Enclosure (1)

CA06449 MHA

Radiological Consequences

Design Basis Calculation

Using AST

Calvert Cliffs Nuclear Power, Inc.
November 3, 2005

ESP No.:	ES200100401	Supp No.	000	Rev. No.	000	Page 1 of 1

FORM 19, CALCULATION COVER SHEET

A. INITIATION (Control Doc Type - DCALC) Page 1 of 137

DCALC No.: CA06449 Revision No.: 000

Vendor Calculation (Check one): ☐ Yes ☒ No

Responsible Group: FOSU

Responsible Engineer: Gerard E. Gryczkowski

B. CALCULATION

ENGINEERING DISCIPLINE: ☐ Civil ☐ Instr & Controls ☒ Nuc Engrg ☐ Electrical ☐ Mechanical ☐ Nuc Fuel Mngmt ☐ Other: ☐ Reliability Engrg

Title: MAXIMUM HYPOTHETICAL ACCIDENT USING ALTERNATE SOURCE TERMS

Unit ☐ 1 ☐ 2 ☒ COMMON

Proprietary or Safeguards Calculation ☐ YES ☒ NO

Comments: NA

Vendor Calc No.: NA REVISION NO.: NA

Vendor Name: NA

Safety Class (Check one): ☒ SR ☐ AQ ☐ NSR

There are assumptions that require Verification during walkdown: AIT #: NA

This calculation **SUPERSEDES**: NA

C. REVIEW AND APPROVAL:

	Printed Name and Signature	Date
Responsible Engineer:	Gerard E. Gryczkowski [signature]	07/06/2005
Independent Reviewer:	IM Sommerville [signature]	8-19-05
Approval:	P.T. Wardroski [signature]	8/22/05

IF the results or conclusions of this calculation or revision might affect a procedure or the basis of a procedure, a Change Notification Form (Form 14) shall be forwarded to the Procedure Development Unit with a summary of the calculation's purpose and results.

2. LIST OF EFFECTIVE PAGES

Page	Latest Rev	Page	Latest Rev	Page	Latest Rev	Page	Latest Rev	Page	Latest Rev
001	0	002	0	003	0	004	0	005	0
006	0	007	0	008	0	009	0	010	0
011	0	012	0	013	0	014	0	015	0
016	0	017	0	018	0	019	0	020	0
021	0	022	0	023	0	024	0	025	0
026	0	027	0	028	0	029	0	030	0
031	0	032	0	033	0	034	0	035	0
036	0	037	0	038	0	039	0	040	0
041	0	042	0	043	0	044	0	045	0
046	0	047	0	048	0	049	0	050	0
051	0	052	0	053	0	054	0	055	0
056	0	057	0	058	0	059	0	060	0
061	0	062	0	063	0	064	0	065	0
066	0	067	0	068	0	069	0	070	0
071	0	072	0	073	0	074	0	075	0
076	0	077	0	078	0	079	0	080	0
081	0	082	0	083	0	084	0	085	0
086	0	087	0	088	0	089	0	090	0
091	0	092	0	093	0	094	0	095	0
096	0	097	0	098	0	099	0	100	0
101	0	102	0	103	0	104	0	105	0
106	0	107	0	108	0	109	0	110	0
111	0	112	0	113	0	114	0	115	0
116	0	117	0	118	0	119	0	120	0
121	0	122	0	123	0	124	0	125	0
126	0	127	0	128	0	129	0	130	0
131	0	132	0	133	0	134	0	135	0
136	0	137	0						

3. REVIEWER COMMENTS

(1) P. 9 – 6B.01 – Please be more specific regarding the table in the reference; It appears as if some nuclides are missing from the reference.
Response: Ref.5 Attachment H specified in Section 6B.01.

(2) p. 12, Please be more specific regarding the "Containment Fan Cooler startup", since there are other Containment Fan Cooler startups which are different on p.15 & 16
Response: In section 6.C.11, "containment fan cooler startup" changed to "filter fan startup."

(3) p. 8, Please explain that all sources except the H_2Purge line path use 63 nuclides but the H_2 purge line uses just the 14 noble gases and Iodines per RG 1.183, Para --
Response: The source terms for each pathway are described in their individual sections and differ among the pathways.

(4) p. 19 or 20 - please explain that the leakrate of 1.1772E-03 cfm is modified by the flashing fraction of 10% to become 1.1772E-04
Response: Section 6.D.12 now makes reference to this fact.

(5) p. 22, Please correct the equation for w to say "w = ", rather than "Y="
Response: Done

(6) p. 22, please determine the correct value for F. The table says 1685.55 and the file says 1645.
Response: 1645 is correct. The table has been fixed.

(7) p. 22, In the table, the value of .2272 is not the ratio of molecular weight of air to the molecule weight of the mixture and does not appear to be used for anything.
Response: It is the mole fraction of air in the containment equal to Pa/P and is used in MWmix. Clarified in the table.

(8) p. 22, Table – there are two different values of rho or density in the table
Response: A roundoff problem. Corrected.

(9) p. 36, Please expand on the explanation of how the filter shine computations are performed to account for the dose as a function of time. It is not really intuitively obvious
Response: See Section 9.G

(10) The control room inleakage coefficient should be 4.719474E-4. It is correct in the file Attachments T - V
Response: Ok

4. TABLE OF CONTENTS

5. INTRODUCTION

10 CFR 100 requires that each nuclear unit perform an MHA analysis to determine the two hour exclusion area boundary dose, which is limited to 25 rem whole body and 300 rem thyroid. 10 CFR 50 Appendix A GDC 19 requires that a control room shall be provided from which actions can be taken to operate the nuclear unit safely under normal conditions and to maintain it in a safe condition under accident conditions. Adequate radiation protection shall be provided to permit access and occupancy of the control room under accident conditions without personnel 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.

Chapter 14.24 of the UFSAR constitutes a safety evaluation based on a Maximum Hypothetical Accident (MHA) which involves a gross release of fission products from the fuel to the containment. During an accidental release, air containing radionuclides may enter the control room through inleakage into the control room ventilation system. The control room thyroid, whole body, and beta skin doses must meet 10 CFR 50 APP.A GDC 19 limits. Similarly, during an accidental release, air containing radionuclides may travel offsite. The offsite thyroid, whole body, and beta skin doses must meet 10 CFR 100 limits.

The current design-basis offsite dose calculations from the containment leakage pathway for a MHA is documented in Ref.40. The corresponding control room thyroid dose exceeded 10 CFR 50 APP.A GDC 19 limits. However, an interim engineering analysis for thyroid dose for control room habitability crediting Self Contained Breathing Apparatuses (SCBAs) was performed in Ref.66 and accepted by the NRC in Ref.67. This calculation was further modified in Ref.68 to incorporate the higher control room inleakage term of 3500 cfm. Thus the time to don SCBAs was reduced to 32 minutes post-MHA to meet 10 CFR 50 App.A GDC 19 limits.

There is a potential for an unmonitored release pathway resulting from the post-LOCA leakage of isolation valves in the Safety Injection or Containment Spray system recirculation lines to the Refueling Water Tank (RWT), which is vented directly to the atmosphere (Ref.36). During the recirculation phase, sump water is recirculated through the ECCS pumps and could leak through various valves and reach the RWT. The two pathways include the two valves in series in the minimum flow recirculation line header (MOV659/660) and the valve from the containment spray pumps (SI459). Ref.69 evaluated offsite doses from these pathways assuming a nominal leakage of 0.1 gpm from each pathway. Based on conservative assumptions, a 2-hour exclusion area boundary (EAB) dose of 0.11 rem thyroid and a 30-day low population zone (LPZ) dose of 9.4 rem thyroid were calculated. Control room doses were not calculated in Ref.69. Ref.70 calculated the offsite and control room doses due to the RWT pathway, using less conservative leakage rates and methodologies. Additional calculations were performed in Refs. 34, 71, and 72 using different control room assumptions; however, since the time to RAS bounded the time to don SCBAs, the control room doses were not important.

If the 4" hydrogen purge line is open at the start of an MHA, there is the possibility of blowdown through the 4" hydrogen purge line. This pathway was included in the design basis calculation Ref.40. Ref.73 calculated a minimum clad rupture time of 26.3 sec post-LOCA. Ref.74 is a TMOD which changed the stroke length of MOV6900 and MOV6901 from 4" to 3" and which assured a total closure time (SIAS signal of 2.4 sec via Ref.32 + EDG startup of 10 sec via Ref.32 + MOV stroke time of 12.5 sec via Ref.75) to less than 26 sec. Thus there will be no activity release through the 4" hydrogen purge line post-LOCA.

Previously, power reactor licensees have typically used the U.S.A.E.C Technical Information Document TID-14844, "Calculation of Distance Factors for Power and Test Reactor Sites," (Ref.18) as the basis for Design Basis Analysis (DBA) source terms. TID-14844 is referenced in 10 CFR 100.11, the power reactor siting regulation, which contains offsite dose limits in terms of whole body and thyroid doses. In December 1999, the Nuclear Regulatory Commission (NRC) issued a new regulation, 10 CFR 50.67, "Accident Source Term," which provided a mechanism for licensed power reactors to replace the traditional accident source term used in their DBA analyses with an Alternate Source Term (AST) methodology. Regulatory guidance for the implementation of these ASTs is provided in Regulatory Guide (RG) 1.183, "Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors" (Ref.08). Section 50.67 of 10 CFR requires a licensee seeking to use AST to

apply for a license amendment and requires that the application contain an evaluation of the consequences of affected DBAs. As part of the implementation of the AST, the Total Effective Dose Equivalent (TEDE) acceptance criterion of 10 CFR 50.67 replaces the previous whole body and thyroid dose guidelines of 10 CFR 100.11 and 10 CFR 50, Appendix A, GDC-19 for the loss-of-coolant accident (LOCA), the main steam line break (MSLB), the steam generator tube rupture (SGTR), the seized rotor event (SRE), the fuel handling accident (FHA), and the control element assembly ejection accident (CEAEE). The TEDE accident dose criteria are listed in Table 6 of RG 1 183 for offsite doses and in 10 CFR 50.67 for control room doses, which limit is 5 Rem TEDE.

The current work utilizes the alternate source term methodology of 10 CFR 50.67 and Regulatory Guide 1.183 to calculate offsite and control room doses for an MHA. Per RG 1.183, the TEDE analysis should include all sources of radiation that will cause exposure to control room personnel. In this work, the following pathways are analyzed:

- Containment pathway
- Hydrogen Purge Line (HPL) pathway
- Ventilation Stack (VS) pathway
- Refueling Water Tank (RWT) pathway
- Containment Shine
- Plume Shine
- Control Room Filter Shine

A bounding control room inleakage value of 3500 cfm was assumed. The following modifications and TS changes are proposed to comply with regulatory requirements.

- Modification of the control room emergency ventilation system to a nominal 10000 cfm flow with a 90% filtration efficiency for elemental and organic iodine and 99% for particulate iodine was credited.
- Also credited was installation of automatic isolation dampers and radiation monitors at Access Controls 11 and 13 on the Auxiliary Building Roof. This modification limits activity ingress into the control room to either the West Road Inlet or the Turbine Building, thus limiting the atmospheric dispersion coefficient value.
- The Technical Specification (TS 3.4.15) limit for RCS activity was reduced from 1.0 μCi/gm to 0.5 μCi/gm.
- The maximum allowable containment leakage rate La contained in the Containment Leakage Rate Testing Program of TS 5.5.16 was reduced from 0.20 percent per day at Pa to 0.16 percent per day at Pa.

The exclusion area boundary (EAB), low population zone (LPZ), and control room (CR) doses for the design-basis MHA are detailed in the following table.

MHA Results			
Results	EAB	LPZ	CR
	Rem	Rem	Rem
Containment Pathway	1.8988	0.4958	3.9682
Penetration Room Pathway	0.1838	0.0485	0.3968
RWT Pathway	1.9676E-05	1.8560E-03	3.2979E-01
Hydrogen Purge Pathway	6.4918E-05	1.5283E-05	7.7048E-05
Containment Shine			0.0547
Plume Shine			0.0030
Control Room Filter Shine			0.0139
Total	2.0827	0.5462	4.7664
Regulatory Limits	25	25	5

Note that all values are below the regulatory limits.

6. INPUT DATA

To determine the exclusion area boundary (EAB), low population zone (LPZ), and control room (CR) doses from a Maximum Hypothetical Accident (MHA), seven release pathways must be modeled:

- Containment pathway
- Hydrogen Purge Line (HPL) pathway
- Penetration Room-Ventilation Stack (VS) pathway
- Refueling Water Tank (RWT) pathway
- Containment Shine
- Plume Shine
- Control Room Filter Shine

(6.A) General Inputs

(6A.01) Initial thermal power is 2754 MWt (UFSAR 3.2.1/Ref.1).

(6A.02) The isotopic half-lives (t_i) were extracted from Ref.06 and are listed in column A of Attachment A. The decay constants (λ_i), listed in column B of Attachment A, are readily calculated via the following algorithm:

$$\lambda_i = \ln(2) / t_i$$

(6A.03) The breathing rates are extracted from Ref.08:

Time (hours)	Breathing Rate (m3/sec)
0-8	3.5E-04
8-24	1.8E-04
24-720	2.3E-04

(6A.04) The control room occupancy factors are extracted from Ref.08:

Time (hours)	Occupancy Factor
0-24	1.0
24-96	0.6
96-720	0.4

(6A.05) Control room inleakage: The control room inleakages for the two trains Air Conditioning Units (ACU) 11 and 12 were measured by NUCON International Inc. via sulfur hexaflouride (SF_6) tracer gas tests as documented in Refs.23-26 (Attachment M). An additional inleakage test was performed by Brookhaven National Laboratory (BNL) via a perfluorocarbon tracer gas (PFT) test as documented in Ref.27 (Attachment N).

	ACU 11	ACU 12
SF_6 Test 11/11/97	4300±300 cfm	3000±300 cfm
SF_6 Test 11/11/97	3600±600 cfm	2550±450 cfm
SF_6 Test 11/11/97	2900±250 cfm	2750±380 cfm
SF_6 Test 1/18/00	2600±200 cfm	3000±250 cfm
PFT Test 5/1/02	2930±185 cfm	2930±185 cfm

The latest SF_6 and PFT tests show fairly good agreement, as indicated above. A conservative value of 3500 cfm will be utilized in this work.

The control room inleakage points were deduced from the PFT testing carried out by Brookhaven National Laboratory and include the Auxiliary Building West Road inlet (WR), the Turbine Building inlet (TB), Access Control 11 (AC11), Access Control 13 (AC13), the Switchgear Rooms (SWGRs), and the Main Steam Isolation Valve Rooms (MSIVs). AC11 and AC13 will be equipped with dampers and radiation monitors, which will isolate this leakage path in case of an accident. The SWGRs are in continual recirculation mode and thus are also isolated from the environment. The MSIV rooms are also isolated from the environment, except for the Main Steam Line Break Accident which occurs in these rooms, due to the thermal buoyancy of the air in these rooms and due to the J-neck exhaust. For conservatism, all of the measured inleakage will be assumed to enter the control room from the most conservative pathway of either the West Road or Turbine Building inlets.

(6A.06) Control room recirculation flow:

- Flowrate: 10000.± 1000 cfm
  (Note that this value will be the result of a new modification.)
- Initiation delay time: 20 minutes
  (Ref.29 conservatively assumes a 20 minute time delay for a manual start of the Control Room Emergency Ventilation System.)
- Filter efficiencies: 90% for elemental and organic iodine species
  (Ref.28 and Technical Specification 5.5.11 allow a 95% filter efficiency for a 2" activated carbon bed depth; however, NRC Generic Letter 99-02 (Ref.30) requires plants that test their activated charcoal to the ASTM D3803-1989 standards to use a safety factor of two. This results in a maximum credited efficiency of 90% for accident analyses.)
- Filter efficiencies: 99% for particulate iodine
  (Per Ref.28, an engineered-safety-feature air filtration system satisfying a filter penetration less than 0.05% at rated flow can be considered to warrant a 99% removal efficiency for particulates in accident dose evaluations. CCNPP will perform an inplace test of the HEPA filter to show a penetration and system bypass flow less than 0.05%)

(6A.07) Control Room Volume: The control room volume is 289194 ft^3 per Ref.19.

(6.B) MHA Containment Pathway

Per RG 1.194 (Ref.43), the total release from containment may be apportioned between the exposed and enclosed building surfaces. A large fraction of the released airborne activity post-MHA is assumed to leak out of the containment through the containment walls.

(6B.01) The inventory of fission products in the reactor core and available for release to the containment atmosphere is based on the maximum full power operation of the core with current licensed values for fuel enrichment, fuel burnup, and a core power equal to the current licensed rated thermal power times the ECCS evaluation uncertainty. The period of irradiation was of sufficient duration to allow the activity of dose-significant radionuclides to reach maximum values. The isotopic activities released from the failed fuel in Ci/MWt were generated in Ref. 05 Case CRCB63 Attachment H, utilizing the isotope generation and depletion computer code SAS2H/ORIGEN-S. For the containment pathway, all 63 isotopic activities are stored in the nuclear inventory file CRCB63.NIF listed in Attachment B. To utilize these isotopic source terms, it is necessary to multiply them by the relevant power level in MWt and by the relevant release fractions in the release fraction and timing files.

(6B.02) The core inventory release fractions, by radionuclide groups, for the gap release and early in-vessel damage phases for a DBA LOCA were extracted from RG 1.183 (Ref.08). The onset and duration of each sequential release phase for the DBA LOCA was extracted from RG 1.183 (Ref.08). The activity released from the core during the Gap Release Phase is modeled as increasing linearly over the duration of the phase, while that released during the Early In-Vessel Phase the activity is assumed to be released at the beginning of the phase. Note that step releases are allowed per RG 1.183. The values are incorporated in the release fraction and timing file MHACTMT.RFT (Attachment C) for use by RADTRAD and are listed in the following table:

Group	Gap Release Phase	Early In-Vessel Phase	Total Release
Noble Gases (Xe,Kr)	0.05	0.95	1.00
Halogens (I,Br)	0.05	0.35	0.40
Alkali Metals (Cs,Rb)	0.05	0.25	0.30
Tellurium Metals (Te,Sb,Se)	0.00	0.05	0.05
Ba, Sr	0.00	0.02	0.02
Noble Metals (Ru,Rh,Pd,Mo,Tc,Co)	0.0000	0.0025	0.0025
Cerium Group (Ce,Pu,Np)	0.0000	0.0005	0.0005
Lanthanides (La,Zr,Nd,Eu, Nb,Pm,Pr,Sm,Y,Cm,Am)	0.0000	0.0002	0.0002
Release Timing	0.00 hr - 0.5 hr	0.5 hr	

(6B.03) The dose conversion factors (DCFs) were extracted from Refs.20-21 and inserted into input files for use by RADTRAD. This data is included in the Conversion Factor Files FGR63.INP in Attachment D for use with failed fuel isotopics. Note that the cloudshine data in the Conversion Factor Files corresponds to the FGR-12 data, while the inhaled chronic data in the Conversion Factor Files corresponds to the worst-case effective data in FGR-11. The remaining data in the Conversion Factor Files is extraneous and not used by RADTRAD.

(6B.04) Per RG 1.183 (Ref.08), of the radioiodine released from the RCS to the containment atmosphere in a LOCA, 95% of the iodine released should be assumed to be cesium iodide (CsI), 4.85% elemental iodine, and 0.15% organic iodine. This includes releases from the gap and fuel pellets. With the exception of elemental and organic iodine and noble gases, fission products should be assumed to be in particulate form.

(6B.05) The containment to site boundary X/Q of 1.30E-4 sec/m^3 was extracted from UFSAR 2.3.6.

(6B.06) The atmospheric dispersion coefficients from the containment to the LPZ (2 miles) were extracted from UFSAR Fig.2.3-3/UFSAR 14.24.3.

Time (hours)	χ/Q (sec/m^3)
0-2	3.30E-05
2-24	2.20E-06
24-720	5.40E-07

(6B.07) Atmospheric dispersion coefficients from the containment to the Control Room: (Ref.19)
The failed fuel activity released into the containment atmosphere is assumed to escape into the environment through the containment wall. The main control room inleakage points include the west road inlets, the turbine building, and Access Controls 11 and 13 on the Auxiliary Building roof. Installation of automatic isolation dampers and radiation monitors at Access Controls 11 and 13 on the Auxiliary Building Roof are credited in this work.

Atmospheric Dispersion Coefficients (sec/m^3)				
	U1-WR	U2-WR	U1-TB	U2-TB
0-2 hr	**1.11E-03**	1.04E-03	1.02E-03	1.02E-03
2-8 hr	**7.29E-04**	5.95E-04	7.10E-04	7.98E-04
8-24hr	**3.19E-04**	2.29E-04	2.57E-04	3.19E-04
1-4 days	**2.36E-04**	1.64E-04	2.19E-04	2.56E-04
4-30 days	**1.98E-04**	1.14E-04	1.77E-04	2.14E-04

The atmospheric dispersion coefficients corresponding to the Unit 1 containment to the west road inlet on the auxiliary building will be conservatively utilized in this work.

(6B.08) Containment volume:

• Net free volume:	1.989E+06 cf (UFSAR Tab.14.20-3, Ref.39)
• Containment sprayed volume:	1.446E+06 cf
Volume fraction:	0.7273 (Ref.40)
• Containment unsprayed volume:	0.543E+06 cf
Volume fraction:	0.2727 (Ref.40)

Note: Assumes sprayed and unsprayed volume fractions remain unchanged from Ref.40.

(6B.09) Fan coolers are credited for mixing of air between the sprayed region and unsprayed region of containment.

(a) Three 110000 cfm cooling units are normally in operation in containment. Upon receipt of a SIAS, the fourth cooling unit is automatically started on the 55000 cfm low speed setting and simultaneously the other three units are switched to low speed operation. If offsite power is not available, the emergency diesel generators are started. Each of two emergency diesel generator busses carries the load of two cooling units (UFSAR 6.5.3 and 6.5.4). Thus, two 55000 cfm cooling units are credited in this work.

(b) Containment fan cooler operation requires 38 seconds to activate:

Pressure buildup, instrument response, SIAS delay	03 seconds	(Ref.32)
Emergency diesel generator startup	10 seconds	(Ref.32)
Load sequencing delay	15 seconds	(UFSAR Table 8.7)
Containment fan cooler startup	10 seconds	(UFSAR Table 7.4)

For conservatism, a 60 second activation delay will be utilized in this work.

(6B.10) Containment Leakage

(a) The maximum allowable containment leakage rate La contained in the Containment Leakage Rate Testing Program of TS 5.5.16 will be reduced from 0.20 percent per day at containment peak pressure Pa to 0.16 percent per day at Pa. Per RG 1.183, the containment should be assumed to leak at the leak rate incorporated in the technical specifications for the first 24 hours, and at 50% of this leak rate for the remaining duration of the accident.

(b) Per Regulatory Guide 1.194 (Ref.43), the total release from containment may be apportioned between the exposed and enclosed building surfaces.

- The CCNPP original licensing basis as described in the Final Safety Analysis Report (FSAR 14.18) assumed that at least 50% of the containment leakage would be into the penetration rooms, which are maintained at negative pressure and which discharge through the penetration room HEPA/charcoal filters into the plant vent.
- Based on Local Leak Rate Testing (LLRT) performed per TS 5.5.16, the Containment Leakage Rate Testing Program, it can be shown (Attachment P) that at least 75% of the containment leakage would be into the penetration rooms.
- Based on the ratio of containment surface enclosed by the Auxiliary Building to the total containment surface area, it can be shown that at least 28.7% of the containment leakage would be into the penetration rooms (Attachment O).

In this work a conservative bypass fraction from the containment to the penetration rooms of 28% was assumed.

(6B.11) Containment iodine removal system:

- o Per UFSAR 6.7, the containment iodine removal system (IRS) incorporates three filter units, each with a capacity to handle 50% of the required air flow. . Each unit consists of activated charcoal filters preceded by HEPA filters. Per TS 5.5.11, each filter unit has a 20000±10% cfm flowrate with a filter efficiency of 90% for elemental and particulate species and 30% for organic species per RG 1.52 (Ref.28).
- o This work assumes that the containment filters affect the entire containment; however, due to the well mixed quality of the containment atmosphere, the effect of applying the containment filter to a particular containment region is minor.

- o Per UFSAR 6.7.2, SIAS automatically starts three recirculation filter units. If offsite power is not available, the emergency diesel generators are started. Each of two emergency diesel generator busses carries the load of two recirculation filter units (UFSAR Table 8-7). Per UFSAR Table 8.7, one iodine removal unit (IRU) is connected to one bus, while the other two are connected to the other bus. Thus, assuming a LOOP concurrent with a LOCA and with the single failure of an emergency diesel generator (EDG), at least one IRU will start within 63 seconds. A second IRU is assumed to be manually switched from the failed EDG to the active EDG within 20 minutes (UFSAR 14.24).
  - o Pressure buildup, instrument response, SIAS delay 03 seconds (Ref.32)
  - o Emergency diesel generator startup 10 seconds (Ref.32)
  - o Load sequencing delay 20 seconds (UFSAR Table 8.7)
  - o Containment fan cooler startup 30 seconds (Ref.33)

(6B.12) Per RG 1.183, reduction in airborne radioactivity in the containment by containment spray systems that have been designed and maintained in accordance with SRP 6.5.2 (Ref.11) may be credited.

