ENCLOSURE 1

CALCULATION N-4072-001 REVISION 6
FUEL HANDLING ACCIDENT INSIDE FUEL HANDLING BUILDING – CONTROL ROOM & OFFSITE DOSES

CALCULATION TITLE PAGE

ICCN NO./ PRELIM. CCN NO.	PAGE ___ OF ___

Calc. No. N-4072-001 DCP/FIDCN/FCN/ECP No. & Rev. N/A

CCN CONVERSION: CCN NO. CCN-

Subject Fuel Handling Accident Inside Fuel Handling Building - Control Room & Offsite Doses Sheet 1 of 261

System Number/Primary Station System Designator 1504 & 1515- / GGA & GKA SONGS Unit 2 & 3 Q-Class II

Tech. Spec./LCS Affecting? ☐ NO ☒ YES, Section No. See below Equipment Tag No. N/A

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

10CFR50.59 REVIEW	CONTROLLED COMPUTER PROGRAM/DATABASE		
IS THIS CALCULATION REVISION BEING ISSUED SOLELY TO INCORPORATE CCNs? ☒ NO ☐ YES AR No. 000801099-13	☒ PROGRAM ☐ DATABASE ACCORDING TO SO123-XXIV-5.1	PROGRAM/DATABASE NAME(S) ☒ ALSO, LISTED BELOW NE319, LOCADOSE NE602, SOURCE	VERSION/RELEASE NO.(S) NE319, Version 3.0 & Version 6.0 NE602, Version D2-5

RECORDS OF ISSUES

REV. DISC.	DESCRIPTION	TOTAL SHTS. LAST SHT.	PREPARED (Print name/sign/date)	APPROVED (Signature/date)	
0 to 5	See CDM for Revisions 0 to 5		ORIG.	FLS	Other
- -			IRE	Other	Other
6	Revised. See Below. Incorporated CCN-6, 7, and 8, 4	261	ORIG. 1/30/03 N. T. Yackle	FLS S. Swoope 2-26-2003	Other
NFM		261	IRE T. Remick 2/6/03 PQS T2RE42	Other M. Drucker 1/30/2003 PQS T2RE42, OJTTRN	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.

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Revision 6 Scope: Revision 6 was performed to account for up to 1000 CFM unfiltered Control Room inleakage.
Revision 6 incorporates CCNs 6, 7 & 8, 4
Revision 6 addresses the time delay implemented in ECP020700544-7.

As discussed in Section 2.3, the results of this calculation support the bases for Technical Specification Limiting Conditions for Operations (LCOs) 3.3.9, 3.3.10, 3.7.11, 3.7.14 and 3.7.16.

As discussed in Section 2.3, the results of this calculation support the bases for Licensee Controlled Specifications (LCSs) 3.3.100, 3.3.112, 3.7.117, 3.7.118, and 3.9.101.

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

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Calc. rev. number and responsible FLS 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., FIDCN, or tracking number.
	Calc/Document No.	Rev. No.	Calc/Document No.	Rev. No.	YES/NO	
Rev. 6 JET 7-6-03	Units 2&3 Calculation DC-1522	2	UFSAR Sections 15.7.3.4 & 15.10.7.3.4 UFSAR Appendices 15B & 15.10B	16	No	
	Units 2&3 Calculation M-0022-008	2 & CCNs 1 to 4	Accident Analysis DBD -- DBD-SO23-TR-AA, Section 4.3.16	4	Yes	AR 000801099-12
	Units 2&3 Calculation M-0073-041	8 & CCNs 20, 22 to 25	Radiation Monitoring DBD — DBD-SO23-690	4	No	
	Units 2&3 Calculation M-0073-095	3 & CCNs 1 to 4	Plant Protection System DBD — DBD-SO23-710	7	No	
	Units 2&3 Calculation M-0076-001	3 & CCNs 1 to 3, 5 to 7, Supplement A	Units 2&3 Calculation J-SPA-179	0 CCNs 2 to 5	No	
	Units 2&3 Calculation N-0450-002	1	Units 2&3 Calculation J-SPA-289	0 CCNs 1 to 3	No	
	Units 2&3 Calculation N-4010-001	5 & CCNs 2, 3	Units 2&3 Calculation J-SPA-329	0	No	
	Units 2&3 Calculation N-4010-002	1	Unit 2 Technical Specifications LCO 3.3.9 LCO 3.3.10 LCO 3.7.11 LCO 3.7.14 LCO 3.7.16	Amend. # 132 127 181 127 127	 No No No No No	

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	Calc/Document No.	Rev. No.	Calc/Document No.	Rev. No.	YES/NO	
Rev. 6 Alef 2-6-03	Units 2&3 Calculation N-4061-002	Rev. 0	Unit 3 Technical Specifications LCO 3.3.9 LCO 3.3.10 LCO 3.7.11 LCO 3.7.14 LCO 3.7.16	Amend. # 121 116 172 116 116	 No No No No No	
	Units 2&3 Calculation N-4060-016	2	Unit 2 Licensee Controlled Specifications LCS 3.3.100 LCS 3.3.112 LCS 3.7.117 LCS 3.7.118 LCS 3.9.101	 6 (1/00) 1 (7/01) 2 (6/02) 1 (6/02) 1 (5/00)	 No No No No No	
	Unit 2 Calculation NFM-2-FP-1202	0	Unit 3 Licensee Controlled Specifications LCS 3.3.100 LCS 3.3.112 LCS 3.7.117 LCS 3.7.118 LCS 3.9.101	 6 (1/00) 1 (7/01) 2 (6/02) 1 (6/02) 1 (5/00)	 No No No No No	
	Unit 3 Calculation NFM-3-FP-1202	0				
	Unit 2 Calculation NFM-2-PH-1203	2				
	Unit 3 Calculation NFM-3-PH-1203	1				
	Unit 2 Calculation NFM-2-PH-1104	2				
	Unit 3 Calculation NFM-3-PH-1104	1				

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	Calc/Document No.	Rev. No.	Calc/Document No.	Rev. No.	YES/NO	
Rev. 6	Unit 2 Calculation NFM-2-PH-1204	0				
~~1-13-05~~ 1-6-05	Unit 3 Calculation NFM-3-PH-1204	2				
	Unit 2 Calculation NFM-2-PH-1205	0				
	Unit 3 Calculation NFM-3-PH-1205	0				
	Unit 2 Calculation NFM-2-PH-0016	1				
	Unit 3 Calculation NFM-3-PH-0016	0				
	Document SO23-990-C299	2				
	Units 2&3 Calculation J-SPA-179	0 & CCNs 2 to 5				
	Units 2 & 3 Calculation NFM-2/3-PH-1116	0				
	Units 2&3 Drawing 10101	29 & DCNs 41 & 42				
	Units 2&3 Drawing 10112	9				
	Units 2&3 Drawing 23186	8				
	Units 2&3 Drawing 25004	25 & DCNs 35 to 38				
	Units 2&3 Drawing 25005	30				

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	Calc/Document No.	Rev. No.	Calc/Document No.	Rev. No.	YES/NO	
Rev. 6	Units 2&3 Drawing 25102	26				
SH 2-6-03	Units 2&3 Drawing 25103	24 & DCNs 29 to 31				
	Units 2&3 Drawing 25401	22				
	Units 2&3 Drawing 25429	6				
	Units 2&3 Drawing 25453	2				
	Unit 2 Drawing 25472	0 & DCN 1				
	Unit 3 Drawing 25483	0				
	Units 2&3 Drawing 31394	20				
	Units 2&3 Drawing 31395	21				
	Units 2&3 Drawing 40002, Sheet 1	33				
	Units 2&3 Drawing 40009	17				
	Units 2&3 Drawing 40090	8 & DCN-9				
	Units 2&3 Drawing 40092	9				
	Units 2&3 Drawing 40096	19				

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	Calc/Document No.	Rev. No.	Calc/Document No.	Rev. No.	YES/NO	
Rev. 6 AK 2-6-03	Units 2&3 Drawing 40098	9 & DCN-10				
	Units 2&3 Drawing 40173A	20				
	Unit 2 Drawing 40173ASO3	5				
	Units 2&3 Drawing 40173C	22				
	Unit 2 Drawing 40177A	20				
	Unit 3 Drawing 40177ASO3	19				
	Units 2&3 Drawing SO23-410-1-1	13 & DCN 2				
	Units 2&3 Drawing SO23-990-228	1				
	Unit 2 Technical Specifications	to Amend. 189				
	Unit 3 Technical Specifications	to Amend. 180				
	Unit 2 Licensee Controlled Specifications (LCS)	to 08/02/02				
	Unit 3 Licensee Controlled Specifications (LCS)	to 08/02/02				
	Units 2&3 UFSAR	to Amend. 16				
	Procedure SO23-I-2.44	6 & TCN 6-5				
	Operating Instruction SO23-3-2.11	16 & TCN 16-5				

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	Calc/Document No.	Rev. No.	Calc/Document No.	Rev. No.	YES/NO	
Rev. 6	Procedure SO23-X-7	10				
Sef 2-6-03	Procedure SO23-X-7.2	6				
	AOI SO23-13-20	7				
	Unit 1 Calculation DC-3782	0 & CCN 1				
	Calculation SNM-DBASE-11	11				
	Unit 2 Calculation NFM-2-PH-1216	0				
	Unit 3 Calculation NFM-3-PH-1216	0				

E&TS DEPARTMENT

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Project or DCP/FCN/ECP _____ Calc. No. N-4072-001

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Subject Fuel Handling Accident Inside Fuel Handling Building - CR & Offsite Doses Sheet 8 of 261

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6	N. YACKLE		T. REMICK							

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1.0 PURPOSE

1.1 Task Description

This calculation determines the control room and offsite doses due to the dropping of a fuel bundle (i.e., assembly) inside the Fuel Handling Building (FHB). This event is more commonly referred to as a design basis Fuel Handling Accident (FHA) inside the Fuel Handling Building (FHA-FHB).

The results of this calculation support the FHA-FHB discussion provided in UFSAR Chapter 15, and in the Accident Analysis DBD-SO23-TR-AA, Section 4.3.16.

As discussed in Section 2.3, the results of this calculation also support the bases for the following Technical Specification Limiting Conditions for Operations (LCOs) and Licensee Controlled Specifications (LCSs):

Tech Spec LCO 3.3.9: Control Room Isolation Signal (CRIS)
Tech Spec LCO 3.3.10: Fuel Handling Isolation Signal (FHIS)
Tech Spec LCO 3.7.11: Control Room Emergency Air Cleanup System (CREACUS)
Tech Spec LCO 3.7.14: Fuel Handling Building Post-Accident Cleanup Filter
Tech Spec LCO 3.7.16: Fuel Storage Pool Water Level

LCS 3.3.100: RPS/ESFAS Response Times
LCS 3.3.112: Fuel Handling Isolation Signal (FHIS)
LCS 3.7.117: Fuel Storage Pool Water Level
LCS 3.7.118: Fuel Handling Building Post-Accident Cleanup Filter System
LCS 3.9.101: Decay Time

1.1.1 Revision 6 Changes

This calculation is being revised to address the assignment in AR #000801099-5, specifically to evaluate the FHA in FHB dose consequences assuming increased unfiltered control room inleakage. The NRC has questioned the unfiltered inleakage assumption contained in submittals of other licensees. To address this issue, in the absence of definitive inleakage test results, Revision 6 of this calculation updates the FHA-FHB calculation model to assume the conservatively high control room unfiltered inleakage rate of 1000 cfm. The EAB and LPZ doses are not impacted by this modeling change. Revision 6 of this calculation still presents the results for the 10 cfm inleakage rate which remains the current analysis of record.

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In addition to the preceding changes, Revision 6 of this calculation also incorporates the following significant modeling changes:

Revision 6 of this calculation incorporates the CCN-6 calculation that evaluates the generation of the control room isolation signal (CRIS) by digital control room radiation monitors 2/3RE7824G1 and/or 2/3RE7825G2. These radiation monitors were installed in the plant by DCP 2&3 6926.01SJ (Reference 6.6j).

Revision 6 of this calculation incorporates the CCN-7 calculation of the EAB dose consequences of a transfer cask drop in the Units 1, 2 and 3 cask loading areas. This evaluation is contained in Appendix A. The transfer cask is loaded with 24 Unit 1 spent fuel assemblies that have been stored in the spent fuel pools for a minimum of 10 years.

Revision 6 of this calculation incorporates the CCN-8 calculation of the impact of increasing the licensed thermal power level by approximately 1.4 percent from 3390 to 3438 MWt. The Revision 6 evaluation of the 1000 cfm control room unfiltered inleakage case also increases the RPF from the 1.72 modeled in CCN-8, back to the value of 1.75 modeled in Revision 5.

Revision 6 of this calculation also addresses the time delay that has been added to the alarm output of the Control Room actuation to prevent transient alarms implemented in ECP020700544-7 that revised J-SPA-179 (Reference 6.1y).

Revision 6 of this calculation also uses LOCADOSE Release 6.0.

1.2 Criteria, Codes and Standards

1.2.1 Control Room Operator Dose Criteria

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. Standard Review Plan 6.4 (Reference 6.4*l*, Section II) clarifies the dose guidelines 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 Offsite Dose Criteria

Offsite dose criteria are defined in 10 CFR 100 (Reference 6.4b). Per Standard Review Plan 15.7.4 Revision 0 (Reference 6.4m), the dose to an individual should be well within the 10 CFR 100 exposure guidelines. This criterion is clarified in SRP 15.7.4 Revision 1, which states that the plant site and the dose mitigating engineered safety features are acceptable with respect to the radiological consequences of a postulated FHA if the calculated whole-body and thyroid doses at the Exclusion Area Boundary (EAB) and at the Low Population Zone (LPZ) are well within the 10 CFR 100, Section 100.11 exposure guidelines. SRP 15.7.4 Revision 1 defines "well within" as meaning 25 percent or less of the 10 CFR 100 exposure guidelines.

Per the exposure guidelines of 10 CFR 100, Section 100.11(a)(1), the dose at the EAB is for the two hours immediately following onset of the postulated accident. Per SRP 15.7.4 Rev. 1, the EAB dose for this initial 2 hour period should not exceed:

EAB (2 hour dose): Whole body gamma dose of 6 rem
Thyroid dose of 75 rem

Per the exposure guidelines of 10 CFR 100, Section 100.11(a)(2), the dose at the outer boundary of the LPZ is for the entire period of the postulated accident. Per SRP 15.7.4 Rev. 1, the LPZ dose during the entire period of the postulated accident should not exceed:

LPZ (accident duration dose): Whole body gamma dose of 6 rem
Thyroid dose of 75 rem

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2.0 RESULTS/CONCLUSIONS AND RECOMMENDATIONS

The doses presented in this summary of results section are rounded off to the nearest one-tenth rem, and doses smaller than 0.1 rem are listed as "< 0.1 rem". This round-off presentation style is in recognition of the inherent uncertainty in this type of dose analysis, and the fact that the dose criteria is given in multiple rem.

Section 2.1 present the results/conclusions of this calculation. Section 2.2 presents a comparison of the current calculation results with previously calculated doses. Section 2.3 presents the relationships between this calculation, the Technical Specifications, and the Licensee Controlled Specifications. In addition, Section 2.4 presents recommendations for the review of various documents that may need to be revised to reflect the methodology and/or results of this calculation.

2.1 Results/Conclusions

Based on the calculations presented in Section 8, Table 2.1-1 presents the Control Room, Exclusion Area Boundary (EAB), and Low Population Zone (LPZ) doses following a design basis Fuel Handling Accident inside the Fuel Handling Building (FHA-FHB). The design basis case is the failure of 60 fuel rods, representing 60 fuel rods in the dropped fuel bundle, and 0 fuel rods in the impacted fuel bundles. A review of Table 2.1-1 shows that the FHA-FHB offsite and control room doses meet the dose criteria listed in Section 1.2.

The design basis case failure of 60 fuel rods is sufficient to induce a high radiation Control Room Isolation Signal (CRIS) which within 3 minutes places the Control Room HVAC system into the high radiation isolation mode and starts both trains of the control room essential HVAC system. In the event of a CRIS failure, the control room doses reported in Table 2.1-1 remain valid provided that manual Operator Action is taken to isolate the control room within this same 3 minute period, or manual Operator Action is taken to isolate the control room prior to any released radioactivity passing through the Control Room HVAC isolation dampers.

As discussed in Section 8.5.6, in the event of a fuel handling accident with high radiation levels, Abnormal Operating Instruction SO23-13-20 (Reference 6.5f) "entry conditions" state that symptoms of a refueling accident include high radiation levels in the Fuel Handling Building, and bubbles emerging from a submerged fuel assembly which has been dropped or damaged. In the event of a fuel handling accident with high radiation levels, Step 2 requires immediate initiation of CRIS and initiation of evacuation of all personnel in the accident area.

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For conservatism, this calculation does not credit FHB airborne iodine and particulate activity removal by Post Accident Cleanup (PACU) Filter Units S2(3)1504ME370 or S2(3)1504ME371.

Table 2.1-1
Fuel Handling Accident Inside the Fuel Handling Building Doses

Location	Criteria (Rem)	Dose (Rem)	
Control Room (event duration dose) [CR isolated at 3 minutes]		10 CFM CR Unfiltered In-leakage 3438 MWt 1.72 Radial Peaking	1000 CFM CR Unfiltered In-leakage 3438 MWt 1.75 Radial Peaking
Thyroid Inhalation	30	5.6	9.3
Beta Skin Immersion	30	1.2	1.2
Whole Body Gamma Immersion and Shine	5	< 0.1	<0.1
EAB (2-hour dose)			
Thyroid Inhalation	75	18.4	18.8
Beta Skin Immersion	no dose criterion	0.1	0.1
Whole Body Gamma Immersion and Shine	6	< 0.1	<0.1
LPZ (event duration dose)			
Thyroid Inhalation	75	0.5	0.5
Beta Skin Immersion	no dose criterion	< 0.1	<0.1
Whole Body Gamma Immersion and Shine	6	< 0.1	<0.1

The EAB dose consequences of a transfer cask drop in the Units 1, 2 and 3 cask loading areas are presented in Appendix A. The transfer cask is loaded with 24 Unit 1 spent fuel assemblies.

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2.2 Comparison with Previous Dose Results

Section 1.1.1 details the differences between the current revision of this calculation and Revision 5 of this calculation. The following differences represent the primary reasons for the change in dose exposure:

Previous revisions of this calculation modeled an unfiltered control room in-leakage flow of 10 cfm. Revision 6 models both 10 cfm and 1000 cfm of unfiltered in-leakage flow to the control room. Additionally, the 1000 cfm case used a 1.75 radial peaking factor (RPF) combined with the average fuel rod gap inventory based on the fission product source term calculated for 3457.8 Mwt (3390 Mwt *1.02) effectively resulting in an average fuel rod gap inventory 1.02 times greater than the 10 cfm case.

Table 2.2-1 presents a comparison of the doses calculated in this calculation revision with the doses calculated in Revision 5 of this calculation. As shown in Table 2.2-1, the current "10 cfm" doses are all equivalent to, the previously calculated doses.

As shown in Table 2.2-1, the current control room "1000 cfm" doses are all greater than the "10 cfm" doses. This is expected due to the introduction of more contaminants into the control room air space, and the two percent increase in the RPF.

As shown in Table 2.2-1, the current offsite "1000 cfm" EAB thyroid dose is two percent greater than the "10 cfm" EAB thyroid dose due solely to the two percent increase in the RPF. The other offsite doses also increase by two percent, but due to their small magnitude and round-off, the reported doses do not change.

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Table 2.2-1
Comparison of Current and Previously Calculated FHA-FHB Doses

Location	Revision 5 Calculated Doses (Rem)		Revision 6 Calculated Doses (Rem)	
Control Room (event duration dose) [CR isolated at 3 minutes]	10 In-leakage	1000 In-leakage	10 In-leakage	1000 In-leakage
Thyroid Inhalation	5.6	N/A	5.6	9.3
Beta Skin Immersion	1.2	N/A	1.2	1.2
Whole Body Gamma Immersion and Shine	< 0.1	N/A	< 0.1	<0.1
EAB (2-hour dose)				
Thyroid Inhalation	18.4		18.4	18.8
Beta Skin Immersion	0.1		0.1	0.1
Whole Body Gamma Immersion and Shine	< 0.1		< 0.1	<0.1
LPZ (event duration dose)				
Thyroid Inhalation	0.5		0.5	0.5
Beta Skin Immersion	< 0.1		< 0.1	<0.1
Whole Body Gamma Immersion and Shine	< 0.1		< 0.1	<0.1

2.3 Relationship between this Calc, the Tech Specs, and the LCS's

The results of this calculation support the bases for several Technical Specification Limiting Conditions for Operations (LCOs) and Licensee Controlled Specifications (LCSs). The following subsections list these LCOs and LCSs, and address the relationship between these licensing commitments and this calculation:

2.3.1 Relationship between this Calculation and the Technical Specification LCO Bases

(1) **Tech Spec LCO 3.3.9** addresses the need for at least one operable Control Room Isolation Signal (CRIS) channel during Modes 1 through 6 and during the movement of irradiated fuel assemblies. Surveillance Requirement 3.3.9.6 requires verification that the CRIS response time is within limits. The Tech Spec Bases for this LCO note that CRIS, in conjunction with the Control Room Emergency Air Cleanup System (CREACUS) (see Tech Spec LCO 3.7.11), maintains the control room atmosphere within conditions suitable for prolonged occupancy throughout the duration of any one of the accidents (e.g., FHA-FHB) discussed in UFSAR Chapter 15. The Tech Spec Bases for Surveillance Requirement 3.3.9.6 note that the response time testing acceptance criteria are included in LCS 3.3.100.

This calculation is consistent with the Tech Spec LCO 3.3.9 Bases statements.

(2) **Tech Spec LCO 3.3.10** addresses the need for at least one operable Fuel Handling [Building] Isolation Signal (FHIS) channel during the movement of irradiated fuel in the FHB. The Tech Spec Bases for this LCO note that FHIS isolates the FHB Normal Ventilation System and automatically initiates the recirculation and filtration systems in the event of a fuel rupture accident in the FHB, thereby helping to mitigate the consequences for the dropping of a spent fuel bundle breaching up to 60 fuel pins.

This calculation is consistent with the Tech Spec LCO 3.3.10 Bases statements. Consistent with the Tech Spec LCO 3.7.14 Bases, this calculation does not credit FHB airborne iodine and particulate activity removal by Post Accident Cleanup (PACU) Filter Units S2(3)1504ME370 or S2(3)1504ME371.

(3) **Tech Spec LCO 3.7.11** addresses the need for two operable CREACUS trains during Modes 1 through 6 and during the movement of irradiated fuel assemblies. The Tech Spec Bases for this LCO note that in the CREACUS Emergency Mode the control room is isolated to protect operational personnel from radioactive exposure through the duration of any one of the postulated limiting faults (e.g., FHA-FHB) discussed in UFSAR Chapter 15. The Bases also note that dose calculations credit only the HEPA filters and charcoal adsorbers of the emergency recirculation air conditioning unit.

This calculation is consistent with the Tech Spec LCO 3.7.11 Bases statements.

(4) **Tech Spec LCO 3.7.14** addresses the need for two operable FHB Post-Accident Cleanup Filter System trains during the movement of irradiated fuel assemblies in the FHB. The Tech Spec Bases for this LCO note that the PACU Filter System is design to mitigate the consequences of a fuel handling accident in which 60 pins in a fuel assembly are assumed to be damaged. The Bases state that the FHA dose calculations take no credit for the FHB PACU Filter System. The Bases also note that the amount of fission products available for release from the FHB is determined for a FHA using the guidance provided in Regulatory Guide 1.25.

This calculation is consistent with the Tech Spec LCO 3.7.14 Bases statements.

(5) **Tech Spec LCO 3.7.16** addresses the need for the fuel storage pool water (i.e., spent fuel pool) level to be greater than or equal to 23 feet over the top of irradiated fuel assemblies seated in the storage racks during the movement of irradiated fuel assemblies in the fuel storage pool [it is noted that LCS 3.7.117 addresses the need for the fuel storage pool water level to be greater than or equal to 23 feet over the top of irradiated fuel assemblies seated in the storage racks when no fuel movement is being performed in the fuel storage pool]. The Tech Spec Bases note that this LCO preserves the ability to use the Regulatory Guide 1.25 assumptions in the FHA dose evaluation. The Tech Spec Bases note that this LCO preserves the Reg. Guide 1.25 requirement for a minimum of 23 feet of water above the damaged fuel assembly for the bulk of the fuel in the storage racks. The Tech Spec Bases also note that Tech Spec LCO 3.9.6 and station procedures require higher water levels and thereby preserve the Reg. Guide 1.25 requirement for a minimum of 23 feet of water above the damaged fuel assembly in the case of a single fuel bundle dropped and laying horizontally on the top of the spent fuel racks.

This calculation is consistent with the Tech Spec LCO 3.7.16 Bases statements.

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2.3.2 Relationship between this Calculation and the Licensee Controlled Specification Bases

(1) LCS 3.3.100 addresses the Reactor Protection System (RPS) and Engineered Safety Features Actuation System (ESFAS) response times. Table 3.3.100-2 gives a CRIS response time of 120 seconds for placing the control room ventilation in emergency mode due to high control room ventilation airborne radiation, and gives Not Applicable as the FHIS response time for placing the Fuel Handling Building Post-Accident Cleanup (PACU) Filter System in operation due to high FHB airborne radiation. The Bases for this LCS state that a specified FHIS response time is not assumed for those channels with response times indicated as not applicable.

This calculation is consistent with the LCS 3.3.100 Bases in that it explicitly models a 3 minute high radiation induced CRIS response time which is greater than the 2 minute response time required by the LCS. This calculation is consistent with the remaining portion of the LCS 3.3.100 Bases in that this calculation does not credit FHB airborne iodine and particulate activity removal by PACU Filter Units S2(3)1504ME370 or S2(3)1504ME371.

(2) LCS 3.3.112 addresses the need for at least one operable Fuel Handling [Building] Isolation Signal (FHIS) channel whenever irradiated fuel is stored in the spent fuel pool and there is no movement of irradiated fuel assemblies. The Bases for this LCS note that a FHIS isolates the FHB and automatically initiates the recirculation and filtration systems in the event of a fuel handling accident in the spent fuel pool.

This calculation is consistent with the LCS 3.3.112 Bases, with the understanding that (as discussed in the preceding evaluation of Tech Spec LCO 3.7.14) this calculation does not credit FHB airborne iodine and particulate activity removal by Post Accident Cleanup (PACU) Filter Units S2(3)1504ME370 or S2(3)1504ME371.

(3) LCS 3.7.117 addresses the need for fuel storage pool (i.e., the spent fuel pool) water level to be a minimum of 23 feet over the top of irradiated fuel assemblies seated in the storage racks when no fuel movement is being performed in the fuel storage pool [it is noted that Tech Spec LCO 3.7.16 addresses the need for the fuel storage pool water level to be greater than or equal to 23 feet over the top of irradiated fuel assemblies seated in the storage racks during the movement of irradiated fuel assemblies in the fuel storage pool]. The Bases for this LCS note that the restrictions on minimum water level ensure that sufficient water depth is available to remove 99 percent of the assumed iodine gap activity released from the

rupture of an irradiated fuel assembly, and that the minimum water depth is consistent with the assumptions of the accident analysis.

This calculation is consistent with the LCS 3.7.117 Bases.

(4) **LCS 3.7.118** addresses the need for two Fuel Handling Building Post-Accident Cleanup (PACU) Filter System trains to be operable during operation of the spent fuel handling machine with a load (other than irradiated fuel) suspended over the spent fuel pool. Per the LCS bases, currently Tech Spec LCO 3.7.14 addresses irradiated fuel load movement over the spent fuel pool, and this LCS is required to consider other (non-LCO covered) movements of the Spent Fuel Handling Machine that could potentially damage irradiated fuel. The LCS 3.7.118 Bases refer to the LCO 3.7.14 for additional Bases information.

Per Section 2.3.1, this calculation is consistent with the Tech Spec LCO 3.7.14 Bases. Therefore, this calculation is also consistent with the LCS 3.7.118 Bases.

(5) **LCS 3.9.101** addresses the need for the reactor to be subcritical for at least 72 hours during the movement of irradiated fuel in the reactor pressure vessel. The Bases for this LCS state that this 72 hour decay time ensures that sufficient time has elapsed to allow the radioactive decay of the short lived fission products, and that this decay time is consistent with the assumptions used in the accident analyses.

This calculation is consistent with the LCS 3.9.101 Bases.

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2.4 Recommendations

2.4.1 The analysis of record (10 cfm control room inleakage) did not change, therefore no documents need to be revised. If a licensing amendment is considered to increase the control room inleakage from 10 cfm to 1,000 cfm, the following documents may need to be revised to reflect the methodology and/or results of this calculation. Action Request 000801099 Assignments #8 and #12 have been initiated to track these recommendations:

Units 2 and 3 UFSAR Sections 15.7.3.4 and 15.10.7.3.4 and Appendices 15B and 15.10B.

Accident Analysis DBD-SO23-TR-AA, Section 4.3.16.

2.4.2 As discussed in Section 8.11, the sum of the environmental cloud gamma radiation shine dose and the control room HVAC filter gamma radiation shine dose is equivalent to less than 29 percent of the gamma immersion dose for the 10 cfm case and less than 32 percent of the gamma immersion dose for the 1000 cfm case. Since each of these radiation shine and immersion dose contributors is associated with the same FHA source term and activity release mechanism, it is recommended that future revisions to this analysis be conservatively simplified by assuming that the sum of the environmental cloud gamma radiation shine dose and the control room HVAC filter gamma radiation shine dose is equal to the gamma immersion dose.

3.0 MODELING ASSUMPTIONS

3.1 Configuration Symmetry Between Units 2 and 3

This analysis and its conclusions are applicable to both Units 2 and 3. References are provided to show that assumptions and design input data that have unit applicability are representative of both units.

3.2 Reactor Shutdown (Decay) Time

Regulatory Guide 1.25 Section C.1a (Reference 6.4i) states that the Fuel Handling Accident should be assumed to occur at a time after shutdown identified by the Technical Specifications as the earliest time fuel handling operations may begin, and that radioactive decay of the fission product inventory during the interval between shutdown and commencement of fuel handling operations may be taken into consideration. Units 2&3 Licensee Controlled Specification 3.9.101 (References 6.4e & 6.4f) requires that the reactor shall be subcritical for at least 72 hours prior to movement of irradiated fuel in the reactor vessel. Therefore, it is assumed that 72 hours of reactor shutdown time will have elapsed prior to the occurrence of the Fuel Handling Accident. This 72 hour delay, which is reflected in the Design Input 4.1 source term, is sufficient time to allow the radioactive decay of short lived fission products that would have otherwise contributed to the Fuel Handling Accident dose consequences, and to allow a reduction in the fuel rod pressures thereby validating the modeled spent fuel pool iodine decontamination factors (refer to Section 8.2.2).

3.3 Daughter Product Isotopes

The effects of daughter products are considered in this analysis. The daughter products generated by the radioactive decay of Iodine are noble gas (Krypton, Xenon) isotopes. The daughter products generated by the radioactive decay of the noble gas isotopes are Rubidium and Cesium.

The Bechtel LOCADOSE computer program (NE-319, References 6.6a and 6.6g) classifies each isotope as a member of one of twelve isotope groups. The isotopes in each group share common characteristics (e.g., applicable filter efficiencies), which are entered into the LOCADOSE input file. Rubidium and Cesium are in LOCADOSE isotope group 5. This grouping is consistent with NUREG-0017 (Reference 6.4n, Table 2-6), which places Rb and Cs in the same element class. Per NUREG-0017 Table 2-17 the Cs isotopes are particulates; it is therefore assumed that the Rb isotopes are also particulates. Therefore, LOCADOSE Group 5 is

considered to consist of particulates which are modeled as being subject to High Efficiency Particulate Air (HEPA) filtration.

3.4 Fuel Rod Gap Iodine Inventory Species Composition

In accordance with Regulatory Guide 1.25 Section C.1f (Reference 6.4i), the iodine gap inventory is assumed to be composed of 99.75 percent inorganic species (i.e., elemental and particulate iodine) and 0.25 percent organic species (i.e., organic iodide). It is assumed that this same relative proportion of inorganic and organic iodine species exists in both once burned and high burnup fuel.

3.5 Release Duration

In accordance with Regulatory Guide 1.25 Section C.1i (Reference 6.4i), all of the radioactive material released into the Fuel Handling Building atmosphere is assumed to be released to the outside environment over a two hour interval.

3.6 Fuel Handling Building PACU Filters

Units 2&3 Technical Specification LCO 3.7.14 (References 6.4c & 6.4d) addresses the need for two operable Post Accident Cleanup (PACU) Filter System trains during the movement of irradiated fuel assemblies in the Fuel Handling Building. Units 2&3 Licensee Controlled Specification 3.7.118 (References 6.4e & 6.4f) addresses the need for two operable PACU Filter System trains during operation of the spent fuel handling machine with a load (other than irradiated fuel) suspended over the spent fuel pool. PACU Filter Units S2(3)1504ME370 or S2(3)1504ME371 (E370 or E371) contain charcoal and HEPA filters capable of removing post-accident airborne iodine and particulates. For conservatism, this calculation does not credit FHB airborne activity removal by PACU Filter Units E370 and E371.

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3.7 Fuel Handling Building Isolation

Units 2&3 Technical Specification LCO 3.3.10 (References 6.4c & 6.4d) requires that one Fuel Handling [Building] Isolation Signal (FHIS) channel should be operable during the movement of irradiated fuel in the FHB. Units 2&3 Licensee Controlled Specification 3.3.112 (References 6.4e & 6.4f) requires that one FHIS channel should be operable whenever loads greater than 1432 pounds, other than irradiated fuel, are being transported over fuel assemblies in the spent fuel pool. Per drawings 40177A (Reference 6.2w) and 40177ASO3 (Reference 6.2x), prior to FHIS actuation the FHB Normal Ventilation System exhausts the post-accident FHB airborne activity to the environment via the Continuous Exhaust Plenum and the Plant Vent Stack. Once FHIS actuation occurs, these drawings show that the FHB Normal Ventilation System intake and exhaust flow paths are isolated. As such, once FHIS actuation occurs, FHB leakage would represent the only means for post-accident FHB airborne activity to be released to the environment. As addressed in Assumption 3.8, it is conservative to use atmospheric dispersion factors which assume that the FHB Normal Ventilation System remains in service with its Plant Vent Stack release point. For conservatism, this calculation assumes that the entire post-accident FHB airborne activity is released to the environment over the two hour accident duration (per Assumption 3.5) at a release rate equivalent to that of the FHB Normal Ventilation System exhaust flowrate (per Design Input 4.3.2). Thus, this calculation takes no credit for FHIS actuation.

3.8 Applicability of Containment Release Atmospheric Dispersion Factors

Design Input 4.7 presents atmospheric dispersion factors (χ/Q) for design basis releases from the Containment Building to the control room and offsite dose receptors. These containment release χ/Q values are assumed to be appropriate for use in this calculation addressing FHA-FHB activity releases.

As discussed in Assumption 3.7, the post-accident FHB airborne activity would be released to the environment via FHB leakage should Fuel Handling [Building] Isolation Signal (FHIS) actuation credit be taken, or via the Plant Vent Stack (PVS) without FHIS actuation credit. Since the FHB is farther away from the control room outside air makeup intake louvers than the Containment Building (per drawings 40002 Sheet 1 [Reference 6.2o] & 40009 [Reference 6.2p], and drawings 10101 [Reference 6.2a] and 10112 [Reference 6.2b]), the FHB activity releases would have more distance for dispersion prior to entering the control room, than would occur with Containment Building activity releases. Similarly, since the PVS is atop the Containment Building (per drawing 40092 [Reference 6.2ae]), the PVS activity releases would have more distance for dispersion prior to entering the control room, than would occur with Containment Building activity releases. Therefore, the Design Input 4.7 Containment Building to control room χ/Q values are assumed to bound both the FHB leakage to control room χ/Q values should FHIS actuation credit be taken, and the PVS to control room χ/Q values should FHIS actuation credit not be taken.

Since the FHB is adjacent to the Containment Building and since the PVS is atop the Containment Building, the distance and terrain features between the possible activity release points and the offsite EAB and LPZ dose receptors are very similar to those characterizing dispersion between Containment Building releases and the offsite dose receptors. Therefore, the Design Input 4.7 Containment Building to offsite χ/Q values are assumed to be equivalent to the FHB to offsite and PVS to offsite χ/Q values.

3.9 Activity Decay During Transport to Dose Receptors

The Fuel Handling Building airborne activity released to the environment is assumed to be instantaneously transported by atmospheric dispersion to the control room HVAC intake and to the offsite EAB and LPZ dose receptors. No credit is taken for radioactive decay of the isotopes in transit to these locations.

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3.10 Control Room and Offsite Breathing Rates

Regulatory Guide 1.4 Section C.2c (Reference 6.4h) addresses at work and at rest breathing rates of individuals present at offsite Exclusion Area Boundary (EAB) and Low Population Zone (LPZ) locations during a loss of coolant accident. These breathing rates, which are presented in Table 3.10-1, will be used in the determination of the thyroid inhalation doses to individuals at the EAB and LPZ during the Fuel Handling Accident. The at-work breathing rate will also be used in the determination of the thyroid inhalation doses to Control Room Operators.

Table 3.10-1 -- Control Room and Offsite Breathing Rates

Time Interval	Control Room Breathing Rate (m^3/sec)	EAB Breathing Rate (m^3/sec)	LPZ Breathing Rate (m^3/sec)
0 to 2 hours	3.47e-04	3.47e-04	3.47e-04
2 to 8 hours	3.47e-04	Not Applicable	3.47e-04
8 to 24 hours	3.47e-04	Not Applicable	1.75e-04
1 to 30 days	3.47e-04	Not applicable	2.32e-04

3.11 Control Room Emergency Filtration Damper Stroke Times

The stroke time of the HVAC isolation dampers in the Control Room HVAC system is assumed to be 6 seconds, based on an E-Mail from F. Santa Ana to T. Remick (Reference 6.3c).

3.12 Unfiltered Control Room Inleakage

Revision 5 of this calculation assumed an unfiltered Control Room inleakage of 10 cfm consistent with Standard Review Plan 6.4 Section III.3.d (Reference 6.4*l*). This inleakage rate accounts for periodic air inleakage into the CR pressure boundary due to a door opening.

The NRC Staff has let it be known in documents such as RIS 2001-19 that the inleakage should be validated in all future dose-related licensing submittals. In the absence of a formal validation test, Revision 6 of this calculation assumes a conservatively large value of 1,000 cfm for control room unfiltered inleakage. Both scenarios (10 and 1,000 cfm) are evaluated.

3.13 Control Room Filter Efficiency Model for Activity Loading

Per Design Input 4.4.2, in the high radiation isolation mode the makeup air entering the control room passes through filters SA1510MA206 and SA1510MA207 (A206 and A207) of the Emergency Ventilation System train, and then through filters SA1510ME418 and SA1510ME419 (E418 and E419) of the Emergency Air Conditioner filter train. For the purpose of determining the shine dose contribution from the control room HVAC filters, control room HVAC intake filters A206 and A207 are assumed to be 100% efficient at removing iodine and particulates from the incoming air. This maximizes the amount of iodine and particulates retained on A206 and A207, and thus maximizes the shine dose from these two filters. In reality, iodine and particulates that are not trapped on the intake filters will eventually be trapped on recirculation filters E418 and E419, which are located in the vicinity of the intake filters per drawing 40002 Sheet 1 (Reference 6.2o). However, the results of the filter shine dose calculation would not be significantly different, since the geometry of the direct shine pathways from E418 and E419 is similar to the geometry of the direct shine pathways from A206 and A207. Modeling the filters with a retention efficiency of 100 percent is consistent with UFSAR Appendix 15B Table 15B-5 footnote b (Reference 6.4g).

3.14 Control Room Filter Volume

Based on Vendor Drawing SO23-410-1-1 (Reference 6.2ac) and an E-mail from D. Higgins to F. Santa Ana (Reference 6.3b), a control room HVAC intake charcoal filter is approximated by a rectangular solid 27¾" long × 24" wide × 19" tall. The volume of a filter is:

$$Filter\ volume = 27.75\ in \times 24\ in \times 19\ in \times \frac{ft^3}{1728\ in^3} = 7.32\ ft^3$$

The 19" height approximates three stacked carbon trays, each with a height of $6\ ^{9}/_{32}$".

3.15 Control Room Post-Accident HVAC Operation

Consistent with UFSAR Appendix 15B (Reference 6.4g), this analysis models two trains of emergency HVAC in operation during the first 8 hours of the accident. Operator action is assumed to be taken within 8 hours to deactivate one train of emergency intake and recirculation units.

3.16 Control Room Filter Accumulation Time

Per Assumption 3.5 all of the radioactive material released into the Fuel Handling Building atmosphere is assumed to be released to the outside environment over a two hour interval. Per Assumption 3.15, both control room filter trains are assumed to operate during the first 8 hours of an accident (after 8 hours one filter train is secured by Operator action). Therefore, the activity released from the FHB and dispersed to the control room HVAC intake is assumed to evenly accumulate onto each of the charcoal filters during the 2 hour release duration. After 2 hours, the activity on each charcoal filter is allowed to decay for the duration of the accident.

3.17 Radioactive Decay Heat at 72 Hours after Shutdown

Per Assumption 3.2 refueling operations begin 72 hours after shutdown. Per Branch Technical Position ASB 9-2 (Reference 6.4o, Figures 1 through 3), the heat generation rate associated with residual radioactive decay 72 hours (2.59e5 seconds) after shutdown is less than 0.5 percent of the heat generation rate during power operations. To address additional decay heat that may be present with the SONGS Units 2&3 high burnup fuel management, it is assumed that the heat generation rate associated with residual radioactive decay at 72 hours is less than one percent of the heat generation rate during power operations.

3.18 Hot Fuel Rod Characteristics During Power Operations

3.18.1 Average Linear Heat Rate

For the purposes of this calculation it is assumed that the temperature difference between the outer surface of the fuel cladding and the coolant is less than 50 °F for a maximum rod average linear heat rate of 8.75 kW/ft.

Per Unit 2 Cycle 12 Fuel Performance Analysis NFM-2-FP-1202 (Reference 6.1*l*, Section 4.12), for batch M/N/P erbia and UO_2 fuel rods, the temperature difference between the outer surface of the fuel cladding and the coolant is less than 50 °F for a maximum rod average linear heat rate of 8.15 kW/ft (which exceeds the core average linear heat rate of 5.371 kW/ft). Per Unit 3 Cycle 12 Fuel Performance Analysis NFM-3-FP-1202 (Reference 6.1m, Section 4.12), for batch M/N/P erbia and UO_2 fuel rods, and for the batch K UO_2 fuel rods, the temperature difference between the outer surface of the fuel cladding and the coolant is less than 50 °F for a maximum rod average linear heat rate of 8.02 kW/ft (which exceeds the core average linear heat rate of 5.373 kW/ft).

As shown above, the linear heat rates for a 50 °F temperature difference between the outer surface of the fuel cladding for both Units 2 and 3 are below the assumed linear heat rate of 8.75 kW/ft; therefore, it is conservative for this analysis to use this linear heat rate for both units.

3.18.2 Maximum Fuel Rod Gap Temperature Difference

For the purposes of this calculation a fuel rod gap space temperature difference of 500 °F during power operations is assumed.

Per Unit 2 Cycle 12 Fuel Performance Analysis NFM-2-FP-1202 (Reference 6.1*l*, Section 4.12), the temperature in the fuel rod gap space during power operations is no more than approximately 316 °F greater than the bulk temperature of the surrounding cooling water. Per Unit 3 Cycle 12 Fuel Performance Analysis NFM-3-FP-1202 (Reference 6.1m, Section 4.12), the temperature in the fuel rod gap space during power operations is no more than approximately 333 °F greater than the bulk temperature of the surrounding cooling water.

As shown above, the temperature difference between the coolant and the fuel rod gap space is no more than 316 °F for Unit 2 and no more than 333 °F for Unit 3. Therefore, it is conservative for this analysis to use a fuel rod gap space temperature difference of 500 °F.

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4.0 DESIGN INPUTS

4.1 Fuel Handling Accident Source Term

This Design Input 4.1 presents the activity profile and isotope characteristics of an average fuel rod. These characteristics are dependent upon fuel burnup.

Per NUREG/CR-5009 (Reference 6.4k, Section 3.2.2 and Table 3.6), Regulatory Guide 1.25 has been generically approved for evaluating fuel with batch average burnups as high as 38 GWD/MTU. Per NUREG/CR-5009 (Section 3.2.2 and Table 3.6), operation with fuel discharge burnup extended from 38 GWD/MTU to 60 GWD/MTU increases the fuel rod gap inventory of several isotopes. Therefore, this calculation defines "low burnup fuel" as fuel with average burnups less than or equal to 38 GWD/MTU, and "high burnup fuel" as fuel with average burnups between 38 and 60 GWD/MTU.

This calculation evaluates Fuel Handling Accidents involving low burnup fuel with source term characteristics consistent with Regulatory Guide 1.25 guidance, and high burnup fuel with source term characteristics consistent with Regulatory Guide 1.25 guidance as modified by NUREG/CR-5009.

The Unit 2 Cycle 10 and Unit 3 Cycle 10 LOCA and Non-LOCA Fission Product Source Terms (References 6.1v and 6.1w, respectively) were calculated based on a reactor thermal power of 3390 Mwt. Unit 2 and Unit 3 Facility Operating License Amendments 180 and 171, respectively, increased the licensed thermal power level by approximately 1.4 percent to 3438 Mwt. This power uprate was evaluated with respect to the fuel handling accident dose analysis by increasing the FHA source term by two percent to the values shown in the Units 2/3 design analysis NFM-2/3-PH-1116 (Reference 6.1aa). To compensate for this two percent source term increase, two percent conservatism was removed from the radial peaking factor of 1.75, justifying a radial peaking factor of 1.71 (1.75/1.02). Therefore, the 10 cfm case continues to use the source term values based on NFM-2-PH-0016 increased by two percent and the 1,000 cfm case uses the updated Cycle 11 source term values from NFM-2/3-PH-1116 (Reference 6.1aa)

4.1.1 Fuel Rod Inventory. Per Assumption 3.2, the Fuel Handling Accident is assumed to occur after 72 hours of reactor shutdown time. Per Regulatory Guide 1.25 Section C.1d (Reference 6.4i), iodine and noble gas gap activity is released from the damaged fuel rods. Table 4.1-1 presents the iodine and noble gas activity inventory in a single fuel rod after 72 hours of decay, as documented in Unit 2 Cycle 10 Source Term Design Analysis NFM-2-PH-0016 (Reference 6.1v, Section 4.0) and the Units 2/3 Cycle 11 Source Term Design

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Analysis NFM-2/3-PH-1116 (Reference 6.1aa, Section 4.0). The U2C10 source term is valid for enrichments from 4 to 5 w/o Uranium-235, for fuel managements where the maximum burnup of any rod within 10% of the limiting radial peaking factor is less than 60 GWD/MTU, for an average power per fuel rod of less than or equal to 0.0666 MWth, and for a maximum number of 300 non-fuel rods in the core. Per Unit 3 Cycle 10 Source Term Design Analysis NFM-3-PH-0016 (Reference 6.1w, Section 4.0), the U3C10 source term is bounded by the U2C10 source term. The U2/3C11 source term is valid for enrichments from 4 to 5 w/o Uranium-235, for fuel managements where the maximum burnup of any rod within 10% of the limiting radial peaking factor is less than 60 GWD/MTU, for an average power per fuel rod of less than or equal to 0.06754 Mwth. Analyses for Cycle 12 (References 6.1ab and 6.1ac), have determined that the Cycle 11 source term is bounding for Cycle 12 operation.

Design Analyses NFM-2-PH-0016 and NFM-2/3-PH-1116 document the presence of tritium in an average fuel rod, but not the presence of other particulate fission products that are also present in spent fuel. Table 4.1-1 does not address these isotopes since Regulatory Guide 1.25 Section C.1d does not require consideration of non-iodine or non-noble gas gap activity releases from the damaged fuel rods.

Table 4.1-1 -- Average Fuel Rod Inventory

Isotope	Average Fuel Rod Inventory after 72 Hours Decay	
	per Design Analysis NFM-2-PH-0016, Section 4.0 (curies/rod)	per Design Analysis NFM-2/3-PH-1116, Section 4.0 (curies/rod)
Iodine-129	1.18e-04	1.20e-04
Iodine-130	3.09e-02	3.15e-02
Iodine-131	1.40e+03	1.43e+03
Iodine-132	8.53e-07	8.70e-07
Iodine-133	3.25+02	3.32+02
Iodine-134	0.00e+00	0.00e+00
Iodine-135	1.79e+00	1.82e+00
Krypton-83m	3.68e-10	3.75e-10
Krypton-85	2.58e+01	2.63e+01
Krypton-85m	8.15e-03	8.31e-03
Krypton-87	1.02e-14	1.04e-14
Krypton-88	4.21e-05	4.30e-05
Xenon-131m	1.91e+01	1.95e+01
Xenon-133m	6.42e+01	6.55+01
Xenon-133	2.81e+03	2.87+03
Xenon-135m	2.74e-01	2.79e-01
Xenon-135	3.69e+01	3.76e+01
Xenon-138	0.00e+00	0.00e+00

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4.1.2 Fuel Rod Gap Inventory. Per Regulatory Guide 1.25 Section C.1d (Reference 6.4i), the gap activity in damaged fuel rods consists of 10 percent of the total noble gases other than Krypton-85, 30 percent of the Krypton-85, and 10 percent of the radioactive iodine in the rods at the time of the accident. Per NUREG/CR-5009 (Reference 6.4k, Section 3.2.2 and Table 3.6), Regulatory Guide 1.25 has been generically approved for evaluating fuel with batch average burnups as high as 38 GWD/MTU.

Per NUREG/CR-5009 (Reference 6.4k, Section 3.2.2 and Table 3.6), operation with fuel discharge burnup extended from 38 GWD/MTU to 60 GWD/MTU increases the fuel rod gap inventory of several isotopes. At these higher fuel discharge burnups, all but the iodine isotopes (i.e., the noble gas isotopes) are calculated to have fuel rod gap inventories less than that recommended by Section C.1d of Regulatory Guide 1.25 for use in Fuel Handling Accident analyses. Per NUREG/CR-5009, at high burnups the fuel rod gap Iodine-131 inventory increases to 12 percent, which is greater than the 10 percent value that is assumed in Regulatory Guide 1.25. Since NUREG/CR-5009 does not address the fuel rod gap inventories of the other iodine isotopes, this analysis will conservatively model the fuel rod gap inventories of all iodine isotopes as having increased to 12 percent.

4.1.3 Number of Failed Fuel Rods. ABB Calculation A-SCE-FMDE-002 (Reference 6.1x) evaluated the extent of any damage produced during fuel handling operations by a fuel bundle dropping either horizontally or vertically onto one or more other fuel bundles stored in the spent fuel pool. Per ABB Calculation A-SCE-FMDE-002 Section 3.0, the maximum number of fuel rods predicted to fail will occur as a result of the horizontal drop of the fuel assembly onto the fuel bundles stored in the spent fuel racks. In this scenario, a total of 60 fuel rods will fail, representing 60 fuel rods in the dropped fuel bundle, and 0 fuel rods in the impacted fuel bundles.

4.1.4 Radial Peaking Factor. Per Design Input 4.1.3, in the event of a Fuel Handling Accident inside the Fuel Handling Building a total of 60 fuel rods will fail. Regulatory Guide 1.25 Section C.1e assumes a radial peaking factor (F_r) of 1.65. However, this F_r may be non-conservative when a small number of fuel rod failures are considered, and overly conservative when a large number of fuel rod failures are considered. To address this concern, Section B of Regulatory Guide 1.25 allows alteration of assumptions due to site specific characteristics, plant design features, and major changes in fuel composition or management.

The maximum full power tilted radial peaking factors were calculated in the Units 2 and 3, Cycles 11 and 12 reload physics analyses are:

U2C11 $F_r = 1.6648$ U2C11 Design Analysis NFM-2-PH-1104 (Reference 6.1p, Section 4.8 and Table 4.8-1)

U3C11 $F_r = 1.6397$ U3C11 Design Analysis NFM-3-PH-1104 (Reference 6.1q, Section 4.8 and Table 4.8-1)

U2C12 $F_r = 1.6504$ U2C12 Design Analysis NFM-2-PH-1204 (Reference 6.1r, Section 4.8 and Table 4.8-1)

U3C12 $F_r = 1.6168$ U3C12 Design Analysis NFM-3-PH-1204 (Reference 6.1s, Section 4.8 and Table 4.8-1)

Based on the preceding analyses, it is conservative for this calculation to model a maximum full power tilted F_r of 1.75 when a small number of once burned fuel rod failures are considered.

When the Unit 2 and Unit 3 Facility Operating License Amendments 180 and 171, respectively, increased the licensed thermal power level by approximately 1.4 percent to 3438 Mwt this power uprate was evaluated with respect to the fuel handling accident dose analysis in summary CCN-8 to this calculation. The evaluation concluded that the AOR remained intact. The increase in the FHA source term by two percent to the values shown in the Units 2/3 design analysis NFM-2/3-PH-1116 (Reference 6.1aa) was compensated for by removing two percent conservatism from the radial peaking factor of 1.75, justifying a radial peaking of 1.71 (1.75/1.02). Therefore, the 10 cfm case continues to use the source term values based on NFM-2-PH-0016 (increased by two percent) and a radial peaking of 1.71.

U2C12 Design Analysis NFM-2-PH-1205 (Reference 6.1t, Section 3.3.1.3) and U3C12 Design Analysis NFM-3-PH-1205 (Reference 6.1u, Section 3.3.1.3 define long term power [parameter Q] as the ratio of burnup-specific F_r to cycle maximum F_r. Analysis presented in U2C12 Design Analysis NFM-2-PH-1205 (Section 4.3c) and U3C12 Design Analysis NFM-3-PH-1205 (Section 4.3c) documents that as fuel burnup increases from beginning of life to 60 GWD/MTU the radial fall-off curves shows a reduction in long term power. Therefore, the F_r for high burnup fuel rods will always be enveloped by the cycle maximum values documented above.

Per Unit 2 Cycle 12 Fuel Performance Analysis NFM-2-FP-1202 (Reference 6.1*l*, Section 3.3.6), the ratio of the hottest rod normalized power to the normalized average power of 60 rods (i.e., the first four rows of rods) in all four of the hot assembly faces is greater than the pin-to-box ratio of 1.03 used in the U2C12 FATES3B computer code average rod cases. Similarly, per Unit 3 Cycle 12 Fuel Performance Analysis NFM-3-FP-1202 (Reference 6.1m, Section 3.3.6), the ratio of the hottest rod normalized power to the normalized average power of

60 rods in three of the four hot assembly faces is greater than the pin-to-box ratio of 1.03 used in the U3C12 FATES3B computer code average rod cases. As such, the power characteristics of 60 rods are representative of the power characteristics of an entire fuel assembly. For this reason, when 60 or more fuel rods in an assembly are failed, the average radial peaking factor (F_r) of the failed rods is equivalent to the failed assembly's Relative Power Density (RPD).

Based on the Unit 2 Cycle 12 Models and Depletion Analysis NFM-2-PH-1203 (Reference 6.1n, Section 4.15 and Appendix A Figures 5-3, 5-4 and 5-5), and Unit 3 Cycle 12 Models and Depletion Analysis NFM-3-PH-1203 (Reference 6.1o, Section 4.15 and Appendix A Figures 5-3, 5-4 and 5-5), the RPDs of all the fuel assemblies were found to be significantly lower than the maximum full power tilted F_r of 1.75 that is used in this calculation.

Therefore, the combined effect of a maximum full power tilted F_r of 1.75 and a gap activity in the damaged fuel rods consisting of 12 percent of the total noble gases other than Krypton-85 will result in conservative results for the event of a Fuel Handling Accident inside the Fuel Handling Building where a total of 60 fuel rods fail.

4.2 Spent Fuel Pool Water Clean-Up of Isotopes

4.2.1 SFP Water Iodine Removal. Per Regulatory Guide 1.25 Section C.1g (Reference 6.4i), the iodine gap activity released to the spent fuel pool water is subject to clean-up due to pool scrubbing. The pool decontamination factors for the inorganic iodine and organic iodide species are 133 and 1, respectively. Per Regulatory Guide 1.25 Sections C.1c and C.1b, these iodine decontamination factors are valid for a minimum 23 foot water depth between the top of the damaged fuel rods and the fuel pool surface, and for a maximum fuel rod pressure of less than 1200 psig. Section 8.2 assesses design compliance with these conditions.

4.2.2 SFP Water Noble Gas Removal. Per Regulatory Guide 1.25 Section C.1h, 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).

4.3 Fuel Handling Building Characteristics

4.3.1 Fuel Handling Building Volume. The FHB volume served by the normal FHB HVAC system is 365,305 ft^3 per Calculation M-0076-001 (Reference 6.1f, page 5).

4.3.2 Fuel Handling Building Normal Ventilation System Exhaust Flowrate. The FHB Normal Ventilation System configuration is shown on FHB HVAC Drawings 40177A (Reference 6.2w) and 40177ASO3 (Reference 6.2x).

Per Assumption 3.7, the entire post-accident FHB airborne activity is released to the environment at a release rate equivalent to that of the FHB Normal Ventilation System exhaust flowrate. To conservatively maximize the release of airborne radionuclides from the FHB, the FHB Normal Ventilation System exhaust flow rate will be modeled as 25,581 cfm, which is equivalent to its upper tolerance of 23,255 +10% cfm as given in FHB HVAC Air Flow Diagram 40090 (Reference 6.2q). The nominal exhaust flowrate of 23,255 cfm is consistent with that given in Calculation M-0076-001 (Reference 6.1f, page 5).

4.4 Control Room Characteristics

4.4.1 Control Room Net Free Volume. The control room net free volume is 266,920 ft^3 per Calculation M-0073-095 (Reference 6.1e, CCN-3 page A6-3).

4.4.2 Control Room CREACUS Charcoal and HEPA Filter Efficiencies. Units 2&3 Technical Specification LCO 3.7.11 (References 6.4c & 6.4d) requires that two Control Room Emergency Air Cleanup System (CREACUS) trains shall be operable in MODES 1 through 6, and during the movement of irradiated fuel assemblies. Per Control Building Air Flow Diagram drawings 40096 (Reference 6.2r) and 40098 (Reference 6.2s), in the high radiation isolation mode the makeup air entering the control room passes through filters SA1510MA206 and SA1510MA207 of the Emergency Ventilation System (EVS) train, and then through filters SA1510ME418 and SA1510ME419 of the Emergency Air Conditioner (EAC) filter train. However, per UFSAR Appendix 15B (Reference 6.4g) and the Tech Spec LCO 3.7.11 Bases, credit is only taken for the EAC filters. The recirculation air passes only through the EAC filter train.

Table 4.4-1 presents the elemental, organic, and particulate iodine removal efficiencies modeled for the LOCADOSE Code intake and recirculation filters. The EAC iodine filter efficiency is based on a charcoal filter depth of 2 inches (per an E-mail from D. Higgins to F. Santa Ana [Reference 6.3b]) and the corresponding charcoal filter efficiency values given in Regulatory Guide 1.52 Table 2 (Reference 6.4j). The EAC particulate efficiency is based on the HEPA efficiencies given in Regulatory Guide 1.52 Section C.5c. Regulatory Guide 1.52 efficiencies are applicable since Technical Specification 5.5.2.12 (References 6.4c and 6.4d) tests the EAC filters to this Regulatory Guide.

Table 4.4-1 -- Control Room CREACUS Charcoal and HEPA Filter Efficiencies

Contaminant Being Removed	Credited EVS Filter Removal Efficiency (A206/A207)	Credited EAC Filter Removal Efficiency (E418/E419)	Intake (EVS & EAC Filters) Removal Efficiency modeled in the LOCADOSE Code	Recirculation (EAC Filter only) Removal Efficiency modeled in the LOCADOSE Code
Elemental Iodine	0%	95%	95%	95%
Organic Iodide	0%	95%	95%	95%
Particulates	0%	99%	99%	99%

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4.4.3 Control Room HVAC Operation Characteristics. The control room HVAC parameters during normal and high radiation isolation operation are presented in Table 4.4-2; the HVAC configuration is shown on Control Room Complex HVAC Drawings 40173A (Reference 6.2t), 40173ASO3 (Reference 6.2u), and 40173C (Reference 6.2v).

During normal HVAC operation the Control Room unfiltered intake flow rate will be modeled as 5820 cfm, and the Control Room unfiltered recirculation (return air) flow rate will be modeled as 29,885 cfm. These values are equivalent to the flow rates given in Control Building Air Flow Diagram 40096 (Reference 6.2r) and in Calculation M-0073-041 (Reference 6.1c, page 7).

To conservatively maximize the introduction of airborne radionuclides into and retention within the control room, the high radiation isolation mode outside air intake flow rate will be increased to its upper tolerance of 2050 ±150 cfm as given in Calculation M-0073-041 (Reference 6.1c, CCN 20 Sheet 15) and the recirculation flowrate will be decreased to its lower tolerance of 35,705 cfm ±10% as given in Calculation M-0073-041 (Reference 6.1c, CCN-20 Sheet 15). These flowrates and their tolerances are consistent with those given in Maintenance Procedure SO23-I-2.44, Step 6.4 (Reference 6.5a).

Per Assumption 3.15, consistent with UFSAR Appendices 15B and 15.10B, this analysis models two trains of emergency HVAC in operation during the first 8 hours of the accident. Operator action is assumed to be taken within 8 hours to deactivate one train of emergency intake and recirculation units.

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Table 4.4-2 -- Control Room HVAC Operation Flowrates and Inleakage Rates

Parameter	CR Normal HVAC Operation (single train operation flowrates)		CR High Radiation Isolation Operation (single train operation flowrates)	
	Value	References	Value	References
Filtered Intake	0 cfm	dwg 40096 (Ref. 6.2r)	2050 + 150 = 2200 cfm	Calc M-0073-041 (Ref 6.1c) dwg 40096 (Ref 6.2r) dwg 40098 (Ref 6.2s) SO23-I-2.44 (Ref 6.5a)
Unfiltered Intake	5820 cfm (inflow) or 6820 cfm [b]	Calc M-0073-041 (Ref 6.1c) dwg 40096 (Ref. 6.2r)	0 (inflow) + 10 or 1,000 (inleakage) = 10 or 1,000 cfm [c]	dwg 40096 (Ref 6.2r) dwg 40098 (Ref 6.2s) Assumption 3.12
Filtered Recirculation [return air]	0 cfm	dwg 40096 (Ref. 6.2r)	(35,705 - 10%) - 2200 = 29,934.5 cfm [a]	Calc M-0073-041 (Ref 6.1c) dwg 40096 (Ref 6.2r) dwg 40098 (Ref 6.2s) SO23-I-2.44 (Ref 6.5a)
Unfiltered Recirculation [return air]	29,885 cfm	Calc M-0073-041 (Ref 6.1c) dwg 40096 (Ref. 6.2r)	0 cfm	dwg 40096 (Ref. 6.2r) dwg 40098 (Ref. 6.2s)

(a) The filtered recirculation flowrate during high radiation isolation operation is rounded down to 29,934 cfm for single train operation, and modeled as 59,869 cfm for two trains operation.

(b) The unfiltered intake flowrate during normal HVAC operation of 5820 cfm is equal to the difference between the supply air flow rate of 35,705 cfm and return air flow rate of 29,885 cfm given in Calculation M-0073-041 page 7. Per Assumption 3.12, two control room inleakage cases are considered in this analysis, 10 cfm and 1,000 cfm in addition to the intake flowrate, Therefore, the unfiltered flow rate into the control room for the 10 cfm case is 5,820 cfm and the 1,000 cfm case is 6,820 cfm.

(c) Per assumption 3.12, two control room inleakage cases are considered in ths analysis, 10 cfm and 1,000 cfm.

4.5 Control Room Radiation Monitor Characteristics

4.5.1 Transfer to High Radiation Isolation Mode. Units 2&3 Technical Specification LCO 3.3.9 (References 6.4c & 6.4d) requires that one Control Room Isolation Signal (CRIS) channel shall be operable in MODES 1 through 6, and during the movement of irradiated fuel assemblies. Per Elementary Diagram drawings 31394 (Reference 6.2m) and 31395 (Reference 6.2n), the control room will automatically transfer to the CRIS high radiation isolation mode if a Safety Injection Actuation Signal (SIAS) is generated, or if radiation monitor 2/3RE782G1 or 2/3RE7825G2 senses high radiation.

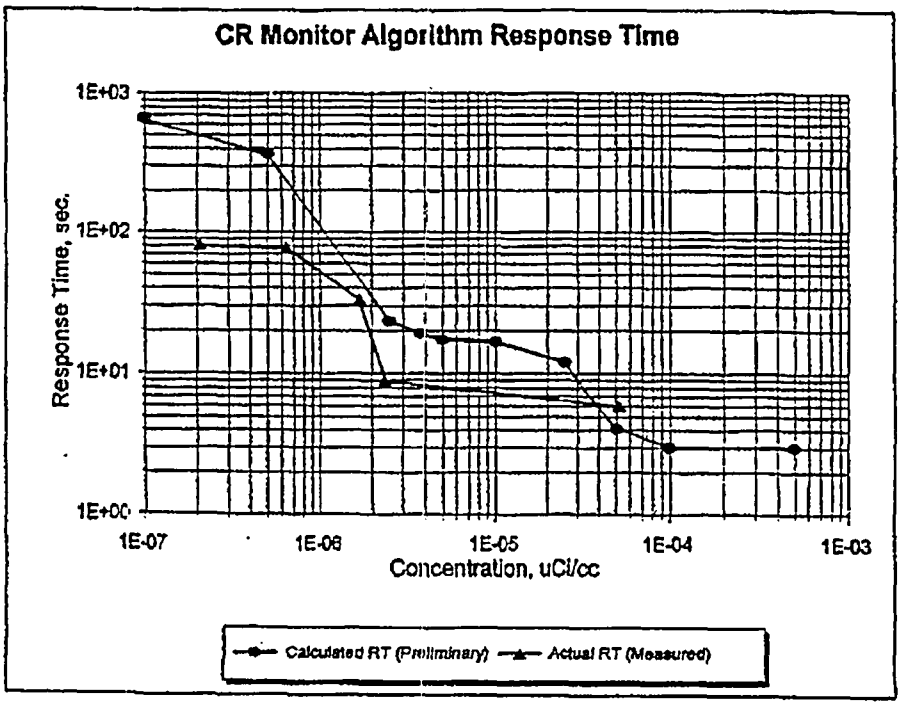
4.5.2 Radiation Monitor High Radiation Trip Initiation Time. Calculation J-SPA-179 (Reference 6.1y) shows that the control room radiation monitor trip initiation time is based on the plenum fill time and the radiation monitor algorithm response time.

Plenum Fill Time. The plenum fill time is the time required for the activity concentration inside the control room HVAC intake plenum to build up to the outside activity concentration present at the control room HVAC intake louvers. Per Calculation J-SPA-179 (CCN-2, Section 8.16.1), the intake plenum activity reaches 90 percent of the incoming outside air activity concentration within 8.5 seconds.

Radiation Monitor Algorithm Response Time. The radiation monitor algorithm response time is the time required for the count rate averaging algorithm to produce a representative concentration value that is greater than the monitor trip set point. Per Calculation J-SPA-179 (CCN-2, Section 8.16.2), the monitor response time is a function of the plenum activity concentration as presented in Figure 4.5-1. For any plenum activity concentration greater than 8.5e-7 μCi/cc the monitor response time will be less than 60 seconds. Note that increasing activity causes the response time to decrease to a minimum detector response time of 3 seconds. Consistent with Calculation J-SPA-179 (CCN-2, Section 8.16.2), an additional allowance, to a minimum time of 60 seconds is used for the algorithm response time.

Delay Relay Time. This is an additional adjustable time. Per J-SPA-179 (CCN-5, Section 8.16.3) this relay delay time can be anywhere from 5 to 40 seconds.

Figure 4.5-1: Control Room Monitor Algorithm Response Time
[per Calculation J-SPA-179 (CCN-2, Figure 8.16.2)]



4.6 Occupancy Factors

The control room occupancy factors (CROFs) are given in Standard Review Plan 6.4 Figure/Table 6.4-1 (Reference 6.4*l*). 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 (i.e., an occupancy factor of 1.0). Based on the time intervals of interest specified in the Section 1.2 dose criteria, 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

4.7 Atmospheric Dispersion Factors

Table 4.7-1 presents the San Onofre site-specific five percentile meteorology atmospheric dispersion factors (χ/Q) for design basis releases from the Containment Building to the control room and offsite EAB and LPZ dose receptors. The Control Room χ/Qs are per Calculation N-4010-001 (Reference 6.1h, CCN-2 Section 2.0), and are presented with and without the control room occupancy factors (CROFs) defined in Design Input 4.6. The offsite χ/Qs are per Calculation N-4010-002 (Reference 6.1i, Revision 1 page 3).

Per Assumption 3.8, the Containment Building to control room χ/Q values are assumed to bound the FHB to control room χ/Q values. Per Assumption 3.8, the Containment Building to offsite χ/Q values are assumed to be equivalent to the FHB to offsite χ/Q values.

Table 4.7-1 -- Atmospheric Dispersion Factors

Receptor	Design Basis Case Five Percentile χ/Q (sec/m^3)				
	0-2 Hours	2-8 Hours	8-24 Hours	24-96 Hours	96-720 Hours
Control Room (with CROF)	3.1e-03	3.1e-03	1.8e-03	5.9e-04	9.6e-05
Control Room (without CROF)	3.1e-03	3.1e-03	1.8e-03	9.8e-04	2.4e-04
EAB	2.72e-04	Not Applicable	Not Applicable	Not Applicable	Not Applicable
LPZ	7.72e-06	7.72e-06	4.74e-06	3.67e-06	2.67e-06

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4.8 Dose Conversion Factors

Table 4.8-1 lists the dose conversion factors (DCFs) modeled in this calculation as input into the LOCADOSE computer program (References 6.6a and 6.6g) library file listed in Section 9.1. Table 4.8-1 lists only those iodine and noble gas isotopes which are present in the damaged fuel rod source term after 72 hours of decay (as identified in Design Input 4.1). DCFs are not presented for the particulate daughter products, since particulate isotopes are not released to the environment.

The thyroid inhalation DCFs are consistent with the requirements of the Technical Specification Section 1.1 definition for "DOSE EQUIVALENT I-131" (References 6.4c and 6.4d). Per this definition, the thyroid DCFs shall be those listed in ICRP Publication 30, Supplement to Part 1, pages 192-212, in tables titled "Committed Dose Equivalent in Target Organs or Tissues per Intake of Unit Activity" (Reference 6.6*l*). The ICRP-30 iodine inhalation DCFs are presented in units of Sieverts per Becquerel (Sv/Bq). Table 4.8-1 converts these DCFs to units of rem per curie as required for input into the LOCADOSE computer program by using conversion factors of 3.7e10 Bq/ci, and 100 rem/Sv.

The default whole body gamma immersion and beta skin immersion DCFs in the Bechtel LOCADOSE computer program will be used in this calculation. These DCFs are consistent with UFSAR Appendix 15B Table 15B-6 (Reference 6.4g).

TABLE 4.8-1 -- Dose Conversion Factors

Isotope	Thyroid Inhalation DCF [a] (Sv/Bq)	Thyroid Inhalation DCF [a] (rem/curie)	Beta Skin Immersion DCF (rem-m^3/curie-sec)	Whole Body Gamma Immersion DCF (rem-m^3/curie-sec)
Iodine-129	1.6e-06	5.92e+06	3.710e-04	3.024e-03
Iodine-130	2.0e-08	7.40e+04	4.990e-02	4.980e-01
Iodine-131	2.9e-07	1.07e+06	3.170e-02	8.720e-02
Iodine-132	1.7e-09	6.29e+03	1.320e-01	5.130e-01
Iodine-133	4.9e-08	1.81e+05	7.350e-02	1.550e-01
Iodine-135	8.5e-09	3.15e+04	1.290e-01	4.210e-01
Krypton-83m	0	0	0	2.396e-06
Krypton-85	0	0	4.246e-02	5.102e-04
Krypton-85m	0	0	4.626e-02	3.708e-02
Krypton-87	0	0	3.083e-01	1.876e-01
Krypton-88	0	0	7.510e-02	4.658e-01
Xenon-131m	0	0	1.508e-02	2.899e-03
Xenon-133m	0	0	3.150e-02	7.954e-03
Xenon-133	0	0	9.697e-03	9.316e-03
Xenon-135m	0	0	2.253e-02	9.887e-02
Xenon-135	0	0	5.894e-02	5.736e-02

(a) Sample Calculation for Iodine-131 Thyroid Inhalation Dose Conversion Factor
= (2.9e-7 Sv/Bq) × (3.7e10 Bq/ci) × (100 rem/Sv) = 1.07e6 rem/ci

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4.9 SOURCE2 Code Source Strength Spectrum Energy Structure

The gamma energy source strengths from the SOURCE2 output will be grouped into a "BASE10" gamma energy structure. The "BASE10" gamma energy structure is presented in Table 4.9-1. This energy structure is part of the SOURCE2 Code library (Reference 6.6c, Table 2-5).

TABLE 4.9-1 -- "BASE10" Gamma Energy Structure

Energy Group Number	Gamma Energy Ranges (MeV/γ-disintegration)
1	$0.0 \le E \le 0.1$
2	$0.1 < E \le 0.4$
3	$0.4 < E \le 0.9$
4	$0.9 < E \le 1.35$
5	$1.35 < E \le 1.80$
6	$1.80 < E \le 2.20$
7	$2.20 < E \le 2.60$
8	$2.60 < E \le 3.00$
9	$3.00 < E \le 5.00$
10	$5.00 < E \le 15.00$

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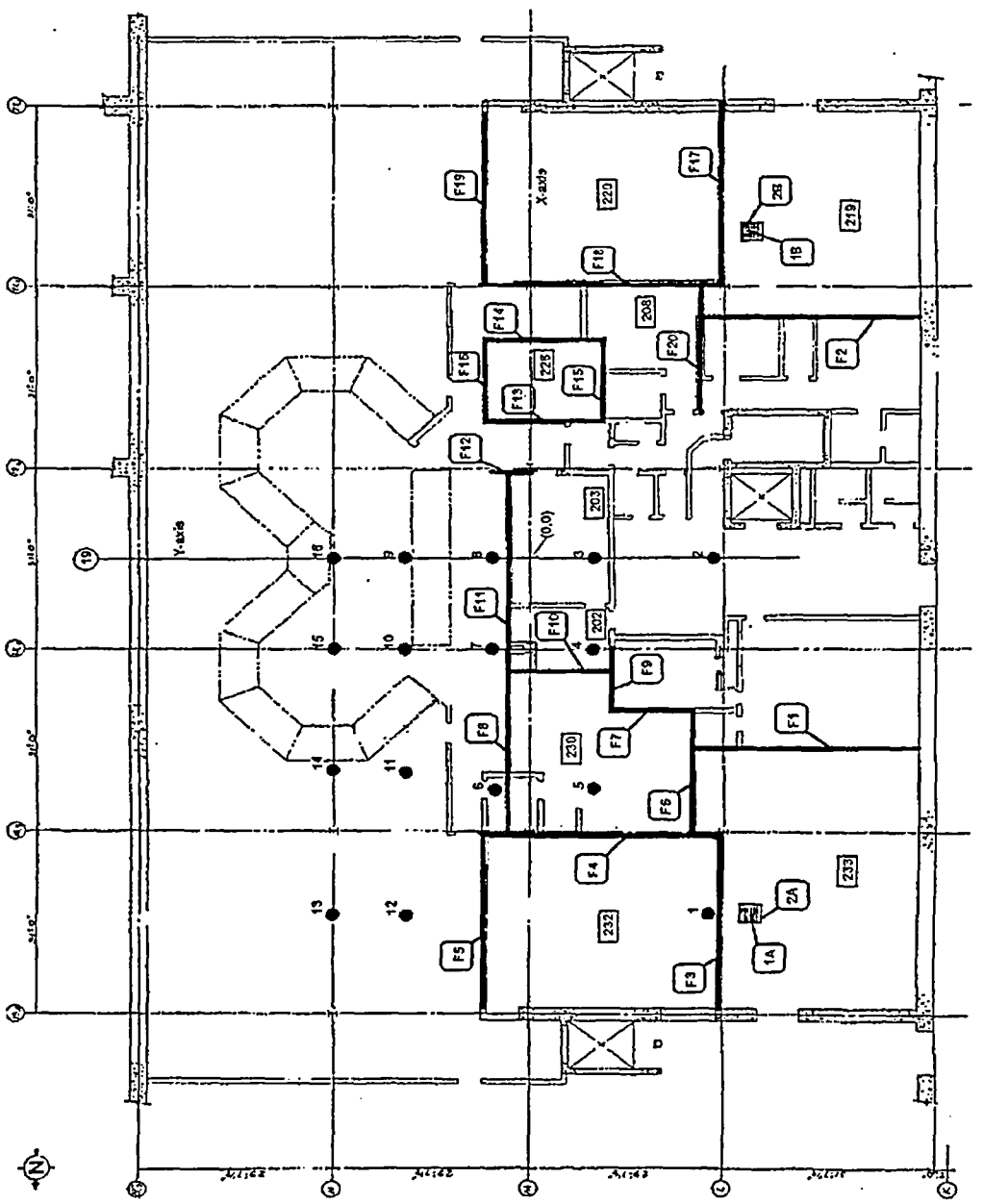
4.10 Control Room Dose Point Locations

Per Section 5.4, Dose Multiplication Factors (DMFs) are used to evaluate Environmental Cloud Shine and Control Room Filter Shine gamma doses. Calculations N-0450-002 (Reference 6.1g) and N-4060-016 (Reference 6.1k) determined DMFs for the 16 control room dose point locations shown in Figure 4-1. To simplify this analysis, doses will only be calculated at the four dose points representing the actual control board area (dose points 9, 10, 15, and 16). The maximum dose at these four dose points will be used to represent the Control Room Operator dose.

Per Calculations N-0450-002 and N-4060-016, Body 1A/2A in Figure 4-1 represents control room HVAC intake charcoal filter SA1510MA206, Body 1B/2B represents control room HVAC intake charcoal filter SA1510MA207, and Bodies F1 through F20 represent the control room fire walls that provide some shielding of the gamma radiation shine from the filters.

As discussed in Design Input 4.12, the dose point locations shown in Figure 4-1 reflect the scenario where filter A207 is secured at 8 hours, with all activity introduced into the control room after 8 hours being passed through filter A206. However, because either filter A206 or A207 could be the filter that is secured at 8 hours, the dose rates at each of the Figure 4-1 dose points should be considered as being approximately symmetrical about column 19 (which is the center of the control room).

