increased SFP water evaporation and a corresponding increase in the release of waterborne radioisotopes to the FHB air space and o[illegible] environment.

The objective of this appendix is to calculate the doses from a SFP boiling accident at the Exclusion Area Boundary (EAB) and the Low Population Zone (LPZ) as well as inside the Control Room assuming CRIS failure.

H2.0 SFP BOILING RESULTS

The resulting doses are as follows:

	DOSE (Rem)	
	Thyroid	Whole Body
Exclusion Area Boundary	<0.1	<0.1
Low Population Zone	<0.1	<0.1
Control Room	19.4	0.3

All doses meet the acceptance criteria of Sections 1.2.1 and 1.2.6.

H3.0 SFP BOILING ASSUMPTIONS

H3.1 A normal fuel offload is assumed. A full core offload is not considered since the Shutdown Cooling System would then be available as backup to the SFP Cooling System, rendering a boiling accident unlikely. This assumption is consistent with Calculation N-4072-007 (Reference 6.1m, Sheet 8).

H3.2 The SFP heat load is based on 150 hours of decay between reactor shutdown and loss of SFP cooling. This assumption is consistent with Calculation N-4072-007 (Reference 6.1m, Sheet 8).

H3.3 The normal fuel building ventilation system is assumed to be in operation during the accident, transporting all activity released from the pool directly to the environment. This assumption is consistent with Calculation N-4072-007 (Reference 6.1m, Sheet 9).

H3.4 A spiking factor of 100 is assumed for iodine and noble gases released from the fuel during the heatup from normal temperature to bulk boiling. This assumption is consistent with Calculation N-4072-007 (Reference 6.1m, Sheet 9).

H3.5 The failed fuel fraction is assumed to be 1%. This assumption is consistent with Calculation N-4072-007 (Reference 6.1m, Sheet 10).

H3.6 All the activity contained within the gaps of damaged fuel rods is assumed to be released. The gaps contain 10% of the iodine, 10% of the noble gases except Kr-85, and 30% of Kr-85 within the fuel rods (Reference 6.4e). This assumption is consistent with Calculation N-4072-007 (Reference 6.1m, Sheet 10).

H3.7 The pool decontamination factors for noble gases and iodines are assumed to be 1 and 10, respectively. This assumption is consistent with Calculation N-4072-007 (Reference 6.1m, Sheets 10, 11).

H3.8 In this calculation, the offsite whole body and thyroid doses determined in Calculation N-4072-007 are scaled to determine control room whole body and thyroid doses. Calculation N-4072-007 did not need to consider offsite beta skin dose consequences to document compliance with the 10 CFR 100 dose criteria. Therefore, this Appendix cannot use scaling to determine the control room beta skin dose. Although calculation of a beta skin dose to control room operators is desirable, it is not required. Per 10 CFR 50 Appendix A General Design Criterion 19, control room radiation protection is deemed adequate if control room personnel are not exposed to a radiation dose in excess of 5 rem whole body, or its equivalent to any part of the body. Section H5 determines the control room whole body and thyroid inhalation doses. Since these doses meet the applicable control room whole body and thyroid inhalation dose criteria of Section 1.2.1, it is reasonable to assume that the control room be[illegible] dose criterion of Section 1.2.1 will also be met.

H4.0 SFP BOILING DESIGN INPUTS

H4.1 Fission product escape rate coefficients for iodines and noble gases are 1.3E-8 and 6.5E-8 sec^{-1}, respectively, per CE Letter S-CE-3036 (Reference 6.3i).

H4.2 Design basis SFP boiling atmospheric dispersion factors are as follows per Calculation N-4072-007 (Reference 6.1m, Sheet 13):

TIME (hour)	χ/Q (sec/m^3)	
	EAB	LPZ
0 - 2	2.72E-4	
0 - 8		7.72E-6
8 - 24		4.74E-6
24 - 96		3.67E-6
96 - 720		2.67E-6

H4.3 Design basis SFP boiling EAB doses are 1.01E-2 and 4.53E-4 Rem to the whole body and thyroid, respectively, per Calculation N-4072-007 (Reference 6.1m, Sheets 34, 42). These doses are based on an occupancy factor of 1.0 and a breathing rate of 3.47E-4 m^3/sec.

H4.4 Design basis SFP boiling whole body LPZ doses are as follows, per Calculation N-4072-007 (Reference 6.1m, Sheet 40). These doses are based on an occupancy factor of 1.0 and a breathing rate of 3.47E-4 m^3/sec.

TIME (hour)	WHOLE BODY DOSE (Rem)
0 - 2	2.88E-4
2 - 8	8.79E-4
8 - 24	1.41E-5
24 - 96	4.93E-5
96 - 720	3.11E-4

In Calculation N-4072-007 (Sheet 40), the break between the second and third time steps occurs at 8.1 hours rather than 8 hours. Assuming the break occurs at 8 hours has a negligible impact on the results of this analysis.