- An acceptable model for the removal of aerosols is described in SRP 6.5.2 (Ref.11) and NUREG/CR-5966 (Ref.12), which is incorporated into the analysis code RADTRAD (Refs.13-15).
  - o Per SRP 6.5.2 the first-order particulate iodine spray removal coefficient may be estimated by:
    - ▪ LP=1.5*(60min/hr)*h*F*(E/D)/VSR =3.414/hr (Ref.11)
    - ▪ h=fall height = 100.ft (UFSAR 6.4.2)
    - ▪ F=Spray pump volume flow rate = 180 cfm (UFSAR 6.4.2)
    - ▪ VSR=Containment volume sprayed region = 1.446E+06 cf (6B.08)
    - ▪ E/D = DF = Ratio of a dimensionless collection efficiency E to the average spray drop diameter D =10/m=3.048/ft (Ref.11)
  - o SRP 6.5.2 states that the particulate iodine removal rate should be reduced by a factor of 10 when a DF of 50 is reached. Per RG 1.183, the reduction in the removal rate is not required if the removal rate is based on the calculated time-dependent airborne aerosol mass.
  - o Per RG 1.183, there is no specified maximum DF for aerosol removal by sprays.
  - o Time delay: 3.sec(CSAS)+67.sec(response)=70.sec (Refs.42, 10, 9 p.27). This work conservatively assumes a 90 second delay.
- An acceptable model for the removal of elemental iodine is described in SRP 6.5.2 (Ref.11) and UFSAR 6.4.2:
  - o LS=6*K*T*F*(60.min/hr) * (0.63) * (0.839) / (VSR*D) = 14.816 / hr
    - ▪ K=Gas phase mass transfer coefficient = 13.2 ft/min (UFSAR 6.4.2)
    - ▪ T=Fall time = 100.ft/735.ft/min = 0.136 min (UFSAR 6.4.2)
    - ▪ F=Spray pump volume flow rate = 180 cfm (UFSAR 6.4.2)
    - ▪ VSR=Sprayed region volume = 1.446E+06 cf (6B.08)
    - ▪ D=Spray drop mass linear diameter = 2.87E-03 ft (UFSAR 6.4.2)
    - ▪ 0.63 = Conversion factor to account for the less accurate prediction using the mass mean diameter as compared to the surface mean diameter used in the derivation of the algorithm (UFSAR 6.4.2)
    - ▪ 0.839 = Conversion factor to account for the less effective stagnant drops as compared to the well mixed drop used in the derivation of the algorithm (UFSAR 6.4.2)
  - o SRP 6.5.2 sets forth a maximum decontamination factor (DF) for elemental iodine based on the maximum iodine activity in the primary containment atmosphere when the sprays actuate, divided by the activity of iodine remaining some time after decontamination.
    - ▪ DF = 1 + Vs * H / Vc = 14.04
    - ▪ Vs = Sump volume = 68329 cf (Ref.40)
    - ▪ Vc = Containment sprayed volume = 1.446E+06 cf (6B.08)
    - ▪ H = 276 (Ref.40)
    - ▪ Teff = Ln(14.04)/Ls = 0.178 hr
    - ▪ Note that the dose results are very insensitive to this value of Teff (e.g., decreasing Teff by 50% increases the control room dose by ~1%)..
  - o A time delay of 30 minutes was assumed in this work for elemental sprays to simplify calculation of DF time.
- Per SRP 6.5.2, it is conservative to assume that organic iodides are not removed by spray.

(6B.13) Containment plateout:

- o Reduction in aerosol airborne radioactivity in the containment by natural deposition within the containment was credited per RG 1.183 (Ref.08). The 10th percentile Powers aerosol decontamination model (Ref.41) for PWR design basis accidents as incorporated into the RADTRAD analysis code was utilized. Aerosol particles grow by coagulating with other aerosol particles or because steam condenses on them thus gravitational settling of aerosols is usually the dominant aerosol removal process.
- o Plateout of organic iodine species was not credited in this work.
- o Plateout of elemental iodine was not credited in this work.

(6.C) MHA Ventilation Stack Pathway

Per RG 1.194 (Ref.43), the total release from containment may be apportioned between the exposed and enclosed building surfaces. Per UFSAR 6.6.2, experience has shown that containment leakage is more likely at penetrations rather than through liner plates or weld joints. Penetration rooms are built adjacent to the outside surface of each containment and enclose the areas around the majority of the penetrations. Thus, a fraction of the containment leakage will leak into the auxiliary building penetration rooms, be processed by the penetration room emergency ventilation system, and be expelled to the atmosphere through the ventilation stacks.

(6C.01) The inventory of fission products in the reactor core and available for release to the containment atmosphere is based on the maximum full power operation of the core with current licensed values for fuel enrichment, fuel burnup, and a core power equal to the current licensed rated thermal power times the ECCS evaluation uncertainty. The period of irradiation was of sufficient duration to allow the activity of dose-significant radionuclides to reach maximum values. The isotopic activities released from the failed fuel in Ci/MWt were generated in Ref. 05 Case CRCB63, utilizing the isotope generation and depletion computer code SAS2H/ORIGEN-S. For the containment pathway, all 63 isotopic activities are stored in the nuclear inventory file CRCB63.NIF listed in Attachment B. To utilize these isotopic source terms, it is necessary to multiply them by the relevant power level in MWt and by the relevant release fractions in the release fraction and timing files.

(6C.02) The core inventory release fractions, by radionuclide groups, for the gap release and early in-vessel damage phases for a DBA LOCA were extracted from RG 1.183 (Ref.08). The onset and duration of each sequential release phase for the DBA LOCA was extracted from RG 1.183 (Ref.08). The activity released from the core during the Gap Release Phase is modeled as increasing linearly over the duration of the phase, while that released during the Early In-Vessel Phase the activity is assumed to be released at the beginning of the phase. Note that step releases are allowed per RG 1.183. The values are incorporated in the release fraction and timing file MHACTMT.RFT (Attachment C) for use by RADTRAD and are listed in the following table:

Group	Gap release Phase	Early In-Vessel Phase	Total Release
Noble Gases (Xe,Kr)	0.05	0.95	1.00
Halogens (I,Br)	0.05	0.35	0.40
Alkali Metals (Cs,Rb)	0.05	0.25	0.30
Tellurium Metals (Te,Sb,Se)	0.00	0.05	0.05
Ba, Sr	0.00	0.02	0.02
Noble Metals (Ru,Rh,Pd,Mo,Tc,Co)	0.0000	0.0025	0.0025
Cerium Group (Ce,Pu,Np)	0.0000	0.0005	0.0005
Lanthanides (La,Zr,Nd,Eu, Nb,Pm,Pr,Sm,Y,Cm,Am)	0.0000	0.0002	0.0002
Release Timing	0.00 hr - 0.5 hr	0.5 hr	

(6C.03) The dose conversion factors (DCFs) were extracted from Refs.20-21 and inserted into input files for use by RADTRAD. This data is included in the Conversion Factor Files FGR63.INP in Attachment D for use with failed fuel isotopics. Note that the cloudshine data in the Conversion Factor Files corresponds to the FGR-12 data, while the inhaled chronic data in the Conversion Factor Files corresponds to the worst-case effective data in FGR-11. The remaining data in the Conversion Factor Files is extraneous and not used by RADTRAD.

(6C.04) Per RG 1.183 (Ref.08), of the radioiodine released from the RCS to the containment atmosphere in a LOCA, 95% of the iodine released should be assumed to be cesium iodide (CsI), 4.85% elemental iodine, and 0.15% organic iodine. This includes releases from the gap and fuel pellets. With the exception of elemental and organic iodine and noble gases, fission products should be assumed to be in particulate form.

(6C.05) Exclusion Area Boundary (EAB) Atmospheric Dispersion Coefficient:
The Ventilation Stack (VS) to EAB, two-hour, atmospheric dispersion coefficient of 1.44E-4 sec/m^3 was calculated via the Gifford wake model extracted from UFSAR 2.3.6, as follows

$$\chi/Q = 1/[\mu * (\pi\sigma_y\sigma_z + cA)] = 1.44E\text{-}4 \text{ sec/m}^3$$

where for 1150 m exclusion area boundary distance and 5% frequency

μ = average wind speed = 1 m/sec
σ_y = standard deviation of the distribution in the lateral direction = 92 m (UFSAR Table 2-14)
σ_z = standard deviation of the distribution in the vertical direction = 24 m (UFSAR Table 2-14)
c= wake factor
A= cross-sectional area of structure from which material is released = 0 m

(6C.06) Low Population Zone (LPZ) Atmospheric Dispersion Coefficients:
The atmospheric dispersion coefficients from the VS to the LPZ (2 miles) was derived via the data and methodology of UFSAR Fig.2.3-3/UFSAR 14.24.3. Note that the 0-2 hour value was adjusted via the Gifford wake model for a point release rather than a containment release.

Time (hours)	χ/Q (sec/m^3)
0-2	3.39E-05
2-24	2.20E-06
24-720	5.40E-07

(6C.07) Atmospheric dispersion coefficients from the VS to the Control Room: (Ref.19)
The failed fuel activity released to the containment atmosphere that then leaks into the Auxiliary Building Penetration Rooms will escape out to the environment via the Ventilation Stacks. The main control room inleakage points include the west road inlets, the turbine building, and Access Controls 11 and 13 on the Auxiliary Building roof. Installation of automatic isolation dampers and radiation monitors at Access Controls 11 and 13 on the Auxiliary Building Roof are credited in this work.

Atmospheric Dispersion Coefficients (sec/m^3)				
	VS1-WR	VS2-WR	VS1-TB	VS2-TB
0-2 hr	9.54E-04	8.73E-04	1.63E-03	1.68E-03
2-8 hr	6.86E-04	5.79E-04	1.19E-03	1.34E-03
8-24hr	2.95E-04	2.12E-04	4.61E-04	5.14E-04
1-4 days	2.13E-04	1.49E-04	3.22E-04	3.84E-04
4-30 days	1.56E-04	1.03E-04	2.61E-04	3.12E-04

The atmospheric dispersion coefficients corresponding to the Unit 2 VS to the turbine building will be conservatively utilized in this work. Note that neither thermal buoyancy nor vertical effluent velocity are credited in this work.

(6C.08) Containment volume:

- Net free volume: 1.989E+06 cf (UFSAR Tab.14.20-3, Ref.39)
- Containment sprayed volume: 1.446E+06 cf
  Volume fraction: 0.7273 (Ref.40)
- Containment unsprayed volume: 0.543E+06 cf
  Volume fraction: 0.2727 (Ref.40)

Note: Assumes sprayed and unsprayed volume fractions remain unchanged from Ref.40.

(6C.09) Fan coolers are credited for mixing of air between the sprayed region and unsprayed region of containment.
(a) Three 110000 cfm cooling units are normally in operation in containment. Upon receipt of a SIAS, the fourth cooling unit is automatically started on the 55000 cfm low speed setting and simultaneously the other three units are switched to low speed operation. If offsite power is not available, the emergency diesel generators are started. Each of two emergency diesel generator busses carries the load of two cooling units (UFSAR 6.5.3 and 6.5.4). Thus, two 55000 cfm cooling units are credited in this work.
(b) Containment fan cooler operation requires 38 seconds to activate:

Pressure buildup, instrument response, SIAS delay	03 seconds	(Ref.32)
Emergency diesel generator startup	10 seconds	(Ref.32)
Load sequencing delay	15 seconds	(UFSAR Table 8.7)
Containment fan cooler startup	10 seconds	(UFSAR Table 7.4)

For conservatism, a 60 second activation delay will be utilized in this work.

(6C.10) Containment Leakage
(a) The maximum allowable containment leakage rate La contained in the Containment Leakage Rate Testing Program of TS 5.5.16 will be reduced from 0.20 percent per day at containment peak pressure Pa to 0.16 percent per day at Pa. Per RG 1.183, the containment should be assumed to leak at the leak rate incorporated in the technical specifications for the first 24 hours, and at 50% of this leak rate for the remaining duration of the accident.
(b) Per Regulatory Guide 1.194 (Ref.43), the total release from containment may be apportioned between the exposed and enclosed building surfaces.

- The CCNPP original licensing basis as described in the Final Safety Analysis Report (FSAR 14.18) assumed that at least 50% of the containment leakage would be into the penetration rooms, which are maintained at negative pressure and which discharge through the penetration room HEPA/charcoal filters into the plant vent.
- Based on Local Leak Rate Testing (LLRT) performed per TS 5.5.16, the Containment Leakage Rate Testing Program, it can be shown (Attachment P) that at least 75% of the containment leakage would be into the penetration rooms.
- Based on the ratio of containment surface enclosed by the Auxiliary Building to the total containment surface area, it can be shown that at least 28.7% of the containment leakage would be into the penetration rooms (Attachment O).

In this work a conservative bypass fraction from the containment to the penetration rooms of 28% was assumed. Thus, 0.0448% of the containment volume leaks from the containment to the auxiliary building penetration rooms per day for the first 24 hours, and 0.0224% per day thereafter.

- Leak Rate = (1.446E+6 cf)*(0.000448)/(24*60) = 0.449867 cfm 0-24 hours Sprayed Region
- Leak Rate = (1.446E+6 cf)*(0.000224)/(24*60) = 0.224933 cfm 24-720 hours Sprayed Region
- Leak Rate = (0.543E+6 cf)*(0.000448)/(24*60) = 0.168933 cfm 0-24 hours Unsprayed Region
- Leak Rate = (0.543E+6 cf)*(0.000224)/(24*60) = 0.084467 cfm 24-720 hours Unsprayed Region

(6C.11) Containment iodine removal system:

- Per UFSAR 6.7, the containment iodine removal system (IRS) incorporates three filter units, each with a capacity to handle 50% of the required air flow. . Each unit consists of activated charcoal filters preceded by HEPA filters. Per TS 5.5.11, each filter unit has a 20000±10% cfm flowrate with a filter efficiency of 90% for elemental and particulate species and 30% for organic species per RG 1.52 (Ref.28).

- o This work assumes that the containment filters affect the entire containment; however, due to the well mixed quality of the containment atmosphere, the effect of applying the containment filter to a particular containment region is minor.
- o Per UFSAR 6.7.2, SIAS automatically starts three recirculation filter units. If offsite power is not available, the emergency diesel generators are started. Each of two emergency diesel generator busses carries the load of two recirculation filter units (UFSAR Table 8-7). Per UFSAR Table 8.7, one iodine removal unit (IRU) is connected to one bus, while the other two are connected to the other bus. Thus, assuming a LOOP concurrent with a LOCA and with the single failure of an emergency diesel generator (EDG), at least one IRU will start within 63 seconds. A second IRU is assumed to be manually switched from the failed EDG to the active EDG within 20 minutes (UFSAR 14.24).
  - o Pressure buildup, instrument response, SIAS delay 03 seconds (Ref.32)
  - o Emergency diesel generator startup 10 seconds (Ref.32)
  - o Load sequencing delay 20 seconds (UFSAR Table 8.7)
  - o Containment fan cooler startup 30 seconds (Ref.33)

(6C.12) Per RG 1.183, reduction in airborne radioactivity in the containment by containment spray systems that have been designed and maintained in accordance with SRP 6.5.2 (Ref.11) may be credited.

- An acceptable model for the removal of aerosols is described in SRP 6.5.2 (Ref.11) and NUREG/CR-5966 (Ref.12), which is incorporated into the analysis code RADTRAD (Refs.13-15).
  - o Per SRP 6.5.2 the first-order particulate iodine spray removal coefficient may be estimated by:
    - LP=1.5*(60min/hr)*h*F*(E/D)/VSR = 3.414/hr (Ref.11)
    - h=fall height = 100.ft (UFSAR 6.4.2)
    - F=Spray pump volume flow rate = 180 cfm (UFSAR 6.4.2)
    - VSR=Containment volume sprayed region = 1.446E+06 cf (6B.08)
    - E/D = DF = Ratio of a dimensionless collection efficiency E to the average spray drop diameter D =10/m=3.048/ft (Ref.11)
  - o SRP 6.5.2 states that the particulate iodine removal rate should be reduced by a factor of 10 when a DF of 50 is reached. Per RG 1.183, the reduction in the removal rate is not required if the removal rate is based on the calculated time-dependent airborne aerosol mass.
  - o Per RG 1.183, there is no specified maximum DF for aerosol removal by sprays.
  - o Time delay: 3.sec(CSAS)+67.sec(response)=70.sec (Refs.42, 10, 9 p.27). This work conservatively assumes a 90 second delay.
- An acceptable model for the removal of elemental iodine is described in SRP 6.5.2 (Ref.11) and UFSAR 6.4.2:
  - o LS=6*K*T*F*(60.min/hr) * (0.63) * (0.839) / (VSR*D) = 14.816 / hr
    - K=Gas phase mass transfer coefficient = 13.2 ft/min (UFSAR 6.4.2)
    - T=Fall time = 100.ft/735.ft/min = 0.136 min (UFSAR 6.4.2)
    - F=Spray pump volume flow rate = 180 cfm (UFSAR 6.4.2)
    - VSR=Sprayed region volume = 1.446E+06 cf (6B.08)
    - D=Spray drop mass linear diameter = 2.87E-03 ft (UFSAR 6.4.2)
    - 0.63 = Conversion factor to account for the less accurate prediction using the mass mean diameter as compared to the surface mean diameter used in the derivation of the algorithm (UFSAR 6.4.2)
    - 0.839 = Conversion factor to account for the less effective stagnant drops as compared to the well mixed drop used in the derivation of the algorithm (UFSAR 6.4.2)
  - o SRP 6.5.2 sets forth a maximum decontamination factor (DF) for elemental iodine based on the maximum iodine activity in the primary containment atmosphere when the sprays actuate, divided by the activity of iodine remaining some time after decontamination.
    - DF = 1 + Vs * H / Vc = 14.04
    - Vs = Sump volume = 68329 cf (Ref.40)
    - Vc = Containment sprayed volume = 1.446E+06 cf (6B.08)
    - H = 276 (Ref.40)
    - Teff = Ln(14.04)/Ls = 0.178 hr
    - Note that the dose results are very insensitive to this value of Teff (e.g., decreasing Teff by 50% increases the control room dose by ~1%)..

- o A time delay of 30 minutes was assumed in this work for elemental sprays to simplify calculation of DF time.
- Per SRP 6.5.2, it is conservative to assume that organic iodides are not removed by spray.

(6C.13) Containment plateout:
- o Reduction in aerosol airborne radioactivity in the containment by natural deposition within the containment was credited per RG 1.183 (Ref.08). The 10th percentile Powers aerosol decontamination model (Ref.41) for PWR design basis accidents as incorporated into the RADTRAD analysis code was utilized. Aerosol particles grow by coagulating with other aerosol particles or because steam condenses on them thus gravitational settling of aerosols is usually the dominant aerosol removal process.
- o Plateout of organic iodine species was not credited in this work.
- o Plateout of elemental iodine was not credited in this work.

(6C.14) Penetration Room Ventilation and Filtration System:
- o Per UFSAR 6.6.1, the Containment Penetration Room Emergency Ventilation System (PREVS) is designed to collect and process containment penetration leakage, so as to reduce to a minimum the environmental radioactivity levels from post-accident containment leaks. To minimize the release of radioactive material to the environment, penetration room ventilation is continuously routed through a prefilter, a high efficiency particulate air (HEPA) filter, and an activated charcoal filter, positioned in series.
- o Following a LOCA, a Containment Isolation Signal (CIS) will start both of the two full-size blowers. The entire system is designed to operate under negative pressure up to the fan discharge.
- o Per TS 5.5.11, each PREVS unit has a design flowrate of 2000 ± 10% cfm with an efficiency of 90% for elemental and particulate species and 30% for organic species.

(6.D) MHA RWT Pathway
Per RG 1.183 (Ref.8), ESF systems that recirculate sump water outside of the primary containment are assumed to leak during their intended operation. This release source may include leakage through valves isolating interfacing systems. There is a potential for an unmonitored release pathway resulting from the post-LOCA leakage of isolation valves in the Safety Injection or Containment Spray system recirculation lines to the Refueling Water Tank (RWT), which is vented directly to the atmosphere (Ref.36). During the recirculation phase, sump water is recirculated through the ECCS pumps and could leak through various valves and reach the RWT. The two pathways include the two valves in series in the minimum flow recirculation line header (MOV659/660) and the valve from the containment spray pumps (SI459). The radiological consequences from the postulated leakage should be analyzed and combined with consequences postulated for other fission product release paths to determine the total calculated radiological consequences from the LOCA.

(6D.01) The inventory of fission products in the reactor core and available for release to the containment sump is based on the maximum full power operation of the core with current licensed values for fuel enrichment, fuel burnup, and a core power equal to the current licensed rated thermal power times the ECCS evaluation uncertainty. The period of irradiation was of sufficient duration to allow the activity of dose-significant radionuclides to reach maximum values. The isotopic activities released from the failed fuel in Ci/MWt were generated in Ref. 05 Case CRCB63, utilizing the isotope generation and depletion computer code SAS2H/ORIGEN-S. For the containment pathway, all 63 isotopic activities are stored in the nuclear inventory file CRCB63.NIF listed in Attachment B. To utilize these isotopic source terms, it is necessary to multiply them by the relevant power level in MWt and by the relevant release fractions in the release fraction and timing files.

(6D.02) The core inventory release fractions, by radionuclide groups, for the gap release and early in-vessel damage phases for a DBA LOCA were extracted from RG 1.183 (Ref.08). The onset and duration of each sequential release phase for the DBA LOCA was extracted from RG 1.183 (Ref.08). The activity released from the core during each release phase is modeled as increasing linearly over the duration of the phase. With the exception of noble gases, all of the fission products released from the fuel should be assumed to instantaneously and homogeneously mix in the primary containment sump water at the time of release from the core. With the exception of iodine, all radioactive materials in the recirculating liquid should be assumed to be retained in the liquid phase. The values are

incorporated in the release fraction and timing file MHARWT.RFT (Attachment G) for use by RADTRAD and are listed in the following table:

Group	Gap release Phase	Early In-Vessel Phase	Total Release
Noble Gases (Xe,Kr)	0.00	0.00	0.00
Halogens (I,Br)	0.05	0.35	0.40
Alkali Metals (Cs,Rb)	0.00	0.00	0.00
Tellurium Metals (Te,Sb,Se)	0.00	0.00	0.00
Ba, Sr	0.00	0.00	0.00
Noble Metals (Ru,Rh,Pd,Mo,Tc,Co)	0.00	0.00	0.00
Cerium Group (Ce,Pu,Np)	0.00	0.00	0.00
Lanthanides (La,Zr,Nd,Eu, Nb,Pm,Pr,Sm,Y,Cm,Am)	0.00	0.00	0.00
Release Timing	0.00 hr - 0.5 hr	0.5 hr-1.8 hr	

(6D.03) The dose conversion factors (DCFs) were extracted from Refs.20-21 and inserted into input files for use by RADTRAD. This data is included in the Conversion Factor Files FGR63.INP in Attachment D for use with failed fuel isotopics. Note that the cloudshine data in the Conversion Factor Files corresponds to the FGR-12 data, while the inhaled chronic data in the Conversion Factor Files corresponds to the worst-case effective data in FGR-11. The remaining data in the Conversion Factor Files is extraneous and not used by RADTRAD.

(6D.04) Per Ref.08, radioiodine that is postulated to be available for releases from the RWT to the environment should be assumed to be 97% elemental and 3% organic.

(6D.05) Exclusion Area Boundary (EAB) Atmospheric Dispersion Coefficient:
The Refueling Water Tank (RWT) to EAB, two-hour, atmospheric dispersion coefficient of 1.44E-4 sec/m^3 was calculated via the Gifford wake model extracted from UFSAR 2.3.6, as follows

$\chi/Q = 1/[\mu * (\pi\sigma_y\sigma_z + cA)] = 1.44E\text{-}4\ sec/m^3$

where for 1150 m exclusion area boundary distance and 5% frequency

μ = average wind speed = 1 m/sec
σ_y= standard deviation of the distribution in the lateral direction = 92 m (UFSAR Table 2-14)
σ_z= standard deviation of the distribution in the vertical direction = 24 m (UFSAR Table 2-14)
c= wake factor
A= cross-sectional area of structure from which material is released = 0 m

(6D.06) Low Population Zone (LPZ) Atmospheric Dispersion Coefficients:
The atmospheric dispersion coefficients from the RWT to the LPZ (2 miles) was derived via the data and methodology of UFSAR Fig.2.3-3/UFSAR 14.24.3. Note that the 0-2 hour value was adjusted via the Gifford wake model for a point release rather than a containment release.