Figure 4-1 -- Control Room Dose Point Locations



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4.11 Environmental Cloud Shine Dose Multiplication Factors – Control Room

Per Calculation N-0450-002 Table 2-3 (Reference 6.1g), the environmental cloud shine dose multiplication factors (DMFs) as functions of BASE10 gamma energies are given in Table 4.11-1 for the dose point 9, 10, 15 and 16 locations which represent the control board area that will be used to represent the Control Room Operator doses (per Design Input 4.10). These DMFs are in units of Rem/hr per MeV/cc-sec of environmental cloud volumetric source strength. Per Calculation N-0450-002, these DMFs consider the presence of contaminated air in the cable riser galleries to the north and south of the control room.

Table 4.11-1 - Environmental Cloud Shine to Control Room Dose Multiplication Factors

BASE10 Gamma Energy Range [MeV]	Effective Gamma Energy [MeV]	Environmental Cloud Shine Dose Multiplication Factors [Rem/hr per MeV/cc-sec]			
		at DP 9	at DP 10	at DP 15	at DP 16
$0.0 \le E \le 0.1$	0.1	5.22E-05	6.42E-05	5.78E-05	5.00E-05
$0.1 < E \le 0.4$	0.4	8.90E-05	1.11E-04	9.66E-05	8.44E-05
$0.4 < E \le 0.9$	0.8	9.26E-05	1.13E-04	9.89E-05	8.82E-05
$0.9 < E \le 1.35$	1.3	1.03E-04	1.22E-04	1.09E-04	9.92E-05
$1.35 < E \le 1.8$	1.7	1.10E-04	1.29E-04	1.16E-04	1.06E-04
$1.8 < E \le 2.2$	2.18	1.21E-04	1.40E-04	1.27E-04	1.18E-04
$2.2 < E \le 2.6$	2.5	1.27E-04	1.47E-04	1.34E-04	1.25E-04
$2.6 < E \le 3.0$	2.8	1.32E-04	1.51E-04	1.38E-04	1.30E-04
$3.0 < E \le 5.0$	4.0	1.48E-04	1.67E-04	1.55E-04	1.47E-04
$5.0 < E \le 10.0$	6.2	1.75E-04	1.93E-04	1.82E-04	1.74E-04

4.12 Control Room Filter Shine Dose Multiplication Factors

Per Calculation N-4060-016 Tables 2-2 and 2-3 (Reference 6.1k), the charcoal filters A206 and A207 shine dose multiplication factors (DMFs) as functions of BASE10 gamma energies are given in Tables 4.12-1 and 4.12-2 for the dose point 9, 10, 15 and 16 locations which represent the control board area that will be used to represent the Control Room Operator doses (per Design Input 4.10). These DMFs are in units of Rem/hr per MeV/cc-sec of charcoal filter volumetric source strength.

Per Calculation N-4060-016 Assumption 3.7, due to symmetry in the control room layout it does not matter which filter (A206 or A207) is assumed to be secured, as long as the dose points are on the side with the operating filter. Based on the dose point locations identified in Design Input 4.10, the control room filter shine DMFs were originated under the assumption that filter A207 is secured at 8 hours, with all activity introduced into the control room after 8 hours being passed through filter A206. As such, activity entering the control room after 8 hours contributes only to the filter A206 activity loading and volumetric source strength.

Per Assumption 3.5, all of the radioactive material released into the Fuel Handling Building atmosphere is assumed to be released to the outside environment over a two hour interval. Therefore, no additional activity will be deposited after 8 hours onto either of the control room filters. Consequently the filters A206 and A207 activity loadings and volumetric source strengths will be identical.

Table 4.12-1 -- Charcoal Filter A206 Shine Dose Multiplication Factors

BASE10 Gamma Energy Range [MeV]	Effective Gamma Energy [MeV]	Filter A206 Shine Dose Multiplication Factors [Rem/hr per MeV/cc-sec]			
		at DP 9	at DP 10	at DP 15	at DP 16
$0.0 \le E \le 0.1$	0.1	2.19E-10	6.15E-10	4.41E-10	3.39E-10
$0.1 < E \le 0.4$	0.4	1.74E-09	3.28E-09	2.43E-09	1.90E-09
$0.4 < E \le 0.9$	0.8	2.02E-09	3.45E-09	2.58E-09	2.02E-09
$0.9 < E \le 1.35$	1.3	2.09E-09	3.38E-09	2.55E-09	2.00E-09
$1.35 < E \le 1.8$	1.7	2.05E-09	3.24E-09	2.45E-09	1.92E-09
$1.8 < E \le 2.2$	2.18	2.02E-09	3.13E-09	2.37E-09	1.86E-09
$2.2 < E \le 2.6$	2.5	1.99E-09	3.06E-09	2.32E-09	1.82E-09
$2.6 < E \le 3.0$	2.8	1.95E-09	2.97E-09	2.25E-09	1.77E-09
$3.0 < E \le 5.0$	4.0	1.78E-09	2.68E-09	2.04E-09	1.60E-09
$5.0 < E \le 10.0$	6.2	1.60E-09	2.38E-09	1.81E-09	1.42E-09

Table 4.12-2 -- Charcoal Filter A207 Shine Dose Multiplication Factors

BASE10 Gamma Energy Range [MeV]	Effective Gamma Energy [MeV]	Filter A207 Shine Dose Multiplication Factors [Rem/hr per MeV/cc-sec]			
		at DP 9	at DP 10	at DP 15	at DP 16
0.0 ≤ E ≤ 0.1	0.1	1.11E-10	1.26E-10	2.96E-11	1.91E-10
0.1 < E ≤ 0.4	0.4	1.34E-09	1.21E-09	5.52E-10	1.55E-09
0.4 < E ≤ 0.9	0.8	1.74E-09	1.49E-09	8.04E-10	1.81E-09
0.9 < E ≤ 1.35	1.3	1.93E-09	1.60E-09	9.57E-10	1.89E-09
1.35 < E ≤ 1.8	1.7	1.95E-09	1.59E-09	9.94E-10	1.86E-09
1.8 < E ≤ 2.2	2.18	1.97E-09	1.59E-09	1.03E-09	1.83E-09
2.2 < E ≤ 2.6	2.5	1.96E-09	1.58E-09	1.04E-09	1.81E-09
2.6 < E ≤ 3.0	2.8	1.93E-09	1.54E-09	1.03E-09	1.77E-09
3.0 < E ≤ 5.0	4.0	1.80E-09	1.43E-09	9.83E-10	1.62E-09
5.0 < E ≤ 10.0	6.2	1.64E-09	1.29E-09	9.10E-10	1.46e-09

4.13 Average Fuel Rod Maximum Internal Pressures

4.13.1 Unit 2 Cycle 12 Power Operations. Per Unit 2 Cycle 12 Fuel Performance Analysis NFM-2-FP-1202 (Reference 6.1*l*, Section 4.12 and Table 4-19), for U2C12 Batch M/N/P erbia and UO_2 fuel, the maximum rod internal pressures at both hot and cold (70 °F) plenum temperatures including temporary gas release as a function of void (rod gap) volume occur at approximately 50 GWD/MTU are as presented in Table 4.13-1.

Table 4.13-1 — U2C12 Maximum Rod Internal Pressures for FHA Dose Calculations

Rod Description	Plenum Temperature (degrees Fahrenheit)	Void Volume (cubic inches)	Rod Internal Pressure [temporary gas release] (psia)
U2C12 Batch P Erbia	615	0.8730	1,866.5
	70	1.1213	716.2
U2C12 Batch P UO_2	614	0.8946	1,615.3
	70	1.1210	636.3
U2C12 Batch M/N Erbia	615	0.8535	1,909.9
	70	1.1046	727.2
U2C12 Batch M/N UO_2	614	0.8766	1,648.8
	70	1.1062	644.9

4.13.2 Unit 3 Cycle 12 Power Operations. Per Unit 3 Cycle 12 Fuel Performance Analysis NFM-3-FP-1202 (Reference 6.1m, Section 4.12 and Table 3.3.6-2), for U3C12 Batch K/M/N/P erbia and UO_2 fuel, the maximum rod internal pressures at both hot and cold (70 °F) plenum temperatures including temporary gas release as a function of void (rod gap) volume occur at approximately 50 GWD/MTU are as presented in Table 4.13-2.

Table 4.13-2 — U3C12 Maximum Rod Internal Pressures for FHA Dose Calculations

Rod Description	Plenum Temperature (degrees Fahrenheit)	Void Volume (cubic inches)	Rod Internal Pressure [temporary gas release] (psia)
U3C12 Batch P Erbia	618	0.8872	2,041.2
	70	1.1440	778.4
U3C12 Batch P UO_2	615	0.9081	1,752.5
	70	1.1398	688.3
U3C12 Batch M/N Erbia	618	0.8402	2,135.5
	70	1.1005	801.5
U3C12 Batch M/N UO_2	616	0.8624	1,824.2
	70	1.0975	706.3
U3C12 Batch K UO_2	616	0.9984	1,745.1
	70	1.3072	656.6

4.14 Spent Fuel Pool Water Temperature

Per Calculation M-0022-008 (Reference 6.1b, CCN-4 page A-5), the maximum spent fuel pool water temperature is 167 °F for the case of a full core offload with consolidated spent fuel storage.

4.15 Water Level Above Irradiated Fuel Assemblies in the Spent Fuel Pool

4.15.1 Water Level Above a Damaged Fuel Assembly Stored in the Spent Fuel Pool. Per Technical Specification LCO 3.7.16 (References 6.4c and 6.4d), the fuel storage pool water (i.e., spent fuel pool) level must be at least 23 feet over the top of irradiated fuel assemblies seated in the storage racks during the movement of irradiated fuel assemblies in the fuel storage pool.

Per Units 2&3 Licensee Controlled Specification 3.7.117 (References 6.4e & 6.4f), the fuel storage pool water level must be at least 23 feet over the top of irradiated fuel assemblies seated in the storage racks when no fuel movement is being performed in the fuel storage pool.

4.15.2 Water Level Above a Damaged Fuel Assembly Laying on Top of the Storage Racks.

The plant elevation at the top of the fuel storage racks has not been found in any plant document, so it will be calculated in Section 8.2.1.2 using the following input data:

The top of the original SFP liner plate is at plant elevation 17'- 6 $^{3}/_{16}$" per drawing 25429 (Reference 6.2i, Section A).

The reliner steel plate attached to the original SFP liner plate during the SFP rerack project has a thickness of 0.125" per drawing 23186 (Reference 6.2c, Section A) as called out on drawing 25453 (Reference 6.2j).

The maximum distance between the reliner plate and the top of the rack support block is 5.32" per drawings 25472 (Reference 6.2k) and 25483 (Reference 6.2l).

The distance between the top of the rack support block and the top of the fuel storage racks is 193.50" per drawings 25472 and 25483.

The width of a fuel assembly is 8.29 inches per drawing SO23-990-228 (Reference 6.2ad).

As discussed in the Technical Specification LCO 3.7.16 (References 6.4c and 6.4d), an increased SFP water level will ensure at least 23 feet of water above a damaged fuel assembly laying on the racks. Per the Tech Spec LCO 3.7.16 Bases, this increased water level is required by Technical Specification LCO 3.9.6 (References 6.4c and 6.4d) when the SFP is connected to the refueling cavity, and is a procedural requirement whenever fuel is being moved. Per Tech Spec LCO 3.9.6, during movement of irradiated fuel assemblies within containment, the refueling water level shall be at least 23 feet above the top of the reactor vessel flange. Per Operating Instruction SO23-3-2.11 (Reference 6.5c, Attachment 18) a water level of 23 feet above the top of the reactor vessel flange is equivalent to plant elevation 60'-6", which is 27'-6 $^{1}/_{2}$" above the top of the fuel assemblies stored in the SFP storage racks.

To ensure that the Tech Spec LCO 3.9.6 height requirement is met, when moving a spent fuel assembly

Site Technical Services Procedures SO23-X-7 (Reference 6.5d, Attachment 2) and SO23-X-7.2 (Reference 6.5e, Attachment 2) require that the SFP water level shall be at least 27'-8 $^{1}/_{16}$" above the top of the fuel assemblies stored in the SFP storage racks (i.e., equivalent to plant elevation 60'-7 $^{9}/_{16}$") . This analysis uses a SFP water level of 27'-8 $^{1}/_{16}$", which is conservatively smaller than the 27'-8 $^{1}/_{2}$" value (i.e., plant elevation 60'-8") cited in Operating Instruction SO23-3-2.11 Attachment 18.

4.16 Concrete Wall Thicknesses

The contaminated air inside the Fuel Handling Building is a gamma radiation shine source contributing to the Control Room Operator dose. Per Architectural Floor Plan drawings 10101 (Reference 6.2a) and 10112 (Reference 6.2b), the FHB shine dose to the control room is attenuated by the intervening presence of a number of concrete building walls. The following concrete walls are considered in the FHB shine dose evaluation:

Unit 2 FHB Shine to Control Room Operating Area:

Unit 2 FHB West Wall	2' 6" thick	(per drawing 25401 [Reference 6.2h])
Unit 2 FHB South Wall	2' 6" thick	(per drawing 25401 [Reference 6.2h])
Radwaste Building North Wall	2' 6" thick	(per drawing 25004 [Reference 6.2d])
Control Room East Wall	2' 6" thick	(per drawing 25102 [Reference 6.2f])

Unit 3 FHB Shine to Control Room Operating Area:

Unit 3 FHB West Wall	2' 6" thick	(per drawing 25401 [Reference 6.2h])
Unit 3 FHB North Wall	2' 6" thick	(per drawing 25401 [Reference 6.2h])
Radwaste Building South Wall	2' 6" thick	(per drawing 25005 [Reference 6.2e])
Control Room East Wall	2' 6" thick	(per drawing 25103 [Reference 6.2g])

4.17 Fuel Rod Dimensions

Per Unit 2 Cycle 12 Fuel Performance Analysis NFM-2-FP-1202 (Reference 6.1*l*, Table 4-1) and Per Unit 3 Cycle 12 Fuel Performance Analysis NFM-3-FP-1202 (Reference 6.1m, Table 4-1) the inner radius of the cladding is 0.332 inches, the outer radius of the cladding is 0.382 inches, and the active length of the fuel rod is 150 inches (12.5 feet).

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

5.0 METHODOLOGY

5.1 General Methodology

Following a Fuel Handling Accident inside the Fuel Handling Building (FHA-FHB), core activity is dispersed into the FHB atmosphere, and from there, to the Control Room and the offsite Exclusion Area Boundary (EAB) and Low Population Zone (LPZ) locations.

The control room dose evaluation considers the following radiation sources:

- Immersion and inhalation within the cloud inside the control room (Section 5.3)
- Gamma radiation shine from the contaminated Fuel Handling Building air (Section 5.4.1)
- Gamma radiation shine from the environmental cloud outside the Control Room Envelope (Section 5.4.2)
- Gamma radiation shine from the emergency control room charcoal filter (Section 5.4.3)

The EAB and LPZ dose evaluations consider the following radiation sources:

- Immersion and inhalation within the environmental cloud at the Offsite locations (Section 5.3)
- Gamma radiation shine from the contaminated Fuel Handling Building air (Section 5.4.1)

The FHA is evaluated with credit taken for a high radiation induced Control Room Isolation Signal (CRIS) which places the Control Room HVAC system into the high radiation isolation mode, and starts both trains of the control room essential HVAC system.

This calculation uses the LOCADOSE (References 6.6a and 6.6g) and SOURCE2 (Reference 6.6c) computer codes to evaluate the doses of interest. These computer codes are described in Section 5.2.

5.2 Computer Code Descriptions

5.2.1 LOCADOSE Computer Code Description.

The inhalation and immersion doses due to the Fuel Handling Accident activity release mechanism will be evaluated with Version 3.0 of Bechtel Standard Computer Program NE-319, "LOCADOSE" (Reference 6.6a) and Version 6.0 of Bechtel Standard Computer Program NE-319, "LOCADOSE" (Reference 6.6g) for the 10 cfm and 1,000 cfm cases, respectively. The LOCADOSE Code consists of three modules: an activity transport program, a dose calculation program, and a filter loading program. The first two modules are 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 production can be performed by this program. Activities, time 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 doses and dose rates. 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 RISC 6000 workstation. Use of the LOCADOSE Code (Version 3.0) on the NFM RISC 6000 workstation has been verified and validated as detailed in a Software Installation Report (Reference 6.6b).

Four error notices have been issued against the LOCADOSE Code Version 3.0:

Bechtel Error Notice 93-1 (Reference 6.6a, issued on July 30, 1993) relates to the modeling of containment spray operation. Since containment sprays are not modeled in this calculation, Bechtel Error Notice 93-1 does not affect this calculation.

SCE Error Number 1 (Reference 6.6a, issued on August 22, 1997) relates to the formatting of the LOCADOSE Dose input file when requesting dose rate output. The concerns addressed in SCE Error Number 1 have been addressed by the proper formatting of the LOCADOSE dose input file.

SCE Error Number 2 (Reference 6.6a, issued on November 9, 1998) addresses the same concern documented in SCE Error Number 1 (the error was addressed for a second time to provide closure to Bechtel LOCADOSE Code Error Notice 98-1). The concerns addressed in SCE Error Number 2 have been addressed by the proper formatting of the LOCADOSE dose input file.

SCE Error Number 3 (Reference 6.6a, issued on November 9, 1998) relates to an error present only in LOCADOSE Version 4.2. Since this calculation employs LOCADOSE Version 3.0, no action is required.

The LOCADOSE Code Version 6.0 was executed on the Nuclear Fuel Management NT station (Device ID D038771). Use of the LOCADOSE Code Version 6.0 has been verified and validated as detailed in a Software Installation Report (Reference 6.6i).

Two error notices havebeen issued against the LOCADOSE Code Version 6.0 Release:

Bechtel Computer Program Error notice 2001-4 (issued on March 29, 2001) (SONGSAPP Defect #2) dealt with input file translation program *TransLat.exe* which converted releases 4 and 5 files to release 6. Since LOCADOSE Release 6.0 was used in Revision 6 of this calculation no conversion was necessary. Therefore, this error notice does not impact this calculation, and

Bechtel Computer Program Error notice 2002-1 (issued on September 4, 2002) (SONGSAPP Defect #36). Error notice 2002-1 identified errors in the Filter Loading Program Module (FiltLoad). These errors include an overestimation of the filter activity loading that yelds dose and filter temperature consequences that are conservatively more severe, and a condition that FiltLoad will about with a math error if Te-131 is included as an isotope. Since the FiltLoad Module is not used in this calculation, this error notice does not impact this analysis.

Section 9.2 of this calculation presents the library, input and output files associated with the LOCADOSE Code analysis.

5.2.2 SOURCE2 Computer Code Description

Calculation of Gamma radiation shine doses requires determination of gamma source strength spectra. Each gamma source strength spectrum will be evaluated with Version D2-5 of Bechtel Standard Computer Program NE-602, "SOURCE2". The SOURCE2 Code determines the gamma source strength spectrum from a user specified energy grouping arrangement and a User specified activity profile. The activity profile represents the total number of curies of each isotope present in the radiation source.

To calculate control room gamma radiation shine dose rates in units of Rem/hr using the Dose Multiplication Factors presented in Design Inputs 4.11 and 4.12 requires input in the form of a gamma source strength spectrum in units of MeV/cc-sec. The SOURCE2 Code will calculate gamma source strength spectrum in units of MeV/cc-sec with input from LOCADOSE in the form of total Curies per isotope for the node of interest, and a Code Multiplier equivalent to one over the nodal volume (1/cc).

The SOURCE2 Code is executed on the Nuclear Fuel Management RISC 6000 workstation. Use of the SOURCE2 Code on the NFM RISC 6000 workstation has been verified and validated as detailed in a Software Installation Report (Reference 6.6d).

No error notices have been issued against the SOURCE2 Code.

Section 9.3 of this calculation presents the input and output files associated with the SOURCE2 Code analysis.

5.3 EAB, LPZ and Inside Control Room Cloud Doses

The immersion and inhalation doses within the environmental cloud at the Exclusion Area Boundary and at the outer boundary of the Low Population Zone, and the immersion and inhalation doses within the cloud inside the control room are evaluated with the LOCADOSE Code using the appropriate assumptions and design inputs from Sections 3 and 4.

The LOCADOSE Code model for the Fuel Handling Accident inside the Fuel Handling Building (FHA-FHB) sequence will be set up with four regions and two offsite dose receptors. As required by the LOCADOSE Code region numbering convention, Region 1 represents the outside environment, and the last region (Region 4) represents the control room. Offsite dose receptor 1 represents an individual at the EAB, and offsite dose receptor 2 represents an individual at the outer boundary of the LPZ. Additionally, a third offsite location is modeled to determine onsite dose at the control room HVAC intake.

Figures 5.3-1 through 5.3-3 show the LOCADOSE Code models used, including information on region volumes, flowrates, and filter removal of iodines (I), noble gases (NG), and particulates (P). The primary difference between the figures is the depiction of control room (CR) HVAC operation prior to and after control room isolation (as detailed in Design Input 4.4):

Figure 5.3-1 depicts CR HVAC operation prior to control room isolation, with the CR HVAC operating in normal mode.

Figure 5.3-2 depicts CR HVAC operation after control room isolation, with both trains of the CR HVAC operating in emergency mode during the first 8 hours of the FHA-FHB event.

Figure 5.3-3 depicts CR HVAC operation after control room isolation, with one train of the CR HVAC operating in emergency mode after the first 8 hours of the FHA-FHB event.

As will be discussed in Section 5.4.3, the control room charcoal filter shine dose is dependent on the CR HVAC intake filters' instantaneous activity loading at various times during the FHA event. Due to atmospheric dispersion, only a portion of the FHB activity release will become entrained in the Control Room HVAC intake flow. To analyze this dispersion and intake into the control room, Figures 5.3-1 through 5.3-3 show the LOCADOSE Code modeling a direct flowpath between the Fuel Handling Building (Region 2) and a Control Room HVAC Intake Filter (Region 3). Section 8.6 calculates the unfiltered flow rate equivalent to the portion of the FHB activity release which becomes entrained in the Control Room HVAC intake flow.

Figure 5.3-1
LOCADOSE Model prior to CR Isolation
CR HVAC In Normal Mode (Neither CR Isolation nor CREACUS Operation)

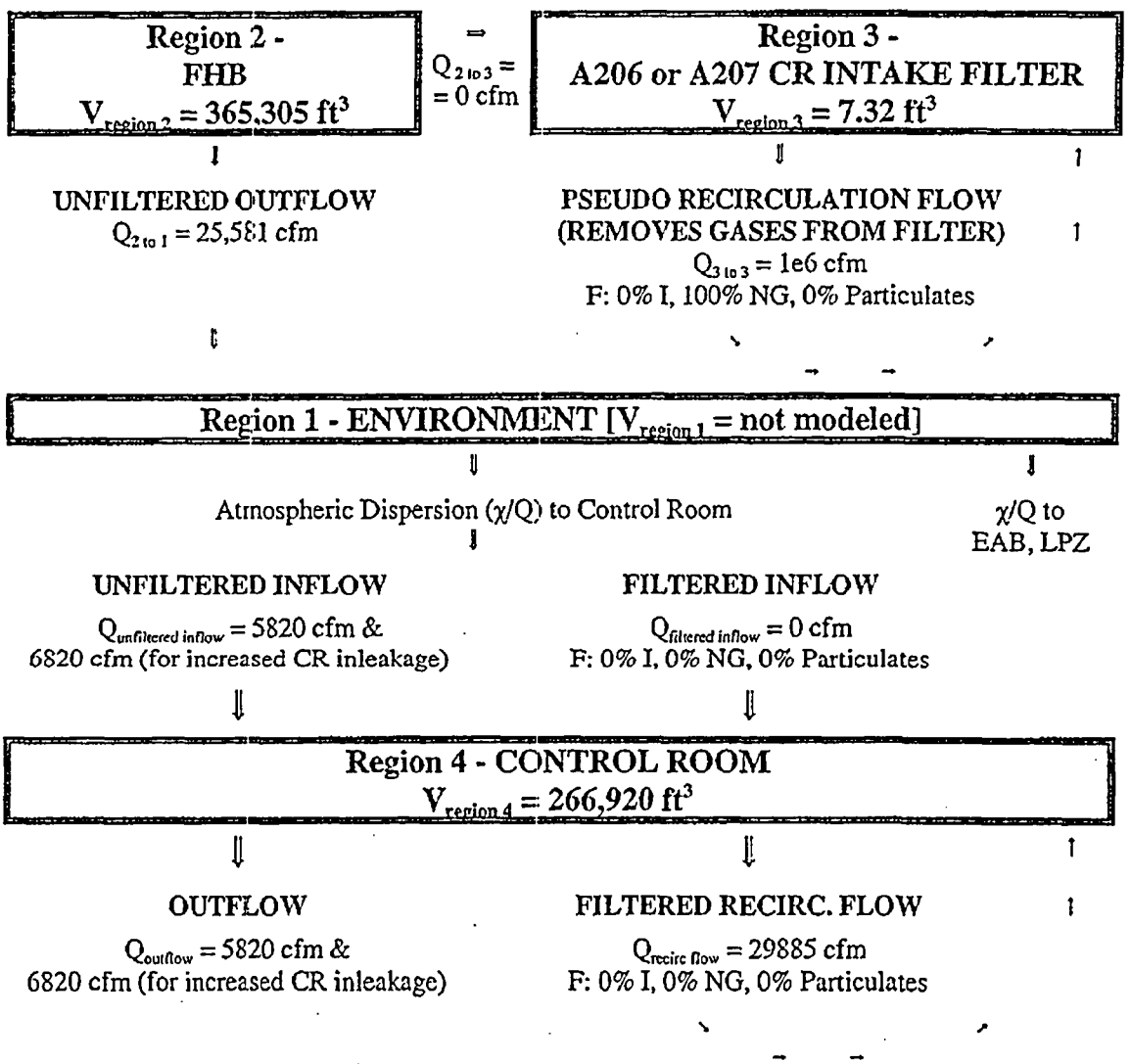

Figure 5.3-2
LOCADOSE Model after CR Isolation and prior to 8 hours
2 Trains of CR HVAC in Emergency Mode (by a High Radiation Induced CRIS)

Region 2 - FHB
$V_{region\ 2} = 365{,}305\ ft^3$

⇒ $Q_{2\ to\ 3} =$ 82 cfm

Region 3 - A206 or A207 CR INTAKE FILTER
$V_{region\ 3} = 7.32\ ft^3$

UNFILTERED OUTFLOW
$Q_{2\ to\ 1} = 25{,}581$ cfm - 82 cfm
$\therefore Q_{2\ to\ 1} = 25{,}499$ cfm

PSEUDO RECIRCULATION FLOW (REMOVES GASES FROM FILTER) 1
$Q_{3\ to\ 3} = 1e6$ cfm
F: 0% I, 100% NG, 0% Particulates

Region 1 - ENVIRONMENT [$V_{region\ 1}$ = not modeled]

Atmospheric Dispersion (χ/Q) to Control Room

χ/Q to EAB, LPZ

UNFILTERED INFLOW
$Q_{unfiltered\ inflow} = 10$ cfm & 1000 cfm (for increased CR inleakage)

FILTERED INFLOW
$Q_{filtered\ inflow} = 4400$ cfm [2 trains]
F: 95% $I_{elem.}$, 95% $I_{org.}$, 99% $I_{partic.}$, 0% NG, 99% Particulates

Region 4 - CONTROL ROOM
$V_{region\ 4} = 266{,}920\ ft^3$

OUTFLOW
$Q_{outflow} = 4410$ cfm & 5400 cfm (for increased CR inleakage)

FILTERED RECIRC. FLOW 1
$Q_{recirc\ flow} = 59869$ cfm [2 trains]
F: 95% $I_{elem.}$, 95% $I_{org.}$, 99% $I_{partic.}$, 0% NG, 99% Particulates

Figure 5.3-3
LOCADOSE Model after 8 hours
1 Train of CR HVAC in Emergency Mode (by a High Radiation Induced CRIS)

Region 2 - FHB
$V_{region\,2} = 365{,}305\ ft^3$

$Q_{2\,to\,3} = 82$ cfm

Region 3 - A206 or A207 CR INTAKE FILTER
$V_{region\,3} = 7.32\ ft^3$

UNFILTERED OUTFLOW
$Q_{2\,to\,1} = 25{,}581$ cfm - 82 cfm
$\therefore Q_{2\,to\,1} = 25{,}499$ cfm

PSEUDO RECIRCULATION FLOW (REMOVES GASES FROM FILTER)
$Q_{3\,to\,3} = 1e6$ cfm
F: 0% I, 100% NG, 0% Particulates

Region 1 - ENVIRONMENT [$V_{region\,1}$ = not modeled]

Atmospheric Dispersion (χ/Q) to Control Room

χ/Q to EAB, LPZ

UNFILTERED INFLOW
$Q_{unfiltered\,inflow} = 10$ cfm & 1000 cfm (for increased CR inleakage)

FILTERED INFLOW
$Q_{filtered\,inflow} = 2200$ cfm [1 train]
F: 95% I_{elem}, 95% I_{org}, 99% I_{partic}, 0% NG, 99% Particulates

Region 4 - CONTROL ROOM
$V_{region\,4} = 266{,}920\ ft^3$

OUTFLOW
$Q_{outflow} = 2210$ cfm & 3200 cfm (for increased CR inleakage)

FILTERED RECIRC. FLOW
$Q_{recirc\,flow} = 29934$ cfm [1 train]
F: 95% I_{elem}, 95% I_{org}, 99% I_{partic}, 0% NG, 99% Particulates

5.4 Gamma Radiation Shine Contributions to the Whole Body Dose

In addition to thyroid inhalation, whole body gamma cloud immersion, and beta skin cloud immersion doses determined with the LOCADOSE Code, this calculation considers contributions to the whole body gamma dose from Fuel Handling Building shine, environmental cloud shine, and control room charcoal filter shine. The general method used to calculate these shine doses is:

- Determine shine instantaneous gamma source strengths as a function of time with the SOURCE2 Code using shine source activity loading and applicable dilution volume as code input parameters.
- Determine shine dose rate as a function of time by scaling the shine instantaneous gamma source strength with the Dose Multiplication Factors (DMFs) presented in Design Inputs 4.11 and 4.12.
- Determine the accident duration whole body gamma shine dose by integrating the shine dose rate profile and considering applicable occupancy factors.

5.4.1 Fuel Handling Building Shine

The contaminated air inside the Fuel Handling Building is a gamma radiation shine source for the Control Room and offsite EAB and LPZ dose receptors.

The shine doses at distant locations such as the EAB and LPZ are typically much less than the offsite immersion doses due to the activity release. This is confirmed by a comparison of the post-LOCA containment shine and offsite immersion doses documented in Calculation N-4061-002 (Reference 6.1j, Sections 8.7 and 8.9). These post-LOCA doses show that the containment shine dose is at least two orders of magnitude (a factor of 100) smaller than the offsite immersion doses. Therefore, if the immersion doses calculated at the EAB and LPZ dose receptors are small (e.g., less than 1 rem), then the direct gamma radiation shine dose from the FHB to the EAB and LPZ will be negligible (i.e., < 0.01 rem), and it will not be necessary to calculate the FHB shine dose at the offsite locations.

The FHB shine dose to the control room may be trivial due to the intervening presence of numerous concrete building walls. Section 8.7 evaluates the radiation shine path between the FHB and the control room.

5.4.2 Environmental Cloud Shine Dose Rates

The contaminated air in the environmental cloud outside of the control room envelope is a gamma radiation shine source for the Control Room dose receptor (the environmental cloud dose contributions to the offsite EAB and LPZ dose receptors are considered in the offsite immersion dose as evaluated with the LOCADOSE Code).

To calculate the environmental shine contributions to the Control Room Operator whole body dose, the source term in the environmental cloud must be calculated. This is performed using the following equation which scales the Fuel Handling Building cloud source term by the FHB release flow rate (thereby determining the source term release rate to the environment), and then scaling by the control room atmospheric dispersion factor (thereby determining the environmental cloud source term at the control room HVAC intake):

$$S_e(t) = S_c(t) \times F \times \frac{\chi}{Q}(t)$$

where:

$S_e(t)$ environmental cloud source term in MeV/cc-sec
$S_c(t)$ FHB cloud source term in MeV/cc-sec [calculated per Section 5.4.1]
F FHB release flow rate in m^3/sec [per Section 8.4]
$\chi/Q(t)$ control room atmospheric dispersion factor in sec/m^3 [per Design Input 4.7]

The environmental cloud source term is then multiplied by the environmental cloud shine DMFs from Design Input 4.11 to generate Control Room Operator dose rates. The dose rates will be time integrated using the Section 5.4.4 methodology to determine the accident duration environmental cloud shine dose.

5.4.3 Control Room Charcoal Filter Shine Dose Rates

Per Design Input 4.4.2, in the high radiation isolation mode the makeup air entering the control room passes through filters SA1510MA206 and SA1510MA207 (A206 and A207) of the Emergency Ventilation System train, and then through filters SA1510ME418 and SA1510ME419 (E418 and E419) of the Emergency Air Conditioner filter train. Per Assumption 3.13, for the purpose of determining the shine dose contribution from the control room HVAC filters, CR HVAC intake filters A206 and A207 are assumed to be 100% efficient at removing iodine and particulates from the incoming air. This maximizes the amount of iodine and particulates retained on A206 and A207, and thus maximizes the shine dose from these two filters. In reality, iodine and particulates that are not trapped on the intake filters will eventually be trapped on recirculation filters E418 and E419, which are located in the vicinity of the intake filters per Drawing 40002 Sheet 1 (Reference 6.2o). However, the results of the filter shine dose calculation would not be significantly different, since the geometry of the direct shine pathways from E418 and E419 is similar to the geometry of the direct shine pathways from A206 and A207.

The SOURCE2 Code will be used to determine the control room HVAC intake filters instantaneous gamma source strengths (MeV/cc-sec), which will be multiplied by the control room filter shine DMFs from Design Input 4.12 to calculate the filter shine contribution to the Control Room Operator whole body gamma dose rates. The dose rates will be time integrated using the Section 5.4.4 methodology to determine the accident duration filter shine dose. Input to the SOURCE2 Code consists of the BASE10 gamma energy structure (per Design Input 4.9), the CR HVAC intake filters' instantaneous activity loading (ci) at various times during the FHA-FHB event (based on the LOCADOSE transport activity

program), and a SOURCE2 Code Multiplier representing one over the CR HVAC intake filter volume (cc^{-1}). Per Assumption 3.14, the volume of each CR HVAC intake filter is 7.32 ft^3 with a corresponding inverse volume of 4.824e-6 cm^{-3}.

The LOCADOSE Code computer run will be used to determine the time dependent filter activity loading (ci) entered into the SOURCE2 Code. Due to atmospheric dispersion, only a portion of the Fuel Handling Building activity release will become entrained in the Control Room HVAC intake flow. To analyze this dispersion and intake into the control room, the LOCADOSE Code will model a direct flowpath between the FHB (Region 2) and the Control Room HVAC intake filter (Region 3). The Region 2 to 3 flowrate will account for the atmospheric dispersion of the Fuel Handling Building activity release, and the actual intake flow rate into the CR HVAC intake filter. Although atmospheric dispersion between the Fuel Handling Building and control room varies with time, per Design Input 4.3.2 the FHB exhaust flowrate that will be modeled will ensure that virtually all of the activity is released from the FHB during the first 2 hours of the event. Therefore, a single Region 2 to 3 flowrate determined by using the 0-8 hour Control Room atmospheric dispersion factor from Design Input 4.7 will be applied for the 30 day analysis duration. Section 8.6 calculates the unfiltered flow rate equivalent to the portion of the FHB activity release which becomes entrained in the Control Room HVAC intake flow.

Since a Control Room HVAC intake filter (Region 3) does not retain noble gases, the LOCADOSE Code will model a "Region 3 recirculation filter" (with an arbitrary flowrate of 1,000,000 cfm and a noble gas filter efficiency of 100 percent) to remove the noble gases that enter Region 3. To maximize the filter shine dose, the LOCADOSE Code will not model a "Region 3 exhaust flow"; this effectively retains 100 percent (less radioactive decay) of the iodine and particulates entering Region 3. Although a large filtered flowrate has been modeled in an effort to prevent the LOCADOSE Code from showing an accumulation of noble gases on the Control Room HVAC intake filter, a review of the LOCADOSE Code output may show the presence of some trace noble gas activity in Region 3 at the end of each time step. Since noble gas activity will not be collected on the CR HVAC intake filter, the SOURCE2 Code input file used to determine instantaneous gamma source strength spectra for the filter shine analysis will zero out the CR HVAC intake filter noble gas activity values.

5.4.4 Determination of 30-Day Time Integrated Doses

The time integrated doses from the shine gamma sources is determined by integrating the instantaneous dose rates determined using the methodology of Sections 5.4.2 and 5.4.3 over the 30 day event duration. The integration method is based on the premise that the activity (and hence the dose rate) in any region between any two times (t_1 and t_2) will behave as an exponential of the form:

$$DR(t) = DR_1 e^{-\lambda(t-t_1)} \qquad (1)$$

Therefore, at time t_2 the dose rate is given by:

$$DR_2 = DR_1 e^{-\lambda(t_2-t_1)} \qquad (2)$$

The effective decay constant λ for the t_1 to t_2 time interval can be calculated from the above equation to be:

$$\lambda = -\frac{\ln(DR_2/DR_1)}{(t_2-t_1)} \qquad (3)$$

Integrating the instantaneous dose rate DR(t) between times t_1 and t_2, and applying the Control Room Occupancy Factor (CROF) from Design Input 4.6 yields:

$$D = \int DR(t)dt = CROF \times \int_{t_1}^{t_2} DR_1 e^{-\lambda(t-t_1)}dt \qquad (4)$$

$$= - CROF \times \frac{DR_1}{\lambda} \left| e^{-\lambda(t-t_1)} \right|_{t_1}^{t_2} \qquad (5)$$

$$= - CROF \times \frac{DR_1}{\lambda} [e^{-\lambda(t_2-t_1)} - 1] \qquad (6)$$

$$= - CROF \times \frac{1}{\lambda} [DR_1 e^{-\lambda(t_2-t_1)} - DR_1] \qquad (7)$$

Inserting equation 2 and then equation 3 into equation 7 yields the following time integrated dose for the t_1 to t_2 time interval:

$$D = \int DR(t)dt = CROF \times \frac{(DR_2 - DR_1)}{\ln(DR_2/DR_1)} (t_2 - t_1) \qquad (8)$$

NOTE 1: The natural logarithm function in the equation 8 denominator will yield inaccurate integrated dose results under certain conditions. To eliminate this concern, the following limitations are placed on the use of equation 8:

1) if $DR_1 = DR_2$ then $D = (DR_1 + DR_2)(t_2 - t_1) / 2$

2) if $DR_1 = 0$, and/or $DR_2 = 0$ then $D = (DR_1 + DR_2)(t_2 - t_1) / 2$
(i.e., a trapezoidal approximation is employed to estimate the integrated dose)

NOTE 2: Due to inclusion of the Control Room Occupancy Factor in this derivation, the actual 30 day shine dose to equipment in the Control Room is higher than that calculated with Equation 8. The Section 10 Quattro-Pro spreadsheets determine 30 day shine doses with and without consideration of the CROF.

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6.0 REFERENCES

6.1 Calculations

6.1a Units 2&3 Calculation DC-1522, Revision 2, "Level Indicators for Spent Fuel Pool and Reactor Cavity"

6.1b Units 2&3 Calculation M-0022-008, Revision 2 (including CCNs 1 through 4), "Spent Fuel Pool Heat Exchanger Performance"

6.1c Units 2&3 Calculation M-0073-041, Revision 8 (including CCNs 20, 22 through 25), "Auxiliary Building - Control Area El. 30'-0" Control Room Complex - Heat Load Calculation"

6.1d DELETED

6.1e Units 2&3 Calculation M-0073-095, Revision 3 (including CCNs 1 through 4), "Infiltration into the Control Room Envelope from Surrounding Areas"

6.1f Units 2&3 Calculation M-0076-001, Revision 3 (including CCNs 1, 2, 3, 5, 6, 7 and Supplement A), "Fuel Handling Building, Normal Cooling System, Heat Load Calculation"

6.1g Units 2&3 Calculation N-0450-002, Revision 1, "Control Room Doses to Personnel"

6.1h Units 2&3 Calculation N-4010-001, Revision 5 (including CCNs 2 and 3), "Control Room χ/Qs"

6.1i Units 2&3 Calculation N-4010-002, Revision 1, "EAB and LPZ χ/Q values"

6.1j Units 2&3 Calculation N-4061-002, Revision 0, "Post-LOCA Containment Leakage - CR and Offsite Doses"

6.1k Units 2&3 Calculation N-4060-016, Revision 2, "Post-LOCA Charcoal Filter Doses – Control Building"

6.1l Design Analysis NFM-2-FP-1202, Revision 00, "SONGS 2 Cycle 12 Fuel Performance Analysis"

6.1m Design Analysis NFM-3-FP-1202, Revision 00, "SONGS 3 Cycle 12 Fuel Performance Analysis"

6.1n Design Analysis NFM-2-PH-1203, Revision 02, "SONGS-2 Cycle 12 CORD/ROCS/MC Design Models, Depletions, Rodded Cases, and Integrated Files"

6.1o Design Analysis NFM-3-PH-1203, Revision 01, "SONGS-3 Cycle 12 CORD/ROCS Design Models, Depletions, Rodded Cases, and Integrated Files"

6.1p Design Analysis NFM-2-PH-1104, Revision 02, "SONGS-2 Cycle 11 Design Parameters and F_r vs Power"

6.1q Design Analysis NFM-3-PH-1104, Revision 01, "SONGS-3 Cycle 11 Design Parameters and F_r vs Power"

6.1r Design Analysis NFM-2-PH-1204, Revision 00, "SONGS-2 Cycle 12 Design Parameters and F_r vs Power"

6.1s Design Analysis NFM-3-PH-1204, Revision 02, "SONGS-3 Cycle 12 Design Parameters and F_r vs. Power"

6.1t Design Analysis NFM-2-PH-1205, Revision 00, "SONGS-2 Cycle 12 Physics Input to LOCA, TORC, and FATES Analysis and Pin Census for Pre-Trip Steam Line Break"

6.1u Design Analysis NFM-3-PH-1205, Revision 00, "SONGS-3 Cycle 12 Physics Input to LOCA, TORC, and FATES Analysis and Pin Census for Pre-Trip Steam Line Break"

6.1v Design Analysis NFM-2-PH-0016, Revision 01, "SONGS 2 Cycle 10 LOCA and Non-LOCA Fission Product Source Term"

6.1w Design Analysis NFM-3-PH-0016, Revision 00, "SONGS 3 Cycle 10 LOCA and Non-LOCA Fission Product Source Term"

6.1x ABB Calculation A-SCE-FMDE-002, Revision 02, "Fuel Bundle Drop Evaluation for SCE Units 2 and 3"

Note 1: This Calculation is in CDM as Document SO23-990-C299 Revision 2

Note 2: Calculation A-SCE-FMDE-002 Revision 02 is Enclosure 2 in ABB letter S-98-209, "Transmittal of Fuel Bundle Drop Evaluation for SONGS Units 2 and 3 (Calculation A-SCE-FMDE-002, Rev. 02)", dated December 7, 1998.

6.1y Units 2&3 Calculation J-SPA-179, Revision 0 (including CCNs 2 through 5), "Control Room Monitor Set Points"

6.1z DELETED

6.1aa Design Analysis NFM-2/3-PH-1116, Revision 00, "SONGS 2 and 3 Cycle 11 LOCA and Non-LOCA Fission Product Source Term", dated March 9, 2000

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6.1ab Design Analysis NFM-2-PH-1216, Revision 00, "SONGS 2 Cycle 12 LOCA and Non-LOCA Fission Product Source Term"

6.1ac Design Analysis NFM-3-PH-1216, Revision 00, "SONGS 3 Cycle 12 LOCA and Non-LOCA Fission Product Source Term"

6.2 Drawings

6.2a Units 2&3 Drawing 10101, Revision 29 (including DCNs 41 and 42)
Architectural Floor Plan - Auxiliary Building Control Area at El. 30'-0"

6.2b Units 2&3 Drawing 10112, Revision 9
Architectural Floor Plan - Auxiliary Building Elevations North & West

6.2c Units 2&3 Drawing 23186, Revision 8
Containment Interior Structure - S.S. Plate for Relining of Fuel Transfer Canal, Sheet 1

6.2d Units 2&3 Drawing 25004, Revision 25 (including DCNs 35 to 38)
Concrete Floor Plan - Auxiliary Building Radwaste Area at El. 37'-0", Sheet 1

6.2e Units 2&3 Drawing 25005, Revision 30
Concrete Floor Plan - Auxiliary Building Radwaste Area at El. 37'-0", Sheet 2

6.2f Units 2&3 Drawing 25102, Revision 26
Concrete Floor Plan - Auxiliary Building Control Area at El. 30'-0", Sheet 1

6.2g Units 2&3 Drawing 25103, Revision 24 (including DCNs 29 to 31)
Concrete Floor Plan - Auxiliary Building Control Area at El. 30'-0", Sheet 2

6.2h Units 2&3 Drawing 25401, Revision 22
Concrete Floor Plan - Fuel Handling Building at El. 30'-0"

6.2i Units 2&3 Drawing 25429, Revision 6
Fuel Handling Building - Spent Fuel Pool Liner Plate Sections and Details, Sheet 1

6.2j Units 2&3 Drawing 25453, Revision 2
Fuel Handling Building - S.S. Plate for Relining of Spent Fuel Pool, Sheet 4

6.2k Unit 2 Drawing 25472, Revision 0 (including DCN 1)
Unit 2 Spent Fuel Storage Rack Installation, Sheet 2

6.2l Unit 3 Drawing 25483, Revision 0
Unit 3 Spent Fuel Storage Rack Installation, Sheet 2

6.2m Units 2&3 Drawing 31394, Revision 20
Elementary Diagram - HVAC Plant Control Room Isolation System Train A

6.2n Units 2&3 Drawing 31395, Revision 21
Elementary Diagram - HVAC Plant Control Room Isolation System Channel B

6.2o Units 2&3 Drawing 40002 Sheet 1, Revision 33
General Arrangement - Unit 2 Plan at El. 45'-0" to 30'-0"

6.2p Units 2&3 Drawing 40009, Revision 17
General Arrangement - Unit 3 Plan at El. 45'-0" to 30'-0"

6.2q Units 2&3 Drawing 40090, Revision 8, (including DCN-9)
Air Flow Diagram - Fuel Handling Building

6.2r Units 2&3 Drawing 40096, Revision 19
Air Flow Diagram - Train B Control Building at El. 30'-0"

6.2s Units 2&3 Drawing 40098, Revision 9, (including DCN-10)
Air Flow Diagram - Train A Control Building at El. 30'-0"

6.2t Units 2&3 Drawing 40173A, Revision 20
P&I Diagram - Control Room Complex HVAC (Normal A.C.) - System No. 1510

6.2u Unit 3 Drawing 40173ASO3, Revision 5
P&I Diagram - Control Room Complex HVAC (Computer Room) - System No. 1510

6.2v Units 2&3 Drawing 40173C, Revision 22
P&I Diagram - Control Room Complex HVAC (Emergency Ventilation System and Air Conditioner Units) - System No. 1510

6.2w Unit 2 Drawing 40177A, Revision 20
P&I Diagram - Miscellaneous Ventilation System (Fuel Handling Building) - System No. 1504

6.2x Unit 3 Drawing 40177ASO3, Revision 19
P&I Diagram - Miscellaneous Ventilation System (Fuel Handling Building) - System No. 1504

6.2y DELETED

6.2z DELETED

6.2aa DELETED

6.2ab DELETED

6.2ac Units 2&3 Drawing SO23-410-1-1, Revision 13 (including DCN 2)
Filter House Auxiliary Building Control Room Emergency HV Unit

6.2ad Units 2&3 Drawing SO23-990-228, Revision 1
Fuel Bundle Assembly

6.2ae Units 2&3 Drawing 40092, Revision 9
Air Flow Diagram - Containment Building

6.3 **Correspondence**

6.3a ABB Memorandum ST-98-427, dated August 10, 1998, "Maximum Internal Gas Pressure for Dose Calculations from Postulated Fuel Handling Accidents"

Note: Memorandum ST-98-427 is Enclosure 3 in ABB letter S-98-139, "Open Porosity Model, Axial Densification Factor, and Maximum Internal Gas Pressure - SONGS Unit 2, Cycle 10 Support", dated September 3, 1998

6.3b E-Mail from D. Higgins (SCE) to F. Santa Ana (SCE) et. al., dated 5/13/93, "CR HVAC Intake Filter Housing" (a copy is included in Section 11.1)

6.3c E-Mail from F. Santa Ana (SCE) to T. Remick (Bechtel), dated 9/16/93, "Control Room HVAC Information" (a copy is included in Section 11.2)

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6.4 **Regulatory Documents**

6.4a 10 CFR Part 50, "Domestic Licensing of Production & Utilization Facilities"

6.4b 10 CFR Part 100, "Reactor Site Criteria"

6.4c San Onofre Unit 2 Technical Specifications,

i)	Section 1.1	page 1.1-3 [Amendment 188]
ii)	LCO 3.3.9	page 3.3-39 [Amendment 132]
iii)	LCO 3.3.10	page 3.3-42 [Amendment 127]
iv)	LCO 3.7.11	page 3.7-24 [Amendment 181]
v)	LCO 3.7.14	page 3.7-27 [Amendment 127]
vi)	LCO 3.7.16	page 3.7-29 [Amendment 127]
vii)	LCO 3.9.6	page 3.9-10 [Amendment 134]
viii)	Section 5.5.2.12	page 5.0-19c [Amendment 187]

6.4d San Onofre Unit 3 Technical Specifications,

i)	Section 1.1	page 1.1-3 [Amendment 179]
ii)	LCO 3.3.9	page 3.3-39 [Amendment 121]
iii)	LCO 3.3.10	page 3.3-42 [Amendment 116]
iv)	LCO 3.7.11	page 3.7-24 [Amendment 172]
v)	LCO 3.7.14	page 3.7-27 [Amendment 116]
vi)	LCO 3.7.16	page 3.7-29 [Amendment 116]
vii)	LCO 3.9.6	page 3.9-10 [Amendment 123]
viii)	Section 5.5.2.12	page 5.0-19c [Amendment 178]

6.4e San Onofre Unit 2 Licensee Controlled Specifications,

i)	LCS 3.3.112	pages 3.3-112-1 through 3.3-112-3 [Rev. 1, 7/17/01]
ii)	LCS 3.7.117	pages 3.7-117-1 and 3.7-117-2 [Rev. 2, 6/12/02]
iii)	LCS 3.7.118	pages 3.7-118-1 and 3.7-118-2 [Rev. 1, 6/12/02]
iv)	LCS 3.9.101	pages 3.9-101-1 and 3.9-101-2 [Rev. 1, 5/25/00]
v)	LCS 3.3.100	pages 3.3-100-1, -5, -6, and -7 [Rev. 6, 1/31/00]

6.4f San Onofre Unit 3 Licensee Controlled Specifications,

i)	LCS 3.3.112	pages 3.3-112-1 through 3.3-112-3 [Rev. 1, 7/17/01]
ii)	LCS 3.7.117	pages 3.7-117-1 and 3.7-117-2 [Rev. 2, 6/12/02]
iii)	LCS 3.7.118	pages 3.7-118-1 and 3.7-118-2 [Rev. 1, 6/12/02]
iv)	LCS 3.9.101	pages 3.9-101-1 and 3.9-101-2 [Rev. 1, 5/25/00]
v)	LCS 3.3.100	pages 3.3-100-1, -5, -6, and -7 [Rev. 6, 1/31/00]

6.4g SONGS 2&3 Updated Final Safety Analysis Report, up to and including Amendment 16

6.4h 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

6.4i 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

6.4j 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

6.4k NUREG/CR-5009, "Assessment of the Use of Extended Burnup Fuel in Light Water Power Reactors", published February 1988

6.4l Standard Review Plan Section 6.4, "Control Room Habitability System"

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

6.4m Standard Review Plan Section 15.7.4, "Radiological Consequences of Fuel Handling Accidents"

i) NUREG 75/087, Revision 0, dated November 24, 1975
ii) NUREG-0800, Revision 1, dated July 1981

6.4n 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

6.4o Branch Technical Position ASB 9-2, Revision 2,"Residual Decay Energy for Light-Water Reactors for Long-Term Cooling", dated July 1981

Note: This Branch Technical Position is attached to NUREG-0800 Standard Review Plan Section 9.2.5, "Ultimate Heat Sink".

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6.5 Procedures

6.5a Maintenance Procedure SO23-I-2.44, Revision 6 (TCN 6-5), "CREACUS - Control Room Emergency Air Clean Up System Operation and Operability Test Surveillance"

6.5b DELETED

6.5c Operating Instruction SO23-3-2.11, Revision 16 (TCN 16-5), "Spent Fuel Pool Operations"

6.5d Site Technical Services Procedure SO23-X-7, Revision 10, "Nuclear Fuel Movement for Refueling Cycles"

6.5e Site Technical Services Procedure SO23-X-7.2, Revision 6, "Nuclear Fuel Movement - Spent Fuel Pool"

6.5f Abnormal Operating Instruction SO23-13-20, Revision 7, "Fuel Handling Accidents/Loss of Cavity or SFP Level Control"

6.6 Other Documents

6.6a LOCADOSE Code, Bechtel Standard Computer Program NE-319, Release 3, dated October 19, 1990. Bechtel Computer Program Error Notice Number 93-1 and SCE Computer Program Error Notice Numbers 1, 2 and 3 have been issued against this code.

6.6b Software Installation Report, LOCADOSE (NE-319) Version 3.0, RISC 6000 Computer System - Device ID D037571, Operating System IBM AIX Version 4.2.1, Revision 1 Approved August 31, 1998.

6.6c SOURCE2 Code, Bechtel Standard Computer Program NE-602, Release D2-5, dated December 11, 1991. No Computer Program Error Notices have been issued against this code.

6.6d Software Installation Report, SOURCE2 (NE-602) Version D2-5, RISC 6000 Computer System - Device ID D037571, Operating System IBM AIX Version 4.2.1, Revision 2 Approved August 31, 1998.

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6	N. YACKLE		T. REMICK							

6.6e DELETED

6.6f DELETED

6.6g LOCADOSE Code, Bechtel Standard Computer Program NE-319, Release 6.0 with:
User's Manual, Revision 8, dated February 2001
Theoretical Manual, Revision 8, dated February 2001
Validation Manual, Revision 9, dated February 2001
Bechtel Computer Program Error Notice Number 2001-4 (SONGSAPP Defect #2) has been issued against this code.
Bechtel Computer Program Error Notice Number 2002-1 (SONGSAPP Defect #36) has been issued against this code.

6.6h Samuel Glasstone, Principles of Nuclear Reactor Engineering, published by D. Van Nostrand Company, Inc. of Princeton, New Jersey

6.6i Software Installation Report, LOCADOSE (NE-319) Release 6.0, Pentium III, 800 MHz Computer System - Devise ID D088771, Operating System NT Version 4.00, Revision 2 Approved May 15, 2001.

6.6j DCP 2/3-6926-01SJ, "Nuclear Measurement Corporation Process, Effluent and Area Radiation Monitoring System Replacement"

6.6k Frank Kreith, Principles of Heat Transfer, 2nd Edition, published by International Textbook of Scranton, Pennsylvania

6.6l ICRP Publication 30, "Limits for Intakes of Radionuclides by Workers", Supplement to Part 1, International Commission on Radiological Protection, adopted July 1978.

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7.0 NOMENCLATURE

7.1 Acronyms

ABB-CE	Asea Brown Boveri - Combustion Engineering
AR	Action Request
CCN	Calculation Change Notice
CE	Combustion Engineering
CFR	Code of Federal Regulations
CR	Control Room
CREACUS	Control Room Emergency Air Cleanup System
CRG	Cable Riser Gallery (adjacent to the control room)
CRIS	Control Room Isolation Signal
CROF	Control Room Occupancy Factor
DCF	Dose Conversion Factor
DCN	Document Change Notice
DCP	Design Change Package
DMF	Dose Multiplication Factor
EAB	Exclusion Area Boundary
EAC	Emergency Air Conditioning
ESFAS	Engineered Safety Feature Actuation System
EVS	Emergency Ventilation Supply
FHA	Fuel Handling Accident
FHA-FHB	Fuel Handling Accident Inside the Fuel Handling Building
FHIS	Fuel Handling [Building] Isolation Signal
F_r	Radial Peaking Factor
HEPA	High Efficiency Particulate Air (filter)
HVAC	Heating, Ventilating and Air Conditioning
ICCN	Interim Calculation Change Notice
ICRP	International Commission on Radiological Protection
LCO	Technical Specification Limiting Condition for Operation
LCS	Licensee Controlled Specification
LOCA	Loss of Coolant Accident
LPZ	Low Population Zone
NRC	Nuclear Regulatory Commission
PACU	Post-Accident Cleanup (filter)
RPD	Relative Power Density
RPS	Reactor Protection System
SIAS	Safety Injection Actuation Signal
SRP	Standard Review Plan (NUREG-75/087 or NUREG-0800)
UxCyy	Unit "x" Cycle "yy"
UFSAR	Updated Final Safety Analysis Report

7.2 Symbols

c_p	specific heat
Gr	Grashof number
h	heat transfer coefficient
k	thermal conductivity
Nu	Nusselt number
Pr	Prandtl number
Q	volumetric source strength
q'	linear heat rate
T	temperature
β	beta radiation
β_{ve}	thermal coefficient of volume expansion
γ	gamma radiation
μ	viscosity
ρ	density
χ/Q	chi over Q, Atmospheric Dispersion Factor

7.3 Units

Bq	Becquerel
Btu	British thermal unit
cc	cubic centimeters
cfm	cubic feet per minute
ci *OR* Ci	curies
cpm	counts per minute (by a radiation monitor)
ft	feet
GWD/MTU	Gigawatt-days per metric tonne of uranium
hr	hours
in	inches
lbm	pound-mass
m	meters
MeV	Million electron volts (mega-electron volts)
min	minutes
MWth	Megawatt-thermal
psia	pounds of force per square inch, absolute
psig	pounds of force per square inch, gauge
sec	seconds
Sv	Sievert
°F	degrees Fahrenheit
°R	degrees Rankine

8.0 COMPUTATIONS

8.1 Fuel Rod Gap Inventory

This section and its Tables 8.1-1a and 8.1-1b calculate the gap inventory of a single failed fuel rod. Per Design Input 4.1.3, in the event of a Fuel Handling Accident inside the Fuel Handling Building (FHA-FHB) a total of 60 fuel rods will fail, representing 60 fuel rods in the dropped fuel bundle, and 0 fuel rods in the impacted fuel bundles. The dropped fuel assembly may contain either low or high burnup fuel. Per Design Input 4.1, "low burnup fuel" is fuel with average burnups less than or equal to 38 GWD/MTU, and "high burnup fuel" is fuel with average burnups between 38 and 60 GWD/MTU.

The parameters used to quantify the fuel rod gap inventory include the fission product isotope inventory, the iodine and noble gas gap release fractions, and the radial peaking factor.

Design Input 4.1.1 presents a composite fission product isotope inventory that bounds the low burnup and high burnup fuel rod inventories. Tables 8.1-1a and 8.1-1b do not include Iodine-134 or Xenon-138, as Design Input 4.1 documents that these isotopes are not present when the FHA-FHB occurs 72 hours following reactor shutdown. The Table 8.1-1a Average Fuel Rod Inventory from the Unit 2 Cycle 10 Source Term Design Analysis NFM-2-PH-0016 (Reference 6.1v, Section 4.0) presented in design input 4.1.1 are increased by the power uprate correction factor of 1.02. The Table 8.1-1a Peak Fuel Rod Gap Inventory is used as input in the 10 cfm case. The Table 8.1-1b Average Fuel Rod Inventory from the Unit 2/3 Cycle 11 Source Term Design Analysis NFM-2/3-PH-1116 (Reference 6.1aa, Section 4.0) presented in design input 4.1.1 were calculated based on 3438 MWt. The Table 8.1-1b Peak Fuel Rod Gap Inventory is used as input in the 1000 cfm case.

Per Design Input 4.1.2, consistent with Regulatory Guide 1.25, the gap activity in the damaged low burnup fuel rods consists of 10 percent of the total noble gases other than Krypton-85, 30 percent of the Krypton-85, and 10 percent of the radioactive iodine in the rods at the time of the accident. Design Input 4.1.2 also notes that at high burnup all but the iodine isotopes are calculated to have fuel rod gap inventories less than that recommended by Reg. Guide 1.25 for use in FHA analyses; at high burnups the fuel rod gap iodine inventory increases to 12 percent, which is greater than the 10 percent value assumed in Reg. Guide 1.25. For conservatism, Tables 8.1-1a and 8.1-1b consider the maximum fuel rod gap inventory of 12 percent iodine, 30 percent Krypton-85, and 10 percent total noble gases other than Krypton-85.

Per Design Input 4.1.4 it is conservative for this calculation to model a radial peaking factor (F_r) of 1.75. For the 10 cfm case and incorporation of CCN-8 to this calculation, some conservatism will be removed from the radial peaking factor (F_r) and a value of approximately 1.71 (i.e. =1.75/1.02) will be used as input.

Sample calculation for Iodine-133:

Iodine-133 Gap Inventory = (325 ci/rod) × (1.02) × (0.12 gap release fraction) × (1.75/1.02 F_r)

Iodine-133 Gap Inventory = 68.3 ci/rod

The preceding value calculated with rounded-off input data compares favorably with the Table 8.1-1a value calculated with all of the significant digits of a spreadsheet.

Table 8.1-1a
Peak Fuel Rod Gap Inventory
(used in 10 cfm case)

Isotope [a]	Average Fuel Rod Inventory 72 hrs decay [per Table 4.1-1] NFM-2-PH-0016, Section 4.0 (curies/rod)	Power Uprate Correction Factor [per DI4.1.1] unitless	Maximum Gap Release Fraction [per DI 4.1.2] (unitless)	Maximum Radial Peaking Factor [per DI 4.1.4]] (unitless) (=1.75/1.02)	Peak Fuel Rod Gap Inventory[b] (curies/rod)
Iodine-129	1.18e-04	1.02	0.12	1.71	2.48e-05
Iodine-130	3.09e-02	1.02	0.12	1.71	6.49e-03
Iodine-131	1.40e+03	1.02	0.12	1.71	2.94e+02
Iodine-132	8.53e-07	1.02	0.12	1.71	1.79e-07
Iodine-133	3.25e+02	1.02	0.12	1.71	6.83e+01
Iodine-135	1.79e+00	1.02	0.12	1.71	3.76e-01
Krypton-83m	3.68e-10	1.02	0.10	1.71	6.44e-11
Krypton-85	2.58e+01	1.02	0.30	1.71	1.35e+01
Krypton-85m	8.15e-03	1.02	0.10	1.71	1.43e-03
Krypton-87	1.02e-14	1.02	0.10	1.71	1.79e-15
Krypton-88	4.21e-05	1.02	0.10	1.71	7.37e-06
Xenon-131m	1.91e+01	1.02	0.10	1.71	3.34e+00
Xenon-133m	6.42e+01	1.02	0.10	1.71	1.12e+01
Xenon-133	2.81e+03	1.02	0.10	1.71	4.92e+02
Xenon-135m	2.74e-01	1.02	0.10	1.71	4.80e-02
Xenon-135	3.69e+01	1.02	0.10	1.71	6.46e+00
Rubidium-88	0.00e+00	1.02	0.00	1.71	0.00e+00
Cesium-135	0.00e+00	1.02	0.00	1.71	0.00e+00

(a) The Rb-88 and Cs-135 daughter isotopes that the LOCADOSE Code library file created are each listed with zero initial (72 hour) and adjusted gap activities.
(b) Sample calculation of I-133 Gap Inventory
(325 ci/rod) * (1.02) * (0.12 gap fraction) * (1.75/1.02 RPF) = 68.3 ci/rod

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

Table 8.1-1b
Peak Fuel Rod Gap Inventory
(used in 1,000 cfm case)

Isotope [a]	Average Fuel Rod Inventory 72 hrs decay [per Table 4.1-1] NFM-2/3-PH-1116, Section 4.0 (curies/rod)	Maximum Gap Release Fraction [per DI 4.1.2] (unitless)	Maximum Radial Peaking Factor [per DI 4.1.4]] (unitless)	Peak Fuel Rod Gap Inventory[b] (curies/rod)
Iodine-129	1.20e-04	0.12	1.75	2.520e-05
Iodine-130	3.15e-02	0.12	1.75	6.615e-03
Iodine-131	1.43e+03	0.12	1.75	3.003e+02
Iodine-132	8.70e-07	0.12	1.75	1.827e-07
Iodine-133	3.32+02	0.12	1.75	6.972e+01
Iodine-135	1.82e+00	0.12	1.75	3.822e-01
Krypton-83m	3.75e-10	0.10	1.75	6.563e-11
Krypton-85	2.63e+01	0.30	1.75	1.381e+01
Krypton-85m	8.31e-03	0.10	1.75	1.454e-03
Krypton-87	1.04e-14	0.10	1.75	1.820e-15
Krypton-88	4.30e-05	0.10	1.75	7.525e-06
Xenon-131m	1.95e+01	0.10	1.75	3.413e+00
Xenon-133m	6.55+01	0.10	1.75	1.146e+01
Xenon-133	2.87+03	0.10	1.75	5.023e+02
Xenon-135m	2.79e-01	0.10	1.75	4.833e-02
Xenon-135	3.76e+01	0.10	1.75	6.580e+00
Rubidium-88	0.00e+00	0.00	1.75	0.000e+00
Cesium-135	0.00e+00	0.00	1.75	0.000e+00

(a) The Rb-88 and Cs-135 daughter isotopes that the LOCADOSE Code library file created are each listed with zero initial (72 hour) and adjusted gap activities.
(b) Sample calculation of I-133 Gap Inventory
(332 ci/rod) * (0.12 gap fraction) * (1.75 RPF) = 69.72 ci/rod

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

8.2 Refueling Water Iodine Removal

The iodine gap activity released to the water is subject to clean-up due to pool scrubbing. Per Design Input 4.2.1, the pool iodine decontamination factors are valid for a minimum 23 foot water depth between the top of the damaged fuel rods and the fuel pool surface, and for a maximum fuel rod pressure of less than 1200 psig.

8.2.1 Compliance with 23 foot Water Depth Requirement

8.2.1.1 Water Level Above a Damaged Fuel Assembly Stored in the Spent Fuel Pool. Per Design Input 4.15.1, Technical Specification LCO 3.7.16 and Licensee Controlled Specification 3.7.117 require that the fuel storage pool water (i.e., spent fuel pool) level must be at least 23 feet over the top of irradiated fuel assemblies seated in the storage racks. With these requirements, any damaged irradiated fuel seated in the storage racks will be covered by at least 23 feet of water.

8.2.1.2 Water Level Above a Damaged Fuel Assembly Laying on Top of the Storage Racks. To determine compliance for the scenario of a damaged fuel assembly laying on top of the storage racks, it is first necessary to determine the plant elevation corresponding to the top of the fuel storage racks. This dimension has not been found in any plant document, so it is calculated in this subsection in a manner similar to that used in the Calculation DC-1522 (Reference 6.1a, page A14) calculation of the minimum spent fuel pool water elevation. Rounded to the nearest one-eighth inch, the top of the fuel storage racks is the sum of the following elevations and heights documented in Design Input 4.15.2:

Plant Elevation at Top of the Original SFP Liner Plate: =17'- 6 $^{3}/_{16}$" = 210.1875"
Reliner Plate Thickness: = 0.125"
Maximum Distance between Reliner Plate and Top of the Support Block: = 5.32"
Distance between Top of the Support Block and Top of Racks: = 193.50"
Plant Elevation at the Top of the Fuel Storage Racks: = 409.1325"
Plant Elevation at the Top of the Fuel Storage Racks: = 34'- 1 $^{1}/_{8}$"

Per Design Input 4.15.2, the width of a fuel assembly is 8.29 inches. Therefore, in the event that a damaged fuel assembly is laying on top of the spent fuel pool storage racks, the top surface of the horizontal damaged fuel assembly would be at approximately plant elevation 34'-9 $^{3}/_{8}$" (= 409.1325" + 8.29" = 417.4225").

Per Design Input 4.15.2, an increased SFP water level that will ensure at least 23 feet of water above the fuel assembly laying on the racks is required by Technical Specification LCO 3.9.6

when the SFP is connected to the refueling cavity, and by Station Procedure whenever fuel is being moved. Per Tech Spec LCO 3.9.6, the refueling water level shall be at least 23 feet above the top of the reactor vessel flange. Per Operating Instruction SO23-3-2.11, a water level of 23 feet above the top of the reactor vessel flange is equivalent to plant elevation 60'-6", which is 27'-6 $^1/_2$" above the top of the fuel assemblies stored in the SFP storage racks.

As noted in Design Input 4.15.2, to ensure that the Tech Spec LCO 3.9.6 height requirement is met, when moving a spent fuel assembly Site Technical Services Procedures SO23-X-7 (Reference 6.5d) and SO23-X-7.2 (Reference 6.5e) require that the SFP water level shall be at least 27'-8 $^1/_{16}$" above the top of the fuel assemblies stored in the SFP storage racks. Conservatively modeling the lower Tech Spec LCO 3.9.6 water level requirement, any damaged irradiated fuel laying on top of the storage racks will be covered by at least 25'-8 $^5/_8$" feet of water (= El. 60'-6" minus El. 34'-9 $^3/_8$").

8.2.2 Compliance with 1200 psig Fuel Rod Pressure Requirement. To determine the compliance with the maximum fuel rod pressure of 1,200 psig the fuel rod void temperature and pressure at spent fuel pool conditions are determined.

Table 4.13-1 and Table 4.13-2 present the U2C12 and U3C12 average rod maximum internal pressures as functions of void (rod gap) volume and plenum temperatures. Using the ideal gas law ($PV = nRT$) the product nR is determined for each set of conditions and fuel batch types. These are shown below on Table 8.2-1 for Unit 2 and on Table 8.2-2 for Unit 3.

A sample calculation for Unit 3 Cycle 12 batch M/N Erbia fuel is shown below:

$$nR = \frac{PV}{T} = \frac{2{,}135.5 psia \times 0.8402 in^3}{618^\circ F + 460^\circ R} = 1.664\, psia - in^3 / ^\circ R$$

$$nR = \frac{PV}{T} = \frac{801.5 psia \times 1.1005 in^3}{70^\circ F + 460^\circ R} = 1.664\, psia - in^3 / ^\circ R$$

Table 8.2-1 — U2C12 Calculation of n*R* Product

Rod Description	Plenum Temperature (degrees Fahrenheit)	Void Volume (cubic inches)	Rod Internal Pressure [temporary gas release] (psia)	n*R* (psia-in^3/°R)
U2C12 Batch P Erbia	615	0.8730	1,866.5	1.516
	70	1.1213	716.2	1.515
U2C12 Batch P UO_2	614	0.8946	1,615.3	1.345
	70	1.1210	636.3	1.346
U2C12 Batch M/N Erbia	615	0.8535	1,909.9	1.516
	70	1.1046	727.2	1.516
U2C12 Batch M/N UO_2	614	0.8766	1,648.8	1.346
	70	1.1062	644.9	1.346

Table 8.2-2 — U3C12 Calculation of n*R* Product

Rod Description	Plenum Temperature (degrees Fahrenheit)	Void Volume (cubic inches)	Rod Internal Pressure [temporary gas release] (psia)	n*R* (psia-in^3/°R)
U3C12 Batch P Erbia	618	0.8872	2,041.2	1.680
	70	1.1440	778.4	1.680
U3C12 Batch P UO_2	615	0.9081	1,752.5	1.480
	70	1.1398	688.3	1.480
U3C12 Batch M/N Erbia	618	0.8402	2,135.5	1.664
	70	1.1005	801.5	1.664
U3C12 Batch M/N UO_2	616	0.8624	1,824.2	1.462
	70	1.0975	706.3	1.463
U3C12 Batch K UO_2	616	0.9984	1,745.1	1.619
	70	1.3072	656.6	1.619

The fact that the same n*R* value is calculated for each set of conditions for each fuel rod type indicates that the fuel rod gap gases behave consistent with the ideal gas law over this temperature range. This conclusion is confirmed by a discussion in ABB Memorandum ST-98-427 (Reference 6.3a), which notes that internal pressure at desired conditions may be determined by application of the perfect gas law based on constant moles of gas (n).

Since the Ideal Gas Law is applicable, the product of the rod internal pressure and void volume (i.e., PV) is directly proportional to temperature (T). A discussion in ABB Memorandum ST-98-427 notes that linear interpolation between the hot void volume at hot conditions (based on hot plenum temperature) and cold void volume at 70 °F will conservatively determine the void volume at spent fuel pool conditions. Therefore, the void volume at SFP conditions can be determined as follows:

$$V_{SFP} = V_C + (V_H - V_C)\frac{T_{SFP} - T_C}{T_H - T_C} \quad \text{Equation 8-1}$$

Where:

V_{SFP}	Void volume at spent fuel pool conditions (in^3)
V_C	Void volume at cold temperature conditions (in^3)
V_H	Void volume at hot temperature conditions (in^3)
T_{SFP}	Void volume temperature at spent fuel pool conditions (°F)
T_C	Void volume temperature at cold conditions (70 °F)
T_H	Void volume temperature at hot conditions (°F)

The void volume temperature at SFP conditions, T_{SFP}, can be determined using cylindrical fuel element heat transfer relationships documented in Nuclear Reactor Engineering (Reference 6.6h, sections 6.69 through 6.71). Using the definitions shown on Figure 8.2-1 (reproduced from Figure 6.5 of Nuclear Reactor Engineering), the temperature differences between the inner and outer surfaces of the fuel cladding and the coolant are:

$$t_1 - t_m = \frac{Qa^2}{2}\left(\frac{1}{k_c}\ln\frac{b}{a} + \frac{1}{hb}\right) \qquad \text{Equation 8-2}$$

$$t_2 - t_m = \frac{Qa^2}{2hb} \qquad \text{Equation 8-3}$$

Where:

t_1	is the temperature of the inner surface of the fuel cladding (°F)
t_2	is the temperature of the outer surface of the fuel cladding (°F)
t_m	is the temperature of the bulk coolant (°F)
Q	is the volumetric source strength (Btu/hr-ft^3)
a	is the inner radius of the fuel cladding (ft)
b	is the outer radius of the fuel cladding (ft)
k_c	is the thermal conductivity of the fuel cladding (Btu/hr-ft-°F)
h	is the heat transfer coefficient between the fuel cladding and the coolant (Btu/hr-ft^2-°F)

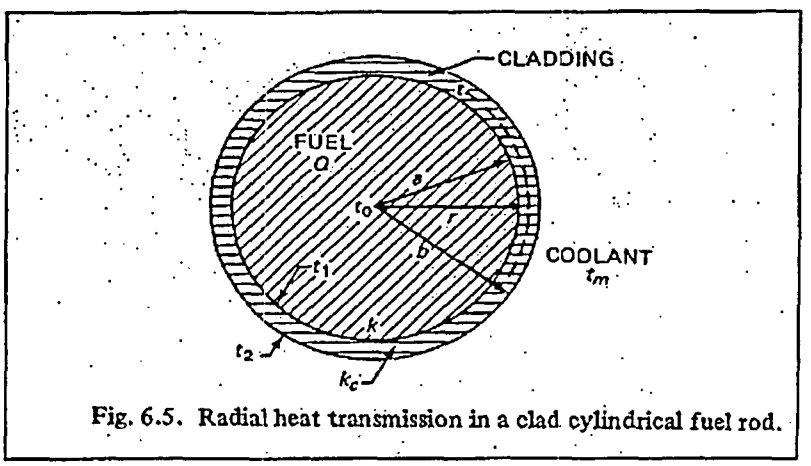

Fig. 6.5. Radial heat transmission in a clad cylindrical fuel rod.

Figure 8.2-1 — Radial Heat Transmission in a Clad Cylindrical Fuel Rod

The volumetric source strength (Q), which is a measure of the rate of heat release per unit volume of fuel, is equal to the quotient of the linear heat rate (q') and the cross sectional area of the fuel:

$$Q = \frac{q'}{\pi a^2} \qquad \text{Equation 8-4}$$

A review of the preceding equations and parameters shows that the temperature gradient between the inner surface of the fuel cladding and the bulk coolant is directly proportional to the linear heat rate, and inversely proportional to the heat transfer coefficient between the fuel cladding and coolant:

$$t_1 - t_m \propto \frac{Q}{h}$$

$$\therefore \left(t_1 - t_m\right)_{at\ shutdown} = \left(t_1 - t_m\right)_{at\ power} \times \frac{\left(Q/h\right)_{at\ shutdown}}{\left(Q/h\right)_{at\ power}}$$

$$\therefore \left(t_1 - t_m\right)_{at\ shutdown} = \left(t_1 - t_m\right)_{at\ power} \times \frac{Q_{at\ shutdown}}{Q_{at\ power}} \times \frac{h_{at\ power}}{h_{at\ shutdown}} \qquad \text{Equation 8-5}$$

Equation 8-5 is solved to estimate the temperature gradient between the fuel rod gap space and the bulk coolant at shutdown conditions. Each of the parameters in this equation are described and determined below.

$$\left(t_1 - t_m\right)_{at\ power}$$

Per Assumption 3.18.2, the temperature at the inner surface of the fuel cladding during power operations is assumed to be no more than 500 °F greater than the bulk temperature of the surrounding cooling water.

$Q_{at\ shutdown}$ / $Q_{at\ power}$

Per Assumption 3.17, when refueling operations begin at 72 hours after shutdown, the heat generation rate associated with residual radioactive decay is assumed to be less than one percent of the heat generation rate during power operations.