H4.5 Design basis SFP boiling thyroid LPZ doses based on a constant breathing rate of 2.32E-4 m^3/sec and an occupancy factor of 1.0 are as follows, per Calculation N-4072-007 (Reference 6.1m, Sheet 32, 33). It should be noted that these doses are adjusted in Calculation N-4072-007 for the varying breathing rates at the LPZ but the unadjusted values shown are utilized in this analysis.

TIME (hour)	THYROID DOSE (Rem)
0 - 2	8.59E-6
2 - 4	2.55E-5
4 - 6	4.34E-5
6 - 8	8.17E-3
8 - 24	5.08E-2
24 - 96	1.20E-1
96 - 720	2.48E-1

H5.0 SFP BOILING METHODOLOGY & COMPUTATIONS

H5.1 General Methodology

Design basis SFP boiling accident doses have been previously calculated in Calculation N-4072-007 (Reference 6.1m) based on the assumptions and design inputs presented in Sections H3.0 and H4.0 as well as applicable items in Sections 3.0 and 4.0. The only difference between Calculation N-4072-007 and the present analysis is that the former used atmospheric dispersion factors (χ/Q) based on 5 percentile meteorology while the present analysis uses 50 percentile meteorology.

H5.2 Whole Body Dose Methodology

Whole body doses due to immersion for 50 percentile χ/Q can be obtained by applying χ/Q and occupancy factor ratios to the doses based on 5 percentile χ/Q. The following equation is utilized:

$$D_{New} = D_{Design}\left(\frac{(\chi/Q)_{New}}{(\chi/Q)_{Design}}\right)\left(\frac{OF_{New}}{OF_{Design}}\right)$$

where "Design" refers to Calculation N-4072-007 (5 percentile χ/Q), "New" refers to the present analysis (50 percentile χ/Q), and OF is the occupancy factor.

Although Calculation N-4072-007 does not evaluate control room doses, the above equation can be used to estimate the 50 percentile χ/Q control room whole body dose at the control room air intake by ratioing LPZ design values from Calculation N-4072-007. This is appropriate since both doses are for 30 days (duration of accident). Such a ratio will yield the dose at the control room air intake. It is conservative to apply the dose at the air intake to personnel within the control room as no credit is taken for the finite volume of the control room. Per Assumption 3.7, the control room whole body dose will be doubled to address gamma radiation shine from sources near the control room.

H5.3 Thyroid Dose Methodology

Thyroid doses due to inhalation for 50 percentile χ/Q can also be obtained by applying χ/Q ratios to the doses based on 5 percentile χ/Q. For this case, however, breathing rates also need to be ratioed, as follows:

$$D_{New} = D_{Design}\left(\frac{(\chi/Q)_{New}}{(\chi/Q)_{Design}}\right)\left(\frac{BR_{New}}{BR_{Design}}\right)\left(\frac{OF_{New}}{OF_{Design}}\right)$$

where "Design" refers to Calculation N-4072-007, "New" refers to the present analysis, BR is the breathing rate, and OF is the occupancy factor. As with the immersion dose evaluation, control room inhalation doses can be estimated by ratioing the LPZ design values from Calculation N-4072-007.

H5.4 EAB Doses

EAB doses are calculated for a single time interval (2 hours) during which χ/Q, breathing rate, and occupancy factor do not change. The EAB whole body dose due to immersion is calculated as follows, based on data in Design Inputs 4.4, 4.5, H4.2, and H4.3:

$$D_{WholeBody} = (1.01E\text{-}2\ Rem)\left(\frac{3.60E\text{-}6\ \sec/m^3}{2.72E\text{-}4\ \sec/m^3}\right)\left(\frac{1.0}{1.0}\right) = 1.34E\text{-}4\ Rem$$

The EAB thyroid dose due to inhalation is calculated as follows, based on the data in Assumption 3.4 and Design Inputs 4.4, 4.5, H4.2, and H4.3:

$$D_{Thyroid} = (4.53E\text{-}4\ Rem)\left(\frac{3.60E\text{-}6\ \sec/m^3}{2.72E\text{-}4\ \sec/m^3}\right)\left(\frac{3.47E\text{-}4\ m^3/\sec}{3.47E\text{-}4\ m^3/\sec}\right)\left(\frac{1.0}{1.0}\right) = 6.00E\text{-}6\ Rem$$

H5.5 LPZ Doses

As LPZ χ/Qs vary over time (Design Input H4.2), the dose equations must be applied for each time interval with the parameters being ratioed changing. The following table shows LPZ whole body doses, based on data in Design Inputs 4.4, 4.5, H4.2, and H4.4.

TIME (hour)	χ/Q (sec/m^3)		OCCUPANCY FACTOR		WHOLE BODY DOSE (Rem)	
	Design	New	Design	New	Design	New
0-8	7.72E-6	9.24E-7	1.0	1.0	1.17E-3	1.40E-4
8-24	4.74E-6	6.03E-7	1.0	1.0	1.41E-5	1.79E-6
24-96	3.67E-6	3.65E-7	1.0	1.0	4.93E-5	4.90E-6
96-720	2.67E-6	3.28E-7	1.0	1.0	3.11E-4	3.82E-5
Total					1.54E-3	1.85E-4

LPZ thyroid doses are as calculated in the following table, based on data in Assumption 3.4 and Design Inputs 4.5, H4.2, and H4.5.