Time (hours)	χ/Q (sec/m^3)
0-2	3.39E-05
2-24	2.20E-06
24-720	5.40E-07

(6D.07) Atmospheric dispersion coefficients from the RWT to the Control Room: (Ref.19)

ESF systems that recirculate sump water outside the primary containment are assumed to leak during their intended operation. The failed fuel activity released to the containment sump that then leaks into the RWT will escape out to the environment via the RWT vent. The main control room inleakage points include the west road inlets, the turbine building, and Access Controls 11 and 13 on the Auxiliary Building roof. Installation of automatic isolation dampers and radiation monitors at Access Controls 11 and 13 on the Auxiliary Building Roof are credited in this work.

Atmospheric Dispersion Coefficients (sec/m^3)				
	RWT1-WR	RWT2-WR	RWT1-TB	RWT2-TB
0-2 hr	2.57E-03	2.30E-03	7.72E-04	7.90E-04
2-8 hr	2.13E-03	1.32E-03	6.18E-04	6.92E-04
8-24hr	8.50E-04	4.87E-04	2.26E-04	2.86E-04
1-4 days	5.71E-04	3.64E-04	1.87E-04	2.21E-04
4-30 days	4.85E-04	2.55E-04	1.45E-04	1.76E-04

The atmospheric dispersion coefficients corresponding to the Unit 1 RWT to the west road inlet will be conservatively utilized in this work.

(6D.08) The liquid volume of the containment sump is 68329 cf per Ref.40.

(6D.09) The air volume of the RWT is 52109.75 cf per Ref.34.

(6D.10) The minimum time to RAS is 32 minutes per Ref. 35.

(6D.11) There is a potential for an unmonitored release pathway resulting from the post-LOCA leakage of isolation valves in the Safety Injection or Containment Spray system recirculation lines to the Refueling Water Tank (RWT), which is vented directly to the atmosphere (Ref.36). During the recirculation phase, sump water is recirculated through the ECCS pumps and could leak through various valves and reach the RWT. The two pathways include the two valves in series in the minimum flow recirculation line header (MOV659/660) and the valve from the containment spray pumps (SI459). By implementing more precise testing, the leakage acceptance criteria through SI459 and MOV659/660 will be reduced to 1000 cc/hr in STP-M28-1/2 (Ref.37). Per RG 1.183 (Ref.8), this leakage must be doubled to account for valve degradation between testing. The leakrate is thus

- LR = (1000 cc/hr) * 2 / (28316.85 cc/cf) / (60 min/hr) = 1.1772E-03 cfm

(6D.12) Per RG 1.183 Appendix A, if the temperature of the leakage exceeds 212°F, the fraction of total iodine in the liquid that becomes airborne should be assumed equal to the fraction of the leakage that flashes to vapor. This flash fraction, FF, should be determined using a constant enthalpy, h, process, based on the maximum time-dependent temperature of the sump water circulating outside the containment.

$$FF = (h_{f1} - h_{f2}) / h_{fg}$$

where h_{f1} is the enthalpy of liquid at system design temperature and pressure; h_{f2} is the enthalpy of liquid at saturation conditions (14.7 psia, 212°F), and h_{fg} is the heat of vaporization at 212°F.

Based on the time-dependent sump temperature data in UFSAR Figures 14.20-5 and 14.20-6 and the ASME steam tables of Ref.31, the following flashing fractions can be calculated.

Sump	Sump	RWT	RWT	RWT	Flashing	Time
Temperature	Fluid Enthalpy	Temperature	Fluid Enthalpy	Fluid-Gas Enthalpy	Fraction	Hours
234	202.4	212	180.2	970.3	0.0229	0.53
212	180.2	212	180.2	970.3	0.0000	
200	168.1	212	180.2	970.3	0.0000	2.78
168	136.0	212	180.2	970.3	0.0000	27.78
148	115.9	212	180.2	970.3	0.0000	277.78

Per this methodology, the flashing fraction does not exceed 3%. However, per RG 1.183 Appendix A, if the temperature of the leakage is less than 212°F or the calculated flash fraction is less than 10%, the amount of iodine that becomes airborne should be assumed to be 10% of the total iodine activity in the leaked fluid, unless a smaller amount can be justified based on the actual sump pH history and area ventilation rates, A 10% flash fraction is conservatively assumed in this work. Thus the leakrate of Section 6.D.11 is decreased by a factor of 10.

(6D.13) Per RG 1.183 (Ref.8), reduction in release activity by dilution or holdup within buildings or by ESF ventilation filtration systems, may be credited where applicable. In order to determine the amount of RWT release to the atmosphere, the breathing of the RWT through the vent due to diurnal temperature variations was calculated in Ref.34. The breathing was determined by performing a 24 hour transient thermal analysis of the RWT using the computer code TSAP and assuming RWT atmospheric temperature characteristics based on the maximum solar load during summer solstice and a minimum ambient nighttime temperature. This methodology results in an average 4.2 cfm leakrate from the RWT to the environment.

(6.E) MHA Hydrogen Purge Line Pathway

Per RG 1.183 (Ref.8), if the primary containment is routinely purged during power operations, releases via the purge system prior to containment isolation should be analyzed and the resulting doses summed with the postulated doses from other release paths. Per Ref.42, the containment vent system is used for an unlimited amount of pressure and containment radioactivity control purposes; however, the vent isolation valves may also be opened for surveillance testing. The 4-inch vent line isolates on a SIAS and CRS.

(6E.01) Per RG 1.183 (Ref.08), if the primary containment is routinely purged during power operations, releases via the purge system prior to containment isolation should be analyzed and the resulting doses summed with the postulated doses from other release paths. The purge release evaluation should assume that 100% of the radionuclide inventory in the reactor coolant system liquid is released to the containment atmosphere at the initiation of the LOCA. This inventory should be based on the TS RCS equilibrium activity. Iodine spikes need not be considered. The purge system is isolated before the onset of the gap release phase, thus release fractions associated with gap release and early in-vessel phases need not be considered.

An EXCEL spreadsheet (MHA.XLS(MHA-ST) displayed in Attachment A) was developed to calculate the activity released to the primary system post-LOCA. The initial primary specific activities in μCi/gm consistent with the TS 3.4.15 1.0 μCi/gm limit were extracted from Ref.4 and are listed in column C of Attachment A. These were converted to total primary isotopic source terms in Attachment A column D via the following algorithm:

$$A_{i0} = AST_i * M_{RCS} * 0.000001 \text{ Ci}$$

where AST_i = Isotopic activity per unit mass (μCi/gm) (Ref.04)
M_{RCS} = Water mass in RCS (gm)

The total primary isotopic source term was then halved in Attachment A column E to reflect that the TS 3.4.15 limit for primary activity will be reduced from 1.0 μCi/gm to 0.5 μCi/gm.

These isotopic activities were inserted into the nuclear inventory file PRI14.NIF for use by RADTRAD. The file is listed in Attachment I and consists of the 14 primary noble gas and iodine isotopes. The activities are the total primary activities and are not per unit power. Thus a power of one should be designated when employing this file.

(6E.02) Per RG 1.183 (Ref.08), 100% of the TS primary iodine and noble gas activities are assumed to be released instantaneously and homogeneously throughout the containment atmosphere at the initiation of the accident. This is incorporated into the failed fuel release fraction and timing file MHAHP.RFT, listed in Attachment J..

(6E.03) The dose conversion factors (DCFs) were extracted from Refs.20-21 and inserted into input files for use by RADTRAD. This data is included in the Conversion Factor File FGR14.INP in Attachment K for use with primary system isotopics. Note that the cloudshine data in the Conversion Factor Files corresponds to the FGR-12 data, while the inhaled chronic data in the Conversion Factor Files corresponds to the worst-case effective data in FGR-11. The remaining data in the Conversion Factor Files is extraneous and not used by RADTRAD.

(6E.04) Per Ref.08, radioiodine that is postulated to be available for releases from the RCS to the environment should be assumed to be 97% elemental and 3% organic.

(6E.05) Exclusion Area Boundary (EAB) Atmospheric Dispersion Coefficient:
The Ventilation Stack (VS) to EAB, two-hour, atmospheric dispersion coefficient of 1.44E-4 sec/m^3 was calculated via the Gifford wake model extracted from UFSAR 2.3.6, as follows

$\chi/Q = 1/[\mu * (\pi\sigma_y\sigma_z + cA)] = 1.44E\text{-}4 \text{ sec/m}^3$

where for 1150 m exclusion area boundary distance and 5% frequency

- μ = average wind speed = 1 m/sec
- σ_y= standard deviation of the distribution in the lateral direction = 92 m (UFSAR Table 2-14)
- σ_z= standard deviation of the distribution in the vertical direction = 24 m (UFSAR Table 2-14)
- c= wake factor
- A= cross-sectional area of structure from which material is released = 0 m

(6E.06) Low Population Zone (LPZ) Atmospheric Dispersion Coefficients:
The atmospheric dispersion coefficients from the VS to the LPZ (2 miles) was derived via the data and methodology of UFSAR Fig.2.3-3/UFSAR 14.24.3. Note that the 0-2 hour value was adjusted via the Gifford wake model for a point release rather than a containment release.

Time (hours)	χ/Q (sec/m^3)
0-2	3.39E-05
2-24	2.20E-06
24-720	5.40E-07

(6E.07) Atmospheric dispersion coefficients from the VS to the Control Room: (Ref.19)
The TS primary activity released to the containment atmosphere that then flows through the Hydrogen Purge Line into the Auxiliary Building Penetration Rooms will escape out to the environment via the Ventilation Stacks. The main control room inleakage points include the west road inlets, the turbine building, and Access Controls 11 and 13 on the Auxiliary Building roof. Installation of automatic isolation dampers and radiation monitors at Access Controls 11 and 13 on the Auxiliary Building Roof are credited in this work.

Atmospheric Dispersion Coefficients (sec/m^3)				
	VS1-WR	VS2-WR	VS1-TB	VS2-TB
0-2 hr	9.54E-04	8.73E-04	1.63E-03	1.68E-03
2-8 hr	6.86E-04	5.79E-04	1.19E-03	1.34E-03
8-24hr	2.95E-04	2.12E-04	4.61E-04	5.14E-04
1-4 days	2.13E-04	1.49E-04	3.22E-04	3.84E-04
4-30 days	1.56E-04	1.03E-04	2.61E-04	3.12E-04

The atmospheric dispersion coefficients corresponding to the Unit 2 VS to the turbine building will be conservatively utilized in this work. Note that neither thermal buoyancy nor vertical effluent velocity are credited in this work.

(6E.08) Containment volume:

- Net free volume: 1.989E+06 cf (UFSAR Tab.14.20-3, Ref.39)
- No sprays are credited during the first 30 seconds, so it is not necessary to segment the containment into sprayed and unsprayed regions.

(6.E.09) Per Ref.42, the maximum total time of 30 seconds for valve closure is based on 2.4 seconds for containment pressure buildup, instrument response, and SIAS delay, 10 seconds for emergency diesel generator startup, and 15 seconds for valve stroke time. An additional; margin of 2.6 seconds is included for conservatism/margin. The failure of one diesel generator would not affect the results, because both diesel generators will start on a SIAS. If one diesel generator fails, the other automatically picks up the load with no significant delay. The purge system is isolated before the onset of the gap release phase, thus release fractions associated with gap release and early in-vessel phases need not be considered.

(6E.10) Penetration Room Ventilation and Filtration System:

- Per UFSAR 6.6.1, the Containment Penetration Room Emergency Ventilation System (PREVS) is designed to collect and process containment penetration leakage, so as to reduce to a minimum the environmental radioactivity levels from post-accident containment leaks. To minimize the release of radioactive material to the environment, penetration room ventilation is continuously routed through a prefilter, a high efficiency particulate air (HEPA) filter, and an activated charcoal filter, positioned in series.
- Following a LOCA, a Containment Isolation Signal (CIS) will start both of the two full-size blowers. The entire system is designed to operate under negative pressure up to the fan discharge.
- Per TS 5.5.11, each PREVS unit has a design flowrate of 2000 ± 10% cfm with an efficiency of 90% for elemental and particulate species and 30% for organic species.

(6.E.11) The flow from the containment to the atmosphere via the 4" hydrogen purge line was calculated assuming peak containment pressure for the full 30 seconds that the line is open.

N2/N1	0.2296		N2/N1=P2/P1 Mole fraction of air
MWair	29		Molecular weight of air (Crane P.A-8)
MWwater	18		Molecular weight of water (Crane P.A-8)
MWmix	20.5259		Molecular weight of mixture=MWair*N2/N1+MWwater*(1-N2/N1)
R	75.2708		Gas constant=1545/M (Crane p.1.0)
T	748	R	Absolute temperature in degrees Rankine (288+460) (UFSAR Figures 14.20-5/6)
Rho	0.1637	lbm/cf	Rho=144*P/(R*T)
k	1.3		Ratio of specific heat at constant pressure to specific heat at constant volume (steam)
P1	64	psia	Containment design pressure (UFSAR Table 14.20-3)
P2	14.696	psia	STP pressure (Steam Tables)
dP/P	0.7704	psia	(P1-P2)/P1
rho	0.1637	lbm/cf	Containment density (M-89-33)
d	4	inches	Pipe diameter (M-89-33)
K	15.3		Flow resistance coefficient (M-89-33)
Y	0.735		Expansion factor (Crane p.A-22)
w	4.4840	lbm/sec	Darcy Equation: w=0.525*Y*d^2*sqrt(dp*rho/K) (Crane Eq 1-11)
F	1643.84	cfm	F=w*60/rho

(6.F) MHA Containment Shine
Per RG 1.183 (Ref.8), the analysis should consider radiation shine from radioactive material in the containment.

(6F.01) The inventory of fission products in the reactor core and available for release to the containment atmosphere is based on the maximum full power operation of the core with current licensed values for fuel enrichment, fuel burnup, and a core power equal to the current licensed rated thermal power times the ECCS evaluation uncertainty.

The period of irradiation was of sufficient duration to allow the activity of dose-significant radionuclides to reach maximum values. The isotopic activities released from the failed fuel in Ci/MWt were generated in Ref. 05 Case CRCB63, utilizing the isotope generation and depletion computer code SAS2H/ORIGEN-S. For the containment shine pathway, all 63 isotopic activities in Ci/MWt are listed in the second column of the spreadsheet (MST.XLS(MSC)) displayed in Attachment Q.

(6F.02) The core inventory release fractions, by radionuclide groups, for the gap release and early in-vessel damage phases for a DBA LOCA were extracted from RG 1.183 (Ref.08). The onset and duration of each sequential release phase for the DBA LOCA was extracted from RG 1.183 (Ref.08). The activity released from the core during the Gap Release and the Early In-Vessel Phase is assumed to be released at the beginning of the accident. Note that step releases are allowed per RG 1.183. The values are incorporated in the third column of the spreadsheet (MST.XLS(MSC)) displayed in Attachment Q.

Group	Gap Release Phase	Early In-Vessel Phase	Total Release
Noble Gases (Xe,Kr)	0.05	0.95	1.00
Halogens (I,Br)	0.05	0.35	0.40
Alkali Metals (Cs,Rb)	0.05	0.25	0.30
Tellurium Metals (Te,Sb,Se)	0.00	0.05	0.05
Ba, Sr	0.00	0.02	0.02
Noble Metals (Ru,Rh,Pd,Mo,Tc,Co)	0.0000	0.0025	0.0025
Cerium Group (Ce,Pu,Np)	0.0000	0.0005	0.0005
Lanthanides (La,Zr,Nd,Eu, Nb,Pm,Pr,Sm,Y,Cm,Am)	0.0000	0.0002	0.0002
Release Timing	0.00 hr	0.00 hr	

(6F.03) For the containment shine pathway, all 63 isotopic activities in Ci released to the containment atmosphere at the beginning of the accident are listed in the fourth column of the spreadsheet (MST.XLS(MSC)) displayed in Attachment Q and are the product of the activity per unit power (Column 2), the release fraction (Column 3), and the core power of 2754 MWt (6A.01). These values are input into Microshield to calculate containment shine doses in the control room. Note that Microshield will allow parent decay and daughter buildup, so that subsequent isotopic quantities as a function of decay time are automatically calculated by Microshield.

(6F.04) For the containment shine analysis, no removal of airborne radioactivity is assumed except for decay.

(6F.05) The geometry required for Microshield execution is the following:

- Containment radius is 65' 0" per Ref.44.
- Containment stainless steel liner plate thickness isn 0.25" per UFSAR 5.1.2.1.
- Containment concrete wall thickness is 3' 9" per Ref.44.
- Containment height is 181' 7.75" per Ref.44.
- Closest distance between containment and control room proper is 17.90' per Refs.59-61.
- The control room concrete wall is 2' thick per Ref.62 p.100.
- Note that the dose point is at 89' from containment, which is approximately 65'+3.75'+17.9'+2'. With Microshield, one gets the same results assuming 65'+3.75'+9.15'+2'+8.75'.

(6.G) MHA Plume Shine

Per RG 1.183 (Ref.8), the analysis should consider radiation shine from the external radioactive plume released from containment.

(6G.01) The inventory of fission products in the reactor core and available for release to the containment atmosphere is based on the maximum full power operation of the core with current licensed values for fuel enrichment, fuel burnup, and a core power equal to the current licensed rated thermal power times the ECCS evaluation uncertainty. The period of irradiation was of sufficient duration to allow the activity of dose-significant radionuclides to reach maximum values. The isotopic activities released from the failed fuel in Ci/MWt were generated in Ref. 05 Case CRCB63, utilizing the isotope generation and depletion computer code SAS2H/ORIGEN-S. For the plume shine pathway, all 63 isotopic activities in Ci/MWt are listed in the second column of the spreadsheet (MST.XLS(MSP)) displayed in Attachment R.

(6G.02) The core inventory release fractions, by radionuclide groups, for the gap release and early in-vessel damage phases for a DBA LOCA were extracted from RG 1.183 (Ref.08). The onset and duration of each sequential release phase for the DBA LOCA was extracted from RG 1.183 (Ref.08). The activity released from the core during the Gap Release and the Early In-Vessel Phase is conservatively assumed to be released at the beginning of the accident for this pathway. Note that step releases are allowed per RG 1.183. The values are incorporated in the third column of the spreadsheet (MST.XLS(MSP)) displayed in Attachment R.

Group	Gap Release Phase	Early In-Vessel Phase	Total Release
Noble Gases (Xe,Kr)	0.05	0.95	1.00
Halogens (I,Br)	0.05	0.35	0.40
Alkali Metals (Cs,Rb)	0.05	0.25	0.30
Tellurium Metals (Te,Sb,Se)	0.00	0.05	0.05
Ba, Sr	0.00	0.02	0.02
Noble Metals (Ru,Rh,Pd,Mo,Tc,Co)	0.0000	0.0025	0.0025
Cerium Group (Ce,Pu,Np)	0.0000	0.0005	0.0005
Lanthanides (La,Zr,Nd,Eu, Nb,Pm,Pr,Sm,Y,Cm,Am)	0.0000	0.0002	0.0002
Release Timing	0.00 hr	0.00 hr	

(6G.03) Containment Leakage
The maximum allowable containment leakage rate La contained in the Containment Leakage Rate Testing Program of TS 5.5.16 will be reduced from 0.20 percent per day at containment peak pressure Pa to 0.16 percent per day at Pa. Per RG 1.183, the containment should be assumed to leak at the leak rate incorporated in the technical specifications for the first 24 hours, and at 50% of this leak rate for the remaining duration of the accident. Thus the fraction of the containment activity that leaks from the containment over 30 days can be calculated to be 0.0016+0.0008*29=0.0248.

(6G.04) For the plume shine pathway, all 63 isotopic activities in Ci released to the containment atmosphere at the beginning of the accident and then leaked out of containment during the accident are listed in the fourth column of the spreadsheet (MST.XLS(MSP)) displayed in Attachment R and are the product of the activity per unit power (Column 2), the release fraction (Column 3), the core power of 2754 MWt (6A.01), and the containment leakage fraction 0.0248 (6G.03). These values are input into Microshield to calculate plume shine doses in the control room.

(6F.05) For the plume shine analysis, no removal of airborne radioactivity is assumed except for decay.

(6G.06) The geometry required for Microshield execution is the following:

- The control room volume is 289194 ft^3 (6A.07), while the control room height is approximately 69'-45'-2'=22'. Assuming that the containment floor area is a square, the effective containment length is sqrt(289194/22) = 114.65 ft = 35 m.

- The maximum containment internal elevation is 190' 1.75" per Ref.44.
- The auxiliary building roof elevation above the containment is 91.5' per Ref.19.
- While the bulk of the auxiliary building roof is 2' of concrete, the minimum thickness is 6" per Ref.62.
- The control room ceiling extends from 67' to 69' elevation and is 2' of concrete per Ref.62.
- Thus the plume height, which is assumed to extend from the auxiliary building roof to the top of containment, is 98.65'. The concrete roof is 0.5'. The 69' auxiliary building distance from floor to ceiling is 22'. The control room ceiling is 2' of concrete. These values are entered into Microshield.

(6G.07) Finally, it is necessary to calculate the activity dilution factor, assuming that the activity exits the containment horizontally flowing towards the control room. Per Ref.19, the average wind velocity, averaged over 8 years, is 2.99 m/sec. It will be conservatively assumed that the wind velocity for the 30 days subsequent to the accident is 0.3 m/sec. Thus the dilution factor can be calculated as 35/(0.3*3600*24*30) = 4.50E-05. This is doubled for the first 24 hour period, since the leak rate is twice as high.

(6.H) MHA Control Room Filter Shine
Per RG 1.183 (Ref.8), the analysis should consider radiation shine from the radioactive material buildup on recirculation filters.

(6H.01) The inventory of fission products in the reactor core and available for release to the containment atmosphere is based on the maximum full power operation of the core with current licensed values for fuel enrichment, fuel burnup, and a core power equal to the current licensed rated thermal power times the ECCS evaluation uncertainty. The period of irradiation was of sufficient duration to allow the activity of dose-significant radionuclides to reach maximum values. The isotopic activities released from the failed fuel in Ci/MWt were generated in Ref. 05 Case CRCB63, utilizing the isotope generation and depletion computer code SAS2H/ORIGEN-S. For the control room filter shine pathway, all 63 isotopic activities in Ci/MWt are listed in the second column of the spreadsheet (MST.XLS(MSF)) displayed in Attachment S.

(6H.02) The core inventory release fractions, by radionuclide groups, for the gap release and early in-vessel damage phases for a DBA LOCA were extracted from RG 1.183 (Ref.08). Note that the control room filtration system filters aerosols and elemental and organic iodines. It does not filter the noble gas radionuclides, so they are excluded from this analysis: their release fractions are set to zero. The activity released from the core during the Gap Release and the Early In-Vessel Phase is conservatively assumed to be released at the beginning of the accident. Note that step releases are allowed per RG 1.183. The values are incorporated in the third column of the spreadsheet (MST.XLS(MSF)) displayed in Attachment S.

Group	Gap Release Phase	Early In-Vessel Phase	Total Release
Noble Gases (Xe,Kr)	0.00	0.00	0.00
Halogens (I,Br)	0.05	0.35	0.40
Alkali Metals (Cs,Rb)	0.05	0.25	0.30
Tellurium Metals (Te,Sb,Se)	0.00	0.05	0.05
Ba, Sr	0.00	0.02	0.02
Noble Metals (Ru,Rh,Pd,Mo,Tc,Co)	0.0000	0.0025	0.0025
Cerium Group (Ce,Pu,Np)	0.0000	0.0005	0.0005
Lanthanides (La,Zr,Nd,Eu, Nb,Pm,Pr,Sm,Y,Cm,Am)	0.0000	0.0002	0.0002
Release Timing	0.00 hr	0.00 hr	

(6H.03) For the control room filter shine calculations, the isotopic activities in Ci released to the containment atmosphere at the beginning of the accident are listed in the fourth column of the spreadsheet (MST.XLS(MSF)) displayed in Attachment S and are the product of the activity per unit power (Column 2), the release fraction (Column 3), and the core power of 2754 MWt (6A.01).

- These values are input into Microshield to calculate control room filter shine doses from aerosols entrained on the control room filters. Note that only 95% of the iodines are in aerosol form; however, for conservatism 100% of all species except noble gases will be assumed to be particulate in this work. Also note that Microshield will allow parent decay and daughter buildup, so that subsequent isotopic quantities as a function of decay time are automatically calculated by Microshield.
- The iodine values are input into Microshield to calculate control room filter shine doses from elemental and organic iodines entrained on the control room filters. Note that Microshield will allow parent decay and daughter buildup, so that subsequent isotopic quantities as a function of decay time are automatically calculated by Microshield.