$h_{at\ power}$

Using Equations 8.3 and 8.4 the heat transfer coefficient at power can be determined from the following expression:

$$h = \frac{Qa^2}{2b(t_2 - t_m)} = \frac{q'}{2\pi b(t_2 - t_m)} \quad \text{Equation 8-6}$$

Per Assumption 3.18.1 the linear heat rate is 8.75 kW/ft and the temperature difference between the outer surface of the cladding and the coolant is less than 50 °F. Per Design Input 4.17 the fuel rod outer diameter is 0.382 inches. Plugging these values into Equation 8-6 along with a conversion factor of 3415.179 Btu/kW-hr, $h_{at\ power}$ is then:

$$h = \frac{[8.75kW/ft] \times [3{,}415.179 Btu/kW-hr] \times [12in/ft]}{2\pi[0.382in] \times [50^\circ F]} \quad \text{Equation 8-7}$$

$= 2{,}988.06$ Btu/hr-ft^2-°F

$h_{at\ shutdown}$

The heat transfer coefficient between the fuel cladding and the coolant during shutdown conditions can be estimated using natural convection heat transfer from vertical cylinders relationships documented in Principles of Heat Transfer, 6th Edition (Reference 6.6k, Equation 4.20 on page 245, and Figure 5.5):

$$\overline{h_c} = Nu\frac{k_f}{L} \quad \text{Equation 8-8}$$

When Gr×Pr < 1 × 10^9 (laminar region):

$$Nu = 0.555(Gr\,\mathrm{Pr})^{1/4} \qquad \text{Equation 8-9}$$

When Gr×Pr > 1 × 10^9 (turbulent region):

$$Nu = 0.0210(Gr\,\mathrm{Pr})^{2/5} \qquad \text{Equation 8-10}$$

Where:

h_c is the convective heat transfer coefficient (Btu/hr-ft^2-°F)

Nu is the average Nusselt number based on the length of the fuel rod (unitless)

k_f is the thermal conductivity of the coolant (Btu/hr-ft-°F)

L is the characteristic length [taken as the active length of the fuel rod] (ft)

Pr is the Prandtl number (unitless)

Gr is the Grashof number = $\dfrac{g\beta\Delta TL^3}{\nu^2}$ (unitless) [Equation 5.8 of Reference 6.6k]

c_p is the specific heat of the coolant (Btu/lbm-°F)

ν is the kinematic viscosity of the coolant $\dfrac{\mu}{\rho}\left(ft^2/\sec\right)$

μ is the viscosity of the coolant (lbm/ft-sec)

ρ is the density of the coolant (lbm/ft-sec)

g is the acceleration of gravity, 32.2 ft/sec^2

β is the thermal coefficient of volume expansion of the fluid (1/°F)

ΔT is the temperature difference between the outer cladding surface of the fuel and the coolant (°F)

Per Design Input 4.14, the maximum refueling pool cooling water bulk temperature is 167 °F (75 °C). Assuming a ΔT of 5.25 °C, the temperature at the outer cladding surface is 80.25 °C. The coolant thermal properties will be evaluated at this temperature. From Table 13 of Appendix 2 of Reference 6.6k the following properties are obtained for water at 75 °C and at 100 °C:

75 °C	100 °C
k_f = 0.671 W m^{-1} K^{-1}	0.682 W m^{-1} K^{-1}
Pr = 2.23	1.75

Linearly interpolating between these values yields the following:

80.25 °C

$k_f = 0.673$ W m^{-1} K^{-1}

Pr = 2.13

Using a conversion constant of 0.5777 Btu hr^{-1} ft^{-1} °F^{-1} per W m^{-1} K^{-1} from Table 13 of Appendix 2 of Reference 6.6k:

$$k_f = 0.389 \text{ Btu hr}^{-1} \text{ ft}^{-1} \text{ °F}^{-1}$$

The term $\frac{g\beta}{\nu^2}$ used to determine the Grashof number is also provided in Table 13 of Appendix 2 of Reference 6.6k, however no values are presented for 80.25 °C. The values up to 100 °C, reproduced below were used to fit a polynomial relationship. These values are plotted in Figure 8.2-2.

T (°C)	$g\beta\nu^{-2}$ 10^9 K^{-1} m^{-3}
10	0.551
20	2.035
30	4.54
40	8.833
50	14.59
100	85.09

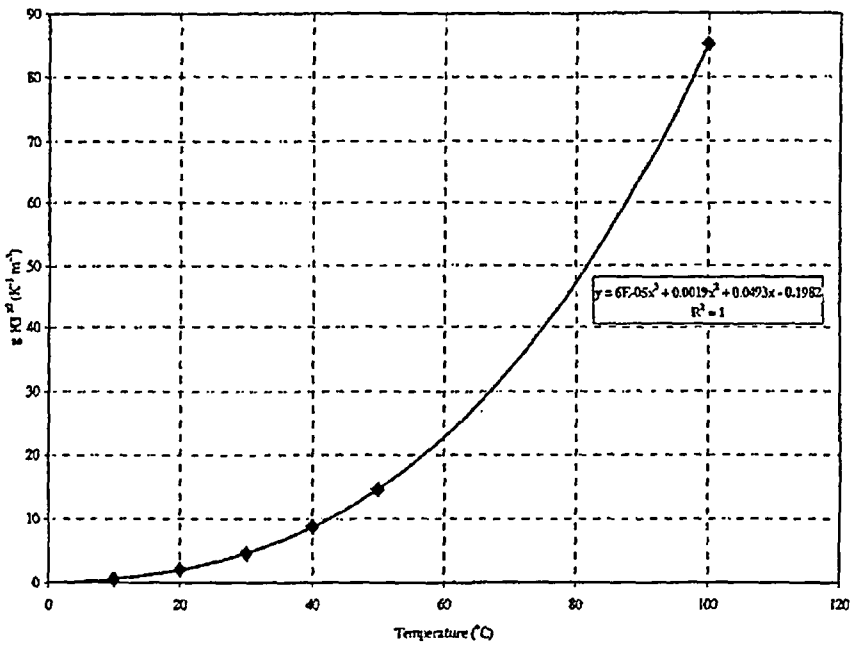

Figure 8.2-2 — $g\,\beta\,\nu^{-2}$ as a Function of Temperature

As shown on Figure 8.2-2 a 3rd order polynomial fits the data extremely well. To validate this polynomial fit, the value at a temperature of 50 °C is calculated to be:

$$g\,\beta\,\nu^{-2} = 6E{-}5 \times 50^3 + 0.0019 \times 50^2 + 0.0493 \times 50 - 0.1982 = 14.52 \times 10^9\ K^{-1}\ m^{-3}$$

This value is in good agreement with the value of 14.59 shown above.

Using this relationship, $g\,\beta\,\nu^{-2}$ at 80.25 °C is calculated to be $47.00 \times 10^9\ K^{-1}\ m^{-3}$. Using the conversion factor of 1.573×10^{-2} provided in Table 13 of Appendix 2 of Reference 6.6k, $g\,\beta\,\nu^{-2}$ is calculated to be $7.39 \times 10^8\ R^{-1}\ ft^{-3}$.

Per Design Input 4.17, the active length of the fuel is 150 inches (12.5 ft).

Using these values, and assuming an average temperature differential of the fuel cladding of 5.25 °C or 9.45 °F, the Grashof number is then:

$$Gr = [12.5ft]^3 \times [9^\circ F] \times [7.39 \times 10^8 \ ^\circ F^{-1} ft^{-3}] = 1.36 \times 10^{13}$$

The product of the Grashof and Prandl numbers is:

$$Gr\,\mathrm{Pr} = [1.36 \times 10^{13}] \times [2.13] = 2.91 \times 10^{13}$$

Since the product of the Grashof and Prandtl numbers is greater than 1×10^9, flow is turbulent and the heat transfer coefficient between the fuel cladding and the coolant during shutdown conditions is calculated using Equation 8-8 and Equation 8-10:

$$\overline{h_c} = 0.0210(Gr\,\mathrm{Pr})^{2/5} \frac{k_f}{L} \qquad \text{Equation 8-11}$$

$$\overline{h_c} = 0.0210(2.91 \times 10^{13})^{2/5} \frac{0.389 Btu\, hr^{-1} ft^{-1\,\circ} F^{-1}}{12.5ft} = 158.68 Btu\, hr^{-1} ft^{-1\,\circ} F^{-1}$$

Using the preceding parameters, the temperature gradient between the inner surface of the fuel cladding and the bulk coolant at shutdown conditions is approximately (using Equation 8-5):

$$(t_1 - t_m)_{at\ shutdown} = (t_1 - t_m)_{at\ power} \times \frac{Q_{at\ shutdown}}{Q_{at\ power}} \times \frac{h_{at\ power}}{h_{at\ shutdown}}$$

$$(t_1 - t_m)_{at\ shutdown} = [500^\circ F] \times 0.01 \times \frac{2{,}988.06}{158.68} = 94.15^\circ F$$

Per Design Input 4.14, the maximum spent fuel pool temperature (t_m) is 167 °F; therefore, the temperature of the void space at shutdown conditions is 261.15 °F.

A critical assumption in the above calculation was the temperature difference between the outer surface of the fuel cladding and the coolant. A value of 5.25 °C (9.45 °F) was assumed. This assumption is validated below.

The temperature difference between the outer surface of the fuel cladding and the bulk coolant can be determined using Equation 8-3 and Equation 8-4:

$$t_2 - t_m = \frac{q'}{2\pi h b} \qquad \text{Equation 8-12}$$

Per Assumption 3.17, when refueling operations begin at 72 hours after shutdown, the heat generation rate associated with residual radioactive decay is assumed to be less than one percent of the heat generation rate during power operations. Therefore, q' at shutdown is one percent of q' at power. Thus, Equation 8-12 is solved to be:

$$t_2 - t_m = \frac{[8.75 kW ft^{-1}] \times [0.01] \times [3{,}415.179 Btu\, hr^{-1}/kW] \times [12 in/ft]}{2\pi [158.68 Btu\, hr^{-1} ft^{-1} {}^\circ F^{-1}] \times [0.382 in]} = 9.42^\circ F$$

As shown above, the temperature difference assumption between the outer surface of the fuel cladding and the coolant of 5.25 °C (9.45 °F) is validated.

The void volume temperatures at shutdown conditions calculated above are then used in Equation 8-1 to determine the void volumes at shutdown conditions. The ideal gas law (PV = nRT) along with these values is used to determine the internal pressures at shutdown conditions. The resultant pressures are presented on Table 8.2-3 for Unit 2 and Table 8.2-4 for Unit 3. A sample calculation for the Unit 3 Cycle 12 Batch M/N Erbia fuel rod is shown below.

From Table 8.2-2, the void volume at 618 °F is 0.8402 in^3, and at 70 °F it is 1.1005 in^3. Thus, the volume at 261.15 °F is calculated to be:

$$V = 1.1005 in^3 + \left(0.8402 in^3 - 1.1005 in^3\right) \frac{261.15^\circ F - 70^\circ F}{618^\circ F - 70^\circ F} = 1.0097 in^3$$

The pressure is then:

$$P = \frac{nRT}{V} = \frac{\left[1.664\,psia\,in^3\,^\circ R^{-1}\right] \times \left[261.15^\circ F + 460^\circ R\right]}{\left[1.0097 in^3\right]} = 1{,}188.77\,psia = 1{,}174\,psig$$

Table 8.2-3 — U2C12 Rod Pressures at Shutdown Conditions

Rod Description	nR (from Table 8.2-1) (psia-in³/°R)	Plenum Temperature (degrees Fahrenheit)	Void Volume (cubic inches)	Rod Internal Pressure (psia)	Rod Internal Pressure (psig)
U2C12 Batch P Erbia	1.516	261.15	1.0342	1,056.95	1,042.25
U2C12 Batch P UO_2	1.345	261.15	1.0414	931.68	916.98
U2C12 Batch M/N Erbia	1.516	261.15	1.0165	1,075.76	1,061.06
U2C12 Batch M/N UO_2	1.346	261.15	1.0255	946.34	931.64

Table 8.2-4 — U3C12 Rod Pressures at Shutdown Conditions

Rod Description	nR (fromTable 8.2-2) (psia-in³/°R)	Plenum Temperature (degrees Fahrenheit)	Void Volume (cubic inches)	Rod Internal Pressure (psia)	Rod Internal Pressure (psig)
U3C12 Batch P Erbia	1.680	261.15	1.0544	1,148.95	1,134.25
U3C12 Batch P UO_2	1.480	261.15	1.0585	1,008.57	993.87
U3C12 Batch M/N Erbia	1.664	261.15	1.0097	1,188.77	1,174.07
U3C12 Batch M/N UO_2	1.462	261.15	1.0152	1,038.60	1,023.90
U3C12 Batch K UO_2	1.619	261.15	1.1991	973.84	959.14

As shown on Table 8.2-3 and Table 8.2-4, the maximum rod internal pressure is for the Unit 3 Cycle 12 Batch M/N Erbia rod. This pressure is 1,174.07 psig, which is below the 1,200 psig criterion. Therefore the Regulatory Guide 1.25 requirements for taking credit for removal of iodine by the spent fuel pool are met.

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

8.3 Initial Fuel Handling Building Airborne Activity Profile

Table 8.3-1a presents the initial Fuel Handling Building airborne activity profile to be input into the LOCADOSE code for the evaluation with 10 cfm of control room unfiltered inleakage. Table 8.3-1b presents the initial spent fuel pool water activity profile to be input into the LOCADOSE code for the evaluation with 1000 cfm of control room unfiltered inleakage. The Table 8.3-1b data will be converted by the LOCADOSE code into the initial Fuel Handling Building airborne activity profile by scaling the pool activity data against the FRACT variable used to specify the fraction of iodine in elemental, organic and particulate forms released to the FHB air space.

The quantity of iodine evolving into the FHB air space is dependent on the iodine species makeup of the fuel rod gap iodine inventory, the ability of the water surrounding the damaged fuel to retain the released iodine, and the total number of failed fuel rods. Per Assumption 3.4, the fuel rod iodine gap inventory 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 Design Input 4.2.1 (as justified in Section 8.2), the pool decontamination factors for the inorganic iodine and organic iodide species are 133 and 1, respectively. Per Design Input 4.1.3, in the event of a Fuel Handling Accident inside the Fuel Handling Building a total of 60 fuel rods will fail. Applying these fractions and factors and the total number of failed fuel rods to the peak fuel rod iodine gap inventory identified in Section 8.1 and its Table 8.1-1 results in the initial FHB airborne iodine activity profile presented in Table 8.3-1.

The quantity of noble gases evolving into the FHB air space is dependent on the fuel rod gap noble gas inventory, the ability of the water surrounding the damaged fuel to retain the released noble gas, and the total number of failed fuel rods. Per Design Input 4.2.2, the retention of noble gases in the pool is negligible (i.e., a decontamination factor of one). Per Design Input 4.1.3, in the event of a FHA-FHB a total of 60 fuel rods will fail. Applying the decontamination factor and total number of failed fuel rods to the peak fuel rod noble gas gap inventories identified in Table 8.1-1a results in the initial FHB airborne noble gas activity profile presented in Table 8.3-1a.

Sample calculations for Elemental Iodine-131 and Krypton-85 for the 10 cfm case (Table 8.3-1a) using LOCADOSE Version 3.0 (which requires iodine input by elemental, organic, and particulate species):

Iodine-131 Elem. = (294 ci/rod) × [(0.9975 species fraction) ÷ (133 DF)] × (60 failed rods)
Iodine-131 Elem. = 1.32e2 ci

Krypton-85 = (13.5 ci/rod) × (60 failed rods)
Krypton-85 = 8.10e2 ci

The preceding values calculated with rounded-off input data compares favorably with the Table 8.3-1a values calculated with all of the significant digits of a spreadsheet.

Table 8.3-1a
Initial Fuel Handling Building Airborne Activity Profile
(10 cfm case)

Isotope [a]	Peak Fuel Rod Gap Inventory [per Table 8.1-1a] (curies/rod)	Iodine Species Fractions [per Assump. 3.4] (unitless)	Iodine Species Decontamination Factor [per DI 4.2.1] (unitless)	Number of Failed Fuel Rods [per DI 4.1.3] (rods)	Initial FHB Airborne Activity (curies)
I-129 elemental	2.48e-05	0.9975	133	60	1.12e-05
I-129 organic	2.48e-05	0.0025	1	60	3.72e-06
I-130 elemental	6.49e-03	0.9975	133	60	2.92e-03
I-130 organic	6.49e-03	0.0025	1	60	9.73e-04
I-131 elemental	2.94e+02	0.9975	133	60	1.32e+02
I-131 organic	2.94e+02	0.0025	1	60	4.41e+01
I-132 elemental	1.79e-07	0.9975	133	60	8.06e-08
I-132 organic	1.79e-07	0.0025	1	60	2.69e-08
I-133 elemental	6.83e+01	0.9975	133	60	3.07e+01
I-133 organic	6.83e+01	0.0025	1	60	1.02e+01
I-135 elemental	3.76e-01	0.9975	133	60	1.69e-01
I-135 organic	3.76e-01	0.0025	1	60	5.64e-02
Krypton-83m	6.44e-11	--	--	60	3.86e-09
Krypton-85	1.35e+01	--	--	60	8.13e+02
Krypton-85m	1.43e-03	--	--	60	8.56e-02
Krypton-87	1.79e-15	--	--	60	1.07e-13
Krypton-88	7.37e-06	--	--	60	4.42e-04
Xenon-131m	3.34e+00	--	--	60	2.01e+02
Xenon-133m	1.12e+01	--	--	60	6.74e+02
Xenon-133	4.92e+02	--	--	60	2.95e+04
Xenon-135m	4.80e-02	--	--	60	2.88e+00
Xenon-135	6.46e+00	--	--	60	3.87e+02
Rubidium-88	0.00e+00	--	--	60	0.00e+00
Cesium-135	0.00e+00	--	--	60	0.00e+00

(a) The Rb-88 and Cs-135 daughter isotopes that the LOCADOSE Code library file created are each listed with zero initial Fuel Handling Building airborne activities.

Sample Initial Activity Released to the SFP calculations for Iodine-131 and Krypton-85 for the 1000 cfm case (Table 8.3-1b) using LOCADOSE Version 6.0 (which does not require iodine input by elemental, organic, and particulate species) are:

Iodine-131 = (300.3 ci/rod) × (60 failed rods)
Iodine-131 = 1.802e+04 ci

Krypton-85 = (13.81 ci/rod) × (60 failed rods)
Krypton-85 = 8.286e2 ci

The preceding values calculated with rounded-off input data compare favorably with the Table 8.3-1b values calculated with all of the significant digits of a spreadsheet.

The initial FHB airborne activity profile is determined by LOCADOSE Version 6.0 using the FRACT variable that specifies the fraction of iodine in each of the following chemical/physical forms (elemental, organic, and particulate). Per Assumption 3.4, the fuel rod iodine gap inventory 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 Design Input 4.2.1 (as justified in Section 8.2), the pool decontamination factors for the inorganic iodine and organic iodide species are 133 and 1, respectively. Therefore, the Iodine fractions used in the LOCADOSE code are as follows:

Organic: $0.0025 \div 1 = 0.0025$

Inorganic: $0.9975 \div 133 = 0.0075$

Table 8.3-1b
Initial Activity Released to the SFP Profile
(1000 cfm case)

Isotope [a]	Peak Fuel Rod Gap Inventory [per Table 8.1-1b] (curies/rod)	Number of Failed Fuel Rods [per DI 4.1.3] (rods)	Initial Activity Released to the SFP (curies)
Iodine-129	2.520e-05	60	1.512e-03
Iodine-130	6.615e-03	60	3.969e-01
Iodine-131	3.003e+02	60	1.802e+04
Iodine-132	1.827e-07	60	1.096e-05
Iodine-133	6.972e+01	60	4.183e+03
Iodine-135	3.822e-01	60	2.293e+01
Krypton-83m	6.563e-11	60	3.938e-09
Krypton-85	1.381e+01	60	8.285e+02
Krypton-85m	1.454e-03	60	8.726e-02
Krypton-87	1.820e-15	60	1.092e-13
Krypton-88	7.525e-06	60	4.515e-04
Xenon-131m	3.413e+00	60	2.048e+02
Xenon-133m	1.146e+01	60	6.878e+02
Xenon-133	5.023e+02	60	3.014e+04
Xenon-135m	4.833e-02	60	2.930e+00
Xenon-135	6.580e+00	60	3.948e+02
Rubidium-88	0.000e+00	60	0.000e+00
Cesium-135	0.000e+00	60	0.000e+00

(a) The Rb-88 and Cs-135 daughter isotopes that the LOCADOSE Code library file created are each listed with zero initial Fuel Handling Building airborne activities.

8.4 Modeling of Fuel Handling Building Airborne Activity Release

Per Assumption 3.5, the fuel handling building airborne activity is to be released to the outside environment over a two hour period. This calculation assumes that this modeling requirement is met if the FHB volume and FHB release flow rate modeled in the LOCADOSE code analysis ensure that at least 99.9 percent of the FHB airborne activity will have been released from the FHB during the first two hours of the Fuel Handling Accident.

Per Design Input 4.3, the effective FHB free volume is 365,305 ft^3 and the FHB Normal Ventilation System exhaust flow rate is 25,581 cfm. These parameter values are modeled in the LOCADOSE code run made in this calculation. The following table summarizes the total FHB airborne activity at the start of an event, and at 2 hours into the event as documented in the LOCADOSE code activity transport program module output files "fha-fhb.to" and "fhb1000.lto" as presented in Section 9.2.3 and Section 9.2.7, respectively. Per this table, the modeling of a FHB volume of 365,305 ft^3 and a FHB exhaust flow rate of 25,581 cfm yields an FHB airborne activity at 2 hours that reflects the removal of 99.98 percent of the initial FHB airborne activity. This FHB airborne activity reduction value validates the use of the modeled FHB volume and FHB exhaust flow rate.

Fuel Handling Building Total Airborne Activity
[per files fha-fhb.to and fhb1000.lto]
(Curies)

Case	Initially	After 2 Hours	% Reduction
10 cfm	3.180e+04	7.039e+00	99.98%
1000 cfm	3.248e+04	7.190e+00	99.98%

8.5 Modeling of Control Room Isolation

Per Design Input 4.5.1 the control room HVAC system will automatically transfer to the high radiation isolation mode if high radiation is sensed by either 2/3RE7824G1 or 2/3RE7825G2. The time period to isolate the control room is based on the following:

- time needed for the contaminated air to travel from the Fuel Handling Building release point to the control room normal HVAC intake
- time needed for the intake plenum to fill
- time needed for the radiation monitor to initiate the isolation signal
- adjustable relay delay time
- time needed for the isolation dampers to close

8.5.1 Activity Concentration at Control Room Air Intake. The activity release rate to the outside environment may be converted to an activity concentration at the control room intake as follows:

$$\frac{Activity\ Release\ (Ci)}{time\ interval\ (sec)} \times \frac{\chi}{Q}\left(\frac{sec}{m^3}\right) \times \frac{m^3}{10^6\,cc} \times \frac{10^6\,\mu Ci}{Ci} = Concentration\ \left(\frac{\mu Ci}{cc}\right)$$

The LOCADOSE activity transport output files included in Section 9.2 contain a time step at 10 seconds (0.00278 hours). This interval, and the design basis 0 to 2 hour Control Room atmospheric dispersion factor (χ/Q per Design Input 4.7) yields the following equation for converting the activity release during the first LOCADOSE time step to an activity concentration at the control room intake:

$$Concentration_{CR\ Intake}\left(\frac{\mu Ci}{cc}\right) = \frac{Activity\ Release_{0\text{-}0.00278hr}\ (Ci)}{10\,sec} \times \frac{3.1x10^{-3}\,sec}{m^3} \times \frac{(m^3 - \mu Ci)}{(cc - Ci)}$$

$$Concentration_{CR\ Intake}\left(\frac{\mu Ci}{cc}\right) = Activity\ Release_{0\text{-}0.00278hr}\ (Ci) \times 3.1x10^{-4}\left(\frac{\mu Ci}{cc - Ci}\right)$$

8.5.2 Intake Plenum Fill Time. Per Design Input 4.5.2, the time necessary for the plenum activity concentration (at the detector location) to reach 90% of the outside air activity concentration is 8.5 seconds.

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

8.5.3 Radiation Monitor Trip Initiation Time. The radiation monitor response time and efficiency values are based on exposure to noble gas isotopes. Per Calculation J-SPA-179 (Reference 6.1y, Section 2.2), control room radiation monitors 2/3RE7824G1 and 2/3RE7825G2 measure the gross activity concentration in the outside air entering the control room area. A CRIS is produced if the activity concentration exceeds a trip setpoint. Per Design Input 4.5.2, the control room radiation monitor response time is slowest when the activity concentration in the outside air flow entering the control room is smallest. Since Krypton-85 is one of the many isotopes present in the "gross activity" accident release, the Krypton-85 concentration in the outside air flow entering the control room area will always be less than the gross activity concentration in the outside air flow entering the control room area. Therefore, this section calculates Krypton-85 concentration in the control room HVAC intake plenum to determine the maximum time required for the averaging algorithm to produce a repesentative concentration value that is greater than the alarm trip setpoint. This maximum time equates to the longest delay prior to the generation of a CRIS. Due to its long half-life of approximately 10.73 years, the activity profile of Krypton-85 in stored spent fuel will not be reduced by more than an order of magnitude (i.e., a factor of ten) from that of freshly irradiated fuel. Note: for completeness, Xenon-133 concentration data is also calculated.

Per the LOCADOSE activity transport output files (Sections 9.2.3 and 9.2.7), the activity releases associated with the failure of 60 fuel rods in the first 10 second interval are as shown in the following table. This analysis scales these activity releases down by a factor of ten to conservatively evaluate radiation monitor trip initiation time for the failure of only 6 fuel rods, or of fuel rods of lesser burnup or older fuel.

Isotope	Fuel Handling Building Airborne Activity Released (60 failed fuel rods)	Fuel Handling Building Airborne Activity Released (6 failed fuel rods)
Krypton-85 (10 cfm case)	9.441 Ci	0.9441 Ci
Krypton-85 (1000 cfm case)	9.621 Ci	0.9621 Ci
Xenon-133 (10 cfm case)	342.6 Ci	34.26 Ci
Xenon-133 (1000 cfm case)	350.0 Ci	35.00 Ci

Per the equation in Section 8.5.1, these activity releases equate to the following activity concentrations at the control room outside air intake for the conservatively small number of only six failed fuel rods (since the 10 cfm case values are smaller they will be used in the subsequent calculation):

Kr-85: 0.9441 Ci × 3.1E-4 μCi/(cc-Ci) = 2.93E-4 μCi/cc at intake

Xe-133: 34.26 Ci × 3.1E-4 μCi/(cc-Ci) = 1.06E-2 μCi/cc at intake

Per Section 8.5.2, within 8.5 seconds the plenum activity concentrations (at the detector location) are 90% of the outside air activity concentrations for the conservatively small number of only six failed fuel rods:

Kr-85: $0.9 \times 2.93E\text{-}4\ \mu Ci/cc = 2.64E\text{-}4\ \mu Ci/cc$ at detector location
Xe-133 $0.9 \times 1.06E\text{-}2\ \mu Ci/cc = 9.54E\text{-}3\ \mu Ci/cc$ at detector location

Per Design Input 4.5.2, the trip initiation time for either of these activity concentrations (including the time assumed for digital signal processing) is 60 seconds for the conservatively small number of only six failed fuel rods.

8.5.4 Adjustable Relay Delay Time. Per Design Input 4.5.2, an adjustable relay time of 5 to 40 seconds is included in the total isolation time. Conservatively, a value of 40 seconds is used in this calculation.

8.5.5 Total High Radiation Isolation Time. Based on the timing determined in the preceding sections, the total control room isolation time for a high radiation induced CRIS is:

transit time to the HVAC intake per Assumption 3.9	0.0 seconds
intake plenum fill time per Section 8.5.2	8.5 seconds
radiation monitor trip initiation time per Section 8.5.3	60.0 seconds
adjustable relay delay time per Section 8.5.4	40.0 seconds
damper closure time per Assumption 3.11	6.0 seconds
total	114.5 seconds

To provide margin in this analysis, and to not require a restrictive CRIS response time, this analysis will model a control room isolation time of 3 minutes for any high radiation induced CRIS.

8.5.6 Radiological Consequences of a CRIS Failure. Per Section 8.5.5, this analysis will model a control room isolation time of 3 minutes for any high radiation induced CRIS. In the event of a CRIS failure, the calculated control room doses will remain valid provided that manual Operator Action is taken to isolate the control room within this same 3 minute period, or manual Operator Action is taken to isolate the control room prior to any released radioactivity passing through the Control Room HVAC isolation dampers.

Abnormal Operating Instruction SO23-13-20 (Reference 6.5f) addresses Refueling Accidents. The AOI "entry conditions" state that symptoms of a refueling accident include high radiation levels in the Fuel Handling Building, and bubbles emerging from a submerged fuel assembly which has been dropped or damaged. In the event of a fuel handling accident with high radiation levels, Step 2 requires immediate initiation of CRIS and initiation of evacuation of all personnel in the accident area.

8.6 Modeling of Flow from FHB to CR HVAC Intake Filter

Upon receipt of a Control Room Isolation Signal the control room HVAC system is automatically shifted to the emergency mode of operation. Transfer to the emergency mode includes starting the emergency air conditioning units, opening the outside air isolation damper to the emergency filtration trains, and starting the fans. Per Assumption 3.15, this analysis models two trains of emergency HVAC in operation during the first 8 hours of the accident. Operator action is assumed to be taken within 8 hours to deactivate one train of emergency intake and recirculation units.

As discussed in Section 5.4.3, the control room charcoal filter shine dose is dependent on the CR HVAC intake filters' instantaneous activity loading at various times during the FHA event. Due to atmospheric dispersion, only a portion of the Fuel Handling Building activity release will become entrained in the Control Room HVAC intake flow. To analyze this dispersion and intake into the control room, the LOCADOSE Code will model a direct flowpath between the Fuel Handling Building (Region 2) and a Control Room HVAC Intake Filter (Region 3). An equivalent unfiltered flow rate from the FHB to the CR HVAC Intake Filter can be determined as follows:

$$Curies_{CR\ Intake\ Filter} = (Activity\ Conc\ at\ CR\ Outside\ Air\ Intake) \times CR\ Intake\ Flowrate$$

$$Curies_{CRIF} = ([Activity\ Released\ From\ FHB] \times \chi/Q_{FHB\ to\ CR}) \times CR\ Intake\ Flowrate$$

$$Curies_{CRIF} = \left(\left[\frac{FHB\ Activity}{FHB\ Volume} \times FHB\ Exhaust\ Flowrate\right] \times \chi/Q\right) \times CR\ Intake\ Flowrate$$

Since the LOCADOSE Code determines the FHB activity per FHB volume, the direct FHB to CR HVAC intake filter (Region 3) flowrate would be as follows:

$$Curies_{CRIF} = \left[\frac{FHB\ Activity}{FHB\ Volume}\right] \times [Flowrate_{FHB\ to\ Region\ 3}]$$

$$\therefore Flowrate_{FHB\ to\ Region\ 3} = FHB\ Exhaust\ Flowrate \times \chi/Q_{FHB\ to\ CR} \times CR\ Intake\ Flowrate$$

Although atmospheric dispersion between the FHB and control room varies with time, per Section 8.4 the FHB exhaust flowrate that will be modeled will ensure that virtually all of the activity is released from the FHB during the first 2 hours of the event. Therefore, a single Region 2 to 3 flowrate determined by using the 0 to 8 hour Control Room atmospheric dispersion factor from Design Input 4.7 will be applied for the 30 day analysis duration. In addition, although one of the two filtered control room intake flow paths will be isolated at 8 hours, since virtually all of the activity is released from the FHB during the first 2 hours of the event, the activity introduced and retained within each intake filter (i.e., the filter loading) will be identical.

Because the purpose of this flowrate is to determine the activity buildup in one Control Room HVAC intake filter, a flowrate of 2200 cfm (per Design Input 4.4.3) will be used for the CR intake flow. Applying the 0 to 8 hour control room χ/Q factor from Design Input 4.7 to the total FHB exhaust

flowrate of 25581 cfm from Design Input 4.3.2 yields the following equivalent single train flowrate into a Control Room

$$Flowrate_{FHB\ to\ Region\ 3} = \frac{25581\ ft^3}{\min} \times \left[\frac{3.1x10^{-3}\ \sec}{m^3} \times \frac{\min}{60\ \sec} \times \frac{0.02832\ m^3}{ft^3}\right] \times \frac{2200\ ft^3}{\min}$$

$$Flowrate_{FHB\ to\ Region\ 3} \approx 82\ cfm$$

HVAC intake filter: Modeling the flow into a Control Room HVAC intake filter (Region 3) in this manner slightly reduces the flow from the FHB (Region 2) to the environment from 25581 cfm to approximately 25499 cfm, and thus slightly reduces the resulting offsite and control room inhalation and immersion doses. The dose reduction is equivalent to the reduction in the FHB exhaust flow to the environment, or (82 cfm ÷ 25581 cfm) × 100% = 0.3%. This dose impact is considered to be negligible since it represents only 0.2 rem of the 75 rem thyroid inhalation dose criterion.

Per Assumption 3.13, the intake filter shine model also accounts for the recirculation filter shine. Therefore, the normal intake flow (for the first 3 minutes) and the inleakage flow must also be considered.

Table 8.6-1

	Volumetric Flowrate (2 train) cfm	**Duration Minutes**	**Total Volume Cubic Feet**
Recirculation, Filtered	5820	3 CR HVAC isolated on hi rad	17,460
HVAC, Filtered	4400	117 CR HVAC in operation	514,800
Inleakage, Unfiltered (2 scenarios)	10 1000	120 end of EAB dose analysis	1,200 120,000
Total **10 cfm Unfiltered inleakage** **1000 cfm Unfiltered inleakage**			 **533,460** **652,260**

Therefore, the single train flow rates for event duration based on Table 8.6-1 are:

For CR unfiltered inleakage of 10 CFM: 533,460 CF ÷ (2 × 120 min) = 2,223 cfm
For CR unfiltered inleakage of 1000 CFM: 652,260 CF ÷ (2 × 120 min) = 2,718 cfm

Based on above the revised flowrate from the FHB to region 3 for CR unfiltered inleakage of 10 cfm is:

$$Flowrate_{FHB\ to\ Region\ 3} = \frac{25581\,ft^3}{\min} \times \left[\frac{3.1x10^{-3}\,\sec}{m^3} \times \frac{\min}{60\,\sec} \times \frac{0.02832\ m^3}{ft^3}\right] \times \frac{2223\ ft^3}{\min}$$

$$Flowrate_{FHB\ to\ Region\ 3} \approx 83\ cfm$$

Similarly, the flowrate from the FHB to region 3 for CR unfiltered inleakage of 1000 CFM is:

$$Flowrate_{FHB\ to\ Region\ 3} = \frac{25581\,ft^3}{\min} \times \left[\frac{3.1x10^{-3}\,\sec}{m^3} \times \frac{\min}{60\,\sec} \times \frac{0.02832\ m^3}{ft^3}\right] \times \frac{2718\ ft^3}{\min}$$

$$Flowrate_{FHB\ to\ Region\ 3} \approx 102\ cfm$$

A correction factor for the normal intake and inleakage flows is applied in Section 8.10.

The CR unfiltered inleakage of 1000 cfm, modeling the flow into a Control Room HVAC intake filter (Region 3) in this manner slightly reduces the flow from the FHB (Region 2) to the environment from 25581 cfm to approximately 25479 cfm, and thus slightly reduces the resulting offsite and control room inhalation and immersion doses. The dose reduction is equivalent to the reduction in the FHB exhaust flow to the environment, or (102 cfm ÷ 25581 cfm) × 100% = 0.4%. This dose impact is considered to be negligible since it represents only 0.3 rem of the 75 rem thyroid inhalation dose criterion.

Since a Control Room HVAC intake filter (Region 3) does not retain noble gases, the LOCADOSE Code will model a "Region 3 recirculation filter" (with an arbitrary flowrate of 1,000,000 cfm and a noble gas filter efficiency of 100 percent) to remove the noble gases that enter Region 3. To maximize the filter shine dose, the LOCADOSE Code will not model a "Region 3 exhaust flow"; this effectively retains 100 percent (less radioactive decay) of the iodine and particulates entering Region 3.

8.7 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). Although the release of radioactivity from the Fuel Handling Building ceases within 2 hours (per Assumption 3.5), this FHA-FHB dose analysis will be evaluated for an event duration of 30 days, which will maximize the direct gamma radiation shine dose contribution from the activity retained on the control room HVAC filter.

Table 8.7-1
LOCADOSE Code Time Steps

Time Step (hours after start of FHA event)	Significance of the Time Step
0 hrs [a]	Beginning of Fuel Handling Accident Inside the Fuel Handling Building limiting fault
0.00278 hr (10 seconds)	Intermediate time step for release data information
0.05 hr (3 minutes)	Control Room HVAC system automatically isolates on high radiation, and placed in two train operation
0.1 hr	Intermediate time step to facilitate shine dose analysis integration
0.2 hr	Intermediate time step to facilitate shine dose analysis integration
0.5 hr	Intermediate time step to facilitate shine dose analysis integration
1 hr	Intermediate time step to facilitate shine dose analysis integration
2 hrs	> 99.98 percent of initial Fuel Handling Building activity has been released to the environment End of EAB dose analysis
4 hrs	Intermediate time step to facilitate shine dose analysis integration
6 hrs	Intermediate time step to facilitate shine dose analysis integration
8 hrs	CR and LPZ χ/Q change LPZ breathing rates changes Control Room HVAC placed in single train operation
10 hrs	Intermediate time step to facilitate shine dose analysis integration
24 hrs	CR and LPZ χ/Q change LPZ breathing rates changes CR occupancy factor changes
96 hrs	CR and LPZ χ/Q change CR occupancy factor changes
720 hrs	End of CR and LPZ dose analyses

(a) 72 hours of decay occur prior to the start of the accident (per Assumption 3.2)

8.8 Fuel Handling Building Cloud Shine Dose

The contaminated air inside the Fuel Handling Building is a gamma radiation shine source for the Control Room and offsite EAB and LPZ dose receptors.

As discussed in Section 5.4.1, the shine dose at distant locations such as the EAB and LPZ are typically much less than the offsite gamma immersion doses due to the activity release. Per Section 9.2.5, the gamma immersion dose of less than 0.1 rem at the EAB and less than 0.01 rem at the LPZ are small. Therefore, the direct gamma radiation shine dose from the FHB to the EAB and LPZ will be negligible (i.e., < 0.01 rem), and it is not necessary to calculate the FHB shine dose at the offsite locations.

The contaminated air inside the Fuel Handling Building is a gamma radiation shine source contributing to the Control Room Operator dose. Per Design Input 4.16, the FHB shine dose to the control room is attenuated by the intervening presence of a number of concrete building walls, including the following:

Unit 2 FHB Shine to Control Room Operating Area:

Unit 2 FHB West Wall	2' 6" thick	(per Design Input 4.16)
Unit 2 FHB South Wall	2' 6" thick	(per Design Input 4.16)
Radwaste Building North Wall	2' 6" thick	(per Design Input 4.16)
Control Room East Wall	2' 6" thick	(per Design Input 4.16)

Unit 3 FHB Shine to Control Room Operating Area:

Unit 3 FHB West Wall	2' 6" thick	(per Design Input 4.16)
Unit 3 FHB North Wall	2' 6" thick	(per Design Input 4.16)
Radwaste Building South Wall	2' 6" thick	(per Design Input 4.16)
Control Room East Wall	2' 6" thick	(per Design Input 4.16)

Additionally, any potential contribution from this radiation source stops at 2 hours, at which time virtually all of the FHB airborne activity will have been released to the environment (per Assumption 3.5). Based on engineering judgement, the direct shine dose from the FHB will be negligible due to this large amount of concrete (the effective thickness of which is increased due to the diagonal path through the concrete), and the geometric attenuation due to the distance between the FHB and the control room.

8.9 Environmental Cloud Shine Dose

The contaminated air in the environmental cloud outside of the control room envelope is a gamma radiation shine source for the Control Room dose receptor (the environmental cloud dose contributions to the offsite EAB and LPZ dose receptors are considered in the offsite immersion dose). The environmental cloud shine dose to the Control Room Operators is dependent on the environmental cloud's activity concentration (i.e., the environmental cloud's gamma source strengths) and the geometry that separates the cloud from the control room.

Environmental cloud shine doses are calculated in the control board area of the control room, at dose points 9, 10, 15 and 16 as shown in Figure 4-1 of Design Input 4.10. Per Design Input 4.10, the maximum dose at these four dose points represents the Control Room Operator dose. Tables 10.1-1 through 10.1-4 present Quattro-Pro spreadsheet evaluations of the environmental cloud shine dose at these locations.

As discussed in Section 5.4.2, the SOURCE2 Code is used to determine the Fuel Handling Building cloud instantaneous gamma source strengths. Input to the SOURCE2 Code consists of the BASE10 gamma energy structure, the FHB cloud's instantaneous activity loading at various times during the FHA event, and a SOURCE2 Code Multiplier representing one over the FHB air dilution volume. The BASE10 gamma energy structure is defined in Design Input 4.9. The FHB cloud's instantaneous activity loadings (ci) at various times are presented in LOCADOSE Code File "fha-fhb.to" (Section 9.2.3), but the loadings modeled in the SOURCE2 Code input file include all of the significant digits contained in LOCADOSE Code File "fha-fhb.trn". Per Design Input 4.3.1, the FHB air dilution volume is 365,305 ft^3 with a corresponding inverse volume of 9.667e-11 cm^{-3}. The SOURCE2 Code input and output files are presented in Section 9.3.1.

To address a fundamental limitation on the accuracy of the SOURCE2 Code answers (Reference 6.6c, Users Manual Section 2.2.1.2), cloud instantaneous gamma source strengths of less than 1e-25 MeV/cc-sec will be assigned values of 0.0 MeV/cc-sec. This simplification has no impact on the environmental cloud shine doses, since the environmental cloud shine dose multiplication factors (Design Input 4.11 DMFs) used to scale these instantaneous source strengths are all smaller than 1e-3 Rem/hr per MeV/cc-sec. As such, the dose rates associated with the omitted environmental cloud instantaneous gamma source strengths of less than 1e-25 MeV/cc-sec are less than 1e-28 Rem/hr (= 1e-25 MeV/cc-sec × 1e-3 Rem/hr per MeV/cc-sec).

Tables 10.1-1 through 10.1-4 determine the environmental cloud instantaneous gamma source strengths by scaling the SOURCE2 Code FHB cloud instantaneous gamma source strengths by the FHB release rate (thereby determining the source term release rate to the environment), and then by the control room atmospheric dispersion factor (thereby determining the environmental cloud instantaneous gamma source strengths at the control room HVAC intake).

NOTE: Tables 10.1-1 through 10.1-4 present instantaneous source strength data at 8 hours, 24 hours, and 96 hours in two columns, one labeled with a negative sign ("-" representing just prior to the stated

time), and one labeled with a positive sign ("+" representing just after the stated time). Although the FHB cloud instantaneous source strength data at each pair of times is identical, the environmental cloud instantaneous source strengths will vary at the stated time due to the control room atmospheric dispersion factor scaling.

As a sample calculation, the Table 10.1-1 environmental cloud instantaneous source strength for BASE10 energy range of 0.0 to 0.1 MeV, at time '8-' hours is:

$$S_e(t) = S_c(t) \times F \times \frac{\chi}{Q}(t)$$

S_c(at 8- hrs, 0.0 to 0.1 MeV)	= 7.67e-12 MeV/cc-sec	(per "ss-c.so" [Section 9.3.1.2])
F	= 12.07 m^3/sec	(per Section 8.4)
χ/Q(0 to 8 hours)	= 3.1e-3 sec/m^3	(per Design Input 4.7)

$$S_e(at\ 8-hrs, 0.0\ to\ 0.1\ MeV) = (7.67e-12\ MeV/cc\text{-sec}) \times (12.07\ m^3/\text{sec}) \times (3.1e-3\ \text{sec}/m^3)$$

$$S_e(at\ 8-hrs, 0.0\ to\ 0.1\ MeV) = 2.87e-13\ MeV/cc\text{-sec}$$

The preceding source strength calculated with rounded-off input data compares favorably with the Section 10.1 source strength calculated with all of the significant digits of a spreadsheet.

In Tables 10.1-1 through 10.1-4 the environmental cloud instantaneous gamma source strengths (MeV/cc-sec) are multiplied by the environmental cloud shine dose point 9, 10, 15 or 16 Dose Multiplication Factors (DMFs, Rem/hr per MeV/cc-sec) from Design Input 4.11 to calculate the environmental cloud shine contribution to the Control Room Operator whole body gamma dose rate (Rem/hr). As a sample calculation, the Table 10.1-1 environmental cloud shine dose rate at dose point 9 at time 10 seconds is:

Dose Rate = $\sum$ Dose Rate at ΔE_i = $\sum S(\Delta E_i) \times DMF(\Delta E_i)$

Dose Rate (DP 9, 10 sec) = [(1.17e+2 MeV/cc-sec) × (5.22e-5 Rem/hr per MeV/cc-sec)]
+ [(2.11e+1) × (8.90e-5)] + [(5.85) × (9.26e-5)] + [(3.30e-1) × (1.03e-4)]
+ [(3.05e-2) × (1.10e-4)] + [(1.18e-3) × (1.21e-4)] + [(1.22e-3) × (1.27e-4)]
+ [(2.27e-8) × (1.32e-4)] + [(1.02e-8) × (1.48e-4)] + [(0.00) × (1.75e-4)]

Dose Rate (DP 9, 10 sec) = 6.11e-3 Rem/hr + 1.88e-3 + 5.42e-4 + 3.40e-5
+ 3.36e-6 + 1.43e-7 + 1.55e-7 + 3.00e-12 + 1.51e-12 + 0.00

Dose Rate (DP 9, 10 sec) = 8.57e-3 Rem/hr

The preceding dose rates calculated with rounded-off input data compare favorably with the Section

10.1 dose rates calculated with all of the significant digits of a spreadsheet.

In Tables 10.1-1 through 10.1-4 the environmental cloud shine dose rates are time integrated using Section 5.4.4 methodology to determine the accident duration environmental cloud shine dose. As a sample calculation, the Table 10.1-1 environmental cloud shine dose at dose point 9 between times 10 seconds and 3 minutes is:

$$D = \int DR(t)dt = CROF \times \frac{(DR_2 - DR_1)}{\ln(DR_2/DR_1)}(t_2 - t_1)$$

t_1	= 10 seconds = 0.00278 hours	
t_2	= 3 minutes = 0.05 hours	
DR(DP 9, t_1 = 10 seconds)	= 8.56e-3 Rem/hr	(per Table 10.1-1)
DR(DP 9, t_2 = 3 minutes)	= 7.01e-3 Rem/hr	(per Table 10.1-1)
CROF(t < 24 hours)	= 1.0	(per Design Input 4.6)

$$D(10\ \text{sec}\ to\ 3\ \text{min}) = [1.0] \times [\frac{7.01e-3\ Rem/hr - 8.56e-3\ Rem/hr}{\ln(\frac{7.01e-3}{8.56e-3})}] \times [0.05\ hr - 0.00278\ hr]$$

$$D(DP\ 9, 10\ \text{sec}\ to\ 3\ \text{min}) = 3.66e-4\ Rem$$

The preceding dose calculated with rounded-off input data compares favorably with the Section 10.1 dose calculated with all of the significant digits of a spreadsheet.

Table 8.9-1 summarizes the 30-day Control Room Operator doses calculated in Tables 10.1-1 through 10.1-4. Per Table 8.9-1, the maximum environmental cloud shine dose within the control board area of the control room occurs at dose point 10. A review of Tables 10.1-1 through 10.1-4 reveals that virtually all of the environmental cloud shine dose to Control Room Operators occurs within the first 1 hour of the Fuel Handling Accident (by which time the majority of the FHB airborne source has been released to the environment).

TABLE 8.9-1
Environmental Cloud Shine Doses (10 cfm case)

Dose Point [Design Input 4.10, Figure 4-1]	Environmental Cloud Shine 30-day Control Room Dose (Rem)
9	2.05e-03
10	2.53e-03
15	2.26e-03
16	1.96e-03

The radial peaking in the 1000 cfm case was effectively increased by 1.02, as the 1000 cfm case uses the the average fuel rod inventory based on NFM-2/3-PH-1116 (Design Input 4.1.1), therefore the maximum environmental cloud shine dose within the control board area of the control room would be increased accordingly. These values are tabularized in Table 8.9-1a.

TABLE 8.9-1a
Environmental Cloud Shine Doses (1000 cfm case)

Dose Point [Design Input 4.10, Figure 4-1]	Environmental Cloud Shine 30-day Control Room Dose (Rem)
9	2.09e-03
10	2.58e-03
15	2.31e-03
16	2.00e-03

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

8.10 Control Room HVAC Filter Shine Dose

Upon receipt of a Control Room Isolation Signal the control room HVAC system is automatically shifted to the emergency mode of operation. Transfer to the emergency mode includes starting the emergency air conditioning units, opening the outside air isolation damper to the emergency filtration trains, and starting the fans. Per Design Input 4.4.3, this analysis models two trains of emergency HVAC in operation during the first 8 hours of the accident. Operator action is assumed to be taken within 8 hours to deactivate one train of emergency intake and recirculation units.

Per the LOCADOSE Code Activity Transport Output Files (Section 9.2.3 and 9.2.8) virtually all of the Fuel Handling Building airborne source is released from the FHB during the first 2 hours of the event. Therefore, although one of the two filtered control room intake flow paths will be isolated at 8 hours, the activity introduced and retained within each filter (i.e., the filter loading) will be identical.

The contaminated iodine and particulate isotopes retained on control room HVAC intake filters SA1510MA206 and SA1510MA207 (A206 and A207) and control room recirculation filters SA1510ME418 and SA1510ME419 (E418 and E419) are gamma radiation shine sources for the Control Room dose receptor. As noted in Section 5.4.3, for the purpose of determining the shine dose contribution from these filters, intake filters A206 and A207 are assumed to be 100% efficient at removing iodine and particulates from the incoming air. This maximizes the amount of iodine and particulates retained on A206 and A207, and thus maximizes the shine dose from these two filters. In reality, iodine and particulates that are not trapped on the intake filters will eventually be trapped on recirculation filters E418 and E419, which are located in the vicinity of the intake filters. However, the results of the filter shine dose calculation would not be significantly different, since the geometry of the direct shine pathways from E418 and E419 is similar to the geometry of the direct shine pathways from A206 and A207.

The control room HVAC filter shine dose to the Control Room Operators is dependent on the filter activity concentration (i.e., the filters' gamma source strengths) and the geometry that separates the filters from the control room.

Control room filter shine doses are calculated in the control board area of the control room, at dose points 9, 10, 15 and 16 as shown in Figure 4-1 of Design Input 4.10. Per Design Input 4.10, the maximum dose at these four dose points represents the Control Room Operator dose. Tables 10.2-1 through 10.2-4 present Quattro-Pro spreadsheet evaluations of the control room filter shine dose at these locations.

As discussed in Section 5.4.3, the SOURCE2 Code is used to determine the control room HVAC filter instantaneous gamma source strengths. Input to the SOURCE2 Code consists of the BASE10 gamma energy structure, a control room HVAC filter instantaneous activity loading at various times during the FHA event, and a SOURCE2 Code Multiplier representing one over the CR HVAC intake filter volume. The BASE10 gamma energy structure is defined in Design Input 4.9. Each filter's instantaneous activity loadings (ci) at various times are presented in LOCADOSE Code File "fha-fhb.to"

(Section 9.2.3), but the loadings modeled in the SOURCE2 Code input file include all of the significant digits contained in LOCADOSE Code File "fha-fhb.trn". Since noble gas activity will not be collected on the CR HVAC intake filter, the SOURCE2 Code input file used to determine instantaneous gamma source strength spectra for the filter shine analysis will zero out the CR HVAC intake filter noble gas activity values. Per Assumption 3.14, the volume of each CR HVAC intake filter is 7.32 ft^3 with a corresponding inverse volume of 4.824e-6 cm^{-3}. The SOURCE2 Code input and output files are presented in Section 9.3.2.

To address a fundamental limitation on the accuracy of the SOURCE2 Code answers (Reference 6.6c, Users Manual Section 2.2.1.2), filter instantaneous gamma source strengths of less than 1e-25 MeV/cc-sec will be assigned values of 0.0 MeV/cc-sec. This simplification has no impact on the control room HVAC filter shine doses, since the control room filter shine dose multiplication factors (Design Input 4.12 DMFs) used to scale these instantaneous source strengths are all smaller than 1e-8 Rem/hr per MeV/cc-sec. As such, the dose rates associated with the omitted filter instantaneous gamma source strengths of less than 1e-25 MeV/cc-sec are less than 1e-33 Rem/hr (= 1e-25 MeV/cc-sec × 1e-8 Rem/hr per MeV/cc-sec).

In Tables 10.2-1 through 10.2-4 the control room HVAC filter instantaneous gamma source strengths (MeV/cc-sec) are multiplied by the control room HVAC filter A206 and A207 shine dose point 9, 10, 15 or 16 Dose Multiplication Factors (DMFs, Rem/hr per MeV/cc-sec) from Design Input 4.12 to calculate the control room HVAC filter A206 and A207 shine contributions to the Control Room Operator whole body gamma dose rate (Rem/hr). The filter A206 and A207 shine dose rates are summed together to determine the total control room HVAC filter shine dose rates. As a sample calculation, the Table 10.2-1 control room HVAC filter shine dose rate at dose point 9 at time 0.1 hours is:

FILTER A206 DOSE RATE (DP 9, 0.1 hours)

$$\text{Filter A206 Dose Rate} = \sum \text{A206 Dose Rate at } \Delta E_i = \sum S(\Delta E_i) \times \text{A206 DMF}(\Delta E_i)$$

Filter A206 Dose Rate = [(3.24e+1 MeV/cc-sec) × (2.19e-10 Rem/hr per MeV/cc-sec)]
+ [(4.87e+3) × (1.74e-9)] + [(2.92e+3) × (2.02e-9)] + [(2.17e+2) × (2.09e-9]
+ [(2.01e+1) × (2.05e-9] + [(7.57e-1) × (2.02e-9)] + [(7.66e-1) × (1.99e-9)]
+ [(3.47e-4) × (1.95e-9)] + [(1.55e-4) × (1.78e-9] + [(0.00) × (1.60e-9)]

Filter A206 Dose Rate = 7.10e-9 Rem/hr + 8.47e-6 + 5.90e-6 + 4.54e-7
+ 4.12e-8 + 1.53e-9 + 1.52e-9 + 6.77e-13 + 2.76e-13 + 0.00

Filter A206 Dose Rate = 1.49e-5 Rem/hr

FILTER A207 DOSE RATE (DP 9, 0.1 hours)

$$\text{Filter A207 Dose Rate} = \sum \text{A207 Dose Rate at } \Delta E_i = \sum S(\Delta E_i) \times \text{A207 DMF}(\Delta E_i)$$

Filter A207 Dose Rate = [(3.24e+1 MeV/cc-sec) × (1.11e-10 Rem/hr per MeV/cc-sec)]
+ [(4.87e+3) × (1.34e-9)] + [(2.92e+3) × (1.74e-9)] + [(2.17e+2) × (1.93e-9]
+ [(2.01e+1) × (1.95e-9] + [(7.57e-1) × (1.97e-9)] + [(7.66e-1) × (1.96e-9)]
+ [(3.47e-4) × (1.93e-9)] + [(1.55e-4) × (1.80e-9] + [(0.00) × (1.64e-9)]

Filter A207 Dose Rate = 3.60e-9 Rem/hr + 6.53e-6 + 5.08e-6 + 4.19e-7
+ 3.92e-8 + 1.49e-9 + 1.50e-9 + 6.70e-13 + 2.79e-13 + 0.00

Filter A207 Dose Rate = 1.21e-5 Rem/hr

TOTAL DOSE RATE (DP 9, 0.1 hours)

Total Dose Rate = Filter A206 Dose Rate + Filter A207 Dose Rate
= 1.49e-5 Rem/hr + 1.21e-5 Rem/hr
= 2.70e-5 Rem/hr

The preceding dose rates calculated with rounded-off input data compare favorably with the Section 10.2 dose rates calculated with all of the significant digits of a spreadsheet.

In Tables 10.2-1 through 10.2-4 the control room HVAC filter shine dose rates are time integrated using Section 5.4.4 methodology to determine the accident duration control room HVAC filter shine dose. As a sample calculation, the Table 10.2-1 control room HVAC filter shine dose at dose point 9 between times 0.1 hours and 0.2 hours:

$$D = \int DR(t)dt = CROF \times \frac{(DR_2 - DR_1)}{\ln(DR_2/DR_1)}(t_2 - t_1)$$

t_1	= 0.1 hours	
t_2	= 0.2 hours	
DR(DP 9, t_1 = 0.1 hours)	= 2.69e-5 Rem/hr	(per Table 10.2-1)
DR(DP 9, t_2 = 0.2 hours)	= 6.64e-4 Rem/hr	(per Table 10.2-1)
CROF(t < 24 hours)	= 1.0	(per Design Input 4.16)

$$D(0.1\,hr\ to\ 0.2\,hr) = [1.0] \times [\frac{6.64e{-}4\,Rem/hr - 2.69e{-}5\,Rem/hr}{\ln(\frac{6.64e{-}4}{2.69e{-}5})}] \times [0.2\,hr - 0.1\,hr]$$

$$D(DP\ 9, 0.1\,hr\ to\ 0.2\,hr) = 4.37e{-}6\,Rem$$

The preceding dose calculated with rounded-off input data compares favorably with the Section 10.2 dose calculated with all of the significant digits of a spreadsheet.

Table 8.10-1 summarizes the 30-day Control Room Operator doses calculated in Tables 10.2-1 through 10.2-4. Per Table 8.10-1, the maximum control room HVAC filter shine dose within the control board area of the control room occurs at dose point 10. A review of Tables 10.2-1 through 10.2-4 reveals that the control room HVAC filter shine dose contributions to Control Room Operators occur continuously during the 30 day event duration (primarily due to the long-lived isotopes that are retained on the filters).

TABLE 8.10-1
Control Room HVAC Filter Shine Doses

Dose Point [Design Input 4.10, Figure 4-1]	Control Room HVAC Filter Shine 30-day Control Room Dose (Rem)
9	1.38e-02
10	**1.97e-02**
15	1.32e-02
16	1.51e-02

The filter shine values given in the above table only included HVAC 2 train filtered flow of 4400 cfm for 117 minutes but did not include 0-3 minute recirculation flow and any unfiltered control room inleakage flow. Therefore the above numbers may be scaled up using the ratio of values given in Table 8.6-1 without the need for reanalysis and are presented in Table 8.10-1a.

For 10 cfm unfiltered CR inleakage: 533,460/514,800 = 1.04
For 1000 cfm unfiltered CR inleakage: 652,260/514,800 = 1.27

TABLE 8.10-1a
Revised Control Room HVAC Filter Shine Doses

Dose Point [Design Input 4.10, Figure 4-1]	Control Room HVAC Filter Shine 30-day Control Room Dose (Rem)		
	CR HVAC only	Normal Intake & 10 cfm CR inleakage	Normal Intake & 1000 cfm CR inleakage
9	1.38e-02	1.44e-02	1.75e-02
10	**1.97e-02**	**2.05e-02**	**2.50e-02**
15	1.32e-02	1.37e-02	1.68e-02
16	1.51e-02	1.57e-02	1.92e-02

8.11 Summation of Offsite and Control Room Doses

Tables 8.11-1a and 8.11-1b sum the offsite and control room doses due to a design basis Fuel Handling Accident Inside the Fuel Handling Building (FHA-FHB). Per Design Input 4.1.3, in the event of an FHA-FHB a total of 60 fuel rods will fail, representing 60 fuel rods in the dropped fuel bundle, and 0 fuel rods in the impacted fuel bundles. The dropped fuel assembly may contain either low fuel or high burnup fuel. Per Design Input 4.1, low burnup fuel is fuel with average burnups less than or equal to 38 GWD/MTU, and high burnup fuel is fuel with average burnups between 38 and 60 GWD/MTU. The doses presented in Table 8.11-1a are calculated based on radial peaking of 1.71 and 10 cfm CR inleakage. The doses presented in Table 8.11-1b are calculated based on radial peaking of 1.75 and 1000 cfm CR inleakage.

The doses presented in Table 8.11-1a and Table 8.11-1b include:

The offsite and control room inhalation and immersion doses that are extracted from the LOCADOSE code output of Sections 9.2.5 and 9.3.5.

Per Section 8.8, the FHB shine to offsite and control room dose receptors is negligible.

The environmental cloud gamma radiation shine dose to control room personnel as summarized in Table 8.9-1 for dose point 10. Per Section 8.9, the environmental cloud shine to offsite dose receptors is considered in the offsite immersion dose.

The control room HVAC filter gamma radiation shine dose to control room personnel as summarized in Table 8.10-1a for dose point 10.

Of note is that the sum of the environmental cloud gamma radiation shine dose and the control room HVAC filter gamma radiation shine dose is equivalent to less than 41 percent of the gamma immersion dose [= (2.53e-3 + 2.05e-2) / 5.720e-2] and less than 48 percent of the gamma immersion dose [= (2.58e-3 + 2.50e-2) / 5.795e-2]for the 10 cfm and 1000 cfm cases, respectively. Since each of these radiation shine and immersion dose contributors is associated with the same FHA source term and activity release mechanism, this Fuel Handling Accident calculation could have been conservatively simplified if it had been assumed that the sum of the environmental cloud gamma radiation shine dose and the control room HVAC filter gamma radiation shine dose was equal to the gamma immersion dose.

Table 8.11-1a
FHA Inside the Fuel Handling Building Doses [a]
(10 cfm case)

Dose Contributor (Calculation Section)	Event Duration Control Room Doses [CR isolated at 3 min] (Rem)	2 Hour EAB Doses (Rem)	Event Duration LPZ Doses (Rem)
THYROID DOSE:			
Inhalation Dose (9.2.5)	5.622e+00	1.841e+01	5.227e-01
BETA SKIN DOSE:			
Immersion Dose (9.2.5)	1.191e+00	1.018e-01	2.891e-03
WHOLE BODY GAMMA DOSE:			
Immersion Dose (9.2.5)	5.720e-02	8.802e-02	2.499e-03
FHB Cloud Shine Dose (8.8)	Negligible	Negligible	Negligible
Environmental Cloud Shine Dose (8.9)	2.53e-03	Included in Immersion Dose	Included in Immersion Dose
CR HVAC Filter Shine Dose (8.10)	2.05e-02	Not Applicable	Not Applicable
TOTAL WHOLE BODY GAMMA DOSE	8.023e-02	8.802e-02	2.499e-03

(a) The doses presented in this table are based on an FHA-FHB in which a total of 60 fuel rods will fail, representing 60 fuel rods in the dropped fuel bundle, and 0 fuel rods in the impacted fuel bundles. The analysis models the 60 fuel rod failure with a 12 percent iodine gap inventory and a 1.72 radial peaking factor. In the event that the FHA-FHB is defined by a different fuel rod damage scenario, then the results presented in this table must be reviewed for applicability.

Table 8.11-1b
FHA Inside the Fuel Handling Building Doses [a]
(1000 cfm case)

Dose Contributor (Calculation Section)	Event Duration Control Room Doses [CR isolated at 3 min] (Rem)	2 Hour EAB Doses (Rem)	Event Duration LPZ Doses (Rem)
THYROID DOSE:			
Inhalation Dose (9.2.10)	9.280e+00	1.883e+01	5.345e-01
BETA SKIN DOSE:			
Immersion Dose (9.2.10)	1.205e+00	1.039e-01	2.951e-03
WHOLE BODY GAMMA DOSE:			
Immersion Dose (9.2.10)	5.795e-02	8.987e-02	2.551e-03
FHB Cloud Shine Dose (8.8)	Negligible	Negligible	Negligible
Environmental Cloud Shine Dose (8.9)	2.58e-03	Included in Immersion Dose	Included in Immersion Dose
CR HVAC Filter Shine Dose (8.10)	2.50e-02	Not Applicable	Not Applicable
TOTAL WHOLE BODY GAMMA DOSE	8.553-02	8.987e-02	2.551e-03

(a) The doses presented in this table are based on an FHA-FHB in which a total of 60 fuel rods will fail, representing 60 fuel rods in the dropped fuel bundle, and 0 fuel rods in the impacted fuel bundles. The analysis models the 60 fuel rod failure with a 12 percent iodine gap inventory and a 1.75 radial peaking factor. In the event that the FHA-FHB is defined by a different fuel rod damage scenario, then the results presented in this table must be reviewed for applicability.

9.0 COMPUTER PROGRAM INPUT AND OUTPUT FILES

This Section presents the computer code input and output files. Section 9.1 provides a listing of the files created during this analysis. Section 9.2 presents the LOCADOSE code input and selected output files, and Section 9.3 presents the SOURCE2 code input and selected output files.

9.1 Files Created During This Analysis

As discussed in Section 5.2 (for the 10 cfm LOCADOSE case), the LOCADOSE and SOURCE2 code analyses were executed on the Nuclear Fuel Management RISC 6000 workstation system. The LOCADOSE activity transport and dose calculation modules and the SOURCE2 program utilized in this analysis were titled and stored as:

/scenuc/nfa/bin/locatrans3.0s	created: 5/15/95(Reference 6.6b)
/scenuc/nfa/bin/locadose3.0s	created: 5/15/95(Reference 6.6b)
/scenuc/nfa/bin/source2d2-5	created: 10/11/95(Reference 6.6d)

The following LOCADOSE files were created during this analysis:

```
-rw-r-----   1 druckemi nf010      5583 Mar 23 10:14 fha.lib
-rw-r-----   1 druckemi nf010       781 Mar 23 10:14 fha-fhb.di
-rw-r--r--   1 druckemi nf010     33929 Mar 23 10:16 fha-fhb.do
-rw-r-----   1 druckemi nf010      4323 Mar 23 10:14 fha-fhb.ti
-rw-r--r--   1 druckemi nf010     90549 Mar 23 10:16 fha-fhb.to
-rw-r--r--   1 druckemi nf010     60624 Mar 23 10:16 fha-fhb.trn  (note 1)
```

NOTE 1: This output file is not presented in Section 9.2. The fha-fhb.trn output file is used by the fha-fhb.di input file to generate the fha-fhb.do output file.

The following SOURCE2 files were created during this analysis:

```
-rw-r--r--   1 druckemi nf010      5385 Mar 25 13:18 ss-c.mev  (note 2)
-rw-r-----   1 druckemi nf010     14865 Mar 25 13:17 ss-c.si
-rw-r--r--   1 druckemi nf010     61800 Mar 25 13:18 ss-c.so

-rw-r--r--   1 druckemi nf010      5385 Mar 25 13:18 ss-f.mev  (note 2)
-rw-r-----   1 druckemi nf010     14865 Mar 25 13:17 ss-f.si
-rw-r--r--   1 druckemi nf010     61800 Mar 25 13:18 ss-f.so
```

NOTE 2: These output files are not presented in Section 9.3. The *.mev output files summarize the gamma source strength spectrums reported in the *.so output files.

As discussed in Section 5.2 (for the 1000 cfm LOCADOSE case), The LOCADOSE Code Version 6.0 was executed on the Nuclear Fuel Management NT station (Device ID D088771). The LOCADOSE activity transport and dose calculation modules utilized in this analysis were titled and stored as:

Trans.exe	created: 2/09/01(Reference 6.6i)
Dose.exe	created: 2/09/01(Reference 6.6i)

The following LOCADOSE files were created during this analysis:

```
11/13/2002  07:22a          1,451 fhb1000.ldi
11/12/2002  12:59p          5,963 fhb1000.lib
11/12/2002  12:58p          2,693 fhb1000.lti
11/13/2002  12:44p         95,369 fhb1000.lto
11/13/2002  12:44p         65,004 fhb1000.ltf     (note 1)
11/13/2002  12:44p         33,559 fhb1000.ldo
```

NOTE 1: This output file is not presented in Section 9.2 The fhb1000.ltf output file is used by the fhb1000.ldi input file to generate the fhb1000.ldo output file.

9.2 LOCADOSE Code Input and Output Files

9.2.1 LOCADOSE Library File - 10 cfm case (fha.lib)

```
FHA.LIB        Thyroid    Lung       Bone    Beta Skin Whole Body
I--129 1.071E-03 1.400E-15 5.920E+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  1 4.090E-02 2.820E-03
I--129 1.071E-03 1.400E-15 5.920E+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  2 4.090E-02 2.820E-03
I--129 1.071E-03 1.400E-15 5.920E+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  3 4.090E-02 2.820E-03
I--130 9.795E+02 1.557E-05 7.400E+04 4.110E+03 5.720E+02 4.990E-02 4.980E-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  4 2.787E-01 2.138E+00
I--130 9.795E+02 1.557E-05 7.400E+04 4.110E+03 5.720E+02 4.990E-02 4.980E-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  5 2.787E-01 2.138E+00
I--130 9.795E+02 1.557E-05 7.400E+04 4.110E+03 5.720E+02 4.990E-02 4.980E-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  6 2.787E-01 2.138E+00
I--131 2.508E+04 9.976E-07 1.070E+06 2.073E+04 3.150E+03 3.170E-02 8.720E-02  1
1 24  0  0  0  0  0
 1.100E-02 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00  7 1.817E-01 3.789E-01
I--131 2.508E+04 9.976E-07 1.070E+06 2.073E+04 3.150E+03 3.170E-02 8.720E-02  2
1 24  0  0  0  0  0
 1.100E-02 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00  8 1.817E-01 3.789E-01
I--131 2.508E+04 9.976E-07 1.070E+06 2.073E+04 3.150E+03 3.170E-02 8.720E-02  3
1 24  0  0  0  0  0
 1.100E-02 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00  9 1.817E-01 3.789E-01
I--132 3.806E+04 8.425E-05 6.290E+03 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 10 4.824E-01 3.559E+00
I--132 3.806E+04 8.425E-05 6.290E+03 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 11 4.824E-01 3.559E+00
I--132 3.806E+04 8.425E-05 6.290E+03 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 12 4.824E-01 3.559E+00
I--133 5.622E+04 9.211E-06 1.810E+05 5.064E+03 1.080E+03 7.350E-02 1.550E-01  1
2 26 25  0  0  0  0
 9.710E-01 2.900E-02 0.000E+00 0.000E+00 0.000E+00 0.000E+00 13 4.067E-01 6.047E-01
I--133 5.622E+04 9.211E-06 1.810E+05 5.064E+03 1.080E+03 7.350E-02 1.550E-01  2
2 26 25  0  0  0  0
 9.710E-01 2.900E-02 0.000E+00 0.000E+00 0.000E+00 0.000E+00 14 4.067E-01 6.047E-01
I--133 5.622E+04 9.211E-06 1.810E+05 5.064E+03 1.080E+03 7.350E-02 1.550E-01  3
2 26 25  0  0  0  0
 9.710E-01 2.900E-02 0.000E+00 0.000E+00 0.000E+00 0.000E+00 15 4.067E-01 6.047E-01
I--135 5.103E+04 2.912E-05 3.150E+04 1.971E+03 3.350E+02 1.290E-01 4.210E-01  1
2 28 27  0  0  0  0
 8.450E-01 1.550E-01 0.000E+00 0.000E+00 0.000E+00 0.000E+00 16 3.691E-01 1.617E+00
I--135 5.103E+04 2.912E-05 3.150E+04 1.971E+03 3.350E+02 1.290E-01 4.210E-01  2
2 28 27  0  0  0  0
 8.450E-01 1.550E-01 0.000E+00 0.000E+00 0.000E+00 0.000E+00 17 3.691E-01 1.617E+00
I--135 5.103E+04 2.912E-05 3.150E+04 1.971E+03 3.350E+02 1.290E-01 4.210E-01  3
2 28 27  0  0  0  0
```

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

8.450E-01 1.550E-01 0.000E+00 0.000E+00 0.000E+00 0.000E+00 18 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 19 0.000E+00 4.610E-04
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 30 2.505E-01 2.236E-03
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 20 0 0 0 0 0
2.100E-01 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 20 2.902E-01 1.610E-01
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 21 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 29 0 0 0 0 0
1.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 22 3.587E-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 23 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 26 0 0 0 0 0
1.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 24 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 25 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 28 0 0 0 0 0
1.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 26 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 30 0 0 0 0 0
1.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 27 3.028E-01 2.466E-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

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇩
6	N. YACKLE		T. REMICK							

9.2.2 LOCADOSE Activity Transport Input File - 10 cfm case (fha-fhb.ti)

```
FHA in FHB, CRIS at 3 min (fha-fhb.to)
MARK DRUCKER
SONGS UNITS 2,3
fha-fhb.ti
N4072-001  5
           1
   2  14  30   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
FHB AIR     A206/7
 0.00000E+00 2.78000E-03  1  1  1  1
  1  0  1
   1.12E-5     0  < elem. I-129,   FHB inventory at 72 hrs decay
   3.72E-6     0  < org. I-129,    FHB inventory at 72 hrs decay
   0           0  < partic. I-129, FHB inventory at 72 hrs decay
   2.92E-3     0  < elem. I-130,   FHB inventory at 72 hrs decay
   9.73E-4     0  < org. I-130,    FHB inventory at 72 hrs decay
   0           0  < partic. I-130, FHB inventory at 72 hrs decay
   1.32E+2     0  < elem. I-131,   FHB inventory at 72 hrs decay
   4.41E+1     0  < org. I-131,    FHB inventory at 72 hrs decay
   0           0  < partic. I-131, FHB inventory at 72 hrs decay
   8.06E-8     0  < elem. I-132,   FHB inventory at 72 hrs decay
   2.69E-8     0  < org. I-132,    FHB inventory at 72 hrs decay
   0           0  < partic. I-132, FHB inventory at 72 hrs decay
   3.07E+1     0  < elem. I-133,   FHB inventory at 72 hrs decay
   1.02E+1     0  < org. I-133,    FHB inventory at 72 hrs decay
   0           0  < partic. I-133, FHB inventory at 72 hrs decay
   1.69E-1     0  < elem. I-135,   FHB inventory at 72 hrs decay
   5.64E-2     0  < org. I-135,    FHB inventory at 72 hrs decay
   0           0  < partic. I-135, FHB inventory at 72 hrs decay
   3.86E-9     0  < Kr-83m,        FHB inventory at 72 hrs decay
   8.13E+2     0  < Kr-85,         FHB inventory at 72 hrs decay
   8.56E-2     0  < Kr-85m,        FHB inventory at 72 hrs decay
   1.07E-13    0  < Kr-87,         FHB inventory at 72 hrs decay
   4.42E-4     0  < Kr-88,         FHB inventory at 72 hrs decay
   2.01E+2     0  < Xe-131m,       FHB inventory at 72 hrs decay
   6.74E+2     0  < Xe-133m,       FHB inventory at 72 hrs decay
   2.95E+4     0  < Xe-133,        FHB inventory at 72 hrs decay
   2.88        0  < Xe-135m,       FHB inventory at 72 hrs decay
   3.87E+2     0  < Xe-135,        FHB inventory at 72 hrs decay
   0           0  < Rb-88,         FHB inventory at 72 hrs decay
   0           0  < Cs-135,        FHB inventory at 72 hrs decay
355305         7.32
  2  1  0  25581
     0   0   0   0   100   100   100   100   100   0   0
  3  3  1.0E+06  0
     0   0   0 100   0   0   0   0   0   0   0
 -1,0,0,0
 -1,0,0,0
           1    3.10000E-03
 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
 2.78000E-03 5.00000E-02  1  1  1  1
  0  0  0
```

```
-1,0,0,0
-1,0,0,0
          0    3.10000E-03
5.00000E-02 0.10000E+00  1  1  1  1
 0  0  0
 2  1  0  25499
    0   0   0   0   100   100   100   100   100   0   0
 2  3  0  82
    0   0   0   0   100   100   100   100   100   0   0
 3  3  1.0E+06  0
    0   0   0 100   0   0   0   0   0   0   0
-1,0,0,0
-1,0,0,0
          1    3.10000E-03
266920  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
0.10000E+00 0.20000E+00  1  1  1  1
 0  0  0
-1,0,0,0
-1,0,0,0
          0    3.10000E-03
0.20000E+00 0.50000E+00  1  1  1  1
 0  0  0
-1,0,0,0
-1,0,0,0
          0    3.10000E-03
0.50000E+00 1.00000E+00  1  1  1  1
 0  0  0
-1,0,0,0
-1,0,0,0
          0    3.10000E-03
1.00000E+00 2.00000E+00  1  1  1  1
 0  0  0
-1,0,0,0
-1,0,0,0
          0    3.10000E-03
2.00000E+00 4.00000E+00  1  1  1  1
 0  0  0
-1,0,0,0
-1,0,0,0
          0    3.10000E-03
4.00000E+00 6.00000E+00  1  1  1  1
 0  0  0
-1,0,0,0
-1,0,0,0
          0    3.10000E-03
6.00000E+00 8.00000E+00  1  1  1  1
 0  0  0
-1,0,0,0
-1,0,0,0
          0    3.10000E-03
8.00000E+00 1.00000E+01  1  1  1  1
  0   0   0
-1,0,0,0
-1,0,0,0
          1    1.80000E-03
266920  2200   10  29934  2210
   95  95  99   0  99  99  99  99  99   0   0
```

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇩
6	N. YACKLE		T. REMICK							

```
   95  95  99   0  99  99  99  99  99   0   0
1.00000E+01 2.40000E+01  1  1  1  1
  0   0   0
-1,0,0,0
-1,0,0,0
          0    1.80000E-03
2.40000E+01 9.60000E+01  1  1  1  1
 0  0  0
-1,0,0,0
-1,0,0,0
          0    9.80000E-04
9.60000E+01 7.20000E+02  1  1  1  1
 0  0  0
-1,0,0,0
-1,0,0,0
          0    2.40000E-04
```

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇩
6	N. YACKLE		T. REMICK							

9.2.3 LOCADOSE Activity Transport Output File Excerpts - 10 cfm case (fha-fhb.to)

NOTE: The following are relevant excerpts from the LOCADOSE Code activity transport output file.

```
Bechtel Standard Computer Program       LOCADOSE, NE319  Version 3.0
(c) 1989 SCE AIX Version. 2 Feb 1995              Calc No. N4072-001 Rev No.   5
Originator MARK DRUCKER          Date 23 Mar 1999
Project SONGS UNITS 2,3      Job No. fha-fhb.ti           Sheet No.    2
Subject FHA in FHB, CRIS at 3 min (fha-fhb.to)
================================================================================



Nodes =  2
Time steps =  14
Number of isotopes= 30
Power =      0. Mwt
Shutdown time= 0.00E+00 hrs
(if negative, no decay prior to start of accident is considered
Release fractions

Elemental Iodine= 1.0     Organic Iodine= 1.0     Particulate Iodine=0.00E+00
Noble Gases= 1.0     Cs, Rb= 1.0     Te, Se, Ss= 1.0
Sr, Ba= 1.0     Noble Metals= 1.0     Rare Earths= 1.0
Other isotopes= 1.0     Halogens (except iodines)= 1.0
 Control room activities will be calculated for this case

Output file LOCATRAN was created on 23 Mar 1999  at 10:16:47

NE313 FHA.LIB     was used to generate isotope data for this run
```

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

```
Bechtel Standard Computer Program       LOCADOSE, NE319  Version 3.0
(c) 1989 SCE AIX Version. 2 Feb 1995            Calc No. N4072-001 Rev No.   5
Originator MARK DRUCKER         Date 23 Mar 1999
Project SONGS UNITS 2,3      Job No. fha-fhb.ti          Sheet No.    3
Subject FHA in FHB, CRIS at 3 min (fha-fhb.to)
================================================================================


*** Time interval =  0.000E+00 -  2.780E-03 hrs
                  Initial Activity in CURIES
              FHB AIR      A206/7
I--129        1.492E-05 0.000E+00
I--130        3.893E-03 0.000E+00
I--131        1.761E+02 0.000E+00
I--132        1.075E-07 0.000E+00
I--133        4.090E+01 0.000E+00
I--135        2.254E-01 0.000E+00
KR-83M        3.860E-09 0.000E+00
KR--85        8.130E+02 0.000E+00
KR-85M        8.560E-02 0.000E+00
KR--87        1.070E-13 0.000E+00
KR--88        4.420E-04 0.000E+00
XE131M        2.010E+02 0.000E+00
XE133M        6.740E+02 0.000E+00
XE-133        2.950E+04 0.000E+00
XE135M        2.880E+00 0.000E+00
XE-135        3.870E+02 0.000E+00
RB--88        0.000E+00 0.000E+00
CS-135        0.000E+00 0.000E+00
Total         3.180E+04 0.000E+00
```