TIME (hour)	χ/Q (sec/m^3)		BREATHING RATE (m^3/sec)		OCCUPANCY FACTOR		THYROID DOSE (Rem)	
	Design	New	Design	New	Design	New	Design	New
0-8	7.72E-6	9.24E-7	2.32E-4	3.47E-4	1.0	1.0	8.25E-3	1.48E-3
8-24	4.74E-6	6.03E-7	2.32E-4	1.75E-4	1.0	1.0	5.08E-2	4.87E-3
24-96	3.67E-6	3.65E-7	2.32E-4	2.32E-4	1.0	1.0	1.20E-1	1.19E-2
96-720	2.67E-6	3.28E-7	2.32E-4	2.32E-4	1.0	1.0	2.48E-1	3.05E-2
Total							4.27E-1	4.88E-2

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
0	Mark Drucker	8/15/97	T. Remick	8/18/97					

H5.6 Control Room Doses

Control room whole body doses are calculated in the following table, based on the data in Design Inputs 4.4, 4.5, H4.2, and H4.4. Per Assumption 3.7, the new dose values include a multiplier of 2 for external shine sources.

TIME (hour)	χ/Q (sec/m³)		OCCUPANCY FACTOR		WHOLE BODY DOSE (Rem)	
	Design	New	Design	New	Design	New
0-8	7.72E-6	7.90E-4	1.0	1.0	1.17E-3	2.39E-1
8-24	4.74E-6	4.60E-4	1.0	1.0	1.41E-5	2.74E-3
24-96	3.67E-6	2.50E-4	1.0	0.6	4.93E-5	4.03E-3
96-720	2.67E-6	6.25E-5	1.0	0.4	3.11E-4	5.82E-3
Total					1.54E-3	2.51E-1

Control room thyroid doses are calculated as follows, based on the data in Assumption 3.4 and Design Inputs 4.4, 4.5, H4.2, and H4.5.

TIME (hour)	χ/Q (sec/m³)		BREATHING RATE (m³/sec)		OCCUPANCY FACTOR		THYROID DOSE (Rem)	
	Design	New	Design	New	Design	New	Design	New
0-8	7.72E-6	7.90E-4	2.32E-4	3.47E-4	1.0	1.0	8.25E-3	1.26E+0
8-24	4.74E-6	4.60E-4	2.32E-4	3.47E-4	1.0	1.0	5.08E-2	7.37E+0
24-96	3.67E-6	2.50E-4	2.32E-4	3.47E-4	1.0	0.6	1.20E-1	7.34E+0
96-720	2.67E-6	6.25E-5	2.32E-4	3.47E-4	1.0	0.4	2.48E-1	3.47E+0
Total							4.27E-1	1.94E+1

EC&FS DEPARTMENT

CALCULATION SHEET

ICCN NO./ PRELIM. CCN NO.	PAGE ___ OF ___
	CCN CONVERSION: CCN NO. CCN --

Project or DCP/MMP DCP 2&3 6926.01SJ Calc. No. N-0720-014

Subject Control Room and Offsite Doses Should CPIS, CRIS, and FHIS Fail

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV
0	Mark Drucker	8/15/97	T. Remick	8/18/97						

ATTACHMENT 1

Author: ALLEN EVINAY at W46
Date: 9/10/96 3:07 PM
Priority: Normal
TO: ALLEN EVINAY
TO: ALAN BROOKH
TO: JOHN BOYAJIAN
TO: MARK DRUCKAI
TO: THOMAS REMICK
TO: RICHARD CHANG
Subject: Pre and Post Trip SLB SIAS Timing

-------------------------------- Message Contents --------------------------------

The SIAS Timing for the pre and post trip SLB events are from S2C9 RAR and additional high-quality non QA'ed CESEC calculations performed for the pre-trip Inside Containment SLB by extending the event time to 20 seconds. These results are summarized below.

POST-TRIP-SLB S2C9-RAR

HZP-LOAC Time-to-SIAS = 17.52 sec page 7-52

HZP-AC Time-to-SIAS = 15.34 sec page 7-60

HFP-LOAC Time-to-SIAS = 22.09 sec page 7-67

HFP-AC Time-to-SIAS = 21.34 sec page 7-74

PRE-TRIP-SLB

HFP-IC-SLB Time-to-SIAS = 16.67 sec

CESEC OUTPUT file sias.ic.out in the ibm-risc directory /home3/evinayar/s2c9-aor/preslb

HFP-OC-SLB Time-to-SIAS = 17.11 sec

CESEC OUTPUT file sias.oc.out in the ibm-risc directory /home3/evinayar/s2c9-aor/preslb

Based on the results summarized here, it is our engineering judgment that the SIAS Actuation during the pre and post trip SLB events should occur within the first 30 second of these events.

A. McEvinay 9/10/96

Allen Evinay
NFM-Engineer

John Boyajian 9-10-96

John Boyajian
NFM-Engineer

R. Chang

Richard Chang
NFM-S2C9-Reload Mgr.