(6H.04) The geometry required for Microshield execution is the following:

- The filter housing assembly for the post-loci control room filters are displayed in Refs. 63-65. The filter unit is 24" in width by 33" in length by 59" in height and is assumed to be composed of carbon. The unit is located 6" above the 69' concrete floor.
- The control room ceiling extends from 67' to 69' elevation and is 2' of concrete per Ref.62.
- Note that Refs.63-65 describe the current 2000 cfm filter units, not the 10000 cfm filter units that will replace them. Use of a smaller unit should concentrate the radionuclides and thus maximize the dose.

(6H.05) Atmospheric dispersion coefficients from the containment to the Control Room: (Ref.19)
The failed fuel activity released into the containment atmosphere is assumed to escape into the environment through the containment wall. The main control room inleakage points include the west road inlets, the turbine building, and Access Controls 11 and 13 on the Auxiliary Building roof. Installation of automatic isolation dampers and radiation monitors at Access Controls 11 and 13 on the Auxiliary Building Roof are credited in this work.

Atmospheric Dispersion Coefficients (sec/m^3)				
	U1-WR	U2-WR	U1-TB	U2-TB
0-2 hr	**1.11E-03**	1.04E-03	1.02E-03	1.02E-03
2-8 hr	**7.29E-04**	5.95E-04	7.10E-04	7.98E-04
8-24hr	**3.19E-04**	2.29E-04	2.57E-04	3.19E-04
1-4 days	**2.36E-04**	1.64E-04	2.19E-04	2.56E-04
4-30 days	**1.98E-04**	1.14E-04	1.77E-04	2.14E-04

The atmospheric dispersion coefficients corresponding to the Unit 1 containment to the west road inlet on the auxiliary building will be conservatively utilized in this work.

(6H.06) The maximum allowable containment leakage rate La contained in the Containment Leakage Rate Testing Program of TS 5.5.16 will be reduced from 0.20 percent per day at containment peak pressure Pa to 0.16 percent per day at Pa. Per RG 1.183, the containment should be assumed to leak at the leak rate incorporated in the technical specifications for the first 24 hours, and at 50% of this leak rate for the remaining duration of the accident.

(6H.07) Containment volume:
Net free volume: 1.989E+06 cf (UFSAR Tab.14.20-3, Ref.39)

(6H.08) Containment Radionuclide Removal Processes:
(a) Per RG 1.183, reduction in airborne radioactivity in the containment by containment spray systems that have been designed and maintained in accordance with SRP 6.5.2 (Ref.11) may be credited.
An acceptable model for the removal of aerosols is described in SRP 6.5.2 (Ref.11) and NUREG/CR-5966 (Ref.12), which is incorporated into the analysis code RADTRAD (Refs.13-15).

- Per SRP 6.5.2 the first-order particulate iodine spray removal coefficient may be estimated by:
    - LP=1.5*(60min/hr)*h*F*(E/D)/VSR = 3.414/hr (Ref.11)

- o h=fall height = 100.ft (UFSAR 6.4.2)
- o F=Spray pump volume flow rate = 180 cfm (UFSAR 6.4.2)
- o VSR=Containment volume sprayed region = 1.446E+06 cf (6B.08)
- o E/D = DF = Ratio of a dimensionless collection efficiency E to the average spray drop diameter D =10/m=3.048/ft (Ref.11)

- SRP 6.5.2 states that the particulate iodine removal rate should be reduced by a factor of 10 when a DF of 50 is reached. Per RG 1.183, the reduction in the removal rate is not required if the removal rate is based on the calculated time-dependent airborne aerosol mass.
- Per RG 1.183, there is no specified maximum DF for aerosol removal by sprays.

(b) Containment iodine removal system:

Per UFSAR 14.24, the containment iodine removal system (IRS) credits two filter units, each with a capacity to handle 50% of the required air flow. . Each unit consists of activated charcoal filters preceded by HEPA filters. Per TS 5.5.11, each filter unit has a 20000±10% cfm flowrate with a filter efficiency of 90% for elemental and particulate species and 30% for organic species per RG 1.52 (Ref.28).

- o Particulate removal coefficient = (2 * 18000 cfm) * (0.90) * (60 min/hr) / Vctmt = 0.977/hr
- o Elemental removal coefficient = (2 * 18000 cfm) * (0.90) * (60 min/hr) / Vctmt = 0.977/hr
- o Organic removal coefficient = (2 * 18000 cfm) * (0.30) * (60 min/hr) / Vctmt = 0.326/hr

(c) Since the activity released from the core during the Gap Release and the Early In-Vessel Phase is conservatively assumed to be released at the beginning of the accident, no delay times for spray and filter activation is assumed.

(6H.09) Per RG 1.183 (Ref.08), of the radioiodine released from the RCS to the containment atmosphere in a LOCA, 95% of the iodine released should be assumed to be cesium iodide (CsI), 4.85% elemental iodine, and 0.15% organic iodine. This includes releases from the gap and fuel pellets. With the exception of elemental and organic iodine and noble gases, fission products should be assumed to be in particulate form.

7. TECHNICAL ASSUMPTIONS

The following technical assumptions were utilized in this work:

(01) No credit is taken for ground deposition of the effluent plume or isotopic decay in transit to the site boundary.

(02) Buildup of daughter nuclides is taken into account as source term nuclides decay.

(03) Leakage of the radioactive sump liquid post-LOCA is not considered a release pathway in this work. SRP 15.6.5 Appendix B states that "The leakage for calculating the radiological consequences should be the maximum operational leakage and should be taken as two times the sum of the simultaneous leakage from all components in the recirculation systems above which the TS would require declaring such systems to be out of service." TMI Action Item III.D.1.1.1 required implementation of a leak reduction program to reduce leakage from systems outside containment which could contain highly radioactive fluids by January 1, 1980. Standard TS Section 6.5.3 System Integrity indicates that the program details can be stored in maintenance procedures. Maintenance Procedure STP-M-573-1 states "Any leakage through the pressure boundary (e.g., welds, pipe wall, valve body, pump case) is unacceptable and shall result in the test being out of specification." Thus the accident analyses do not include any post-accident leakage. This response to TMI Action Item IIID.1.1.1 was submitted to the NRC and approved on April 7, 1980. Currently, TRM 15.4.3 requires structural integrity of ASME class 1 components. Deviations require restoration or isolation of the affected component.

(04) Fuel that is damaged during a LOCA will release iodine in several chemical forms to the reactor coolant and to the containment atmosphere. A portion of the iodine in the containment atmosphere is washed to the sump by containment sprays. The emergency core cooling water is borated for reactivity control. This borated water causes the sump solution to be acidic. In an acidic solution, the dissolved iodine will be converted into a volatile form and evolve out of solution, increasing the airborne iodine levels in containment and increasing the consequences from the accident due to containment atmosphere leakage. Adjusting the pH of the recirculation solution to levels ≥ 7.0 prevents a significant fraction of the dissolved iodine from converting to a volatile form, thus decreasing the level of airborne iodine in Containment and reducing the radiological consequences from containment atmosphere leakage post-LOCA. Trisodium phosphate dodecahydrate (TSP) is placed in baskets on the floor of the containment building to ensure that iodine, which may be dissolved in the recirculated reactor cooling water following a LOCA, remains in solution. Refs.79-80 calculate the mass of TSP required to neutralize the containment sump pH following a LOCA, assuming a boron level of 3105.5 ppm. This mass of TSP is converted into a TSP volume of 289.3 ft^3, which is captured in TS 3.5.5. Note that the dodecahydrate form of TSP is used because of the high humidity in containment during normal operation. Since the TSP is hydrated, it is less likely to absorb large amounts of water from the humid atmosphere and will undergo less physical and chemical change than the anhydrous form of TSP. Refs.79-80 only consider boron as a source of acidity in the post-LOCA environment.

NUREG/CR-5950 (Ref.82) identified the following additional sources of acid in containment post-LOCA:

- Nitric acid generated by irradiation of air and water in containment
- Hydrochloric acid generated by the breakdown of certain cable jacketing when it is exposed to high temperatures and radiation
- Hydriodic acid generated by a reaction of iodine in water
- Carbonic acid generated by water absorbing CO_2 fromthe air or from limestone concrete

The issue is of negligible significance at Calvert Cliffs. Hydriodic and carbonic acids, can be discounted entirely due to ambient conditions in containment. The impact on containment TSP quantities by the other two acid sources described in the NUREG)hydrochloric and nitric acids) was calculated in Ref.81 and was determined to be minor. Ref.81 considered the additional acidity caused by hydrochloric acid and nitric acid, which are produced by the degradation of electric cable insulation and sump water exposure to high levels of radioactivity, respectively. That work calculated that 166. lbm or 3.08 ft^3 of additional TSP is required to neutralize the hydrochloric and nitric acids produced by the degradation of electric cable insulation and sump water exposure to high levels of radioactivity. This 1% increase in TSP was deemed insignificant and have a negligible effect on pH (Ref.83).

8. REFERENCES

(01) "Power Levels of Nuclear Power Plants", Regulatory Guide 1.49 Rev.1, 12/73.

(02) CCNPP Core Operating Limits Report for Unit 1 Cycle 17 Rev.1

(03) CCNPP Core Operating Limits Report for Unit 2 Cycle 16 Rev.0

(04) "Primary and Secondary Isotopic Calculations", CA06422

(05) "Control Room Habitability Source Term Calculations", CA06358.

(06) "Chart of the Nuclides - Nuclides and Isotopes", GE Nuclear Energy, Fifteenth Edition.

(07) "Gas Gap Isotopic Fraction Calculations", CA06421.

(08) "Alternate Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors", Regulatory Guide 1.183

(09) "Calculation of Delay Time for the Containment Spray", BGE Calculation 000-TH-9302 Rev.1, 7/7/94.

(10) "Resolution of AIT Milestones Concerning MHA Analysis", NEU-94-102, 3/31/94.

(11) "Containment Spray as a Fission Product Cleanup System", SRP 6.5.2 Rev.2, 12/88.

(12) D.A.Powers and S.B.Burson, "A Simplified Model of Aerosol Removal by Containment Sprays," NUREG/CR-5966, USNRC, June, 1993.

(13) "RADTRAD: A Simplified Model for Radionuclide Transport and Removal and Dose Estimation", NUREG/CR-6604, SAND98-0272

(14) "RADTRAD: A Simplified Model for Radionuclide Transport and Removal and Dose Estimation", NUREG/CR-6604, SAND98-0272/1, Supplement 1.

(15) "RADTRAD: A Simplified Model for Radionuclide Transport and Removal and Dose Estimation", NUREG/CR-6604, Supplement 2

(16) "RADTRAD 3.03 Installation and Verification on PCB386", CA06210

(17) "RADTRAD 3.03 Validation", CA06207

(18) "Calculation of Distance Factors for Power and Test Reactor Sites", TID-14844, 3/23/62.

(19) CA06012: CRHVAC Atmospheric Dispersion Coefficient Calculations

(20) Federal Guidance Report (FGR) 11, "Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors," 1989

(21) Federal Guidance Report (FGR) 12, "External Exposure to Radionuclides in Air, Water, and Soil," 1993,

(22) "Fuel Performance Analysis", Westinghouse Calculation CN-WFE-02-45, Rev.0

(23) "Control Room HVAC Inleakage Test", ETP-97-064R Rev.0, 11/11/1997 (First Run)

(24) "Control Room HVAC Inleakage Test", ETP-97-064R Rev.0, 11/11/1997 (Third Run)

(25) "Control Room HVAC Inleakage Test", ETP-97-064R Rev.0, 11/11/1997 (Fourth Run)

(26) "Control Room HVAC Inleakage Test", ETP-97-064R Rev.0, 1/18/2000.

(27) "Perfluorocarbon Tracer Gas Testing", ETP-01-035R Rev.0, 5/1/2002

(28)) Regulatory Guide 1.52 Rev.2: "Design, Testing, and Maintenance Criteria for Post Accident ESF Atmosphere Cleanup System Air Filtration and Absorption Units of LWRs"

(29) "Control Room Recirculation Filter Initiation Time Delay", NEU-95-026

(30) NRC Generic Letter 99-02: Laboratory Testing of Nuclear-Grade Activated Charcoal

(31) ASME Steam Tables, 5th Edition, United Engineering Center, N.Y., N.Y.

(32) "Containment Vent System", BGE to NRC, 8/9/85.

(33) STP O-56A-1 ESFAS Equipment Response Time Rev.11

(34) CA02620, "Control Room and Offsite Dose from the RWT Pathway @ 730 cfm Inleakage"

(35) CA04903, "Evaluation of Minimum Time to RAS"

(36) "Potential Radioactive Leakage to Tank Vented to Atmosphere", NRC Information Notice 91-56.

(37) STP-M28-1/2: Safety Injection Valve Leak Test

(38) Crane Technical Paper No. 410, Flow of Fluids through Valves, Fittings, and Pipes

(39) Bechtel letter from A.J.Arnold to C.H.Poindexter, 4/4/75, CDCC#63854.

(40) "Offsite and Control Room Doses Following a LOCA", Bechtel Calculation M-89-33 Rev.3, 7/9/91.

(41) D.A.Powers, et al, "A Simplified Model of Aerosol Removal by Natural Processes in Reactor Containments," NUREG/CR-6189, USNRC, July 1996.

(42) Letter NRC to BGE, 8/9/1985, "Containment Vent System"

(43) Regulatory Guide 1.194, "Atmospheric Relative Concentrations for Control Room Radiological Habitability Assessments at Nuclear Power Plants"

(44) BGE Drawing 61740SH0001 Rev.20, "Containment Liner Plan, Elevations and Penetrations"

(45) BGE Drawing 62144SH0001 Rev.2, "Post Accident Radiation Doses, Auxiliary Building Plan at El 5' "

(46) BGE Drawing 62145SH0001 Rev.2, "Post Accident Radiation Doses, Auxiliary Building Plan at El 27' "

(47) BGE Drawing 62146SH0001 Rev.2, "Post Accident Radiation Doses, Auxiliary Building Plan at El 45' "

(48) Calculation M-90-172, "Internal Plant Flooding for the West Piping Penetration Rooms"

(49) "LLRT Results for the Equipment Hatch and Emergency Air Lock", Telephone and Conference Memorandum G.E.Gryczkowski to D.Collins, 5/7/96 (Attachment A)

(50) "Unit 1 Reactor Containment Building Integrated Leakage Rate Test Report", 4/24/78 (Attachment B)

(51) "Unit 1 Reactor Containment Building Integrated Leakage Rate Test Report", 6/22/82 (Attachment C)

(52) "Unit 1 Primary Reactor Containment Integrated Leakage Rate Test Report", 5/85 (Attachment D)

(53) "Unit 1 Primary Reactor Containment Integrated Leakage Rate Test Report", 5/88 (Attachment E)

(54) "Unit 1 Reactor Containment Building Integrated Leakage Rate Test Report", 7/92 (Attachment F)

(55) "Unit 2 Primary Reactor Containment Integrated Leakage Rate Test Report", 11/16/79 (Attachment G)

(56) "Unit 2 Reactor Containment Building Integrated Leakage Rate Test Report", 12/22/82 (Attachment H)

(57) "Unit 2 Primary Reactor Containment Integrated Leakage Rate Test Report", 11/85 (Attachment I)

(58) "Unit 2 Primary Reactor Containment Integrated Leakage Rate Test Report", 1/91 (Attachment J)

(59) BGE Drawing 60204SH0001 Rev.35, Equipment Location Containment & Auxiliary Building Unit 1 at El 45'

(60) BGE Drawing 62046SH0001 Rev.5, Auxiliary Building Control Room Reflected Ceiling Plan at El.45'

(61) BGE Drawing 62042SH0001 Rev.15, Architectural Partial Floor Plan Control Room El.45'

(62) Bechtel Calculation M-93-2: Maximum Post-LOCA Doses in Auxiliary Building Rooms

(63) BGE Drawing 12321SH0007 Rev.6: Filter House Assembly Control Room Post Loc.1 Fresh Air (Filters No. 11 and 12)

(64) BGE Drawing 12396A-454: Control Room Plenums for Post-LOCI Filters

(65) BGE Drawing 12396A-455: Control Room Plenums for Post-LOCI Filters

(66) "Control Room Thyroid Doses Post-LOCA", NEU-93-085, 3/25/93.

(67) "Control Room Habitability Interim Analysis for Thyroid Dose", Correspondence NRC to BGE, 6/22/95.

(68) "SCBA Utilization Post-MHA with 3500 cfm Control Room Inleakage", CA04985.

(69) "RWT Release Pathway, post-LOCA", 000-DA-9201 Rev.1, 10/26/92.

(70) "Offsite and Control Room Doses from Leakage to the RWT", NC-94-032 Rev.0, 1/18/95.

(71) "Control Room and Offsite Doses from the RWT Pathway Post-MHA @ 2000 cfm Inleakage", CA03781

(72) "Control Room and Offsite Doses from the RWT Pathway Post-MHA @ 3000 cfm Inleakage", CA04160

(73) "Calvert Cliffs Reload Analysis Recorded Calculations", ABB/CE B-94-116, 6/13/94.

(74) "Change Stroke Length of 1MOV6900 and 1MOV6901 to 3 Inches", TMOD-1-98-0007

(75) "Miscellaneous Containment Isolation Valves Quarterly Test", STP-O-65D-1, Rev.3, 5/6/99.

(76) Microshield Version 5 User's Manual, Grove Engineering, October 1996.

(77) CA06445: Microshield 5.05 - Computer Code Installation and Verification

(78) CA06446: Microshield 5.05 - Computer Code Validation

(79) "Mass of TSP Required to Ensure a Minimum Sump pH of 7.0 in the Event of a LOCA", BGE Calculation M-93-33, Rev.1, 4/16/93.

(80) "Increasing the Volume of TSP Baskets in Containment", BGE Calculation C-80-11, Rev.4, 9/29/94.

(81) "Additional TSP Required to Compensate for Production of Nitric Acid and Hydrochloric Acid", CA04602

(82) "Iodine Evolution and pH Control", NUREG/CR-5950

(83) Telecon J.H.Wood (BGE) and S.Barshay (ABB), 12/2/98.

9. METHODS OF ANALYSIS

(9.A) RADTRAD Containment Pathway Computations

Per RG 1.194 (Ref.43), the total release from containment atmosphere may be apportioned between the exposed and enclosed building surfaces. A large fraction of the released airborne activity post-MHA is assumed to leak out of the containment through the containment walls. This was modeled by utilizing the RADTRAD computer code.

The isotopic activities released from the failed fuel per unit power were generated by the isotope generation and depletion computer code SAS2H/ORIGEN-S and multiplied by the relevant power level and release fractions. The core inventory release fractions by radionuclide groups for the gap release and early in-vessel damage phases were extracted from RG 1.183 Table 2. The maximum allowable containment leakage rate La contained in the Containment Leakage Rate Testing Program of TS 5.5.16 will be reduced from 0.20 percent per day at containment peak pressure Pa to 0.16 percent per day at Pa. Per RG 1.183, the containment should be assumed to leak at the leak rate incorporated in the technical specifications for the first 24 hours, and at 50% of this leak rate for the remaining duration of the accident. Per Regulatory Guide 1.194 (Ref.43), the total release from containment may be apportioned between the exposed and enclosed building surfaces. In this work a conservative bypass fraction from the containment to the penetration rooms of 28% was assumed. The containment atmosphere is cleansed by the iodine removal system, which filters particulates and elemental and organic iodine, by spray, which removes particulates and elemental iodine, and by natural deposition, which removes particulates.

The activity released to the environment is transported to the site boundary and to the control room via appropriate atmospheric dispersion coefficients. The control room inleakage modeled by RADTRAD is a constant 3500 cfm in this work. Control room filtration is credited based on a modification to increase recirculation flow to a nominal 10000 cfm. A charcoal filter efficiency of 90% is credited for elemental and organic iodine, while a HEPA efficiency of 99% is credited for particulate iodine. A 20 minute time delay consistent with a manual start of the CREVS is assumed. The control room and site boundary doses are calculated based on RG 1.183 breathing rates and occupancy factors and on FGR 11 and 12 dose conversion factors.

(9.B) RADTRAD Ventilation Stack Pathway Computations

Per RG 1.194 (Ref.43), the total release from containment may be apportioned between the exposed and enclosed building surfaces. Per UFSAR 6.6.2, experience has shown that containment leakage is more likely at penetrations rather than through liner plates or weld joints. Penetration rooms are built adjacent to the outside surface of each containment and enclose the areas around the majority of the penetrations. Thus, a fraction of the containment leakage will leak into the auxiliary building penetration rooms, be processed by the penetration room emergency ventilation system, and be expelled to the atmosphere through the ventilation stacks. This was modeled by utilizing the RADTRAD computer code.

The isotopic activities released from the failed fuel per unit power were generated by the isotope generation and depletion computer code SAS2H/ORIGEN-S and multiplied by the relevant power level and release fractions. The core inventory release fractions by radionuclide groups for the gap release and early in-vessel damage phases were extracted from RG 1.183 Table 2. The maximum allowable containment leakage rate La contained in the Containment Leakage Rate Testing Program of TS 5.5.16 will be reduced from 0.20 percent per day at containment peak pressure Pa to 0.16 percent per day at Pa. Per RG 1.183, the containment should be assumed to leak at the leak rate incorporated in the technical specifications for the first 24 hours, and at 50% of this leak rate for the remaining duration of the accident. Per Regulatory Guide 1.194 (Ref.43), the total release from containment may be apportioned between the exposed and enclosed building surfaces. In this work a conservative bypass fraction from the containment to the penetration rooms of 28% was assumed. The containment atmosphere is cleansed by the iodine removal system, which filters particulates and elemental and organic iodine, by spray, which removes particulates and elemental iodine, and by natural deposition, which removes particulates. Per UFSAR 6.6.1, the Containment Penetration Room Emergency Ventilation System (PREVS) is designed to collect and process containment penetration leakage, so as to reduce to a minimum the environmental radioactivity levels from post-

accident containment leaks. To minimize the release of radioactive material to the environment, penetration room ventilation is continuously routed through a prefilter, a high efficiency particulate air (HEPA) filter, and an activated charcoal filter, positioned in series. The PREVS filters all three species of radionuclide effluent.

The activity released to the environment is transported to the site boundary and to the control room via appropriate atmospheric dispersion coefficients. The control room inleakage modeled by RADTRAD is a constant 3500 cfm in this work. Control room filtration is credited based on a modification to increase recirculation flow to a nominal 10000 cfm. A charcoal filter efficiency of 90% is credited for elemental and organic iodine, while a HEPA efficiency of 99% is credited for particulate iodine. A 20 minute time delay consistent with a manual start of the CREVS is assumed. The control room and site boundary doses are calculated based on RG 1.183 breathing rates and occupancy factors and on FGR 11 and 12 dose conversion factors.

(9.C) RADTRAD RWT Pathway Computations

Per RG 1.183 (Ref.8), ESF systems that recirculate sump water outside of the primary containment are assumed to leak during their intended operation. This release source may include leakage through valves isolating interfacing systems. There is a potential for an unmonitored release pathway resulting from the post-LOCA leakage of isolation valves in the Safety Injection or Containment Spray system recirculation lines to the Refueling Water Tank (RWT), which is vented directly to the atmosphere (Ref.36). During the recirculation phase, sump water is recirculated through the ECCS pumps and could leak through various valves and reach the RWT. The two pathways include the two valves in series in the minimum flow recirculation line header (MOV659/660) and the valve from the containment spray pumps (SI459). This was modeled by utilizing the RADTRAD computer code.

The isotopic activities released from the failed fuel per unit power were generated by the isotope generation and depletion computer code SAS2H/ORIGEN-S and multiplied by the relevant power level and release fractions. The core inventory release fractions by radionuclide groups for the gap release and early in-vessel damage phases were extracted from RG 1.183 Table 2; however, per RG 1.183 Appendix A Section 5.3, with the exception of iodine, all radioactive materials in the recirculating liquid should be assumed to be retained in the liquid phase. The minimum time to RAS of 32 minutes determines the beginning of the sump recirculation phase. During the recirculation phase, sump water is recirculated through the ECCS pumps and could leak through various valves and reach the RWT. This leak rate is doubled per the requirements of RG 1.183. 10% of the fluid leaking into the RWT is assumed to flash and release its iodine content into the RWT atmosphere. Per RG 1.183 (Ref.8), reduction in release activity by dilution or holdup within buildings or by ESF ventilation filtration systems, may be credited where applicable. In order to determine the amount of RWT release to the atmosphere, the breathing of the RWT through the vent due to diurnal temperature variations was calculated in Ref.34. The breathing was determined by performing a 24 hour transient thermal analysis of the RWT using the computer code TSAP and assuming RWT atmospheric temperature characteristics based on the maximum solar load during summer solstice and a minimum ambient nighttime temperature. This methodology results in an average 4.2 cfm leakrate from the RWT to the environment.