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

```
Bechtel Standard Computer Program       LOCADOSE, NE319  Version 3.0
(c) 1989 SCE AIX Version. 2 Feb 1995              Calc No. N4072-001 Rev No.   5
Originator MARK DRUCKER          Date 23 Mar 1999
Project SONGS UNITS 2,3      Job No. fha-fhb.ti          Sheet No.    6
Subject FHA in FHB, CRIS at 3 min (fha-fhb.to)
================================================================================
****Results for Activity Computation at the end of  2.7800E-03 hours

                Distribution of Instantaneous Activity in CURIES
              FHB AIR      A206/7 Cont Room
I--129        1.475E-05 0.000E+00 1.473E-09
I--130        3.847E-03 1.301E-35 3.842E-07
I--131        1.741E+02 4.800E-29 1.738E-02
I--132        1.062E-07 0.000E+00 1.060E-11
I--133        4.042E+01 3.047E-31 4.036E-03
I--135        2.227E-01 5.493E-34 2.224E-05
KR-83M        3.811E-09 0.000E+00 3.806E-13
KR--85        8.036E+02 1.652E-35 8.024E-02
KR-85M        8.457E-02 0.000E+00 8.445E-06
KR--87        1.056E-13 0.000E+00 1.054E-17
KR--88        4.366E-04 0.000E+00 4.360E-08
XE131M        1.987E+02 0.000E+00 1.984E-02
XE133M        6.661E+02 1.367E-35 6.652E-02
XE-133        2.916E+04 5.854E-34 2.912E+00
XE135M        2.826E+00 0.000E+00 2.822E-04
XE-135        3.824E+02 0.000E+00 3.819E-02
RB--88        2.830E-06 0.000E+00 2.826E-10
CS-135        2.851E-11 0.000E+00 2.847E-15
Total         3.143E+04 4.831E-29 3.138E+00

Bechtel Standard Computer Program       LOCADOSE, NE319  Version 3.0
(c) 1989 SCE AIX Version. 2 Feb 1995              Calc No. N4072-001 Rev No.   5
Originator MARK DRUCKER          Date 23 Mar 1999
Project SONGS UNITS 2,3      Job No. fha-fhb.ti          Sheet No.    7
Subject FHA in FHB, CRIS at 3 min (fha-fhb.to)
================================================================================
****Results for Activity Computation at the end of  2.7800E-03 hours

                Activity Released from Each Node in CURIES
                Since Last Printout

              FHB AIR      A206/7   Total
I--129        1.733E-07 0.000E+00 1.733E-07
I--130        4.520E-05 0.000E+00 4.520E-05
I--131        2.045E+00 0.000E+00 2.045E+00
I--132        1.248E-09 0.000E+00 1.248E-09
I--133        4.749E-01 0.000E+00 4.749E-01
I--135        2.617E-03 0.000E+00 2.617E-03
KR-83M        4.480E-11 0.000E+00 4.480E-11
KR--85        9.441E+00 0.000E+00 9.441E+00
KR-85M        9.938E-04 0.000E+00 9.938E-04
KR--87        1.242E-15 0.000E+00 1.242E-15
KR--88        5.131E-06 0.000E+00 5.131E-06
XE131M        2.334E+00 0.000E+00 2.334E+00
XE133M        7.827E+00 0.000E+00 7.827E+00
XE-133        3.426E+02 0.000E+00 3.426E+02
XE135M        3.332E-02 0.000E+00 3.332E-02
XE-135        4.494E+00 0.000E+00 4.494E+00
RB--88        1.661E-08 0.000E+00 1.661E-08
CS-135        1.672E-13 0.000E+00 1.672E-13
Total         3.692E+02 0.000E+00 3.692E+02
```

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

```
Bechtel Standard Computer Program       LOCADOSE, NE319  Version 3.0
(c) 1989 SCE AIX Version. 2 Feb 1995              Calc No. N4072-001 Rev No.   5
Originator MARK DRUCKER          Date 23 Mar 1999
Project SONGS UNITS 2,3      Job No. fha-fhb.ti          Sheet No.   10
Subject FHA in FHB, CRIS at 3 min (fha-fhb.to)
================================================================================
****Results for Activity Computation at the end of  5.0000E-02 hours

                  Distribution of Instantaneous Activity in CURIES
              FHB AIR      A206/7 Cont Room
I--129        1.209E-05 3.711E-23 2.327E-08
I--130        3.147E-03 2.525E-34 6.056E-06
I--131        1.427E+02 8.004E-28 2.747E-01
I--132        8.582E-08 0.000E+00 1.652E-10
I--133        3.310E+01 1.916E-29 6.370E-02
I--135        1.817E-01 7.977E-33 3.498E-04
KR-83M        3.070E-09 0.000E+00 5.909E-12
KR--85        6.590E+02 1.423E-35 1.268E+00
KR-85M        6.885E-02 0.000E+00 1.325E-04
KR--87        8.439E-14 0.000E+00 1.624E-16
KR--88        3.539E-04 0.000E+00 6.812E-07
XE131M        1.629E+02 0.000E+00 3.135E-01
XE133M        5.459E+02 1.177E-35 1.051E+00
XE-133        2.390E+04 5.044E-34 4.601E+01
XE135M        2.047E+00 0.000E+00 3.941E-03
XE-135        3.125E+02 0.000E+00 6.014E-01
RB--88        3.930E-05 0.000E+00 7.550E-08
CS-135        4.199E-10 3.992E-17 8.070E-13
Total         2.576E+04 3.992E-17 4.958E+01

Bechtel Standard Computer Program       LOCADOSE, NE319  Version 3.0
(c) 1989 SCE AIX Version. 2 Feb 1995              Calc No. N4072-001 Rev No.   5
Originator MARK DRUCKER          Date 23 Mar 1999
Project SONGS UNITS 2,3      Job No. fha-fhb.ti          Sheet No.   11
Subject FHA in FHB, CRIS at 3 min (fha-fhb.to)
================================================================================
****Results for Activity Computation at the end of  5.0000E-02 hours

                  Activity Released from Each Node in CURIES
                  Since Last Printout

              FHB AIR      A206/7    Total
I--129        2.654E-06 0.000E+00 2.654E-06
I--130        6.914E-04 0.000E+00 6.914E-04
I--131        3.132E+01 0.000E+00 3.132E+01
I--132        1.897E-08 0.000E+00 1.897E-08
I--133        7.269E+00 0.000E+00 7.269E+00
I--135        3.998E-02 0.000E+00 3.998E-02
KR-83M        6.800E-10 0.000E+00 6.800E-10
KR--85        1.446E+02 0.000E+00 1.446E+02
KR-85M        1.517E-02 0.000E+00 1.517E-02
KR--87        1.877E-14 0.000E+00 1.877E-14
KR--88        7.813E-05 0.000E+00 7.813E-05
XE131M        3.575E+01 0.000E+00 3.575E+01
XE133M        1.198E+02 0.000E+00 1.198E+02
XE-133        5.246E+03 0.000E+00 5.246E+03
XE135M        4.793E-01 0.000E+00 4.793E-01
XE-135        6.870E+01 0.000E+00 6.870E+01
RB--88        4.506E-06 0.000E+00 4.506E-06
CS-135        4.713E-11 0.000E+00 4.713E-11
Total         5.654E+03 0.000E+00 5.654E+03
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Bechtel Standard Computer Program LOCADOSE, NE319 Version 3.0
(c) 1989 SCE AIX Version. 2 Feb 1995 Calc No. N4072-001 Rev No. 5
Originator MARK DRUCKER Date 23 Mar 1999
Project SONGS UNITS 2,3 Job No. fha-fhb.ti Sheet No. 14
Subject FHA in FHB, CRIS at 3 min (fha-fhb.to)

****Results for Activity Computation at the end of .1000 hours

Distribution of Instantaneous Activity in CURIES

	FHB AIR	A206/7	Cont Room
I--129	9.802E-06	7.345E-09	1.224E-08
I--130	2.543E-03	1.906E-06	3.175E-06
I--131	1.156E+02	8.666E-02	1.444E-01
I--132	6.851E-08	5.134E-11	8.553E-11
I--133	2.678E+01	2.007E-02	3.343E-02
I--135	1.465E-01	1.098E-04	1.829E-04
KR-83M	2.442E-09	4.012E-18	9.096E-12
KR--85	5.341E+02	8.776E-07	1.990E+00
KR-85M	5.537E-02	9.098E-11	2.063E-04
KR--87	6.656E-14	1.094E-22	2.480E-16
KR--88	2.834E-04	4.657E-13	1.056E-06
XE131M	1.320E+02	2.169E-07	4.918E-01
XE133M	4.422E+02	7.266E-07	1.647E+00
XE-133	1.937E+04	3.183E-05	7.216E+01
XE135M	1.456E+00	2.397E-09	5.420E-03
XE-135	2.523E+02	4.146E-07	9.400E-01
RB--88	5.981E-05	3.238E-08	1.050E-07
CS-135	6.793E-10	3.770E-13	1.165E-12
Total	2.087E+04	1.069E-01	7.741E+01

Bechtel Standard Computer Program LOCADOSE, NE319 Version 3.0
(c) 1989 SCE AIX Version. 2 Feb 1995 Calc No. N4072-001 Rev No. 5
Originator MARK DRUCKER Date 23 Mar 1999
Project SONGS UNITS 2,3 Job No. fha-fhb.ti Sheet No. 15
Subject FHA in FHB, CRIS at 3 min (fha-fhb.to)

****Results for Activity Computation at the end of .1000 hours

Activity Released from Each Node in CURIES
Since Last Printout

	FHB AIR	A206/7	Total
I--129	2.284E-06	0.000E+00	2.284E-06
I--130	5.935E-04	0.000E+00	5.935E-04
I--131	2.695E+01	0.000E+00	2.695E+01
I--132	1.609E-08	0.000E+00	1.609E-08
I--133	6.246E+00	0.000E+00	6.246E+00
I--135	3.424E-02	0.000E+00	3.424E-02
KR-83M	5.746E-10	0.000E+00	5.746E-10
KR--85	1.245E+02	0.000E+00	1.245E+02
KR-85M	1.295E-02	0.000E+00	1.295E-02
KR--87	1.573E-14	0.000E+00	1.573E-14
KR--88	6.646E-05	0.000E+00	6.646E-05
XE131M	3.076E+01	0.000E+00	3.076E+01
XE133M	1.031E+02	0.000E+00	1.031E+02
XE-133	4.514E+03	0.000E+00	4.514E+03
XE135M	3.633E-01	0.000E+00	3.633E-01
XE-135	5.891E+01	0.000E+00	5.891E+01
RB--88	1.063E-05	0.000E+00	1.063E-05
CS-135	1.174E-10	0.000E+00	1.174E-10
Total	4.865E+03	0.000E+00	4.865E+03

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

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Bechtel Standard Computer Program       LOCADOSE, NE319  Version 3.0
(c) 1989 SCE AIX Version. 2 Feb 1995              Calc No. N4072-001 Rev No.   5
Originator MARK DRUCKER         Date 23 Mar 1999
Project SONGS UNITS 2,3      Job No. fha-fhb.ti          Sheet No.   18
Subject FHA in FHB, CRIS at 3 min (fha-fhb.to)
================================================================================
****Results for Activity Computation at the end of   .2000     hours

                Distribution of Instantaneous Activity in CURIES
              FHB AIR      A206/7 Cont Room
I--129        6.439E-06 1.812E-08 3.670E-09
I--130        1.661E-03 4.676E-06 9.469E-07
I--131        7.595E+01 2.138E-01 4.328E-02
I--132        4.366E-08 1.229E-10 2.489E-11
I--133        1.753E+01 4.935E-02 9.994E-03
I--135        9.526E-02 2.681E-04 5.429E-05
KR-83M        1.544E-09 2.538E-18 1.285E-11
KR--85        3.509E+02 5.765E-07 2.920E+00
KR-85M        3.582E-02 5.885E-11 2.981E-04
KR--87        4.141E-14 6.804E-23 3.446E-16
KR--88        1.817E-04 2.986E-13 1.512E-06
XE131M        8.670E+01 1.425E-07 7.215E-01
XE133M        2.901E+02 4.767E-07 2.414E+00
XE-133        1.272E+04 2.090E-05 1.058E+02
XE135M        7.368E-01 1.223E-09 6.108E-03
XE-135        1.645E+02 2.703E-07 1.369E+00
RB--88        6.950E-05 1.063E-07 1.766E-07
CS-135        8.895E-10 1.468E-12 2.038E-12
Total         1.370E+04 2.634E-01 1.133E+02

Bechtel Standard Computer Program       LOCADOSE, NE319  Version 3.0
(c) 1989 SCE AIX Version. 2 Feb 1995              Calc No. N4072-001 Rev No.   5
Originator MARK DRUCKER         Date 23 Mar 1999
Project SONGS UNITS 2,3      Job No. fha-fhb.ti          Sheet No.   19
Subject FHA in FHB, CRIS at 3 min (fha-fhb.to)
================================================================================
****Results for Activity Computation at the end of   .2000     hours

                Activity Released from Each Node in CURIES
                Since Last Printout

              FHB AIR      A206/7   Total
I--129        3.352E-06 0.000E+00 3.352E-06
I--130        8.674E-04 0.000E+00 8.674E-04
I--131        3.954E+01 0.000E+00 3.954E+01
I--132        2.310E-08 0.000E+00 2.310E-08
I--133        9.144E+00 0.000E+00 9.144E+00
I--135        4.986E-02 0.000E+00 4.986E-02
KR-83M        8.204E-10 0.000E+00 8.204E-10
KR--85        1.826E+02 0.000E+00 1.826E+02
KR-85M        1.880E-02 0.000E+00 1.880E-02
KR--87        2.220E-14 0.000E+00 2.220E-14
KR--88        9.583E-05 0.000E+00 9.583E-05
XE131M        4.514E+01 0.000E+00 4.514E+01
XE133M        1.511E+02 0.000E+00 1.511E+02
XE-133        6.622E+03 0.000E+00 6.622E+03
XE135M        4.421E-01 0.000E+00 4.421E-01
XE-135        8.598E+01 0.000E+00 8.598E+01
RB--88        2.807E-05 0.000E+00 2.807E-05
CS-135        3.392E-10 0.000E+00 3.392E-10
Total         7.136E+03 0.000E+00 7.136E+03
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REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

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Bechtel Standard Computer Program       LOCADOSE, NE319  Version 3.0
(c) 1989 SCE AIX Version. 2 Feb 1995              Calc No. N4072-001 Rev No.   5
Originator MARK DRUCKER          Date 23 Mar 1999
Project SONGS UNITS 2,3      Job No. fha-fhb.ti          Sheet No.   22
Subject FHA in FHB, CRIS at 3 min (fha-fhb.to)
================================================================================
****Results for Activity Computation at the end of   .5000     hours

                  Distribution of Instantaneous Activity in CURIES
              FHB AIR      A206/7 Cont Room
I--129        1.826E-06 3.291E-08 3.124E-10
I--130        4.632E-04 8.350E-06 7.925E-08
I--131        2.151E+01 3.878E-01 3.680E-03
I--132        1.130E-08 2.038E-10 1.934E-12
I--133        4.922E+00 8.874E-02 8.422E-04
I--135        2.617E-02 4.718E-04 4.478E-06
KR-83M        3.908E-10 6.422E-19 1.385E-11
KR--85        9.948E+01 1.635E-07 3.525E+00
KR-85M        9.694E-03 1.593E-11 3.435E-04
KR--87        9.969E-15 1.638E-23 3.533E-16
KR--88        4.791E-05 7.872E-14 1.698E-06
XE131M        2.456E+01 4.036E-08 8.704E-01
XE133M        8.193E+01 1.346E-07 2.903E+00
XE-133        3.600E+03 5.915E-06 1.276E+02
XE135M        9.643E-02 1.815E-10 3.340E-03
XE-135        4.559E+01 7.492E-08 1.616E+00
RB--88        3.506E-05 2.017E-07 2.427E-07
CS-135        6.263E-10 4.701E-12 3.040E-12
Total         3.878E+03 4.770E-01 1.365E+02

Bechtel Standard Computer Program       LOCADOSE, NE319  Version 3.0
(c) 1989 SCE AIX Version. 2 Feb 1995              Calc No. N4072-001 Rev No.   5
Originator MARK DRUCKER          Date 23 Mar 1999
Project SONGS UNITS 2,3      Job No. fha-fhb.ti          Sheet No.   23
Subject FHA in FHB, CRIS at 3 min (fha-fhb.to)
================================================================================
****Results for Activity Computation at the end of   .5000     hours

                  Activity Released from Each Node in CURIES
                  Since Last Printout

              FHB AIR      A206/7    Total
I--129        4.599E-06 0.000E+00 4.599E-06
I--130        1.179E-03 0.000E+00 1.179E-03
I--131        5.422E+01 0.000E+00 5.422E+01
I--132        3.009E-08 0.000E+00 3.009E-08
I--133        1.247E+01 0.000E+00 1.247E+01
I--135        6.719E-02 0.000E+00 6.719E-02
KR-83M        1.055E-09 0.000E+00 1.055E-09
KR--85        2.506E+02 0.000E+00 2.506E+02
KR-85M        2.511E-02 0.000E+00 2.511E-02
KR--87        2.774E-14 0.000E+00 2.774E-14
KR--88        1.261E-04 0.000E+00 1.261E-04
XE131M        6.190E+01 0.000E+00 6.190E+01
XE133M        2.069E+02 0.000E+00 2.069E+02
XE-133        9.077E+03 0.000E+00 9.077E+03
XE135M        3.951E-01 0.000E+00 3.951E-01
XE-135        1.164E+02 0.000E+00 1.164E+02
RB--88        6.715E-05 0.000E+00 6.715E-05
CS-135        1.006E-09 0.000E+00 1.006E-09
Total         9.780E+03 0.000E+00 9.780E+03
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REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

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Bechtel Standard Computer Program      LOCADOSE, NE319  Version 3.0
(c) 1989 SCE AIX Version. 2 Feb 1995            Calc No. N4072-001 Rev No.   5
Originator MARK DRUCKER         Date 23 Mar 1999
Project SONGS UNITS 2,3      Job No. fha-fhb.ti          Sheet No.   26
Subject FHA in FHB, CRIS at 3 min (fha-fhb.to)
================================================================================
****Results for Activity Computation at the end of   1.000     hours

                Distribution of Instantaneous Activity in CURIES
            FHB AIR      A206/7 Cont Room
I--129      2.234E-07 3.805E-08 3.292E-11
I--130      5.511E-05 9.387E-06 8.122E-09
I--131      2.627E+00 4.475E-01 3.872E-04
I--132      1.188E-09 2.024E-10 1.752E-13
I--133      5.924E-01 1.009E-01 8.731E-05
I--135      3.039E-03 5.176E-04 4.479E-07
KR-83M      3.957E-11 6.502E-20 8.306E-12
KR--85      1.217E+01 2.000E-08 2.555E+00
KR-85M      1.098E-03 1.804E-12 2.305E-04
KR--87      9.289E-16 1.526E-24 1.950E-16
KR--88      5.193E-06 8.534E-15 1.090E-06
XE131M      3.002E+00 4.934E-09 6.301E-01
XE133M      9.959E+00 1.637E-08 2.090E+00
XE-133      4.393E+02 7.219E-07 9.221E+01
XE135M      3.493E-03 3.176E-11 6.470E-04
XE-135      5.371E+00 8.829E-09 1.127E+00
RB--88      5.239E-06 1.157E-07 1.673E-07
CS-135      1.518E-10 7.031E-12 2.293E-12
Total       4.730E+02 5.489E-01 9.862E+01

Bechtel Standard Computer Program      LOCADOSE, NE319  Version 3.0
(c) 1989 SCE AIX Version. 2 Feb 1995            Calc No. N4072-001 Rev No.   5
Originator MARK DRUCKER         Date 23 Mar 1999
Project SONGS UNITS 2,3      Job No. fha-fhb.ti          Sheet No.   27
Subject FHA in FHB, CRIS at 3 min (fha-fhb.to)
================================================================================
****Results for Activity Computation at the end of   1.000     hours

                Activity Released from Each Node in CURIES
                Since Last Printout

            FHB AIR      A206/7   Total
I--129      1.597E-06 0.000E+00 1.597E-06
I--130      4.014E-04 0.000E+00 4.014E-04
I--131      1.881E+01 0.000E+00 1.881E+01
I--132      9.403E-09 0.000E+00 9.403E-09
I--133      4.282E+00 0.000E+00 4.282E+00
I--135      2.250E-02 0.000E+00 2.250E-02
KR-83M      3.212E-10 0.000E+00 3.212E-10
KR--85      8.703E+01 0.000E+00 8.703E+01
KR-85M      8.265E-03 0.000E+00 8.265E-03
KR--87      7.977E-15 0.000E+00 7.977E-15
KR--88      4.026E-05 0.000E+00 4.026E-05
XE131M      2.148E+01 0.000E+00 2.148E+01
XE133M      7.152E+01 0.000E+00 7.152E+01
XE-133      3.146E+03 0.000E+00 3.146E+03
XE135M      5.810E-02 0.000E+00 5.810E-02
XE-135      3.938E+01 0.000E+00 3.938E+01
RB--88      3.349E-05 0.000E+00 3.349E-05
CS-135      7.244E-10 0.000E+00 7.244E-10
Total       3.389E+03 0.000E+00 3.389E+03
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REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

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Bechtel Standard Computer Program       LOCADOSE, NE319  Version 3.0
(c) 1989 SCE AIX Version. 2 Feb 1995              Calc No. N4072-001 Rev No.   5
Originator MARK DRUCKER          Date 23 Mar 1999
Project SONGS UNITS 2,3      Job No. fha-fhb.ti          Sheet No.   30
Subject FHA in FHB, CRIS at 3 min (fha-fhb.to)
================================================================================
****Results for Activity Computation at the end of   2.000     hours

                    Distribution of Instantaneous Activity in CURIES
              FHB AIR      A206/7 Cont Room
I--129        3.344E-09 3.875E-08 4.923E-13
I--130        7.801E-07 9.039E-06 1.148E-10
I--131        3.919E-02 4.541E-01 5.769E-05
I--132        1.314E-11 1.522E-10 1.934E-15
I--133        8.580E-03 9.942E-02 1.263E-06
I--135        4.097E-05 4.747E-04 6.030E-09
KR-83M        4.057E-13 6.666E-22 2.192E-12
KR--85        1.822E-01 2.994E-10 9.846E-01
KR-85M        1.408E-05 2.314E-14 7.608E-05
KR--87        8.063E-18 1.325E-26 4.357E-17
KR--88        6.102E-08 1.003E-16 3.297E-07
XE131M        4.484E-02 7.517E-11 2.422E-01
XE133M        1.472E-01 2.464E-10 7.950E-01
XE-133        6.542E+00 1.081E-08 3.534E+01
XE135M        1.076E-05 2.418E-11 1.775E-05
XE-135        7.452E-02 1.262E-10 4.026E-01
RB--88        7.684E-08 1.419E-08 5.450E-08
CS-135        4.550E-12 7.609E-12 8.713E-13
Total         7.039E+00 5.540E-01 3.777E+01

Bechtel Standard Computer Program       LOCADOSE, NE319  Version 3.0
(c) 1989 SCE AIX Version. 2 Feb 1995              Calc No. N4072-001 Rev No.   5
Originator MARK DRUCKER          Date 23 Mar 1999
Project SONGS UNITS 2,3      Job No. fha-fhb.ti          Sheet No.   31
Subject FHA in FHB, CRIS at 3 min (fha-fhb.to)
================================================================================
****Results for Activity Computation at the end of   2.000     hours

                    Activity Released from Each Node in CURIES
                    Since Last Printout

              FHB AIR      A206/7   Total
I--129        2.193E-07 0.000E+00 2.193E-07
I--130        5.344E-05 0.000E+00 5.344E-05
I--131        2.577E+00 0.000E+00 2.577E+00
I--132        1.093E-09 0.000E+00 1.093E-09
I--133        5.774E-01 0.000E+00 5.774E-01
I--135        2.915E-03 0.000E+00 2.915E-03
KR-83M        3.581E-11 0.000E+00 3.581E-11
KR--85        1.195E+01 0.000E+00 1.195E+01
KR-85M        1.042E-03 0.000E+00 1.042E-03
KR--87        8.124E-16 0.000E+00 8.124E-16
KR--88        4.837E-06 0.000E+00 4.837E-06
XE131M        2.946E+00 0.000E+00 2.946E+00
XE133M        9.750E+00 0.000E+00 9.750E+00
XE-133        4.308E+02 0.000E+00 4.308E+02
XE135M        2.301E-03 0.000E+00 2.301E-03
XE-135        5.185E+00 0.000E+00 5.185E+00
RB--88        5.036E-06 0.000E+00 5.036E-06
CS-135        1.798E-10 0.000E+00 1.798E-10
Total         4.638E+02 0.000E+00 4.638E+02
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REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

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Bechtel Standard Computer Program       LOCADOSE, NE319  Version 3.0
(c) 1989 SCE AIX Version. 2 Feb 1995              Calc No. N4072-001 Rev No.   5
Originator MARK DRUCKER          Date 23 Mar 1999
Project SONGS UNITS 2,3      Job No. fha-fhb.ti          Sheet No.   34
Subject FHA in FHB, CRIS at 3 min (fha-fhb.to)
================================================================================
****Results for Activity Computation at the end of   4.000     hours

                  Distribution of Instantaneous Activity in CURIES
             FHB AIR      A206/7 Cont Room
I--129       7.497E-13 3.876E-08 1.103E-16
I--130       1.563E-10 8.083E-06 2.301E-14
I--131       8.722E-06 4.510E-01 1.284E-09
I--132       1.606E-15 8.302E-11 2.363E-19
I--133       1.800E-06 9.306E-02 2.649E-10
I--135       7.446E-09 3.850E-04 1.096E-12
KR-83M       4.264E-17 7.006E-26 1.417E-13
KR--85       4.085E-05 6.713E-14 1.358E-01
KR-85M       2.317E-09 3.806E-18 7.701E-06
KR--87       6.076E-22 9.983E-31 2.020E-18
KR--88       8.425E-12 1.384E-20 2.801E-08
XE131M       1.000E-05 1.504E-12 3.325E-02
XE133M       3.213E-05 4.467E-12 1.068E-01
XE-133.      1.452E-03 6.405E-11 4.823E+00
XE135M       8.192E-09 2.039E-11 1.238E-08
XE-135       1.435E-05 3.210E-12 4.768E-02
RB--88       6.409E-11 1.384E-10 7.759E-09
CS-135       4.136E-15 7.625E-12 1.597E-13
Total        1.560E-03 5.445E-01 5.146E+00

Bechtel Standard Computer Program       LOCADOSE, NE319  Version 3.0
(c) 1989 SCE AIX Version. 2 Feb 1995              Calc No. N4072-001 Rev No.   5
Originator MARK DRUCKER          Date 23 Mar 1999
Project SONGS UNITS 2,3      Job No. fha-fhb.ti          Sheet No.   35
Subject FHA in FHB, CRIS at 3 min (fha-fhb.to)
================================================================================
****Results for Activity Computation at the end of   4.000     hours

                  Activity Released from Each Node in CURIES
                  Since Last Printout

             FHB AIR      A206/7    Total
I--129       3.333E-09 0.000E+00 3.333E-09
I--130       7.672E-07 0.000E+00 7.672E-07
I--131       3.902E-02 0.000E+00 3.902E-02
I--132       1.221E-11 0.000E+00 1.221E-11
I--133       8.483E-03 0.000E+00 8.483E-03
I--135       3.984E-05 0.000E+00 3.984E-05
KR-83M       3.709E-13 0.000E+00 3.709E-13
KR--85       1.816E-01 0.000E+00 1.816E-01
KR-85M       1.354E-05 0.000E+00 1.354E-05
KR--87       7.114E-18 0.000E+00 7.114E-18
KR--88       5.750E-08 0.000E+00 5.750E-08
XE131M       4.466E-02 0.000E+00 4.466E-02
XE133M       1.462E-01 0.000E+00 1.462E-01
XE-133       6.511E+00 0.000E+00 6.511E+00
XE135M       8.955E-06 0.000E+00 8.955E-06
XE-135       7.294E-02 0.000E+00 7.294E-02
RB--88       6.972E-08 0.000E+00 6.972E-08
CS-135       4.997E-12 0.000E+00 4.997E-12
Total        7.004E+00 0.000E+00 7.004E+00
```

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

Bechtel Standard Computer Program LOCADOSE, NE319 Version 3.0
(c) 1989 SCE AIX Version. 2 Feb 1995 Calc No. N4072-001 Rev No. 5
Originator MARK DRUCKER Date 23 Mar 1999
Project SONGS UNITS 2,3 Job No. fha-fhb.ti Sheet No. 38
Subject FHA in FHB, CRIS at 3 min (fha-fhb.to)

****Results for Activity Computation at the end of 6.000 hours

Distribution of Instantaneous Activity in CURIES

	FHB AIR	A206/7	Cont Room
I--129	1.680E-16	3.876E-08	2.473E-20
I--130	3.132E-14	7.226E-06	4.610E-18
I--131	1.941E-09	4.478E-01	2.857E-13
I--132	1.962E-19	4.526E-11	2.888E-23
I--133	3.775E-10	8.709E-02	5.557E-14
I--135	1.353E-12	3.122E-04	1.992E-16
KR-83M	4.481E-21	7.871E-30	9.352E-15
KR--85	9.156E-09	1.608E-17	1.870E-02
KR-85M	3.811E-13	6.262E-22	7.783E-07
KR--87	4.579E-26	7.005E-35	9.352E-20
KR--88	1.163E-15	1.911E-24	2.376E-09
XE131M	2.232E-09	1.477E-12	4.556E-03
XE133M	7.016E-09	4.131E-12	1.432E-02
XE-133	3.222E-07	5.770E-11	6.570E-01
XE135M	1.496E-12	1.654E-11	8.489E-12
XE-135	2.764E-09	2.584E-12	5.639E-03
RB--88	8.960E-15	1.290E-12	6.581E-10
CS-135	1.527E-18	7.625E-12	1.888E-14
Total	3.456E-07	5.352E-01	7.003E-01

Bechtel Standard Computer Program LOCADOSE, NE319 Version 3.0
(c) 1989 SCE AIX Version. 2 Feb 1995 Calc No. N4072-001 Rev No. 5
Originator MARK DRUCKER Date 23 Mar 1999
Project SONGS UNITS 2,3 Job No. fha-fhb.ti Sheet No. 39
Subject FHA in FHB, CRIS at 3 min (fha-fhb.to)

****Results for Activity Computation at the end of 6.000 hours

Activity Released from Each Node in CURIES
Since Last Printout

	FHB AIR	A206/7	Total
I--129	7.471E-13	0.000E+00	7.471E-13
I--130	1.537E-10	0.000E+00	1.537E-10
I--131	8.685E-06	0.000E+00	8.685E-06
I--132	1.492E-15	0.000E+00	1.492E-15
I--133	1.780E-06	0.000E+00	1.780E-06
I--135	7.240E-09	0.000E+00	7.240E-09
KR-83M	3.898E-17	0.000E+00	3.898E-17
KR--85	4.071E-05	0.000E+00	4.071E-05
KR-85M	2.227E-09	0.000E+00	2.227E-09
KR--87	5.361E-22	0.000E+00	5.361E-22
KR--88	7.939E-12	0.000E+00	7.939E-12
XE131M	9.963E-06	0.000E+00	9.963E-06
XE133M	3.192E-05	0.000E+00	3.192E-05
XE-133	1.445E-03	0.000E+00	1.445E-03
XE135M	5.437E-09	0.000E+00	5.437E-09
XE-135	1.405E-05	0.000E+00	1.405E-05
RB--88	4.388E-11	0.000E+00	4.388E-11
CS-135	4.210E-15	0.000E+00	4.210E-15
Total	1.552E-03	0.000E+00	1.552E-03

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

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Bechtel Standard Computer Program       LOCADOSE, NE319  Version 3.0
(c) 1989 SCE AIX Version. 2 Feb 1995              Calc No. N4072-001 Rev No.   5
Originator MARK DRUCKER          Date 23 Mar 1999
Project SONGS UNITS 2,3      Job No. fha-fhb.ti          Sheet No.   42
Subject FHA in FHB, CRIS at 3 min (fha-fhb.to)
********************************************************************************
****Results for Activity Computation at the end of   8.000     hours

                Distribution of Instantaneous Activity in CURIES
             FHB AIR      A206/7 Cont Room
I--129       3.767E-20 3.876E-08 5.760E-24
I--130       6.277E-18 6.460E-06 9.239E-22
I--131       4.320E-13 4.446E-01 7.592E-17
I--132       2.398E-23 2.468E-11 3.529E-27
I--133       7.919E-14 8.150E-02 1.166E-17
I--135       2.460E-16 2.532E-04 3.621E-20
KR-83M       4.709E-25 3.357E-32 5.909E-16
KR--85       2.052E-12 1.463E-19 2.575E-03
KR-85M       6.269E-17 1.030E-25 7.866E-08
KR--87       3.451E-30 0.000E+00 4.330E-21
KR--88       1.606E-19 2.639E-28 2.015E-10
XE131M       4.979E-13 1.466E-12 6.243E-04
XE133M       1.532E-12 3.866E-12 1.921E-03
XE-133       7.149E-11 5.400E-11 8.951E-02
XE135M       2.719E-16 1.341E-11 5.774E-15
XE-135       5.322E-13 2.095E-12 6.668E-04
RB--88       1.237E-18 1.201E-14 5.582E-11
CS-135       4.578E-22 7.625E-12 2.233E-15
Total        7.661E-11 5.263E-01 9.530E-02

Bechtel Standard Computer Program       LOCADOSE, NE319  Version 3.0
(c) 1989 SCE AIX Version. 2 Feb 1995              Calc No. N4072-001 Rev No.   5
Originator MARK DRUCKER          Date 23 Mar 1999
Project SONGS UNITS 2,3      Job No. fha-fhb.ti          Sheet No.   43
Subject FHA in FHB, CRIS at 3 min (fha-fhb.to)
********************************************************************************
****Results for Activity Computation at the end of   8.000     hours

                Activity Released from Each Node in CURIES
                Since Last Printout

             FHB AIR      A206/7    Total
I--129       1.675E-16 0.000E+00 1.675E-16
I--130       3.081E-14 0.000E+00 3.081E-14
I--131       1.933E-09 0.000E+00 1.933E-09
I--132       1.824E-19 0.000E+00 1.824E-19
I--133       3.733E-10 0.000E+00 3.733E-10
I--135       1.316E-12 0.000E+00 1.316E-12
KR-83M       4.097E-21 0.000E+00 4.097E-21
KR--85       9.125E-09 0.000E+00 9.125E-09
KR-85M       3.663E-13 0.000E+00 3.663E-13
KR--87       0.000E+00 0.000E+00 0.000E+00
KR--88       1.096E-15 0.000E+00 1.096E-15
XE131M       2.223E-09 0.000E+00 2.223E-09
XE133M       6.970E-09 0.000E+00 6.970E-09
XE-133       3.206E-07 0.000E+00 3.206E-07
XE135M       9.923E-13 0.000E+00 9.923E-13
XE-135       2.705E-09 0.000E+00 2.705E-09
RB--88       6.129E-15 0.000E+00 6.129E-15
CS-135       1.539E-18 0.000E+00 1.539E-18
Total        3.440E-07 0.000E+00 3.440E-07
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REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

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Bechtel Standard Computer Program       LOCADOSE, NE319  Version 3.0
(c) 1989 SCE AIX Version, 2 Feb 1995          Calc No. N4072-001 Rev No.   5
Originator MARK DRUCKER         Date 23 Mar 1999
Project SONGS UNITS 2,3      Job No. fha-fhb.ti          Sheet No.   46
Subject FHA in FHB, CRIS at 3 min (fha-fhb.to)
================================================================================
****Results for Activity Computation at the end of   10.00     hours

                Distribution of Instantaneous Activity in CURIES
              FHB AIR      A206/7 Cont Room
I--129        8.443E-24 3.876E-08 2.455E-24
I--130        1.258E-21 5.774E-06 1.997E-25
I--131        9.614E-17 4.414E-01 3.078E-18
I--132        2.930E-27 1.345E-11 9.382E-29
I--133        1.661E-17 7.627E-02 5.319E-19
I--135        4.471E-20 2.053E-04 7.100E-24
KR-83M        4.949E-29 0.000E+00 1.026E-16
KR--85        4.600E-16 7.559E-25 9.534E-04
KR-85M        1.031E-20 1.695E-29 2.137E-08
KR--87        0.000E+00 0.000E+00 5.389E-22
KR--88        2.217E-23 3.643E-32 4.595E-11
XE131M        1.111E-16 1.456E-12 2.300E-04
XE133M        3.345E-16 3.618E-12 6.928E-04
XE-133        1.586E-14 5.054E-11 3.279E-02
XE135M        4.942E-20 1.087E-11 1.053E-17
XE-135        1.025E-16 1.699E-12 2.120E-04
RB--88        1.708E-22 1.117E-16 1.675E-11
CS-135        1.249E-25 7.625E-12 1.073E-15
Total         1.698E-14 5.179E-01 3.488E-02

Bechtel Standard Computer Program       LOCADOSE, NE319  Version 3.0
(c) 1989 SCE AIX Version, 2 Feb 1995          Calc No. N4072-001 Rev No.   5
Originator MARK DRUCKER         Date 23 Mar 1999
Project SONGS UNITS 2,3      Job No. fha-fhb.ti          Sheet No.   47
Subject FHA in FHB, CRIS at 3 min (fha-fhb.to)
================================================================================
****Results for Activity Computation at the end of   10.00     hours

                Activity Released from Each Node in CURIES
                Since Last Printout

              FHB AIR      A205/7   Total
I--129        3.754E-20 0.000E+00 3.754E-20
I--130        6.173E-18 0.000E+00 6.173E-18
I--131        4.301E-13 0.000E+00 4.301E-13
I--132        2.205E-23 0.000E+00 2.205E-23
I--133        7.831E-14 0.000E+00 7.831E-14
I--135        2.392E-16 0.000E+00 2.392E-16
KR-83M        4.262E-25 0.000E+00 4.262E-25
KR--85        2.045E-12 0.000E+00 2.045E-12
KR-85M        6.026E-17 0.000E+00 6.026E-17
KR--87        0.000E+00 0.000E+00 0.000E+00
KR--88        1.513E-19 0.000E+00 1.513E-19
XE131M        4.959E-13 0.000E+00 4.959E-13
XE133M        1.522E-12 0.000E+00 1.522E-12
XE-133        7.115E-11 0.000E+00 7.115E-11
XE135M        1.804E-16 0.000E+00 1.804E-16
XE-135        5.210E-13 0.000E+00 5.210E-13
RB--88        8.463E-19 0.000E+00 8.463E-19
CS-135        4.596E-22 0.000E+00 4.596E-22
Total         7.625E-11 0.000E+00 7.625E-11
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REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

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Bechtel Standard Computer Program      LOCADOSE, NE319  Version 3.0
(c) 1989 SCE AIX Version. 2 Feb 1995            Calc No. N4072-001 Rev No.   5
Originator MARK DRUCKER         Date 23 Mar 1999
Project SONGS UNITS 2,3      Job No. fha-fhb.ti          Sheet No.   50
Subject FHA in FHB, CRIS at 3 min (fha-fhb.to)
********************************************************************************
****Results for Activity Computation at the end of   24.00     hours

                  Distribution of Instantaneous Activity in CURIES
             FHB AIR      A206/7 Cont Room
I--129       0.000E+00 3.876E-08 2.454E-24
I--130       0.000E+00 2.635E-06 0.000E+00
I--131       0.000E+00 4.197E-01 2.913E-18
I--132       0.000E+00 1.926E-13 1.337E-30
I--133       0.000E+00 4.795E-02 3.327E-19
I--135       0.000E+00 4.731E-05 0.000E+00
XR-83M       0.000E+00 0.000E+00 4.874E-22
XR--85       5.004E-34 0.000E+00 9.094E-07
KR-85M       0.000E+00 0.000E+00 2.338E-12
KR--87       0.000E+00 0.000E+00 2.495E-28
KR--88       0.000E+00 0.000E+00 1.474E-15
XE131M       2.146E-35 1.385E-12 2.120E-07
XE133M       1.593E-34 2.281E-12 5.495E-07
XE-133       2.501E-33 3.186E-11 2.901E-05
XE135M       0.000E+00 2.528E-12 9.489E-31
XE-135       1.217E-35 3.950E-13 6.966E-08
RB--88       0.000E+00 6.753E-31 5.761E-16
CS-135       0.000E+00 7.625E-12 3.714E-19
Total        3.195E-33 4.677E-01 3.075E-05

Bechtel Standard Computer Program      LOCADOSE, NE319  Version 3.0
(c) 1989 SCE AIX Version. 2 Feb 1995            Calc No. N4072-001 Rev No.   5
Originator MARK DRUCKER         Date 23 Mar 1999
Project SONGS UNITS 2,3      Job No. fha-fhb.ti          Sheet No.   51
Subject FHA in FHB, CRIS at 3 min (fha-fhb.to)
********************************************************************************
****Results for Activity Computation at the end of   24.00     hours

                  Activity Released from Each Node in CURIES
                  Since Last Printout

             FHB AIR      A206/7   Total
I--129       8.353E-24 0.000E+00 8.353E-24
I--130       1.237E-21 0.000E+00 1.237E-21
I--131       9.575E-17 0.000E+00 9.575E-17
I--132       0.000E+00 0.000E+00 0.000E+00
I--133       1.643E-17 0.000E+00 1.643E-17
I--135       4.348E-20 0.000E+00 4.348E-20
KR-83M       0.000E+00 0.000E+00 0.000E+00
KR--85       4.586E-16 0.000E+00 4.586E-16
KR-85M       9.914E-21 0.000E+00 9.914E-21
KR--87       0.000E+00 0.000E+00 0.000E+00
KR--88       2.078E-23 0.000E+00 2.078E-23
XE131M       1.106E-16 0.000E+00 1.106E-16
XE133M       3.324E-16 0.000E+00 3.324E-16
XE-133       1.579E-14 0.000E+00 1.579E-14
XE135M       3.279E-20 0.000E+00 3.279E-20
XE-135       1.003E-16 0.000E+00 1.003E-16
RB--88       1.169E-22 0.000E+00 1.169E-22
CS-135       0.000E+00 0.000E+00 0.000E+00
Total        1.691E-14 0.000E+00 1.691E-14
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REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

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Bechtel Standard Computer Program       LOCADOSE, NE319  Version 3.0
(c) 1989 SCE AIX Version. 2 Feb 1995            Calc No. N4072-001 Rev No.   5
Originator MARK DRUCKER         Date 23 Mar 1999
Project SONGS UNITS 2,3      Job No. fha-fhb.ti          Sheet No.   54
Subject FHA in FHB, CRIS at 3 min (fha-fhb.to)
================================================================================
****Results for Activity Computation at the end of   96.00     hours

                Distribution of Instantaneous Activity in CURIES
              FHB AIR      A206/7 Cont Room
I--129        0.000E+00 3.876E-08 1.212E-27
I--130        0.000E+00 4.656E-08 0.000E+00
I--131        0.000E+00 3.241E-01 0.000E+00
I--132        0.000E+00 6.321E-23 0.000E+00
I--133        4.920E-35 4.404E-03 0.000E+00
I--135        0.000E+00 2.494E-08 8.653E-26
KR-83M        0.000E+00 0.000E+00 0.000E+00
KR--85        0.000E+00 0.000E+00 2.659E-22
KR-85M        0.000E+00 0.000E+00 0.000E+00
KR--87        0.000E+00 0.000E+00 0.000E+00
KR--88        0.000E+00 0.000E+00 0.000E+00
XE131M        0.000E+00 1.073E-12 5.198E-23
XE133M        0.000E+00 2.156E-13 6.220E-23
XE-133        0.000E+00 3.012E-12 5.749E-21
XE135M        0.000E+00 1.463E-15 1.319E-26
XE-135        0.000E+00 2.285E-16 9.914E-26
RB--88        0.000E+00 0.000E+00 0.000E+00
CS-135        0.000E+00 7.625E-12 0.000E+00
Total         4.920E-35 3.285E-01 6.129E-21

Bechtel Standard Computer Program       LOCADOSE, NE319  Version 3.0
(c) 1989 SCE AIX Version. 2 Feb 1995            Calc No. N4072-001 Rev No.   5
Originator MARK DRUCKER         Date 23 Mar 1999
Project SONGS UNITS 2,3      Job No. fha-fhb.ti          Sheet No.   55
Subject FHA in FHB, CRIS at 3 min (fha-fhb.to)
================================================================================
****Results for Activity Computation at the end of   96.00     hours

                Activity Released from Each Node in CURIES
                Since Last Printout

              FHB AIR      A206/7   Total
I--129        0.000E+00 0.000E+00 0.000E+00
I--130        0.000E+00 0.000E+00 0.000E+00
I--131        0.000E+00 0.000E+00 0.000E+00
I--132        0.000E+00 0.000E+00 0.000E+00
I--133        0.000E+00 0.000E+00 0.000E+00
I--135        0.000E+00 0.000E+00 0.000E+00
KR-83M        0.000E+00 0.000E+00 0.000E+00
KR--85        0.000E+00 0.000E+00 0.000E+00
KR-85M        0.000E+00 0.000E+00 0.000E+00
KR--87        0.000E+00 0.000E+00 0.000E+00
KR--88        0.000E+00 0.000E+00 0.000E+00
XE131M        0.000E+00 0.000E+00 0.000E+00
XE133M        0.000E+00 0.000E+00 0.000E+00
XE-133        0.000E+00 0.000E+00 0.000E+00
XE135M        0.000E+00 0.000E+00 0.000E+00
XE-135        0.000E+00 0.000E+00 0.000E+00
RB--88        0.000E+00 0.000E+00 0.000E+00
CS-135        0.000E+00 0.000E+00 0.000E+00
Total         0.000E+00 0.000E+00 0.000E+00
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REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

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Bechtel Standard Computer Program       LOCADOSE, NE319  Version 3.0
(c) 1989 SCE AIX Version. 2 Feb 1995              Calc No. N4072-001 Rev No.   5
Originator MARK DRUCKER          Date 23 Mar 1999
Project SONGS UNITS 2,3      Job No. fha-fhb.ti          Sheet No.   58
Subject FHA in FHB, CRIS at 3 min (fha-fhb.to)
================================================================================
****Results for Activity Computation at the end of   720.0     hours

                  Distribution of Instantaneous Activity in CURIES
             FHB AIR      A206/7 Cont Room
I--129       0.000E+00 3.876E-08 1.320E-29
I--130       0.000E+00 3.006E-23 0.000E+00
I--131       0.000E+00 3.447E-02 0.000E+00
I--132       0.000E+00 0.000E+00 0.000E+00
I--133       0.000E+00 4.546E-12 0.000E+00
I--135       0.000E+00 0.000E+00 0.000E+00
KR-83M       0.000E+00 0.000E+00 0.000E+00
KR--85       0.000E+00 0.000E+00 0.000E+00
KR-85M       0.000E+00 0.000E+00 0.000E+00
KR--87       0.000E+00 0.000E+00 0.000E+00
KR--88       0.000E+00 0.000E+00 0.000E+00
XE131M       0.000E+00 1.213E-13 0.000E+00
XE133M       0.000E+00 4.143E-22 0.000E+00
XE-133       0.000E+00 5.787E-21 0.000E+00
XE135M       0.000E+00 0.000E+00 0.000E+00
XE-135       0.000E+00 0.000E+00 0.000E+00
RB--88       0.000E+00 0.000E+00 0.000E+00
CS-135       0.000E+00 7.625E-12 0.000E+00
Total        0.000E+00 3.447E-02 1.320E-29

Bechtel Standard Computer Program       LOCADOSE, NE319  Version 3.0
(c) 1989 SCE AIX Version. 2 Feb 1995              Calc No. N4072-001 Rev No.   5
Originator MARK DRUCKER          Date 23 Mar 1999
Project SONGS UNITS 2,3      Job No. fha-fhb.ti          Sheet No.   59
Subject FHA in FHB, CRIS at 3 min (fha-fhb.to)
================================================================================

****Results for Activity Computation at the end of   720.0     hours

                  Activity Released from Each Node in CURIES
                  Since Last Printout

             FHB AIR      A205/7   Total
I--129       0.000E+00 0.000E+00 0.000E+00
I--130       0.000E+00 0.000E+00 0.000E+00
I--131       0.000E+00 0.000E+00 0.000E+00
I--132       0.000E+00 0.000E+00 0.000E+00
I--133       0.000E+00 0.000E+00 0.000E+00
I--135       0.000E+00 0.000E+00 0.000E+00
KR-83M       0.000E+00 0.000E+00 0.000E+00
KR--85       0.000E+00 0.000E+00 0.000E+00
KR-85M       0.000E+00 0.000E+00 0.000E+00
KR--87       0.000E+00 0.000E+00 0.000E+00
KR--88       0.000E+00 0.000E+00 0.000E+00
XE131M       0.000E+00 0.000E+00 0.000E+00
XE133M       0.000E+00 0.000E+00 0.000E+00
XE-133       0.000E+00 0.000E+00 0.000E+00
XE135M       0.000E+00 0.000E+00 0.000E+00
XE-135       0.000E+00 0.000E+00 0.000E+00
RB--88       0.000E+00 0.000E+00 0.000E+00
CS-135       0.000E+00 0.000E+00 0.000E+00
Total        0.000E+00 0.000E+00 0.000E+00
```

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

9.2.4 LOCADOSE Dose Calculation Input File - 10 cfm case (fha-fhb.di)

```
FHA in FHB, CRIS at 3 min (fha-fhb.do)
MARK DRUCKER
SONGS UNITS 2,3
fha-fhb.di
N4072-001  5
           1
DORDRRDOFDRO
   2   5   4   3   1   0   0
REM REM/HR
  2.7200E-04  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
  3.4700E-04  0.0000E+00  0.0000E+00  0.0000E+00
  7.7200E-06  7.7200E-06  4.7400E-06  3.6700E-06  2.6700E-06
  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  1.0000E+00
```

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
6	N. YACKLE		T. REMICK						

REV ⇓

9.2.5 LOCADOSE Dose Calculation Output File Excerpts - 10 cfm case (fha-fhb.do)

NOTE: The following are relevant excerpts from the LOCADOSE Code dose calculation output file.

```
Bechtel Standard Computer Program       LOCADOSE, NE319  Version 3.0
(c) 1989 SCE AIX Version. 2 Feb 1995              Calc No. N4072-001 Rev No.   5
Originator MARK DRUCKER          Date 23 Mar 1999
Project SONGS UNITS 2,3      Job No. fha-fhb.di           Sheet No.    2
Subject FHA in FHB, CRIS at 3 min (fha-fhb.do)
==========================================================================

NE319 Dose Input Summary


        File LOCATRAN generated on 23 Mar 1999  at 10:16:47 is used by this run

        The following options and calculations are performed:
          Doserates within regions will be calculated
          Doserates offsite will be calculated
          Doses within regions will be calculated
          Offsite Doses will be calculated
          Control Room doses will be calculated

        This run evaluates  30 isotopes using  4 regions and 14 time-steps
        Offsite doses for  2 dose points will be calculated

        NE313   FHA.LIB   was used to generate the isotope data for this run

        Isotopes Considered in this Run
        I--129  I--129  I--129  I--130  I--130  I--130  I--131  I--131
        I--131  I--132  I--132  I--132  I--133  I--133  I--133  I--135
        I--135  I--135  KR-83M  KR--85  KR-85M  KR--87  KR--88  XE131M
        XE133M  XE-133  XE135M  XE-135  RB--88  CS-135
```

E&TS DEPARTMENT

CALCULATION SHEET

ICCN NO./ PRELIM. CCN NO.	PAGE ___ OF ___

Project or DCP/FCN/ECP _____ Calc. No. N-4072-001

CCN CONVERSION: CCN NO. CCN --

Subject Fuel Handling Accident Inside Fuel Handling Building - CR & Offsite Doses Sheet 146 of 261

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

Bechtel Standard Computer Program LOCADOSE, NE319 Version 3.0
(c) 1989 SCE AIX Version. 2 Feb 1995 Calc No. N4072-001 Rev No. 5
Originator MARK DRUCKER Date 23 Mar 1999
Project SONGS UNITS 2,3 Job No. fha-fhb.di Sheet No. 8
Subject FHA in FHB, CRIS at 3 min (fha-fhb.do)

NE319 Dose Rate Within Regions Summary

Dose rates in REM/HR for region 4 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
2.780E-03	3.195E+00	6.377E-02	9.770E-03	1.769E-02	8.902E-04
5.000E-02	5.048E+01	1.008E+00	1.544E-01	2.795E-01	1.406E-02
1.000E-01	2.653E+01	5.435E-01	8.114E-02	4.316E-01	2.106E-02
2.000E-01	7.954E+00	1.871E-01	2.432E-02	6.288E-01	3.030E-02
5.000E-01	6.760E-01	5.001E-02	2.067E-03	7.558E-01	3.628E-02
1.000E+00	7.109E-02	2.790E-02	2.172E-04	5.451E-01	2.615E-02
2.000E+00	1.058E-03	1.016E-02	3.229E-06	2.081E-01	9.974E-03
4.000E+00	2.350E-07	1.378E-03	7.161E-10	2.820E-02	1.349E-03
6.000E+00	5.221E-11	1.872E-04	2.042E-13	3.819E-03	1.824E-04
8.000E+00	1.654E-14	2.544E-05	5.429E-15	5.175E-04	2.468E-05
1.000E+01	1.887E-15	9.299E-06	2.591E-15	1.887E-04	8.987E-06
2.400E+01	5.255E-16	8.156E-09	2.472E-18	1.641E-07	7.751E-09
9.600E+01	1.636E-24	1.675E-24	5.288E-27	3.324E-23	1.507E-24
7.200E+02	1.292E-26	1.967E-28	5.411E-30	2.333E-33	1.106E-33

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇩
6	N. YACKLE		T. REMICK							

Bechtel Standard Computer Program LOCADOSE, NE319 Version 3.0
(c) 1989 SCE AIX Version. 2 Feb 1995 Calc No. N4072-001 Rev No. 5
Originator MARK DRUCKER Date 23 Mar 1999
Project SONGS UNITS 2,3 Job No. fha-fhb.di Sheet No. 13
Subject FHA in FHB, CRIS at 3 min (fha-fhb.do)

NE319 Doses Within Regions Summary

Doses in REM for region 4 Cont Room

Time Interval (hr) From	to	Thyroid	Lung	Bone	Beta Skin	Whole Body
0.0000E+00	2.7800E-03	4.452E-03	8.887E-05	1.362E-05	2.465E-05	1.241E-06
2.7800E-03	5.0000E-02	1.317E+00	2.629E-02	4.028E-03	7.293E-03	3.669E-04
5.0000E-02	.1000	1.859E+00	3.747E-02	5.684E-03	1.795E-02	8.858E-04
.1000	.2000	1.526E+00	3.267E-02	4.666E-03	5.404E-02	2.615E-03
.2000	.5000	7.713E-01	2.583E-02	2.358E-03	2.192E-01	1.053E-02
.5000	1.000	1.282E-01	1.858E-02	3.919E-04	3.305E-01	1.586E-02
1.000	2.000	1.663E-02	1.751E-02	5.081E-05	3.532E-01	1.694E-02
2.000	4.000	2.515E-04	8.790E-03	7.673E-07	1.801E-01	8.627E-03
4.000	6.000	5.585E-08	1.193E-03	1.703E-10	2.439E-02	1.166E-03
6.000	8.000	1.242E-11	1.621E-04	6.158E-14	3.303E-03	1.577E-04
8.000	10.00	8.072E-15	3.208E-05	7.580E-15	6.518E-04	3.107E-05
10.00	24.00	9.472E-15	1.847E-05	3.729E-15	3.741E-04	1.779E-05
24.00	96.00	4.608E-17	9.740E-09	8.717E-19	1.959E-07	9.242E-09
96.00	720.0	3.292E-24	1.348E-24	1.379E-27	2.651E-23	1.199E-24
	Total	5.622E+00	1.686E-01	1.719E-02	1.191E+00	5.720E-02

Bechtel Standard Computer Program LOCADOSE, NE319 Version 3.0
(c) 1989 SCE AIX Version. 2 Feb 1995 Calc No. N4072-001 Rev No. 5
Originator MARK DRUCKER Date 23 Mar 1999
Project SONGS UNITS 2,3 Job No. fha-fhb.di Sheet No. 14
Subject FHA in FHB, CRIS at 3 min (fha-fhb.do)

NE319 Doses Within Regions Summary

Cumulative doses in REM for region 4 Cont Room

Time (hr)	Thyroid	Lung	Bone	Beta Skin	Whole Body
2.780E-03	4.452E-03	8.887E-05	1.362E-05	2.465E-05	1.241E-06
5.000E-02	1.322E+00	2.638E-02	4.042E-03	7.317E-03	3.682E-04
1.000E-01	3.180E+00	6.385E-02	9.726E-03	2.527E-02	1.254E-03
2.000E-01	4.706E+00	9.652E-02	1.439E-02	7.931E-02	3.869E-03
5.000E-01	5.477E+00	1.224E-01	1.675E-02	2.985E-01	1.440E-02
1.000E+00	5.605E+00	1.409E-01	1.714E-02	6.290E-01	3.026E-02
2.000E+00	5.622E+00	1.584E-01	1.719E-02	9.821E-01	4.720E-02
4.000E+00	5.622E+00	1.672E-01	1.719E-02	1.162E+00	5.582E-02
6.000E+00	5.622E+00	1.684E-01	1.719E-02	1.187E+00	5.699E-02
8.000E+00	5.622E+00	1.686E-01	1.719E-02	1.190E+00	5.715E-02
1.000E+01	5.622E+00	1.686E-01	1.719E-02	1.191E+00	5.718E-02
2.400E+01	5.622E+00	1.686E-01	1.719E-02	1.191E+00	5.720E-02
9.600E+01	5.622E+00	1.686E-01	1.719E-02	1.191E+00	5.720E-02
7.200E+02	5.622E+00	1.686E-01	1.719E-02	1.191E+00	5.720E-02

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

Bechtel Standard Computer Program LOCADOSE, NE319 Version 3.0
(c) 1989 SCE AIX Version. 2 Feb 1995 Calc No. N4072-001 Rev No. 5
Originator MARK DRUCKER Date 23 Mar 1999
Project SONGS UNITS 2,3 Job No. fha-fhb.di Sheet No. 15
Subject FHA in FHB, CRIS at 3 min (fha-fhb.do)

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	7.766E+01	1.550E+00	2.375E-01	4.301E-01	3.719E-01
2.780E-03	7.676E+01	1.532E+00	2.348E-01	4.251E-01	3.676E-01
5.000E-02	6.293E+01	1.256E+00	1.925E-01	3.484E-01	3.013E-01
1.000E-01	5.083E+01	1.015E+00	1.555E-01	2.814E-01	2.433E-01
2.000E-01	3.338E+01	6.663E-01	1.021E-01	1.846E-01	1.596E-01
5.000E-01	9.450E+00	1.885E-01	2.889E-02	5.220E-02	4.509E-02
1.000E+00	1.154E+00	2.302E-02	3.524E-03	6.356E-03	5.488E-03
2.000E+00	1.719E-02	3.428E-04	5.247E-05	9.428E-05	8.131E-05
4.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
6.000E+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
1.000E+01	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. N4072-001 Rev No. 5
Originator MARK DRUCKER Date 23 Mar 1999
Project SONGS UNITS 2,3 Job No. fha-fhb.di Sheet No. 16
Subject FHA in FHB, CRIS at 3 min (fha-fhb.do)

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	2.204E+00	4.400E-02	6.742E-03	1.221E-02	1.056E-02
2.780E-03	2.179E+00	4.349E-02	6.663E-03	1.206E-02	1.043E-02
5.000E-02	1.786E+00	3.566E-02	5.463E-03	9.889E-03	8.551E-03
1.000E-01	1.443E+00	2.880E-02	4.412E-03	7.986E-03	6.904E-03
2.000E-01	9.473E-01	1.891E-02	2.897E-03	5.241E-03	4.530E-03
5.000E-01	2.682E-01	5.353E-03	8.199E-04	1.481E-03	1.280E-03
1.000E+00	3.274E-02	6.533E-04	1.000E-04	1.804E-04	1.558E-04
2.000E+00	4.879E-04	9.731E-06	1.489E-06	2.676E-06	2.308E-06
4.000E+00	1.084E-07	2.159E-09	3.301E-10	5.894E-10	5.075E-10
6.000E+00	2.407E-11	4.792E-13	7.318E-14	1.300E-13	1.117E-13
8.000E+00	5.347E-15	1.064E-16	1.623E-17	2.868E-17	2.461E-17
1.000E+01	3.678E-15	7.311E-21	1.114E-21	3.889E-21	3.332E-21
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

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

Bechtel Standard Computer Program LOCADOSE, NE319 Version 3.0
(c) 1989 SCE AIX Version. 2 Feb 1995 Calc No. N4072-001 Rev No. 5
Originator MARK DRUCKER Date 23 Mar 1999
Project SONGS UNITS 2,3 Job No. fha-fhb.di Sheet No. 17
Subject FHA in FHB, CRIS at 3 min (fha-fhb.do)

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	2.7800E-03	2.146E-01	4.285E-03	6.565E-04	1.189E-03	1.028E-03
2.7800E-03	5.0000E-02	3.287E+00	6.562E-02	1.005E-02	1.820E-02	1.574E-02
5.0000E-02	.1000	2.829E+00	5.647E-02	8.651E-03	1.566E-02	1.354E-02
.1000	- .2000	4.149E+00	8.283E-02	1.269E-02	2.296E-02	1.985E-02
.2000	- .5000	5.689E+00	1.135E-01	1.739E-02	3.145E-02	2.718E-02
.5000	- 1.000	1.972E+00	3.936E-02	6.028E-03	1.089E-02	9.402E-03
1.000	- 2.000	2.702E-01	5.390E-03	8.252E-04	1.487E-03	1.284E-03
2.000	- 4.000	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
4.000	- 6.000	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
6.000	- 8.000	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
8.000	- 10.00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
10.00	- 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	1.841E+01	3.675E-01	5.630E-02	1.018E-01	8.802E-02

Bechtel Standard Computer Program LOCADOSE, NE319 Version 3.0
(c) 1989 SCE AIX Version. 2 Feb 1995 Calc No. N4072-001 Rev No. 5
Originator MARK DRUCKER Date 23 Mar 1999
Project SONGS UNITS 2,3 Job No. fha-fhb.di Sheet No. 18
Subject FHA in FHB, CRIS at 3 min (fha-fhb.do)

NE319 Offsite Dose Summary

Cumulative doses in REM for distance 1

Time (hr)	Thyroid	Lung	Bone	Beta Skin	Whole Body
2.780E-03	2.146E-01	4.285E-03	6.565E-04	1.189E-03	1.028E-03
5.000E-02	3.502E+00	6.991E-02	1.071E-02	1.939E-02	1.677E-02
1.000E-01	6.331E+00	1.264E-01	1.936E-02	3.505E-02	3.031E-02
2.000E-01	1.048E+01	2.092E-01	3.205E-02	5.801E-02	5.016E-02
5.000E-01	1.617E+01	3.228E-01	4.944E-02	8.946E-02	7.734E-02
1.000E+00	1.814E+01	3.621E-01	5.547E-02	1.003E-01	8.674E-02
2.000E+00	1.841E+01	3.675E-01	5.630E-02	1.018E-01	8.802E-02
4.000E+00	1.841E+01	3.675E-01	5.630E-02	1.018E-01	8.802E-02
6.000E+00	1.841E+01	3.675E-01	5.630E-02	1.018E-01	8.802E-02
8.000E+00	1.841E+01	3.675E-01	5.630E-02	1.018E-01	8.802E-02
1.000E+01	1.841E+01	3.675E-01	5.630E-02	1.018E-01	8.802E-02
2.400E+01	1.841E+01	3.675E-01	5.630E-02	1.018E-01	8.802E-02
9.600E+01	1.841E+01	3.675E-01	5.630E-02	1.018E-01	8.802E-02
7.200E+02	1.841E+01	3.675E-01	5.630E-02	1.018E-01	8.802E-02

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

Bechtel Standard Computer Program LOCADOSE, NE319 Version 3.0
(c) 1989 SCE AIX Version. 2 Feb 1995 Calc No. N4072-001 Rev No. 5
Originator MARK DRUCKER Date 23 Mar 1999
Project SONGS UNITS 2,3 Job No. fha-fhb.di Sheet No. 19
Subject FHA in FHB, CRIS at 3 min (fha-fhb.do)

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	2.7800E-03	6.092E-03	1.216E-04	1.853E-05	3.374E-05	2.918E-05
2.7800E-03	5.0000E-02	9.330E-02	1.863E-03	2.854E-04	5.166E-04	4.468E-04
5.0000E-02	.1000	8.028E-02	1.603E-03	2.455E-04	4.444E-04	3.843E-04
.1000	.2000	1.178E-01	2.351E-03	3.601E-04	6.517E-04	5.634E-04
.2000	.5000	1.615E-01	3.223E-03	4.936E-04	8.926E-04	7.714E-04
.5000	1.000	5.598E-02	1.117E-03	1.711E-04	3.090E-04	2.669E-04
1.000	2.000	7.668E-03	1.530E-04	2.342E-05	4.220E-05	3.643E-05
2.000	4.000	1.160E-04	2.313E-06	3.539E-07	6.353E-07	5.478E-07
4.000	6.000	2.576E-08	5.131E-10	7.844E-11	1.400E-10	1.205E-10
6.000	8.000	5.721E-12	1.139E-13	1.739E-14	3.087E-14	2.653E-14
8.000	10.00	3.935E-16	7.827E-18	1.194E-18	4.182E-18	3.589E-18
10.00	24.00	8.745E-20	1.738E-21	2.649E-22	9.239E-22	7.916E-22
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	5.227E-01	1.043E-02	1.598E-03	2.891E-03	2.499E-03

Bechtel Standard Computer Program LOCADOSE, NE319 Version 3.0
(c) 1989 SCE AIX Version. 2 Feb 1995 Calc No. N4072-001 Rev No. 5
Originator MARK DRUCKER Date 23 Mar 1999
Project SONGS UNITS 2,3 Job No. fha-fhb.di Sheet No. 20
Subject FHA in FHB, CRIS at 3 min (fha-fhb.do)

NE319 Offsite Dose Summary

Cumulative doses in REM for distance 2

Time (hr)	Thyroid	Lung	Bone	Beta Skin	Whole Body
2.780E-03	6.092E-03	1.216E-04	1.863E-05	3.374E-05	2.918E-05
5.000E-02	9.939E-02	1.984E-03	3.040E-04	5.504E-04	4.759E-04
1.000E-01	1.797E-01	3.587E-03	5.495E-04	9.948E-04	8.602E-04
2.000E-01	2.974E-01	5.938E-03	9.097E-04	1.647E-03	1.424E-03
5.000E-01	4.589E-01	9.160E-03	1.403E-03	2.539E-03	2.195E-03
1.000E+00	5.149E-01	1.028E-02	1.574E-03	2.848E-03	2.462E-03
2.000E+00	5.226E-01	1.043E-02	1.598E-03	2.89CE-03	2.498E-03
4.000E+00	5.227E-01	1.043E-02	1.598E-03	2.891E-03	2.499E-03
6.000E+00	5.227E-01	1.043E-02	1.598E-03	2.891E-03	2.499E-03
8.000E+00	5.227E-01	1.043E-02	1.598E-03	2.891E-03	2.499E-03
1.000E+01	5.227E-01	1.043E-02	1.598E-03	2.891E-03	2.499E-03
2.400E+01	5.227E-01	1.043E-02	1.598E-03	2.891E-03	2.499E-03
9.600E+01	5.227E-01	1.043E-02	1.598E-03	2.891E-03	2.499E-03
7.200E+02	5.227E-01	1.043E-02	1.598E-03	2.891E-03	2.499E-03

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

9.2.6 LOCADOSE Library File - 1000 cfm case (fhb1000.lib)

```
4072-001rev611/04/2002 ICRP30Thy&RG1.109Immer
Thyroid   Lung       Bone       Beta Skin Whole Body
Elem IodOrg Iod Part IodNbl Gas  Cs, Rb  Te, Se  Sr, Ba Nbl MetlRa Earth Other  HalogensTrnsUran
I--129 1.071E-03 1.400E-15 5.920E+06 9.015E+04 2.480E+03 3.710E-04 3.024E-03 01 0
000000000000000000 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 001 4.090E-02
2.820E-03
I--129 1.071E-03 1.400E-15 5.920E+06 9.015E+04 2.480E+03 3.710E-04 3.024E-03 02 0
000000000000000000 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 002 4.090E-02
2.820E-03
I--129 1.071E-03 1.400E-15 5.920E+06 9.015E+04 2.480E+03 3.710E-04 3.024E-03 03 0
000000000000000000 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 003 4.090E-02
2.820E-03
I--130 9.795E+02 1.557E-05 7.400E+04 4.110E+03 5.720E+02 4.990E-02 4.980E-01 01 0
000000000000000000 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 004 2.787E-01
2.138E+00
I--130 9.795E+02 1.557E-05 7.400E+04 4.110E+03 5.720E+02 4.990E-02 4.980E-01 02 0
000000000000000000 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 005 2.787E-01
2.138E+00
I--130 9.795E+02 1.557E-05 7.400E+04 4.110E+03 5.720E+02 4.990E-02 4.980E-01 03 0
000000000000000000 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 006 2.787E-01
2.138E+00
I--131 2.508E+04 9.976E-07 1.070E+06 2.073E+04 3.150E+03 3.170E-02 8.720E-02 01 1
024000000000000000 1.100E-02 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 007 1.817E-01
3.789E-01
I--131 2.508E+04 9.976E-07 1.070E+06 2.073E+04 3.150E+03 3.170E-02 8.720E-02 02 1
024000000000000000 1.100E-02 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 008 1.817E-01
3.789E-01
I--131 2.508E+04 9.976E-07 1.070E+06 2.073E+04 3.150E+03 3.170E-02 8.720E-02 03 1
024000000000000000 1.100E-02 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 009 1.817E-01
3.789E-01
I--132 3.806E+04 8.425E-05 6.290E+03 8.879E+02 1.450E+02 1.320E-01 5.130E-01 01 0
000000000000000000 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 010 4.824E-01
3.559E+00
I--132 3.806E+04 8.425E-05 6.290E+03 8.879E+02 1.450E+02 1.320E-01 5.130E-01 02 0
000000000000000000 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 011 4.824E-01
3.559E+00
I--132 3.806E+04 8.425E-05 6.290E+03 8.879E+02 1.450E+02 1.320E-01 5.130E-01 03 0
000000000000000000 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 012 4.824E-01
3.559E+00
I--133 5.622E+04 9.211E-06 1.810E+05 5.064E+03 1.080E+03 7.350E-02 1.550E-01 01 2
026025000000000000 9.710E-01 2.900E-02 0.000E+00 0.000E+00 0.000E+00 0.000E+00 013 4.067E-01
6.047E-01
I--133 5.622E+04 9.211E-06 1.810E+05 5.064E+03 1.080E+03 7.350E-02 1.550E-01 02 2
026025000000000000 9.710E-01 2.900E-02 0.000E+00 0.000E+00 0.000E+00 0.000E+00 014 4.067E-01
6.047E-01
I--133 5.622E+04 9.211E-06 1.810E+05 5.064E+03 1.080E+03 7.350E-02 1.550E-01 03 2
026025000000000000 9.710E-01 2.900E-02 0.000E+00 0.000E+00 0.000E+00 0.000E+00 015 4.067E-01
6.047E-01
I--135 5.103E+04 2.912E-05 3.150E+04 1.971E+03 3.350E+02 1.290E-01 4.210E-01 01 2
028027000000000000 8.450E-01 1.550E-01 0.000E+00 0.000E+00 0.000E+00 0.000E+00 016 3.691E-01
1.617E+00
I--135 5.103E+04 2.912E-05 3.150E+04 1.971E+03 3.350E+02 1.290E-01 4.210E-01 02 2
028027000000000000 8.450E-01 1.550E-01 0.000E+00 0.000E+00 0.000E+00 0.000E+00 017 3.691E-01
1.617E+00
I--135 5.103E+04 2.912E-05 3.150E+04 1.971E+03 3.350E+02 1.290E-01 4.210E-01 03 2
028027000000000000 8.450E-01 1.550E-01 0.000E+00 0.000E+00 0.000E+00 0.000E+00 018 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 04 0
000000000000000000 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 019 0.000E+00
4.610E-04
KR--85 4.102E+02 2.054E-09 0.000E+00 2.410E+00 0.000E+00 4.246E-02 5.102E-04 04 0
000000000000000000 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 031 2.505E-01
2.236E-03
```

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

```
KR-85M 1.297E+04 4.297E-05 0.000E+00 2.910E+00 0.000E+00 4.626E-02 3.708E-02 04 1
020000000000000000 2.100E-01 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 020 2.902E-01
1.610E-01
KR--87 2.335E+04 1.514E-04 0.000E+00 1.530E+01 0.000E+00 3.083E-01 1.876E-01 04 1
029000000000000000 1.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 021 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 04 1
030000000000000000 1.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 022 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 04 0
000000000000000000 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 023 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 04 1
026000000000000000 1.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 024 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 04 0
000000000000000000 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 025 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 04 1
028000000000000000 1.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 026 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 04 1
031000000000000000 1.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 027 3.028E-01
2.466E-01
RB--87 0.000E+00 4.656E-19 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 05 0
000000000000000000 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 028 7.880E-02
0.000E+00
RB--88 0.000E+00 6.496E-04 0.000E+00 2.908E+02 0.000E+00 4.790E-01 1.550E-01 05 0
000000000000000000 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 029 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 05 0
000000000000000000 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 0.000E+00 030 5.630E-02
0.000E+00
```

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

9.2.7 LOCADOSE Activity Transport Input File - 1000 cfm case (fhb1000.lti)

```
FHA in FHB, 1000 cfm CR Inleakage - 1.75 Peaking
Nancy Yackle
SONGS UNITS 2,3
fhb1000.lti
N4072-001 06
      1
   2   1   1   0
 0 0  0.00000E+00  0.00000E+00  2  0  0  0
CFM  CUFT CURIES
 1.000E+00 1.000E+00 1.000E+00 1.000E+00 1.000E+00 1.000E+00
 1.000E+00 1.000E+00 1.000E+00 1.000E+00 1.000E+00 1.000E+00
 0.0075000 0.0025000 0.0000000
FHB AIR     A206/7
0.00000E+00 2.78000E-03  1  1  1  1
  1  0  1  1  0  0  0
  1  2
I--129  1.512E-03
I--130  3.969E-01
I--131  1.802E+04
I--132  1.096E-05
I--133  4.183E+03
I--135  2.293E+01
KR-83M  3.938E-09
KR--85  8.285E+02
KR-85M  8.726E-02
KR--87  1.092E-13
KR--88  4.515E-04
XE131M  2.048E+02
XE133M  6.878E+02
XE-133  3.014E+04
XE135M  2.930E+00
XE-135  3.948E+02
RB--88  0.000E+00
CS-135  0.000E+00
DONE
  3.65305E+05   7.32
  2  1  0  25581
     0   0   0   0   100   100   100   100   100   0   0   0
  3  3  1.0E+06  0
     0   0   0 100   0   0   0   0   0   0   0   0
  -1,0,0,0
  1    3.10000E-03
  266920  0  6820  29885  6820
     0   0   0   0   0   0   0   0   0   0   0   0
     0   0   0   0   0   0   0   0   0   0   0   0
2.78000E-03 5.00000E-02  1  1  1  1
  0  0  0  0  0  0  0
  0    3.10000E-03
5.00000E-02 0.10000E+00  1  1  1  1
  0  0  0  1  0  0  0
  2  1  0  25479
     0   0   0   0   100   100   100   100   100   0   0   0
  2  3  0  102
     0   0   0   0   100   100   100   100   100   0   0   0
  3  3  1.0E+06  0
     0   0   0 100   0   0   0   0   0   0   0   0
  -1,0,0,0
  1    3.10000E-03
  266920  4400  1000  59870  5400
    95  95  99   0  99  99  99  99  99   0   0   0
    95  95  99   0  99  99  99  99  99   0   0   0
0.10000E+00 0.20000E+00  1  1  1  1
  0  0  0  0  0  0  0
```

```
  0    3.10000E-03
0.20000E+00 0.50000E+00  1  1  1  1
  0  0  0  0  0  0  0
  0    3.10000E-03
0.50000E+00 1.00000E+00  1  1  1  1
  0  0  0  0  0  0  0
  0    3.10000E-03
1.00000E+00 2.00000E+00  1  1  1  1
  0  0  0  0  0  0  0
  0    3.10000E-03
2.00000E+00 4.00000E+00  1  1  1  1
  0  0  0  0  0  0  0
  0    3.10000E-03
4.00000E+00 6.00000E+00  1  1  1  1
  0  0  0  0  0  0  0
  0    3.10000E-03
6.00000E+00 8.00000E+00  1  1  1  1
  0  0  0  0  0  0  0
  0    3.10000E-03
8.00000E+00 1.00000E+01  1  1  1  1
  0  0  0  0  0  0  0
  1    1.80000E-03
  266920  2200  1000  29935  3200
    95  95  99   0  99  99  99  99  99   0   0   0
    95  95  99   0  99  99  99  99  99   0   0   0
1.00000E+01 2.40000E+01  1  1  1  1
  0  0  0  0  0  0  0
  0    1.80000E-03
2.40000E+01 9.60000E+01  1  1  1  1
  0  0  0  0  0  0  0
  0    9.80000E-04
9.60000E+01 7.20000E+02  1  1  1  1
  0  0  0  0  0  0  0
  0    2.40000E-04
```

9.2.8 LOCADOSE Activity Transport Output File Excerpts - 1000 cfm case (fhb1000.lto)

NOTE: The following are relevant excerpts from the LOCADOSE Code activity transport output file.

```
Bechtel Standard Computer Program LocaDose, NE319 Version 6.0, © 2001
Calc No.: N4072-001 Rev No.:  06 Input: fhb1000.lti
Originator: Nancy Yackle          Date: 13 Nov 2002
Project: SONGS UNITS 2,3          Job No.: fhb1000.lti          Sheet No.    1
Subject: FHA in FHB, 1000 cfm CR Inleakage - 1.75 Peaking
```

Standard Computer Program
NE319 LOCADOSE Version 6.0

This is the Activity Transport Program. This program calculates activities, integrated activities and releases for each node per time-step and stores them on a file for use by the Dose Calculation Programs.