The activity released to the environment is transported to the site boundary and to the control room via appropriate atmospheric dispersion coefficients. The control room inleakage modeled by RADTRAD is a constant 3500 cfm in this work. Control room filtration is credited based on a modification to increase recirculation flow to a nominal 10000 cfm. A charcoal filter efficiency of 90% is credited for elemental and organic iodine, while a HEPA efficiency of 99% is credited for particulate iodine. A 20 minute time delay consistent with a manual start of the CREVS is assumed. The control room and site boundary doses are calculated based on RG 1.183 breathing rates and occupancy factors and on FGR 11 and 12 dose conversion factors.

(9.D) RADTRAD Hydrogen Purge Line Pathway Computations

Per RG 1.183, if the primary containment is routinely purged during power operations, releases via the purge system prior to containment isolation should be analyzed and the resulting doses summed with the postulated doses from other release paths. Per Ref.42, the containment vent system is used for an unlimited amount of pressure and containment radioactivity control purposes; however, the vent isolation valves may also be opened for surveillance testing. The 4-inch vent line isolates on a SIAS and CRS. The purge release evaluation should assume that 100% of the radionuclide inventory in the reactor coolant system liquid is released to the containment atmosphere at the initiation of the LOCA. This inventory should be based on the TS RCS equilibrium activity. The purge system is

isolated before the onset of the gap release phase, thus release fractions associated with gap release and early in-vessel phases need not be considered. Per RG 1.183, 100% of the TS primary iodine and noble gas activities are assumed to be released instantaneously and homogeneously throughout the containment atmosphere at the initiation of the accident. The flow from the containment through the 4" hydrogen purge line and out the ventilation stack was calculated assuming peak containment pressure for the full 30 seconds that the line is open and assuming relevant line parameters. Per UFSAR 6.6.1, the Containment Penetration Room Emergency Ventilation System (PREVS) is designed to collect and process containment penetration leakage, so as to reduce to a minimum the environmental radioactivity levels from post-accident containment leaks. To minimize the release of radioactive material to the environment, penetration room ventilation is continuously routed through a prefilter, a high efficiency particulate air (HEPA) filter, and an activated charcoal filter, positioned in series. The PREVS filters all three species of radionuclide effluent.

The activity released to the environment is transported to the site boundary and to the control room via appropriate atmospheric dispersion coefficients. The control room inleakage modeled by RADTRAD is a constant 3500 cfm in this work. Control room filtration is credited based on a modification to increase recirculation flow to a nominal 10000 cfm. A charcoal filter efficiency of 90% is credited for elemental and organic iodine, while a HEPA efficiency of 99% is credited for particulate iodine. A 20 minute time delay consistent with a manual start of the CREVS is assumed. The control room and site boundary doses are calculated based on RG 1.183 breathing rates and occupancy factors and on FGR 11 and 12 dose conversion factors.

(9.E) MICROSHIELD Containment Shine Computations

Per RG 1.183, the analysis should consider radiation shine from radioactive material in the containment.

The isotopic activities released from the failed fuel per unit power were generated by the isotope generation and depletion computer code SAS2H/ORIGEN-S and multiplied by the relevant power level and release fractions. The core inventory release fractions by radionuclide groups for the gap release and early in-vessel damage phases were extracted from RG 1.183 Table 2. For the containment shine pathway, all 63 isotopic activities in Ci are released to the containment atmosphere at the beginning of the accident. These values are input into Microshield to calculate containment shine doses in the control room. For the containment shine analysis, no removal of airborne radioactivity is assumed except for decay. Note that Microshield will allow parent decay and daughter buildup, so that subsequent isotopic quantities as a function of decay time are automatically calculated by Microshield.

(9.F) MICROSHIELD Plume Shine Computations

Per RG 1.183, the analysis should consider radiation shine from the external radioactive plume released from containment.

The isotopic activities released from the failed fuel per unit power were generated by the isotope generation and depletion computer code SAS2H/ORIGEN-S and multiplied by the relevant power level, release fractions, and leakage fraction. The core inventory release fractions by radionuclide groups for the gap release and early in-vessel damage phases were extracted from RG 1.183 Table 2. For the containment shine pathway, all 63 isotopic activities in Ci are released to the containment atmosphere at the beginning of the accident. The maximum allowable containment leakage rate La contained in the Containment Leakage Rate Testing Program of TS 5.5.16 will be reduced from 0.20 percent per day at containment peak pressure Pa to 0.16 percent per day at Pa. Per RG 1.183, the containment should be assumed to leak at the leak rate incorporated in the technical specifications for the first 24 hours, and at 50% of this leak rate for the remaining duration of the accident. The leakage fraction is the integrated leakage over thirty days divided by the initial inventory. The resulting isotopic values are input into Microshield to calculate containment shine doses in the control room. For the plume shine analysis, no removal of airborne radioactivity is assumed except for decay. Note that Microshield will allow parent decay and daughter buildup, so that subsequent isotopic quantities as a function of decay time are automatically calculated by Microshield. The Microshield results assume that all of the released activity is released from containment at the beginning of the accident and sits over the control room for 30 days. To correct for release timing and dispersion via wind, a dilution factor is calculated which conservatively assumes that all containment release passes directly over the control room at a wind speed that is one-tenth the wind speed integrated over 8 years.

(9.G) MICROSHIELD Control Room Filter Shine Computations
Per RG 1.183, the analysis should consider radiation shine from the radioactive material buildup on recirculation filters.

The isotopic activities released from the failed fuel per unit power were generated by the isotope generation and depletion computer code SAS2H/ORIGEN-S and multiplied by the relevant power level and release fractions. The core inventory release fractions by radionuclide groups for the gap release and early in-vessel damage phases were extracted from RG 1.183 Table 2. Note that the control room filtration system filters aerosols and elemental and organic iodines. It does not filter the noble gas radionuclides, so they are excluded from this analysis: their release fractions are set to zero. The activity released from the core during the Gap Release and the Early In-Vessel Phase is conservatively assumed to be released at the beginning of the accident. Per RG 1.183 (Ref.08), of the radioiodine released from the RCS to the containment atmosphere in a LOCA, 95% of the iodine released should be assumed to be cesium iodide (CsI), 4.85% elemental iodine, and 0.15% organic iodine. This includes releases from the gap and fuel pellets. With the exception of elemental and organic iodine and noble gases, fission products should be assumed to be in particulate form. The maximum allowable containment leakage rate La contained in the Containment Leakage Rate Testing Program of TS 5.5.16 will be reduced from 0.20 percent per day at containment peak pressure Pa to 0.16 percent per day at Pa. Per RG 1.183, the containment should be assumed to leak at the leak rate incorporated in the technical specifications for the first 24 hours, and at 50% of this leak rate for the remaining duration of the accident. For the control room filter shine calculations, the containment atmosphere is cleansed by the iodine removal system, which filters particulates and elemental and organic iodine and by spray, which removes particulates. The activity released to the environment is transported to the control room via appropriate atmospheric dispersion coefficients. The control room inleakage is a constant 3500 cfm in this work. Control room filtration is credited based on a modification to increase recirculation flow to a nominal 10000 cfm. A charcoal filter efficiency of 100% is credited for elemental, organic, and particulate iodine.

The resulting isotopic values from Attachment S are input into Microshield to calculate control room filter shine dose rates in the control room from particulates (Attachment Y), while the iodine isotopic values are input into Microshield to calculate control room filter shine dose rates in the control room from elemental and organic iodine (Attachment Z). Note that this methodology deposits the entire relevant core radionuclide inventory on the control room filter and then adjusts the resultant dose rates to account for decay, containment removal mechanisms, and transport to the control room filters. The radionuclide decay process is simulated in Microshield and is manifested in the time-dependent Microshield dose rates listed in column H of Attachments T, U, and V. The algorithms for converting those dose rates into integrated doses are as follows and constitute the basis of the spreadsheets in Attachments T, U, and V.

- The containment radionuclide removal fraction is defined as f1 and is calculated in column F of Attachments T, U, and V.
  - The containment isotopic inventories "Nc" as a function of time "t" can be derived from the following rate equation. Note that the decay term is handled later by the Microshield program.
    - dNc/dt = -λc * Nc
      Nc = fs * Nco * exp(-λc * t)
      f1 = Nc/Nco = fs * exp(-λc * t) (Column F in Attachments T-V)
    - Nco = Containment radionuclide inventory in Ci
      fs = Species fraction (1 for particulate, 0.0485 for elemental, 0.0015 for organic)
      λc = Containment cleanup rate (4.391/hr for particulate, 0.977 for elemental, 0.326 for organic)
  - The average containment isotopic inventories between times t1 and t2 can be derived as follows:
    - <Nc> = ∫ Nc dt / Δt = (fs * Nco / Δt) * ∫ exp(-λc * t) dt
      <Nc> = (fs * Nco / Δt / λc)*(exp(-λc * t1)- exp(-λc * t2))
- The control room inleakage coefficient α is defined as follows:
  - α = (X/Q) * Fcr * La * (4.719474E-4 m^3/sec/cfm) / (24 hr/day) (Column E in Attachments T-V)
  - (X/Q) = Atmospheric dispersion coefficients in sec/m^3 (Column B in Attachments T-V)
    Fcr = Control room inleakage in cfm (Column C in Attachments T-V)
    La = Containment leak rate in fraction/day (Column D in Attachments T-V)

- The fraction of containment radionuclide that are released from containment, enter the control room, and are depositrd on the filter is defined as f2 and is calculated in column G of Attachments T, U, and V.
  - The equilibrium control room isotopic inventories can be derived from the following rate equation:
    - $dNcr/dt = \alpha Nc - (\lambda i + \lambda f) * Ncr$
      $Ncr = \alpha / (\lambda i + \lambda f) * \langle Nc \rangle$
  - The filter isotopic inventories can be derived from the following rate equation:
    - $dNf/dt = \lambda f * Ncr$
      $Nf = \Sigma (\lambda f * \alpha / (\lambda i + \lambda f) * \langle Nc \rangle * \Delta t)$
      $Nf = \Sigma (\lambda f * \alpha / (\lambda i + \lambda f) * (fs * Nco / \lambda c)*(\exp(-\lambda c * t1) - \exp(-\lambda c * t2)))$
      $f2 = Nf/Nco = \Sigma (\lambda f * \alpha / (\lambda i + \lambda f) * (fs/\lambda c)*(\exp(-\lambda c*t1) - \exp(-\lambda c*t2)))$ (Col G in Atts T-V)
- The integrated dose in Rem and listed in Column I of Attachments T-V can thus be calculated as
  - $D = \Sigma(DR * Nf/Nco * 0.001 * \Delta t)$
  - DR is the Microshield generated dose rate at time t in mR/hr. Note that the radionuclide decay is embedded in this variable.

10. CALCULATIONS

The following RADTRAD computations were performed in this calculational package for the MHA:

RADTRAD Cases				
Pathway	Containment	Ventilation Stack	Purge Line	RWT
Case Input Files	mhactmt.psf	mhavs.psf	mhahp.psf	mharwt.psf
Dose Conversion Factor File	fgr63.inp	fgr63.inp	fgr14.inp	fgr63.inp
Release Fraction/Timing File	mhactmt.rft	mhactmt.rft	mhahp.rft	mharwt.rft
Nuclear Inventory File	crcb63.nif	crcb63.nif	pri14.nif	crcb63.nif
Case Output Files	mhactmt.o0	mhavs.o0	mhahp.o0	mharwt.o0

The following MICROSHIELD computations were performed in this calculational package for the containment shine cases:

Microshield Containment Shine Files		
Decay Time (hrs)	Input File	Output File
0	MHA000.MS5	MHA000.pdf
1	MHA001.MS5	MHA001.pdf
2	MHA002.MS5	MHA002.pdf
3	MHA003.MS5	MHA003.pdf
4	MHA004.MS5	MHA004.pdf
5	MHA005.MS5	MHA005.pdf
6	MHA006.MS5	MHA006.pdf
7	MHA007.MS5	MHA007.pdf
8	MHA008.MS5	MHA008.pdf
9	MHA009.MS5	MHA009.pdf
10	MHA010.MS5	MHA010.pdf
11	MHA011.MS5	MHA011.pdf
12	MHA012.MS5	MHA012.pdf
24	MHA024.MS5	MHA024.pdf
48	MHA048.MS5	MHA048.pdf
240	MHA240.MS5	MHA240.pdf
480	MHA480.MS5	MHA480.pdf
720	MHA720.MS5	MHA720.pdf

The following MICROSHIELD computations were performed in this calculational package for the plume shine cases:

Microshield Plume Shine Files		
Decay Time (hrs)	Input File	Output File
0	MHC000.MS5	MHC000.pdf
1	MHC001.MS5	MHC001.pdf
2	MHC002.MS5	MHC002.pdf
3	MHC003.MS5	MHC003.pdf
6	MHC006.MS5	MHC006.pdf

9	MHC009.MS5	MHC009.pdf
12	MHC012.MS5	MHC012.pdf
24	MHC024.MS5	MHC024.pdf
48	MHC048.MS5	MHC048.pdf
240	MHC240.MS5	MHC240.pdf
480	MHC480.MS5	MHC480.pdf
720	MHC720.MS5	MHC720.pdf

The following MICROSHIELD computations were performed in this calculational package for the control room filter shine cases:

Microshield Filter Shine Files		
Decay Time (hrs)	Input File	Output File
0	MHF000.MS5	MHF000.pdf
1	MHF001.MS5	MHF001.pdf
2	MHF002.MS5	MHF002.pdf
3	MHF003.MS5	MHF003.pdf
4	MHF004.MS5	MHF004.pdf
5	MHF005.MS5	MHF005.pdf
6	MHF006.MS5	MHF006.pdf
7	MHF007.MS5	MHF007.pdf
8	MHF008.MS5	MHF008.pdf
9	MHF009.MS5	MHF009.pdf
12	MHF012.MS5	MHF012.pdf
18	MHF018.MS5	MHF018.pdf
24	MHF024.MS5	MHF024.pdf
25	MHF025.MS5	MHF025.pdf
48	MHF048.MS5	MHF048.pdf
72	MHF072.MS5	MHF072.pdf
96	MHF096.MS5	MHF096.pdf
97	MHF097.MS5	MHF097.pdf
120	MHF120.MS5	MHF120.pdf
240	MHF240.MS5	MHF240.pdf
480	MHF480.MS5	MHF480.pdf
720	MHF720.MS5	MHF720.pdf

The following MICROSHIELD computations were performed in this calculational package for the iodine only control room filter shine cases:

Microshield Filter Shine Files - Iodine Only		
Decay Time (hrs)	Input File	Output File
0	MHG000.MS5	MHG000.pdf
2	MHG002.MS5	MHG002.pdf
3	MHG003.MS5	MHG003.pdf
4	MHG004.MS5	MHG004.pdf
6	MHG006.MS5	MHG006.pdf
8	MHG008.MS5	MHG008.pdf
9	MHG009.MS5	MHG009.pdf
12	MHG012.MS5	MHG012.pdf

18	MHG018.MS5	MHG018.pdf
24	MHG024.MS5	MHG024.pdf
25	MHG025.MS5	MHG025.pdf
48	MHG048.MS5	MHG048.pdf
72	MHG072.MS5	MHG072.pdf
96	MHG096.MS5	MHG096.pdf
97	MHG097.MS5	MHG097.pdf
120	MHG120.MS5	MHG120.pdf
240	MHG240.MS5	MHG240.pdf
480	MHG480.MS5	MHG480.pdf
720	MHG720.MS5	MHG720.pdf

11. DOCUMENTATION OF COMPUTER CODES

(11.A) RADTRAD

This work employed the RADTRAD computer code, which was verified, benchmarked, and documented in Refs.13-17 and which models the transport of halogen and noble gas isotopes from a primary containment to a secondary containment and thence to the environment and control room. The installation of RADTRAD is detailed in Ref.16 and the validation in Ref.17.

The RADTRAD computer code can calculate TEDE and thyroid doses to personnel at the site boundary, low population zone, and control room per the alternate source term methodology 10 CFR 50.67 and Regulatory Guide 1.183 or can calculate whole body and thyroid doses to personnel at the site boundary, low population zone, and control room per the standard source term methodology of TID-14844 (Ref.18) resulting from any postulated accident which releases radioactivity within the containment, spent fuel pool, or within any primary system. RADTRAD models the transport of radioactivity from up to 63 radioisotopes from the sprayed and unsprayed regions of a primary containment or a SFP area, through the secondary containment if any, and then to the environment and to the control room. The code includes the capability to model time-dependent activity release; containment spray, filtration, and leakage; control room filtration and inleakage; primary and secondary containment purge filters; control room intake filters; atmospheric dispersion; and natural decay. Doses are calculated for individuals residing at the site boundary or low population zone and in the control room.

Some inputs for the RADTRAD computer program were generated via an EXCEL spreadsheet.

(11.B) MICROSHIELD

This work employed the MICROSHIELD computer code, which was verified, benchmarked, and documented in Refs.76-78 and which is used to analyze shielding and exposure from gamma radiation. The installation of MICROSHIELD is detailed in Ref.77 and the validation in Ref.78.

MICROSHIELD is capable of modeling various geometries including distance and orientation between source and dose point; dimension of the source region; and the dimensions, locations, and orientations of intervening shields. MICROSHIELD has solution algoritms for 16 source geometries including points, lines, disks, spheres, cylinders, rectangular volumes, truncated cones, infinite planes, and infinite slabs with various shields. The source and shield material compositions, densities, and buildup factors can be specified. A source strength as a function of isotopic content or photon energy spectrum can also be specified.

The inputs and outputs of the MICROSHIELD computer program were processed by EXCEL spreadsheets.

12. RESULTS

The current work utilizes the alternate source term methodology of 10 CFR 50.67 and Regulatory Guide 1.183 to calculate offsite and control room doses for an MHA. Per RG 1.183, the TEDE analysis should include all sources of radiation that will cause exposure to control room personnel. In this work, the following pathways are analyzed:

(12.A) Containment Pathway
The containment pathway results were generated via RADTRAD and are partially listed in Attachment E. The EAB, LPZ, and CR doses are 1.8988, 0.4958, and 3.9862 Rem TEDE, respectively.

(12.B) Hydrogen Purge Line (HPL) Pathway
The hydrogen purge line pathway results were generated via RADTRAD and are partially listed in Attachment L. The EAB, LPZ, and CR doses are 6.4918E-05, 1.5283E-05, and 7.7048E-05 Rem TEDE, respectively.

(12.C) Penetration Room-Ventilation Stack (VS) Pathway
The penetration room-ventilation stack pathway results were generated via RADTRAD and are partially listed in Attachment F. The EAB, LPZ, and CR doses are 0.18381, 0.048542, and 0.39677 Rem TEDE, respectively.

(12.D) Refueling Water Tank (RWT) Pathway
The RWT pathway results were generated via RADTRAD and are partially listed in Attachment H. The EAB, LPZ, and CR doses are 1.9676E-05, 1.8560E-03, and 0.32979 Rem TEDE, respectively.

(12.E) Containment Shine
The control room dose rates generated by containment shine were calculated via MICROSHIELD, and the zero decay case is listed in Attachment W. The remaining MICROSHIELD output files are contained on the accompanying CD-ROM with the naming convention as described in Section 10 of this work.

MICROSHIELD Containment Results		
Time(hr)	DR(mR/hr)	Dose(Rem)
0	7.112	0.0000
1	7.296	0.0072
2	4.738	0.0132
3	3.224	0.0172
4	2.312	0.0200
5	1.714	0.0220
6	1.299	0.0235
7	0.9998	0.0246
8	0.7795	0.0255
9	0.6142	0.0262
10	0.4886	0.0268
11	0.3922	0.0272
12	0.3176	0.0276
24	0.05886	0.0298
48	0.04466	0.0311
240	0.04831	0.0400
480	0.02866	0.0492
720	0.01675	0.0547

(12.F) Plume Shine

The control room dose rates generated by plume shine were calculated via MICROSHIELD, and the zero decay case is listed in Attachment X. The remaining MICROSHIELD output files are contained on the accompanying CD-ROM with the naming convention as described in Section 10 of this work.

MICROSHIELD Plume Results			
Time(hr)	DR(mR/hr)	Dilution Factor	Dose(Rem)
0	5743.00	0.00009	0.0000
1	4047.00	0.00009	0.0004
2	2754.00	0.00009	0.0007
3	2022.00	0.00009	0.0010
6	1004.00	0.00009	0.0014
9	573.30	0.00009	0.0016
12	356.40	0.00009	0.0017
24	105.50	0.00009	0.0020
48	54.61	0.000045	0.0020
240	39.49	0.000045	0.0025
480	24.51	0.000045	0.0028
720	16.30	0.000045	0.0030

(12.G) Control Room Filter Shine

The control room dose rates generated by control room filter shine were calculated via MICROSHIELD, and the zero decay cases are listed in Attachment Y for all isotopes except the noble gases and in Attachment Z for the iodines only. The remaining MICROSHIELD output files are contained on the accompanying CD-ROM with the naming convention as described in Section 10 of this work. The actual 30 day control room doses were calculated in EXCEL spreadsheets listed in Attachments T, U, and V for particulate, elemental, and organic radionuclides as 1.3241E-02, 5.9184E-04, and 3.9598E-05 Rem TEDE, respectively.

13. CONCLUSIONS

The current work utilizes the alternate source term methodology of 10 CFR 50.67 and Regulatory Guide 1.183 to calculate offsite and control room doses for an MHA. Per RG 1.183, the TEDE analysis should include all sources of radiation that will cause exposure to control room personnel. In this work, the following pathways are analyzed:

- Containment pathway
- Hydrogen Purge Line (HPL) pathway
- Ventilation Stack (VS) pathway
- Refueling Water Tank (RWT) pathway
- Containment Shine
- Plume Shine
- Control Room Filter Shine

A bounding control room inleakage value of 3500 cfm was assumed. The following modifications and TS changes are proposed to comply with regulatory requirements.

- Alternate Source Term Methodology was employed.
- Modification of the control room emergency ventilation system to a nominal 10000 cfm flow with a 90% filtration efficiency for elemental and organic iodine and 99% for particulate iodine was credited.
- Also credited was installation of automatic isolation dampers and radiation monitors at Access Controls 11 and 13 on the Auxiliary Building Roof. This modification limits activity ingress into the control room to either the West Road Inlet or the Turbine Building, thus limiting the atmospheric dispersion coefficient value.
- The Technical Specification (TS 3.4.15) limit for RCS activity was reduced from 1.0 μCi/gm to 0.5 μCi/gm.
- The maximum allowable containment leakage rate La contained in the Containment Leakage Rate Testing Program of TS 5.5.16 was reduced from 0.20 percent per day at Pa to 0.16 percent per day at Pa.

The exclusion area boundary (EAB), low population zone (LPZ), and control room (CR) doses for the design-basis MHA are detailed in the following table.

MHA Results			
Results	EAB	LPZ	CR
	Rem	Rem	Rem
Containment Pathway	1.8988	0.4958	3.9682
Penetration Room Pathway	0.1838	0.0485	0.3968
RWT Pathway	1.9676E-05	1.8560E-03	3.2979E-01
Hydrogen Purge Pathway	6.4918E-05	1.5283E-05	7.7048E-05
Containment Shine			0.0547
Plume Shine			0.0030
Control Room Filter Shine			0.0139
Total	2.0827	0.5462	4.7664
Regulatory Limits	25	25	5

Note that all values are below the regulatory limits.

14. ATTACHMENTS

ATTACHMENT A
MAXIMUM HYPOTHETICAL ACCIDENT PRIMARY RELEASE ACTIVITIES

			1 µCi/g	1µCii/g	0.5 µCii/g
	Halflife	lambda	Primary	Primary	Primary
			Source	Source	Source
	sec	1/sec	µCi/g	Ci	Ci
	A	B	C	D	E
Kr-85	3.3830E+08	2.0489E-09	3.8761E+01	7.9975E+03	7.9975E+03
Kr-85m	1.6128E+04	4.2978E-05	2.0344E+00	4.1975E+02	4.1975E+02
Kr-87	4.5780E+03	1.5141E-04	1.1747E+00	2.4238E+02	2.4238E+02
Kr-88	1.0224E+04	6.7796E-05	3.6579E+00	7.5473E+02	7.5473E+02
I-131	6.9466E+05	9.9783E-07	7.7893E-01	1.6071E+02	8.0357E+01
I-132	8.2800E+03	8.3713E-05	2.5868E-01	5.3372E+01	2.6686E+01
I-133	7.4880E+04	9.2568E-06	1.0972E+00	2.2638E+02	1.1319E+02
I-134	3.1560E+03	2.1963E-04	1.4798E-01	3.0532E+01	1.5266E+01
I-135	2.3796E+04	2.9129E-05	6.0207E-01	1.2422E+02	6.2112E+01
Xe-133	4.5317E+05	1.5296E-06	4.0021E+02	8.2574E+04	8.2574E+04
Xe-135	3.2724E+04	2.1182E-05	9.5607E+00	1.9726E+03	1.9726E+03
Xe-133m	1.8922E+05	3.6632E-06	5.7016E+00	1.1764E+03	1.1764E+03
Xe-135m	9.1800E+02	7.5506E-04	1.2511E+00	2.5814E+02	2.5814E+02
Xe138	8.4600E+02	8.1932E-04	6.6019E-01	1.3622E+02	1.3622E+02
A	Half-lives: Chart of the Nuclides Fifteenth Edition'				
B	Decay constants: Ln(2)/A(i)				
C	Primary Source in microCi/gm: CA06422				
D	Primary Source in Ci for 1.0 microCi/gm total (F*Mtot*1.e-6): CA06422				
E	Primary Source in Ci for 0.5 microCi/gm total: CA06422				

ATTACHMENT B
NUCLEAR INVENTORY FILE CRCB63.NIF

```
Nuclide Inventory Name:
 Normalized MACCS Sample 3412 MWth PWR Core Inventory
 Power Level:
  0.1000E+01
 Nuclides:
  63
 Nuclide 001:
 Co-58
   7
  0.6117120000E+07
  0.5800E+02
  8.0012E+02
 none      0.0000E+00
 none      0.0000E+00
 none      0.0000E+00
 Nuclide 002:
 Co-60
   7
  0.1663401096E+09
  0.6000E+02
  9.8625E+02
 none      0.0000E+00
 none      0.0000E+00
 none      0.0000E+00
 Nuclide 003:
 Kr-85
   1
  0.3382974720E+09
  0.8500E+02
  3.7180E+02
 none      0.0000E+00
 none      0.0000E+00
 none      0.0000E+00
 Nuclide 004:
 Kr-85m
   1
  0.1612800000E+05
  0.8500E+02
  7.9679E+03
 Kr-85     0.2100E+00
 none      0.0000E+00
 none      0.0000E+00
 Nuclide 005:
 Kr-87
   1
  0.4578000000E+04
  0.8700E+02
  1.6208E+04
 Rb-87     0.1000E+01
 none      0.0000E+00
```

```
none      0.0000E+00
Nuclide 006:
Kr-88
  1
 0.1022400000E+05
 0.8800E+02
 2.2658E+04
Rb-88     0.1000E+01
none      0.0000E+00
none      0.0000E+00
Nuclide 007:
Rb-86
  3
 0.1612224000E+07
 0.8600E+02
 5.9034E+01
none      0.0000E+00
none      0.0000E+00
none      0.0000E+00
Nuclide 008:
Sr-89
  5
 0.4363200000E+07
 0.8900E+02
 3.3293E+04
none      0.0000E+00
none      0.0000E+00
none      0.0000E+00
Nuclide 009:
Sr-90
  5
 0.9189573120E+09
 0.9000E+02
 3.1769E+03
Y-90      0.1000E+01
none      0.0000E+00
none      0.0000E+00
Nuclide 010:
Sr-91
  5
 0.3420000000E+05
 0.9100E+02
 3.8931E+04
Y-91m     0.5800E+00
Y-91      0.4200E+00
none      0.0000E+00
Nuclide 011:
Sr-92
  5
 0.9756000000E+04
 0.9200E+02
 4.0190E+04
Y-92      0.1000E+01
none      0.0000E+00
```

```
none     0.0000E+00
Nuclide 012:
Y-90
  9
 0.2304000000E+06
 0.9000E+02
 3.4567E+03
none     0.0000E+00
none     0.0000E+00
none     0.0000E+00
Nuclide 013:
Y-91
  9
 0.5055264000E+07
 0.9100E+02
 4.2527E+04
none     0.0000E+00
none     0.0000E+00
none     0.0000E+00
Nuclide 014:
Y-92
  9
 0.1274400000E+05
 0.9200E+02
 4.0519E+04
none     0.0000E+00
none     0.0000E+00
none     0.0000E+00
Nuclide 015:
Y-93
  9
 0.3636000000E+05
 0.9300E+02
 2.9622E+04
Zr-93    0.1000E+01
none     0.0000E+00
none     0.0000E+00
Nuclide 016:
Zr-95
  9
 0.5527872000E+07
 0.9500E+02
 5.8246E+04
Nb-95m   0.7000E-02
Nb-95    0.9900E+00
none     0.0000E+00
Nuclide 017:
Zr-97
  9
 0.6084000000E+05
 0.9700E+02
 4.9425E+04
Nb-97m   0.9500E+00
Nb-97    0.5300E-01
```

```
none      0.0000E+00
Nuclide 018:
Nb-95
  9
 0.3036960000E+07
 0.9500E+02
 6.0839E+04
none      0.0000E+00
none      0.0000E+00
none      0.0000E+00
Nuclide 019:
Mo-99
  7
 0.2376000000E+06
 0.9900E+02
 5.0834E+04
Tc-99m    0.8800E+00
Tc-99     0.1200E+00
none      0.0000E+00
Nuclide 020:
Tc-99m
  7
 0.2167200000E+05
 0.9900E+02
 4.5424E+04
Tc-99     0.1000E+01
none      0.0000E+00
none      0.0000E+00
Nuclide 021:
Ru-103
  7
 0.3393792000E+07
 0.1030E+03
 4.8774E+04
Rh-103m   0.1000E+01
none      0.0000E+00
none      0.0000E+00
Nuclide 022:
Ru-105
  7
 0.1598400000E+05
 0.1050E+03
 3.1455E+04
Rh-105    0.1000E+01
none      0.0000E+00
none      0.0000E+00
Nuclide 023:
Ru-106
  7
 0.3181248000E+08
 0.1060E+03
 1.9695E+04
Rh-106    0.1000E+01
none      0.0000E+00
```

```
none      0.0000E+00
Nuclide 024:
Rh-105
  7
 0.1272960000E+06
 0.1050E+03
 2.8507E+04
none      0.0000E+00
none      0.0000E+00
none      0.0000E+00
Nuclide 025:
Sb-127
  4
 0.3326400000E+06
 0.1270E+03
 2.4299E+03
Te-127m   0.1800E+00
Te-127    0.8200E+00
none      0.0000E+00
Nuclide 026:
Sb-129
  4
 0.1555200000E+05
 0.1290E+03
 8.7888E+03
Te-129m   0.2200E+00
Te-129    0.7700E+00
none      0.0000E+00
Nuclide 027:
Te-127
  4
 0.3366000000E+05
 0.1270E+03
 2.4664E+03
none      0.0000E+00
none      0.0000E+00
none      0.0000E+00
Nuclide 028:
Te-127m
  4
 0.9417600000E+07
 0.1270E+03
 4.6272E+02
Te-127    0.9800E+00
none      0.0000E+00
none      0.0000E+00
Nuclide 029:
Te-129
  4
 0.4176000000E+04
 0.1290E+03
 8.4012E+03
I-129     0.1000E+01
none      0.0000E+00
```

```
none     0.0000E+00
Nuclide 030:
Te-129m
  4
 0.2903040000E+07
 0.1290E+03
 1.8872E+03
Te-129   0.6500E+00
I-129    0.3500E+00
none     0.0000E+00
Nuclide 031:
Te-131m
  4
 0.1080000000E+06
 0.1310E+03
 5.0686E+03
Te-131   0.2200E+00
I-131    0.7800E+00
none     0.0000E+00
Nuclide 032:
Te-132
  4
 0.2815200000E+06
 0.1320E+03
 3.8391E+04
I-132    0.1000E+01
none     0.0000E+00
none     0.0000E+00
Nuclide 033:
I-131
  2
 0.6946560000E+06
 0.1310E+03
 2.7562E+04
Xe-131m  0.1100E-01
none     0.0000E+00
none     0.0000E+00
Nuclide 034:
I-132
  2
 0.8280000000E+04
 0.1320E+03
 3.9464E+04
none     0.0000E+00
none     0.0000E+00
none     0.0000E+00
Nuclide 035:
I-133
  2
 0.7488000000E+05
 0.1330E+03
 5.5715E+04
Xe-133m  0.2900E-01
Xe-133   0.9700E+00
```

```
none      0.0000E+00
Nuclide 036:
I-134
  2
 0.3156000000E+04
 0.1340E+03
 6.2858E+04
none      0.0000E+00
none      0.0000E+00
none      0.0000E+00
Nuclide 037:
I-135
  2
 0.2379600000E+05
 0.1350E+03
 5.2964E+04
Xe-135m  0.1500E+00
Xe-135   0.8500E+00
none      0.0000E+00
Nuclide 038:
Xe-133
  1
 0.4531680000E+06
 0.1330E+03
 5.5707E+04
none      0.0000E+00
none      0.0000E+00
none      0.0000E+00
Nuclide 039:
Xe-135
  1
 0.3272400000E+05
 0.1350E+03
 1.7708E+04
Cs-135   0.1000E+01
none      0.0000E+00
none      0.0000E+00
Nuclide 040:
Cs-134
  3
 0.6507177120E+08
 0.1340E+03
 7.1917E+03
none      0.0000E+00
none      0.0000E+00
none      0.0000E+00
Nuclide 041:
Cs-136
  3
 0.1131840000E+07
 0.1360E+03
 1.7111E+03
none      0.0000E+00
none      0.0000E+00
```

```
none     0.0000E+00
Nuclide 042:
Cs-137
  3
 0.9467280000E+09
 0.1370E+03
 4.7857E+03
Ba-137m  0.9500E+00
none     0.0000E+00
none     0.0000E+00
Nuclide 043:
Ba-139
  6
 0.4962000000E+04
 0.1390E+03
 5.1001E+04
none     0.0000E+00
none     0.0000E+00
none     0.0000E+00
Nuclide 044:
Ba-140
  6
 0.1100736000E+07
 0.1400E+03
 5.2928E+04
La-140   0.1000E+01
none     0.0000E+00
none     0.0000E+00
Nuclide 045:
La-140
  9
 0.1449792000E+06
 0.1400E+03
 5.4255E+04
none     0.0000E+00
none     0.0000E+00
none     0.0000E+00
Nuclide 046:
La-141
  9
 0.1414800000E+05
 0.1410E+03
 4.6433E+04
Ce-141   0.1000E+01
none     0.0000E+00
none     0.0000E+00
Nuclide 047:
La-142
  9
 0.5550000000E+04
 0.1420E+03
 4.4898E+04
none     0.0000E+00
none     0.0000E+00
```

```
none     0.0000E+00
Nuclide 048:
Ce-141
  8
 0.2808086400E+07
 0.1410E+03
 5.1883E+04
none     0.0000E+00
none     0.0000E+00
none     0.0000E+00
Nuclide 049:
Ce-143
  8
 0.1188000000E+06
 0.1430E+03
 4.4327E+04
Pr-143   0.1000E+01
none     0.0000E+00
none     0.0000E+00
Nuclide 050:
Ce-144
  8
 0.2456352000E+08
 0.1440E+03
 4.2317E+04
Pr-144m  0.1800E-01
Pr-144   0.9800E+00
none     0.0000E+00
Nuclide 051:
Pr-143
  9
 0.1171584000E+07
 0.1430E+03
 4.6904E+04
none     0.0000E+00
none     0.0000E+00
none     0.0000E+00
Nuclide 052:
Nd-147
  9
 0.9486720000E+06
 0.1470E+03
 1.9151E+04
Pm-147   0.1000E+01
none     0.0000E+00
none     0.0000E+00
Nuclide 053:
Np-239
  8
 0.2034720000E+06
 0.2390E+03
 5.5833E+05
Pu-239   0.1000E+01
none     0.0000E+00
```

```
none     0.0000E+00
Nuclide 054:
Pu-238
  8
 0.2768863824E+10
 0.2380E+03
 1.7259E+02
U-234    0.1000E+01
none     0.0000E+00
none     0.0000E+00
Nuclide 055:
Pu-239
  8
 0.7594336440E+12
 0.2390E+03
 1.1469E+01
U-235    0.1000E+01
none     0.0000E+00
none     0.0000E+00
Nuclide 056:
Pu-240
  8
 0.2062920312E+12
 0.2400E+03
 2.0026E+01
U-236    0.1000E+01
none     0.0000E+00
none     0.0000E+00
Nuclide 057:
Pu-241
  8
 0.4544294400E+09
 0.2410E+03
 4.9593E+03
U-237    0.2400E-04
Am-241   0.1000E+01
none     0.0000E+00
Nuclide 058:
Am-241
  9
 0.1363919472E+11
 0.2410E+03
 7.3183E+00
Np-237   0.1000E+01
none     0.0000E+00
none     0.0000E+00
Nuclide 059:
Cm-242
  9
 0.1406592000E+08
 0.2420E+03
 2.0078E+03
Pu-238   0.1000E+01
none     0.0000E+00
```

```
none      0.0000E+00
Nuclide 060:
Cm-244
  9
 0.571508136E+9
 0.2440E+03
 3.1650E+02
Pu-240    0.1000E+01
none      0.0000E+00
none      0.0000E+00
Nuclide 061:
Xe-133m
  1
 1.8922000000E+05
 0.1330E+03
 1.7354E+03
Xe-133    0.1000E+01
none      0.0000E+00
none      0.0000E+00
Nuclide 062:
Xe-135m
  1
 9.1800000000E+02
 0.1350E+03
 1.1635E+04
Xe-135    0.1000E+01
none      0.0000E+00
none      0.0000E+00
Nuclide 063:
Xe-138
  1
 8.4600000000E+02
 0.1380E+03
 4.9330E+04
none      0.0000E+00
none      0.0000E+00
none      0.0000E+00
End of Nuclear Inventory File
```

ATTACHMENT C
RELEASE FRACTION AND TIMING FILE MHACTMT.RFT

```
Release Fraction and Timing Name:
 PWR, RG 1.183, Table 2 Section 3.2
 Duration (h):  Design Basis Accident
  0.5000E+00  0.0001E+00  0.0000E+00  0.0000E+00
 Noble Gases:
  0.5000E-01  0.9500E+00  0.0000E+00  0.0000E+00
 Iodine:
  0.5000E-01  0.3500E+00  0.0000E+00  0.0000E+00
 Cesium:
  0.5000E-01  0.2500E+00  0.0000E+00  0.0000E+00
 Tellurium:
  0.0000E+00  0.5000E-01  0.0000E+00  0.0000E+00
 Strontium:
  0.0000E+00  0.2000E-01  0.0000E+00  0.0000E+00
 Barium:
  0.0000E+00  0.2000E-01  0.0000E+00  0.0000E+00
 Ruthenium:
  0.0000E+00  0.2500E-02  0.0000E+00  0.0000E+00
 Cerium:
  0.0000E+00  0.5000E-03  0.0000E+00  0.0000E+00
 Lanthanum:
  0.0000E+00  0.2000E-03  0.0000E+00  0.0000E+00
 Non-Radioactive Aerosols (kg):
  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
 End of Release File
```

ATTACHMENT D
CONVERSION FACTORS FILE FGR63.INP

```
FGRDCF 10/24/95   03:24:50   beta-test version 1.10, minor FORTRAN fixes 5/4/95
Implicit daughter halflives (m) less than  90 and less than 0.100 of parent
         9 ORGANS DEFINED IN THIS FILE:
GONADS
BREAST
LUNGS
RED MARR
BONE SUR
THYROID
REMAINDER
EFFECTIVE
SKIN(FGR)
        63 NUCLIDES DEFINED IN THIS FILE:
Co-58     Y
Co-60     Y
Kr-85
Kr-85m
Kr-87
Kr-88
Rb-86     D
Sr-89     Y
Sr-90     Y
Sr-91     Y     Including:Y-91m
Sr-92     Y
Y-90      Y
Y-91      Y
Y-92      Y
Y-93      Y
Zr-95     D
Zr-97     Y     Including:Nb-97m , Including:Nb-97
Nb-95     Y
Mo-99     Y
Tc-99m    D
Ru-103    Y     Including:Rh-103m
Ru-105    Y
Ru-106    Y     Including:Rh-106
Rh-105    Y
Sb-127    W
Sb-129    W
Te-127    W
Te-127m   W
Te-129    W
Te-129m   W     Including:Te-129
Te-131m   W     Including:Te-131
Te-132    W
I-131     D
I-132     D
I-133     D
I-134     D
I-135     D     Including:Xe-135m
```

Xe-133		
Xe-135		
Cs-134	D	
Cs-136	D	
Cs-137	D	Including:Ba-137m
Ba-139	D	
Ba-140	D	
La-140	W	
La-141	D	
La-142	D	
Ce-141	Y	
Ce-143	Y	
Ce-144	Y	Including:Pr-144m, Including:Pr-144
Pr-143	Y	
Nd-147	Y	
Np-239	W	
Pu-238	Y	
Pu-239	Y	
Pu-240	Y	
Pu-241	Y	
Am-241	W	
Cm-242	W	
Cm-244	W	
Xe-133m		
Xe-135m		
Xe-138		

	CLOUDSHINE	GROUND SHINE 8HR	GROUND SHINE 7DAY	GROUND SHINE RATE	INHALED ACUTE	INHALED CHRONIC	INGESTION
Co-58							
GONADS	4.660E-14	2.867E-11	5.828E-10	9.970E-16	-1.000E+00	6.170E-10	1.040E-09
BREAST	5.300E-14	2.737E-11	5.565E-10	9.520E-16	-1.000E+00	9.370E-10	1.790E-10
LUNGS	4.640E-14	2.617E-11	5.319E-10	9.100E-16	-1.000E+00	1.600E-08	8.530E-11
RED MARR	4.530E-14	2.671E-11	5.430E-10	9.290E-16	-1.000E+00	9.230E-10	2.600E-10
BONE SUR	7.410E-14	3.795E-11	7.716E-10	1.320E-15	-1.000E+00	6.930E-10	1.250E-10
THYROID	4.770E-14	2.720E-11	5.530E-10	9.460E-16	-1.000E+00	8.720E-10	6.310E-11
REMAINDER	4.440E-14	2.585E-11	5.255E-10	8.990E-16	-1.000E+00	1.890E-09	1.580E-09
EFFECTIVE	4.760E-14	2.732E-11	5.553E-10	9.500E-16	-1.000E+00	2.940E-09	8.090E-10
SKIN(FGR)	5.580E-14	3.278E-11	6.664E-10	1.140E-15	-1.000E+00	0.000E+00	0.000E+00
Co-60							
GONADS	1.230E-13	7.056E-11	1.480E-09	2.450E-15	-1.000E+00	4.760E-09	3.190E-09
BREAST	1.390E-13	6.739E-11	1.413E-09	2.340E-15	-1.000E+00	1.840E-08	1.100E-09
LUNGS	1.240E-13	6.537E-11	1.371E-09	2.270E-15	-1.000E+00	3.450E-07	8.770E-10
RED MARR	1.230E-13	6.710E-11	1.407E-09	2.330E-15	-1.000E+00	1.720E-08	1.320E-09
BONE SUR	1.780E-13	8.956E-11	1.879E-09	3.110E-15	-1.000E+00	1.350E-08	9.390E-10
THYROID	1.270E-13	6.480E-11	1.359E-09	2.250E-15	-1.000E+00	1.620E-08	7.880E-10
REMAINDER	1.200E-13	6.508E-11	1.365E-09	2.260E-15	-1.000E+00	3.600E-08	4.970E-09
EFFECTIVE	1.260E-13	6.768E-11	1.419E-09	2.350E-15	-1.000E+00	5.910E-08	2.770E-09
SKIN(FGR)	1.450E-13	7.948E-11	1.667E-09	2.760E-15	-1.000E+00	0.000E+00	0.000E+00
Kr-85							
GONADS	1.170E-16	8.121E-14	1.704E-12	2.820E-18	-1.000E+00	0.000E+00	0.000E+00
BREAST	1.340E-16	7.891E-14	1.656E-12	2.740E-18	-1.000E+00	0.000E+00	0.000E+00
LUNGS	1.140E-16	7.056E-14	1.481E-12	2.450E-18	-1.000E+00	0.000E+00	0.000E+00
RED MARR	1.090E-16	6.998E-14	1.469E-12	2.430E-18	-1.000E+00	0.000E+00	0.000E+00
BONE SUR	2.200E-16	1.287E-13	2.702E-12	4.470E-18	-1.000E+00	0.000E+00	0.000E+00

THYROID	1.180E-16	7.459E-14	1.565E-12	2.590E-18-1.000E+00	0.000E+00	0.000E+00
REMAINDER	1.090E-16	6.941E-14	1.457E-12	2.410E-18-1.000E+00	0.000E+00	0.000E+00
EFFECTIVE	1.190E-16	7.603E-14	1.596E-12	2.640E-18-1.000E+00	0.000E+00	0.000E+00
SKIN(FGR)	1.320E-14	2.304E-11	4.835E-10	8.000E-16-1.000E+00	0.000E+00	0.000E+00
Kr-85m						
GONADS	7.310E-15	2.594E-12	3.653E-12	1.570E-16-1.000E+00	0.000E+00	0.000E+00
BREAST	8.410E-15	2.527E-12	3.560E-12	1.530E-16-1.000E+00	0.000E+00	0.000E+00
LUNGS	7.040E-15	2.379E-12	3.351E-12	1.440E-16-1.000E+00	0.000E+00	0.000E+00
RED MARR	6.430E-15	2.346E-12	3.304E-12	1.420E-16-1.000E+00	0.000E+00	0.000E+00
BONE SUR	1.880E-14	5.286E-12	7.446E-12	3.200E-16-1.000E+00	0.000E+00	0.000E+00
THYROID	7.330E-15	2.395E-12	3.374E-12	1.450E-16-1.000E+00	0.000E+00	0.000E+00
REMAINDER	6.640E-15	2.313E-12	3.257E-12	1.400E-16-1.000E+00	0.000E+00	0.000E+00
EFFECTIVE	7.480E-15	2.511E-12	3.537E-12	1.520E-16-1.000E+00	0.000E+00	0.000E+00
SKIN(FGR)	2.240E-14	2.247E-11	3.164E-11	1.360E-15-1.000E+00	0.000E+00	0.000E+00
Kr-87						
GONADS	4.000E-14	4.962E-12	5.026E-12	7.610E-16-1.000E+00	0.000E+00	0.000E+00
BREAST	4.500E-14	4.740E-12	4.802E-12	7.270E-16-1.000E+00	0.000E+00	0.000E+00
LUNGS	4.040E-14	4.603E-12	4.663E-12	7.060E-16-1.000E+00	0.000E+00	0.000E+00
RED MARR	4.000E-14	4.708E-12	4.769E-12	7.220E-16-1.000E+00	0.000E+00	0.000E+00
BONE SUR	6.020E-14	6.514E-12	6.598E-12	9.990E-16-1.000E+00	0.000E+00	0.000E+00
THYROID	4.130E-14	4.473E-12	4.531E-12	6.860E-16-1.000E+00	0.000E+00	0.000E+00
REMAINDER	3.910E-14	4.590E-12	4.650E-12	7.040E-16-1.000E+00	0.000E+00	0.000E+00
EFFECTIVE	4.120E-14	4.773E-12	4.835E-12	7.320E-16-1.000E+00	0.000E+00	0.000E+00
SKIN(FGR)	1.370E-13	8.802E-11	8.916E-11	1.350E-14-1.000E+00	0.000E+00	0.000E+00
Kr-88						
GONADS	9.900E-14	2.278E-11	2.655E-11	1.800E-15-1.000E+00	0.000E+00	0.000E+00
BREAST	1.110E-13	2.177E-11	2.537E-11	1.720E-15-1.000E+00	0.000E+00	0.000E+00
LUNGS	1.010E-13	2.139E-11	2.493E-11	1.690E-15-1.000E+00	0.000E+00	0.000E+00
RED MARR	1.000E-13	2.190E-11	2.552E-11	1.730E-15-1.000E+00	0.000E+00	0.000E+00
BONE SUR	1.390E-13	2.886E-11	3.363E-11	2.280E-15-1.000E+00	0.000E+00	0.000E+00
THYROID	1.030E-13	2.012E-11	2.345E-11	1.590E-15-1.000E+00	0.000E+00	0.000E+00
REMAINDER	9.790E-14	2.139E-11	2.493E-11	1.690E-15-1.000E+00	0.000E+00	0.000E+00
EFFECTIVE	1.020E-13	2.202E-11	2.567E-11	1.740E-15-1.000E+00	0.000E+00	0.000E+00
SKIN(FGR)	1.350E-13	5.607E-11	6.534E-11	4.430E-15-1.000E+00	0.000E+00	0.000E+00
Rb-86						
GONADS	4.710E-15	2.788E-12	5.187E-11	9.740E-17-1.000E+00	1.340E-09	2.150E-09
BREAST	5.340E-15	2.662E-12	4.953E-11	9.300E-17-1.000E+00	1.330E-09	2.140E-09
LUNGS	4.710E-15	2.553E-12	4.750E-11	8.920E-17-1.000E+00	3.300E-09	2.140E-09
RED MARR	4.640E-15	2.619E-12	4.873E-11	9.150E-17-1.000E+00	2.320E-09	3.720E-09
BONE SUR	7.050E-15	3.635E-12	6.764E-11	1.270E-16-1.000E+00	4.270E-09	6.860E-09
THYROID	4.840E-15	2.599E-12	4.836E-11	9.080E-17-1.000E+00	1.330E-09	2.140E-09
REMAINDER	4.520E-15	2.542E-12	4.729E-11	8.880E-17-1.000E+00	1.380E-09	2.330E-09
EFFECTIVE	4.810E-15	2.665E-12	4.958E-11	9.310E-17-1.000E+00	1.790E-09	2.530E-09
SKIN(FGR)	4.850E-14	2.210E-10	4.111E-09	7.720E-15-1.000E+00	0.000E+00	0.000E+00
Sr-89						
GONADS	7.730E-17	7.155E-14	1.436E-12	2.490E-18-1.000E+00	7.950E-12	8.050E-12
BREAST	9.080E-17	7.212E-14	1.447E-12	2.510E-18-1.000E+00	7.960E-12	7.980E-12
LUNGS	7.080E-17	5.689E-14	1.142E-12	1.980E-18-1.000E+00	8.350E-08	7.970E-12
RED MARR	6.390E-17	5.345E-14	1.073E-12	1.860E-18-1.000E+00	1.070E-10	1.080E-10
BONE SUR	1.940E-16	1.560E-13	3.131E-12	5.430E-18-1.000E+00	1.590E-10	1.610E-10
THYROID	7.600E-17	6.063E-14	1.217E-12	2.110E-18-1.000E+00	7.960E-12	7.970E-12
REMAINDER	6.710E-17	5.603E-14	1.124E-12	1.950E-18-1.000E+00	3.970E-09	8.250E-09
EFFECTIVE	7.730E-17	6.523E-14	1.309E-12	2.270E-18-1.000E+00	1.120E-08	2.500E-09
SKIN(FGR)	3.690E-14	1.914E-10	3.841E-09	6.660E-15-1.000E+00	0.000E+00	0.000E+00