```
Bechtel Standard Computer Program LocaDose, NE319 Version 6.0, - 2001
Calc No.: N4072-001 Rev No.:  06 Input: fhb1000.lti
Originator: Nancy Yackle          Date: 13 Nov 2002
Project: SONGS UNITS 2,3          Job No.: fhb1000.lti          Sheet No.    2
Subject: FHA in FHB, 1000 cfm CR Inleakage - 1.75 Peaking
================================================================================

Nodes=               2
Number of isotopes= 31
Power (MWt)=         0.
Shutdown time=      0.0     hrs
(if negative, no decay prior to start of accident is considered)
Control room activities will be calculated for this case
Daughter product activities are considered in this case

Isotope groups and release fractions used in this run:

Isotope group  1 Elem Iod release fraction 7.500E-03

    I--129 I--130 I--131 I--132 I--133 I--135

Isotope group  2 Org Iod  release fraction 2.500E-03

    I--129 I--130 I--131 I--132 I--133 I--135

Isotope group  3 Part Iod release fraction  0.00

    I--129 I--130 I--131 I--132 I--133 I--135

Isotope group  4 Nbl Gas  release fraction  1.00

    KR-83M KR--85 KR-85M KR--87 KR--88 XE131M XE133M XE-133 XE135M XE-135

Isotope group  5  Cs, Rb  release fraction  1.00

    RB--87 RB--88 CS-135

This run created file fhb1000.ltf
on 13 Nov 2002  at 12:44:47

The library file fhb1000.lib
created with isotopic data using 4072-001rev6 on 11/04/2002 is used in this run
```

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

```
Bechtel Standard Computer Program LocaDose, NE319 Version 6.0, © 2001
Calc No.: N4072-001 Rev No.:  06 Input: fhb1000.lti
Originator: Nancy Yackle         Date: 13 Nov 2002
Project: SONGS UNITS 2,3         Job No.: fhb1000.lti          Sheet No.    3
Subject: FHA in FHB, 1000 cfm CR Inleakage - 1.75 Peaking
================================================================================


*** Time interval =  0.000E+00 -  2.780E-03 hrs
                  Initial Activity in CURIES
               FHB AIR      A206/7
I--129         1.512E-05 0.000E+00
I--130         3.969E-03 0.000E+00
I--131         1.802E+02 0.000E+00
I--132         1.096E-07 0.000E+00
I--133         4.183E+01 0.000E+00
I--135         2.293E-01 0.000E+00
KR-83M         3.938E-09 0.000E+00
KR--85         8.285E+02 0.000E+00
KR-85M         8.726E-02 0.000E+00
KR--87         1.092E-13 0.000E+00
KR--88         4.515E-04 0.000E+00
XE131M         2.048E+02 0.000E+00
XE133M         6.878E+02 0.000E+00
XE-133         3.014E+04 0.000E+00
XE135M         2.930E+00 0.000E+00
XE-135         3.948E+02 0.000E+00
RB--87         0.000E+00 0.000E+00
RB--88         0.000E+00 0.000E+00
CS-135         0.000E+00 0.000E+00
Total          3.248E+04 0.000E+00
```

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

```
Bechtel Standard Computer Program LocaDose, NE319 Version 6.0, © 2001
Calc No.: N4072-001 Rev No.:  06 Input: fhb1000.lti
Originator: Nancy Yackle          Date: 13 Nov 2002
Project: SONGS UNITS 2,3          Job No.: fhb1000.lti          Sheet No.    6
Subject: FHA in FHB, 1000 cfm CR Inleakage - 1.75 Peaking
================================================================================

****Results for Activity Computation at the end of  2.7800E-03 hours

                Distribution of Instantaneous Activity in CURIES
              FHB AIR      A206/7 Cont Room
I--129        1.494E-05 0.000E+00 1.748E-09
I--130        3.922E-03 0.000E+00 4.588E-07
I--131        1.781E+02 0.000E+00 2.083E-02
I--132        1.082E-07 0.000E+00 1.266E-11
I--133        4.134E+01 0.000E+00 4.836E-03
I--135        2.266E-01 0.000E+00 2.650E-05
KR-83M        3.888E-09 0.000E+00 4.548E-13
KR--85        8.189E+02 0.000E+00 9.579E-02
KR-85M        8.621E-02 0.000E+00 1.008E-05
KR--87        1.078E-13 0.000E+00 1.261E-17
KR--88        4.460E-04 0.000E+00 5.217E-08
XE131M        2.024E+02 0.000E+00 2.368E-02
XE133M        6.798E+02 0.000E+00 7.952E-02
XE-133        2.979E+04 0.000E+00 3.485E+00
XE135M        2.875E+00 0.000E+00 3.363E-04
XE-135        3.901E+02 0.000E+00 4.564E-02
RB--87        1.256E-31 0.000E+00 1.469E-35
RB--88        2.891E-06 0.000E+00 3.381E-10
CS-135        2.909E-11 0.000E+00 3.402E-15
Total         3.210E+04 0.000E+00 3.755E+00


Bechtel Standard Computer Program LocaDose, NE319 Version 6.0, © 2001
Calc No.: N4072-001 Rev No.:  06 Input: fhb1000.lti
Originator: Nancy Yackle          Date: 13 Nov 2002
Project: SONGS UNITS 2,3          Job No.: fhb1000.lti          Sheet No.    7
Subject: FHA in FHB, 1000 cfm CR Inleakage - 1.75 Peaking
================================================================================

****Results for Activity Computation at the end of  2.7800E-03 hours

                Activity Released from Each Node in CURIES
                Since Last Printout

              FHB AIR      A206/7   Total
I--129        1.756E-07 0.000E+00 1.756E-07
I--130        4.609E-05 0.000E+00 4.609E-05
I--131        2.093E+00 0.000E+00 2.093E+00
I--132        1.272E-09 0.000E+00 1.272E-09
I--133        4.857E-01 0.000E+00 4.857E-01
I--135        2.662E-03 0.000E+00 2.662E-03
KR-83M        4.571E-11 0.000E+00 4.571E-11
KR--85        9.621E+00 0.000E+00 9.621E+00
KR-85M        1.013E-03 0.000E+00 1.013E-03
KR--87        1.267E-15 0.000E+00 1.267E-15
KR--88        5.241E-06 0.000E+00 5.241E-06
XE131M        2.378E+00 0.000E+00 2.378E+00
XE133M        7.987E+00 0.000E+00 7.987E+00
XE-133        3.500E+02 0.000E+00 3.500E+02
XE135M        3.390E-02 0.000E+00 3.390E-02
XE-135        4.584E+00 0.000E+00 4.584E+00
RB--87        0.000E+00 0.000E+00 0.000E+00
RB--88        1.697E-08 0.000E+00 1.697E-08
CS-135        1.705E-13 0.000E+00 1.705E-13
Total         3.772E+02 0.000E+00 3.772E+02
```

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

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Bechtel Standard Computer Program LocaDose, NE319 Version 6.0, - 2001
Calc No.: N4072-001 Rev No.:  06 Input: fhb1000.1ti
Originator: Nancy Yackle          Date: 13 Nov 2002
Project: SONGS UNITS 2,3          Job No.: fhb1000.1ti          Sheet No.   10
Subject: FHA in FHB, 1000 cfm CR Inleakage - 1.75 Peaking
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****Results for Activity Computation at the end of 5.0000E-02 hours

Distribution of Instantaneous Activity in CURIES

	FHB AIR	A206/7	Cont Room
I--129	1.226E-05	0.000E+00	2.748E-08
I--130	3.208E-03	0.000E+00	7.194E-06
I--131	1.460E+02	0.000E+00	3.275E-01
I--132	8.750E-08	0.000E+00	1.962E-10
I--133	3.385E+01	0.000E+00	7.590E-02
I--135	1.849E-01	0.000E+00	4.146E-04
KR-83M	3.132E-09	0.000E+00	7.023E-12
KR--85	6.715E+02	0.000E+00	1.506E+00
KR-85M	7.018E-02	0.000E+00	1.574E-04
KR--87	8.613E-14	0.000E+00	1.931E-16
KR--88	3.615E-04	0.000E+00	8.107E-07
XE131M	1.660E+02	0.000E+00	3.722E-01
XE133M	5.571E+02	0.000E+00	1.249E+00
XE-133	2.442E+04	0.000E+00	5.477E+01
XE135M	2.083E+00	0.000E+00	4.671E-03
XE-135	3.188E+02	0.000E+00	7.149E-01
RB--87	6.907E-30	0.000E+00	6.442E-33
RB--88	4.015E-05	0.000E+00	8.985E-08
CS-135	4.283E-10	0.000E+00	9.592E-13
Total	2.632E+04	0.000E+00	5.902E+01

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Bechtel Standard Computer Program LocaDose, NE319 Version 6.0, - 2001
Calc No.: N4072-001 Rev No.:  06 Input: fhb1000.1ti
Originator: Nancy Yackle          Date: 13 Nov 2002
Project: SONGS UNITS 2,3          Job No.: fhb1000.1ti          Sheet No.   11
Subject: FHA in FHB, 1000 cfm CR Inleakage - 1.75 Peaking
```

****Results for Activity Computation at the end of 5.0000E-02 hours

Activity Released from Each Node in CURIES
Since Last Printout

	FHB AIR	A206/7	Total
I--129	2.689E-06	0.000E+00	2.689E-06
I--130	7.049E-04	0.000E+00	7.049E-04
I--131	3.205E+01	0.000E+00	3.205E+01
I--132	1.934E-08	0.000E+00	1.934E-08
I--133	7.434E+00	0.000E+00	7.434E+00
I--135	4.068E-02	0.000E+00	4.068E-02
KR-83M	6.937E-10	0.000E+00	6.937E-10
KR--85	1.474E+02	0.000E+00	1.474E+02
KR-85M	1.546E-02	0.000E+00	1.546E-02
KR--87	1.915E-14	0.000E+00	1.915E-14
KR--88	7.981E-05	0.000E+00	7.981E-05
XE131M	3.643E+01	0.000E+00	3.643E+01
XE133M	1.223E+02	0.000E+00	1.223E+02
XE-133	5.360E+03	0.000E+00	5.360E+03
XE135M	4.876E-01	0.000E+00	4.876E-01
XE-135	7.009E+01	0.000E+00	7.009E+01
RB--87	0.000E+00	0.000E+00	0.000E+00
RB--88	4.603E-06	0.000E+00	4.603E-06
CS-135	4.808E-11	0.000E+00	4.808E-11
Total	5.776E+03	0.000E+00	5.776E+03

Bechtel Standard Computer Program LocaDose, NE319 Version 6.0, © 2001
Calc No.: N4072-001 Rev No.: 06 Input: fhb1000.lti
Originator: Nancy Yackle Date: 13 Nov 2002
Project: SONGS UNITS 2,3 Job No.: fhb1000.lti Sheet No. 14
Subject: FHA in FHB, 1000 cfm CR Inleakage - 1.75 Peaking

****Results for Activity Computation at the end of 0.1000 hours

Distribution of Instantaneous Activity in CURIES

	FHB AIR	A206/7	Cont Room
I--129	9.933E-06	9.259E-09	1.658E-08
I--130	2.593E-03	2.417E-06	4.328E-06
I--131	1.183E+02	1.103E-01	1.975E-01
I--132	6.985E-08	6.511E-11	1.166E-10
I--133	2.739E+01	2.553E-02	4.572E-02
I--135	1.491E-01	1.390E-04	2.488E-04
KR-83M	2.491E-09	5.091E-18	1.093E-11
KR--85	5.443E+02	1.112E-06	2.388E+00
KR-85M	5.644E-02	1.154E-10	2.476E-04
KR--87	6.793E-14	1.388E-22	2.980E-16
KR--88	2.895E-04	5.917E-13	1.270E-06
XE131M	1.345E+02	2.749E-07	5.900E-01
XE133M	4.513E+02	9.223E-07	1.979E+00
XE-133	1.979E+04	4.045E-05	8.681E+01
XE135M	1.481E+00	3.034E-09	6.493E-03
XE-135	2.574E+02	5.261E-07	1.129E+00
RB--87	1.137E-29	0.000E+00	6.295E-33
RB--88	6.110E-05	4.115E-08	1.357E-07
CS-135	6.930E-10	4.792E-13	1.508E-12
Total	2.132E+04	1.360E-01	9.315E+01

Bechtel Standard Computer Program LocaDose, NE319 Version 6.0, © 2001
Calc No.: N4072-001 Rev No.: 06 Input: fhb1000.lti
Originator: Nancy Yackle Date: 13 Nov 2002
Project: SONGS UNITS 2,3 Job No.: fhb1000.lti Sheet No. 15
Subject: FHA in FHB, 1000 cfm CR Inleakage - 1.75 Peaking

****Results for Activity Computation at the end of 0.1000 hours

Activity Released from Each Node in CURIES
Since Last Printout

	FHB AIR	A206/7	Total
I--129	2.313E-06	0.000E+00	2.313E-06
I--130	6.046E-04	0.000E+00	6.046E-04
I--131	2.756E+01	0.000E+00	2.756E+01
I--132	1.639E-08	0.000E+00	1.639E-08
I--133	6.383E+00	0.000E+00	6.383E+00
I--135	3.480E-02	0.000E+00	3.480E-02
KR-83M	5.857E-10	0.000E+00	5.857E-10
KR--85	1.267E+02	0.000E+00	1.267E+02
KR-85M	1.320E-02	0.000E+00	1.320E-02
KR--87	1.604E-14	0.000E+00	1.604E-14
KR--88	6.783E-05	0.000E+00	6.783E-05
XE131M	3.132E+01	0.000E+00	3.132E+01
XE133M	1.051E+02	0.000E+00	1.051E+02
XE-133	4.609E+03	0.000E+00	4.609E+03
XE135M	3.693E-01	0.000E+00	3.693E-01
XE-135	6.005E+01	0.000E+00	6.005E+01
RB--87	0.000E+00	0.000E+00	0.000E+00
RB--88	1.085E-05	0.000E+00	1.085E-05
CS-135	1.196E-10	0.000E+00	1.196E-10
Total	4.966E+03	0.000E+00	4.966E+03

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

Bechtel Standard Computer Program LocaDose, NE319 Version 6.0, © 2001
Calc No.: N4072-001 Rev No.: 06 Input: fhb1000.lti
Originator: Nancy Yackle Date: 13 Nov 2002
Project: SONGS UNITS 2,3 Job No.: fhb1000.lti Sheet No. 18
Subject: FHA in FHB, 1000 cfm CR Inleakage - 1.75 Peaking

****Results for Activity Computation at the end of 0.2000 hours

Distribution of Instantaneous Activity in CURIES

	FHB AIR	A206/7	Cont Room
I--129	6.525E-06	2.285E-08	7.196E-09
I--130	1.694E-03	5.930E-06	1.868E-06
I--131	7.771E+01	2.721E-01	8.571E-02
I--132	4.452E-08	1.559E-10	4.909E-11
I--133	1.793E+01	6.279E-02	1.978E-02
I--135	9.691E-02	3.393E-04	1.069E-04
KR-83M	1.576E-09	3.220E-18	1.539E-11
KR--85	3.576E+02	7.308E-07	3.492E+00
KR-85M	3.651E-02	7.463E-11	3.566E-04
KR--87	4.226E-14	8.638E-23	4.128E-16
KR--88	1.856E-04	3.794E-13	1.813E-06
XE131M	8.834E+01	1.806E-07	8.629E-01
XE133M	2.961E+02	6.051E-07	2.892E+00
XE-133	1.299E+04	2.656E-05	1.269E+02
XE135M	7.495E-01	1.548E-09	7.295E-03
XE-135	1.678E+02	3.430E-07	1.639E+00
RB--87	1.476E-29	0.000E+00	1.613E-32
RB--88	7.099E-05	1.351E-07	2.322E-07
CS-135	9.075E-10	1.863E-12	2.716E-12
Total	1.400E+04	3.352E-01	1.359E+02

Bechtel Standard Computer Program LocaDose, NE319 Version 6.0, © 2001
Calc No.: N4072-001 Rev No.: 06 Input: fhb1000.lti
Originator: Nancy Yackle Date: 13 Nov 2002
Project: SONGS UNITS 2,3 Job No.: fhb1000.lti Sheet No. 19
Subject: FHA in FHB, 1000 cfm CR Inleakage - 1.75 Peaking.

****Results for Activity Computation at the end of 0.2000 hours

Activity Released from Each Node in CURIES
Since Last Printout

	FHB AIR	A206/7	Total
I--129	3.394E-06	0.000E+00	3.394E-06
I--130	8.836E-04	0.000E+00	8.836E-04
I--131	4.043E+01	0.000E+00	4.043E+01
I--132	2.353E-08	0.000E+00	2.353E-08
I--133	9.344E+00	0.000E+00	9.344E+00
I--135	5.069E-02	0.000E+00	5.069E-02
KR-83M	8.363E-10	0.000E+00	8.363E-10
KR--85	1.860E+02	0.000E+00	1.860E+02
KR-85M	1.915E-02	0.000E+00	1.915E-02
KR--87	2.263E-14	0.000E+00	2.263E-14
KR--88	9.782E-05	0.000E+00	9.782E-05
XE131M	4.596E+01	0.000E+00	4.596E+01
XE133M	1.541E+02	0.000E+00	1.541E+02
XE-133	6.760E+03	0.000E+00	6.760E+03
XE135M	4.495E-01	0.000E+00	4.495E-01
XE-135	8.764E+01	0.000E+00	8.764E+01
RB--87	0.000E+00	0.000E+00	0.000E+00
RB--88	2.865E-05	0.000E+00	2.865E-05
CS-135	3.458E-10	0.000E+00	3.458E-10
Total	7.284E+03	0.000E+00	7.284E+03

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

Bechtel Standard Computer Program LocaDose, NE319 Version 6.0, - 2001
Calc No.: N4072-001 Rev No.: 06 Input: fhb1000.lti
Originator: Nancy Yackle Date: 13 Nov 2002
Project: SONGS UNITS 2,3 Job No.: fhb1000.lti Sheet No. 22
Subject: FHA in FHB, 1000 cfm CR Inleakage - 1.75 Peaking

****Results for Activity Computation at the end of 0.5000 hours

Distribution of Instantaneous Activity in CURIES

	FHB AIR	A206/7	Cont Room
I--129	1.850E-06	4.149E-08	1.444E-09
I--130	4.722E-04	1.059E-05	3.685E-07
I--131	2.201E+01	4.936E-01	1.718E-02
I--132	1.152E-08	2.584E-10	8.993E-12
I--133	5.034E+00	1.129E-01	3.929E-03
I--135	2.662E-02	5.971E-04	2.078E-05
KR-83M	3.987E-10	8.149E-19	1.594E-11
KR--85	1.014E+02	2.072E-07	4.054E+00
KR-85M	9.882E-03	2.020E-11	3.952E-04
KR--87	1.017E-14	2.080E-23	4.058E-16
KR--88	4.894E-05	1.000E-13	1.957E-06
XE131M	2.503E+01	5.116E-08	1.001E+00
XE133M	8.361E+01	1.709E-07	3.343E+00
XE-133	3.678E+03	7.518E-06	1.471E+02
XE135M	9.810E-02	2.297E-10	3.838E-03
XE-135	4.651E+01	9.507E-08	1.860E+00
RB--87	9.795E-30	1.233E-32	3.521E-32
RB--88	3.582E-05	2.563E-07	2.941E-07
CS-135	6.390E-10	5.957E-12	3.785E-12
Total	3.962E+03	6.071E-01	1.574E+02

Bechtel Standard Computer Program LocaDose, NE319 Version 6.0, - 2001
Calc No.: N4072-001 Rev No.: 06 Input: fhb1000.lti
Originator: Nancy Yackle Date: 13 Nov 2002
Project: SONGS UNITS 2,3 Job No.: fhb1000.lti Sheet No. 23
Subject: FHA in FHB, 1000 cfm CR Inleakage - 1.75 Peaking

****Results for Activity Computation at the end of 0.5000 hours

Activity Released from Each Mode in CURIES
Since Last Printout

	FHB AIR	A206/7	Total
I--129	4.657E-06	0.000E+00	4.657E-06
I--130	1.201E-03	0.000E+00	1.201E-03
I--131	5.543E+01	0.000E+00	5.543E+01
I--132	3.065E-08	0.000E+00	3.065E-08
I--133	1.275E+01	0.000E+00	1.275E+01
I--135	6.830E-02	0.000E+00	6.830E-02
KR-83M	1.075E-09	0.000E+00	1.075E-09
KR--85	2.552E+02	0.000E+00	2.552E+02
KR-85M	2.558E-02	0.000E+00	2.558E-02
KR--87	2.829E-14	0.000E+00	2.829E-14
KR--88	1.287E-04	0.000E+00	1.287E-04
XE131M	6.303E+01	0.000E+00	6.303E+01
XE133M	2.109E+02	0.000E+00	2.109E+02
XE-133	9.267E+03	0.000E+00	9.267E+03
XE135M	4.016E-01	0.000E+00	4.016E-01
XE-135	1.187E+02	0.000E+00	1.187E+02
RB--87	0.000E+00	0.000E+00	0.000E+00
RB--88	6.854E-05	0.000E+00	6.854E-05
CS-135	1.025E-09	0.000E+00	1.025E-09
Total	9.983E+03	0.000E+00	9.983E+03

E&TS DEPARTMENT

CALCULATION SHEET

ICCN NO./ PRELIM. CCN NO.	PAGE ___ OF ___

Project or DCP/FCN/ECP _____ Calc. No. N-4072-001

CCN CONVERSION: CCN NO. CCN --

Subject Fuel Handling Accident Inside Fuel Handling Building - CR & Offsite Doses Sheet 163 of 261

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

Bechtel Standard Computer Program LocaDose, NE319 Version 6.0, r 2001
Calc No.: N4072-001 Rev No.: 06 Input: fhb1000.lti
Originator: Nancy Yackle Date: 13 Nov 2002
Project: SONGS UNITS 2,3 Job No.: fhb1000.lti Sheet No. 26
Subject: FHA in FHB, 1000 cfm CR Inleakage - 1.75 Peaking

****Results for Activity Computation at the end of 1.000 hours

Distribution of Instantaneous Activity in CURIES

	FHB AIR	A20E/7	Cont Room
I--129	2.264E-07	4.796E-08	1.726E-10
I--130	5.618E-05	1.190E-05	4.284E-08
I--131	2.688E+00	5.696E-01	2.050E-03
I--132	1.212E-09	2.567E-10	9.239E-13
I--133	6.058E-01	1.284E-01	4.620E-04
I--135	3.091E-03	6.550E-04	2.357E-06
KR-83M	4.037E-11	8.251E-20	8.734E-12
KR--85	1.240E+01	2.535E-08	2.683E+00
KR-85M	1.119E-03	2.288E-12	2.421E-04
KR--87	9.480E-16	1.938E-24	2.051E-16
KR--88	5.305E-06	1.084E-14	1.148E-06
XE131M	3.059E+00	6.254E-09	6.617E-01
XE133M	1.016E+01	2.078E-08	2.199E+00
XE-133	4.488E+02	9.174E-07	9.710E+01
XE135M	3.553E-03	4.019E-11	6.801E-04
XE-135	5.479E+00	1.120E-08	1.185E+00
RB--87	2.136E-30	5.393E-33	2.282E-32
RB--88	5.352E-06	1.471E-07	1.791E-07
CS-135	1.548E-10	8.923E-12	2.496E-12
Total	4.832E+02	6.986E-01	1.038E+02

Bechtel Standard Computer Program LocaDose, NE319 Version 6.0, r 2001
Calc No.: N4072-001 Rev No.: 06 Input: fhb1000.lti
Originator: Nancy Yackle Date: 13 Nov 2002
Project: SONGS UNITS 2,3 Job No.: fhb1000.lti Sheet No. 27
Subject: FHA in FHB, 1000 cfm CR Inleakage - 1.75 Peaking

****Results for Activity Computation at the end of 1.000 hours

Activity Released from Each Node in CURIES
Since Last Printout

	FHB AIR	A206/7	Total
I--129	1.617E-06	0.000E+00	1.617E-06
I--130	4.089E-04	0.000E+00	4.089E-04
I--131	1.923E+01	0.000E+00	1.923E+01
I--132	9.579E-09	0.000E+00	9.579E-09
I--133	4.376E+00	0.000E+00	4.376E+00
I--135	2.287E-02	0.000E+00	2.287E-02
KR-83M	3.274E-10	0.000E+00	3.274E-10
KR--85	8.862E+01	0.000E+00	8.862E+01
KR-85M	8.418E-03	0.000E+00	8.418E-03
KR--87	8.134E-15	0.000E+00	8.134E-15
KR--88	4.109E-05	0.000E+00	4.109E-05
XE131M	2.187E+01	0.000E+00	2.187E+01
XE133M	7.292E+01	0.000E+00	7.292E+01
XE-133	3.212E+03	0.000E+00	3.212E+03
XE135M	5.906E-02	0.000E+00	5.906E-02
XE-135	4.014E+01	0.000E+00	4.014E+01
RB--87	0.000E+00	0.000E+00	0.000E+00
RB--88	3.419E-05	0.000E+00	3.419E-05
CS-135	7.384E-10	0.000E+00	7.384E-10
Total	3.459E+03	0.000E+00	3.459E+03

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

Bechtel Standard Computer Program LocaDose, NE319 Version 6.0, © 2001
Calc No.: N4072-001 Rev No.: 06 Input: fhb1000.lti
Originator: Nancy Yackle Date: 13 Nov 2002
Project: SONGS UNITS 2,3 Job No.: fhb1000.lti Sheet No. 30
Subject: FHA in FHB, 1000 cfm CR Inleakage - 1.75 Peaking

****Results for Activity Computation at the end of 2.000 hours

Distribution of Instantaneous Activity in CURIES

	FHB AIR	A206/7	Cont Room
I--129	3.389E-09	4.885E-08	2.584E-12
I--130	7.953E-07	1.146E-05	6.064E-10
I--131	4.010E-02	5.780E-01	3.057E-05
I--132	1.339E-11	1.931E-10	1.021E-14
I--133	8.775E-03	1.265E-01	6.690E-06
I--135	4.168E-05	6.007E-04	3.177E-08
KR-83M	4.139E-13	8.459E-22	1.863E-12
KR--85	1.857E-01	3.796E-10	8.358E-01
KR-85M	1.435E-05	2.934E-14	6.461E-05
KR--87	8.229E-18	1.682E-26	3.704E-17
KR--88	6.233E-08	1.274E-16	2.806E-07
XE131M	4.568E-02	9.528E-11	2.056E-01
XE133M	1.502E-01	3.128E-10	6.759E-01
XE-133	6.684E+00	1.374E-08	3.008E+01
XE135M	1.094E-05	3.050E-11	1.515E-05
XE-135	7.602E-02	1.602E-10	3.421E-01
RB--87	4.094E-33	1.204E-35	5.217E-33
RB--88	7.849E-08	1.803E-08	4.718E-08
CS-135	4.642E-12	9.657E-12	7.542E-13
Total	7.190E+00	7.051E-01	3.214E+01

Bechtel Standard Computer Program LocaDose, NE319 Version 6.0, © 2001
Calc No.: N4072-001 Rev No.: 06 Input: fhb1000.lti
Originator: Nancy Yackle Date: 13 Nov 2002
Project: SONGS UNITS 2,3 Job No.: fhb1000.lti Sheet No. 31
Subject: FHA in FHB, 1000 cfm CR Inleakage - 1.75 Peaking

****Results for Activity Computation at the end of 2.000 hours

Activity Released from Each Node in CURIES
Since Last Printout

	FHB AIR	A206/7	Total
I--129	2.221E-07	0.000E+00	2.221E-07
I--130	5.444E-05	0.000E+00	5.444E-05
I--131	2.635E+00	0.000E+00	2.635E+00
I--132	1.113E-09	0.000E+00	1.113E-09
I--133	5.900E-01	0.000E+00	5.900E-01
I--135	2.964E-03	0.000E+00	2.964E-03
KR-83M	3.651E-11	0.000E+00	3.651E-11
KR--85	1.217E+01	0.000E+00	1.217E+01
KR-85M	1.061E-03	0.000E+00	1.061E-03
KR--87	8.285E-16	0.000E+00	8.285E-16
KR--88	4.937E-06	0.000E+00	4.937E-06
XE131M	2.999E+00	0.000E+00	2.999E+00
XE133M	9.942E+00	0.000E+00	9.942E+00
XE-133	4.398E+02	0.000E+00	4.398E+02
XE135M	2.339E-03	0.000E+00	2.339E-03
XE-135	5.286E+00	0.000E+00	5.286E+00
RB--87	0.000E+00	0.000E+00	0.000E+00
RB--88	5.140E-06	0.000E+00	5.140E-06
CS-135	1.833E-10	0.000E+00	1.833E-10
Total	4.735E+02	0.000E+00	4.735E+02

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

Bechtel Standard Computer Program LocaDose, NE319 Version 6.0, c 2001
Calc No.: N4072-001 Rev No.: 06 Input: fhb1000.lti
Originator: Nancy Yackle Date: 13 Nov 2002
Project: SONGS UNITS 2,3 Job No.: fhb1000.lti Sheet No. 34
Subject: FHA in FHB, 1000 cfm CR Inleakage - 1.75 Peaking

****Results for Activity Computation at the end of 4.000 hours

Distribution of Instantaneous Activity in CURIES

	FHB AIR	A206/7	Cont Room
I--129	7.597E-13	4.887E-08	5.792E-16
I--130	1.594E-10	1.025E-05	1.215E-13
I--131	8.925E-06	5.741E-01	6.804E-09
I--132	1.637E-15	1.053E-10	1.248E-18
I--133	1.841E-06	1.184E-01	1.403E-09
I--135	7.575E-09	4.872E-04	5.775E-12
KR-83M	4.350E-17	8.890E-26	7.726E-14
KR--85	4.163E-05	8.508E-14	7.394E-02
KR-85M	2.361E-09	4.827E-18	4.194E-06
KR--87	6.201E-22	1.267E-30	1.101E-18
KR--88	8.606E-12	1.759E-20	1.529E-08
XE131M	1.019E-05	1.914E-12	1.810E-02
XE133M	3.279E-05	5.683E-12	5.823E-02
XE-133	1.483E-03	8.147E-11	2.633E+00
XE135M	8.334E-09	2.581E-11	6.948E-09
XE-135	1.464E-05	4.062E-12	2.599E-02
RB--87	0.000E+00	0.000E+00	3.470E-34
RB--88	6.547E-11	1.759E-10	4.785E-09
CS-135	4.219E-15	9.677E-12	9.784E-14
Total	1.593E-03	6.930E-01	2.809E+00

Bechtel Standard Computer Program LocaDose, NE319 Version 6.0, c 2001
Calc No.: N4072-001 Rev No.: 06 Input: fhb1000.lti
Originator: Nancy Yackle Date: 13 Nov 2002
Project: SONGS UNITS 2,3 Job No.: fhb1000.lti Sheet No. 35
Subject: FHA in FHB, 1000 cfm CR Inleakage - 1.75 Peaking

****Results for Activity Computation at the end of 4.000 hours

Activity Released from Each Node in CURIES
Since Last Printout

	FHB AIR	A206/7	Total
I--129	3.375E-09	0.000E+00	3.375E-09
I--130	7.816E-07	0.000E+00	7.816E-07
I--131	3.990E-02	0.000E+00	3.990E-02
I--132	1.244E-11	0.000E+00	1.244E-11
I--133	8.669E-03	0.000E+00	8.669E-03
I--135	4.049E-05	0.000E+00	4.049E-05
KR-83M	3.781E-13	0.000E+00	3.781E-13
KR--85	1.849E-01	0.000E+00	1.849E-01
KR-85M	1.379E-05	0.000E+00	1.379E-05
KR--87	7.255E-18	0.000E+00	7.255E-18
KR--88	5.869E-08	0.000E+00	5.869E-08
XE131M	4.547E-02	0.000E+00	4.547E-02
XE133M	1.491E-01	0.000E+00	1.491E-01
XE-133	6.647E+00	0.000E+00	6.647E+00
XE135M	9.103E-06	0.000E+00	9.103E-06
XE-135	7.435E-02	0.000E+00	7.435E-02
RB--87	0.000E+00	0.000E+00	0.000E+00
RB--88	7.117E-08	0.000E+00	7.117E-08
CS-135	5.094E-12	0.000E+00	5.094E-12
Total	7.150E+00	0.000E+00	7.150E+00

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
6	N. YACKLE		T. REMICK						

REV ⇩

Bechtel Standard Computer Program LocaDose, NE319 Version 6.0, © 2001
Calc No.: N4072-001 Rev No.: 06 Input: fhb1000.lti
Originator: Nancy Yackle Date: 13 Nov 2002
Project: SONGS UNITS 2,3 Job No.: fhb1000.lti Sheet No. 38
Subject: FHA in FHB, 1000 cfm CR Inleakage - 1.75 Peaking

****Results for Activity Computation at the end of 6.000 hours

Distribution of Instantaneous Activity in CURIES

	FHB AIR	A206/7	Cont Room
I--129	1.703E-16	4.887E-08	1.298E-19
I--130	3.193E-14	9.164E-06	2.435E-17
I--131	1.986E-09	5.700E-01	1.514E-12
I--132	2.000E-19	5.740E-11	1.525E-22
I--133	3.861E-10	1.108E-01	2.944E-13
I--135	1.377E-12	3.951E-04	1.050E-15
KR-83M	4.571E-21	9.344E-30	3.196E-15
KR--85	9.331E-09	1.907E-17	6.524E-03
KR-85M	3.885E-13	7.940E-22	2.716E-07
KR--87	4.673E-26	9.551E-35	3.267E-20
KR--88	1.188E-15	2.428E-24	8.308E-10
XE131M	2.274E-09	1.880E-12	1.589E-03
XE133M	7.160E-09	5.256E-12	5.004E-03
XE-133	3.291E-07	7.341E-11	2.298E-01
XE135M	1.522E-12	2.093E-11	3.116E-12
XE-135	2.819E-09	3.269E-12	1.969E-03
RB--87	0.000E+00	0.000E+00	1.029E-35
RB--88	9.153E-15	1.640E-12	2.601E-10
CS-135	1.558E-18	9.677E-12	7.414E-15
Total	3.531E-07	6.812E-01	2.449E-01

Bechtel Standard Computer Program LocaDose, NE319 Version 6.0, © 2001
Calc No.: N4072-001 Rev No.: 06 Input: fhb1000.lti
Originator: Nancy Yackle Date: 13 Nov 2002
Project: SONGS UNITS 2,3 Job No.: fhb1000.lti Sheet No. 39
Subject: FHA in FHB, 1000 cfm CR Inleakage - 1.75 Peaking

****Results for Activity Computation at the end of 6.000 hours

Activity Released from Each Node in CURIES
Since Last Printout

	FHB AIR	A205/7	Total
I--129	7.565E-13	0.000E+00	7.565E-13
I--130	1.566E-10	0.000E+00	1.566E-10
I--131	8.880E-06	0.000E+00	8.880E-06
I--132	1.520E-15	0.000E+00	1.520E-15
I--133	1.819E-06	0.000E+00	1.819E-06
I--135	7.360E-09	0.000E+00	7.360E-09
KR-83M	3.974E-17	0.000E+00	3.974E-17
KR--85	4.145E-05	0.000E+00	4.145E-05
KR-85M	2.268E-09	0.000E+00	2.268E-09
KR--87	5.467E-22	0.000E+00	5.467E-22
KR--88	8.103E-12	0.000E+00	8.103E-12
XE131M	1.014E-05	0.000E+00	1.014E-05
XE133M	3.255E-05	0.000E+00	3.255E-05
XE-133	1.475E-03	0.000E+00	1.475E-03
XE135M	5.526E-09	0.000E+00	5.526E-09
XE-135	1.432E-05	0.000E+00	1.432E-05
RB--87	0.000E+00	0.000E+00	0.000E+00
RB--88	4.478E-11	0.000E+00	4.478E-11
CS-135	4.292E-15	0.000E+00	4.292E-15
Total	1.584E-03	0.000E+00	1.584E-03

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

Bechtel Standard Computer Program LocaDose, NE319 Version 6.0, © 2001
Calc No.: N4072-001 Rev No.: 05 Input: fhb1000.lti
Originator: Nancy Yackle Date: 13 Nov 2002
Project: SONGS UNITS 2,3 Job No.: fhb1000.lti Sheet No. 42
Subject: FHA in FHB, 1000 cfm CR Inleakage - 1.75 Peaking

****Results for Activity Computation at the end of 8.000 hours

Distribution of Instantaneous Activity in CURIES

	FHB AIR	A206/7	Cont Room
I--129	3.817E-20	4.887E-08	2.910E-23
I--130	6.399E-18	8.192E-06	4.879E-21
I--131	4.420E-13	5.659E-01	3.370E-16
I--132	2.445E-23	3.130E-11	1.864E-26
I--133	8.100E-14	1.037E-01	6.175E-17
I--135	2.502E-16	3.204E-04	1.908E-19
KR-83M	4.805E-25	9.820E-34	1.322E-16
KR--85	2.091E-12	4.275E-21	5.757E-04
KR-85M	6.391E-17	1.306E-25	1.759E-08
KR--87	3.522E-30	0.000E+00	9.693E-22
KR--88	1.640E-19	3.353E-28	4.515E-11
XE131M	5.073E-13	1.866E-12	1.395E-04
XE133M	1.563E-12	4.919E-12	4.301E-04
XE-133	7.304E-11	6.870E-11	2.006E-02
XE135M	2.766E-16	1.697E-11	1.371E-15
XE-135	5.429E-13	2.651E-12	1.492E-04
RB--87	0.000E+00	0.000E+00	0.000E+00
RB--88	1.264E-18	1.526E-14	1.413E-11
CS-135	4.670E-22	9.677E-12	5.618E-16
Total	7.827E-11	6.699E-01	2.136E-02

Bechtel Standard Computer Program LocaDose, NE319 Version 6.0, © 2001
Calc No.: N4072-001 Rev No.: 05 Input: fhb1000.lti
Originator: Nancy Yackle Date: 13 Nov 2002
Project: SONGS UNITS 2,3 Job No.: fhb1000.lti Sheet No. 43
Subject: FHA in FHB, 1000 cfm CR Inleakage - 1.75 Peaking

****Results for Activity Computation at the end of 8.000 hours

Activity Released from Each Node in CURIES
Since Last Printout

	FHB AIR	A206/7	Total
I--129	1.696E-16	0.000E+00	1.696E-16
I--130	3.138E-14	0.000E+00	3.138E-14
I--131	1.976E-09	0.000E+00	1.976E-09
I--132	1.858E-19	0.000E+00	1.858E-19
I--133	3.815E-10	0.000E+00	3.815E-10
I--135	1.338E-12	0.000E+00	1.338E-12
KR-83M	4.176E-21	0.000E+00	4.176E-21
KR--85	9.291E-09	0.000E+00	9.291E-09
KR-85M	3.731E-13	0.000E+00	3.731E-13
KR--87	0.000E+00	0.000E+00	0.000E+00
KR--88	1.119E-15	0.000E+00	1.119E-15
XE131M	2.263E-09	0.000E+00	2.263E-09
XE133M	7.107E-09	0.000E+00	7.107E-09
XE-133	3.273E-07	0.000E+00	3.273E-07
XE135M	1.009E-12	0.000E+00	1.009E-12
XE-135	2.758E-09	0.000E+00	2.758E-09
RB--87	0.000E+00	0.000E+00	0.000E+00
RB--88	6.256E-15	0.000E+00	6.256E-15
CS-135	1.569E-18	0.000E+00	1.569E-18
Total	3.511E-07	0.000E+00	3.511E-07

Bechtel Standard Computer Program LocaDose, NE319 Version 6.0, - 2001
Calc No.: N4072-001 Rev No.: 06 Input: fhb1000.lti
Originator: Nancy Yackle Date: 13 Nov 2002
Project: SONGS UNITS 2,3 Job No.: fhb1000.lti Sheet No. 46
Subject: FHA in FHB, 1000 cfm CR Inleakage - 1.75 Peaking

****Results for Activity Computation at the end of 10.00 hours

Distribution of Instantaneous Activity in CURIES

	FHB AIR	A206/7	Cont Room
I--129	8.556E-24	4.887E-08	1.159E-26
I--130	1.282E-21	7.323E-06	1.736E-24
I--131	9.838E-17	5.618E-01	1.332E-19
I--132	2.988E-27	1.706E-11	4.046E-30
I--133	1.699E-17	9.703E-02	2.301E-20
I--135	4.549E-20	2.598E-04	6.159E-23
KR-83M	5.049E-29	0.000E+00	1.471E-17
KR--85	4.688E-16	9.582E-25	1.366E-04
KR-85M	1.051E-20	2.149E-29	3.063E-09
KR--87	0.000E+00	0.000E+00	7.731E-23
KR--88	2.265E-23	4.629E-32	6.598E-12
XE131M	1.132E-16	1.853E-12	3.295E-05
XE133M	3.414E-16	4.603E-12	9.938E-05
XE-133	1.621E-14	6.429E-11	4.709E-03
XE135M	5.027E-20	1.376E-11	1.604E-18
XE-135	1.046E-16	2.150E-12	3.040E-05
RB--87	0.000E+00	0.000E+00	0.000E+00
RB--88	1.745E-22	1.420E-16	2.668E-12
CS-135	1.274E-25	9.677E-12	1.689E-16
Total	1.735E-14	6.591E-01	5.008E-03

Bechtel Standard Computer Program LocaDose, NE319 Version 6.0, - 2001
Calc No.: N4072-001 Rev No.: 06 Input: fhb1000.lti
Originator: Nancy Yackle Date: 13 Nov 2002
Project: SONGS UNITS 2,3 Job No.: fhb1000.lti Sheet No. 47
Subject: FHA in FHB, 1000 cfm CR Inleakage - 1.75 Peaking

****Results for Activity Computation at the end of 10.00 hours

Activity Released from Each Node in CURIES
Since Last Printout

	FHB AIR	A206/7	Total
I--129	3.801E-20	0.000E+00	3.801E-20
I--130	6.288E-18	0.000E+00	6.288E-18
I--131	4.398E-13	0.000E+00	4.398E-13
I--132	2.246E-23	0.000E+00	2.246E-23
I--133	8.002E-14	0.000E+00	8.002E-14
I--135	2.431E-16	0.000E+00	2.431E-16
KR-83M	4.345E-25	0.000E+00	4.345E-25
KR--85	2.083E-12	0.000E+00	2.083E-12
KR-85M	6.138E-17	0.000E+00	6.138E-17
KR--87	0.000E+00	0.000E+00	0.000E+00
KR--88	1.545E-19	0.000E+00	1.545E-19
XE131M	5.048E-13	0.000E+00	5.048E-13
XE133M	1.552E-12	0.000E+00	1.552E-12
XE-133	7.264E-11	0.000E+00	7.264E-11
XE135M	1.833E-16	0.000E+00	1.833E-16
XE-135	5.310E-13	0.000E+00	5.310E-13
RB--87	0.000E+00	0.000E+00	0.000E+00
RB--88	8.638E-19	0.000E+00	8.638E-19
CS-135	4.684E-22	0.000E+00	4.684E-22
Total	7.783E-11	0.000E+00	7.783E-11

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

Bechtel Standard Computer Program LocaDose, NE319 Version 6.0, - 2001
Calc No.: N4072-001 Rev No.: 06 Input: fhb1000.lti
Originator: Nancy Yackle Date: 13 Nov 2002
Project: SONGS UNITS 2,3 Job No.: fhb1000.lti Sheet No. 50
Subject: FHA in FHB, 1000 cfm CR Inleakage - 1.75 Peaking

****Results for Activity Computation at the end of 24.00 hours

Distribution of Instantaneous Activity in CURIES

	FHB AIR	A206/7	Cont Room
I--129	0.000E+00	4.887E-08	0.000E+00
I--130	0.000E+00	3.341E-06	0.000E+00
I--131	0.000E+00	5.343E-01	0.000E+00
I--132	0.000E+00	2.443E-13	0.000E+00
I--133	0.000E+00	6.100E-02	0.000E+00
I--135	0.000E+00	5.987E-05	0.000E+00
KR-83M	0.000E+00	0.000E+00	3.100E-24
KR--85	0.000E+00	0.000E+00	5.778E-09
KR-85M	0.000E+00	0.000E+00	1.486E-14
KR--87	0.000E+00	0.000E+00	1.588E-30
KR--88	0.000E+00	0.000E+00	9.388E-18
XE131M	0.000E+00	1.763E-12	1.347E-09
XE133M	0.000E+00	2.902E-12	3.496E-09
XE-133	0.000E+00	4.053E-11	1.848E-07
XE135M	0.000E+00	3.199E-12	0.000E+00
XE-135	0.000E+00	4.998E-13	4.430E-10
RB--87	0.000E+00	0.000E+00	0.000E+00
RB--88	0.000E+00	8.581E-31	4.169E-18
CS-135	0.000E+00	9.677E-12	2.654E-21
Total	0.000E+00	5.953E-01	1.958E-07

Bechtel Standard Computer Program LocaDose, NE319 Version 6.0, - 2001
Calc No.: N4072-001 Rev No.: 06 Input: fhb1000.lti
Originator: Nancy Yackle Date: 13 Nov 2002
Project: SONGS UNITS 2,3 Job No.: fhb1000.lti Sheet No. 51
Subject: FHA in FHB, 1000 cfm CR Inleakage - 1.75 Peaking

****Results for Activity Computation at the end of 24.00 hours

Activity Released from Each Node in CURIES
Since Last Printout

	FHB AIR	A206/7	Total
I--129	8.459E-24	0.000E+00	8.459E-24
I--130	1.260E-21	0.000E+00	1.260E-21
I--131	9.790E-17	0.000E+00	9.790E-17
I--132	0.000E+00	0.000E+00	0.000E+00
I--133	1.679E-17	0.000E+00	1.679E-17
I--135	4.420E-20	0.000E+00	4.420E-20
KR-83M	0.000E+00	0.000E+00	0.000E+00
KR--85	4.669E-16	0.000E+00	4.669E-16
KR-85M	1.010E-20	0.000E+00	1.010E-20
KR--87	0.000E+00	0.000E+00	0.000E+00
KR--88	2.121E-23	0.000E+00	2.121E-23
XE131M	1.127E-16	0.000E+00	1.127E-16
XE133M	3.389E-16	0.000E+00	3.389E-16
XE-133	1.612E-14	0.000E+00	1.612E-14
XE135M	3.333E-20	0.000E+00	3.333E-20
XE-135	1.023E-16	0.000E+00	1.023E-16
RB--87	0.000E+00	0.000E+00	0.000E+00
RB--88	1.193E-22	0.000E+00	1.193E-22
CS-135	0.000E+00	0.000E+00	0.000E+00
Total	1.726E-14	0.000E+00	1.726E-14

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

Bechtel Standard Computer Program LocaDose, NE319 Version 6.0, © 2001
Calc No.: N4072-001 Rev No.: 06 Input: fhb1000.lti
Originator: Nancy Yackle Date: 13 Nov 2002
Project: SONGS UNITS 2,3 Job No.: fhb1000.lti Sheet No. 54
Subject: FHA in FHB, 1000 cfm CR Inleakage - 1.75 Peaking

****Results for Activity Computation at the end of 96.00 hours

Distribution of Instantaneous Activity in CURIES

	FHB AIR	A206/7	Cont Room
I--129	0.000E+00	4.887E-08	0.000E+00
I--130	0.000E+00	5.905E-08	0.000E+00
I--131	0.000E+00	4.125E-01	0.000E+00
I--132	0.000E+00	8.017E-23	0.000E+00
I--133	0.000E+00	5.603E-03	0.000E+00
I--135	0.000E+00	3.156E-08	0.000E+00
KR-83M	0.000E+00	0.000E+00	0.000E+00
KR--85	0.000E+00	0.000E+00	1.858E-31
KR-85M	0.000E+00	0.000E+00	0.000E+00
KR--87	0.000E+00	0.000E+00	0.000E+00
KR--88	0.000E+00	0.000E+00	0.000E+00
XE131M	0.000E+00	1.365E-12	0.000E+00
XE133M	0.000E+00	2.743E-13	0.000E+00
XE-133	0.000E+00	3.831E-12	4.033E-30
XE135M	0.000E+00	1.851E-15	0.000E+00
XE-135	0.000E+00	2.892E-16	0.000E+00
RB--87	0.000E+00	0.000E+00	0.000E+00
RB--88	0.000E+00	0.000E+00	0.000E+00
CS-135	0.000E+00	9.677E-12	0.000E+00
Total	0.000E+00	4.181E-01	4.219E-30

Bechtel Standard Computer Program LocaDose, NE319 Version 6.0, © 2001
Calc No.: N4072-001 Rev No.: 06 Input: fhb1000.lti
Originator: Nancy Yackle Date: 13 Nov 2002
Project: SONGS UNITS 2,3 Job No.: fhb1000.lti Sheet No. 55
Subject: FHA in FHB, 1000 cfm CR Inleakage - 1.75 Peaking

****Results for Activity Computation at the end of 96.00 hours

Activity Released from Each Node in CURIES
Since Last Printout

	FHB AIR	A206/7	Total
I--129	0.000E+00	0.000E+00	0.000E+00
I--130	0.000E+00	0.000E+00	0.000E+00
I--131	0.000E+00	0.000E+00	0.000E+00
I--132	0.000E+00	0.000E+00	0.000E+00
I--133	0.000E+00	0.000E+00	0.000E+00
I--135	0.000E+00	0.000E+00	0.000E+00
KR-83M	0.000E+00	0.000E+00	0.000E+00
KR--85	0.000E+00	0.000E+00	0.000E+00
KR-85M	0.000E+00	0.000E+00	0.000E+00
KR--87	0.000E+00	0.000E+00	0.000E+00
KR--88	0.000E+00	0.000E+00	0.000E+00
XE131M	0.000E+00	0.000E+00	0.000E+00
XE133M	0.000E+00	0.000E+00	0.000E+00
XE-133	0.000E+00	0.000E+00	0.000E+00
XE135M	0.000E+00	0.000E+00	0.000E+00
XE-135	0.000E+00	0.000E+00	0.000E+00
RB--87	0.000E+00	0.000E+00	0.000E+00
RB--88	0.000E+00	0.000E+00	0.000E+00
CS-135	0.000E+00	0.000E+00	0.000E+00
Total	0.000E+00	0.000E+00	0.000E+00

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

```
Bechtel Standard Computer Program LocaDose, NE319 Version 6.0, © 2001
Calc No.: N4072-001 Rev No.:  06 Input: fhb1000.lti
Originator: Nancy Yackle          Date: 13 Nov 2002
Project: SONGS UNITS 2,3          Job No.: fhb1000.lti          Sheet No.   58
Subject: FHA in FHB, 1000 cfm CR Inleakage - 1.75 Peaking
*****************************************************************************

****Results for Activity Computation at the end of   720.0     hours

                  Distribution of Instantaneous Activity in CURIES
              FHB AIR      A206/7 Cont Room
I--129        0.000E+00 4.837E-08 0.000E+00
I--130        0.000E+00 3.812E-23 0.000E+00
I--131        0.000E+00 4.387E-02 0.000E+00
I--132        0.000E+00 0.000E+00 0.000E+00
I--133        0.000E+00 5.783E-12 0.000E+00
I--135        0.000E+00 0.000E+00 0.000E+00
KR-83M        0.000E+00 0.000E+00 0.000E+00
KR--85        0.000E+00 0.000E+00 0.000E+00
KR-85M        0.000E+00 0.000E+00 0.000E+00
KR--87        0.000E+00 0.000E+00 0.000E+00
KR--88        0.000E+00 0.000E+00 0.000E+00
XE131M        0.000E+00 1.544E-13 0.000E+00
XE133M        0.000E+00 5.271E-22 0.000E+00
XE-133        0.000E+00 7.362E-21 0.000E+00
XE135M        0.000E+00 0.000E+00 0.000E+00
XE-135        0.000E+00 0.000E+00 0.000E+00
RB--87        0.000E+00 0.000E+00 0.000E+00
RB--88        0.000E+00 0.000E+00 0.000E+00
CS-135        0.000E+00 9.677E-12 0.000E+00
Total         0.000E+00 4.387E-02 0.000E+00


Bechtel Standard Computer Program LocaDose, NE319 Version 6.0, © 2001
Calc No.: N4072-001 Rev No.:  06 Input: fhb1000.lti
Originator: Nancy Yackle          Date: 13 Nov 2002
Project: SONGS UNITS 2,3          Job No.: fhb1000.lti          Sheet No.   59
Subject: FHA in FHB, 1000 cfm CR Inleakage - 1.75 Peaking
*****************************************************************************

****Results for Activity Computation at the end of   720.0     hours

                  Activity Released from Each Node in CURIES
                  Since Last Printout

              FHB AIR      A206/7   Total
I--129        0.000E+00 0.000E+00 0.000E+00
I--130        0.000E+00 0.000E+00 0.000E+00
I--131        0.000E+00 0.000E+00 0.000E+00
I--132        0.000E+00 0.000E+00 0.000E+00
I--133        0.000E+00 0.000E+00 0.000E+00
I--135        0.000E+00 0.000E+00 0.000E+00
KR-83M        0.000E+00 0.000E+00 0.000E+00
KR--85        0.000E+00 0.000E+00 0.000E+00
KR-85M        0.000E+00 0.000E+00 0.000E+00
KR--87        0.000E+00 0.000E+00 0.000E+00
KR--88        0.000E+00 0.000E+00 0.000E+00
XE131M        0.000E+00 0.000E+00 0.000E+00
XE133M        0.000E+00 0.000E+00 0.000E+00
XE-133        0.000E+00 0.000E+00 0.000E+00
XE135M        0.000E+00 0.000E+00 0.000E+00
XE-135        0.000E+00 0.000E+00 0.000E+00
RB--87        0.000E+00 0.000E+00 0.000E+00
RB--88        0.000E+00 0.000E+00 0.000E+00
CS-135        0.000E+00 0.000E+00 0.000E+00
Total         0.000E+00 0.000E+00 0.000E+00
```

9.2.9 LOCADOSE Dose Calculation Input File - 1000 cfm case (fhb1000.ldi)

```
FHA in FHB, 1000 cfm CR Inleakage - 1.75 Peaking
Nancy Yackle
SONGS UNITS 2,3
fhb1000.ldi
N4072-001 06
      1
DOFDORDRODRR
   2   2   4
   3   5   4   3   1   0
REM REM/HR
  2.7200E-04  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
  3.4700E-04  0.0000E+00  0.0000E+00  0.0000E+00
  7.7200E-06  7.7200E-06  4.7400E-06  3.6700E-06  2.6700E-06
  3.4700E-04  3.4700E-04  1.7500E-04  2.3200E-04
  3.1000E-03  3.1000E-03  1.8000E-03  9.8000E-04  2.4000E-04
  3.4700E-04  3.4700E-04  3.4700E-04  3.4700E-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  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  1.0000E+00
```

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

9.2.10 LOCADOSE Dose Calculation Output File - 1000 cfm case (fhb1000.ldo)

NOTE: The following are relevant excerpts from the LOCADOSE Code dose calculation output file.

```
Bechtel Standard Computer Program LocaDose, NE319 Version 6.0, © 2001
 Calc No.: N4072-001 Rev No.:  06 Input: fhb1000.ldi
 Originator: Nancy Yackle         Date: 13 Nov 2002
 Project: SONGS UNITS 2,3         Job No.: fhb1000.ldi          Sheet No.    1
 Subject: FHA in FHB, 1000 cfm CR Inleakage - 1.75 Peaking
==========================================================================

        Standard Computer Program
        NE319 LOCADOSE Version 6.0


This is the Dose Calculation Program.  This program
calculates doses and dose rates for people at locations
within building regions and at off-site locations.

  © Bechtel Corporation, 1978, 2001
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    This program contains proprietary and confidential
    information belonging to Bechtel Power Corporation.
    This program is also an unpublished work protected by
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    of the information contained in this program is
    strictly prohibited without the express prior written
    permission of Bechtel Power Corporation, 50 Beale Street
    San Francisco, California 94105, U.S.A.
```

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

```
Bechtel Standard Computer Program LocaDose, NE319 Version 6.0, - 2001
Calc No.: N4072-001 Rev No.:  06 Input: fhb1000.ldi
Originator: Nancy Yackle          Date: 13 Nov 2002
Project: SONGS UNITS 2,3          Job No.: fhb1000.ldi          Sheet No.    2
Subject: FHA in FHB, 1000 cfm CR Inleakage - 1.75 Peaking
================================================================================

NE319 Dose Input Summary


This run uses the file fhb1000.ltf
generated on 13 Nov 2002  at 12:44:47

        The following options and calculations are performed:

          Doserates within regions will be calculated
          Doserates offsite will be calculated
          Doses within regions will be calculated
          Offsite Doses will be calculated
          Control Room doses will be calculated

        This run evaluates  31 isotopes using  4 regions
        Offsite doses for  3 dose points will be calculated

The library file fhb1000.lib is used in this run
4072-001rev6 isotope data created on 11/04/2002 is used
Dose Conversion Factors from  ICRP30Thy&RG1.109Immer are used


        Isotopes Considered in this Run
        I--129  I--129  I--129  I--130  I--130  I--130  I--131  I--131
        I--131  I--132  I--132  I--132  I--133  I--133  I--133  I--135
        I--135  I--135  KR-83M  KR--85  KR-85M  KR--87  KR--88  XE131M
        XE133M  XE-133  XE135M  XE-135  RB--87  RB--88  CS-135
```

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

```
Bechtel Standard Computer Program LocaDose, NE319 Version 6.0, r 2001
Calc No.: N4072-001 Rev No.:  06 Input: fhb1000.ldi
Originator: Nancy Yackle          Date: 13 Nov 2002
Project: SONGS UNITS 2,3          Job No.: fhb1000.ldi          Sheet No.    3
Subject: FHA in FHB, 1000 cfm CR Inleakage - 1.75 Peaking
================================================================================

NE319 Dose Input Summary

        Finite Cloud Correction Factors for Each Region

    Region     2         3         4
    Factor 1.000E+00 1.000E+00 1.000E+00


        Occupancy Factor for Each Region

      Period (hrs)    Region     2         3         4
     0.000    - 24.00          1.000E+00 1.000E+00 1.000E+00
     24.00    - 96.00          1.000E+00 1.000E+00 6.000E-01
     96.00    - 720.0          1.000E+00 1.000E+00 4.000E-01


        Breathing Rates (m^3/sec) for Each Region
      Period (hrs)    Region     2         3         4
     0.000    - 720.0          3.470E-04 3.470E-04 3.470E-04
```

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

```
Bechtel Standard Computer Program LocaDose, NE319 Version 6.0, © 2001
Calc No.: N4072-001 Rev No.:  06 Input: fhb1000.ldi
Originator: Nancy Yackle          Date: 13 Nov 2002
Project: SONGS UNITS 2,3          Job No.: fhb1000.ldi          Sheet No.    4
Subject: FHA in FHB, 1000 cfm CR Inleakage - 1.75 Peaking
================================================================================

NE319 Dose Input Summary


        Finite Cloud Correction Factor for Each Dose Point

        Dose Point Distance (m) Finite Cloud Factor
             1       NOT APPLIC      1.000E+00
             2       NOT APPLIC      1.000E+00
             3       NOT APPLIC      1.000E+00

        X/Q IN sec/m^3 for Each Dose Point

      Period (hrs)   Dosepoint   1          2          3
    0.000    - 2.000          2.720E-04 7.720E-06 3.100E-03
    2.000    - 8.000          0.000E+00 7.720E-06 3.100E-03
    8.000    - 24.00          0.000E+00 4.740E-06 1.800E-03
    24.00    - 96.00          0.000E+00 3.670E-06 9.800E-04
    96.00    - 720.0          0.000E+00 2.670E-06 2.400E-04

        Breathing Rates in m^3/sec for Each Dose Point

      Period (hrs)   Dosepoint   1          2          3
    0.000    - 2.000          3.470E-04 3.470E-04 3.470E-04
    2.000    - 8.000          0.000E+00 3.470E-04 3.470E-04
    8.000    - 24.00          0.000E+00 1.750E-04 3.470E-04
    24.00    - 720.0          0.000E+00 2.320E-04 3.470E-04
```

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

Bechtel Standard Computer Program LocaDose, NE319 Version 6.0, - 2001
Calc No.: N4072-001 Rev No.: 06 Input: fhb1000.1di
Originator: Nancy Yackle Date: 13 Nov 2002
Project: SONGS UNITS 2,3 Job No.: fhb1000.1di Sheet No. 5
Subject: FHA in FHB, 1000 cfm CR Inleakage - 1.75 Peaking

NE319 Dose Rate Within Regions Summary

Dose rates in REM/HR for region 2 FHB AIR

		Inhalation		Immersion	
Time	Thyroid	Lung	Bone	Beta Skin	Whole Body
0.000E+00	2.420E+04	4.831E+02	7.401E+01	1.338E+02	7.487E+00
2.780E-03	2.392E+04	4.775E+02	7.315E+01	1.322E+02	7.399E+00
5.000E-02	1.961E+04	3.915E+02	5.997E+01	1.084E+02	6.064E+00
1.000E-01	1.589E+04	3.172E+02	4.859E+01	8.779E+01	4.912E+00
2.000E-01	1.043E+04	2.083E+02	3.191E+01	5.761E+01	3.223E+00
5.000E-01	2.954E+03	5.896E+01	9.030E+00	1.629E+01	9.106E-01
1.000E+00	3.606E+02	7.195E+00	1.102E+00	1.983E+00	1.108E-01
2.000E+00	5.374E+00	1.072E-01	1.640E-02	2.941E-02	1.642E-03
4.000E+00	1.194E-03	2.378E-05	3.635E-06	6.480E-06	3.611E-07
6.000E+00	2.651E-07	5.277E-09	8.060E-10	1.429E-09	7.948E-11
8.000E+00	5.889E-11	1.171E-12	1.787E-13	3.153E-13	1.751E-14
1.000E+01	1.308E-14	2.600E-16	3.964E-17	6.963E-17	3.862E-18
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 6.0, - 2001
Calc No.: N4072-001 Rev No.: 06 Input: fhb1000.1di
Originator: Nancy Yackle Date: 13 Nov 2002
Project: SONGS UNITS 2,3 Job No.: fhb1000.1di Sheet No. 6
Subject: FHA in FHB, 1000 cfm CR Inleakage - 1.75 Peaking

NE319 Dose Rate Within Regions Summary

Dose rates in REM/HR for region 4 Cont Room

		Inhalation		Immersion	
Time	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
2.780E-03	3.829E+00	7.644E-02	1.171E-02	2.117E-02	1.065E-03
5.000E-02	6.018E+01	1.201E+00	1.841E-01	3.326E-01	1.674E-02
1.000E-01	3.630E+01	7.401E-01	1.110E-01	5.195E-01	2.542E-02
2.000E-01	1.575E+01	3.468E-01	4.816E-02	7.545E-01	3.644E-02
5.000E-01	3.155E+00	1.044E-01	9.645E-03	8.713E-01	4.187E-02
1.000E+00	3.763E-01	3.531E-02	1.150E-03	5.738E-01	2.754E-02
2.000E+00	5.607E-03	8.737E-03	1.711E-05	1.771E-01	8.488E-03
4.000E+00	1.245E-06	7.524E-04	3.794E-09	1.539E-02	7.364E-04
6.000E+00	2.766E-10	6.548E-05	8.589E-13	1.335E-03	6.379E-05
8.000E+00	6.214E-14	5.702E-06	1.542E-15	1.160E-04	5.531E-06
1.000E+01	2.331E-16	1.335E-06	4.077E-16	2.709E-05	1.291E-06
2.400E+01	3.281E-21	5.195E-11	6.403E-21	1.045E-09	4.937E-11
9.600E+01	0.000E+00	1.120E-33	0.000E+00	2.238E-32	1.044E-33
7.200E+02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

Bechtel Standard Computer Program LocaDose, NE319 Version 6.0, © 2001
Calc No.: N4072-001 Rev No.: 06 Input: fhb1000.ldi
Originator: Nancy Yackle Date: 13 Nov 2002
Project: SONGS UNITS 2,3 Job No.: fhb1000.ldi Sheet No. 7
Subject: FHA in FHB, 1000 cfm CR Inleakage - 1.75 Peaking

NE319 Doses Within Regions Summary

Doses in REM for region 2 FHB AIR

		Inhalation			Immersion	
Time Interval (hr)		Thyroid	Lung	Bone	Beta Skin	Whole Body
0.000	-2.7800E-03	6.688E+01	1.335E+00	2.046E-01	3.697E-01	2.069E-02
2.7800E-03	-5.0000E-02	1.024E+03	2.045E+01	3.133E+00	5.661E+00	3.168E-01
5.0000E-02	-0.1000	8.843E+02	1.765E+01	2.704E+00	4.886E+00	2.734E-01
0.1000	-0.2000	1.297E+03	2.589E+01	3.967E+00	7.164E+00	4.008E-01
0.2000	-0.5000	1.778E+03	3.549E+01	5.437E+00	9.813E+00	5.489E-01
0.5000	- 1.000	6.166E+02	1.230E+01	1.884E+00	3.396E+00	1.899E-01
1.000	- 2.000	8.446E+01	1.685E+00	2.580E-01	4.640E-01	2.592E-02
2.000	- 4.000	1.277E+00	2.547E-02	3.898E-03	6.984E-03	3.898E-04
4.000	- 6.000	2.837E-04	5.652E-06	8.639E-07	1.539E-06	8.572E-08
6.000	- 8.000	6.301E-08	1.254E-09	1.915E-10	3.393E-10	1.887E-11
8.000	- 10.00	1.400E-11	2.784E-13	4.247E-14	7.488E-14	4.159E-15
10.00	- 24.00	3.111E-15	6.182E-17	9.423E-18	1.654E-17	9.173E-19
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	5.753E+03	1.148E+02	1.759E+01	3.176E+01	1.777E+00

Bechtel Standard Computer Program LocaDose, NE319 Version 6.0, © 2001
Calc No.: N4072-001 Rev No.: 06 Input: fhb1000.ldi
Originator: Nancy Yackle Date: 13 Nov 2002
Project: SONGS UNITS 2,3 Job No.: fhb1000.ldi Sheet No. 8
Subject: FHA in FHB, 1000 cfm CR Inleakage - 1.75 Peaking

NE319 Doses Within Regions Summary

Cumulative doses in REM for region 2 FHB AIR

		Inhalation		Immersion	
Time	Thyroid	Lung	Bone	Beta Skin	Whole Body
2.780E-03	6.688E+01	1.335E+00	2.046E-01	3.697E-01	2.069E-02
5.000E-02	1.091E+03	2.178E+01	3.337E+00	6.031E+00	3.375E-01
1.000E-01	1.975E+03	3.943E+01	6.042E+00	1.092E+01	6.109E-01
2.000E-01	3.273E+03	6.533E+01	1.001E+01	1.808E+01	1.012E+00
5.000E-01	5.051E+03	1.008E+02	1.545E+01	2.789E+01	1.561E+00
1.000E+00	5.668E+03	1.131E+02	1.733E+01	3.129E+01	1.750E+00
2.000E+00	5.752E+03	1.148E+02	1.759E+01	3.175E+01	1.776E+00
4.000E+00	5.753E+03	1.148E+02	1.759E+01	3.176E+01	1.777E+00
6.000E+00	5.753E+03	1.148E+02	1.759E+01	3.176E+01	1.777E+00
8.000E+00	5.753E+03	1.148E+02	1.759E+01	3.176E+01	1.777E+00
1.000E+01	5.753E+03	1.148E+02	1.759E+01	3.176E+01	1.777E+00
2.400E+01	5.753E+03	1.148E+02	1.759E+01	3.176E+01	1.777E+00
9.600E+01	5.753E+03	1.148E+02	1.759E+01	3.176E+01	1.777E+00
7.200E+02	5.753E+03	1.148E+02	1.759E+01	3.176E+01	1.777E+00

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

Bechtel Standard Computer Program LocaDose, NE319 Version 6.0, - 2001
Calc No.: N4072-001 Rev No.: 06 Input: fhb1000.1di
Originator: Nancy Yackle Date: 13 Nov 2002
Project: SONGS UNITS 2,3 Job No.: fhb1000.1di Sheet No. 9
Subject: FHA in FHB, 1000 cfm CR Inleakage - 1.75 Peaking

NE319 Doses Within Regions Summary

Doses in REM for region 4 Cont Room

Time Interval (hr)		Inhalation Thyroid	Inhalation Lung	Inhalation Bone	Immersion Beta Skin	Immersion Whole Body
0.000	-2.7800E-03	5.337E-03	1.065E-04	1.632E-05	2.950E-05	1.485E-06
2.7800E-03	-5.0000E-02	1.573E+00	3.141E-02	4.812E-03	8.695E-03	4.376E-04
5.0000E-02	-0.1000	2.351E+00	4.734E-02	7.189E-03	2.153E-02	1.064E-03
0.1000	-0.2000	2.415E+00	5.071E-02	7.384E-03	6.503E-02	3.155E-03
0.2000	-0.5000	2.197E+00	5.580E-02	6.719E-03	2.581E-01	1.242E-02
0.5000	- 1.000	6.485E-01	3.054E-02	1.982E-03	3.657E-01	1.756E-02
1.000	- 2.000	8.813E-02	1.833E-02	2.692E-04	3.411E-01	1.636E-02
2.000	- 4.000	1.333E-03	6.488E-03	4.067E-06	1.325E-01	6.347E-03
4.000	- 6.000	2.960E-07	5.627E-04	9.015E-10	1.150E-02	5.499E-04
6.000	- 8.000	6.575E-11	4.898E-05	2.073E-13	9.978E-04	4.765E-05
8.000	- 10.00	1.999E-14	6.016E-06	1.496E-15	1.222E-04	5.828E-06
10.00	- 24.00	2.057E-16	1.840E-06	3.903E-16	3.729E-05	1.775E-06
24.00	- 96.00	1.768E-21	4.299E-11	3.450E-21	8.644E-10	4.082E-11
96.00	- 720.0	0.000E+00	5.775E-34	0.000E+00	1.028E-32	5.746E-34
	Total	9.280E+00	2.413E-01	2.838E-02	1.205E+00	5.795E-02

Bechtel Standard Computer Program LocaDose, NE319 Version 6.0, - 2001
Calc No.: N4072-001 Rev No.: 06 Input: fhb1000.1di
Originator: Nancy Yackle Date: 13 Nov 2002
Project: SONGS UNITS 2,3 Job No.: fhb1000.1di Sheet No. 10
Subject: FHA in FHB, 1000 cfm CR Inleakage - 1.75 Peaking

NE319 Doses Within Regions Summary

Cumulative doses in REM for region 4 Cont Room

Time	Inhalation Thyroid	Inhalation Lung	Inhalation Bone	Immersion Beta Skin	Immersion Whole Body
2.780E-03	5.337E-03	1.065E-04	1.632E-05	2.950E-05	1.485E-06
5.000E-02	1.579E+00	3.151E-02	4.828E-03	8.724E-03	4.391E-04
1.000E-01	3.929E+00	7.885E-02	1.202E-02	3.026E-02	1.503E-03
2.000E-01	6.344E+00	1.296E-01	1.940E-02	9.528E-02	4.658E-03
5.000E-01	8.542E+00	1.854E-01	2.612E-02	3.534E-01	1.708E-02
1.000E+00	9.190E+00	2.159E-01	2.810E-02	7.190E-01	3.464E-02
2.000E+00	9.278E+00	2.342E-01	2.837E-02	1.060E+00	5.100E-02
4.000E+00	9.280E+00	2.407E-01	2.838E-02	1.193E+00	5.735E-02
6.000E+00	9.280E+00	2.413E-01	2.838E-02	1.204E+00	5.790E-02
8.000E+00	9.280E+00	2.413E-01	2.838E-02	1.205E+00	5.795E-02
1.000E+01	9.280E+00	2.413E-01	2.838E-02	1.205E+00	5.795E-02
2.400E+01	9.280E+00	2.413E-01	2.838E-02	1.205E+00	5.795E-02
9.600E+01	9.280E+00	2.413E-01	2.838E-02	1.205E+00	5.795E-02
7.200E+02	9.280E+00	2.413E-01	2.838E-02	1.205E+00	5.795E-02

Bechtel Standard Computer Program LocaDose, NE319 Version 6.0, - 2001
Calc No.: N4072-001 Rev No.: 06 Input: fhb1000.ldi
Originator: Nancy Yackle Date: 13 Nov 2002
Project: SONGS UNITS 2,3 Job No.: fhb1000.ldi Sheet No. 11
Subject: FHA in FHB, 1000 cfm CR Inleakage - 1.75 Peaking

NE319 Offsite Dose Rate Summary

Dose rates in REM/HR for distance 1

		Inhalation		Immersion	
Time	Thyroid	Lung	Bone	Beta Skin	Whole Body
0.000E+00	7.947E+01	1.586E+00	2.430E-01	4.393E-01	3.800E-01
2.780E-03	7.854E+01	1.568E+00	2.402E-01	4.341E-01	3.756E-01
5.000E-02	6.440E+01	1.285E+00	1.969E-01	3.558E-01	3.078E-01
1.000E-01	5.197E+01	1.037E+00	1.589E-01	2.871E-01	2.483E-01
2.000E-01	3.413E+01	6.812E-01	1.044E-01	1.884E-01	1.629E-01
5.000E-01	9.662E+00	1.928E-01	2.954E-02	5.327E-02	4.603E-02
1.000E+00	1.179E+00	2.353E-02	3.604E-03	6.486E-03	5.602E-03
2.000E+00	1.758E-02	3.505E-04	5.364E-05	9.621E-05	8.301E-05
4.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
6.000E+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
1.000E+01	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 6.0, - 2001
Calc No.: N4072-001 Rev No.: 06 Input: fhb1000.ldi
Originator: Nancy Yackle Date: 13 Nov 2002
Project: SONGS UNITS 2,3 Job No.: fhb1000.ldi Sheet No. 12
Subject: FHA in FHB, 1000 cfm CR Inleakage - 1.75 Peaking

NE319 Offsite Dose Rate Summary

Dose rates in REM/HR for distance 2

		Inhalation		Immersion	
Time	Thyroid	Lung	Bone	Beta Skin	Whole Body
0.000E+00	2.255E+00	4.503E-02	6.898E-03	1.247E-02	1.079E-02
2.780E-03	2.229E+00	4.450E-02	6.818E-03	1.232E-02	1.066E-02
5.000E-02	1.828E+00	3.648E-02	5.590E-03	1.010E-02	8.736E-03
1.000E-01	1.475E+00	2.945E-02	4.511E-03	8.149E-03	7.048E-03
2.000E-01	9.686E-01	1.933E-02	2.962E-03	5.348E-03	4.624E-03
5.000E-01	2.742E-01	5.473E-03	8.383E-04	1.512E-03	1.307E-03
1.000E+00	3.348E-02	6.679E-04	1.023E-04	1.841E-04	1.590E-04
2.000E+00	4.989E-04	9.949E-06	1.523E-06	2.731E-06	2.356E-06
4.000E+00	1.108E-07	2.208E-09	3.375E-10	6.015E-10	5.181E-10
6.000E+00	2.461E-11	4.899E-13	7.482E-14	1.326E-13	1.140E-13
8.000E+00	5.467E-15	1.087E-16	1.659E-17	2.927E-17	2.513E-17
1.000E+01	3.761E-19	7.475E-21	1.139E-21	3.969E-21	3.402E-21
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

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	R E V ⇓
6	N. YACKLE		T. REMICK							

Bechtel Standard Computer Program LocaDose, NE319 Version 6.0, © 2001
Calc No.: N4072-001 Rev No.: 06 Input: fhb1000.ldi
Originator: Nancy Yackle Date: 13 Nov 2002
Project: SONGS UNITS 2,3 Job No.: fhb1000.ldi Sheet No. 13
Subject: FHA in FHB, 1000 cfm CR Inleakage - 1.75 Peaking

NE319 Offsite Dose Rate Summary

Dose rates in REM/HR for distance 3

		Inhalation		Immersion	
Time	Thyroid	Lung	Bone	Beta Skin	Whole Body
0.000E+00	9.057E+02	1.808E+01	2.770E+00	5.006E+00	4.331E+00
2.780E-03	8.952E+02	1.787E+01	2.738E+00	4.948E+00	4.280E+00
5.000E-02	7.339E+02	1.465E+01	2.245E+00	4.056E+00	3.508E+00
1.000E-01	5.923E+02	1.182E+01	1.811E+00	3.272E+00	2.830E+00
2.000E-01	3.890E+02	7.764E+00	1.189E+00	2.148E+00	1.857E+00
5.000E-01	1.101E+02	2.198E+00	3.366E-01	6.071E-01	5.247E-01
1.000E+00	1.344E+01	2.682E-01	4.107E-02	7.393E-02	6.385E-02
2.000E+00	2.003E-01	3.995E-03	6.114E-04	1.096E-03	9.461E-04
4.000E+00	4.449E-05	8.864E-07	1.355E-07	2.415E-07	2.080E-07
6.000E+00	9.882E-09	1.967E-10	3.004E-11	5.326E-11	4.580E-11
8.000E+00	2.195E-12	4.366E-14	6.662E-15	1.175E-14	1.009E-14
1.000E+01	2.832E-16	5.628E-18	8.580E-19	1.507E-18	1.292E-18
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 6.0, © 2001
Calc No.: N4072-001 Rev No.: 06 Input: fhb1000.ldi
Originator: Nancy Yackle Date: 13 Nov 2002
Project: SONGS UNITS 2,3 Job No.: fhb1000.ldi Sheet No. 14.
Subject: FHA in FHB, 1000 cfm CR Inleakage - 1.75 Peaking

NE319 Offsite Dose Summary

Doses in REM for distance 1

		Inhalation			Immersion	
Time Interval (hr)		Thyroid	Lung	Bone	Beta Skin	Whole Body
0.000	-2.7800E-03	2.196E-01	4.384E-03	6.717E-04	1.214E-03	1.050E-03
2.7800E-03	-5.0000E-02	3.364E+00	6.715E-02	1.029E-02	1.859E-02	1.608E-02
5.0000E-02	-0.1000	2.892E+00	5.773E-02	8.845E-03	1.598E-02	1.382E-02
0.1000	-0.2000	4.243E+00	8.469E-02	1.297E-02	2.343E-02	2.026E-02
0.2000	-0.5000	5.816E+00	1.161E-01	1.778E-02	3.210E-02	2.775E-02
0.5000	- 1.000	2.017E+00	4.024E-02	6.163E-03	1.111E-02	9.598E-03
1.000	- 2.000	2.762E-01	5.511E-03	8.437E-04	1.517E-03	1.310E-03
2.000	- 4.000	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
4.000	- 6.000	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
6.000	- 8.000	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
8.000	- 10.00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
10.00	- 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	1.883E+01	3.758E-01	5.757E-02	1.039E-01	8.987E-02

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

Bechtel Standard Computer Program LocaDose, NE319 Version 6.0, - 2001
Calc No.: N4072-001 Rev No.: 06 Input: fhb1000.1di
Originator: Nancy Yackle Date: 13 Nov 2002
Project: SONGS UNITS 2,3 Job No.: fhb1000.1di Sheet No. 15
Subject: FHA in FHB, 1000 cfm CR Inleakage - 1.75 Peaking