Sr-90						
GONADS	7.780E-18	9.590E-15	2.014E-13	3.330E-19-1.000E+00	2.690E-10	5.040E-11
BREAST	9.490E-18	1.008E-14	2.116E-13	3.500E-19-1.000E+00	2.690E-10	5.040E-11
LUNGS	6.440E-18	6.307E-15	1.324E-13	2.190E-19-1.000E+00	2.860E-06	5.040E-11
RED MARR	5.440E-18	5.558E-15	1.167E-13	1.930E-19-1.000E+00	3.280E-08	6.450E-09
BONE SUR	2.280E-17	2.393E-14	5.025E-13	8.310E-19-1.000E+00	7.090E-08	1.390E-08
THYROID	7.330E-18	7.171E-15	1.506E-13	2.490E-19-1.000E+00	2.690E-10	5.040E-11
REMAINDER	6.110E-18	6.422E-15	1.348E-13	2.230E-19-1.000E+00	5.730E-09	6.700E-09
EFFECTIVE	7.530E-18	8.179E-15	1.717E-13	2.840E-19-1.000E+00	3.510E-07	3.230E-09
SKIN(FGR)	9.200E-15	4.032E-12	8.465E-11	1.400E-16-1.000E+00	0.000E+00	0.000E+00
Sr-91						
GONADS	4.819E-14	2.155E-11	5.062E-11	1.026E-15-1.000E+00	5.669E-11	2.520E-10
BREAST	5.477E-14	2.059E-11	4.838E-11	9.806E-16-1.000E+00	1.775E-11	3.676E-11
LUNGS	4.803E-14	1.970E-11	4.626E-11	9.376E-16-1.000E+00	2.170E-09	1.055E-11
RED MARR	4.691E-14	2.011E-11	4.722E-11	9.570E-16-1.000E+00	2.275E-11	5.659E-11
BONE SUR	7.674E-14	2.852E-11	6.709E-11	1.360E-15-1.000E+00	1.306E-11	2.070E-11
THYROID	4.938E-14	2.035E-11	4.782E-11	9.693E-16-1.000E+00	9.930E-12	1.968E-12
REMAINDER	4.610E-14	1.948E-11	4.573E-11	9.268E-16-1.000E+00	5.802E-10	2.557E-09
EFFECTIVE	4.924E-14	2.057E-11	4.832E-11	9.793E-16-1.000E+00	4.547E-10	8.455E-10
SKIN(FGR)	9.938E-14	1.748E-10	3.987E-10	8.080E-15-1.000E+00	0.000E+00	0.000E+00
Sr-92						
GONADS	6.610E-14	1.593E-11	1.830E-11	1.300E-15-1.000E+00	1.020E-11	8.180E-11
BREAST	7.480E-14	1.520E-11	1.745E-11	1.240E-15-1.000E+00	6.490E-12	1.700E-11
LUNGS	6.670E-14	1.483E-11	1.703E-11	1.210E-15-1.000E+00	1.050E-09	7.220E-12
RED MARR	6.620E-14	1.520E-11	1.745E-11	1.240E-15-1.000E+00	6.980E-12	2.290E-11
BONE SUR	9.490E-14	2.010E-11	2.308E-11	1.640E-15-1.000E+00	4.360E-12	8.490E-12
THYROID	6.820E-14	1.446E-11	1.661E-11	1.180E-15-1.000E+00	3.920E-12	1.300E-12
REMAINDER	6.450E-14	1.471E-11	1.689E-11	1.200E-15-1.000E+00	2.900E-10	1.720E-09
EFFECTIVE	6.790E-14	1.532E-11	1.759E-11	1.250E-15-1.000E+00	2.180E-10	5.430E-10
SKIN(FGR)	8.560E-14	2.280E-11	2.618E-11	1.860E-15-1.000E+00	0.000E+00	0.000E+00
Y-90						
GONADS	1.890E-16	1.586E-13	1.601E-12	5.750E-18-1.000E+00	5.170E-13	1.430E-14
BREAST	2.200E-16	1.578E-13	1.593E-12	5.720E-18-1.000E+00	5.170E-13	1.270E-14
LUNGS	1.770E-16	1.313E-13	1.326E-12	4.760E-18-1.000E+00	9.310E-09	1.260E-14
RED MARR	1.620E-16	1.261E-13	1.273E-12	4.570E-18-1.000E+00	1.520E-11	3.700E-13
BONE SUR	4.440E-16	3.228E-13	3.259E-12	1.170E-17-1.000E+00	1.510E-11	3.670E-13
THYROID	1.870E-16	1.385E-13	1.398E-12	5.020E-18-1.000E+00	5.170E-13	1.260E-14
REMAINDER	1.680E-16	1.291E-13	1.303E-12	4.680E-18-1.000E+00	3.870E-09	9.680E-09
EFFECTIVE	1.900E-16	1.468E-13	1.482E-12	5.320E-18-1.000E+00	2.280E-09	2.910E-09
SKIN(FGR)	6.240E-14	2.897E-10	2.924E-09	1.050E-14-1.000E+00	0.000E+00	0.000E+00
Y-91						
GONADS	2.560E-16	1.756E-13	3.546E-12	6.110E-18-1.000E+00	8.200E-12	3.540E-12
BREAST	2.930E-16	1.713E-13	3.459E-12	5.960E-18-1.000E+00	8.920E-12	5.540E-13
LUNGS	2.500E-16	1.526E-13	3.082E-12	5.310E-18-1.000E+00	9.870E-08	2.020E-13
RED MARR	2.410E-16	1.521E-13	3.070E-12	5.290E-18-1.000E+00	3.190E-10	6.590E-12
BONE SUR	4.560E-16	2.903E-13	5.862E-12	1.010E-17-1.000E+00	3.180E-10	6.130E-12
THYROID	2.600E-16	1.564E-13	3.157E-12	5.440E-18-1.000E+00	8.500E-12	1.290E-13
REMAINDER	2.390E-16	1.509E-13	3.047E-12	5.250E-18-1.000E+00	4.200E-09	8.570E-09
EFFECTIVE	2.600E-16	1.650E-13	3.332E-12	5.740E-18-1.000E+00	1.320E-08	2.570E-09
SKIN(FGR)	3.850E-14	1.989E-10	4.016E-09	6.920E-15-1.000E+00	0.000E+00	0.000E+00
Y-92						
GONADS	1.270E-14	3.855E-12	4.872E-12	2.650E-16-1.000E+00	2.610E-12	1.960E-11
BREAST	1.440E-14	3.680E-12	4.652E-12	2.530E-16-1.000E+00	1.500E-12	3.550E-12
LUNGS	1.270E-14	3.535E-12	4.468E-12	2.430E-16-1.000E+00	1.240E-09	1.390E-12

RED MARR	1.250E-14	3.608E-12	4.560E-12	2.480E-16	-1.000E+00	2.070E-12	4.910E-12
BONE SUR	1.950E-14	5.091E-12	6.435E-12	3.500E-16	-1.000E+00	1.510E-12	1.750E-12
THYROID	1.300E-14	3.579E-12	4.523E-12	2.460E-16	-1.000E+00	1.050E-12	1.770E-13
REMAINDER	1.220E-14	3.506E-12	4.431E-12	2.410E-16	-1.000E+00	2.030E-10	1.700E-09
EFFECTIVE	1.300E-14	3.680E-12	4.652E-12	2.530E-16	-1.000E+00	2.110E-10	5.150E-10
SKIN(FGR)	1.140E-13	2.022E-10	2.556E-10	1.390E-14	-1.000E+00	0.000E+00	0.000E+00
Y-93							
GONADS	4.670E-15	2.108E-12	4.989E-12	9.510E-17	-1.000E+00	5.310E-12	2.200E-11
BREAST	5.300E-15	2.026E-12	4.794E-12	9.140E-17	-1.000E+00	1.740E-12	3.130E-12
LUNGS	4.680E-15	1.937E-12	4.585E-12	8.740E-17	-1.000E+00	2.520E-09	8.670E-13
RED MARR	4.580E-15	1.972E-12	4.669E-12	8.900E-17	-1.000E+00	4.040E-12	4.930E-12
BONE SUR	7.580E-15	2.948E-12	6.977E-12	1.330E-16	-1.000E+00	3.140E-12	1.730E-12
THYROID	4.790E-15	1.908E-12	4.516E-12	8.610E-17	-1.000E+00	9.260E-13	1.260E-13
REMAINDER	4.510E-15	1.919E-12	4.543E-12	8.660E-17	-1.000E+00	9.250E-10	4.090E-09
EFFECTIVE	4.800E-15	2.021E-12	4.784E-12	9.120E-17	-1.000E+00	5.820E-10	1.230E-09
SKIN(FGR)	8.500E-14	2.726E-10	6.452E-10	1.230E-14	-1.000E+00	0.000E+00	0.000E+00
Zr-95							
GONADS	3.530E-14	2.182E-11	4.421E-10	7.590E-16	-1.000E+00	1.880E-09	8.160E-10
BREAST	4.010E-14	2.084E-11	4.223E-10	7.250E-16	-1.000E+00	1.910E-09	1.050E-10
LUNGS	3.510E-14	1.989E-11	4.030E-10	6.920E-16	-1.000E+00	2.170E-09	2.340E-11
RED MARR	3.430E-14	2.030E-11	4.112E-10	7.060E-16	-1.000E+00	1.300E-08	2.140E-10
BONE SUR	5.620E-14	2.875E-11	5.824E-10	1.000E-15	-1.000E+00	1.030E-07	4.860E-10
THYROID	3.610E-14	2.076E-11	4.205E-10	7.220E-16	-1.000E+00	1.440E-09	8.270E-12
REMAINDER	3.360E-14	1.963E-11	3.978E-10	6.830E-16	-1.000E+00	2.280E-09	2.530E-09
EFFECTIVE	3.600E-14	2.078E-11	4.211E-10	7.230E-16	-1.000E+00	6.390E-09	1.020E-09
SKIN(FGR)	4.500E-14	2.561E-11	5.190E-10	8.910E-16	-1.000E+00	0.000E+00	0.000E+00
Zr-97							
GONADS	4.331E-14	2.179E-11	7.799E-11	9.253E-16	-1.000E+00	1.840E-10	6.228E-10
BREAST	4.928E-14	2.083E-11	7.455E-11	8.846E-16	-1.000E+00	4.706E-11	8.137E-11
LUNGS	4.322E-14	1.992E-11	7.127E-11	8.456E-16	-1.000E+00	4.108E-09	1.770E-11
RED MARR	4.224E-14	2.034E-11	7.279E-11	8.634E-16	-1.000E+00	6.376E-11	1.302E-10
BONE SUR	6.897E-14	2.881E-11	1.031E-10	1.224E-15	-1.000E+00	3.504E-11	4.558E-11
THYROID	4.443E-14	2.061E-11	7.377E-11	8.755E-16	-1.000E+00	2.315E-11	2.671E-12
REMAINDER	4.139E-14	1.966E-11	7.035E-11	8.345E-16	-1.000E+00	2.041E-09	6.990E-09
EFFECTIVE	4.432E-14	2.078E-11	7.438E-11	8.824E-16	-1.000E+00	1.171E-09	2.283E-09
SKIN(FGR)	9.835E-14	2.281E-10	8.148E-10	9.587E-15	-1.000E+00	0.000E+00	0.000E+00
Nb-95							
GONADS	3.660E-14	2.253E-11	4.435E-10	7.850E-16	-1.000E+00	4.320E-10	8.050E-10
BREAST	4.160E-14	2.150E-11	4.231E-10	7.490E-16	-1.000E+00	4.070E-10	1.070E-10
LUNGS	3.650E-14	2.055E-11	4.045E-10	7.160E-16	-1.000E+00	8.320E-09	2.740E-11
RED MARR	3.560E-14	2.101E-11	4.135E-10	7.320E-16	-1.000E+00	4.420E-10	1.990E-10
BONE SUR	5.790E-14	2.957E-11	5.819E-10	1.030E-15	-1.000E+00	5.130E-10	2.940E-10
THYROID	3.750E-14	2.144E-11	4.220E-10	7.470E-16	-1.000E+00	3.580E-10	1.180E-11
REMAINDER	3.490E-14	2.032E-11	4.000E-10	7.080E-16	-1.000E+00	1.070E-09	1.470E-09
EFFECTIVE	3.740E-14	2.147E-11	4.226E-10	7.480E-16	-1.000E+00	1.570E-09	6.950E-10
SKIN(FGR)	4.300E-14	2.598E-11	5.112E-10	9.050E-16	-1.000E+00	0.000E+00	0.000E+00
Mo-99							
GONADS	7.130E-15	4.282E-12	4.403E-11	1.550E-16	-1.000E+00	9.510E-11	2.180E-10
BREAST	8.130E-15	4.116E-12	4.233E-11	1.490E-16	-1.000E+00	2.750E-11	3.430E-11
LUNGS	7.060E-15	3.867E-12	3.977E-11	1.400E-16	-1.000E+00	4.290E-09	1.510E-11
RED MARR	6.820E-15	3.923E-12	4.034E-11	1.420E-16	-1.000E+00	5.240E-11	8.320E-11
BONE SUR	1.240E-14	6.105E-12	6.278E-11	2.210E-16	-1.000E+00	4.130E-11	6.320E-11
THYROID	7.270E-15	4.033E-12	4.147E-11	1.460E-16	-1.000E+00	1.520E-11	1.030E-11
REMAINDER	6.740E-15	3.812E-12	3.920E-11	1.380E-16	-1.000E+00	1.740E-09	4.280E-09

EFFECTIVE	7.280E-15	4.061E-12	4.176E-11	1.470E-16	-1.000E+00	1.070E-09	1.360E-09
SKIN(FGR)	3.140E-14	1.039E-10	1.068E-09	3.760E-15	-1.000E+00	0.000E+00	0.000E+00
Tc-99m							
GONADS	5.750E-15	2.334E-12	3.877E-12	1.240E-16	-1.000E+00	2.770E-12	9.750E-12
BREAST	6.650E-15	2.258E-12	3.752E-12	1.200E-16	-1.000E+00	2.150E-12	3.570E-12
LUNGS	5.490E-15	2.127E-12	3.533E-12	1.130E-16	-1.000E+00	2.280E-11	3.140E-12
RED MARR	4.910E-15	2.070E-12	3.439E-12	1.100E-16	-1.000E+00	3.360E-12	6.290E-12
BONE SUR	1.630E-14	5.383E-12	8.942E-12	2.860E-16	-1.000E+00	2.620E-12	4.060E-12
THYROID	5.750E-15	2.145E-12	3.564E-12	1.140E-16	-1.000E+00	5.010E-11	8.460E-11
REMAINDER	5.150E-15	2.070E-12	3.439E-12	1.100E-16	-1.000E+00	1.020E-11	3.340E-11
EFFECTIVE	5.890E-15	2.277E-12	3.783E-12	1.210E-16	-1.000E+00	8.800E-12	1.680E-11
SKIN(FGR)	7.140E-15	2.710E-12	4.502E-12	1.440E-16	-1.000E+00	0.000E+00	0.000E+00
Ru-103							
GONADS	2.191E-14	1.404E-11	2.783E-10	4.892E-16	-1.000E+00	3.070E-10	5.720E-10
BREAST	2.512E-14	1.350E-11	2.677E-10	4.705E-16	-1.000E+00	3.110E-10	1.200E-10
LUNGS	2.180E-14	1.273E-11	2.522E-10	4.432E-16	-1.000E+00	1.561E-08	7.310E-11
RED MARR	2.100E-14	1.287E-11	2.551E-10	4.483E-16	-1.000E+00	3.190E-10	1.660E-10
BONE SUR	3.892E-14	1.958E-11	3.882E-10	6.823E-16	-1.000E+00	2.370E-10	9.631E-11
THYROID	2.241E-14	1.331E-11	2.639E-10	4.638E-16	-1.000E+00	2.570E-10	6.250E-11
REMAINDER	2.080E-14	1.248E-11	2.472E-10	4.346E-16	-1.000E+00	1.250E-09	2.110E-09
EFFECTIVE	2.251E-14	1.332E-11	2.641E-10	4.642E-16	-1.000E+00	2.421E-09	8.271E-10
SKIN(FGR)	2.774E-14	1.785E-11	3.543E-10	6.229E-16	-1.000E+00	0.000E+00	0.000E+00
Ru-105							
GONADS	3.720E-14	1.327E-11	1.861E-11	8.070E-16	-1.000E+00	1.590E-11	9.670E-11
BREAST	4.240E-14	1.271E-11	1.783E-11	7.730E-16	-1.000E+00	6.610E-12	1.590E-11
LUNGS	3.700E-14	1.210E-11	1.697E-11	7.360E-16	-1.000E+00	5.730E-10	6.210E-12
RED MARR	3.590E-14	1.230E-11	1.725E-11	7.480E-16	-1.000E+00	7.700E-12	2.350E-11
BONE SUR	6.280E-14	1.809E-11	2.537E-11	1.100E-15	-1.000E+00	4.620E-12	8.890E-12
THYROID	3.800E-14	1.260E-11	1.766E-11	7.660E-16	-1.000E+00	4.150E-12	1.820E-12
REMAINDER	3.540E-14	1.189E-11	1.667E-11	7.230E-16	-1.000E+00	1.610E-10	8.540E-10
EFFECTIVE	3.810E-14	1.265E-11	1.773E-11	7.690E-16	-1.000E+00	1.230E-10	2.870E-10
SKIN(FGR)	6.730E-14	7.368E-11	1.033E-10	4.480E-15	-1.000E+00	0.000E+00	0.000E+00
Ru-106							
GONADS	1.010E-14	6.411E-12	1.340E-10	2.230E-16	-1.000E+00	1.300E-09	1.640E-09
BREAST	1.160E-14	6.152E-12	1.286E-10	2.140E-16	-1.000E+00	1.780E-09	1.440E-09
LUNGS	1.010E-14	5.836E-12	1.220E-10	2.030E-16	-1.000E+00	1.040E-06	1.420E-09
RED MARR	9.750E-15	5.893E-12	1.232E-10	2.050E-16	-1.000E+00	1.760E-09	1.460E-09
BONE SUR	1.720E-14	8.883E-12	1.856E-10	3.090E-16	-1.000E+00	1.610E-09	1.430E-09
THYROID	1.030E-14	6.066E-12	1.268E-10	2.110E-16	-1.000E+00	1.720E-09	1.410E-09
REMAINDER	9.630E-15	5.721E-12	1.196E-10	1.990E-16	-1.000E+00	1.200E-08	2.110E-08
EFFECTIVE	1.040E-14	6.095E-12	1.274E-10	2.120E-16	-1.000E+00	1.290E-07	7.400E-09
SKIN(FGR)	1.090E-13	4.082E-10	8.531E-09	1.420E-14	-1.000E+00	0.000E+00	0.000E+00
Rh-105							
GONADS	3.640E-15	2.127E-12	1.411E-11	7.980E-17	-1.000E+00	2.110E-11	5.800E-11
BREAST	4.160E-15	2.063E-12	1.369E-11	7.740E-17	-1.000E+00	5.610E-12	8.970E-12
LUNGS	3.570E-15	1.935E-12	1.284E-11	7.260E-17	-1.000E+00	9.580E-10	3.860E-12
RED MARR	3.380E-15	1.946E-12	1.291E-11	7.300E-17	-1.000E+00	7.770E-12	1.470E-11
BONE SUR	7.530E-15	3.332E-12	2.210E-11	1.250E-16	-1.000E+00	4.460E-12	6.750E-12
THYROID	3.680E-15	1.983E-12	1.316E-11	7.440E-17	-1.000E+00	2.880E-12	2.910E-12
REMAINDER	3.390E-15	1.885E-12	1.250E-11	7.070E-17	-1.000E+00	4.530E-10	1.270E-09
EFFECTIVE	3.720E-15	2.031E-12	1.347E-11	7.620E-17	-1.000E+00	2.580E-10	3.990E-10
SKIN(FGR)	1.070E-14	4.691E-12	3.112E-11	1.760E-16	-1.000E+00	0.000E+00	0.000E+00
Sb-127							
GONADS	3.260E-14	1.985E-11	2.441E-10	7.100E-16	-1.000E+00	2.520E-10	6.140E-10