NE319 Offsite Dose Summary

Cumulative doses in REM for distance 1

		Inhalation		Immersion	
Time	Thyroid	Lung	Bone	Beta Skin	Whole Body
2.780E-03	2.196E-01	4.384E-03	6.717E-04	1.214E-03	1.050E-03
5.000E-02	3.583E+00	7.153E-02	1.096E-02	1.980E-02	1.713E-02
1.000E-01	6.476E+00	1.293E-01	1.980E-02	3.578E-02	3.095E-02
2.000E-01	1.072E+01	2.140E-01	3.278E-02	5.922E-02	5.122E-02
5.000E-01	1.653E+01	3.300E-01	5.056E-02	9.131E-02	7.896E-02
1.000E+00	1.855E+01	3.703E-01	5.672E-02	1.024E-01	8.856E-02
2.000E+00	1.883E+01	3.758E-01	5.757E-02	1.039E-01	8.987E-02
4.000E+00	1.883E+01	3.758E-01	5.757E-02	1.039E-01	8.987E-02
6.000E+00	1.883E+01	3.758E-01	5.757E-02	1.039E-01	8.987E-02
8.000E+00	1.883E+01	3.758E-01	5.757E-02	1.039E-01	8.987E-02
1.000E+01	1.883E+01	3.758E-01	5.757E-02	1.039E-01	8.987E-02
2.400E+01	1.883E+01	3.758E-01	5.757E-02	1.039E-01	8.987E-02
9.600E+01	1.883E+01	3.758E-01	5.757E-02	1.039E-01	8.987E-02
7.200E+02	1.883E+01	3.758E-01	5.757E-02	1.039E-01	8.987E-02

Bechtel Standard Computer Program LocaDose, NE319 Version 6.0, - 2001
Calc No.: N4072-001 Rev No.: 06 Input: fhb1000.1di
Originator: Nancy Yackle Date: 13 Nov 2002
Project: SONGS UNITS 2,3 Job No.: fhb1000.1di Sheet No. 16
Subject: FHA in FHB, 1000 cfm CR Inleakage - 1.75 Peaking

NE319 Offsite Dose Summary

Doses in REM for distance 2

		Inhalation			Immersion	
Time Interval (hr)		Thyroid	Lung	Bone	Beta Skin	Whole Body
0.000	-2.7800E-03	6.234E-03	1.244E-04	1.907E-05	3.446E-05	2.981E-05
2.7800E-03	-5.0000E-02	9.547E-02	1.906E-03	2.920E-04	5.276E-04	4.564E-04
5.0000E-02	-0.1000	8.209E-02	1.639E-03	2.510E-04	4.535E-04	3.923E-04
0.1000	-0.2000	1.204E-01	2.404E-03	3.682E-04	6.651E-04	5.751E-04
0.2000	-0.5000	1.651E-01	3.295E-03	5.047E-04	9.109E-04	7.875E-04
0.5000	- 1.000	5.724E-02	1.142E-03	1.749E-04	3.153E-04	2.724E-04
1.000	- 2.000	7.840E-03	1.564E-04	2.395E-05	4.307E-05	3.719E-05
2.000	- 4.000	1.186E-04	2.364E-06	3.618E-07	6.483E-07	5.593E-07
4.000	- 6.000	2.634E-08	5.247E-10	8.020E-11	1.428E-10	1.230E-10
6.000	- 8.000	5.850E-12	1.164E-13	1.778E-14	3.150E-14	2.708E-14
8.000	- 10.00	4.024E-16	8.003E-18	1.221E-18	4.268E-18	3.664E-18
10.00	- 24.00	8.941E-20	1.777E-21	2.709E-22	9.428E-22	8.081E-22
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	5.345E-01	1.067E-02	1.634E-03	2.951E-03	2.551E-03

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

Bechtel Standard Computer Program LocaDose, NE319 Version 6.0, ⌐ 2001
Calc No.: N4072-001 Rev No.: 06 Input: fhb1000.ldi
Originator: Nancy Yackle Date: 13 Nov 2002
Project: SONGS UNITS 2,3 Job No.: fhb1000.ldi Sheet No. 17
Subject: FHA in FHB, 1000 cfm CR Inleakage - 1.75 Peaking

NE319 Offsite Dose Summary

Cumulative doses in REM for distance 2

		Inhalation		Immersion	
Time	Thyroid	Lung	Bone	Beta Skin	Whole Body
2.780E-03	6.234E-03	1.244E-04	1.907E-05	3.446E-05	2.981E-05
5.000E-02	1.017E-01	2.030E-03	3.110E-04	5.621E-04	4.862E-04
1.000E-01	1.838E-01	3.669E-03	5.621E-04	1.016E-03	8.785E-04
2.000E-01	3.042E-01	6.073E-03	9.303E-04	1.681E-03	1.454E-03
5.000E-01	4.693E-01	9.367E-03	1.435E-03	2.592E-03	2.241E-03
1.000E+00	5.265E-01	1.051E-02	1.610E-03	2.907E-03	2.514E-03
2.000E+00	5.344E-01	1.067E-02	1.634E-03	2.950E-03	2.551E-03
4.000E+00	5.345E-01	1.067E-02	1.634E-03	2.951E-03	2.551E-03
6.000E+00	5.345E-01	1.067E-02	1.634E-03	2.951E-03	2.551E-03
8.000E+00	5.345E-01	1.067E-02	1.634E-03	2.951E-03	2.551E-03
1.000E+01	5.345E-01	1.067E-02	1.634E-03	2.951E-03	2.551E-03
2.400E+01	5.345E-01	1.067E-02	1.634E-03	2.951E-03	2.551E-03
9.600E+01	5.345E-01	1.067E-02	1.634E-03	2.951E-03	2.551E-03
7.200E+02	5.345E-01	1.067E-02	1.634E-03	2.951E-03	2.551E-03

Bechtel Standard Computer Program LocaDose, NE319 Version 6.0, ⌐ 2001
Calc No.: N4072-001 Rev No.: 06 Input: fhb1000.ldi
Originator: Nancy Yackle Date: 13 Nov 2002
Project: SONGS UNITS 2,3 Job No.: fhb1000.ldi Sheet No. 18
Subject: FHA in FHB, 1000 cfm CR Inleakage - 1.75 Peaking

NE319 Offsite Dose Summary

Doses in REM for distance 3

		Inhalation			Immersion	
Time Interval (hr)		Thyroid	Lung	Bone	Beta Skin	Whole Body
0.000	-2.7800E-03	2.503E+00	4.997E-02	7.656E-03	1.384E-02	1.197E-02
2.7800E-03	-5.0000E-02	3.834E+01	7.653E-01	1.172E-01	2.119E-01	1.833E-01
5.0000E-02	-0.1000	3.296E+01	6.580E-01	1.008E-01	1.821E-01	1.575E-01
0.1000	-0.2000	4.835E+01	9.652E-01	1.479E-01	2.671E-01	2.309E-01
0.2000	-0.5000	6.529E+01	1.323E+00	2.027E-01	3.658E-01	3.162E-01
0.5000	- 1.000	2.298E+01	4.587E-01	7.025E-02	1.266E-01	1.094E-01
1.000	- 2.000	3.148E+00	6.281E-02	9.616E-03	1.729E-02	1.493E-02
2.000	- 4.000	4.761E-02	9.495E-04	1.453E-04	2.603E-04	2.246E-04
4.000	- 6.000	1.058E-05	2.107E-07	3.220E-08	5.736E-08	4.939E-08
6.000	- 8.000	2.349E-09	4.676E-11	7.140E-12	1.265E-11	1.087E-11
8.000	- 10.00	3.030E-13	6.026E-15	9.193E-16	1.621E-15	1.391E-15
10.00	- 24.00	6.733E-17	1.338E-18	2.040E-19	3.580E-19	3.069E-19
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	2.146E+02	4.284E+00	6.562E-01	1.185E+00	1.024E+00

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE
6	N. YACKLE		T. REMICK						

REV ⇓

Bechtel Standard Computer Program LocaDose, NE319 Version 6.0, - 2001
Calc No.: N4072-001 Rev No.: 06 Input: fhb1000.ldi
Originator: Nancy Yackle Date: 13 Nov 2002
Project: SONGS UNITS 2,3 Job No.: fhb1000.ldi Sheet No. 19
Subject: FHA in FHB, 1000 cfm CR Inleakage - 1.75 Peaking

NE319 Offsite Dose Summary

Cumulative doses in REM for distance 3

		Inhalation		Immersion	
Time	Thyroid	Lung	Bone	Beta Skin	Whole Body
2.780E-03	2.503E+00	4.997E-02	7.656E-03	1.384E-02	1.197E-02
5.000E-02	4.084E+01	8.153E-01	1.249E-01	2.257E-01	1.952E-01
1.000E-01	7.380E+01	1.473E+00	2.257E-01	4.078E-01	3.528E-01
2.000E-01	1.222E+02	2.438E+00	3.736E-01	6.749E-01	5.837E-01
5.000E-01	1.884E+02	3.762E+00	5.762E-01	1.041E+00	8.999E-01
1.000E+00	2.114E+02	4.220E+00	6.465E-01	1.167E+00	1.009E+00
2.000E+00	2.146E+02	4.283E+00	6.561E-01	1.185E+00	1.024E+00
4.000E+00	2.146E+02	4.284E+00	6.562E-01	1.185E+00	1.024E+00
6.000E+00	2.146E+02	4.284E+00	6.562E-01	1.185E+00	1.024E+00
8.000E+00	2.146E+02	4.284E+00	6.562E-01	1.185E+00	1.024E+00
1.000E+01	2.146E+02	4.284E+00	6.562E-01	1.185E+00	1.024E+00
2.400E+01	2.146E+02	4.284E+00	6.562E-01	1.185E+00	1.024E+00
9.600E+01	2.146E+02	4.284E+00	6.562E-01	1.185E+00	1.024E+00
7.200E+02	2.146E+02	4.284E+00	6.562E-01	1.185E+00	1.024E+00

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

9.3 SOURCE2 Code Input and Output Files

9.3.1 Outside Cloud Shine Files

9.3.1.1 Outside Cloud SOURCE2 Input File (ss-c.si)

```
SOUR   N4072-001 5   MARK DRUCKER      SONGS UNITS 2,3   ss-c.si
fha-fhb.to  FHA in FHB - FHB Cloud Source Strengths
Activity at   .0000     hours for node  2 FHB AIR
   18   11    0    0    0    0      .9667DE-10      .00000E+00      .00000E+00


          KR-83M             3.86000E-09
          KR--85             8.13000E+02
          KR-85M             8.56000E-02
          KR--87             1.07000E-13
          KR--88             4.42000E-04
          XE131M             2.01000E+02
          XE133M             6.74000E+02
          XE-133             2.95000E+04
          XE135M             2.88000E+00
          XE-135             3.87000E+02
          RB--88             0.00000E+00
          CS-135             0.00000E+00
          I--129             1.49200E-05
          I--130             3.89300E-03
          I--131             1.76100E+02
          I--132             1.07500E-07
          I--133             4.09000E+01
          I--135             2.25400E-01
SOUR   N4072-001 5   MARK DRUCKER      SONGS UNITS 2,3   ss-c.si
fha-fhb.to  FHA in FHB - FHB Cloud Source Strengths
Activity at  2.7800E-03 hours for node  2 FHB AIR
   18   11    0    0    0    0      .9667DE-10      .00000E+00      .00000E+00


          KR-83M             3.81116E-09
          KR--85             8.03559E+02
          KR-85M             8.45696E-02
          KR--87             1.05597E-13
          KR--88             4.36573E-04
          XE131M             1.98665E+02
          XE133M             6.66149E+02
          XE-133             2.91570E+04
          XE135M             2.82586E+00
          XE-135             3.82426E+02
          RB--88             2.83000E-06
          CS-135             2.85127E-11
          I--129             1.47467E-05
          I--130             3.84719E-03
          I--131             1.74053E+02
          I--132             1.06162E-07
          I--133             4.04213E+01
          I--135             2.22718E-01
SOUR   N4072-001 5   MARK DRUCKER      SONGS UNITS 2,3   ss-c.si
fha-fhb.to  FHA in FHB - FHB Cloud Source Strengths
Activity at  5.0000E-02 hours for node  2 FHB AIR
```

```
    18  11   0   0   0   0     .96670E-10     .00000E+00     .00000E+00


          KR-83M            3.06992E-09
          KR--85            6.58952E+02
          KR-85M            6.88459E-02
          KR--87            8.43941E-14
          KR--88            3.53935E-04
          XE131M            1.62895E+02
          XE133M            5.45931E+02
          XE-133            2.39039E+04
          XE135M            2.04744E+00
          XE-135            3.12488E+02
          RB--88            3.93025E-05
          CS-135            4.19866E-10
          I--129            1.20930E-05
          I--130            3.14652E-03
          I--131            1.42707E+02
          I--132            8.58195E-08
          I--133            3.30953E+01
          I--135            1.81736E-01
SOUR   N4072-001 5   MARK DRUCKER      SONGS UNITS 2,3   ss-c.si
fha-fhb.to  FHA in FHB - FHB Cloud Source Strengths
Activity at   .1000     hours for node  2 FHB AIR
   18  11   0   0   0   0     .96670E-10     .00000E+00     .00000E+00


          KR-83M            2.44156E-09
          KR--85            5.34094E+02
          KR-85M            5.53711E-02
          KR--87            6.65641E-14
          KR--88            2.83417E-04
          XE131M            1.32013E+02
          XE133M            4.42197E+02
          XE-133            1.93694E+04
          XE135M            1.45589E+00
          XE-135            2.52322E+02
          RB--88            5.98139E-05
          CS-135            6.79348E-10
          I--129            9.80158E-06
          I--130            2.54318E-03
          I--131            1.15646E+02
          I--132            6.85115E-08
          I--133            2.67800E+01
          I--135            1.46531E-01
SOUR   N4072-001 5   MARK DRUCKER      SONGS UNITS 2,3   ss-c.si
fha-fhb.to  FHA in FHB - FHB Cloud Source Strengths
Activity at   .2000     hours for node  2 FHB AIR
   18  11   0   0   0   0     .96670E-10     .00000E+00     .00000E+00


          KR-83M            1.54435E-09
          KR--85            3.50869E+02
          KR-85M            3.58172E-02
          KR--87            4.14092E-14
          KR--88            1.81731E-04
          XE131M            8.67041E+01
          XE133M            2.90116E+02
          XE-133            1.27178E+04
```

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

```
           XE135M              7.36752E-01
           XE-135              1.64511E+02
           RB--88              6.94987E-05
           CS-135              8.89540E-10
           I--129              6.43907E-06
           I--130              1.66139E-03
           I--131              7.59455E+01
           I--132              4.35635E-08
           I--133              1.75347E+01
           I--135              9.52583E-02
SOUR   N4072-001 5   MARK DRUCKER      SONGS UNITS 2,3   ss-c.si
fha-fhb.to  FHA in FHB - FHB Cloud Source Strengths
Activity at   .5000     hours for node  2 FHB AIR
   18   11    0    0    0    0     .96670E-10     .00000E+00     .00000E+00


           KR-83M              3.90828E-10
           KR--85              9.94776E+01
           KR-85M              9.69436E-03
           KR--87              9.96934E-15
           KR--88              4.79116E-05
           XE131M              2.45643E+01
           XE133M              8.19290E+01
           XE-133              3.59992E+03
           XE135M              9.64260E-02
           XE-135              4.55924E+01
           RB--88              3.50619E-05
           CS-135              6.26331E-10
           I--129              1.82560E-06
           I--130              4.63179E-04
           I--131              2.15088E+01
           I--132              1.13027E-08
           I--133              4.92220E+00
           I--135              2.61714E-02
SOUR   N4072-001 5   MARK DRUCKER      SONGS UNITS 2,3   ss-c.si
fha-fhb.to  FHA in FHB - FHB Cloud Source Strengths
Activity at   1.000     hours for node  2 FHB AIR
   18   11    0    0    0    0     .96670E-10     .00000E+00     .00000E+00


           KR-83M              3.95716E-11
           KR--85              1.21720E+01
           KR-85M              1.09790E-03
           KR--87              9.28857E-16
           KR--88              5.19348E-06
           XE131M              3.00202E+00
           XE133M              9.95900E+00
           XE-133              4.39303E+02
           XE135M              3.49271E-03
           XE-135              5.37062E+00
           RB--88              5.23941E-06
           CS-135              1.51767E-10
           I--129              2.23379E-07
           I--130              5.51079E-05
           I--131              2.62707E+00
           I--132              1.18839E-09
           I--133              5.92373E-01
           I--135              3.03878E-03
SOUR   N4072-001 5   MARK DRUCKER      SONGS UNITS 2,3   ss-c.si
```

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

```
fha-fhb.to  FHA in FHB - FHB Cloud Source Strengths
Activity at   2.000     hours for node  2 FHB AIR
   18   11    0    0    0    0     .96670E-10     .00000E+00     .00000E+00


          KR-83M             4.05677E-13
          KR--85             1.82234E-01
          KR-85M             1.40817E-05
          KR--87             8.06331E-18
          KR--88             6.10232E-08
          XE131M             4.48365E-02
          XE133M             1.47154E-01
          XE-133             6.54200E+00
          XE135M             1.07556E-05
          XE-135             7.45174E-02
          RB--88             7.68354E-08
          CS-135             4.55027E-12
          I--129             3.34437E-09
          I--130             7.80088E-07
          I--131             3.91909E-02
          I--132             1.31374E-11
          I--133             8.57959E-03
          I--135             4.09679E-05
SOUR   N4072-001 5   MARK DRUCKER      SONGS UNITS 2,3   ss-c.si
fha-fhb.to  FHA in FHB - FHB Cloud Source Strengths
Activity at   4.000     hours for node  2 FHB AIR
   18   11    0    0    0    0     .96670E-10     .00000E+00     .00000E+00


          KR-83M             4.26358E-17
          KR--85             4.08478E-05
          KR-85M             2.31652E-09
          KR--87             6.07636E-22
          KR--88             8.42494E-12
          XE131M             1.00028E-05
          XE133M             3.21317E-05
          XE-133             1.45175E-03
          XE135M             8.19234E-09
          XE-135             1.43498E-05
          RB--88             6.40916E-11
          CS-135             4.13552E-15
          I--129             7.49652E-13
          I--130             1.56316E-10
          I--131             8.72191E-06
          I--132             1.60551E-15
          I--133             1.79974E-06
          I--135             7.44617E-09
SOUR   N4072-001 5   MARK DRUCKER      SONGS UNITS 2,3   ss-c.si
fha-fhb.to  FHA in FHB - FHB Cloud Source Strengths
Activity at   6.000     hours for node  2 FHB AIR
   18   11    0    0    0    0     .96670E-10     .00000E+00     .00000E+00


          KR-83M             4.48092E-21
          KR--85             9.15604E-09
          KR-85M             3.81082E-13
          KR--87             4.57903E-26
          KR--88             1.16316E-15
          XE131M             2.23157E-09
```

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

```
           XE133M            7.01607E-09
           XE-133            3.22158E-07
           XE135M            1.49589E-12
           XE-135            2.76353E-09
           RB--88            8.96014E-15
           CS-135            1.52697E-18
           I--129            1.68037E-16
           I--130            3.13229E-14
           I--131            1.94105E-09
           I--132            1.96207E-19
           I--133            3.77532E-10
           I--135            1.35339E-12
SOUR   N4072-001 5   MARK DRUCKER      SONGS UNITS 2,3   ss-c.si
fha-fhb.to  FHA in FHB - FHB Cloud Source Strengths
Activity at   8.000     hours for node  2 FHB AIR
   18   11    0    0    0    0     .96670E-10     .00000E+00     .00000E+00


           KR-83M            4.70935E-25
           KR--85            2.05233E-12
           KR-85M            6.26903E-17
           KR--87            3.45066E-30
           KR--88            1.60588E-19
           XE131M            4.97853E-13
           XE133M            1.53197E-12
           XE-133            7.14886E-11
           XE135M            2.71896E-16
           XE-135            5.32193E-13
           RB--88            1.23728E-18
           CS-135            4.57823E-22
           I--129            3.76661E-20
           I--130            6.27656E-18
           I--131            4.31980E-13
           I--132            2.39783E-23
           I--133            7.91948E-14
           I--135            2.45987E-16
SOUR   N4072-001 5   MARK DRUCKER      SONGS UNITS 2,3   ss-c.si
fha-fhb.to  FHA in FHB - FHB Cloud Source Strengths
Activity at   10.00     hours for node  2 FHB AIR
   18   11    0    0    0    0     .96670E-10     .00000E+00     .00000E+00


           KR-83M            4.94942E-29
           KR--85            4.60030E-16
           KR-85M            1.03129E-20
           KR--87            0.00000E+00
           KR--88            2.21709E-23
           XE131M            1.11068E-16
           XE133M            3.34506E-16
           XE-133            1.58634E-14
           XE135M            4.94188E-20
           XE-135            1.02486E-16
           RB--88            1.70822E-22
           CS-135            1.24874E-25
           I--129            8.44298E-24
           I--130            1.25771E-21
           I--131            9.61368E-17
           I--132            2.93036E-27
           I--133            1.66127E-17
```

```
          I--135              4.47097E-20
SOUR   N4072-001 5   MARK DRUCKER      SONGS UNITS 2,3   ss-c.si
fha-fhb.to  FHA in FHB - FHB Cloud Source Strengths
Activity at   24.00     hours for node  2 FHB AIR
   18   11    0    0    0    0     .96670E-10     .00000E+00     .00000E+00


          KR-83M              0.00000E+00
          KR--85              5.00392E-34
          KR-85M              0.00000E+00
          KR--87              0.00000E+00
          KR--88              0.00000E+00
          XE131M              2.14637E-35
          XE133M              1.59313E-34
          XE-133              2.50149E-33
          XE135M              0.00000E+00
          XE-135              1.21748E-35
          RB--88              0.00000E+00
          CS-135              0.00000E+00
          I--129              0.00000E+00
          I--130              0.00000E+00
          I--131              0.00000E+00
          I--132              0.00000E+00
          I--133              0.00000E+00
          I--135              0.00000E+00
SOUR   N4072-001 5   MARK DRUCKER      SONGS UNITS 2,3   ss-c.si
fha-fhb.to  FHA in FHB - FHB Cloud Source Strengths
Activity at   96.00     hours for node  2 FHB AIR
   18   11    0    0    0    0     .96670E-10     .00000E+00     .00000E+00


          KR-83M              0.00000E+00
          KR--85              0.00000E+00
          KR-85M              0.00000E+00
          KR--87              0.00000E+00
          KR--88              0.00000E+00
          XE131M              0.00000E+00
          XE133M              0.00000E+00
          XE-133              0.00000E+00
          XE135M              0.00000E+00
          XE-135              0.00000E+00
          RB--88              0.00000E+00
          CS-135              0.00000E+00
          I--129              0.00000E+00
          I--130              0.00000E+00
          I--131              0.00000E+00
          I--132              0.00000E+00
          I--133              4.92034E-35
          I--135              0.00000E+00
SOUR   N4072-001 5   MARK DRUCKER      SONGS UNITS 2,3   ss-c.si
fha-fhb.to  FHA in FHB - FHB Cloud Source Strengths
Activity at   720.0     hours for node  2 FHB AIR
   18   11    0    0    0   10     .96670E-10     .00000E+00     .00000E+00


          KR-83M              0.00000E+00
          KR--85              0.00000E+00
          KR-85M              0.00000E+00
          KR--87              0.00000E+00
```

KR--88	0.00000E+00
XE131M	0.00000E+00
XE133M	0.00000E+00
XE-133	0.00000E+00
XE135M	0.00000E+00
XE-135	0.00000E+00
RB--88	0.00000E+00
CS-135	0.00000E+00
I--129	0.00000E+00
I--130	0.00000E+00
I--131	0.00000E+00
I--132	0.00000E+00
I--133	0.00000E+00
I--135	0.00000E+00

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

9.3.1.2 Outside Cloud SOURCE2 Output File (ss-c.so)
NOTE: The following are relevant excerpts from the SOURCE2 Code output file.

```
NE602-SOURCE2(02-5) [ (C)1972,1991 BECHTEL. SCE AIX VERS.  OCT 95]
ORIGINATOR: MARK DRUCKER       DATE: 03/25/99     CALC:  N4072-001REV:  5
   PROJECT: SONGS UNITS 2,3     JOB: ss-c.si     CHECK:_______ DATE:__/__/__
   SUBJECT: fha-fhb.to  FHA in FHB - FHB Cloud Source Strengths  PAGE:       2

CASE TITLE: Activity at   .0000     hours for node  2 FHB AIR

                  ACTIVITY AS A FUNCTION OF DECAY TIME (CURIES/CC   )
                 ---------------------------------------------------
        ISOTOPE              .000 SEC
       -----------          -----------
         KR-83M             3.73146E-19
         KR--85             7.85927E-08
         KR-85M             8.27495E-12
         KR--87             1.03437E-23
         KR--88             4.27281E-14
         XE131M             1.94307E-08
         XE133M             6.51556E-08
         XE-133             2.85176E-06
         XE135M             2.78410E-10
         XE-135             3.74113E-08
         RB--88             0.00000E+00
         CS-135             0.00000E+00
         I--129             1.44232E-15
         I--130             3.76336E-13
         I--131             1.70236E-08
         I--132             1.03920E-17
         I--133             3.95380E-09
         I--135             2.17894E-11
       -----------          -----------
         TOTAL              3.07364E-06

NE602-SOURCE2(02-5) [ (C)1972,1991 BECHTEL. SCE AIX VERS.  OCT 95]
ORIGINATOR: MARK DRUCKER       DATE: 03/25/99     CALC:  N4072-001REV:  5
   PROJECT: SONGS UNITS 2,3     JOB: ss-c.si     CHECK:_______ DATE:__/__/__
   SUBJECT: fha-fhb.to  FHA in FHB - FHB Cloud Source Strengths  PAGE:       3

CASE TITLE: Activity at   .0000     hours for node  2 FHB AIR

            GAMMA SOURCE STRENGTH AS A FUCTION OF DECAY TIME (MEV/CC-SEC  )
           ---------------------------------------------------------------
      ENERGY GROUP              .000 SEC
      ------------             -----------
  .000 -  .100 MEV             3.16361E+03
  .100 -  .400 MEV             5.69883E+02
  .400 -  .900 MEV             1.58173E+02
  .900 - 1.350 MEV             8.93682E+00
 1.350 - 1.800 MEV             8.24909E-01
 1.800 - 2.200 MEV             3.18115E-02
 2.200 - 2.600 MEV             3.30328E-02
 2.600 - 3.000 MEV             4.58228E-15
 3.000 - 5.000 MEV             7.07075E-15
 5.000 -15.000 MEV             0.00000E+00
      ------------             -----------
        TOTAL                  3.90149E+03
```

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

NE602-SOURCE2(D2-5) [(C)1972,1991 BECHTEL. SCE AIX VERS. OCT 95]
ORIGINATOR: MARK DRUCKER DATE: 03/25/99 CALC: N4072-001REV: 5
PROJECT: SONGS UNITS 2,3 JOB: ss-c.si CHECK:_____ DATE:_/_/_
SUBJECT: fha-fhb.to FHA in FHB - FHB Cloud Source Strengths PAGE: 5

CASE TITLE: Activity at 2.7800E-03 hours for node 2 FHB AIR

ACTIVITY AS A FUNCTION OF DECAY TIME (CURIES/CC)

ISOTOPE	.000 SEC
KR-83M	3.68425E-19
KR--85	7.76800E-08
KR-85M	8.17534E-12
KR--87	1.02081E-23
KR--88	4.22035E-14
XE131M	1.92049E-08
XE133M	6.43966E-08
XE-133	2.81861E-06
XE135M	2.73176E-10
XE-135	3.69691E-08
RB--88	2.73576E-16
CS-135	2.75632E-21
I--129	1.42556E-15
I--130	3.71908E-13
I--131	1.68257E-08
I--132	1.02627E-17
I--133	3.90753E-09
I--135	2.15301E-11
TOTAL	3.03789E-06

NE602-SOURCE2(D2-5) [(C)1972,1991 BECHTEL. SCE AIX VERS. OCT 95]
ORIGINATOR: MARK DRUCKER DATE: 03/25/99 CALC: N4072-001REV: 5
PROJECT: SONGS UNITS 2,3 JOB: ss-c.si CHECK:_____ DATE:_/_/_
SUBJECT: fha-fhb.to FHA in FHB - FHB Cloud Source Strengths PAGE: 6

CASE TITLE: Activity at 2.7800E-03 hours for node 2 FHB AIR

GAMMA SOURCE STRENGTH AS A FUCTION OF DECAY TIME (MEV/CC-SEC)

ENERGY GROUP	.000 SEC
.000 - .100 MEV	3.12683E+03
.100 - .400 MEV	5.63195E+02
.400 - .900 MEV	1.56291E+02
.900 - 1.350 MEV	8.83208E+00
1.350 - 1.800 MEV	8.15167E-01
1.800 - 2.200 MEV	3.14367E-02
2.200 - 2.600 MEV	3.26392E-02
2.600 - 3.000 MEV	6.07878E-07
3.000 - 5.000 MEV	2.71304E-07
5.000 -15.000 MEV	0.00000E+00
TOTAL	3.85603E+03

NE602-SOURCE2(D2-5) [(C)1972,1991 BECHTEL. SCE AIX VERS. OCT 95]

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

ORIGINATOR: MARK DRUCKER DATE: 03/25/99 CALC: N4072-001REV: 5
PROJECT: SONGS UNITS 2,3 JOB: ss-c.si CHECK:_____ DATE:__/__/__
SUBJECT: fha-fhb.to FHA in FHB - FHB Cloud Source Strengths PAGE: 8

CASE TITLE: Activity at 5.0000E-02 hours for node 2 FHB AIR

ACTIVITY AS A FUNCTION OF DECAY TIME (CURIES/CC)

ISOTOPE	.000 SEC
KR-83M	2.96769E-19
KR--85	6.37009E-08
KR-85M	6.65533E-12
KR--87	8.15838E-24
KR--88	3.42149E-14
XE131M	1.57471E-08
XE133M	5.27752E-08
XE-133	2.31079E-06
XE135M	1.97926E-10
XE-135	3.02082E-08
RB--88	3.79937E-15
CS-135	4.05884E-20
I--129	1.16903E-15
I--130	3.04174E-13
I--131	1.37955E-08
I--132	8.29617E-18
I--133	3.19932E-09
I--135	1.75684E-11
TOTAL	2.49044E-06

NE602-SOURCE2(D2-5) [(C)1972,1991 BECHTEL. SCE AIX VERS. OCT 95]
ORIGINATOR: MARK DRUCKER DATE: 03/25/99 CALC: N4072-001REV: 5
PROJECT: SONGS UNITS 2,3 JOB: ss-c.si CHECK:_____ DATE:__/__/__
SUBJECT: fha-fhb.to FHA in FHB - FHB Cloud Source Strengths PAGE: 9

CASE TITLE: Activity at 5.0000E-02 hours for node 2 FHB AIR

GAMMA SOURCE STRENGTH AS A FUCTION OF DECAY TIME (MEV/CC-SEC)

ENERGY GROUP	.000 SEC
.000 - .100 MEV	2.56348E+03
.100 - .400 MEV	4.60884E+02
.400 - .900 MEV	1.27565E+02
.900 - 1.350 MEV	7.22940E+00
1.350 - 1.800 MEV	6.66200E-01
1.800 - 2.200 MEV	2.57017E-02
2.200 - 2.600 MEV	2.66255E-02
2.600 - 3.000 MEV	8.44209E-06
3.000 - 5.000 MEV	3.76781E-06
5.000 -15.000 MEV	0.00000E+00
TOTAL	3.15988E+03

NE602-SOURCE2(D2-5) [(C)1972,1991 BECHTEL. SCE AIX VERS. OCT 95]

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

ORIGINATOR: MARK DRUCKER DATE: 03/25/99 CALC: N4072-001REV: 5
PROJECT: SONGS UNITS 2,3 JOB: ss-c.si CHECK:_____ DATE:__/__/__
SUBJECT: fha-fhb.to FHA in FHB - FHB Cloud Source Strengths PAGE: 11

CASE TITLE: Activity at .1000 hours for node 2 FHB AIR

ACTIVITY AS A FUNCTION OF DECAY TIME (CURIES/CC)

ISOTOPE	.000 SEC
KR-83M	2.36026E-19
KR--85	5.16309E-08
KR-85M	5.35272E-12
KR--87	6.43475E-24
KR--88	2.73979E-14
XE131M	1.27617E-08
XE133M	4.27472E-08
XE-133	1.87244E-06
XE135M	1.40741E-10
XE-135	2.43920E-08
RB--88	5.78221E-15
CS-135	6.56726E-20
I--129	9.47519E-16
I--130	2.45849E-13
I--131	1.11795E-08
I--132	6.62301E-18
I--133	2.58882E-09
I--135	1.41652E-11
TOTAL	2.01790E-06

NE602-SOURCE2(D2-5) [(C)1972,1991 BECHTEL. SCE AIX VERS. OCT 95]
ORIGINATOR: MARK DRUCKER DATE: 03/25/99 CALC: N4072-001REV: 5
PROJECT: SONGS UNITS 2,3 JOB: ss-c.si CHECK:_____ DATE:__/__/__
SUBJECT: fha-fhb.to FHA in FHB - FHB Cloud Source Strengths PAGE: 12

CASE TITLE: Activity at .1000 hours for node 2 FHB AIR

GAMMA SOURCE STRENGTH AS A FUCTION OF DECAY TIME (MEV/CC-SEC)

ENERGY GROUP	.000 SEC
.000 - .100 MEV	2.07720E+03
.100 - .400 MEV	3.72734E+02
.400 - .900 MEV	1.02922E+02
.900 - 1.350 MEV	5.84821E+00
1.350 - 1.800 MEV	5.38030E-01
1.800 - 2.200 MEV	2.07602E-02
2.200 - 2.600 MEV	2.14611E-02
2.600 - 3.000 MEV	1.28479E-05
3.000 - 5.000 MEV	5.73418E-06
5.000 -15.000 MEV	0.00000E+00
TOTAL	2.55928E+03

NE602-SOURCE2(D2-5) [(C)1972,1991 BECHTEL. SCE AIX VERS. OCT 95]

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

ORIGINATOR: MARK DRUCKER DATE: 03/25/99 CALC: N4072-001REV: 5
PROJECT: SONGS UNITS 2,3 JOB: ss-c.si CHECK:_____ DATE:__/__/__
SUBJECT: fha-fhb.to FHA in FHB - FHB Cloud Source Strengths PAGE: 14

CASE TITLE: Activity at .2000 hours for node 2 FHB AIR

ACTIVITY AS A FUNCTION OF DECAY TIME (CURIES/CC)

ISOTOPE	.000 SEC
KR-83M	1.49292E-19
KR--85	3.39185E-08
KR-85M	3.46245E-12
KR--87	4.00303E-24
KR--88	1.75679E-14
XE131M	8.38169E-09
XE133M	2.80455E-08
XE-133	1.22943E-06
XE135M	7.12218E-11
XE-135	1.59033E-08
RB--88	6.71844E-15
CS-135	8.59918E-20
I--129	6.22465E-16
I--130	1.60607E-13
I--131	7.34165E-09
I--132	4.22095E-18
I--133	1.69508E-09
I--135	9.20862E-12
TOTAL	1.32480E-06

NE602-SOURCE2(D2-5) [(C)1972,1991 BECHTEL. SCE AIX VERS. OCT 95]
ORIGINATOR: MARK DRUCKER DATE: 03/25/99 CALC: N4072-001REV: 5
PROJECT: SONGS UNITS 2,3 JOB: ss-c.si CHECK:_____ DATE:__/__/__
SUBJECT: fha-fhb.to FHA in FHB - FHB Cloud Source Strengths PAGE: 15

CASE TITLE: Activity at .2000 hours for node 2 FHB AIR

GAMMA SOURCE STRENGTH AS A FUCTION OF DECAY TIME (MEV/CC-SEC)

ENERGY GROUP	.000 SEC
.000 - .100 MEV	1.36387E+03
.100 - .400 MEV	2.43790E+02
.400 - .900 MEV	6.70678E+01
.900 - 1.350 MEV	3.82706E+00
1.350 - 1.800 MEV	3.50922E-01
1.800 - 2.200 MEV	1.35360E-02
2.200 - 2.600 MEV	1.39431E-02
2.600 - 3.000 MEV	1.49282E-05
3.000 - 5.000 MEV	6.66264E-06
5.000 -15.000 MEV	0.00000E+00
TOTAL	1.67893E+03

NE602-SOURCE2(D2-5) [(C)1972,1991 BECHTEL. SCE AIX VERS. OCT 95]
ORIGINATOR: MARK DRUCKER DATE: 03/25/99 CALC: N4072-001REV: 5

E&TS DEPARTMENT

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Project or DCP/FCN/ECP _____ Calc. No. N-4072-001

CCN CONVERSION: CCN NO. CCN --

Subject Fuel Handling Accident Inside Fuel Handling Building - CR & Offsite Doses Sheet 197 of 261

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

PROJECT: SONGS UNITS 2,3 JOB: ss-c.si CHECK:_____ DATE:__/__/__
SUBJECT: fha-fhb.to FHA in FHB - FHB Cloud Source Strengths PAGE: 17

CASE TITLE: Activity at .5000 hours for node 2 FHB AIR

ACTIVITY AS A FUNCTION OF DECAY TIME (CURIES/CC)

ISOTOPE	.000 SEC
KR-83M	3.77813E-20
KR--85	9.61650E-09
KR-85M	9.37154E-13
KR--87	9.63736E-25
KR--88	4.63161E-15
XE131M	2.37463E-09
XE133M	7.92008E-09
XE-133	3.48004E-07
XE135M	9.32150E-12
XE-135	4.40742E-09
RB--88	3.38943E-15
CS-135	6.05474E-20
I--129	1.76481E-16
I--130	4.47755E-14
I--131	2.07926E-09
I--132	1.09263E-18
I--133	4.75829E-10
I--135	2.52999E-12
TOTAL	3.74891E-07

NE602-SOURCE2(D2-5) [(C)1972,1991 BECHTEL. SCE AIX VERS. OCT 95]
ORIGINATOR: MARK DRUCKER DATE: 03/25/99 CALC: N4072-001REV: 5
PROJECT: SONGS UNITS 2,3 JOB: ss-c.si CHECK:_____ DATE:__/__/__
SUBJECT: fha-fhb.to FHA in FHB - FHB Cloud Source Strengths PAGE: 18

CASE TITLE: Activity at .5000 hours for node 2 FHB AIR

GAMMA SOURCE STRENGTH AS A FUCTION OF DECAY TIME (MEV/CC-SEC)

ENERGY GROUP	.000 SEC
.000 - .100 MEV	3.86059E+02
.100 - .400 MEV	6.82160E+01
.400 - .900 MEV	1.86655E+01
.900 - 1.350 MEV	1.07250E+00
1.350 - 1.800 MEV	9.73778E-02
1.800 - 2.200 MEV	3.73856E-03
2.200 - 2.600 MEV	3.82389E-03
2.600 - 3.000 MEV	7.53122E-06
3.000 - 5.000 MEV	3.36128E-06
5.000 -15.000 MEV	0.00000E+00
TOTAL	4.74118E+02

NE602-SOURCE2(D2-5) [(C)1972,1991 BECHTEL. SCE AIX VERS. OCT 95]
ORIGINATOR: MARK DRUCKER DATE: 03/25/99 CALC: N4072-001REV: 5
PROJECT: SONGS UNITS 2,3 JOB: ss-c.si CHECK:_____ DATE:__/__/__

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇩
6	N. YACKLE		T. REMICK							

SUBJECT: fha-fhb.to FHA in FHB - FHB Cloud Source Strengths PAGE: 20

CASE TITLE: Activity at 1.000 hours for node 2 FHB AIR

ACTIVITY AS A FUNCTION OF DECAY TIME (CURIES/CC)

ISOTOPE	.000 SEC
KR-83M	3.82539E-21
KR--85	1.17667E-09
KR-85M	1.06134E-13
KR--87	8.97926E-26
KR--88	5.02054E-16
XE131M	2.90205E-10
XE133M	9.62736E-10
XE-133	4.24674E-08
XE135M	3.37640E-13
XE-135	5.19178E-10
RB--88	5.06494E-16
CS-135	1.46713E-20
I--129	2.15940E-17
I--130	5.32728E-15
I--131	2.53959E-10
I--132	1.14882E-19
I--133	5.72647E-11
I--135	2.93759E-13
TOTAL	4.57282E-08

NE602-SOURCE2(D2-5) [(C)1972,1991 BECHTEL. SCE AIX VERS. OCT 95]
ORIGINATOR: MARK DRUCKER DATE: 03/25/99 CALC: N4072-001REV: 5
PROJECT: SONGS UNITS 2,3 JOB: ss-c.si CHECK:_____ DATE:__/__/__
SUBJECT: fha-fhb.to FHA in FHB - FHB Cloud Source Strengths PAGE: 21

CASE TITLE: Activity at 1.000 hours for node 2 FHB AIR

GAMMA SOURCE STRENGTH AS A FUCTION OF DECAY TIME (MEV/CC-SEC)

ENERGY GROUP	.000 SEC
.000 - .100 MEV	4.71114E+01
.100 - .400 MEV	8.16759E+00
.400 - .900 MEV	2.23566E+00
.900 - 1.350 MEV	1.28722E-01
1.350 - 1.800 MEV	1.14988E-02
1.800 - 2.200 MEV	4.35148E-04
2.200 - 2.600 MEV	4.42733E-04
2.600 - 3.000 MEV	1.12541E-06
3.000 - 5.000 MEV	5.02287E-07
5.000 -15.000 MEV	0.00000E+00
TOTAL	5.76557E+01

NE602-SOURCE2(D2-5) [(C)1972,1991 BECHTEL. SCE AIX VERS. OCT 95]
ORIGINATOR: MARK DRUCKER DATE: 03/25/99 CALC: N4072-001REV: 5
PROJECT: SONGS UNITS 2,3 JOB: ss-c.si CHECK:_____ DATE:__/__/__
SUBJECT: fha-fhb.to FHA in FHB - FHB Cloud Source Strengths PAGE: 23

CASE TITLE: Activity at 2.000 hours for node 2 FHB AIR

ACTIVITY AS A FUNCTION OF DECAY TIME (CURIES/CC)

ISOTOPE	.000 SEC
KR-83M	3.92168E-23
KR--85	1.76166E-11
KR-85M	1.36128E-15
KR--87	7.79480E-28
KR--88	5.89911E-18
XE131M	4.33434E-12
XE133M	1.42254E-11
XE-133	6.32415E-10
XE135M	1.03974E-15
XE-135	7.20360E-12
RB--88	7.42768E-18
CS-135	4.39875E-22
I--129	3.23300E-19
I--130	7.54111E-17
I--131	3.78858E-12
I--132	1.26999E-21
I--133	8.29389E-13
I--135	3.96037E-15
TOTAL	6.80419E-10

NE602-SOURCE2(D2-5) [(C)1972,1991 BECHTEL. SCE AIX VERS. OCT 95]
ORIGINATOR: MARK DRUCKER DATE: 03/25/99 CALC: N4072-001REV: 5
PROJECT: SONGS UNITS 2,3 JOB: ss-c.si CHECK:_____ DATE:__/__/__
SUBJECT: fha-fhb.to FHA in FHB - FHB Cloud Source Strengths PAGE: 24

CASE TITLE: Activity at 2.000 hours for node 2 FHB AIR

GAMMA SOURCE STRENGTH AS A FUCTION OF DECAY TIME (MEV/CC-SEC)

ENERGY GROUP	.000 SEC
.000 - .100 MEV	7.01572E-01
.100 - .400 MEV	1.17192E-01
.400 - .900 MEV	3.23823E-02
.900 - 1.350 MEV	1.85471E-03
1.350 - 1.800 MEV	1.60494E-04
1.800 - 2.200 MEV	5.86019E-06
2.200 - 2.600 MEV	5.93804E-06
2.600 - 3.000 MEV	1.65041E-08
3.000 - 5.000 MEV	7.36598E-09
5.000 -15.000 MEV	0.00000E+00
TOTAL	8.53173E-01

NE602-SOURCE2(D2-5) [(C)1972,1991 BECHTEL. SCE AIX VERS. OCT 95]
ORIGINATOR: MARK DRUCKER DATE: 03/25/99 CALC: N4072-001REV: 5
PROJECT: SONGS UNITS 2,3 JOB: ss-c.si CHECK:_____ DATE:__/__/__
SUBJECT: fha-fhb.to FHA in FHB - FHB Cloud Source Strengths PAGE: 26

CASE TITLE: Activity at 4.000 hours for node 2 FHB AIR

ACTIVITY AS A FUNCTION OF DECAY TIME (CURIES/CC)

ISOTOPE	.000 SEC
KR-83M	4.12160E-27
KR--85	3.94876E-15
KR-85M	2.23938E-19
KR--87	5.87402E-32
KR--88	8.14439E-22
XE131M	9.66971E-16
XE133M	3.10617E-15
XE-133	1.40341E-13
XE135M	7.91954E-19
XE-135	1.38720E-15
RB--88	6.19574E-21
CS-135	3.99781E-25
I--129	7.24689E-23
I--130	1.51111E-20
I--131	8.43147E-16
I--132	1.55205E-25
I--133	1.73981E-16
I--135	7.19821E-19
TOTAL	1.50769E-13

NE602-SOURCE2(D2-5) [(C)1972,1991 BECHTEL. SCE AIX VERS. OCT 95]
ORIGINATOR: MARK DRUCKER DATE: 03/25/99 CALC: N4072-001REV: 5
PROJECT: SONGS UNITS 2,3 JOB: ss-c.si CHECK:_____ DATE:__/__/__
SUBJECT: fha-fhb.to FHA in FHB - FHB Cloud Source Strengths PAGE: 27

CASE TITLE: Activity at 4.000 hours for node 2 FHB AIR

GAMMA SOURCE STRENGTH AS A FUCTION OF DECAY TIME (MEV/CC-SEC)

ENERGY GROUP	.000 SEC
.000 - .100 MEV	1.55688E-04
.100 - .400 MEV	2.42211E-05
.400 - .900 MEV	6.84087E-06
.900 - 1.350 MEV	3.85423E-07
1.350 - 1.800 MEV	3.13905E-08
1.800 - 2.200 MEV	1.13308E-09
2.200 - 2.600 MEV	1.07027E-09
2.600 - 3.000 MEV	1.37667E-11
3.000 - 5.000 MEV	6.14427E-12
5.000 -15.000 MEV	0.00000E+00
TOTAL	1.87169E-04

NE602-SOURCE2(D2-5) [(C)1972,1991 BECHTEL. SCE AIX VERS. OCT 95]
ORIGINATOR: MARK DRUCKER DATE: 03/25/99 CALC: N4072-001REV: 5
PROJECT: SONGS UNITS 2,3 JOB: ss-c.si CHECK:_____ DATE:__/__/__
SUBJECT: fha-fhb.to FHA in FHB - FHB Cloud Source Strengths PAGE: 29

CASE TITLE: Activity at 6.000 hours for node 2 FHB AIR

ACTIVITY AS A FUNCTION OF DECAY TIME (CURIES/CC)

E&TS DEPARTMENT

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CCN CONVERSION: CCN NO. CCN --

Subject Fuel Handling Accident Inside Fuel Handling Building - CR & Offsite Doses Sheet 201 of 261

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

ISOTOPE	.000 SEC
KR-83M	4.33171E-31
KR--85	8.85114E-19
KR-85M	3.68392E-23
KR--87	4.42655E-36
KR--88	1.12443E-25
XE131M	2.15726E-19
XE133M	6.78243E-19
XE-133	3.11430E-17
XE135M	1.44608E-22
XE-135	2.67150E-19
RB--88	8.66177E-25
CS-135	1.47612E-28
I--129	1.62441E-26
I--130	3.02798E-24
I--131	1.87641E-19
I--132	1.89673E-29
I--133	3.64960E-20
I--135	1.30832E-22
TOTAL	3.34137E-17

NE602-SOURCE2(D2-5) [(C)1972,1991 BECHTEL. SCE AIX VERS. OCT 95]
ORIGINATOR: MARK DRUCKER DATE: 03/25/99 CALC: N4072-001REV: 5
PROJECT: SONGS UNITS 2,3 JOB: ss-c.si CHECK:_____ DATE:__/__/__
SUBJECT: fha-fhb.to FHA in FHB - FHB Cloud Source Strengths PAGE: 30

CASE TITLE: Activity at 6.000 hours for node 2 FHB AIR

GAMMA SOURCE STRENGTH AS A FUCTION OF DECAY TIME (MEV/CC-SEC)

ENERGY GROUP	.000 SEC
.000 - .100 MEV	3.45487E-08
.100 - .400 MEV	5.03106E-09
.400 - .900 MEV	1.44621E-09
.900 - 1.350 MEV	8.01868E-11
1.350 - 1.800 MEV	6.17041E-12
1.800 - 2.200 MEV	2.01430E-13
2.200 - 2.600 MEV	1.93264E-13
2.600 - 3.000 MEV	1.92462E-15
3.000 - 5.000 MEV	8.58982E-16
5.000 -15.000 MEV	0.00000E+00
TOTAL	4.11127E-08

NE602-SOURCE2(D2-5) [(C)1972,1991 BECHTEL. SCE AIX VERS. OCT 95]
ORIGINATOR: MARK DRUCKER DATE: 03/25/99 CALC: N4072-001REV: 5
PROJECT: SONGS UNITS 2,3 JOB: ss-c.si CHECK:_____ DATE:__/__/__
SUBJECT: fha-fhb.to FHA in FHB - FHB Cloud Source Strengths PAGE: 32

CASE TITLE: Activity at 8.000 hours for node 2 FHB AIR

ACTIVITY AS A FUNCTION OF DECAY TIME (CURIES/CC)

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

ISOTOPE	.000 SEC
KR-83M	4.55253E-35
KR--85	1.98399E-22
KR-85M	6.06027E-27
KR--87	3.33575E-40
KR--88	1.55240E-29
XE131M	4.81275E-23
XE133M	1.48096E-22
XE-133	6.91080E-21
XE135M	2.62842E-26
XE-135	5.14471E-23
RB--88	1.19608E-28
CS-135	4.42578E-32
I--129	3.64118E-30
I--130	6.06755E-28
I--131	4.17595E-23
I--132	2.31798E-33
I--133	7.65576E-24
I--135	2.37796E-26
TOTAL	7.40634E-21

NE602-SOURCE2(D2-5) [(C)1972,1991 BECHTEL. SCE AIX VERS. OCT 95]
ORIGINATOR: MARK DRUCKER DATE: 03/25/99 CALC: N4072-001REV: 5
PROJECT: SONGS UNITS 2,3 JOB: ss-c.si CHECK:_____ DATE:__/__/__
SUBJECT: fha-fhb.to FHA in FHB - FHB Cloud Source Strengths PAGE: 33

CASE TITLE: Activity at 8.000 hours for node 2 FHB AIR

GAMMA SOURCE STRENGTH AS A FUCTION OF DECAY TIME (MEV/CC-SEC)

ENERGY GROUP	.000 SEC
.000 - .100 MEV	7.66655E-12
.100 - .400 MEV	1.05016E-12
.400 - .900 MEV	3.06427E-13
.900 - 1.350 MEV	1.66998E-14
1.350 - 1.800 MEV	1.21908E-15
1.800 - 2.200 MEV	3.59587E-17
2.200 - 2.600 MEV	3.49521E-17
2.600 - 3.000 MEV	2.65765E-19
3.000 - 5.000 MEV	1.18614E-19
5.000 -15.000 MEV	0.00000E+00
TOTAL	9.04113E-12

NE602-SOURCE2(D2-5) [(C)1972,1991 BECHTEL. SCE AIX VERS. OCT 95]
ORIGINATOR: MARK DRUCKER DATE: 03/25/99 CALC: N4072-001REV: 5
PROJECT: SONGS UNITS 2,3 JOB: ss-c.si CHECK:_____ DATE:__/__/__
SUBJECT: fha-fhb.to FHA in FHB - FHB Cloud Source Strengths PAGE: 35

CASE TITLE: Activity at 10.00 hours for node 2 FHB AIR

ACTIVITY AS A FUNCTION OF DECAY TIME (CURIES/CC)

ISOTOPE	.000 SEC

KR-83M	4.78460E-39
KR--85	4.44711E-26
KR-85M	9.96948E-31
KR--87	0.00000E+00
KR--88	2.14326E-33
XE131M	1.07369E-26
XE133M	3.23367E-26
XE-133	1.53351E-24
XE135M	4.77732E-30
XE-135	9.90732E-27
RB--88	1.65134E-32
CS-135	1.20716E-35
I--129	8.16183E-34
I--130	1.21583E-31
I--131	9.29354E-27
I--132	2.83278E-37
I--133	1.60595E-27
I--135	4.32209E-30
TOTAL	1.64188E-24

NE602-SOURCE2(D2-5) [(C)1972,1991 BECHTEL. SCE AIX VERS. OCT 95]
ORIGINATOR: MARK DRUCKER DATE: 03/25/99 CALC: N4072-001REV: 5
PROJECT: SONGS UNITS 2,3 JOB: ss-c.si CHECK:_____ DATE:__/__/__
SUBJECT: fha-fhb.to FHA in FHB - FHB Cloud Source Strengths PAGE: 36

CASE TITLE: Activity at 10.00 hours for node 2 FHB AIR

GAMMA SOURCE STRENGTH AS A FUCTION OF DECAY TIME (MEV/CC-SEC)

ENERGY GROUP	.000 SEC
.000 - .100 MEV	1.70122E-15
.100 - .400 MEV	2.20261E-16
.400 - .900 MEV	6.50678E-17
.900 - 1.350 MEV	3.48103E-18
1.350 - 1.800 MEV	2.42049E-19
1.800 - 2.200 MEV	6.44561E-21
2.200 - 2.600 MEV	6.32863E-21
2.600 - 3.000 MEV	3.66922E-23
3.000 - 5.000 MEV	1.63762E-23
5.000 -15.000 MEV	0.00000E+00
TOTAL	1.99028E-15

NE602-SOURCE2(D2-5) [(C)1972,1991 BECHTEL. SCE AIX VERS. OCT 95]
ORIGINATOR: MARK DRUCKER DATE: 03/25/99 CALC: N4072-001REV: 5
PROJECT: SONGS UNITS 2,3 JOB: ss-c.si CHECK:_____ DATE:__/__/__
SUBJECT: fha-fhb.to FHA in FHB - FHB Cloud Source Strengths PAGE: 38

CASE TITLE: Activity at 24.00 hours for node 2 FHB AIR

ACTIVITY AS A FUNCTION OF DECAY TIME (CURIES/CC)

ISOTOPE	.000 SEC

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

KR-83M	0.00000E+00
KR--85	4.90454E-44
KR-85M	0.00000E+00
KR--87	0.00000E+00
KR--88	0.00000E+00
XE131M	1.40130E-45
XE133M	1.54143E-44
XE-133	2.42425E-43
XE135M	0.00000E+00
XE-135	1.40130E-45
RB--88	0.00000E+00
CS-135	0.00000E+00
I--129	0.00000E+00
I--130	0.00000E+00
I--131	0.00000E+00
I--132	0.00000E+00
I--133	0.00000E+00
I--135	0.00000E+00
TOTAL	3.09687E-43

NE602-SOURCE2(D2-5) [(C)1972,1991 BECHTEL. SCE AIX VERS. OCT 95]
ORIGINATOR: MARK DRUCKER DATE: 03/25/99 CALC: N4072-001REV: 5
PROJECT: SONGS UNITS 2,3 JOB: ss-c.si CHECK:_____ DATE:__/__/__
SUBJECT: fha-fhb.to FHA in FHB - FHB Cloud Source Strengths PAGE: 39

CASE TITLE: Activity at 24.00 hours for node 2 FHB AIR

GAMMA SOURCE STRENGTH AS A FUCTION OF DECAY TIME (MEV/CC-SEC)

ENERGY GROUP	.000 SEC
.000 - .100 MEV	2.68822E-34
.100 - .400 MEV	2.51869E-35
.400 - .900 MEV	5.11502E-36
.900 - 1.350 MEV	2.2308BE-39
1.350 - 1.800 MEV	0.00000E+00
1.800 - 2.200 MEV	0.00000E+00
2.200 - 2.600 MEV	0.00000E+00
2.600 - 3.000 MEV	0.00000E+00
3.000 - 5.000 MEV	0.00000E+00
5.000 -15.000 MEV	0.00000E+00
TOTAL	2.99126E-34

NE602-SOURCE2(D2-5) [(C)1972,1991 BECHTEL. SCE AIX VERS. OCT 95]
ORIGINATOR: MARK DRUCKER DATE: 03/25/99 CALC: N4072-001REV: 5
PROJECT: SONGS UNITS 2,3 JOB: ss-c.si CHECK:_____ DATE:__/__/__
SUBJECT: fha-fhb.to FHA in FHB - FHB Cloud Source Strengths PAGE: 41

CASE TITLE: Activity at 96.00 . hours for node 2 FHB AIR

ACTIVITY AS A FUNCTION OF DECAY TIME (CURIES/CC)

ISOTOPE	.000 SEC
KR-83M	0.00000E+00

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

KR--85	0.00000E+00
KR-85M	0.00000E+00
KR--87	0.00000E+00
KR--88	0.00000E+00
XE131M	0.00000E+00
XE133M	0.00000E+00
XE-133	0.00000E+00
XE135M	0.00000E+00
XE-135	0.00000E+00
RB--88	0.00000E+00
CS-135	0.00000E+00
I--129	0.00000E+00
I--130	0.00000E+00
I--131	0.00000E+00
I--132	0.00000E+00
I--133	4.20390E-45
I--135	0.00000E+00
TOTAL	4.20390E-45

NE602-SOURCE2(D2-5) [(C)1972,1991 BECHTEL. SCE AIX VERS. OCT 95]
ORIGINATOR: MARK DRUCKER DATE: 03/25/99 CALC: N4072-001REV: 5
PROJECT: SONGS UNITS 2,3 JOB: ss-c.si CHECK:_____ DATE:_/_/__
SUBJECT: fha-fhb.to FHA in FHB - FHB Cloud Source Strengths PAGE: 42

CASE TITLE: Activity at 96.00 hours for node 2 FHB AIR

GAMMA SOURCE STRENGTH AS A FUCTION OF DECAY TIME (MEV/CC-SEC)

ENERGY GROUP	.000 SEC
.000 - .100 MEV	0.00000E+00
.100 - .400 MEV	4.19893E-37
.400 - .900 MEV	8.45183E-35
.900 - 1.350 MEV	8.71865E-36
1.350 - 1.800 MEV	4.01428E-37
1.800 - 2.200 MEV	0.00000E+00
2.200 - 2.600 MEV	0.00000E+00
2.600 - 3.000 MEV	0.00000E+00
3.000 - 5.000 MEV	0.00000E+00
5.000 -15.000 MEV	0.00000E+00
TOTAL	9.40583E-35

NE602-SOURCE2(D2-5) [(C)1972,1991 BECHTEL. SCE AIX VERS. OCT 95]
ORIGINATOR: MARK DRUCKER DATE: 03/25/99 CALC: N4072-001REV: 5
PROJECT: SONGS UNITS 2,3 JOB: ss-c.si CHECK:_____ DATE:_/_/__
SUBJECT: fha-fhb.to FHA in FHB - FHB Cloud Source Strengths PAGE: 44

CASE TITLE: Activity at 720.0 hours for node 2 FHB AIR

ACTIVITY AS A FUNCTION OF DECAY TIME (CURIES/CC)

ISOTOPE	.000 SEC
KR-83M	0.00000E+00
KR--85	0.00000E+00

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

KR-85M	0.00000E+00
KR--87	0.00000E+00
KR--88	0.00000E+00
XE131M	0.00000E+00
XE133M	0.00000E+00
XE-133	0.00000E+00
XE135M	0.00000E+00
XE-135	0.00000E+00
RB--88	0.00000E+00
CS-135	0.00000E+00
I--129	0.00000E+00
I--130	0.00000E+00
I--131	0.00000E+00
I--132	0.00000E+00
I--133	0.00000E+00
I--135	0.00000E+00
TOTAL	0.00000E+00

NE602-SOURCE2(02-5) [(C)1972,1991 BECHTEL. SCE AIX VERS. OCT 95]
ORIGINATOR: MARK DRUCKER DATE: 03/25/99 CALC: N4072-001REV: 5
PROJECT: SONGS UNITS 2,3 JOB: ss-c.si CHECK:_____ DATE:__/__/__
SUBJECT: fha-fhb.to FHA in FHB - FHB Cloud Source Strengths PAGE: 45

CASE TITLE: Activity at 720.0 hours for node 2 FHB AIR

GAMMA SOURCE STRENGTH AS A FUCTION OF DECAY TIME (MEV/CC-SEC)

ENERGY GROUP	.000 SEC
.000 - .100 MEV	0.00000E+00
.100 - .400 MEV	0.00000E+00
.400 - .900 MEV	0.00000E+00
.900 - 1.350 MEV	0.00000E+00
1.350 - 1.800 MEV	0.00000E+00
1.800 - 2.200 MEV	0.00000E+00
2.200 - 2.600 MEV	0.00000E+00
2.600 - 3.000 MEV	0.00000E+00
3.000 - 5.000 MEV	0.00000E+00
5.000 -15.000 MEV	0.00000E+00
TOTAL	0.00000E+00

9.3.2 Control Room HVAC Intake Filter Shine Files

9.3.2.1 Control Room HVAC Intake Filter Shine SOURCE2 Input File (ss-f.si)

```
SOUR  N4072-001 5   MARK DRUCKER      SONGS UNITS 2,3   ss-f.si
fha-fhb.to  FHA in FHB - CR Filter Source Strengths
Activity at   .0000     hours for node  3    A206/7
   18   11    0    0    0    0     .48240E-05     .00000E+00     .00000E+00
```

KR-83M	0.00000E+00
KR--85	0.00000E+00
KR-85M	0.00000E+00
KR--87	0.00000E+00
KR--88	0.00000E+00

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

```
           XE131M              0.00000E+00
           XE133M              0.00000E+00
           XE-133              0.00000E+00
           XE135M              0.00000E+00
           XE-135              0.00000E+00
           RB--88              0.00000E+00
           CS-135              0.00000E+00
           I--129              0.00000E+00
           I--130              0.00000E+00
           I--131              0.00000E+00
           I--132              0.00000E+00
           I--133              0.00000E+00
           I--135              0.00000E+00
SOUR   N4072-001 5   MARK DRUCKER      SONGS UNITS 2,3   ss-f.si
fha-fhb.to  FHA in FHB - CR Filter Source Strengths
Activity at  2.7800E-03 hours for node  3    A206/7
   18   11    0    0    0    0     .48240E-05      .00000E+00      .00000E+00


           KR-83M              0.00000E+00
           KR--85              0.00000E+00
           KR-85M              0.00000E+00
           KR--87              0.00000E+00
           KR--88              0.00000E+00
           XE131M              0.00000E+00
           XE133M              0.00000E+00
           XE-133              0.00000E+00
           XE135M              0.00000E+00
           XE-135              0.00000E+00
           RB--88              0.00000E+00
           CS-135              0.00000E+00
           I--129              0.00000E+00
           I--130              1.30099E-35
           I--131              4.79993E-29
           I--132              0.00000E+00
           I--133              3.04749E-31
           I--135              5.49256E-34
SOUR   N4072-001 5   MARK DRUCKER      SONGS UNITS 2,3   ss-f.si
fha-fhb.to  FHA in FHB - CR Filter Source Strengths
Activity at  5.0000E-02 hours for node  3    A206/7
   18   11    0    0    0    0     .48240E-05      .00000E+00      .00000E+00


           KR-83M              0.00000E+00
           KR--85              0.00000E+00
           KR-85M              0.00000E+00
           KR--87              0.00000E+00
           KR--88              0.00000E+00
           XE131M              0.00000E+00
           XE133M              0.00000E+00
           XE-133              0.00000E+00
           XE135M              0.00000E+00
           XE-135              0.00000E+00
           RB--88              0.00000E+00
           CS-135              3.99212E-17
           I--129              3.71101E-23
           I--130              2.52473E-34
           I--131              8.00363E-28
           I--132              0.00000E+00
```

```
          I--133            1.91641E-29
          I--135            7.97659E-33
SOUR   N4072-001 5   MARK DRUCKER      SONGS UNITS 2,3   ss-f.si
fha-fhb.to  FHA in FHB - CR Filter Source Strengths
Activity at   .1000     hours for node  3    A206/7
   18   11    0    0    0    0     .48240E-05     .00000E+00     .00000E+00


          KR-83M            0.00000E+00
          KR--85            0.00000E+00
          KR-85M            0.00000E+00
          KR--87            0.00000E+00
          KR--88            0.00000E+00
          XE131M            0.00000E+00
          XE133M            0.00000E+00
          XE-133            0.00000E+00
          XE135M            0.00000E+00
          XE-135            0.00000E+00
          RB--88            3.23845E-08
          CS-135            3.76964E-13
          I--129            7.34501E-09
          I--130            1.90578E-06
          I--131            8.66617E-02
          I--132            5.13405E-11
          I--133            2.00681E-02
          I--135            1.09806E-04
SOUR   N4072-001 5   MARK DRUCKER      SONGS UNITS 2,3   ss-f.si
fha-fhb.to  FHA in FHB - CR Filter Source Strengths
Activity at   .2000     hours for node  3    A206/7
   18   11    0    0    0    0     .48240E-05     .00000E+00     .00000E+00


          KR-83M            0.00000E+00
          KR--85            0.00000E+00
          KR-85M            0.00000E+00
          KR--87            0.00000E+00
          KR--88            0.00000E+00
          XE131M            0.00000E+00
          XE133M            0.00000E+00
          XE-133            0.00000E+00
          XE135M            0.00000E+00
          XE-135            0.00000E+00
          RB--88            1.06321E-07
          CS-135            1.46762E-12
          I--129            1.81235E-08
          I--130            4.67617E-06
          I--131            2.13758E-01
          I--132            1.22896E-10
          I--133            4.93534E-02
          I--135            2.68116E-04
SOUR   N4072-001 5   MARK DRUCKER      SONGS UNITS 2,3   ss-f.si
fha-fhb.to  FHA in FHB - CR Filter Source Strengths
Activity at   .5000     hours for node  3    A206/7
   18   11    0    0    0    0     .48240E-05     .00000E+00     .00000E+00


          KR-83M            0.00000E+00
          KR--85            0.00000E+00
          KR-85M            0.00000E+00
```

```
          KR--87              0.00000E+00
          KR--88              0.00000E+00
          XE131M              0.00000E+00
          XE133M              0.00000E+00
          XE-133              0.00000E+00
          XE135M              0.00000E+00
          XE-135              0.00000E+00
          RB--88              2.01740E-07
          CS-135              4.70112E-12
          I--129              3.29121E-08
          I--130              8.35024E-06
          I--131              3.87762E-01
          I--132              2.03767E-10
          I--133              8.87379E-02
          I--135              4.71820E-04
 SOUR   N4072-001 5   MARK DRUCKER      SONGS UNITS 2,3   ss-f.si
 fha-fhb.to  FHA in FHB - CR Filter Source Strengths
 Activity at   1.000     hours for node  3    A206/7
    18   11    0    0    0    0     .48240E-05     .00000E+00     .00000E+00


          KR-83M              0.00000E+00
          KR--85              0.00000E+00
          KR-85M              0.00000E+00
          KR--87              0.00000E+00
          KR--88              0.00000E+00
          XE131M              0.00000E+00
          XE133M              0.00000E+00
          XE-133              0.00000E+00
          XE135M              0.00000E+00
          XE-135              0.00000E+00
          RB--88              1.15733E-07
          CS-135              7.03066E-12
          I--129              3.80480E-08
          I--130              9.38651E-06
          I--131              4.47468E-01
          I--132              2.02418E-10
          I--133              1.00899E-01
          I--135              5.17594E-04
 SOUR   N4072-001 5   MARK DRUCKER      SONGS UNITS 2,3   ss-f.si
 fha-fhb.to  FHA in FHB - CR Filter Source Strengths
 Activity at   2.000     hours for node  3    A206/7
    18   11    0    0    0    0     .48240E-05     .00000E+00     .00000E+00


          KR-83M              0.00000E+00
          KR--85              0.00000E+00
          KR-85M              0.00000E+00
          KR--87              0.00000E+00
          KR--88              0.00000E+00
          XE131M              0.00000E+00
          XE133M              0.00000E+00
          XE-133              0.00000E+00
          XE135M              0.00000E+00
          XE-135              0.00000E+00
          RB--88              1.41910E-08
          CS-135              7.60899E-12
          I--129              3.87533E-08
          I--130              9.03937E-06
```

```
          I--131              4.54130E-01
          I--132              1.52232E-10
          I--133              9.94171E-02
          I--135              4.74720E-04
SOUR   N4072-001 5   MARK DRUCKER      SONGS UNITS 2,3   ss-f.si
fha-fhb.to  FHA in FHB - CR Filter Source Strengths
Activity at   4.000     hours for node  3    A206/7
   18   11    0    0    0    0     .48240E-05     .00000E+00     .00000E+00

          KR-83M              0.00000E+00
          KR--85              0.00000E+00
          KR-85M              0.00000E+00
          KR--87              0.00000E+00
          KR--88              0.00000E+00
          XE131M              0.00000E+00
          XE133M              0.00000E+00
          XE-133              0.00000E+00
          XE135M              0.00000E+00
          XE-135              0.00000E+00
          RB--88              1.38398E-10
          CS-135              7.62506E-12
          I--129              3.87640E-08
          I--130              8.08299E-06
          I--131              4.51004E-01
          I--132              8.30199E-11
          I--133              9.30634E-02
          I--135              3.85037E-04
SOUR   N4072-001 5   MARK DRUCKER      SONGS UNITS 2,3   ss-f.si
fha-fhb.to  FHA in FHB - CR Filter Source Strengths
Activity at   6.000     hours for node  3    A206/7
   18   11    0    0    0    0     .48240E-05     .00000E+00     .00000E+00

          KR-83M              0.00000E+00
          KR--85              0.00000E+00
          KR-85M              0.00000E+00
          KR--87              0.00000E+00
          KR--88              0.00000E+00
          XE131M              0.00000E+00
          XE133M              0.00000E+00
          XE-133              0.00000E+00
          XE135M              0.00000E+00
          XE-135              0.00000E+00
          RB--88              1.29037E-12
          CS-135              7.62507E-12
          I--129              3.87640E-08
          I--130              7.22580E-06
          I--131              4.47776E-01
          I--132              4.52626E-11
          I--133              8.70918E-02
          I--135              3.12210E-04
SOUR   N4072-001 5   MARK DRUCKER      SONGS UNITS 2,3   ss-f.si
fha-fhb.to  FHA in FHB - CR Filter Source Strengths
Activity at   8.000     hours for node  3    A206/7
   18   11    0    0    0    0     .48240E-05     .00000E+00     .00000E+00

          KR-83M              0.00000E+00
```

```
          KR--85              0.00000E+00
          KR-85M              0.00000E+00
          KR--87              0.00000E+00
          KR--88              0.00000E+00
          XE131M              0.00000E+00
          XE133M              0.00000E+00
          XE-133              0.00000E+00
          XE135M              0.00000E+00
          XE-135              0.00000E+00
          RB--88              1.20082E-14
          CS-135              7.62507E-12
          I--129              3.87640E-08
          I--130              6.45951E-06
          I--131              4.44571E-01
          I--132              2.46772E-11
          I--133              8.15033E-02
          I--135              2.53157E-04
SOUR   N4072-001 5   MARK DRUCKER      SONGS UNITS 2,3   ss-f.si
fha-fhb.to  FHA in FHB - CR Filter Source Strengths
Activity at   10.00     hours for node  3    A206/7
   18   11    0    0    0    0     .48240E-05     .00000E+00     .00000E+00


          KR-83M              0.00000E+00
          KR--85              0.00000E+00
          KR-85M              0.00000E+00
          KR--87              0.00000E+00
          KR--88              0.00000E+00
          XE131M              0.00000E+00
          XE133M              0.00000E+00
          XE-133              0.00000E+00
          XE135M              0.00000E+00
          XE-135              0.00000E+00
          RB--88              1.11746E-16
          CS-135              7.62507E-12
          I--129              3.87640E-08
          I--130              5.77449E-06
          I--131              4.41390E-01
          I--132              1.34541E-11
          I--133              7.62734E-02
          I--135              2.05274E-04
SOUR   N4072-001 5   MARK DRUCKER      SONGS UNITS 2,3   ss-f.si
fha-fhb.to  FHA in FHB - CR Filter Source Strengths
Activity at   24.00     hours for node  3    A206/7
   18   11    0    0    0    0     .48240E-05     .00000E+00     .00000E+00


          KR-83M              0.00000E+00
          KR--85              0.00000E+00
          KR-85M              0.00000E+00
          KR--87              0.00000E+00
          KR--88              0.00000E+00
          XE131M              0.00000E+00
          XE133M              0.00000E+00
          XE-133              0.00000E+00
          XE135M              0.00000E+00
          XE-135              0.00000E+00
          RB--88              6.75306E-31
          CS-135              7.62507E-12
```

```
          I--129              3.87640E-08
          I--130              2.63458E-06
          I--131              4.19746E-01
          I--132              1.92643E-13
          I--133              4.79467E-02
          I--135              4.73089E-05
SOUR   N4072-001 5   MARK DRUCKER      SONGS UNITS 2,3   ss-f.si
fha-fhb.to  FHA in FHB - CR Filter Source Strengths
Activity at   96.00     hours for node  3    A206/7
   18   11    0    0    0    0     .48240E-05     .00000E+00     .00000E+00


          KR-83M              0.00000E+00
          KR--85              0.00000E+00
          KR-85M              0.00000E+00
          KR--87              0.00000E+00
          KR--88              0.00000E+00
          XE131M              0.00000E+00
          XE133M              0.00000E+00
          XE-133              0.00000E+00
          XE135M              0.00000E+00
          XE-135              0.00000E+00
          RB--88              0.00000E+00
          CS-135              7.62507E-12
          I--129              3.87640E-08
          I--130              4.65596E-08
          I--131              3.24106E-01
          I--132              6.32125E-23
          I--133              4.40437E-03
          I--135              2.49419E-08
SOUR   N4072-001 5   MARK DRUCKER      SONGS UNITS 2,3   ss-f.si
fha-fhb.to  FHA in FHB - CR Filter Source Strengths
Activity at   720.0     hours for node  3    A206/7
   18   11    0    0    0   10     .48240E-05     .00000E+00     .00000E+00


          KR-83M              0.00000E+00
          KR--85              0.00000E+00
          KR-85M              0.00000E+00
          KR--87              0.00000E+00
          KR--88              0.00000E+00
          XE131M              0.00000E+00
          XE133M              0.00000E+00
          XE-133              0.00000E+00
          XE135M              0.00000E+00
          XE-135              0.00000E+00
          RB--88              0.00000E+00
          CS-135              7.62508E-12
          I--129              3.87640E-08
          I--130              3.00560E-23
          I--131              3.44691E-02
          I--132              0.00000E+00
          I--133              4.54611E-12
          I--135              0.00000E+00
```

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

9.3.2.2 Control Room HVAC Intake Filter Shine SOURCE2 Output File (ss-f.so)
NOTE: *The following are relevant excerpts from the SOURCE2 Code output file.*

```
NE602-SOURCE2(D2-5) [ (C)1972,1991 BECHTEL. SCE AIX VERS.  OCT 95]
ORIGINATOR: MARK DRUCKER       DATE: 03/25/99     CALC:  N4072-001REV:  5
   PROJECT: SONGS UNITS 2,3     JOB: ss-f.si     CHECK:_______ DATE:__/__/__
   SUBJECT: fha-fhb.to  FHA in FHB - CR Filter Source Strengths  PAGE:       2

CASE TITLE: Activity at   .0000     hours for node  3    A206/7

                  ACTIVITY AS A FUNCTION OF DECAY TIME (CURIES/CC   )
                  ---------------------------------------------------

       ISOTOPE              .000 SEC
     ------------         -----------
        KR-83M            0.00000E+00
        KR--85            0.00000E+00
        KR-85M            0.00000E+00
        KR--87            0.00000E+00
        KR--88            0.00000E+00
        XE131M            0.00000E+00
        XE133M            0.00000E+00
        XE-133            0.00000E+00
        XE135M            0.00000E+00
        XE-135            0.00000E+00
        RB--88            0.00000E+00
        CS-135            0.00000E+00
        I--129            0.00000E+00
        I--130            0.00000E+00
        I--131            0.00000E+00
        I--132            0.00000E+00
        I--133            0.00000E+00
        I--135            0.00000E+00
     ------------         -----------
        TOTAL             0.00000E+00

NE602-SOURCE2(D2-5) [ (C)1972,1991 BECHTEL. SCE AIX VERS.  OCT 95]
ORIGINATOR: MARK DRUCKER       DATE: 03/25/99     CALC:  N4072-001REV:  5
   PROJECT: SONGS UNITS 2,3     JOB: ss-f.si     CHECK:_______ DATE:__/__/__
   SUBJECT: fha-fhb.to  FHA in FHB - CR Filter Source Strengths  PAGE:       3

CASE TITLE: Activity at   .0000     hours for node  3    A206/7

            GAMMA SOURCE STRENGTH AS A FUCTION OF DECAY TIME (MEV/CC-SEC  )
            ---------------------------------------------------------------

     ENERGY GROUP            .000 SEC
     ------------          -----------
  .000 -  .100 MEV         0.00000E+00
  .100 -  .400 MEV         0.00000E+00
  .400 -  .900 MEV         0.00000E+00
  .900 - 1.350 MEV         0.00000E+00
 1.350 - 1.800 MEV         0.00000E+00
 1.800 - 2.200 MEV         0.00000E+00
 2.200 - 2.600 MEV         0.00000E+00
 2.600 - 3.000 MEV         0.00000E+00
 3.000 - 5.000 MEV         0.00000E+00
 5.000 -15.000 MEV         0.00000E+00
     ------------          -----------
        TOTAL              0.00000E+00
```

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

NE602-SOURCE2(D2-5) [(C)1972,1991 BECHTEL. SCE AIX VERS. OCT 95]
ORIGINATOR: MARK DRUCKER DATE: 03/25/99 CALC: N4072-001REV: 5
PROJECT: SONGS UNITS 2,3 JOB: ss-f.si CHECK:_____ DATE:_/_/_
SUBJECT: fha-fhb.to FHA in FHB - CR Filter Source Strengths PAGE: 5

CASE TITLE: Activity at 2.7800E-03 hours for node 3 A206/7

ACTIVITY AS A FUNCTION OF DECAY TIME (CURIES/CC)

ISOTOPE	.000 SEC
KR-83M	0.00000E+00
KR--85	0.00000E+00
KR-85M	0.00000E+00
KR--87	0.00000E+00
KR--88	0.00000E+00
XE131M	0.00000E+00
XE133M	0.00000E+00
XE-133	0.00000E+00
XE135M	0.00000E+00
XE-135	0.00000E+00
RB--88	0.00000E+00
CS-135	0.00000E+00
I--129	0.00000E+00
I--130	6.27600E-41
I--131	2.31549E-34
I--132	0.00000E+00
I--133	1.47011E-36
I--135	2.64961E-39
TOTAL	2.33021E-34

NE602-SOURCE2(D2-5) [(C)1972,1991 BECHTEL. SCE AIX VERS. OCT 95]
ORIGINATOR: MARK DRUCKER DATE: 03/25/99 CALC: N4072-001REV: 5
PROJECT: SONGS UNITS 2,3 JOB: ss-f.si CHECK:_____ DATE:_/_/_
SUBJECT: fha-fhb.to FHA in FHB - CR Filter Source Strengths PAGE: 6

CASE TITLE: Activity at 2.7800E-03 hours for node 3 A206/7

GAMMA SOURCE STRENGTH AS A FUCTION OF DECAY TIME (MEV/CC-SEC)

ENERGY GROUP	.000 SEC
.000 - .100 MEV	1.79202E-26
.100 - .400 MEV	2.69232E-24
.400 - .900 MEV	5.65717E-25
.900 - 1.350 MEV	3.13137E-27
1.350 - 1.800 MEV	1.94733E-28
1.800 - 2.200 MEV	3.77684E-30
2.200 - 2.600 MEV	3.83295E-30
2.600 - 3.000 MEV	0.00000E+00
3.000 - 5.000 MEV	0.00000E+00
5.000 -15.000 MEV	0.00000E+00
TOTAL	3.27929E-24

NE602-SOURCE2(D2-5) [(C)1972,1991 BECHTEL. SCE AIX VERS. OCT 95]

E&TS DEPARTMENT

CALCULATION SHEET

ICCN NO./ PRELIM. CCN NO.	PAGE ___ OF ___

Project or DCP/FCN/ECP _____ Calc. No. N-4072-001

CCN CONVERSION: CCN NO. CCN --

Subject Fuel Handling Accident Inside Fuel Handling Building - CR & Offsite Doses Sheet 215 of 261

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

ORIGINATOR: MARK DRUCKER DATE: 03/25/99 CALC: N4072-001REV: 5
PROJECT: SONGS UNITS 2,3 JOB: ss-f.si CHECK:_____ DATE:__/__/__
SUBJECT: fha-fhb.to FHA in FHB - CR Filter Source Strengths PAGE: 8

CASE TITLE: Activity at 5.0000E-02 hours for node 3 A206/7

ACTIVITY AS A FUNCTION OF DECAY TIME (CURIES/CC)

ISOTOPE	.000 SEC
KR-83M	0.00000E+00
KR--85	0.00000E+00
KR-85M	0.00000E+00
KR--87	0.00000E+00
KR--88	0.00000E+00
XE131M	0.00000E+00
XE133M	0.00000E+00
XE-133	0.00000E+00
XE135M	0.00000E+00
XE-135	0.00000E+00
RB--88	0.00000E+00
CS-135	1.92580E-22
I--129	1.79019E-28
I--130	1.21793E-39
I--131	3.86095E-33
I--132	0.00000E+00
I--133	9.24476E-35
I--135	3.84791E-38
TOTAL	1.92580E-22

NE602-SOURCE2(D2-5) [(C)1972,1991 BECHTEL. SCE AIX VERS. OCT 95]
ORIGINATOR: MARK DRUCKER DATE: 03/25/99 CALC: N4072-001REV: 5
PROJECT: SONGS UNITS 2,3 JOB: ss-f.si CHECK:_____ DATE:__/__/__
SUBJECT: fha-fhb.to FHA in FHB - CR Filter Source Strengths PAGE: 9

CASE TITLE: Activity at 5.0000E-02 hours for node 3 A206/7

GAMMA SOURCE STRENGTH AS A FUCTION OF DECAY TIME (MEV/CC-SEC)

ENERGY GROUP	.000 SEC
.000 - .100 MEV	1.86792E-20
.100 - .400 MEV	4.48998E-23
.400 - .900 MEV	1.07988E-23
.900 - 1.350 MEV	1.92930E-25
1.350 - 1.800 MEV	9.61720E-27
1.800 - 2.200 MEV	5.48493E-29
2.200 - 2.600 MEV	5.56642E-29
2.600 - 3.000 MEV	0.00000E+00
3.000 - 5.000 MEV	0.00000E+00
5.000 -15.000 MEV	0.00000E+00
TOTAL	1.87351E-20

NE602-SOURCE2(D2-5) [(C)1972,1991 BECHTEL. SCE AIX VERS. OCT 95]
ORIGINATOR: MARK DRUCKER DATE: 03/25/99 CALC: N4072-001REV: 5

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

PROJECT: SONGS UNITS 2,3 JOB: ss-f.si CHECK:_____ DATE:__/__/__
SUBJECT: fha-fhb.to FHA in FHB - CR Filter Source Strengths PAGE: 11

CASE TITLE: Activity at .1000 hours for node 3 A206/7

ACTIVITY AS A FUNCTION OF DECAY TIME (CURIES/CC)

ISOTOPE	.000 SEC
KR-83M	0.00000E+00
KR--85	0.00000E+00
KR-85M	0.00000E+00
KR--87	0.00000E+00
KR--88	0.00000E+00
XE131M	0.00000E+00
XE133M	0.00000E+00
XE-133	0.00000E+00
XE135M	0.00000E+00
XE-135	0.00000E+00
RB--88	1.56223E-13
CS-135	1.81847E-18
I--129	3.54323E-14
I--130	9.19348E-12
I--131	4.18056E-07
I--132	2.47667E-16
I--133	9.68085E-08
I--135	5.29704E-10
TOTAL	5.15404E-07

NE602-SOURCE2(D2-5) [(C)1972,1991 BECHTEL. SCE AIX VERS. OCT 95]
ORIGINATOR: MARK DRUCKER DATE: 03/25/99 CALC: N4072-001REV: 5
PROJECT: SONGS UNITS 2,3 JOB: ss-f.si CHECK:_____ DATE:__/__/__
SUBJECT: fha-fhb.to FHA in FHB - CR Filter Source Strengths PAGE: 12

CASE TITLE: Activity at .1000 hours for node 3 A206/7

GAMMA SOURCE STRENGTH AS A FUCTION OF DECAY TIME (MEV/CC-SEC)

ENERGY GROUP	.000 SEC
.000 - .100 MEV	3.23545E+01
.100 - .400 MEV	4.87065E+03
.400 - .900 MEV	2.91757E+03
.900 - 1.350 MEV	2.17236E+02
1.350 - 1.800 MEV	2.01094E+01
1.800 - 2.200 MEV	7.57395E-01
2.200 - 2.600 MEV	7.66280E-01
2.600 - 3.000 MEV	3.47122E-04
3.000 - 5.000 MEV	1.54925E-04
5.000 -15.000 MEV	0.00000E+00
TOTAL	8.05944E+03

NE602-SOURCE2(D2-5) [(C)1972,1991 BECHTEL. SCE AIX VERS. OCT 95]
ORIGINATOR: MARK DRUCKER DATE: 03/25/99 CALC: N4072-001REV: 5
PROJECT: SONGS UNITS 2,3 JOB: ss-f.si CHECK:_____ DATE:__/__/__

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

SUBJECT: fha-fhb.to FHA in FHB - CR Filter Source Strengths PAGE: 14

CASE TITLE: Activity at .2000 hours for node 3 A206/7

ACTIVITY AS A FUNCTION OF DECAY TIME (CURIES/CC)

ISOTOPE	.000 SEC
KR-83M	0.00000E+00
KR--85	0.00000E+00
KR-85M	0.00000E+00
KR--87	0.00000E+00
KR--88	0.00000E+00
XE131M	0.00000E+00
XE133M	0.00000E+00
XE-133	0.00000E+00
XE135M	0.00000E+00
XE-135	0.00000E+00
RB--88	5.12892E-13
CS-135	7.07980E-18
I--129	8.74278E-14
I--130	2.25578E-11
I--131	1.03117E-06
I--132	5.92850E-16
I--133	2.38081E-07
I--135	1.29339E-09
TOTAL	1.27057E-06

NE602-SOURCE2(D2-5) [(C)1972,1991 BECHTEL. SCE AIX VERS. OCT 95]
ORIGINATOR: MARK DRUCKER DATE: 03/25/99 CALC: N4072-001REV: 5
PROJECT: SONGS UNITS 2,3 JOB: ss-f.si CHECK:_____ DATE:__/__/__
SUBJECT: fha-fhb.to FHA in FHB - CR Filter Source Strengths PAGE: 15

CASE TITLE: Activity at .2000 hours for node 3 A206/7

GAMMA SOURCE STRENGTH AS A FUCTION OF DECAY TIME (MEV/CC-SEC)

ENERGY GROUP	.000 SEC
.000 - .100 MEV	7.98049E+01
.100 - .400 MEV	1.20138E+04
.400 - .900 MEV	7.18216E+03
.900 - 1.350 MEV	5.33960E+02
1.350 - 1.800 MEV	4.92642E+01
1.800 - 2.200 MEV	1.85132E+00
2.200 - 2.600 MEV	1.87105E+00
2.600 - 3.000 MEV	1.13963E-03
3.000 - 5.000 MEV	5.08632E-04
5.000 -15.000 MEV	0.00000E+00
TOTAL	1.98627E+04

NE602-SOURCE2(D2-5) [(C)1972,1991 BECHTEL. SCE AIX VERS. OCT 95]
ORIGINATOR: MARK DRUCKER DATE: 03/25/99 CALC: N4072-001REV: 5
PROJECT: SONGS UNITS 2,3 JOB: ss-f.si CHECK:_____ DATE:__/__/__
SUBJECT: fha-fhb.to FHA in FHB - CR Filter Source Strengths PAGE: 17

CASE TITLE: Activity at .5000 hours for node 3 A206/7

ACTIVITY AS A FUNCTION OF DECAY TIME (CURIES/CC)

ISOTOPE	.000 SEC
KR-83M	0.00000E+00
KR--85	0.00000E+00
KR-85M	0.00000E+00
KR--87	0.00000E+00
KR--88	0.00000E+00
XE131M	0.00000E+00
XE133M	0.00000E+00
XE-133	0.00000E+00
XE135M	0.00000E+00
XE-135	0.00000E+00
RB--88	9.73194E-13
CS-135	2.26782E-17
I--129	1.58768E-13
I--130	4.02816E-11
I--131	1.87056E-06
I--132	9.82972E-16
I--133	4.28072E-07
I--135	2.27606E-09
TOTAL	2.30095E-06

NE602-SOURCE2(D2-5) [(C)1972,1991 BECHTEL. SCE AIX VERS. OCT 95]
ORIGINATOR: MARK DRUCKER DATE: 03/25/99 CALC: N4072-001REV: 5
PROJECT: SONGS UNITS 2,3 JOB: ss-f.si CHECK:_____ DATE:__/__/__
SUBJECT: fha-fhb.to FHA in FHB - CR Filter Source Strengths PAGE: 18

CASE TITLE: Activity at .5000 hours for node 3 A206/7

GAMMA SOURCE STRENGTH AS A FUCTION OF DECAY TIME (MEV/CC-SEC)

ENERGY GROUP	.000 SEC
.000 - .100 MEV	1.44768E+02
.100 - .400 MEV	2.17928E+04
.400 - .900 MEV	1.29516E+04
.900 - 1.350 MEV	9.58532E+02
1.350 - 1.800 MEV	8.75630E+01
1.800 - 2.200 MEV	3.25893E+00
2.200 - 2.600 MEV	3.29260E+00
2.600 - 3.000 MEV	2.16241E-03
3.000 - 5.000 MEV	9.6511DE-04
5.000 -15.000 MEV	0.00000E+00
TOTAL	3.59418E+04

NE602-SOURCE2(D2-5) [(C)1972,1991 BECHTEL. SCE AIX VERS. OCT 95]
ORIGINATOR: MARK DRUCKER DATE: 03/25/99 CALC: N4072-001REV: 5
PROJECT: SONGS UNITS 2,3 JOB: ss-f.si CHECK:_____ DATE:__/__/__
SUBJECT: fha-fhb.to FHA in FHB - CR Filter Source Strengths PAGE: 20

CASE TITLE: Activity at 1.000 hours for node 3 A206/7

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

ACTIVITY AS A FUNCTION OF DECAY TIME (CURIES/CC)

ISOTOPE	.000 SEC
KR-83M	0.00000E+00
KR--85	0.00000E+00
KR-85M	0.00000E+00
KR--87	0.00000E+00
KR--88	0.00000E+00
XE131M	0.00000E+00
XE133M	0.00000E+00
XE-133	0.00000E+00
XE135M	0.00000E+00
XE-135	0.00000E+00
RB--88	5.58296E-13
CS-135	3.39159E-17
I--129	1.83544E-13
I--130	4.52805E-11
I--131	2.15859E-06
I--132	9.76464E-16
I--133	4.86737E-07
I--135	2.49687E-09
TOTAL	2.64787E-06

NE602-SOURCE2(D2-5) [(C)1972,1991 BECHTEL. SCE AIX VERS. OCT 95]
ORIGINATOR: MARK DRUCKER DATE: 03/25/99 CALC: N4072-001REV: 5
PROJECT: SONGS UNITS 2,3 JOB: ss-f.si CHECK:_____ DATE:__/__/__
SUBJECT: fha-fhb.to FHA in FHB - CR Filter Source Strengths PAGE: 21

CASE TITLE: Activity at 1.000 hours for node 3 A206/7

GAMMA SOURCE STRENGTH AS A FUCTION OF DECAY TIME (MEV/CC-SEC)

ENERGY GROUP	.000 SEC
.000 - .100 MEV	1.67059E+02
.100 - .400 MEV	2.51476E+04
.400 - .900 MEV	1.47994E+04
.900 - 1.350 MEV	1.08707E+03
1.350 - 1.800 MEV	9.76942E+01
1.800 - 2.200 MEV	3.56748E+00
2.200 - 2.600 MEV	3.61202E+00
2.600 - 3.000 MEV	1.24052E-03
3.000 - 5.000 MEV	5.53659E-04
5.000 -15.000 MEV	0.00000E+00
TOTAL	4.13060E+04

NE602-SOURCE2(D2-5) [(C)1972,1991 BECHTEL. SCE AIX VERS. OCT 95]
ORIGINATOR: MARK DRUCKER DATE: 03/25/99 CALC: N4072-001REV: 5
PROJECT: SONGS UNITS 2,3 JOB: ss-f.si CHECK:_____ DATE:__/__/__
SUBJECT: fha-fhb.to FHA in FHB - CR Filter Source Strengths PAGE: 23

CASE TITLE: Activity at 2.000 hours for node 3 A206/7

ACTIVITY AS A FUNCTION OF DECAY TIME (CURIES/CC)

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

ISOTOPE	.000 SEC
KR-83M	0.00000E+00
KR--85	0.00000E+00
KR-85M	0.00000E+00
KR--87	0.00000E+00
KR--88	0.00000E+00
XE131M	0.00000E+00
XE133M	0.00000E+00
XE-133	0.00000E+00
XE135M	0.00000E+00
XE-135	0.00000E+00
RB--88	6.84574E-14
CS-135	3.67058E-17
I--129	1.86946E-13
I--130	4.36059E-11
I--131	2.19072E-06
I--132	7.34367E-16
I--133	4.79588E-07
I--135	2.29005E-09
TOTAL	2.67265E-06

NE602-SOURCE2(D2-5) [(C)1972,1991 BECHTEL. SCE AIX VERS. OCT 95]
ORIGINATOR: MARK DRUCKER DATE: 03/25/99 CALC: N4072-001REV: 5
PROJECT: SONGS UNITS 2,3 JOB: ss-f.si CHECK:_____ DATE:__/__/__
SUBJECT: fha-fhb.to FHA in FHB - CR Filter Source Strengths PAGE: 24

CASE TITLE: Activity at 2.000 hours for node 3 A206/7

GAMMA SOURCE STRENGTH AS A FUCTION OF DECAY TIME (MEV/CC-SEC)

ENERGY GROUP	.000 SEC
.000 - .100 MEV	1.69546E+02
.100 - .400 MEV	2.55204E+04
.400 - .900 MEV	1.47289E+04
.900 - 1.350 MEV	1.06583E+03
1.350 - 1.800 MEV	9.27695E+01
1.800 - 2.200 MEV	3.26534E+00
2.200 - 2.600 MEV	3.31281E+00
2.600 - 3.000 MEV	1.52110E-04
3.000 - 5.000 MEV	6.78888E-05
5.000 -15.000 MEV	0.00000E+00
TOTAL	4.15841E+04

NE602-SOURCE2(D2-5) [(C)1972,1991 BECHTEL. SCE AIX VERS. OCT 95]
ORIGINATOR: MARK DRUCKER DATE: 03/25/99 CALC: N4072-001REV: 5
PROJECT: SONGS UNITS 2,3 JOB: ss-f.si CHECK:_____ DATE:__/__/__
SUBJECT: fha-fhb.to FHA in FHB - CR Filter Source Strengths PAGE: 26

CASE TITLE: Activity at 4.000 hours for node 3 A206/7

ACTIVITY AS A FUNCTION OF DECAY TIME (CURIES/CC)

ISOTOPE	.000 SEC
KR-83M	0.00000E+00
KR--85	0.00000E+00
KR-85M	0.00000E+00
KR--87	0.00000E+00
KR--88	0.00000E+00
XE131M	0.00000E+00
XE133M	0.00000E+00
XE-133	0.00000E+00
XE135M	0.00000E+00
XE-135	0.00000E+00
RB--88	6.67632E-16
CS-135	3.67833E-17
I--129	1.86998E-13
I--130	3.89923E-11
I--131	2.17564E-06
I--132	4.00488E-16
I--133	4.48938E-07
I--135	1.85742E-09
TOTAL	2.62648E-06

NE602-SOURCE2(02-5) [(C)1972,1991 BECHTEL. SCE AIX VERS. OCT 95]
ORIGINATOR: MARK DRUCKER DATE: 03/25/99 CALC: N4072-001REV: 5
PROJECT: SONGS UNITS 2,3 JOB: ss-f.si CHECK:_____ DATE:__/__/__
SUBJECT: fha-fhb.to FHA in FHB - CR Filter Source Strengths PAGE: 27

CASE TITLE: Activity at 4.000 hours for node 3 A206/7

GAMMA SOURCE STRENGTH AS A FUCTION OF DECAY TIME (MEV/CC-SEC)

ENERGY GROUP	.000 SEC
.000 - .100 MEV	1.68379E+02
.100 - .400 MEV	2.53418E+04
.400 - .900 MEV	1.40753E+04
.900 - 1.350 MEV	9.88835E+02
1.350 - 1.800 MEV	8.09695E+01
1.800 - 2.200 MEV	2.64764E+00
2.200 - 2.600 MEV	2.68696E+00
2.600 - 3.000 MEV	1.48346E-06
3.000 - 5.000 MEV	6.62087E-07
5.000 -15.000 MEV	0.00000E+00
TOTAL	4.06606E+04

NE602-SOURCE2(02-5) [(C)1972,1991 BECHTEL. SCE AIX VERS. OCT 95]
ORIGINATOR: MARK DRUCKER DATE: 03/25/99 CALC: N4072-001REV: 5
PROJECT: SONGS UNITS 2,3 JOB: ss-f.si CHECK:_____ DATE:__/__/__
SUBJECT: fha-fhb.to FHA in FHB - CR Filter Source Strengths PAGE: 29

CASE TITLE: Activity at 6.000 hours for node 3 A206/7

ACTIVITY AS A FUNCTION OF DECAY TIME (CURIES/CC)

ISOTOPE	.000 SEC
KR-83M	0.00000E+00
KR--85	0.00000E+00
KR-85M	0.00000E+00
KR--87	0.00000E+00
KR--88	0.00000E+00
XE131M	0.00000E+00
XE133M	0.00000E+00
XE-133	0.00000E+00
XE135M	0.00000E+00
XE-135	0.00000E+00
RB--88	6.22475E-18
CS-135	3.67833E-17
I--129	1.86998E-13
I--130	3.48573E-11
I--131	2.16007E-06
I--132	2.18347E-16
I--133	4.20131E-07
I--135	1.50610E-09
TOTAL	2.58174E-06

NE602-SOURCE2(02-5) [(C)1972,1991 BECHTEL. SCE AIX VERS. OCT 95]
ORIGINATOR: MARK DRUCKER DATE: 03/25/99 CALC: N4072-001REV: 5
PROJECT: SONGS UNITS 2,3 JOB: ss-f.si CHECK:_____ DATE:__/__/__
SUBJECT: fha-fhb.to FHA in FHB - CR Filter Source Strengths PAGE: 30

CASE TITLE: Activity at 6.000 hours for node 3 A206/7

GAMMA SOURCE STRENGTH AS A FUCTION OF DECAY TIME (MEV/CC-SEC)

ENERGY GROUP	.000 SEC
.000 - .100 MEV	1.67174E+02
.100 - .400 MEV	2.51576E+04
.400 - .900 MEV	1.34581E+04
.900 - 1.350 MEV	9.18185E+02
1.350 - 1.800 MEV	7.10132E+01
1.800 - 2.200 MEV	2.14685E+00
2.200 - 2.600 MEV	2.17874E+00
2.600 - 3.000 MEV	1.38312E-08
3.000 - 5.000 MEV	6.17304E-09
5.000 -15.000 MEV	0.00000E+00
TOTAL	3.97764E+04

NE602-SOURCE2(02-5) [(C)1972,1991 BECHTEL. SCE AIX VERS. OCT 95]
ORIGINATOR: MARK DRUCKER DATE: 03/25/99 CALC: N4072-001REV: 5
PROJECT: SONGS UNITS 2,3 JOB: ss-f.si CHECK:_____ DATE:__/__/__
SUBJECT: fha-fhb.to FHA in FHB - CR Filter Source Strengths PAGE: 32

CASE TITLE: Activity at 8.000 hours for node 3 A206/7

ACTIVITY AS A FUNCTION OF DECAY TIME (CURIES/CC)

ISOTOPE	.000 SEC

KR-83M	0.00000E+00
KR--85	0.00000E+00
KR-85M	0.00000E+00
KR--87	0.00000E+00
KR--88	0.00000E+00
XE131M	0.00000E+00
XE133M	0.00000E+00
XE-133	0.00000E+00
XE135M	0.00000E+00
XE-135	0.00000E+00
RB--88	5.79276E-20
CS-135	3.67833E-17
I--129	1.86998E-13
I--130	3.11607E-11
I--131	2.14461E-06
I--132	1.19043E-16
I--133	3.93172E-07
I--135	1.22123E-09
TOTAL	2.53903E-06

NE602-SOURCE2(D2-5) [(C)1972,1991 BECHTEL. SCE AIX VERS. OCT 95]
ORIGINATOR: MARK DRUCKER DATE: 03/25/99 CALC: N4072-001REV: 5
PROJECT: SONGS UNITS 2,3 JOB: ss-f.si CHECK:_____ DATE:__/__/__
SUBJECT: fha-fhb.to FHA in FHB - CR Filter Source Strengths PAGE: 33

CASE TITLE: Activity at 8.000 hours for node 3 A206/7

GAMMA SOURCE STRENGTH AS A FUCTION OF DECAY TIME (MEV/CC-SEC)

ENERGY GROUP	.000 SEC
.000 - .100 MEV	1.65977E+02
.100 - .400 MEV	2.49750E+04
.400 - .900 MEV	1.28786E+04
.900 - 1.350 MEV	8.53429E+02
1.350 - 1.800 MEV	6.25960E+01
1.800 - 2.200 MEV	1.74078E+00
2.200 - 2.600 MEV	1.76664E+00
2.600 - 3.000 MEV	1.28713E-10
3.000 - 5.000 MEV	5.74464E-11
5.000 -15.000 MEV	0.00000E+00
TOTAL	3.89392E+04

NE602-SOURCE2(D2-5) [(C)1972,1991 BECHTEL. SCE AIX VERS. OCT 95]
ORIGINATOR: MARK DRUCKER DATE: 03/25/99 CALC: N4072-001REV: 5
PROJECT: SONGS UNITS 2,3 JOB: ss-f.si CHECK:_____ DATE:__/__/__
SUBJECT: fha-fhb.to FHA in FHB - CR Filter Source Strengths PAGE: 35

CASE TITLE: Activity at 10.00 hours for node 3 A206/7

ACTIVITY AS A FUNCTION OF DECAY TIME (CURIES/CC)

ISOTOPE	.000 SEC

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV
6	N. YACKLE		T. REMICK							⇓

KR-83M	0.00000E+00
KR--85	0.00000E+00
KR-85M	0.00000E+00
KR--87	0.00000E+00
KR--88	0.00000E+00
XE131M	0.00000E+00
XE133M	0.00000E+00
XE-133	0.00000E+00
XE135M	0.00000E+00
XE-135	0.00000E+00
RB--88	5.39063E-22
CS-135	3.67833E-17
I--129	1.86998E-13
I--130	2.78561E-11
I--131	2.12927E-06
I--132	6.49026E-17
I--133	3.67943E-07
I--135	9.90242E-10
TOTAL	2.49823E-06

NE602-SOURCE2(D2-5) [(C)1972,1991 BECHTEL. SCE AIX VERS. OCT 95]
ORIGINATOR: MARK DRUCKER DATE: 03/25/99 CALC: N4072-001REV: 5
PROJECT: SONGS UNITS 2,3 JOB: ss-f.si CHECK:_____ DATE:__/__/__
SUBJECT: fha-fhb.to FHA in FHB - CR Filter Source Strengths PAGE: 36

CASE TITLE: Activity at 10.00 hours for node 3 A206/7

GAMMA SOURCE STRENGTH AS A FUCTION OF DECAY TIME (MEV/CC-SEC)

ENERGY GROUP	.000 SEC
.000 - .100 MEV	1.64789E+02
.100 - .400 MEV	2.47939E+04
.400 - .900 MEV	1.23345E+04
.900 - 1.350 MEV	7.93932E+02
1.350 - 1.800 MEV	5.54492E+01
1.800 - 2.200 MEV	1.41152E+00
2.200 - 2.600 MEV	1.43249E+00
2.600 - 3.000 MEV	1.19778E-12
3.000 - 5.000 MEV	5.34585E-13
5.000 -15.000 MEV	0.00000E+00
TOTAL	3.81455E+04

NE602-SOURCE2(D2-5) [(C)1972,1991 BECHTEL. SCE AIX VERS. OCT 95]
ORIGINATOR: MARK DRUCKER DATE: 03/25/99 CALC: N4072-001REV: 5
PROJECT: SONGS UNITS 2,3 JOB: ss-f.si CHECK:_____ DATE:__/__/__
SUBJECT: fha-fhb.to FHA in FHB - CR Filter Source Strengths PAGE: 38

CASE TITLE: Activity at 24.00 hours for node 3 A206/7

ACTIVITY AS A FUNCTION OF DECAY TIME (CURIES/CC)

ISOTOPE	.000 SEC
KR-83M	0.00000E+00

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

KR--85	0.00000E+00
KR-85M	0.00000E+00
XR--87	0.00000E+00
KR--88	0.00000E+00
XE131M	0.00000E+00
XE133M	0.00000E+00
XE-133	0.00000E+00
XE135M	0.00000E+00
XE-135	0.00000E+00
RB--88	3.25768E-36
CS-135	3.67833E-17
I--129	1.86998E-13
I--130	1.27092E-11
I--131	2.02485E-06
I--132	9.29310E-19
I--133	2.31295E-07
I--135	2.28218E-10
TOTAL	2.25639E-06

NE602-SOURCE2(D2-5) [(C)1972,1991 BECHTEL. SCE AIX VERS. OCT 95]
ORIGINATOR: MARK DRUCKER DATE: 03/25/99 CALC: N4072-001REV: 5
PROJECT: SONGS UNITS 2,3 JOB: ss-f.si CHECK:_____ DATE:__/__/__
SUBJECT: fha-fhb.to FHA in FHB - CR Filter Source Strengths PAGE: 39

CASE TITLE: Activity at 24.00 hours for node 3 A206/7

GAMMA SOURCE STRENGTH AS A FUCTION OF DECAY TIME (MEV/CC-SEC)

ENERGY GROUP	.000 SEC
.000 - .100 MEV	1.56709E+02
.100 - .400 MEV	2.35659E+04
.400 - .900 MEV	9.34066E+03
.900 - 1.350 MEV	4.86639E+02
1.350 - 1.800 MEV	2.67698E+01
1.800 - 2.200 MEV	3.25310E-01
2.200 - 2.600 MEV	3.30143E-01
2.600 - 3.000 MEV	7.23846E-27
3.000 - 5.000 MEV	3.23062E-27
5.000 -15.000 MEV	0.00000E+00
TOTAL	3.35775E+04

NE602-SOURCE2(D2-5) [(C)1972,1991 BECHTEL. SCE AIX VERS. OCT 95]
ORIGINATOR: MARK DRUCKER DATE: 03/25/99 CALC: N4072-001REV: 5
PROJECT: SONGS UNITS 2,3 JOB: ss-f.si CHECK:_____ DATE:__/__/__
SUBJECT: fha-fhb.to FHA in FHB - CR Filter Source Strengths PAGE: 41

CASE TITLE: Activity at 96.00 hours for node 3 A206/7

ACTIVITY AS A FUNCTION OF DECAY TIME (CURIES/CC)

ISOTOPE	.000 SEC
KR-83M	0.00000E+00
KR--85	0.00000E+00

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇩
6	N. YACKLE		T. REMICK							

KR-85M	0.00000E+00
KR--87	0.00000E+00
KR--88	0.00000E+00
XE131M	0.00000E+00
XE133M	0.00000E+00
XE-133	0.00000E+00
XE135M	0.00000E+00
XE-135	0.00000E+00
RB--88	0.00000E+00
CS-135	3.67833E-17
I--129	1.86998E-13
I--130	2.24603E-13
I--131	1.56349E-06
I--132	3.04937E-28
I--133	2.12467E-08
I--135	1.20320E-13
TOTAL	1.58473E-06

NE602-SOURCE2(D2-5) [(C)1972,1991 BECHTEL. SCE AIX VERS. OCT 95]
ORIGINATOR: MARK DRUCKER DATE: 03/25/99 CALC: N4072-001REV: 5
PROJECT: SONGS UNITS 2,3 JOB: ss-f.si CHECK:_____ DATE:__/__/__
SUBJECT: fha-fhb.to FHA in FHB - CR Filter Source Strengths PAGE: 42

CASE TITLE: Activity at 96.00 hours for node 3 A206/7

GAMMA SOURCE STRENGTH AS A FUCTION OF DECAY TIME (MEV/CC-SEC)

ENERGY GROUP	.000 SEC
.000 - .100 MEV	1.21002E+02
.100 - .400 MEV	1.81805E+04
.400 - .900 MEV	4.04738E+03
.900 - 1.350 MEV	4.40695E+01
1.350 - 1.800 MEV	2.03136E+00
1.800 - 2.200 MEV	1.71508E-04
2.200 - 2.600 MEV	1.74056E-04
2.600 - 3.000 MEV	0.00000E+00
3.000 - 5.000 MEV	0.00000E+00
5.000 -15.000 MEV	0.00000E+00
TOTAL	2.23950E+04

NE602-SOURCE2(D2-5) [(C)1972,1991 BECHTEL. SCE AIX VERS. OCT 95]
ORIGINATOR: MARK DRUCKER DATE: 03/25/99 CALC: N4072-001REV: 5
PROJECT: SONGS UNITS 2,3 JOB: ss-f.si CHECK:_____ DATE:__/__/__
SUBJECT: fha-fhb.to FHA in FHB - CR Filter Source Strengths PAGE: 44

CASE TITLE: Activity at 720.0 hours for node 3 A206/7

ACTIVITY AS A FUNCTION OF DECAY TIME (CURIES/CC)

ISOTOPE	.000 SEC
KR-83M	0.00000E+00
KR--85	0.00000E+00
KR-85M	0.00000E+00

KR--87	0.00000E+00
KR--88	0.00000E+00
XE131M	0.00000E+00
XE133M	0.00000E+00
XE-133	0.00000E+00
XE135M	0.00000E+00
XE-135	0.00000E+00
RB--88	0.00000E+00
CS-135	3.67834E-17
I--129	1.86998E-13
I--130	1.44990E-28
I--131	1.66279E-07
I--132	0.00000E+00
I--133	2.19304E-17
I--135	0.00000E+00
TOTAL	1.66279E-07

NE602-SOURCE2(D2-5) [(C)1972,1991 BECHTEL. SCE AIX VERS. OCT 95]
ORIGINATOR: MARK DRUCKER . DATE: 03/25/99 CALC: N4072-001REV: 5
PROJECT: SONGS UNITS 2,3 JOB: ss-f.si CHECK:_____ DATE:__/__/__
SUBJECT: fha-fhb.to FHA in FHB - CR Filter Source Strengths PAGE: 45

CASE TITLE: Activity at 720.0 hours for node 3 A206/7

GAMMA SOURCE STRENGTH AS A FUCTION OF DECAY TIME (MEV/CC-SEC)

ENERGY GROUP	.000 SEC
.000 - .100 MEV	1.28688E+01
.100 - .400 MEV	1.93329E+03
.400 - .900 MEV	3.85014E+02
.900 - 1.350 MEV	4.54825E-08
1.350 - 1.800 MEV	2.09413E-09
1.800 - 2.200 MEV	0.00000E+00
2.200 - 2.600 MEV	0.00000E+00
2.600 - 3.000 MEV	0.00000E+00
3.000 - 5.000 MEV	0.00000E+00
5.000 -15.000 MEV	0.00000E+00
TOTAL	2.33118E+03

10.0 QUATTRO-PRO SPREADSHEET EVALUATIONS

10.1 QUATTRO-PRO Evaluation of Environmental Cloud Shine

Section 8.9 addresses environmental cloud shine doses in the control board area of the control room, at dose points 9, 10, 15 and 16 as shown in Figure 4-1 of Design Input 4.10. Per Design Input 4.10, the maximum dose at these four dose points represents the Control Room Operator dose. Tables 10.1-1 through 10.1-4 present Quattro-Pro spreadsheet evaluations of the environmental cloud shine dose at these locations. Sample calculations of these spreadsheet evaluations are presented in Section 8.9.

TABLE 10.1-1 (Page 1 of 2) ENVIRONMENTAL CLOUD SHINE DOSE TO DOSE POINT 9

Base10	FHB CLOUD SOURCE STRENGTH SPECTRA (MeV/cc-sec) [per SOURCE2 Output File "ss-c.so" (see Section 9.3.1.2)]								
Energy Ranges	0 hrs	2.78e-3 hrs	0.05 hrs	0.1 hrs	0.2 hrs	0.5 hrs	1 hrs	2.0 hrs	4.0 hrs
0.0 to 0.1	3.16E+03	3.13E+03	2.56E+03	2.08E+03	1.36E+03	3.86E+02	4.71E+01	7.02E-01	1.56E-04
0.1 to 0.4	5.70E+02	5.63E+02	4.61E+02	3.73E+02	2.44E+02	6.82E+01	8.17E+00	1.17E-01	2.42E-05
0.4 to 0.9	1.58E+02	1.56E+02	1.28E+02	1.03E+02	6.71E+01	1.87E+01	2.24E+00	3.24E-02	6.84E-06
0.9 to 1.35	8.94E+00	8.83E+00	7.23E+00	5.85E+00	3.83E+00	1.07E+00	1.29E-01	1.85E-03	3.85E-07
1.35 to 1.8	8.25E-01	8.15E-01	6.66E-01	5.38E-01	3.51E-01	9.74E-02	1.15E-02	1.60E-04	3.14E-08
1.8 to 2.2	3.18E-02	3.14E-02	2.57E-02	2.08E-02	1.35E-02	3.74E-03	4.35E-04	5.86E-06	1.13E-09
2.2 to 2.6	3.30E-02	3.26E-02	2.66E-02	2.15E-02	1.39E-02	3.82E-03	4.43E-04	5.94E-06	1.07E-09
2.6 to 3.0	4.58E-15	6.08E-07	8.44E-06	1.28E-05	1.49E-05	7.53E-06	1.13E-06	1.65E-08	1.38E-11
3.0 to 5.0	7.07E-15	2.71E-07	3.77E-06	5.73E-06	6.66E-06	3.36E-06	5.02E-07	7.37E-09	6.14E-12
5.0 to 15.0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
totals	3.90E+03	3.86E+03	3.16E+03	2.56E+03	1.68E+03	4.74E+02	5.77E+01	8.53E-01	1.87E-04
FHB Release Flow Rate (m^3/s)	12.07	12.07	12.07	12.07	12.07	12.07	12.07	12.07	12.07
FHB to CR X/Q (s/m^3)	3.1E-03	3.1E-03	3.1E-03	3.1E-03	3.1E-03	3.1E-03	3.1E-03	3.1E-03	3.1E-03

Base10	ENVIRONMENTAL CLOUD SOURCE STRENGTH SPECTRA (MeV/cc-sec)								
Energy Ranges	0 hrs	2.78e-3 hrs	0.05 hrs	0.1 hrs	0.2 hrs	0.5 hrs	1 hrs	2.0 hrs	4.0 hrs
0.0 to 0.1	1.18E+02	1.17E+02	9.59E+01	7.77E+01	5.10E+01	1.44E+01	1.76E+00	2.63E-02	5.83E-06
0.1 to 0.4	2.13E+01	2.11E+01	1.72E+01	1.39E+01	9.12E+00	2.55E+00	3.06E-01	4.38E-03	9.06E-07
0.4 to 0.9	5.92E+00	5.85E+00	4.77E+00	3.85E+00	2.51E+00	6.98E-01	8.37E-02	1.21E-03	2.56E-07
0.9 to 1.35	3.34E-01	3.30E-01	2.71E-01	2.19E-01	1.43E-01	4.01E-02	4.82E-03	6.94E-05	1.44E-08
1.35 to 1.8	3.09E-02	3.05E-02	2.49E-02	2.01E-02	1.31E-02	3.64E-03	4.30E-04	6.01E-06	1.17E-09
1.8 to 2.2	1.19E-03	1.18E-03	9.62E-04	7.77E-04	5.06E-04	1.40E-04	1.63E-05	2.19E-07	4.24E-11
2.2 to 2.6	1.24E-03	1.22E-03	9.96E-04	8.03E-04	5.22E-04	1.43E-04	1.66E-05	2.22E-07	4.00E-11
2.6 to 3.0	1.71E-16	2.27E-08	3.16E-07	4.81E-07	5.59E-07	2.82E-07	4.21E-08	6.18E-10	5.15E-13
3.0 to 5.0	2.65E-16	1.02E-08	1.41E-07	2.15E-07	2.49E-07	1.26E-07	1.88E-08	2.76E-10	2.30E-13
5.0 to 15.0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
totals	1.46E+02	1.44E+02	1.18E+02	9.58E+01	6.28E+01	1.77E+01	2.16E+00	3.19E-02	7.00E-06

Base10	ENV. CLOUD SHINE DMF	ENVIRONMENTAL CLOUD SHINE DOSE RATES AT DOSE POINT 9 (rem/hour)								
Energy Ranges	AT DP9	0 hrs	2.78e-3 hrs	0.05 hrs	0.1 hrs	0.2 hrs	0.5 hrs	1 hrs	2.0 hrs	4.0 hrs
0.0 to 0.1	5.22E-05	6.18E-03	6.11E-03	5.01E-03	4.06E-03	2.66E-03	7.54E-04	9.20E-05	1.37E-06	3.04E-10
0.1 to 0.4	8.90E-05	1.90E-03	1.88E-03	1.53E-03	1.24E-03	8.12E-04	2.27E-04	2.72E-05	3.90E-07	8.07E-11
0.4 to 0.9	9.26E-05	5.48E-04	5.42E-04	4.42E-04	3.57E-04	2.32E-04	6.47E-05	7.75E-06	1.12E-07	2.37E-11
0.9 to 1.35	1.03E-04	3.44E-05	3.40E-05	2.79E-05	2.25E-05	1.47E-05	4.13E-06	4.96E-07	7.15E-09	1.49E-12
1.35 to 1.8	1.10E-04	3.40E-06	3.36E-06	2.74E-06	2.21E-06	1.44E-06	4.01E-07	4.73E-08	6.61E-10	1.29E-13
1.8 to 2.2	1.21E-04	1.44E-07	1.42E-07	1.16E-07	9.40E-08	6.13E-08	1.69E-08	1.97E-09	2.65E-11	5.13E-15
2.2 to 2.6	1.27E-04	1.57E-07	1.55E-07	1.27E-07	1.02E-07	6.63E-08	1.82E-08	2.10E-09	2.82E-11	5.09E-15
2.6 to 3.0	1.32E-04	2.26E-20	3.00E-12	4.17E-11	6.35E-11	7.37E-11	3.72E-11	5.56E-12	8.15E-14	6.80E-17
3.0 to 5.0	1.48E-04	3.92E-20	1.50E-12	2.09E-11	3.18E-11	3.69E-11	1.86E-11	2.78E-12	4.08E-14	3.40E-17
5.0 to 15.0	1.75E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
totals		8.66E-03	8.56E-03	7.01E-03	5.68E-03	3.72E-03	1.05E-03	1.28E-04	1.88E-06	4.10E-10

Initial Time (hours)	Final Time (hours)	Control Room Occup. Factor (unitless)	Initial Shine Dose Rate (rem/hour)	Final Shine Dose Rate (rem/hour)	Env Cloud Shine Dose at DP 9 w/o CROF (rem)	Env Cloud Shine Dose at DP 9 w/ CROF (rem)
0	0.00278	1.0	8.66E-03	8.56E-03	2.39E-05	2.39E-05
0.00278	0.05	1.0	8.56E-03	7.01E-03	3.67E-04	3.67E-04
0.05	0.1	1.0	7.01E-03	5.68E-03	3.16E-04	3.16E-04
0.1	0.2	1.0	5.68E-03	3.72E-03	4.63E-04	4.63E-04
0.2	0.5	1.0	3.72E-03	1.05E-03	6.34E-04	6.34E-04
0.5	1	1.0	1.05E-03	1.28E-04	2.19E-04	2.19E-04
1	2	1.0	1.28E-04	1.88E-06	2.98E-05	2.98E-05
2	4	1.0	1.88E-06	4.10E-10	4.46E-07	4.46E-07
4	6	1.0	4.10E-10	8.96E-14	9.73E-11	9.73E-11
6	8	1.0	8.96E-14	1.96E-17	2.13E-14	2.13E-14
8	10	1.0	1.14E-17	2.49E-21	2.70E-18	2.70E-18
10	24	1.0	2.49E-21	0.00E+00	1.75E-20	1.75E-20
24	96	0.6	0.00E+00	0.00E+00	0.00E+00	0.00E+00
96	720	0.4	0.00E+00	0.00E+00	0.00E+00	0.00E+00
totals					2.05E-03	2.05E-03

TABLE 10.1-1 (Page 2 of 2) ENVIRONMENTAL CLOUD SHINE DOSE TO DOSE POINT 9

Base10	FHB CLOUD SOURCE STRENGTH SPECTRA (MeV/cc-sec) [per SOURCE2 Output File "ss-c.so" (see Section 9.3.1.2)]								
Energy Ranges	6.0 hrs	8.0- hrs	8.0+ hrs	10 hrs	24- hrs	24+ hrs	96- hrs	96+ hrs	720 hrs
0.0 to 0.1	3.45E-08	7.67E-12	7.67E-12	1.70E-15	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0.1 to 0.4	5.03E-09	1.05E-12	1.05E-12	2.20E-16	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0.4 to 0.9	1.45E-09	3.06E-13	3.06E-13	6.51E-17	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0.9 to 1.35	8.02E-11	1.67E-14	1.67E-14	3.48E-18	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1.35 to 1.8	6.17E-12	1.22E-15	1.22E-15	2.42E-19	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1.8 to 2.2	2.01E-13	3.60E-17	3.60E-17	6.45E-21	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2.2 to 2.6	1.93E-13	3.50E-17	3.50E-17	6.33E-21	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2.6 to 3.0	1.92E-15	2.66E-19	2.66E-19	3.67E-23	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
3.0 to 5.0	8.59E-16	1.19E-19	1.19E-19	1.64E-23	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
5.0 to 15.0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
totals	4.11E-08	9.04E-12	9.04E-12	1.99E-15	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FHB Release Flow Rate (m^3/s)	12.07	12.07	12.07	12.07	12.07	12.07	12.07	12.07	12.07
FHB to CR X/Q (s/m^3)	3.1E-03	3.1E-03	1.8E-03	1.8E-03	1.8E-03	9.8E-04	9.8E-04	2.4E-04	2.4E-04

Base10	ENVIRONMENTAL CLOUD SOURCE STRENGTH SPECTRA (MeV/cc-sec)								
Energy Ranges	6.0 hrs	8.0- hrs	8.0+ hrs	10 hrs	24- hrs	24+ hrs	96- hrs	96+ hrs	720 hrs
0.0 to 0.1	1.29E-09	2.87E-13	1.67E-13	3.70E-17	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0.1 to 0.4	1.88E-10	3.93E-14	2.28E-14	4.79E-18	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0.4 to 0.9	5.41E-11	1.15E-14	6.66E-15	1.41E-18	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0.9 to 1.35	3.00E-12	6.25E-16	3.63E-16	7.56E-20	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1.35 to 1.8	2.31E-13	4.56E-17	2.65E-17	5.26E-21	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1.8 to 2.2	7.54E-15	1.35E-18	7.81E-19	1.40E-22	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2.2 to 2.6	7.23E-15	1.31E-18	7.59E-19	1.37E-22	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2.6 to 3.0	7.20E-17	9.94E-21	5.77E-21	7.97E-25	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
3.0 to 5.0	3.21E-17	4.44E-21	2.58E-21	3.56E-25	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
5.0 to 15.0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
totals	1.54E-09	3.38E-13	1.96E-13	4.32E-17	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Base10	ENV. CLOUD SHINE DMF	ENVIRONMENTAL CLOUD SHINE DOSE RATES AT DOSE POINT 9 (rem/hour)								
Energy Ranges	AT DP9	6.0 hrs	8.0- hrs	8.0+ hrs	10 hrs	24- hrs	24+ hrs	96- hrs	96+ hrs	720 hrs
0.0 to 0.1	5.22E-05	6.75E-14	1.50E-17	8.69E-18	1.93E-21	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0.1 to 0.4	8.90E-05	1.68E-14	3.50E-18	2.03E-18	4.26E-22	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0.4 to 0.9	9.26E-05	5.01E-15	1.06E-18	6.16E-19	1.31E-22	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0.9 to 1.35	1.03E-04	3.09E-16	6.44E-20	3.74E-20	7.79E-24	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1.35 to 1.8	1.10E-04	2.54E-17	5.02E-21	2.91E-21	5.78E-25	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1.8 to 2.2	1.21E-04	9.12E-19	1.63E-22	9.45E-23	1.69E-26	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2.2 to 2.6	1.27E-04	9.18E-19	1.66E-22	9.64E-23	1.75E-26	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2.6 to 3.0	1.32E-04	9.51E-21	1.31E-24	7.62E-25	1.05E-28	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
3.0 to 5.0	1.48E-04	4.76E-21	6.57E-25	3.81E-25	5.27E-29	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
5.0 to 15.0	1.75E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
totals		8.96E-14	1.96E-17	1.14E-17	2.49E-21	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

TABLE 10.1-2 (Page 1 of 2) ENVIRONMENTAL CLOUD SHINE DOSE TO DOSE POINT 10

Base10 Energy Ranges	FHB CLOUD SOURCE STRENGTH SPECTRA (MeV/cc-sec) [per SOURCE2 Output File "ss-c.so" (see Section 9.3.1.2)] 0 hrs	2.78e-3 hrs	0.05 hrs	0.1 hrs	0.2 hrs	0.5 hrs	1 hrs	2.0 hrs	4.0 hrs
0.0 to 0.1	3.16E+03	3.13E+03	2.56E+03	2.08E+03	1.36E+03	3.86E+02	4.71E+01	7.02E-01	1.56E-04
0.1 to 0.4	5.70E+02	5.63E+02	4.61E+02	3.73E+02	2.44E+02	6.82E+01	8.17E+00	1.17E-01	2.42E-05
0.4 to 0.9	1.58E+02	1.56E+02	1.28E+02	1.03E+02	6.71E+01	1.87E+01	2.24E+00	3.24E-02	6.84E-06
0.9 to 1.35	8.94E+00	8.83E+00	7.23E+00	5.85E+00	3.83E+00	1.07E+00	1.29E-01	1.85E-03	3.85E-07
1.35 to 1.8	8.25E-01	8.15E-01	6.66E-01	5.38E-01	3.51E-01	9.74E-02	1.15E-02	1.60E-04	3.14E-08
1.8 to 2.2	3.18E-02	3.14E-02	2.57E-02	2.08E-02	1.35E-02	3.74E-03	4.35E-04	5.86E-06	1.13E-09
2.2 to 2.6	3.30E-02	3.26E-02	2.66E-02	2.15E-02	1.39E-02	3.82E-03	4.43E-04	5.94E-06	1.07E-09
2.6 to 3.0	4.58E-15	6.08E-07	8.44E-06	1.28E-05	1.49E-05	7.53E-06	1.13E-06	1.65E-08	1.38E-11
3.0 to 5.0	7.07E-15	2.71E-07	3.77E-06	5.73E-06	6.66E-06	3.36E-06	5.02E-07	7.37E-09	6.14E-12
5.0 to 15.0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
totals	3.90E+03	3.86E+03	3.16E+03	2.56E+03	1.68E+03	4.74E+02	5.77E+01	8.53E-01	1.87E-04
FHB Release Flow Rate (m^3/s)	12.07	12.07	12.07	12.07	12.07	12.07	12.07	12.07	12.07
FHB to CR X/Q (s/m^3)	3.1E-03	3.1E-03	3.1E-03	3.1E-03	3.1E-03	3.1E-03	3.1E-03	3.1E-03	3.1E-03

Base10 Energy Ranges	ENVIRONMENTAL CLOUD SOURCE STRENGTH SPECTRA (MeV/cc-sec) 0 hrs	2.78e-3 hrs	0.05 hrs	0.1 hrs	0.2 hrs	0.5 hrs	1 hrs	2.0 hrs	4.0 hrs
0.0 to 0.1	1.18E+02	1.17E+02	9.59E+01	7.77E+01	5.10E+01	1.44E+01	1.76E+00	2.63E-02	5.83E-06
0.1 to 0.4	2.13E+01	2.11E+01	1.72E+01	1.39E+01	9.12E+00	2.55E+00	3.06E-01	4.38E-03	9.06E-07
0.4 to 0.9	5.92E+00	5.85E+00	4.77E+00	3.85E+00	2.51E+00	6.98E-01	8.37E-02	1.21E-03	2.56E-07
0.9 to 1.35	3.34E-01	3.30E-01	2.71E-01	2.19E-01	1.43E-01	4.01E-02	4.82E-03	6.94E-05	1.44E-08
1.35 to 1.8	3.09E-02	3.05E-02	2.49E-02	2.01E-02	1.31E-02	3.64E-03	4.30E-04	6.01E-06	1.17E-09
1.8 to 2.2	1.19E-03	1.18E-03	9.62E-04	7.77E-04	5.06E-04	1.40E-04	1.63E-05	2.19E-07	4.24E-11
2.2 to 2.6	1.24E-03	1.22E-03	9.96E-04	8.03E-04	5.22E-04	1.43E-04	1.66E-05	2.22E-07	4.00E-11
2.6 to 3.0	1.71E-16	2.27E-08	3.16E-07	4.81E-07	5.59E-07	2.82E-07	4.21E-08	6.18E-10	5.15E-13
3.0 to 5.0	2.65E-16	1.02E-08	1.41E-07	2.15E-07	2.49E-07	1.26E-07	1.88E-08	2.76E-10	2.30E-13
5.0 to 15.0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
totals	1.46E+02	1.44E+02	1.18E+02	9.58E+01	6.28E+01	1.77E+01	2.16E+00	3.19E-02	7.00E-06

Base10 Energy Ranges	ENV. CLOUD SHINE DMF AT DP10	ENVIRONMENTAL CLOUD SHINE DOSE RATES AT DOSE POINT 10 (rem/hour) 0 hrs	2.78e-3 hrs	0.05 hrs	0.1 hrs	0.2 hrs	0.5 hrs	1 hrs	2.0 hrs	4.0 hrs
0.0 to 0.1	6.42E-05	7.60E-03	7.51E-03	6.16E-03	4.99E-03	3.28E-03	9.27E-04	1.13E-04	1.69E-06	3.74E-10
0.1 to 0.4	1.11E-04	2.37E-03	2.34E-03	1.91E-03	1.55E-03	1.01E-03	2.83E-04	3.39E-05	4.87E-07	1.01E-10
0.4 to 0.9	1.13E-04	6.69E-04	6.61E-04	5.39E-04	4.35E-04	2.84E-04	7.89E-05	9.45E-06	1.37E-07	2.89E-11
0.9 to 1.35	1.22E-04	4.08E-05	4.03E-05	3.30E-05	2.67E-05	1.75E-05	4.90E-06	5.88E-07	8.47E-09	1.76E-12
1.35 to 1.8	1.29E-04	3.98E-06	3.93E-06	3.22E-06	2.60E-06	1.69E-06	4.70E-07	5.55E-08	7.75E-10	1.52E-13
1.8 to 2.2	1.40E-04	1.67E-07	1.65E-07	1.35E-07	1.09E-07	7.09E-08	1.96E-08	2.28E-09	3.07E-11	5.94E-15
2.2 to 2.6	1.47E-04	1.82E-07	1.80E-07	1.46E-07	1.18E-07	7.67E-08	2.10E-08	2.44E-09	3.27E-11	5.89E-15
2.6 to 3.0	1.51E-04	2.59E-20	3.43E-12	4.77E-11	7.26E-11	8.43E-11	4.26E-11	6.36E-12	9.32E-14	7.78E-17
3.0 to 5.0	1.67E-04	4.42E-20	1.70E-12	2.35E-11	3.58E-11	4.16E-11	2.10E-11	3.14E-12	4.60E-14	3.84E-17
5.0 to 15.0	1.93E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
totals		1.07E-02	1.06E-02	8.65E-03	7.00E-03	4.59E-03	1.30E-03	1.57E-04	2.32E-06	5.05E-10

Initial Time (hours)	Final Time (hours)	Control Room Occup. Factor (unitless)	Initial Shine Dose Rate (rem/hour)	Final Shine Dose Rate (rem/hour)	Env Cloud Shine Dose at DP 10 w/o CROF (rem)	Env Cloud Shine Dose at DP 10 w/ CROF (rem)
0	0.00278	1.0	1.07E-02	1.06E-02	2.95E-05	2.95E-05
0.00278	0.05	1.0	1.06E-02	8.65E-03	4.52E-04	4.52E-04
0.05	0.1	1.0	8.65E-03	7.00E-03	3.90E-04	3.90E-04
0.1	0.2	1.0	7.00E-03	4.59E-03	5.71E-04	5.71E-04
0.2	0.5	1.0	4.59E-03	1.30E-03	7.81E-04	7.81E-04
0.5	1	1.0	1.30E-03	1.57E-04	2.70E-04	2.70E-04
1	2	1.0	1.57E-04	2.32E-06	3.67E-05	3.67E-05
2	4	1.0	2.32E-06	5.05E-10	5.50E-07	5.50E-07
4	6	1.0	5.05E-10	1.10E-13	1.20E-10	1.20E-10
6	8	1.0	1.10E-13	2.42E-17	2.62E-14	2.62E-14
8	10	1.0	1.40E-17	3.07E-21	3.33E-18	3.33E-18
10	24	1.0	3.07E-21	0.00E+00	2.15E-20	2.15E-20
24	96	0.6	0.00E+00	0.00E+00	0.00E+00	0.00E+00
96	720	0.4	0.00E+00	0.00E+00	0.00E+00	0.00E+00
totals					2.53E-03	2.53E-03

TABLE 10.1-2 (Page 2 of 2) ENVIRONMENTAL CLOUD SHINE DOSE TO DOSE POINT 10

Base10	FHB CLOUD SOURCE STRENGTH SPECTRA (MeV/cc-sec) [per SOURCE2 Output File "ss-c.so" (see Section 9.3.1.2)]								
Energy Ranges	6.0 hrs	8.0- hrs	8.0+ hrs	10 hrs	24- hrs	24+ hrs	96- hrs	96+ hrs	720 hrs
0.0 to 0.1	3.45E-08	7.67E-12	7.67E-12	1.70E-15	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0.1 to 0.4	5.03E-09	1.05E-12	1.05E-12	2.20E-16	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0.4 to 0.9	1.45E-09	3.06E-13	3.06E-13	6.51E-17	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0.9 to 1.35	8.02E-11	1.67E-14	1.67E-14	3.48E-18	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1.35 to 1.8	6.17E-12	1.22E-15	1.22E-15	2.42E-19	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1.8 to 2.2	2.01E-13	3.60E-17	3.60E-17	6.45E-21	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2.2 to 2.6	1.93E-13	3.50E-17	3.50E-17	6.33E-21	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2.6 to 3.0	1.92E-15	2.66E-19	2.66E-19	3.67E-23	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
3.0 to 5.0	8.59E-16	1.19E-19	1.19E-19	1.64E-23	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
5.0 to 15.0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
totals	4.11E-08	9.04E-12	9.04E-12	1.99E-15	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FHB Release Flow Rate (m^3/s)	12.07	12.07	12.07	12.07	12.07	12.07	12.07	12.07	12.07
FHB to CR X/Q (s/m^3)	3.1E-03	3.1E-03	1.8E-03	1.8E-03	1.8E-03	9.8E-04	9.8E-04	2.4E-04	2.4E-04

Base10	ENVIRONMENTAL CLOUD SOURCE STRENGTH SPECTRA (MeV/cc-sec)								
Energy Ranges	6.0 hrs	8.0- hrs	8.0+ hrs	10 hrs	24- hrs	24+ hrs	96- hrs	96+ hrs	720 hrs
0.0 to 0.1	1.29E-09	2.87E-13	1.67E-13	3.70E-17	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0.1 to 0.4	1.88E-10	3.93E-14	2.28E-14	4.79E-18	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0.4 to 0.9	5.41E-11	1.15E-14	6.66E-15	1.41E-18	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0.9 to 1.35	3.00E-12	6.25E-16	3.63E-16	7.56E-20	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1.35 to 1.8	2.31E-13	4.56E-17	2.65E-17	5.26E-21	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1.8 to 2.2	7.54E-15	1.35E-18	7.81E-19	1.40E-22	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2.2 to 2.6	7.23E-15	1.31E-18	7.59E-19	1.37E-22	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2.6 to 3.0	7.20E-17	9.94E-21	5.77E-21	7.97E-25	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
3.0 to 5.0	3.21E-17	4.44E-21	2.58E-21	3.56E-25	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
5.0 to 15.0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
totals	1.54E-09	3.38E-13	1.96E-13	4.32E-17	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Base10	ENV. CLOUD SHINE DMF	ENVIRONMENTAL CLOUD SHINE DOSE RATES AT DOSE POINT 10 (rem/hour)								
Energy Ranges	AT DP10	6.0 hrs	8.0- hrs	8.0+ hrs	10 hrs	24- hrs	24+ hrs	96- hrs	96+ hrs	720 hrs
0.0 to 0.1	6.42E-05	8.30E-14	1.84E-17	1.07E-17	2.37E-21	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0.1 to 0.4	1.11E-04	2.09E-14	4.36E-18	2.53E-18	5.31E-22	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0.4 to 0.9	1.13E-04	6.11E-15	1.30E-18	7.52E-19	1.60E-22	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0.9 to 1.35	1.22E-04	3.66E-16	7.62E-20	4.43E-20	9.23E-24	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1.35 to 1.8	1.29E-04	2.98E-17	5.88E-21	3.42E-21	6.78E-25	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1.8 to 2.2	1.40E-04	1.06E-18	1.88E-22	1.09E-22	1.96E-26	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2.2 to 2.6	1.47E-04	1.06E-18	1.92E-22	1.12E-22	2.02E-26	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2.6 to 3.0	1.51E-04	1.09E-20	1.50E-24	8.72E-25	1.20E-28	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
3.0 to 5.0	1.67E-04	5.37E-21	7.41E-25	4.30E-25	5.94E-29	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
5.0 to 15.0	1.93E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
totals		1.10E-13	2.42E-17	1.40E-17	3.07E-21	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

TABLE 10.1-3 (Page 1 of 2) ENVIRONMENTAL CLOUD SHINE DOSE TO DOSE POINT 15

Base10 Energy Ranges	FHB CLOUD SOURCE STRENGTH SPECTRA (MeV/cc-sec) [per SOURCE2 Output File "ss-c.so" (see Section 9.3.1.2)] 0 hrs	2.78e-3 hrs	0.05 hrs	0.1 hrs	0.2 hrs	0.5 hrs	1 hrs	2.0 hrs	4.0 hrs
0.0 to 0.1	3.16E+03	3.13E+03	2.56E+03	2.08E+03	1.36E+03	3.86E+02	4.71E+01	7.02E-01	1.56E-04
0.1 to 0.4	5.70E+02	5.63E+02	4.61E+02	3.73E+02	2.44E+02	6.82E+01	8.17E+00	1.17E-01	2.42E-05
0.4 to 0.9	1.58E+02	1.56E+02	1.28E+02	1.03E+02	6.71E+01	1.87E+01	2.24E+00	3.24E-02	6.84E-06
0.9 to 1.35	8.94E+00	8.83E+00	7.23E+00	5.85E+00	3.83E+00	1.07E+00	1.29E-01	1.85E-03	3.85E-07
1.35 to 1.8	8.25E-01	8.15E-01	6.66E-01	5.38E-01	3.51E-01	9.74E-02	1.15E-02	1.60E-04	3.14E-08
1.8 to 2.2	3.18E-02	3.14E-02	2.57E-02	2.08E-02	1.35E-02	3.74E-03	4.35E-04	5.86E-06	1.13E-09
2.2 to 2.6	3.30E-02	3.26E-02	2.66E-02	2.15E-02	1.39E-02	3.82E-03	4.43E-04	5.94E-06	1.07E-09
2.6 to 3.0	4.58E-15	6.08E-07	8.44E-06	1.28E-05	1.49E-05	7.53E-06	1.13E-06	1.65E-08	1.38E-11
3.0 to 5.0	7.07E-15	2.71E-07	3.77E-06	5.73E-06	6.66E-06	3.36E-06	5.02E-07	7.37E-09	6.14E-12
5.0 to 15.0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
totals	3.90E+03	3.86E+03	3.16E+03	2.56E+03	1.68E+03	4.74E+02	5.77E+01	8.53E-01	1.87E-04
FHB Release Flow Rate (m^3/s)	12.07	12.07	12.07	12.07	12.07	12.07	12.07	12.07	12.07
FHB to CR X/Q (s/m^3)	3.1E-03	3.1E-03	3.1E-03	3.1E-03	3.1E-03	3.1E-03	3.1E-03	3.1E-03	3.1E-03

Base10 Energy Ranges	ENVIRONMENTAL CLOUD SOURCE STRENGTH SPECTRA (MeV/cc-sec) 0 hrs	2.78e-3 hrs	0.05 hrs	0.1 hrs	0.2 hrs	0.5 hrs	1 hrs	2.0 hrs	4.0 hrs
0.0 to 0.1	1.18E+02	1.17E+02	9.59E+01	7.77E+01	5.10E+01	1.44E+01	1.76E+00	2.63E-02	5.83E-06
0.1 to 0.4	2.13E+01	2.11E+01	1.72E+01	1.39E+01	9.12E+00	2.55E+00	3.06E-01	4.38E-03	9.06E-07
0.4 to 0.9	5.92E+00	5.85E+00	4.77E+00	3.85E+00	2.51E+00	6.98E-01	8.37E-02	1.21E-03	2.56E-07
0.9 to 1.35	3.34E-01	3.30E-01	2.71E-01	2.19E-01	1.43E-01	4.01E-02	4.82E-03	6.94E-05	1.44E-08
1.35 to 1.8	3.09E-02	3.05E-02	2.49E-02	2.01E-02	1.31E-02	3.64E-03	4.30E-04	6.01E-06	1.17E-09
1.8 to 2.2	1.19E-03	1.18E-03	9.62E-04	7.77E-04	5.06E-04	1.40E-04	1.63E-05	2.19E-07	4.24E-11
2.2 to 2.6	1.24E-03	1.22E-03	9.96E-04	8.03E-04	5.22E-04	1.43E-04	1.66E-05	2.22E-07	4.00E-11
2.6 to 3.0	1.71E-16	2.27E-08	3.16E-07	4.81E-07	5.59E-07	2.82E-07	4.21E-08	6.18E-10	5.15E-13
3.0 to 5.0	2.65E-16	1.02E-08	1.41E-07	2.15E-07	2.49E-07	1.26E-07	1.88E-08	2.76E-10	2.30E-13
5.0 to 15.0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
totals	1.46E+02	1.44E+02	1.18E+02	9.58E+01	6.28E+01	1.77E+01	2.16E+00	3.19E-02	7.00E-06

Base10 Energy Ranges	ENV. CLOUD SHINE DMF AT DP15	ENVIRONMENTAL CLOUD SHINE DOSE RATES AT DOSE POINT 15 (rem/hour) 0 hrs	2.78e-3 hrs	0.05 hrs	0.1 hrs	0.2 hrs	0.5 hrs	1 hrs	2.0 hrs	4.0 hrs
0.0 to 0.1	5.78E-05	6.84E-03	6.76E-03	5.54E-03	4.49E-03	2.95E-03	8.35E-04	1.02E-04	1.52E-06	3.37E-10
0.1 to 0.4	9.66E-05	2.06E-03	2.04E-03	1.67E-03	1.35E-03	8.81E-04	2.47E-04	2.95E-05	4.24E-07	8.75E-11
0.4 to 0.9	9.89E-05	5.85E-04	5.78E-04	4.72E-04	3.81E-04	2.48E-04	6.91E-05	8.27E-06	1.20E-07	2.53E-11
0.9 to 1.35	1.09E-04	3.64E-05	3.60E-05	2.95E-05	2.39E-05	1.56E-05	4.37E-06	5.25E-07	7.56E-09	1.57E-12
1.35 to 1.8	1.16E-04	3.58E-06	3.54E-06	2.89E-06	2.34E-06	1.52E-06	4.23E-07	4.99E-08	6.97E-10	1.36E-13
1.8 to 2.2	1.27E-04	1.51E-07	1.49E-07	1.22E-07	9.87E-08	6.43E-08	1.78E-08	2.07E-09	2.78E-11	5.38E-15
2.2 to 2.6	1.34E-04	1.66E-07	1.64E-07	1.33E-07	1.08E-07	6.99E-08	1.92E-08	2.22E-09	2.98E-11	5.37E-15
2.6 to 3.0	1.38E-04	2.37E-20	3.14E-12	4.36E-11	6.63E-11	7.71E-11	3.89E-11	5.81E-12	8.52E-14	7.11E-17
3.0 to 5.0	1.55E-04	4.10E-20	1.57E-12	2.19E-11	3.33E-11	3.86E-11	1.95E-11	2.91E-12	4.27E-14	3.56E-17
5.0 to 15.0	1.82E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
totals		9.53E-03	9.42E-03	7.71E-03	6.25E-03	4.10E-03	1.16E-03	1.40E-04	2.07E-06	4.51E-10

Initial Time (hours)	Final Time (hours)	Control Room Occup. Factor (unitless)	Initial Shine Dose Rate (rem/hour)	Final Shine Dose Rate (rem/hour)	Env Cloud Shine Dose at DP 15 w/o CROF (rem)	Env Cloud Shine Dose at DP 15 w/ CROF (rem)
0	0.00278	1.0	9.53E-03	9.42E-03	2.63E-05	2.63E-05
0.00278	0.05	1.0	9.42E-03	7.71E-03	4.03E-04	4.03E-04
0.05	0.1	1.0	7.71E-03	6.25E-03	3.48E-04	3.48E-04
0.1	0.2	1.0	6.25E-03	4.10E-03	5.10E-04	5.10E-04
0.2	0.5	1.0	4.10E-03	1.16E-03	6.97E-04	6.97E-04
0.5	1	1.0	1.16E-03	1.40E-04	2.41E-04	2.41E-04
1	2	1.0	1.40E-04	2.07E-06	3.28E-05	3.28E-05
2	4	1.0	2.07E-06	4.51E-10	4.91E-07	4.91E-07
4	6	1.0	4.51E-10	9.86E-14	1.07E-10	1.07E-10
6	8	1.0	9.86E-14	2.16E-17	2.34E-14	2.34E-14
8	10	1.0	1.25E-17	2.75E-21	2.97E-18	2.97E-18
10	24	1.0	2.75E-21	0.00E+00	1.92E-20	1.92E-20
24	96	0.6	0.00E+00	0.00E+00	0.00E+00	0.00E+00
96	720	0.4	0.00E+00	0.00E+00	0.00E+00	0.00E+00
totals					2.26E-03	2.26E-03

TABLE 10.1-3 (Page 2 of 2) ENVIRONMENTAL CLOUD SHINE DOSE TO DOSE POINT 15

Base10	FHB CLOUD SOURCE STRENGTH SPECTRA (MeV/cc-sec) [per SOURCE2 Output File "ss-c.so" (see Section 9.3.1.2)]								
Energy Ranges	6.0 hrs	8.0- hrs	8.0+ hrs	10 hrs	24- hrs	24+ hrs	96- hrs	96+ hrs	720 hrs
0.0 to 0.1	3.45E-08	7.67E-12	7.67E-12	1.70E-15	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0.1 to 0.4	5.03E-09	1.05E-12	1.05E-12	2.20E-16	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0.4 to 0.9	1.45E-09	3.06E-13	3.06E-13	6.51E-17	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0.9 to 1.35	8.02E-11	1.67E-14	1.67E-14	3.48E-18	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1.35 to 1.8	6.17E-12	1.22E-15	1.22E-15	2.42E-19	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1.8 to 2.2	2.01E-13	3.60E-17	3.60E-17	6.45E-21	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2.2 to 2.6	1.93E-13	3.50E-17	3.50E-17	6.33E-21	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2.6 to 3.0	1.92E-15	2.66E-19	2.66E-19	3.67E-23	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
3.0 to 5.0	8.59E-16	1.19E-19	1.19E-19	1.64E-23	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
5.0 to 15.0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
totals	4.11E-08	9.04E-12	9.04E-12	1.99E-15	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FHB Release Flow Rate (m^3/s)	12.07	12.07	12.07	12.07	12.07	12.07	12.07	12.07	12.07
FHB to CR X/Q (s/m^3)	3.1E-03	3.1E-03	1.8E-03	1.8E-03	1.8E-03	9.8E-04	9.8E-04	2.4E-04	2.4E-04

Base10	ENVIRONMENTAL CLOUD SOURCE STRENGTH SPECTRA (MeV/cc-sec)								
Energy Ranges	6.0 hrs	8.0- hrs	8.0+ hrs	10 hrs	24- hrs	24+ hrs	96- hrs	96+ hrs	720 hrs
0.0 to 0.1	1.29E-09	2.87E-13	1.67E-13	3.70E-17	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0.1 to 0.4	1.88E-10	3.93E-14	2.28E-14	4.79E-18	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0.4 to 0.9	5.41E-11	1.15E-14	6.66E-15	1.41E-18	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0.9 to 1.35	3.00E-12	6.25E-16	3.63E-16	7.56E-20	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1.35 to 1.8	2.31E-13	4.56E-17	2.65E-17	5.26E-21	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1.8 to 2.2	7.54E-15	1.35E-18	7.81E-19	1.40E-22	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2.2 to 2.6	7.23E-15	1.31E-18	7.59E-19	1.37E-22	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2.6 to 3.0	7.20E-17	9.94E-21	5.77E-21	7.97E-25	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
3.0 to 5.0	3.21E-17	4.44E-21	2.58E-21	3.56E-25	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
5.0 to 15.0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
totals	1.54E-09	3.38E-13	1.96E-13	4.32E-17	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Base10	ENV. CLOUD SHINE DMF	ENVIRONMENTAL CLOUD SHINE DOSE RATES AT DOSE POINT 15 (rem/hour)								
Energy Ranges	AT DP15	6.0 hrs	8.0- hrs	8.0+ hrs	10 hrs	24- hrs	24+ hrs	96- hrs	96+ hrs	720 hrs
0.0 to 0.1	5.78E-05	7.47E-14	1.66E-17	9.63E-18	2.14E-21	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0.1 to 0.4	9.66E-05	1.82E-14	3.80E-18	2.20E-18	4.62E-22	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0.4 to 0.9	9.89E-05	5.35E-15	1.13E-18	6.58E-19	1.40E-22	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0.9 to 1.35	1.09E-04	3.27E-16	6.81E-20	3.95E-20	8.24E-24	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1.35 to 1.8	1.16E-04	2.68E-17	5.29E-21	3.07E-21	6.10E-25	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1.8 to 2.2	1.27E-04	9.57E-19	1.71E-22	9.92E-23	1.78E-26	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2.2 to 2.6	1.34E-04	9.69E-19	1.75E-22	1.02E-22	1.84E-26	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2.6 to 3.0	1.38E-04	9.94E-21	1.37E-24	7.97E-25	1.10E-28	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
3.0 to 5.0	1.55E-04	4.98E-21	6.88E-25	3.99E-25	5.51E-29	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
5.0 to 15.0	1.82E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
totals		9.86E-14	2.16E-17	1.25E-17	2.75E-21	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

TABLE 10.1-4 (Page 1 of 2) ENVIRONMENTAL CLOUD SHINE DOSE TO DOSE POINT 16

Base10 Energy Ranges	FHB CLOUD SOURCE STRENGTH SPECTRA (MeV/cc-sec) [per SOURCE2 Output File "ss-c.so" (see Section 9.3.1.2)] 0 hrs	2.78e-3 hrs	0.05 hrs	0.1 hrs	0.2 hrs	0.5 hrs	1 hrs	2.0 hrs	4.0 hrs
0.0 to 0.1	3.16E+03	3.13E+03	2.56E+03	2.08E+03	1.36E+03	3.86E+02	4.71E+01	7.02E-01	1.56E-04
0.1 to 0.4	5.70E+02	5.63E+02	4.61E+02	3.73E+02	2.44E+02	6.82E+01	8.17E+00	1.17E-01	2.42E-05
0.4 to 0.9	1.58E+02	1.56E+02	1.28E+02	1.03E+02	6.71E+01	1.87E+01	2.24E+00	3.24E-02	6.84E-06
0.9 to 1.35	8.94E+00	8.83E+00	7.23E+00	5.85E+00	3.83E+00	1.07E+00	1.29E-01	1.85E-03	3.85E-07
1.35 to 1.8	8.25E-01	8.15E-01	6.66E-01	5.38E-01	3.51E-01	9.74E-02	1.15E-02	1.60E-04	3.14E-08
1.8 to 2.2	3.18E-02	3.14E-02	2.57E-02	2.08E-02	1.35E-02	3.74E-03	4.35E-04	5.86E-06	1.13E-09
2.2 to 2.6	3.30E-02	3.26E-02	2.66E-02	2.15E-02	1.39E-02	3.82E-03	4.43E-04	5.94E-06	1.07E-09
2.6 to 3.0	4.58E-15	6.08E-07	8.44E-06	1.28E-05	1.49E-05	7.53E-06	1.13E-06	1.65E-08	1.38E-11
3.0 to 5.0	7.07E-15	2.71E-07	3.77E-06	5.73E-06	6.66E-06	3.36E-06	5.02E-07	7.37E-09	6.14E-12
5.0 to 15.0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
totals	3.90E+03	3.86E+03	3.16E+03	2.56E+03	1.68E+03	4.74E+02	5.77E+01	8.53E-01	1.87E-04
FHB Release Flow Rate (m^3/s)	12.07	12.07	12.07	12.07	12.07	12.07	12.07	12.07	12.07
FHB to CR X/Q (s/m^3)	3.1E-03	3.1E-03	3.1E-03	3.1E-03	3.1E-03	3.1E-03	3.1E-03	3.1E-03	3.1E-03

Base10 Energy Ranges	ENVIRONMENTAL CLOUD SOURCE STRENGTH SPECTRA (MeV/cc-sec) 0 hrs	2.78e-3 hrs	0.05 hrs	0.1 hrs	0.2 hrs	0.5 hrs	1 hrs	2.0 hrs	4.0 hrs
0.0 to 0.1	1.18E+02	1.17E+02	9.59E+01	7.77E+01	5.10E+01	1.44E+01	1.76E+00	2.63E-02	5.83E-06
0.1 to 0.4	2.13E+01	2.11E+01	1.72E+01	1.39E+01	9.12E+00	2.55E+00	3.06E-01	4.38E-03	9.06E-07
0.4 to 0.9	5.92E+00	5.85E+00	4.77E+00	3.85E+00	2.51E+00	6.98E-01	8.37E-02	1.21E-03	2.56E-07
0.9 to 1.35	3.34E-01	3.30E-01	2.71E-01	2.19E-01	1.43E-01	4.01E-02	4.82E-03	6.94E-05	1.44E-08
1.35 to 1.8	3.05E-02	3.05E-02	2.49E-02	2.01E-02	1.31E-02	3.64E-03	4.30E-04	6.01E-06	1.17E-09
1.8 to 2.2	1.19E-03	1.18E-03	9.62E-04	7.77E-04	5.06E-04	1.40E-04	1.63E-05	2.19E-07	4.24E-11
2.2 to 2.6	1.24E-03	1.22E-03	9.96E-04	8.03E-04	5.22E-04	1.43E-04	1.66E-05	2.22E-07	4.00E-11
2.6 to 3.0	1.71E-16	2.27E-08	3.16E-07	4.81E-07	5.59E-07	2.82E-07	4.21E-08	6.18E-10	5.15E-13
3.0 to 5.0	2.65E-16	1.02E-08	1.41E-07	2.15E-07	2.49E-07	1.26E-07	1.88E-08	2.76E-10	2.30E-13
5.0 to 15.0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
totals	1.46E+02	1.44E+02	1.18E+02	9.58E+01	6.28E+01	1.77E+01	2.16E+00	3.19E-02	7.00E-06

Base10 Energy Ranges	ENV. CLOUD SHINE DMF AT DP16	ENVIRONMENTAL CLOUD SHINE DOSE RATES AT DOSE POINT 16 (rem/hour) 0 hrs	2.78e-3 hrs	0.05 hrs	0.1 hrs	0.2 hrs	0.5 hrs	1 hrs	2.0 hrs	4.0 hrs
0.0 to 0.1	5.00E-05	5.92E-03	5.85E-03	4.80E-03	3.89E-03	2.55E-03	7.22E-04	8.81E-05	1.31E-06	2.91E-10
0.1 to 0.4	8.44E-05	1.80E-03	1.78E-03	1.46E-03	1.18E-03	7.70E-04	2.15E-04	2.58E-05	3.70E-07	7.65E-11
0.4 to 0.9	8.82E-05	5.22E-04	5.16E-04	4.21E-04	3.40E-04	2.21E-04	6.16E-05	7.38E-06	1.07E-07	2.26E-11
0.9 to 1.35	9.92E-05	3.32E-05	3.28E-05	2.68E-05	2.17E-05	1.42E-05	3.98E-06	4.78E-07	6.88E-09	1.43E-12
1.35 to 1.8	1.06E-04	3.27E-06	3.23E-06	2.64E-06	2.13E-06	1.39E-06	3.86E-07	4.56E-08	6.37E-10	1.25E-13
1.8 to 2.2	1.18E-04	1.40E-07	1.39E-07	1.13E-07	9.17E-08	5.98E-08	1.65E-08	1.92E-09	2.59E-11	5.00E-15
2.2 to 2.6	1.25E-04	1.54E-07	1.53E-07	1.25E-07	1.00E-07	6.52E-08	1.79E-08	2.07E-09	2.78E-11	5.01E-15
2.6 to 3.0	1.30E-04	2.23E-20	2.96E-12	4.11E-11	6.25E-11	7.26E-11	3.66E-11	5.47E-12	8.03E-14	6.70E-17
3.0 to 5.0	1.47E-04	3.89E-20	1.49E-12	2.07E-11	3.15E-11	3.66E-11	1.85E-11	2.76E-12	4.05E-14	3.38E-17
5.0 to 15.0	1.74E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
totals		8.23E-03	8.18E-03	6.70E-03	5.43E-03	3.56E-03	1.00E-03	1.22E-04	1.80E-06	3.92E-10

Initial Time (hours)	Final Time (hours)	Control Room Occup. Factor (unitless)	Initial Shine Dose Rate (rem/hour)	Final Shine Dose Rate (rem/hour)	Env Cloud Shine Dose at DP 16 w/o CROF (rem)	Env Cloud Shine Dose at DP 16 w/ CROF (rem)
0	0.00278	1.0	8.28E-03	8.18E-03	2.29E-05	2.29E-05
0.00278	0.05	1.0	8.18E-03	6.70E-03	3.50E-04	3.50E-04
0.05	0.1	1.0	6.70E-03	5.43E-03	3.02E-04	3.02E-04
0.1	0.2	1.0	5.43E-03	3.56E-03	4.43E-04	4.43E-04
0.2	0.5	1.0	3.56E-03	1.00E-03	6.06E-04	6.06E-04
0.5	1	1.0	1.00E-03	1.22E-04	2.09E-04	2.09E-04
1	2	1.0	1.22E-04	1.80E-06	2.85E-05	2.85E-05
2	4	1.0	1.80E-06	3.92E-10	4.26E-07	4.26E-07
4	6	1.0	3.92E-10	8.56E-14	9.30E-11	9.30E-11
6	8	1.0	8.56E-14	1.87E-17	2.03E-14	2.03E-14
8	10	1.0	1.09E-17	2.38E-21	2.58E-18	2.58E-18
10	24	1.0	2.38E-21	0.00E+00	1.67E-20	1.67E-20
24	96	0.6	0.00E+00	0.00E+00	0.00E+00	0.00E+00
96	720	0.4	0.00E+00	0.00E+00	0.00E+00	0.00E+00
totals					1.96E-03	1.96E-03

TABLE 10.1-4 (Page 2 of 2) ENVIRONMENTAL CLOUD SHINE DOSE TO DOSE POINT 16

Base10 Energy Ranges	FHB CLOUD SOURCE STRENGTH SPECTRA (MeV/cc-sec) [per SOURCE2 Output File "ss-c.so" (see Section 9.3.1.2)] 6.0 hrs	8.0- hrs	8.0+ hrs	10 hrs	24- hrs	24+ hrs	96- hrs	96+ hrs	720 hrs
0.0 to 0.1	3.45E-08	7.67E-12	7.67E-12	1.70E-15	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0.1 to 0.4	5.03E-09	1.05E-12	1.05E-12	2.20E-16	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0.4 to 0.9	1.45E-09	3.06E-13	3.06E-13	6.51E-17	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0.9 to 1.35	8.02E-11	1.67E-14	1.67E-14	3.48E-18	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1.35 to 1.8	6.17E-12	1.22E-15	1.22E-15	2.42E-19	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1.8 to 2.2	2.01E-13	3.60E-17	3.60E-17	6.45E-21	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2.2 to 2.6	1.93E-13	3.50E-17	3.50E-17	6.33E-21	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2.6 to 3.0	1.92E-15	2.66E-19	2.66E-19	3.67E-23	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
3.0 to 5.0	8.59E-16	1.19E-19	1.19E-19	1.64E-23	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
5.0 to 15.0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
totals	4.11E-08	9.04E-12	9.04E-12	1.99E-15	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
FHB Release Flow Rate (m^3/s)	12.07	12.07	12.07	12.07	12.07	12.07	12.07	12.07	12.07
FHB to CR X/Q (s/m^3)	3.1E-03	3.1E-03	1.8E-03	1.8E-03	1.8E-03	9.8E-04	9.8E-04	2.4E-04	2.4E-04

Base10 Energy Ranges	ENVIRONMENTAL CLOUD SOURCE STRENGTH SPECTRA (MeV/cc-sec) 6.0 hrs	8.0- hrs	8.0+ hrs	10 hrs	24- hrs	24+ hrs	96- hrs	96+ hrs	720 hrs
0.0 to 0.1	1.29E-09	2.87E-13	1.67E-13	3.70E-17	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0.1 to 0.4	1.88E-10	3.93E-14	2.28E-14	4.79E-18	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0.4 to 0.9	5.41E-11	1.15E-14	6.66E-15	1.41E-18	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0.9 to 1.35	3.00E-12	6.25E-16	3.63E-16	7.56E-20	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1.35 to 1.8	2.31E-13	4.56E-17	2.65E-17	5.26E-21	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1.8 to 2.2	7.54E-15	1.35E-18	7.81E-19	1.40E-22	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2.2 to 2.6	7.23E-15	1.31E-18	7.59E-19	1.37E-22	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2.6 to 3.0	7.20E-17	9.94E-21	5.77E-21	7.97E-25	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
3.0 to 5.0	3.21E-17	4.44E-21	2.58E-21	3.56E-25	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
5.0 to 15.0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
totals	1.54E-09	3.38E-13	1.96E-13	4.32E-17	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Base10 Energy Ranges	ENV. CLOUD SHINE DMF AT DP16	ENVIRONMENTAL CLOUD SHINE DOSE RATES AT DOSE POINT 16 (rem/hour) 6.0 hrs	8.0- hrs	8.0+ hrs	10 hrs	24- hrs	24+ hrs	96- hrs	96+ hrs	720 hrs
0.0 to 0.1	5.00E-05	6.46E-14	1.43E-17	8.33E-18	1.85E-21	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0.1 to 0.4	8.44E-05	1.59E-14	3.32E-18	1.93E-18	4.04E-22	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0.4 to 0.9	8.82E-05	4.77E-15	1.01E-18	5.87E-19	1.25E-22	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
0.9 to 1.35	9.92E-05	2.98E-16	6.20E-20	3.60E-20	7.50E-24	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1.35 to 1.8	1.06E-04	2.45E-17	4.84E-21	2.81E-21	5.57E-25	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1.8 to 2.2	1.18E-04	8.89E-19	1.59E-22	9.22E-23	1.65E-26	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2.2 to 2.6	1.25E-04	9.04E-19	1.63E-22	9.49E-23	1.72E-26	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
2.6 to 3.0	1.30E-04	9.36E-21	1.29E-24	7.51E-25	1.04E-28	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
3.0 to 5.0	1.47E-04	4.72E-21	6.52E-25	3.79E-25	5.23E-29	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
5.0 to 15.0	1.74E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
totals		8.56E-14	1.87E-17	1.09E-17	2.38E-21	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

10.2 QUATTRO-PRO Evaluation of Control Room HVAC Filter Shine

Section 8.10 addresses control room HVAC filter shine doses in the control board area of the control room, at dose points 9, 10, 15 and 16 as shown in Figure 4-1 of Design Input 4.10. Per Design Input 4.10, the maximum dose at these four dose points represents the Control Room Operator dose. Tables 10.2-1 through 10.2-4 present Quattro-Pro spreadsheet evaluations of the control room HVAC filter shine dose at these locations. Sample calculations of these spreadsheet evaluations are presented in Section 8.10.

TABLE 10.2-1 (Page 1 of 2) CONTROL ROOM FILTER SHINE DOSE TO DOSE POINT 9

Base10 Energy Ranges	FILTER SOURCE STRENGTH SPECTRA (MeV/cc-sec) [per SOURCE2 Output File "ss-f.so" (see Section 9.3.2.2)] 0 hrs	2.78e-3 hrs	0.05 hrs	0.1 hrs	0.2 hrs	0.5 hrs	1 hrs	2.0 hrs	4.0 hrs
0.0 to 0.1	0.00E+00	0.00E+00	1.87E-20	3.24E+01	7.98E+01	1.45E+02	1.67E+02	1.70E+02	1.68E+02
0.1 to 0.4	0.00E+00	2.69E-24	4.49E-23	4.87E+03	1.20E+04	2.18E+04	2.51E+04	2.55E+04	2.53E+04
0.4 to 0.9	0.00E+00	5.66E-25	1.08E-23	2.92E+03	7.18E+03	1.30E+04	1.48E+04	1.47E+04	1.41E+04
0.9 to 1.35	0.00E+00	0.00E+00	1.93E-25	2.17E+02	5.34E+02	9.59E+02	1.09E+03	1.07E+03	9.89E+02
1.35 to 1.8	0.00E+00	0.00E+00	0.00E+00	2.01E+01	4.93E+01	8.76E+01	9.77E+01	9.28E+01	8.10E+01
1.8 to 2.2	0.00E+00	0.00E+00	0.00E+00	7.57E-01	1.85E+00	3.26E+00	3.57E+00	3.27E+00	2.65E+00
2.2 to 2.6	0.00E+00	0.00E+00	0.00E+00	7.66E-01	1.87E+00	3.29E+00	3.61E+00	3.31E+00	2.69E+00
2.6 to 3.0	0.00E+00	0.00E+00	0.00E+00	3.47E-04	1.14E-03	2.16E-03	1.24E-03	1.52E-04	1.48E-06
3.0 to 5.0	0.00E+00	0.00E+00	0.00E+00	1.55E-04	5.09E-04	9.65E-04	5.54E-04	6.79E-05	6.62E-07
5.0 to 15.0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
totals	0.00E+00	3.26E-24	1.87E-20	8.06E+03	1.99E+04	3.59E+04	4.13E+04	4.16E+04	4.07E+04

Base10 Energy Ranges	FILTER A206 SHINE DMF AT DP9	FILTER A206 SHINE DOSE RATES AT DOSE POINT 9 (rem/hour) 0 hrs	2.78e-3 hrs	0.05 hrs	0.1 hrs	0.2 hrs	0.5 hrs	1 hrs	2.0 hrs	4.0 hrs
0.0 to 0.1	2.19E-10	0.00E+00	0.00E+00	4.09E-30	7.09E-09	1.75E-08	3.17E-08	3.66E-08	3.71E-08	3.69E-08
0.1 to 0.4	1.74E-09	0.00E+00	4.68E-33	7.81E-32	8.47E-06	2.09E-05	3.79E-05	4.38E-05	4.44E-05	4.41E-05
0.4 to 0.9	2.02E-09	0.00E+00	1.14E-33	2.18E-32	5.89E-06	1.45E-05	2.62E-05	2.99E-05	2.98E-05	2.84E-05
0.9 to 1.35	2.09E-09	0.00E+00	0.00E+00	4.03E-34	4.54E-07	1.12E-06	2.00E-06	2.27E-06	2.23E-06	2.07E-06
1.35 to 1.8	2.05E-09	0.00E+00	0.00E+00	0.00E+00	4.12E-08	1.01E-07	1.80E-07	2.00E-07	1.90E-07	1.66E-07
1.8 to 2.2	2.02E-09	0.00E+00	0.00E+00	0.00E+00	1.53E-09	3.74E-09	6.58E-09	7.21E-09	6.60E-09	5.35E-09
2.2 to 2.6	1.99E-09	0.00E+00	0.00E+00	0.00E+00	1.52E-09	3.72E-09	6.55E-09	7.19E-09	6.59E-09	5.35E-09
2.6 to 3.0	1.95E-09	0.00E+00	0.00E+00	0.00E+00	6.77E-13	2.22E-12	4.22E-12	2.42E-12	2.97E-13	2.89E-15
3.0 to 5.0	1.78E-09	0.00E+00	0.00E+00	0.00E+00	2.76E-13	9.05E-13	1.72E-12	9.86E-13	1.21E-13	1.18E-15
5.0 to 15.0	1.60E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
A206 totals		0.00E+00	5.83E-33	4.19E-30	1.49E-05	3.67E-05	6.63E-05	7.62E-05	7.66E-05	7.48E-05

Base10 Energy Ranges	FILTER A207 SHINE DMF AT DP9	FILTER A207 SHINE DOSE RATES AT DOSE POINT 9 (rem/hour) 0 hrs	2.78e-3 hrs	0.05 hrs	0.1 hrs	0.2 hrs	0.5 hrs	1 hrs	2.0 hrs	4.0 hrs
0.0 to 0.1	1.11E-10	0.00E+00	0.00E+00	2.07E-30	3.59E-09	8.86E-09	1.61E-08	1.85E-08	1.88E-08	1.87E-08
0.1 to 0.4	1.34E-09	0.00E+00	3.61E-33	6.02E-32	6.53E-06	1.61E-05	2.92E-05	3.37E-05	3.42E-05	3.40E-05
0.4 to 0.9	1.74E-09	0.00E+00	9.84E-34	1.88E-32	5.08E-06	1.25E-05	2.25E-05	2.58E-05	2.56E-05	2.45E-05
0.9 to 1.35	1.93E-09	0.00E+00	0.00E+00	3.72E-34	4.19E-07	1.03E-06	1.85E-06	2.10E-06	2.06E-06	1.91E-06
1.35 to 1.8	1.95E-09	0.00E+00	0.00E+00	0.00E+00	3.92E-08	9.61E-08	1.71E-07	1.91E-07	1.81E-07	1.58E-07
1.8 to 2.2	1.97E-09	0.00E+00	0.00E+00	0.00E+00	1.49E-09	3.65E-09	6.42E-09	7.03E-09	6.43E-09	5.22E-09
2.2 to 2.6	1.96E-09	0.00E+00	0.00E+00	0.00E+00	1.50E-09	3.67E-09	6.45E-09	7.08E-09	6.49E-09	5.27E-09
2.6 to 3.0	1.93E-09	0.00E+00	0.00E+00	0.00E+00	6.70E-13	2.20E-12	4.17E-12	2.39E-12	2.94E-13	2.86E-15
3.0 to 5.0	1.80E-09	0.00E+00	0.00E+00	0.00E+00	2.79E-13	9.16E-13	1.74E-12	9.97E-13	1.22E-13	1.19E-15
5.0 to 15.0	1.64E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
A207 totals		0.00E+00	4.59E-33	2.15E-30	1.21E-05	2.97E-05	5.38E-05	6.18E-05	6.21E-05	6.05E-05
A206 + A207 totals		0.00E+00	1.04E-32	6.34E-30	2.69E-05	6.64E-05	1.20E-04	1.38E-04	1.39E-04	1.35E-04

Initial Time (hours)	Final Time (hours)	Control Room Occup. Factor (unitless)	Initial Shine Dose Rate (rem/hour)	Final Shine Dose Rate (rem/hour)	Filter Shine Dose at DP 9 w/o CROF (rem)	Filter Shine Dose at DP 9 w/ CROF (rem)
0	0.00278	1.0	0.00E+00	1.04E-32	1.45E-35	1.45E-35
0.00278	0.05	1.0	1.04E-32	6.34E-30	4.66E-32	4.66E-32
0.05	0.1	1.0	6.34E-30	2.69E-05	2.38E-08	2.38E-08
0.1	0.2	1.0	2.69E-05	6.64E-05	4.37E-06	4.37E-06
0.2	0.5	1.0	6.64E-05	1.20E-04	2.72E-05	2.72E-05
0.5	1	1.0	1.20E-04	1.38E-04	6.44E-05	6.44E-05
1	2	1.0	1.38E-04	1.39E-04	1.38E-04	1.38E-04
2	4	1.0	1.39E-04	1.35E-04	2.74E-04	2.74E-04
4	6	1.0	1.35E-04	1.32E-04	2.67E-04	2.67E-04
6	8	1.0	1.32E-04	1.29E-04	2.61E-04	2.61E-04
8	10	1.0	1.29E-04	1.26E-04	2.55E-04	2.55E-04
10	24	1.0	1.26E-04	1.10E-04	1.65E-03	1.65E-03
24	96	0.6	1.10E-04	7.14E-05	6.43E-03	3.86E-03
96	720	0.4	7.14E-05	7.41E-06	1.76E-02	7.05E-03
totals					2.70E-02	1.38E-02

TABLE 10.2-1 (Page 2 of 2) CONTROL ROOM FILTER SHINE DOSE TO DOSE POINT 9

Base10 Energy Ranges	FILTER SOURCE STRENGTH SPECTRA (MeV/cc-sec) [per SOURCE2 Output File "ss-f.so" (see Section 9.3.2.2)] 6.0 hrs	8.0 hrs	10 hrs	24 hrs	96 hrs	720 hrs
0.0 to 0.1	1.67E+02	1.66E+02	1.65E+02	1.57E+02	1.21E+02	1.29E+01
0.1 to 0.4	2.52E+04	2.50E+04	2.48E+04	2.36E+04	1.82E+04	1.93E+03
0.4 to 0.9	1.35E+04	1.29E+04	1.23E+04	9.34E+03	4.05E+03	3.85E+02
0.9 to 1.35	9.18E+02	8.53E+02	7.94E+02	4.87E+02	4.41E+01	4.55E-08
1.35 to 1.8	7.10E+01	6.26E+01	5.54E+01	2.68E+01	2.03E+00	2.09E-09
1.8 to 2.2	2.15E+00	1.74E+00	1.41E+00	3.25E-01	1.72E-04	0.00E+00
2.2 to 2.6	2.18E+00	1.77E+00	1.43E+00	3.30E-01	1.74E-04	0.00E+00
2.6 to 3.0	1.38E-08	1.29E-10	1.20E-12	0.00E+00	0.00E+00	0.00E+00
3.0 to 5.0	6.17E-09	5.74E-11	5.35E-13	0.00E+00	0.00E+00	0.00E+00
5.0 to 15.0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
totals	3.98E+04	3.89E+04	3.81E+04	3.36E+04	2.24E+04	2.33E+03

Base10 Energy Ranges	FILTER A206 SHINE DMF AT DP9	FILTER A206 SHINE DOSE RATES AT DOSE POINT 9 (rem/hour) 6.0 hrs	8.0 hrs	10 hrs	24 hrs	96 hrs	720 hrs
0.0 to 0.1	2.19E-10	3.66E-08	3.63E-08	3.61E-08	3.42E-08	2.65E-08	2.82E-09
0.1 to 0.4	1.74E-09	4.38E-05	4.35E-05	4.31E-05	4.10E-05	3.16E-05	3.36E-06
0.4 to 0.9	2.02E-09	2.72E-05	2.60E-05	2.49E-05	1.89E-05	8.18E-06	7.78E-07
0.9 to 1.35	2.09E-09	1.92E-06	1.78E-06	1.66E-06	1.02E-06	9.21E-08	9.51E-17
1.35 to 1.8	2.05E-09	1.46E-07	1.28E-07	1.14E-07	5.49E-08	4.16E-09	4.29E-18
1.8 to 2.2	2.02E-09	4.34E-09	3.52E-09	2.85E-09	6.57E-10	3.46E-13	0.00E+00
2.2 to 2.6	1.99E-09	4.34E-09	3.52E-09	2.85E-09	6.57E-10	3.46E-13	0.00E+00
2.6 to 3.0	1.95E-09	2.70E-17	2.51E-19	2.34E-21	0.00E+00	0.00E+00	0.00E+00
3.0 to 5.0	1.78E-09	1.10E-17	1.02E-19	9.52E-22	0.00E+00	0.00E+00	0.00E+00
5.0 to 15.0	1.60E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
A206 totals		7.31E-05	7.14E-05	6.99E-05	6.10E-05	3.99E-05	4.14E-06

Base10 Energy Ranges	FILTER A207 SHINE DMF AT DP9	FILTER A207 SHINE DOSE RATES AT DOSE POINT 9 (rem/hour) 6.0 hrs	8.0 hrs	10 hrs	24 hrs	96 hrs	720 hrs
0.0 to 0.1	1.11E-10	1.86E-08	1.84E-08	1.83E-08	1.74E-08	1.34E-08	1.43E-09
0.1 to 0.4	1.34E-09	3.37E-05	3.35E-05	3.32E-05	3.16E-05	2.44E-05	2.59E-06
0.4 to 0.9	1.74E-09	2.34E-05	2.24E-05	2.15E-05	1.63E-05	7.04E-06	6.70E-07
0.9 to 1.35	1.93E-09	1.77E-06	1.65E-06	1.53E-06	9.40E-07	8.51E-08	8.78E-17
1.35 to 1.8	1.95E-09	1.38E-07	1.22E-07	1.08E-07	5.22E-08	3.96E-09	4.08E-18
1.8 to 2.2	1.97E-09	4.23E-09	3.43E-09	2.78E-09	6.41E-10	3.38E-13	0.00E+00
2.2 to 2.6	1.96E-09	4.27E-09	3.46E-09	2.81E-09	6.47E-10	3.41E-13	0.00E+00
2.6 to 3.0	1.93E-09	2.67E-17	2.48E-19	2.31E-21	0.00E+00	0.00E+00	0.00E+00
3.0 to 5.0	1.80E-09	1.11E-17	1.03E-19	9.62E-22	0.00E+00	0.00E+00	0.00E+00
5.0 to 15.0	1.64E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
A207 totals		5.91E-05	5.77E-05	5.64E-05	4.88E-05	3.15E-05	3.26E-06
A206 + A207 totals		1.32E-04	1.29E-04	1.26E-04	1.10E-04	7.14E-05	7.41E-06

TABLE 10.2-2 (Page 1 of 2) CONTROL ROOM FILTER SHINE DOSE TO DOSE POINT 10

Base10 Energy Ranges	FILTER SOURCE STRENGTH SPECTRA (MeV/cc-sec) [per SOURCE2 Output File "ss-f.so" (see Section 9.3.2.2)] 0 hrs	2.78e-3 hrs	0.05 hrs	0.1 hrs	0.2 hrs	0.5 hrs	1 hrs	2.0 hrs	4.0 hrs
0.0 to 0.1	0.00E+00	0.00E+00	1.87E-20	3.24E+01	7.98E+01	1.45E+02	1.67E+02	1.70E+02	1.68E+02
0.1 to 0.4	0.00E+00	2.69E-24	4.49E-23	4.87E+03	1.20E+04	2.18E+04	2.51E+04	2.55E+04	2.53E+04
0.4 to 0.9	0.00E+00	5.66E-25	1.08E-23	2.92E+03	7.18E+03	1.30E+04	1.48E+04	1.47E+04	1.41E+04
0.9 to 1.35	0.00E+00	0.00E+00	1.93E-25	2.17E+02	5.34E+02	9.59E+02	1.09E+03	1.07E+03	9.89E+02
1.35 to 1.8	0.00E+00	0.00E+00	0.00E+00	2.01E+01	4.93E+01	8.76E+01	9.77E+01	9.28E+01	8.10E+01
1.8 to 2.2	0.00E+00	0.00E+00	0.00E+00	7.57E-01	1.85E+00	3.26E+00	3.57E+00	3.27E+00	2.65E+00
2.2 to 2.6	0.00E+00	0.00E+00	0.00E+00	7.66E-01	1.87E+00	3.29E+00	3.61E+00	3.31E+00	2.69E+00
2.6 to 3.0	0.00E+00	0.00E+00	0.00E+00	3.47E-04	1.14E-03	2.16E-03	1.24E-03	1.52E-04	1.48E-06
3.0 to 5.0	0.00E+00	0.00E+00	0.00E+00	1.55E-04	5.09E-04	9.65E-04	5.54E-04	6.79E-05	6.62E-07
5.0 to 15.0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
totals	0.00E+00	3.26E-24	1.87E-20	8.06E+03	1.99E+04	3.59E+04	4.13E+04	4.16E+04	4.07E+04

Base10 Energy Ranges	FILTER A206 SHINE DMF AT DP10	FILTER A206 SHINE DOSE RATES AT DOSE POINT 10 (rem/hour) 0 hrs	2.78e-3 hrs	0.05 hrs	0.1 hrs	0.2 hrs	0.5 hrs	1 hrs	2.0 hrs	4.0 hrs
0.0 to 0.1	6.15E-10	0.00E+00	0.00E+00	1.15E-29	1.99E-08	4.91E-08	8.90E-08	1.03E-07	1.04E-07	1.04E-07
0.1 to 0.4	3.28E-09	0.00E+00	8.83E-33	1.47E-31	1.60E-05	3.94E-05	7.15E-05	8.25E-05	8.37E-05	8.31E-05
0.4 to 0.9	3.45E-09	0.00E+00	1.95E-33	3.73E-32	1.01E-05	2.48E-05	4.47E-05	5.11E-05	5.08E-05	4.86E-05
0.9 to 1.35	3.38E-09	0.00E+00	0.00E+00	6.52E-34	7.34E-07	1.80E-06	3.24E-06	3.67E-06	3.60E-06	3.34E-06
1.35 to 1.8	3.24E-09	0.00E+00	0.00E+00	0.00E+00	6.52E-08	1.60E-07	2.84E-07	3.17E-07	3.01E-07	2.62E-07
1.8 to 2.2	3.13E-09	0.00E+00	0.00E+00	0.00E+00	2.37E-09	5.79E-09	1.02E-08	1.12E-08	1.02E-08	8.29E-09
2.2 to 2.6	3.06E-09	0.00E+00	0.00E+00	0.00E+00	2.34E-09	5.73E-09	1.01E-08	1.11E-08	1.01E-08	8.22E-09
2.6 to 3.0	2.97E-09	0.00E+00	0.00E+00	0.00E+00	1.03E-12	3.38E-12	6.42E-12	3.68E-12	4.52E-13	4.41E-15
3.0 to 5.0	2.68E-09	0.00E+00	0.00E+00	0.00E+00	4.15E-13	1.36E-12	2.59E-12	1.48E-12	1.82E-13	1.77E-15
5.0 to 15.0	2.38E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
A206 totals		0.00E+00	1.08E-32	1.17E-29	2.69E-05	6.62E-05	1.20E-04	1.38E-04	1.39E-04	1.35E-04

Base10 Energy Ranges	FILTER A207 SHINE DMF AT DP10	FILTER A207 SHINE DOSE RATES AT DOSE POINT 10 (rem/hour) 0 hrs	2.78e-3 hrs	0.05 hrs	0.1 hrs	0.2 hrs	0.5 hrs	1 hrs	2.0 hrs	4.0 hrs
0.0 to 0.1	1.26E-10	0.00E+00	0.00E+00	2.35E-30	4.08E-09	1.01E-08	1.82E-08	2.10E-08	2.14E-08	2.12E-08
0.1 to 0.4	1.21E-09	0.00E+00	3.26E-33	5.43E-32	5.89E-06	1.45E-05	2.64E-05	3.04E-05	3.09E-05	3.07E-05
0.4 to 0.9	1.49E-09	0.00E+00	8.43E-34	1.61E-32	4.35E-06	1.07E-05	1.93E-05	2.21E-05	2.19E-05	2.10E-05
0.9 to 1.35	1.60E-09	0.00E+00	0.00E+00	3.09E-34	3.48E-07	8.54E-07	1.53E-06	1.74E-06	1.71E-06	1.58E-06
1.35 to 1.8	1.59E-09	0.00E+00	0.00E+00	0.00E+00	3.20E-08	7.83E-08	1.39E-07	1.55E-07	1.48E-07	1.29E-07
1.8 to 2.2	1.59E-09	0.00E+00	0.00E+00	0.00E+00	1.20E-09	2.94E-09	5.18E-09	5.67E-09	5.19E-09	4.21E-09
2.2 to 2.6	1.58E-09	0.00E+00	0.00E+00	0.00E+00	1.21E-09	2.96E-09	5.20E-09	5.71E-09	5.23E-09	4.25E-09
2.6 to 3.0	1.54E-09	0.00E+00	0.00E+00	0.00E+00	5.35E-13	1.76E-12	3.33E-12	1.91E-12	2.34E-13	2.28E-15
3.0 to 5.0	1.43E-09	0.00E+00	0.00E+00	0.00E+00	2.22E-13	7.27E-13	1.38E-12	7.92E-13	9.71E-14	9.47E-16
5.0 to 15.0	1.29E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
A207 totals		0.00E+00	4.10E-33	2.42E-30	1.06E-05	2.62E-05	4.74E-05	5.44E-05	5.47E-05	5.34E-05
A206 + A207 totals		0.00E+00	1.49E-32	1.41E-29	3.75E-05	9.24E-05	1.67E-04	1.92E-04	1.93E-04	1.89E-04

Initial Time (hours)	Final Time (hours)	Control Room Occup. Factor (unitless)	Initial Shine Dose Rate (rem/hour)	Final Shine Dose Rate (rem/hour)	Filter Shine Dose at DP 10 w/o CROF (rem)	Filter Shine Dose at DP 10 w/ CROF (rem)
0	0.00278	1.0	0.00E+00	1.49E-32	2.07E-35	2.07E-35
0.00278	0.05	1.0	1.49E-32	1.41E-29	9.70E-32	9.70E-32
0.05	0.1	1.0	1.41E-29	3.75E-05	3.33E-08	3.33E-08
0.1	0.2	1.0	3.75E-05	9.24E-05	6.09E-06	6.09E-06
0.2	0.5	1.0	9.24E-05	1.67E-04	3.78E-05	3.78E-05
0.5	1	1.0	1.67E-04	1.92E-04	8.97E-05	8.97E-05
1	2	1.0	1.92E-04	1.93E-04	1.93E-04	1.93E-04
2	4	1.0	1.93E-04	1.89E-04	3.82E-04	3.82E-04
4	6	1.0	1.89E-04	1.85E-04	3.73E-04	3.73E-04
6	8	1.0	1.85E-04	1.80E-04	3.65E-04	3.65E-04
8	10	1.0	1.80E-04	1.77E-04	3.57E-04	3.57E-04
10	24	1.0	1.77E-04	1.55E-04	2.32E-03	2.32E-03
24	96	0.6	1.55E-04	1.02E-04	9.11E-03	5.45E-03
96	720	0.4	1.02E-04	1.06E-05	2.52E-02	1.01E-02
totals					3.84E-02	1.97E-02

TABLE 10.2-2 (Page 2 of 2) CONTROL ROOM FILTER SHINE DOSE TO DOSE POINT 10

Base10 Energy Ranges	FILTER SOURCE STRENGTH SPECTRA (MeV/cc-sec) [per SOURCE2 Output File "ss-f.so" (see Section 9.3.2.2)] 6.0 hrs	8.0 hrs	10 hrs	24 hrs	96 hrs	720 hrs
0.0 to 0.1	1.67E+02	1.66E+02	1.65E+02	1.57E+02	1.21E+02	1.29E+01
0.1 to 0.4	2.52E+04	2.50E+04	2.48E+04	2.36E+04	1.82E+04	1.93E+03
0.4 to 0.9	1.35E+04	1.29E+04	1.23E+04	9.34E+03	4.05E+03	3.85E+02
0.9 to 1.35	9.18E+02	8.53E+02	7.94E+02	4.87E+02	4.41E+01	4.55E-08
1.35 to 1.8	7.10E+01	6.26E+01	5.54E+01	2.68E+01	2.03E+00	2.09E-09
1.8 to 2.2	2.15E+00	1.74E+00	1.41E+00	3.25E-01	1.72E-04	0.00E+00
2.2 to 2.6	2.18E+00	1.77E+00	1.43E+00	3.30E-01	1.74E-04	0.00E+00
2.6 to 3.0	1.38E-08	1.29E-10	1.20E-12	0.00E+00	0.00E+00	0.00E+00
3.0 to 5.0	6.17E-09	5.74E-11	5.35E-13	0.00E+00	0.00E+00	0.00E+00
5.0 to 15.0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
totals	3.98E+04	3.89E+04	3.81E+04	3.36E+04	2.24E+04	2.33E+03

Base10 Energy Ranges	FILTER A206 SHINE DMF AT DP10	FILTER A206 SHINE DOSE RATES AT DOSE POINT 10 (rem/hour) 6.0 hrs	8.0 hrs	10 hrs	24 hrs	96 hrs	720 hrs
0.0 to 0.1	6.15E-10	1.03E-07	1.02E-07	1.01E-07	9.64E-08	7.44E-08	7.91E-09
0.1 to 0.4	3.28E-09	8.25E-05	8.19E-05	8.13E-05	7.73E-05	5.96E-05	6.34E-06
0.4 to 0.9	3.45E-09	4.64E-05	4.44E-05	4.26E-05	3.22E-05	1.40E-05	1.33E-06
0.9 to 1.35	3.38E-09	3.10E-06	2.88E-06	2.68E-06	1.65E-06	1.49E-07	1.54E-16
1.35 to 1.8	3.24E-09	2.30E-07	2.03E-07	1.80E-07	8.67E-08	6.58E-09	6.78E-18
1.8 to 2.2	3.13E-09	6.72E-09	5.45E-09	4.42E-09	1.02E-09	5.37E-13	0.00E+00
2.2 to 2.6	3.06E-09	6.67E-09	5.41E-09	4.38E-09	1.01E-09	5.33E-13	0.00E+00
2.6 to 3.0	2.97E-09	4.11E-17	3.82E-19	3.56E-21	0.00E+00	0.00E+00	0.00E+00
3.0 to 5.0	2.68E-09	1.65E-17	1.54E-19	1.43E-21	0.00E+00	0.00E+00	0.00E+00
5.0 to 15.0	2.38E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
A206 totals		1.32E-04	1.30E-04	1.27E-04	1.11E-04	7.38E-05	7.68E-06

Base10 Energy Ranges	FILTER A207 SHINE DMF AT DP10	FILTER A207 SHINE DOSE RATES AT DOSE POINT 10 (rem/hour) 6.0 hrs	8.0 hrs	10 hrs	24 hrs	96 hrs	720 hrs
0.0 to 0.1	1.26E-10	2.11E-08	2.09E-08	2.08E-08	1.97E-08	1.52E-08	1.62E-09
0.1 to 0.4	1.21E-09	3.04E-05	3.02E-05	3.00E-05	2.85E-05	2.20E-05	2.34E-06
0.4 to 0.9	1.49E-09	2.01E-05	1.92E-05	1.84E-05	1.39E-05	6.03E-06	5.74E-07
0.9 to 1.35	1.60E-09	1.47E-06	1.37E-06	1.27E-06	7.79E-07	7.05E-08	7.28E-17
1.35 to 1.8	1.59E-09	1.13E-07	9.95E-08	8.82E-08	4.26E-08	3.23E-09	3.33E-18
1.8 to 2.2	1.59E-09	3.41E-09	2.77E-09	2.24E-09	5.17E-10	2.73E-13	0.00E+00
2.2 to 2.6	1.58E-09	3.44E-09	2.79E-09	2.26E-09	5.22E-10	2.75E-13	0.00E+00
2.6 to 3.0	1.54E-09	2.13E-17	1.98E-19	1.84E-21	0.00E+00	0.00E+00	0.00E+00
3.0 to 5.0	1.43E-09	8.83E-18	8.21E-20	7.64E-22	0.00E+00	0.00E+00	0.00E+00
5.0 to 15.0	1.29E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
A207 totals		5.21E-05	5.09E-05	4.98E-05	4.33E-05	2.81E-05	2.91E-06
A206 + A207 totals		1.85E-04	1.80E-04	1.77E-04	1.55E-04	1.02E-04	1.06E-05

TABLE 10.2-3 (Page 1 of 2) CONTROL ROOM FILTER SHINE DOSE TO DOSE POINT 15

Base10 Energy Ranges	FILTER SOURCE STRENGTH SPECTRA (MeV/cc-sec) [per SOURCE2 Output File "ss-f.so" (see Section 9.3.2.2)] 0 hrs	2.78e-3 hrs	0.05 hrs	0.1 hrs	0.2 hrs	0.5 hrs	1 hrs	2.0 hrs	4.0 hrs
0.0 to 0.1	0.00E+00	0.00E+00	1.87E-20	3.24E+01	7.98E+01	1.45E+02	1.67E+02	1.70E+02	1.68E+02
0.1 to 0.4	0.00E+00	2.69E-24	4.49E-23	4.87E+03	1.20E+04	2.18E+04	2.51E+04	2.55E+04	2.53E+04
0.4 to 0.9	0.00E+00	5.66E-25	1.08E-23	2.92E+03	7.18E+03	1.30E+04	1.48E+04	1.47E+04	1.41E+04
0.9 to 1.35	0.00E+00	0.00E+00	1.93E-25	2.17E+02	5.34E+02	9.59E+02	1.09E+03	1.07E+03	9.89E+02
1.35 to 1.8	0.00E+00	0.00E+00	0.00E+00	2.01E+01	4.93E+01	8.76E+01	9.77E+01	9.28E+01	8.10E+01
1.8 to 2.2	0.00E+00	0.00E+00	0.00E+00	7.57E-01	1.85E+00	3.26E+00	3.57E+00	3.27E+00	2.65E+00
2.2 to 2.6	0.00E+00	0.00E+00	0.00E+00	7.66E-01	1.87E+00	3.29E+00	3.61E+00	3.31E+00	2.69E+00
2.6 to 3.0	0.00E+00	0.00E+00	0.00E+00	3.47E-04	1.14E-03	2.16E-03	1.24E-03	1.52E-04	1.48E-06
3.0 to 5.0	0.00E+00	0.00E+00	0.00E+00	1.55E-04	5.09E-04	9.65E-04	5.54E-04	6.79E-05	6.62E-07
5.0 to 15.0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
totals	0.00E+00	3.26E-24	1.87E-20	8.06E+03	1.99E+04	3.59E+04	4.13E+04	4.16E+04	4.07E+04

Base10 Energy Ranges	FILTER A206 SHINE DMF AT DP15	FILTER A206 SHINE DOSE RATES AT DOSE POINT 15 (rem/hour) 0 hrs	2.78e-3 hrs	0.05 hrs	0.1 hrs	0.2 hrs	0.5 hrs	1 hrs	2.0 hrs	4.0 hrs
0.0 to 0.1	4.41E-10	0.00E+00	0.00E+00	8.24E-30	1.43E-08	3.52E-08	6.38E-08	7.37E-08	7.48E-08	7.43E-08
0.1 to 0.4	2.43E-09	0.00E+00	6.54E-33	1.09E-31	1.18E-05	2.92E-05	5.30E-05	6.11E-05	6.20E-05	6.16E-05
0.4 to 0.9	2.58E-09	0.00E+00	1.46E-33	2.79E-32	7.53E-06	1.85E-05	3.34E-05	3.82E-05	3.80E-05	3.63E-05
0.9 to 1.35	2.55E-09	0.00E+00	0.00E+00	4.92E-34	5.54E-07	1.36E-06	2.44E-06	2.77E-06	2.72E-06	2.52E-06
1.35 to 1.8	2.45E-09	0.00E+00	0.00E+00	0.00E+00	4.93E-08	1.21E-07	2.15E-07	2.39E-07	2.27E-07	1.98E-07
1.8 to 2.2	2.37E-09	0.00E+00	0.00E+00	0.00E+00	1.80E-09	4.39E-09	7.72E-09	8.45E-09	7.74E-09	6.27E-09
2.2 to 2.6	2.32E-09	0.00E+00	0.00E+00	0.00E+00	1.78E-09	4.34E-09	7.64E-09	8.38E-09	7.69E-09	6.23E-09
2.6 to 3.0	2.25E-09	0.00E+00	0.00E+00	0.00E+00	7.81E-13	2.56E-12	4.87E-12	2.79E-12	3.42E-13	3.34E-15
3.0 to 5.0	2.04E-09	0.00E+00	0.00E+00	0.00E+00	3.16E-13	1.04E-12	1.97E-12	1.13E-12	1.38E-13	1.35E-15
5.0 to 15.0	1.81E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
A206 totals		0.00E+00	8.00E-33	8.37E-30	2.00E-05	4.92E-05	8.91E-05	1.02E-04	1.03E-04	1.01E-04

Base10 Energy Ranges	FILTER A207 SHINE DMF AT DP15	FILTER A207 SHINE DOSE RATES AT DOSE POINT 15 (rem/hour) 0 hrs	2.78e-3 hrs	0.05 hrs	0.1 hrs	0.2 hrs	0.5 hrs	1 hrs	2.0 hrs	4.0 hrs
0.0 to 0.1	2.96E-11	0.00E+00	0.00E+00	5.53E-31	9.58E-10	2.36E-09	4.29E-09	4.94E-09	5.02E-09	4.98E-09
0.1 to 0.4	5.52E-10	0.00E+00	1.49E-33	2.48E-32	2.69E-06	6.63E-06	1.20E-05	1.39E-05	1.41E-05	1.40E-05
0.4 to 0.9	8.04E-10	0.00E+00	4.55E-34	8.68E-33	2.35E-06	5.77E-06	1.04E-05	1.19E-05	1.18E-05	1.13E-05
0.9 to 1.35	9.57E-10	0.00E+00	0.00E+00	1.85E-34	2.08E-07	5.11E-07	9.17E-07	1.04E-06	1.02E-06	9.46E-07
1.35 to 1.8	9.94E-10	0.00E+00	0.00E+00	0.00E+00	2.00E-08	4.90E-08	8.70E-08	9.71E-08	9.22E-08	8.05E-08
1.8 to 2.2	1.03E-09	0.00E+00	0.00E+00	0.00E+00	7.80E-10	1.91E-09	3.36E-09	3.67E-09	3.36E-09	2.73E-09
2.2 to 2.6	1.04E-09	0.00E+00	0.00E+00	0.00E+00	7.97E-10	1.95E-09	3.42E-09	3.76E-09	3.45E-09	2.79E-09
2.6 to 3.0	1.03E-09	0.00E+00	0.00E+00	0.00E+00	3.58E-13	1.17E-12	2.23E-12	1.28E-12	1.57E-13	1.53E-15
3.0 to 5.0	9.83E-10	0.00E+00	0.00E+00	0.00E+00	1.52E-13	5.00E-13	9.49E-13	5.44E-13	6.67E-14	6.51E-16
5.0 to 15.0	9.10E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
A207 totals		0.00E+00	1.94E-33	5.87E-31	5.26E-06	1.30E-05	2.35E-05	2.69E-05	2.71E-05	2.63E-05
A206 + A207 totals		0.00E+00	9.94E-33	8.96E-30	2.52E-05	6.22E-05	1.13E-04	1.29E-04	1.30E-04	1.27E-04

Initial Time (hours)	Final Time (hours)	Control Room Occup. Factor (unitless)	Initial Shine Dose Rate (rem/hour)	Final Shine Dose Rate (rem/hour)	Filter Shine Dose at DP 15 w/o CROF (rem)	Filter Shine Dose at DP 15 w/ CROF (rem)
0	0.00278	1.0	0.00E+00	9.94E-33	1.38E-35	1.38E-35
0.00278	0.05	1.0	9.94E-33	8.96E-30	6.21E-32	6.21E-32
0.05	0.1	1.0	8.96E-30	2.52E-05	2.24E-08	2.24E-08
0.1	0.2	1.0	2.52E-05	6.22E-05	4.10E-06	4.10E-06
0.2	0.5	1.0	6.22E-05	1.13E-04	2.55E-05	2.55E-05
0.5	1	1.0	1.13E-04	1.29E-04	6.04E-05	6.04E-05
1	2	1.0	1.29E-04	1.30E-04	1.30E-04	1.30E-04
2	4	1.0	1.30E-04	1.27E-04	2.57E-04	2.57E-04
4	6	1.0	1.27E-04	1.24E-04	2.51E-04	2.51E-04
6	8	1.0	1.24E-04	1.21E-04	2.45E-04	2.45E-04
8	10	1.0	1.21E-04	1.19E-04	2.40E-04	2.40E-04
10	24	1.0	1.19E-04	1.04E-04	1.56E-03	1.56E-03
24	96	0.6	1.04E-04	6.81E-05	6.10E-03	3.66E-03
96	720	0.4	6.81E-05	7.07E-06	1.68E-02	6.73E-03
totals					2.57E-02	1.32E-02

TABLE 10.2-3 (Page 2 of 2) CONTROL ROOM FILTER SHINE DOSE TO DOSE POINT 15

Base10 Energy Ranges	FILTER SOURCE STRENGTH SPECTRA (MeV/cc-sec) [per SOURCE2 Output File "ss-f.so" (see Section 9.3.2.2)] 6.0 hrs	8.0 hrs	10 hrs	24 hrs	96 hrs	720 hrs
0.0 to 0.1	1.67E+02	1.66E+02	1.65E+02	1.57E+02	1.21E+02	1.29E+01
0.1 to 0.4	2.52E+04	2.50E+04	2.48E+04	2.36E+04	1.82E+04	1.93E+03
0.4 to 0.9	1.35E+04	1.29E+04	1.23E+04	9.34E+03	4.05E+03	3.85E+02
0.9 to 1.35	9.18E+02	8.53E+02	7.94E+02	4.87E+02	4.41E+01	4.55E-08
1.35 to 1.8	7.10E+01	6.26E+01	5.54E+01	2.68E+01	2.03E+00	2.09E-09
1.8 to 2.2	2.15E+00	1.74E+00	1.41E+00	3.25E-01	1.72E-04	0.00E+00
2.2 to 2.6	2.18E+00	1.77E+00	1.43E+00	3.30E-01	1.74E-04	0.00E+00
2.6 to 3.0	1.38E-08	1.29E-10	1.20E-12	0.00E+00	0.00E+00	0.00E+00
3.0 to 5.0	6.17E-09	5.74E-11	5.35E-13	0.00E+00	0.00E+00	0.00E+00
5.0 to 15.0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
totals	3.98E+04	3.89E+04	3.81E+04	3.36E+04	2.24E+04	2.33E+03

Base10 Energy Ranges	FILTER A206 SHINE DMF AT DP15	FILTER A206 SHINE DOSE RATES AT DOSE POINT 15 (rem/hour) 6.0 hrs	8.0 hrs	10 hrs	24 hrs	96 hrs	720 hrs
0.0 to 0.1	4.41E-10	7.37E-08	7.32E-08	7.27E-08	6.91E-08	5.34E-08	5.68E-09
0.1 to 0.4	2.43E-09	6.11E-05	6.07E-05	6.02E-05	5.73E-05	4.42E-05	4.70E-06
0.4 to 0.9	2.58E-09	3.47E-05	3.32E-05	3.18E-05	2.41E-05	1.04E-05	9.93E-07
0.9 to 1.35	2.55E-09	2.34E-06	2.18E-06	2.02E-06	1.24E-06	1.12E-07	1.16E-16
1.35 to 1.8	2.45E-09	1.74E-07	1.53E-07	1.36E-07	6.56E-08	4.98E-09	5.13E-18
1.8 to 2.2	2.37E-09	5.09E-09	4.13E-09	3.35E-09	7.71E-10	4.06E-13	0.00E+00
2.2 to 2.6	2.32E-09	5.05E-09	4.10E-09	3.32E-09	7.66E-10	4.04E-13	0.00E+00
2.6 to 3.0	2.25E-09	3.11E-17	2.90E-19	2.70E-21	0.00E+00	0.00E+00	0.00E+00
3.0 to 5.0	2.04E-09	1.26E-17	1.17E-19	1.09E-21	0.00E+00	0.00E+00	0.00E+00
5.0 to 15.0	1.81E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
A206 totals		9.85E-05	9.63E-05	9.43E-05	8.27E-05	5.48E-05	5.70E-06

Base10 Energy Ranges	FILTER A207 SHINE DMF AT DP15	FILTER A207 SHINE DOSE RATES AT DOSE POINT 15 (rem/hour) 6.0 hrs	8.0 hrs	10 hrs	24 hrs	96 hrs	720 hrs
0.0 to 0.1	2.96E-11	4.95E-09	4.91E-09	4.88E-09	4.64E-09	3.58E-09	3.81E-10
0.1 to 0.4	5.52E-10	1.39E-05	1.38E-05	1.37E-05	1.30E-05	1.00E-05	1.07E-06
0.4 to 0.9	8.04E-10	1.08E-05	1.04E-05	9.92E-06	7.51E-06	3.25E-06	3.10E-07
0.9 to 1.35	9.57E-10	8.79E-07	8.17E-07	7.60E-07	4.66E-07	4.22E-08	4.35E-17
1.35 to 1.8	9.94E-10	7.06E-08	6.22E-08	5.51E-08	2.66E-08	2.02E-09	2.08E-18
1.8 to 2.2	1.03E-09	2.21E-09	1.79E-09	1.45E-09	3.35E-10	1.77E-13	0.00E+00
2.2 to 2.6	1.04E-09	2.27E-09	1.84E-09	1.49E-09	3.43E-10	1.81E-13	0.00E+00
2.6 to 3.0	1.03E-09	1.42E-17	1.33E-19	1.23E-21	0.00E+00	0.00E+00	0.00E+00
3.0 to 5.0	9.83E-10	6.07E-18	5.65E-20	5.25E-22	0.00E+00	0.00E+00	0.00E+00
5.0 to 15.0	9.10E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
A207 totals		2.57E-05	2.50E-05	2.44E-05	2.10E-05	1.33E-05	1.38E-06
A206 + A207 totals		1.24E-04	1.21E-04	1.19E-04	1.04E-04	6.81E-05	7.07E-06

TABLE 10.2-4 (Page 1 of 2) CONTROL ROOM FILTER SHINE DOSE TO DOSE POINT 16

Base10 Energy Ranges	FILTER SOURCE STRENGTH SPECTRA (MeV/cc-sec) [per SOURCE2 Output File "ss-f.so" (see Section 9.3.2.2)] 0 hrs	2.78e-3 hrs	0.05 hrs	0.1 hrs	0.2 hrs	0.5 hrs	1 hrs	2.0 hrs	4.0 hrs
0.0 to 0.1	0.00E+00	0.00E+00	1.87E-20	3.24E+01	7.98E+01	1.45E+02	1.67E+02	1.70E+02	1.68E+02
0.1 to 0.4	0.00E+00	2.69E-24	4.49E-23	4.87E+03	1.20E+04	2.18E+04	2.51E+04	2.55E+04	2.53E+04
0.4 to 0.9	0.00E+00	5.66E-25	1.08E-23	2.92E+03	7.18E+03	1.30E+04	1.48E+04	1.47E+04	1.41E+04
0.9 to 1.35	0.00E+00	0.00E+00	1.93E-25	2.17E+02	5.34E+02	9.59E+02	1.09E+03	1.07E+03	9.89E+02
1.35 to 1.8	0.00E+00	0.00E+00	0.00E+00	2.01E+01	4.93E+01	8.76E+01	9.77E+01	9.28E+01	8.10E+01
1.8 to 2.2	0.00E+00	0.00E+00	0.00E+00	7.57E-01	1.85E+00	3.26E+00	3.57E+00	3.27E+00	2.65E+00
2.2 to 2.6	0.00E+00	0.00E+00	0.00E+00	7.66E-01	1.87E+00	3.29E+00	3.61E+00	3.31E+00	2.69E+00
2.6 to 3.0	0.00E+00	0.00E+00	0.00E+00	3.47E-04	1.14E-03	2.16E-03	1.24E-03	1.52E-04	1.48E-06
3.0 to 5.0	0.00E+00	0.00E+00	0.00E+00	1.55E-04	5.09E-04	9.65E-04	5.54E-04	6.79E-05	6.62E-07
5.0 to 15.0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
totals	0.00E+00	3.26E-24	1.87E-20	8.06E+03	1.99E+04	3.59E+04	4.13E+04	4.16E+04	4.07E+04

Base10 Energy Ranges	FILTER A206 SHINE DMF AT DP16	FILTER A206 SHINE DOSE RATES AT DOSE POINT 16 (rem/hour) 0 hrs	2.78e-3 hrs	0.05 hrs	0.1 hrs	0.2 hrs	0.5 hrs	1 hrs	2.0 hrs	4.0 hrs
0.0 to 0.1	3.39E-10	0.00E+00	0.00E+00	6.33E-30	1.10E-08	2.71E-08	4.91E-08	5.66E-08	5.75E-08	5.71E-08
0.1 to 0.4	1.90E-09	0.00E+00	5.12E-33	8.53E-32	9.25E-06	2.28E-05	4.14E-05	4.78E-05	4.85E-05	4.81E-05
0.4 to 0.9	2.02E-09	0.00E+00	1.14E-33	2.18E-32	5.89E-06	1.45E-05	2.62E-05	2.99E-05	2.98E-05	2.84E-05
0.9 to 1.35	2.00E-09	0.00E+00	0.00E+00	3.86E-34	4.34E-07	1.07E-06	1.92E-06	2.17E-06	2.13E-06	1.98E-06
1.35 to 1.8	1.92E-09	0.00E+00	0.00E+00	0.00E+00	3.86E-08	9.46E-08	1.68E-07	1.88E-07	1.78E-07	1.55E-07
1.8 to 2.2	1.86E-09	0.00E+00	0.00E+00	0.00E+00	1.41E-09	3.44E-09	6.06E-09	6.64E-09	6.07E-09	4.92E-09
2.2 to 2.6	1.82E-09	0.00E+00	0.00E+00	0.00E+00	1.39E-09	3.41E-09	5.99E-09	6.57E-09	6.03E-09	4.89E-09
2.6 to 3.0	1.77E-09	0.00E+00	0.00E+00	0.00E+00	6.14E-13	2.02E-12	3.83E-12	2.20E-12	2.69E-13	2.63E-15
3.0 to 5.0	1.60E-09	0.00E+00	0.00E+00	0.00E+00	2.48E-13	8.14E-13	1.54E-12	8.86E-13	1.09E-13	1.06E-15
5.0 to 15.0	1.42E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
A206 totals		0.00E+00	6.26E-33	6.44E-30	1.56E-05	3.85E-05	6.97E-05	8.01E-05	8.06E-05	7.88E-05

Base10 Energy Ranges	FILTER A207 SHINE DMF AT DP16	FILTER A207 SHINE DOSE RATES AT DOSE POINT 16 (rem/hour) 0 hrs	2.78e-3 hrs	0.05 hrs	0.1 hrs	0.2 hrs	0.5 hrs	1 hrs	2.0 hrs	4.0 hrs
0.0 to 0.1	1.91E-10	0.00E+00	0.00E+00	3.57E-30	6.18E-09	1.52E-08	2.77E-08	3.19E-08	3.24E-08	3.22E-08
0.1 to 0.4	1.55E-09	0.00E+00	4.17E-33	6.96E-32	7.55E-06	1.86E-05	3.38E-05	3.90E-05	3.96E-05	3.93E-05
0.4 to 0.9	1.81E-09	0.00E+00	1.02E-33	1.95E-32	5.28E-06	1.30E-05	2.34E-05	2.68E-05	2.67E-05	2.55E-05
0.9 to 1.35	1.89E-09	0.00E+00	0.00E+00	3.65E-34	4.11E-07	1.01E-06	1.81E-06	2.05E-06	2.01E-06	1.87E-06
1.35 to 1.8	1.86E-09	0.00E+00	0.00E+00	0.00E+00	3.74E-08	9.16E-08	1.63E-07	1.82E-07	1.73E-07	1.51E-07
1.8 to 2.2	1.83E-09	0.00E+00	0.00E+00	0.00E+00	1.39E-09	3.39E-09	5.96E-09	6.53E-09	5.98E-09	4.85E-09
2.2 to 2.6	1.81E-09	0.00E+00	0.00E+00	0.00E+00	1.39E-09	3.39E-09	5.96E-09	6.54E-09	6.00E-09	4.86E-09
2.6 to 3.0	1.77E-09	0.00E+00	0.00E+00	0.00E+00	6.14E-13	2.02E-12	3.83E-12	2.20E-12	2.69E-13	2.63E-15
3.0 to 5.0	1.62E-09	0.00E+00	0.00E+00	0.00E+00	2.51E-13	8.24E-13	1.56E-12	8.97E-13	1.10E-13	1.07E-15
5.0 to 15.0	1.46E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
A207 totals		0.00E+00	5.20E-33	3.66E-30	1.33E-05	3.27E-05	5.92E-05	6.80E-05	6.84E-05	6.68E-05
A206 + A207 totals		0.00E+00	1.15E-32	1.01E-29	2.89E-05	7.13E-05	1.29E-04	1.48E-04	1.49E-04	1.46E-04

Initial Time (hours)	Final Time (hours)	Control Room Occup. Factor (unitless)	Initial Shine Dose Rate (rem/hour)	Final Shine Dose Rate (rem/hour)	Filter Shine Dose at DP 16 w/o CROF (rem)	Filter Shine Dose at DP 16 w/ CROF (rem)
0	0.00278	1.0	0.00E+00	1.15E-32	1.59E-35	1.59E-35
0.00278	0.05	1.0	1.15E-32	1.01E-29	7.02E-32	7.02E-32
0.05	0.1	1.0	1.01E-29	2.89E-05	2.57E-08	2.57E-08
0.1	0.2	1.0	2.89E-05	7.13E-05	4.70E-06	4.70E-06
0.2	0.5	1.0	7.13E-05	1.29E-04	2.92E-05	2.92E-05
0.5	1	1.0	1.29E-04	1.48E-04	6.92E-05	6.92E-05
1	2	1.0	1.48E-04	1.49E-04	1.49E-04	1.49E-04
2	4	1.0	1.49E-04	1.46E-04	2.95E-04	2.95E-04
4	6	1.0	1.46E-04	1.42E-04	2.88E-04	2.88E-04
6	8	1.0	1.42E-04	1.39E-04	2.81E-04	2.81E-04
8	10	1.0	1.39E-04	1.36E-04	2.75E-04	2.75E-04
10	24	1.0	1.36E-04	1.19E-04	1.78E-03	1.78E-03
24	96	0.6	1.19E-04	7.85E-05	7.01E-03	4.21E-03
96	720	0.4	7.85E-05	8.15E-06	1.94E-02	7.75E-03
totals					2.96E-02	1.51E-02

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

11.0 COPIES OF MISCELLANEOUS REFERENCES

11.1 Reference 6.3b -- E-Mail from D. Higgins (SCE) to F. Santa Ana (SCE)

[6] From: DAN HIGGINS at AWS3 5/13/93 9:25AM (3025 bytes: 53 ln)
To: FABIAN SANTA ANA at NESL5, THOMAS REMICK at NESL2, MARK DRUCKER at NESL2
cc: KEVIN FLYNN, DALE WICKMAN, DAN HIGGINS, JIM LYLE, MARK HERSCHTHAL
Subject: CR HVAC Intake Filter Housing
---------- Message Contents ----------

Fabian....Thank you for the vote of confidence!
Tom...Dale Wickman is your man for this system. He has taken over responsibility for the Emergency HVAC systems formerly handled by Kevin. Kevin now has Radwaste systems. However, I will answer your questions on this one and give Dale a break. Firstly, you have the right drawing. The 3 carbon trays you see are IES Standard CS-8T carbon trays for type II adsorber cells. The cells are built of type 304 SS with 26 gauge perforated plate (0.045 holes) and flanged reinforced 14 gauge 14 gauge faceplates. There are (2) 2" deep beds per charcoal cell. Cell dimensions are 24"W x 27-3/4"D x 6-9/32"H. Details of this cell with a cutaway can be found in the Nuclear Air Cleaning Handbook by C. A. Burchsted, ERDA 76-21 on page 58. Secondly, I believe the drawing you have is the only one we have available. Based on observation and notes on other AAF drawings, the steel housing is #11 GA (.1011 min.). Same for all housings.

Dale (PAX 86152) will be able to help you with any other questions you may have.

Have a good day!

Dan Higgins 5-13-93 D.C. Higgins 2-17-94

Tom,
I have not come across any document regarding the deatails of the Control Room Emergency Ventilation Unit (MA206/207). Your best bet would be Station Technical who have hands on knowledge of these units.
I suggest you get in touch with either Dan Higgins (PAX 89211) or Kevin Flynn (PAX 89212).
I am confident that they have the documents you need to complete your analysis.
Fabian 5/13/93

Fabian,
We are doing a reanalysis of the filter shine radiological dose from the Control Room HVAC Intake filters (SA1510MA206 and SA1510MA207). As of now, I have not been able to find a drawing of the filter unit that has the following dimensions:

a. Charcoal filter tray (length x width x height per tray)
b. Thickness of steel housing, at the charcoal filter location

The only drawing I have been able to find is SO23-410-1-1 (American Air Filter drawing R107D-160325). If you can suggest any other documents (such as a vendor manual) that might have the information I am looking for, I would appreciate it.

Thank you

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

11.2 Reference 6.3c -- E-Mail From F. Santa Ana (SCE) to T. Remick (Bechtel)

NOTE: Only Items 1 through 7 are used in this calculation.

[104] From: FELICIA UDREA 2/17/94 7:59AM (4957 bytes: 99 ln)
To: FABIAN SANTA ANA
Subject: Control Room HVAC Information
---------- Forwarded ----------
From: FABIAN SANTA ANA at NESL5 9/16/93 10:17AM (4782 bytes: 99 ln)
To: THOMAS REMICK at NESL6
cc: FABIAN SANTA ANA, VINCENT BARONE at NESL4, FELICIA UDREA, PATRICIA YEAGLEY at NESL3, GOPAL PATEL at NESL2
Subject: Control Room HVAC Information
---------- Message Contents ----------

Felicia, Please research and provide the required information.
Please patch the input to me prior to issue. Thanks Fabian
8/27/93

F: CHARGE THIS TO OIR 92-086, I.E. DBD.

PKY

Pat,
Please provide the charge number on this task. Thanks
Fabian

Fabian,
We are in the process of doing a reanalysis of the Fuel Handling Accident radiological consequences. As a part of the analysis, Control Room doses will be calculated. Can you suggest any "good" references for the following Control Room HVAC information? I have indicated the current values used in some analyses, or the value from current references. Also please let me know if you disagree with any of the values I have listed. Thanks!

Tom

1. HV-9702 stroke time closed (Normal fan E295 Train A discharge) -- 6 seconds per N-4060-014 page 9
Calc. N-4060-014 dated 1980 uses UFSAR 6.4.2.2.2f as reference which indicated 6 seconds closure time. (Items 1 through 7)

2. HV-9703 stroke time closed (Normal fan E295 Train B discharge) -- 6 seconds per N-4060-014 page 9

3. HV-9711 stroke time closed (Normal fan E295 Train B suction) -- 6 seconds per N-4060-014 page 9

4. HV-9712 stroke time closed (Normal fan E295 Train A suction) -- 6 seconds per N-4060-014 page 9

5. HV-9778 stroke time open (Recirc B E419 suction) -- 6 seconds per N-4060-014 page 9

6. FV-9742 stroke time open (Emergency supply B A206 suction) -- 6 seconds per N-4060-014 page 9

7. FV-9761 stroke time open (Emergency supply A A207 suction) -- 6 seconds per N-4060-014 page 9

8. Recirc A E418 time to clear low flow condition - unknown, needed to

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

determine A207 start time Need Controls input.

9. Recirc B E419 time to clear low flow condition -- unknown, needed to determine A206 start time Need Controls input.

11. A206/7 intake filter efficiencies (based on 6 inch charcoal depth):

Elemental iodine -- 99% (TS 4.7.5.c.3, RG 1.52 C.6.a, SO23-410-1-1-13)
Organic iodine -- 99% (TS 4.7.5.c.3, RG 1.52 C.6.a, SO23-410-1-1-13)
Particulate iodine -- 99% (TS 4.7.5.c.2, RG 1.52 C.5.c)
Other Particulates -- 99% (TS 4.7.5.c.2, RG 1.52 C.5.c)

12. E418/9 recirculation filter efficiencies --
Activated carbon bed depth is 2 inch per Dan Higgins as indicated on Drawing SO23-410-1-7, revision 11.
For efficiency use RG 1.52, paragraph C.6.a.

Elemental iodine -- unknown charcoal depth, need filter drawing
Organic iodine -- unknown charcoal depth, need filter drawing
Particulate iodine -- 99% (TS 4.7.5.c.2, RG 1.52 C.5.c)
Other Particulates -- 99% (TS 4.7.5.c.2, RG 1.52 C.5.c)

13. A206/7 flowrate -- 2,050 cfm + 150 cfm = 2,200 cfm (Tech Spec 4.7.5.a)

Two trains in service equals 4,400 cfm

14. E418/9 recirculation flowrate -- (35,485 cfm - 10%) - 2,200 cfm = 29,737 cfm (Tech Spec 4.7.5.a)

Two trains in service equals 59,474 cfm

15. Normal Ventilation E295 flowrate:

Recirc -- 29,885 cfm per 40096 - 10% = 26,897 cfm
Outside Air -- 5,820 cfm per 40096 + 10% = 6,402 cfm

16. Control Room unfiltered air inleakage -- 10 cfm per Standard Review Plan 6.4, Section (II.3.d.3) III 3.2.ii

17. Control Room volume -- 244,398 ft3 per M-073-041, Revision 7
Control Room volume was changed to 244,398 ft3 in the Revision 5 of calculation M-073-041 dated 1985. A volume recalculation is in the review cycle. (Gopal Patel)

18. Transit time from HVAC duct to RE-7824/25 -- 5.6 seconds per calculation A-92-NF-003 section 4.5 Need Controls input.

19. Time when one intake train is secured -- 8 hours post-LOCA per EOI SO23-12-3, Revision 8, Floating Step FS-15

INFORMATION PROVIDED ABOVE HAVE BEEN REVIEWED AGAINST THE REFERENCED DOCUMENTS TO BE CORRECT.

E D [illegible] 2/N/94

E&TS DEPARTMENT

CALCULATION SHEET

ICCN NO./ PRELIM. CCN NO.	PAGE ___ OF ___

Project or DCP/FCN/ECP _____ Calc. No. N-4072-001

CCN CONVERSION: CCN NO. CCN --

Subject Fuel Handling Accident Inside Fuel Handling Building - CR & Offsite Doses Sheet 249 of 261

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

APPENDIX A

EVALUATION OF A TRANSFER CASK DROP
IN THE UNITS 1, 2 AND 3 CASK POOL AREAS

REV	ORIGINATOR	DATE	IRE	DATE	REV	ORIGINATOR	DATE	IRE	DATE	REV ⇓
6	N. YACKLE		T. REMICK							

A1.0 PURPOSE

The purpose of this Appendix is to assess the dose consequences of a transfer cask drop in the Unit 1 Spent Fuel Building cask loading area, or a transfer cask drop in the cask pool of either the Unit 2 or Unit 3 Fuel Handling Buildings. A transfer cask drop is currently not postulated to occur in the Unit 1 spent fuel pool area because a single failure proof crane will be used for all lifts. The Unit 1 calculation is included for completeness. Even though single failure proof cranes will be used at Units 2 and 3 to lift the transfer cask out of the cask pools, a drop can be postulated when the cask is placed on the step of the cask pools for lifting yolk change-out. During this evolution, the cask is not restrained and could fall back into the lower portion of the cask pool if an earthquake occurs. The fuel rods from all 24 Unit 1 assemblies are expected to rupture on cask impact with the bottom of the pool. All the radioactive fission gases remaining in the fuel rod gap volume are expected to be released.

A2.0 RESULTS/CONCLUSIONS AND RECOMMENDATIONS

Per Section 1.2.2, the EAB dose criteria for a fuel handling accident are 6 rem whole body gamma, and 75 rem thyroid. The EAB whole body gamma doses due to a transfer cask drop in the Unit 1 Spent Fuel Building, or a transfer cask drop in the Unit 2 or Unit 3 Fuel Handling Buildings are 0.0094 rem and 0.0027 rem, respectively. The thyroid dose is zero, since all the iodine isotopes have decayed to zero. The EAB beta skin doses for a transfer cask drop at Unit 1 and Units 2/3 are 0.78 rem and 0.22 rem, respectively. The doses are negligibly small compared to the allowable doses.

A3.0 MODELING ASSUMPTIONS

A3.1 All fuel rods in the 24 assemblies loaded into the canister inside the transfer cask are assumed to be intact when they are loaded. All the fuel rods are then assumed to rupture as a result of the cask drop.

A3.2 All of the radioactive material released into the Fuel Storage/Fuel Handling Building atmospheres is assumed to be instantaneously released to the outside environment as a puff release. The dose received at the exclusion area boundary (EAB) for a puff release is the same as the integrated dose for a two hour release.

A3.3 A minimum of 10 years has elapsed since permanent discharge from the core for all Unit 1 fuel assemblies that are loaded into the canister/transfer cask.

A4.0 DESIGN INPUTS

A4.1 The Unit 1 spent fuel pool contains all assemblies off-loaded subsequent to shutdown at the end of Unit 1 Cycle 11. End of Cycle 11 shutdown occurred on November 30, 1992 (Reference

A6.2a). All fission gases in the spent fuel rods in the Unit 1 spent fuel pool have therefore decayed for a minimum of 10 years prior to the earliest estimated removal from the spent fuel pools which will occur no earlier than January, 2003.

Per Reference A6.2a, the most recently off loaded Unit 1 spent fuel assembly stored in the Unit 2 spent fuel pool is Assembly G029. It was permanently discharged at the end of Unit 1 Cycle 8 (November 21, 1985).

Per Reference A6.2a, the most recently off loaded Unit 1 spent fuel assemblies stored in the Unit 3 spent fuel pool were permanently discharged at the end of Unit 1 Cycle 10 (June 30, 1990).

The Unit 1 assembly with the highest burnup is located in the Unit 1 spent fuel pool (Reference A6.2a). Since the Unit 1 spent fuel pool contains the highest burned assembly, and the assemblies which have been stored the shortest time since reactor shutdown, the source terms for Unit 1 fuel in the Unit 1 pool bound the source terms for Unit 1 assemblies stored in either the Unit 2 or Unit 3 spent fuel pools.

A4.2 Per Reference A6.1a, Table 1, Column 5, Unit 1 assembly iodine and noble gas radioisotope inventories at reactor shutdown (no decay) are shown in Table A4.1.

Table A4.1
Assembly Iodine and Noble Gas Inventories at Reactor Shutdown

ISOTOPE	ACTIVITY (A_0) (ci/assy)
I-131	251600
I-132	339500
I-133	468200
I-134	526100
I-135	453500
Xe-131m	2650
Xe-133m	12700
Xe-133	586600

ISOTOPE	ACTIVITY (A_0) (ci/assy)
Xe-135m	140100
Xe-135	189800
Xe-137	437600
Xe-138	435700
Kr-83m	36940
Kr-85m	87900
Kr-85	5120
Kr-87	186600
Kr-88	235000
Kr-89	341400

A4.3 Per Reference 6.4i, Section C.1d, all of the gap activity in the damaged fuel rods is released from the damaged fuel rods. This gap activity consists of 10 percent of the total noble gases other than Krypton-85, 30 percent of the Krypton-85, and 10 percent of the radioactive iodine in the rods at the time of the accident.

A4.4 The decay constants for the all isotopes listed in Table A4.1 are shown in Table A4.2. The values for all isotopes are taken from References 6.6a (Theoretical Manual).

Table A4.2
Isotopic Decay Constants

ISOTOPE	DECAY CONSTANT (λ) $(sec)^{-1}$
I-131	0
I-132	0.0000843
I-133	0.000009
I-134	0.00022
I-135	0.0000291
Xe-131m	0
Xe-133m	0.000004
Xe-133	0.000002
Xe-135m	0.000738
Xe-135	0.0000212
Xe-137	0.003024
Xe-138	0.0008151
Kr-83m	0.0001052
Kr-85m	0.000043
Kr-85	0
Kr-87	0.0001514
Kr-88	0.0000673
Kr-89	0.003632

A4.5 Per Reference 6.6a, the Kr-85 beta skin immersion dose conversion factor (DCF_{bsi}) is 4.246E-02 rem-m^3/curie-sec, and the Kr-85 whole body gamma immersion dose conversion factor (DCF_{wbgi}) is 5.102E-04 rem-m^3/curie-sec.

A4.6 Per Design Input 4.7, the exclusion area boundary (EAB) atmospheric dispersion factor (χ/Q) is 2.72E-04 sec/m^3 for the Units 2/3 Fuel Handling Buildings.

A4.7 Per Reference A6.1a, Design Input 2, the exclusion area boundary (EAB) atmospheric dispersion factor (χ/Q) is 9.50E-04 sec/m^3 for the Unit 1 Fuel Storage Building.

A5.0 METHODOLOGY

All calculations in this Appendix were completed using a spread sheet, or were done by hand using a calculator. The iodine and noble gas radioisotope 10-year decayed assembly inventories were calculated using the following equation for radioactive decay (Reference A6.2b):

$$A = A_0 e^{-\lambda t}$$

Where

A = Inventory of isotope A at time t (ci)

A_0 = Inventory of isotope A at time t = 0 (ci)

λ = decay (transformation) constant of isotope A (sec^{-1})

t = elapsed time (sec)

Since a puff release is assumed for this calculation, the beta skin and whole body dose received at the EAB for each isotope is given by the following equation:

$$D = A_R * \chi/Q * DCF$$

Where

D = Dose (beta skin immersion or whole body gamma immersion) (rem)

A_R = Inventory released for each isotope (ci)

χ/Q = Atmospheric dispersion factor (sec/m^3)

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DCF = Dose Conversion Factor (beta skin immersion or whole body gamma immersion)

This equation is adapted from Reference 6.6a, Section 4.3; terms that are not applicable for a puff release are eliminated.

The inventory released for each isotope is given by the following equation:

$$A_R = A_{(assembly)} * n * f$$

Where

$A_{(assembly)}$ = Assembly decayed inventory (ci/assy)

n = Number of assemblies in cask (assy)

f = gap fraction (unitless)

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A6.0 REFERENCES

A6.1 Calculations

A6.1a SONGS Unit 1 Calculation No. DC-3782, Revision 0, "SONGS 1 E-Planning Doses Due to Fuel Handling Accident", dated 10/29/92, including CCN No. 1 dated 06/02/94.

A6.2 Other Documents

A6.2a SNM-DBASE-10, Software Installation Report, "Special Nuclear Material Database", dated 05/05/99; Appendix C Excerpt including the data base listing for Unit 1.

A6.2b Cember, Herman, "Introduction to Health Physics", Second Edition, Pergamon Press, 1989.

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A7.0 NOMENCLATURE

EAB	exclusion area boundary
A_0	Inventory of isotope A at time t = 0 (ci)
λ	decay (transformation) constant of isotope A (sec^{-1})
DCF	dose conversion factor
DCF_{bsi}	dose conversion factor, beta skin immersion (rem-m^3/curie-sec)
DCF_{wbgi}	dose conversion factor, whole body gamma immersion (rem-m^3/curie-sec)
χ/Q	atmospheric dispersion factor (sec/m^3)
A	Inventory of isotope A at time t (ci)
t	elapsed time (sec)
D	Dose (beta skin immersion or whole body gamma immersion) (rem)
A_R	Inventory released for each isotope (ci)
$A_{(assembly)}$	Assembly decayed inventory (ci/assy)
n	Number of assemblies in cask (assy)
f	gap fraction (unitless)
D_{wbgi}	whole body gamma immersion dose (rem)
D_{bsi}	beta skin immersion dose (rem)
assy	assembly
ci	curie
sec	second
m	meter

A8.0 COMPUTATIONS

The iodine and noble gas radioisotope assembly inventory 10 years after reactor shutdown are calculated in a spread sheet using the equation for radioactive decay provided above. The results are shown in Table A8.1.

TABLE A8.1
Iodine and Noble Gas Assembly Inventory
10 Years After Reactor Shutdown

ISOTOPE	ASSEMBLY ACTIVITY ($A_{(assembly)}$) (ci/assy)
I-131	0
I-132	0
I-133	0
I-134	0
I-135	0
Xe-131m	0
Xe-133m	0
Xe-133	0
Xe-135m	0
Xe-135	0
Xe-137	0
Xe-138	0
Kr-83m	0
Kr-85m	0
Kr-85	2679
Kr-87	0
Kr-88	0

ISOTOPE	ASSEMBLY ACTIVITY ($A_{(assembly)}$) (ci/assy)
Kr-89	0

Since all iodine isotopes and all noble gas isotopes except Kr-85 have decayed to zero after 10 years of decay, only the beta skin and whole body immersion doses due to Kr-85 are calculated.

A8.1 Unit 1 EAB Whole Body Gamma Immersion Dose

Per Table A8.1 above, Assumption A3.1 and Design Inputs A4.3, A4.5 and A4.7:

$A_{(assmbly)}$ =Assembly decayed inventory = 2.679E+03 ci/assy

n =Number of assemblies in cask = 24 assy

f =gap fraction = 30%/100% = 0.30

χ/Q =9.50E-04 sec/m^3

DCF_{wbgi} =5.102E-04 rem-m^3/curie-sec.

And

$D_{wbgi} = A * \chi/Q * DCF_{wbgi}$

$D_{wbgi} = A_{(assmbly)} * n * f * \chi/Q * DCF_{wbgi}$

D_{wbgi} = 2.679E+03 ci/assy *24 assy*0.30*9.50E-04 sec/m^3*5.102E-04 rem-m^3/curie-sec

D_{wbgi} = 9.35E-03 rem

A8.2 Unit 1 EAB Beta Skin Immersion Dose

Per Table A8.1 above, Assumption A3.1 and Design Inputs A4.3, A4.5 and A4.7:

$A_{(assmbly)}$=Assembly decayed inventory =2.679E+03 ci/assy

n =Number of assemblies in cask =24 assy

f =gap fraction = 30%/100% =0.30

χ/Q =9.50E-04 sec/m^3

DCF_{bsi} =4.246E-02 rem-m^3/curie-sec.

And,

$D_{bsi} = A * \chi/Q * DCF_{bsi}$

$D_{bsi} = A_{(assmbly)} * n * f * \chi/Q * DCF_{bsi}$

D_{bsi} = 2.679E+03 ci/assy *24 assy*0.30*9.50E-04 sec/m^3*4.246E-02 rem-m^3/curie-sec

D_{bsi} = 7.77E-01 rem

A8.3 Unit 2/3 EAB Whole Body Gamma Immersion Dose

Per Table A8.1 above, Assumption A3.1 and Design Inputs A4.3, A4.5 and A4.6:

$A_{(assmbly)}$ = Assembly decayed inventory = 2.679E+03 ci/assy

n =Number of assemblies in cask = 24 assy

f =gap fraction = 30%/100% = 0.30

χ/Q =2.72E-04 sec/m^3

DCF_{wbgi} =5.102E-04 rem-m^3/curie-sec.

And,

$D_{wbgi} = A * \chi/Q * DCF_{wbgi}$

$D_{wbgi} = A_{(assmbly)} * n * f * \chi/Q * DCF_{wbgi}$

D_{wbgi} = 2.679E+03 ci/assy *24 assy*0.30*2.72E-04 sec/m^3*5.102E-04 rem-m^3/curie-sec

D_{wbgi} = 2.68E-03 rem

A8.4 Unit 2/3 EAB Beta Skin Immersion Dose

Per Table A8.1 above, Assumption A3.1 and Design Inputs A4.3, A4.5 and A4.6:

$A_{(assmbly)}$=Assembly decayed inventory =2.679E+03 ci/assy

n =Number of assemblies in cask =24 assy

f =gap fraction = 30%/100% =0.30

χ/Q =2.72E-04 sec/m^3

DCF_{bsi} =4.246E-02 rem-m^3/curie-sec.

And,

$D_{bsi} = A * \chi/Q * DCF_{bsi}$

$D_{bsi} = A_{(assmbly)} * n * f * \chi/Q * DCF_{bsi}$

D_{bsi} = 2.679E+03 ci/assy *24 assy*0.30*2.72E-04 sec/m^3*4.246E-02 rem-m^3/curie-sec

D_{bsi} = 2.23E-01 rem