BREAST	3.720E-14	1.904E-11	2.341E-10	6.810E-16-1.000E+00	9.120E-11	7.600E-11
LUNGS	3.240E-14	1.809E-11	2.224E-10	6.470E-16-1.000E+00	6.940E-09	1.570E-11
RED MARR	3.140E-14	1.834E-11	2.255E-10	6.560E-16-1.000E+00	1.610E-10	1.330E-10
BONE SUR	5.520E-14	2.720E-11	3.345E-10	9.730E-16-1.000E+00	1.340E-10	5.240E-11
THYROID	3.330E-14	1.884E-11	2.317E-10	6.740E-16-1.000E+00	6.150E-11	4.640E-12
REMAINDER	3.090E-14	1.775E-11	2.183E-10	6.350E-16-1.000E+00	2.330E-09	5.870E-09
EFFECTIVE	3.330E-14	1.890E-11	2.324E-10	6.760E-16-1.000E+00	1.630E-09	1.950E-09
SKIN(FGR)	5.580E-14	7.967E-11	9.799E-10	2.850E-15-1.000E+00	0.000E+00	0.000E+00
Sb-129						
GONADS	6.970E-14	2.336E-11	3.231E-11	1.440E-15-1.000E+00	2.150E-11	1.510E-10
BREAST	7.910E-14	2.222E-11	3.074E-11	1.370E-15-1.000E+00	1.280E-11	2.560E-11
LUNGS	6.980E-14	2.141E-11	2.962E-11	1.320E-15-1.000E+00	8.980E-10	9.390E-12
RED MARR	6.860E-14	2.190E-11	3.029E-11	1.350E-15-1.000E+00	1.700E-11	3.670E-11
BONE SUR	1.070E-13	3.033E-11	4.196E-11	1.870E-15-1.000E+00	1.460E-11	1.340E-11
THYROID	7.160E-14	2.174E-11	3.007E-11	1.340E-15-1.000E+00	9.720E-12	1.470E-12
REMAINDER	6.710E-14	2.125E-11	2.939E-11	1.310E-15-1.000E+00	1.870E-10	1.450E-09
EFFECTIVE	7.140E-14	2.238E-11	3.096E-11	1.380E-15-1.000E+00	1.740E-10	4.840E-10
SKIN(FGR)	1.050E-13	8.273E-11	1.144E-10	5.100E-15-1.000E+00	0.000E+00	0.000E+00
Te-127						
GONADS	2.370E-16	1.191E-13	2.661E-13	5.480E-18-1.000E+00	2.020E-12	4.020E-12
BREAST	2.730E-16	1.158E-13	2.588E-13	5.330E-18-1.000E+00	1.880E-12	3.000E-12
LUNGS	2.320E-16	1.060E-13	2.370E-13	4.880E-18-1.000E+00	4.270E-10	2.890E-12
RED MARR	2.210E-16	1.058E-13	2.365E-13	4.870E-18-1.000E+00	4.090E-12	6.570E-12
BONE SUR	4.650E-16	1.862E-13	4.162E-13	8.570E-18-1.000E+00	4.090E-12	6.460E-12
THYROID	2.400E-16	1.106E-13	2.472E-13	5.090E-18-1.000E+00	1.840E-12	2.860E-12
REMAINDER	2.210E-16	1.036E-13	2.316E-13	4.770E-18-1.000E+00	1.110E-10	6.130E-10
EFFECTIVE	2.420E-16	1.125E-13	2.515E-13	5.180E-18-1.000E+00	8.600E-11	1.870E-10
SKIN(FGR)	1.140E-14	1.173E-11	2.622E-11	5.400E-16-1.000E+00	0.000E+00	0.000E+00
Te-127m						
GONADS	1.900E-16	4.689E-13	9.642E-12	1.630E-17-1.000E+00	1.100E-10	1.250E-10
BREAST	2.690E-16	5.150E-13	1.059E-11	1.790E-17-1.000E+00	1.100E-10	9.740E-11
LUNGS	7.620E-17	1.602E-13	3.295E-12	5.570E-18-1.000E+00	3.340E-08	9.620E-11
RED MARR	6.430E-17	1.249E-13	2.567E-12	4.340E-18-1.000E+00	5.360E-09	5.430E-09
BONE SUR	3.940E-16	9.005E-13	1.852E-11	3.130E-17-1.000E+00	2.040E-08	2.070E-08
THYROID	1.500E-16	2.779E-13	5.714E-12	9.660E-18-1.000E+00	9.660E-11	9.430E-11
REMAINDER	8.640E-17	1.999E-13	4.111E-12	6.950E-18-1.000E+00	1.660E-09	2.980E-09
EFFECTIVE	1.470E-16	3.251E-13	6.684E-12	1.130E-17-1.000E+00	5.810E-09	2.230E-09
SKIN(FGR)	8.490E-16	1.496E-12	3.076E-11	5.200E-17-1.000E+00	0.000E+00	0.000E+00
Te-129						
GONADS	2.710E-15	3.889E-13	3.922E-13	6.510E-17-1.000E+00	5.050E-13	1.590E-12
BREAST	3.120E-15	3.800E-13	3.832E-13	6.360E-17-1.000E+00	5.390E-13	6.050E-13
LUNGS	2.640E-15	3.298E-13	3.326E-13	5.520E-17-1.000E+00	1.530E-10	4.910E-13
RED MARR	2.540E-15	3.298E-13	3.326E-13	5.520E-17-1.000E+00	6.190E-13	7.640E-13
BONE SUR	4.880E-15	5.753E-13	5.802E-13	9.630E-17-1.000E+00	6.220E-13	5.400E-13
THYROID	2.740E-15	3.525E-13	3.555E-13	5.900E-17-1.000E+00	5.090E-13	3.360E-13
REMAINDER	2.520E-15	3.262E-13	3.289E-13	5.460E-17-1.000E+00	7.280E-12	1.790E-10
EFFECTIVE	2.750E-15	3.590E-13	3.621E-13	6.010E-17-1.000E+00	2.090E-11	5.450E-11
SKIN(FGR)	3.570E-14	3.429E-11	3.458E-11	5.740E-15-1.000E+00	0.000E+00	0.000E+00
Te-129m						
GONADS	3.321E-15	2.206E-12	4.799E-11	8.561E-17-1.000E+00	1.783E-10	2.420E-10
BREAST	3.838E-15	2.181E-12	4.739E-11	8.454E-17-1.000E+00	1.694E-10	1.664E-10
LUNGS	3.176E-15	1.741E-12	3.815E-11	6.808E-17-1.000E+00	4.040E-08	1.593E-10
RED MARR	3.071E-15	1.729E-12	3.793E-11	6.768E-17-1.000E+00	3.100E-09	3.500E-09
BONE SUR	5.772E-15	3.287E-12	7.147E-11	1.275E-16-1.000E+00	7.050E-09	7.990E-09

THYROID	3.341E-15	1.923E-12	4.201E-11	7.495E-17	-1.000E+00	1.563E-10	1.572E-10
REMAINDER	3.048E-15	1.746E-12	3.822E-11	6.819E-17	-1.000E+00	3.275E-09	7.196E-09
EFFECTIVE	3.337E-15	1.974E-12	4.308E-11	7.686E-17	-1.000E+00	6.484E-09	2.925E-09
SKIN(FGR)	3.811E-14	1.501E-10	3.360E-09	6.001E-15	-1.000E+00	0.000E+00	0.000E+00
Te-131m							
GONADS	7.292E-14	4.020E-11	2.343E-10	1.535E-15	-1.000E+00	2.345E-10	7.415E-10
BREAST	8.286E-14	3.853E-11	2.246E-10	1.472E-15	-1.000E+00	9.309E-11	1.361E-10
LUNGS	7.265E-14	3.657E-11	2.131E-10	1.397E-15	-1.000E+00	2.296E-09	6.335E-11
RED MARR	7.097E-14	3.736E-11	2.178E-10	1.427E-15	-1.000E+00	1.417E-10	2.435E-10
BONE SUR	1.174E-13	5.467E-11	3.189E-10	2.090E-15	-1.000E+00	2.276E-10	3.248E-10
THYROID	7.471E-14	3.741E-11	2.181E-10	1.429E-15	-1.000E+00	3.669E-08	4.383E-08
REMAINDER	6.965E-14	3.626E-11	2.113E-10	1.385E-15	-1.000E+00	9.509E-10	3.153E-09
EFFECTIVE	7.463E-14	3.825E-11	2.229E-10	1.461E-15	-1.000E+00	1.758E-09	2.514E-09
SKIN(FGR)	1.038E-13	1.033E-10	6.188E-10	4.056E-15	-1.000E+00	0.000E+00	0.000E+00
Te-132							
GONADS	1.020E-14	6.812E-12	7.706E-11	2.450E-16	-1.000E+00	4.150E-10	5.410E-10
BREAST	1.180E-14	6.756E-12	7.643E-11	2.430E-16	-1.000E+00	3.630E-10	3.500E-10
LUNGS	9.650E-15	5.727E-12	6.479E-11	2.060E-16	-1.000E+00	1.670E-09	3.300E-10
RED MARR	8.950E-15	5.588E-12	6.322E-11	2.010E-16	-1.000E+00	4.270E-10	4.440E-10
BONE SUR	2.420E-14	1.273E-11	1.441E-10	4.580E-16	-1.000E+00	7.120E-10	8.300E-10
THYROID	1.020E-14	5.978E-12	6.762E-11	2.150E-16	-1.000E+00	6.280E-08	5.950E-08
REMAINDER	9.160E-15	5.644E-12	6.385E-11	2.030E-16	-1.000E+00	7.890E-10	1.490E-09
EFFECTIVE	1.030E-14	6.339E-12	7.171E-11	2.280E-16	-1.000E+00	2.550E-09	2.540E-09
SKIN(FGR)	1.390E-14	8.313E-12	9.405E-11	2.990E-16	-1.000E+00	0.000E+00	0.000E+00
I-131							
GONADS	1.780E-14	1.119E-11	1.789E-10	3.940E-16	-1.000E+00	2.530E-11	4.070E-11
BREAST	2.040E-14	1.082E-11	1.730E-10	3.810E-16	-1.000E+00	7.880E-11	1.210E-10
LUNGS	1.760E-14	1.016E-11	1.626E-10	3.580E-16	-1.000E+00	6.570E-10	1.020E-10
RED MARR	1.680E-14	1.022E-11	1.635E-10	3.600E-16	-1.000E+00	6.260E-11	9.440E-11
BONE SUR	3.450E-14	1.675E-11	2.679E-10	5.900E-16	-1.000E+00	5.730E-11	8.720E-11
THYROID	1.810E-14	1.053E-11	1.685E-10	3.710E-16	-1.000E+00	2.920E-07	4.760E-07
REMAINDER	1.670E-14	9.908E-12	1.585E-10	3.490E-16	-1.000E+00	8.030E-11	1.570E-10
EFFECTIVE	1.820E-14	1.067E-11	1.707E-10	3.760E-16	-1.000E+00	8.890E-09	1.440E-08
SKIN(FGR)	2.980E-14	1.825E-11	2.920E-10	6.430E-16	-1.000E+00	0.000E+00	0.000E+00
I-132							
GONADS	1.090E-13	2.523E-11	2.771E-11	2.320E-15	-1.000E+00	9.950E-12	2.330E-11
BREAST	1.240E-13	2.414E-11	2.652E-11	2.220E-15	-1.000E+00	1.410E-11	2.520E-11
LUNGS	1.090E-13	2.305E-11	2.532E-11	2.120E-15	-1.000E+00	2.710E-10	2.640E-11
RED MARR	1.070E-13	2.360E-11	2.592E-11	2.170E-15	-1.000E+00	1.400E-11	2.460E-11
BONE SUR	1.730E-13	3.327E-11	3.655E-11	3.060E-15	-1.000E+00	1.240E-11	2.190E-11
THYROID	1.120E-13	2.381E-11	2.616E-11	2.190E-15	-1.000E+00	1.740E-09	3.870E-09
REMAINDER	1.050E-13	2.283E-11	2.509E-11	2.100E-15	-1.000E+00	3.780E-11	1.650E-10
EFFECTIVE	1.120E-13	2.403E-11	2.640E-11	2.210E-15	-1.000E+00	1.030E-10	1.820E-10
SKIN(FGR)	1.580E-13	8.199E-11	9.007E-11	7.540E-15	-1.000E+00	0.000E+00	0.000E+00
I-133							
GONADS	2.870E-14	1.585E-11	6.748E-11	6.270E-16	-1.000E+00	1.950E-11	3.630E-11
BREAST	3.280E-14	1.519E-11	6.468E-11	6.010E-16	-1.000E+00	2.940E-11	4.680E-11
LUNGS	2.860E-14	1.446E-11	6.156E-11	5.720E-16	-1.000E+00	8.200E-10	4.530E-11
RED MARR	2.770E-14	1.466E-11	6.242E-11	5.800E-16	-1.000E+00	2.720E-11	4.300E-11
BONE SUR	4.870E-14	2.161E-11	9.202E-11	8.550E-16	-1.000E+00	2.520E-11	4.070E-11
THYROID	2.930E-14	1.502E-11	6.393E-11	5.940E-16	-1.000E+00	4.860E-08	9.100E-08
REMAINDER	2.730E-14	1.418E-11	6.038E-11	5.610E-16	-1.000E+00	5.000E-11	1.550E-10
EFFECTIVE	2.940E-14	1.509E-11	6.425E-11	5.970E-16	-1.000E+00	1.580E-09	2.800E-09
SKIN(FGR)	5.830E-14	1.150E-10	4.897E-10	4.550E-15	-1.000E+00	0.000E+00	0.000E+00

I-134							
GONADS	1.270E-13	1.200E-11	1.202E-11	2.640E-15	-1.000E+00	4.250E-12	1.100E-11
BREAST	1.440E-13	1.145E-11	1.147E-11	2.520E-15	-1.000E+00	6.170E-12	1.170E-11
LUNGS	1.270E-13	1.100E-11	1.102E-11	2.420E-15	-1.000E+00	1.430E-10	1.260E-11
RED MARR	1.250E-13	1.127E-11	1.129E-11	2.480E-15	-1.000E+00	6.080E-12	1.090E-11
BONE SUR	1.960E-13	1.568E-11	1.571E-11	3.450E-15	-1.000E+00	5.310E-12	9.320E-12
THYROID	1.300E-13	1.127E-11	1.129E-11	2.480E-15	-1.000E+00	2.880E-10	6.210E-10
REMAINDER	1.220E-13	1.091E-11	1.093E-11	2.400E-15	-1.000E+00	2.270E-11	1.340E-10
EFFECTIVE	1.300E-13	1.150E-11	1.152E-11	2.530E-15	-1.000E+00	3.550E-11	6.660E-11
SKIN(FGR)	1.870E-13	4.477E-11	4.485E-11	9.850E-15	-1.000E+00	0.000E+00	0.000E+00
I-135							
GONADS	8.078E-14	3.113E-11	5.489E-11	1.599E-15	-1.000E+00	1.700E-11	3.610E-11
BREAST	9.143E-14	2.971E-11	5.240E-11	1.526E-15	-1.000E+00	2.340E-11	3.850E-11
LUNGS	8.145E-14	2.886E-11	5.089E-11	1.482E-15	-1.000E+00	4.410E-10	3.750E-11
RED MARR	8.054E-14	2.965E-11	5.228E-11	1.523E-15	-1.000E+00	2.240E-11	3.650E-11
BONE SUR	1.184E-13	3.983E-11	7.024E-11	2.046E-15	-1.000E+00	2.010E-11	3.360E-11
THYROID	8.324E-14	2.852E-11	5.030E-11	1.465E-15	-1.000E+00	8.460E-09	1.790E-08
REMAINDER	7.861E-14	2.883E-11	5.084E-11	1.481E-15	-1.000E+00	4.700E-11	1.540E-10
EFFECTIVE	8.294E-14	2.989E-11	5.271E-11	1.535E-15	-1.000E+00	3.320E-10	6.080E-10
SKIN(FGR)	1.156E-13	9.826E-11	1.733E-10	5.047E-15	-1.000E+00	0.000E+00	0.000E+00
Xe-133							
GONADS	1.610E-15	1.465E-12	2.052E-11	5.200E-17	-1.000E+00	0.000E+00	0.000E+00
BREAST	1.960E-15	1.505E-12	2.107E-11	5.340E-17	-1.000E+00	0.000E+00	0.000E+00
LUNGS	1.320E-15	1.045E-12	1.464E-11	3.710E-17	-1.000E+00	0.000E+00	0.000E+00
RED MARR	1.070E-15	8.791E-13	1.231E-11	3.120E-17	-1.000E+00	0.000E+00	0.000E+00
BONE SUR	5.130E-15	4.254E-12	5.958E-11	1.510E-16	-1.000E+00	0.000E+00	0.000E+00
THYROID	1.510E-15	1.181E-12	1.653E-11	4.190E-17	-1.000E+00	0.000E+00	0.000E+00
REMAINDER	1.240E-15	1.042E-12	1.460E-11	3.700E-17	-1.000E+00	0.000E+00	0.000E+00
EFFECTIVE	1.560E-15	1.299E-12	1.819E-11	4.610E-17	-1.000E+00	0.000E+00	0.000E+00
SKIN(FGR)	4.970E-15	1.953E-12	2.734E-11	6.930E-17	-1.000E+00	0.000E+00	0.000E+00
Xe-135							
GONADS	1.170E-14	5.455E-12	1.194E-11	2.530E-16	-1.000E+00	0.000E+00	0.000E+00
BREAST	1.330E-14	5.325E-12	1.166E-11	2.470E-16	-1.000E+00	0.000E+00	0.000E+00
LUNGS	1.130E-14	4.959E-12	1.086E-11	2.300E-16	-1.000E+00	0.000E+00	0.000E+00
RED MARR	1.070E-14	4.959E-12	1.086E-11	2.300E-16	-1.000E+00	0.000E+00	0.000E+00
BONE SUR	2.570E-14	9.120E-12	1.997E-11	4.230E-16	-1.000E+00	0.000E+00	0.000E+00
THYROID	1.180E-14	5.023E-12	1.100E-11	2.330E-16	-1.000E+00	0.000E+00	0.000E+00
REMAINDER	1.080E-14	4.829E-12	1.058E-11	2.240E-16	-1.000E+00	0.000E+00	0.000E+00
EFFECTIVE	1.190E-14	5.217E-12	1.142E-11	2.420E-16	-1.000E+00	0.000E+00	0.000E+00
SKIN(FGR)	3.120E-14	4.506E-11	9.867E-11	2.090E-15	-1.000E+00	0.000E+00	0.000E+00
Cs-134							
GONADS	7.400E-14	4.607E-11	9.646E-10	1.600E-15	-1.000E+00	1.300E-08	2.060E-08
BREAST	8.430E-14	4.406E-11	9.224E-10	1.530E-15	-1.000E+00	1.080E-08	1.720E-08
LUNGS	7.370E-14	4.204E-11	8.802E-10	1.460E-15	-1.000E+00	1.180E-08	1.760E-08
RED MARR	7.190E-14	4.262E-11	8.922E-10	1.480E-15	-1.000E+00	1.180E-08	1.870E-08
BONE SUR	1.200E-13	6.105E-11	1.278E-09	2.120E-15	-1.000E+00	1.100E-08	1.740E-08
THYROID	7.570E-14	4.377E-11	9.163E-10	1.520E-15	-1.000E+00	1.110E-08	1.760E-08
REMAINDER	7.060E-14	4.147E-11	8.681E-10	1.440E-15	-1.000E+00	1.390E-08	2.210E-08
EFFECTIVE	7.570E-14	4.377E-11	9.163E-10	1.520E-15	-1.000E+00	1.250E-08	1.980E-08
SKIN(FGR)	9.450E-14	6.249E-11	1.308E-09	2.170E-15	-1.000E+00	0.000E+00	0.000E+00
Cs-136							
GONADS	1.040E-13	6.223E-11	1.102E-09	2.180E-15	-1.000E+00	1.880E-09	3.040E-09
BREAST	1.180E-13	5.966E-11	1.056E-09	2.090E-15	-1.000E+00	1.670E-09	2.650E-09
LUNGS	1.040E-13	5.710E-11	1.011E-09	2.000E-15	-1.000E+00	2.320E-09	2.620E-09

RED MARR	1.010E-13	5.824E-11	1.031E-09	2.040E-15	-1.000E+00	1.860E-09	2.950E-09
BONE SUR	1.660E-13	8.422E-11	1.491E-09	2.950E-15	-1.000E+00	1.700E-09	2.710E-09
THYROID	1.070E-13	5.852E-11	1.036E-09	2.050E-15	-1.000E+00	1.730E-09	2.740E-09
REMAINDER	9.950E-14	5.652E-11	1.001E-09	1.980E-15	-1.000E+00	2.190E-09	3.520E-09
EFFECTIVE	1.060E-13	5.966E-11	1.056E-09	2.090E-15	-1.000E+00	1.980E-09	3.040E-09
SKIN(FGR)	1.250E-13	7.251E-11	1.284E-09	2.540E-15	-1.000E+00	0.000E+00	0.000E+00
Cs-137							
GONADS	2.669E-14	1.669E-11	3.530E-10	5.840E-16	-1.000E+00	8.760E-09	1.390E-08
BREAST	3.047E-14	1.596E-11	3.376E-10	5.585E-16	-1.000E+00	7.840E-09	1.240E-08
LUNGS	2.649E-14	1.517E-11	3.209E-10	5.309E-16	-1.000E+00	8.820E-09	1.270E-08
RED MARR	2.583E-14	1.542E-11	3.260E-10	5.394E-16	-1.000E+00	8.300E-09	1.320E-08
BONE SUR	4.382E-14	2.238E-11	4.734E-10	7.832E-16	-1.000E+00	7.940E-09	1.260E-08
THYROID	2.725E-14	1.588E-11	3.358E-10	5.556E-16	-1.000E+00	7.930E-09	1.260E-08
REMAINDER	2.536E-14	1.490E-11	3.152E-10	5.215E-16	-1.000E+00	9.120E-09	1.450E-08
EFFECTIVE	2.725E-14	1.585E-11	3.353E-10	5.546E-16	-1.000E+00	8.630E-09	1.350E-08
SKIN(FGR)	4.392E-14	5.253E-11	1.110E-09	1.836E-15	-1.000E+00	0.000E+00	0.000E+00
Ba-139							
GONADS	2.130E-15	3.368E-13	3.429E-13	4.790E-17	-1.000E+00	2.560E-12	1.560E-12
BREAST	2.450E-15	3.297E-13	3.357E-13	4.690E-17	-1.000E+00	2.460E-12	5.170E-13
LUNGS	2.030E-15	3.002E-13	3.057E-13	4.270E-17	-1.000E+00	2.530E-10	3.890E-13
RED MARR	1.870E-15	2.932E-13	2.985E-13	4.170E-17	-1.000E+00	3.410E-12	8.590E-13
BONE SUR	5.290E-15	6.841E-13	6.965E-13	9.730E-17	-1.000E+00	2.490E-12	4.380E-13
THYROID	2.130E-15	3.044E-13	3.100E-13	4.330E-17	-1.000E+00	2.400E-12	2.660E-13
REMAINDER	1.920E-15	2.932E-13	2.985E-13	4.170E-17	-1.000E+00	4.820E-11	3.570E-10
EFFECTIVE	2.170E-15	3.227E-13	3.286E-13	4.590E-17	-1.000E+00	4.640E-11	1.080E-10
SKIN(FGR)	6.160E-14	7.241E-11	7.373E-11	1.030E-14	-1.000E+00	0.000E+00	0.000E+00
Ba-140							
GONADS	8.410E-15	5.451E-12	9.607E-11	1.910E-16	-1.000E+00	4.300E-10	9.960E-10
BREAST	9.640E-15	5.280E-12	9.305E-11	1.850E-16	-1.000E+00	2.870E-10	1.590E-10
LUNGS	8.270E-15	4.852E-12	8.550E-11	1.700E-16	-1.000E+00	1.660E-09	6.630E-11
RED MARR	7.930E-15	4.880E-12	8.601E-11	1.710E-16	-1.000E+00	1.290E-09	4.390E-10
BONE SUR	1.550E-14	8.020E-12	1.413E-10	2.810E-16	-1.000E+00	2.410E-09	5.530E-10
THYROID	8.530E-15	5.109E-12	9.003E-11	1.790E-16	-1.000E+00	2.560E-10	5.250E-11
REMAINDER	7.890E-15	4.766E-12	8.399E-11	1.670E-16	-1.000E+00	1.410E-09	7.370E-09
EFFECTIVE	8.580E-15	5.137E-12	9.053E-11	1.800E-16	-1.000E+00	1.010E-09	2.560E-09
SKIN(FGR)	2.520E-14	5.565E-11	9.808E-10	1.950E-15	-1.000E+00	0.000E+00	0.000E+00
La-140							
GONADS	1.140E-13	6.027E-11	4.425E-10	2.240E-15	-1.000E+00	4.540E-10	1.340E-09
BREAST	1.290E-13	5.758E-11	4.228E-10	2.140E-15	-1.000E+00	1.450E-10	1.800E-10
LUNGS	1.150E-13	5.596E-11	4.109E-10	2.080E-15	-1.000E+00	4.210E-09	4.010E-11
RED MARR	1.140E-13	5.731E-11	4.208E-10	2.130E-15	-1.000E+00	2.140E-10	2.810E-10
BONE SUR	1.690E-13	7.776E-11	5.709E-10	2.890E-15	-1.000E+00	1.410E-10	9.770E-11
THYROID	1.180E-13	5.462E-11	4.010E-10	2.030E-15	-1.000E+00	6.870E-11	6.400E-12
REMAINDER	1.110E-13	5.569E-11	4.089E-10	2.070E-15	-1.000E+00	2.120E-09	6.260E-09
EFFECTIVE	1.170E-13	5.812E-11	4.267E-10	2.160E-15	-1.000E+00	1.310E-09	2.280E-09
SKIN(FGR)	1.660E-13	2.217E-10	1.628E-09	8.240E-15	-1.000E+00	0.000E+00	0.000E+00
La-141							
GONADS	2.330E-15	7.315E-13	9.675E-13	4.740E-17	-1.000E+00	1.010E-11	3.770E-12
BREAST	2.640E-15	7.007E-13	9.267E-13	4.540E-17	-1.000E+00	9.840E-12	7.070E-13
LUNGS	2.340E-15	6.713E-13	8.879E-13	4.350E-17	-1.000E+00	6.460E-10	2.720E-13
RED MARR	2.310E-15	6.852E-13	9.063E-13	4.440E-17	-1.000E+00	2.930E-11	1.070E-12
BONE SUR	3.490E-15	9.923E-13	1.312E-12	6.430E-17	-1.000E+00	1.200E-10	6.060E-13
THYROID	2.390E-15	6.590E-13	8.716E-13	4.270E-17	-1.000E+00	9.400E-12	5.290E-14
REMAINDER	2.260E-15	6.682E-13	8.838E-13	4.330E-17	-1.000E+00	2.280E-10	1.240E-09

EFFECTIVE	2.390E-15	7.007E-13	9.267E-13	4.540E-17-1.000E+00	1.570E-10	3.740E-10
SKIN(FGR)	6.580E-14	1.667E-10	2.204E-10	1.080E-14-1.000E+00	0.000E+00	0.000E+00
La-142						
GONADS	1.400E-13	1.978E-11	2.034E-11	2.540E-15-1.000E+00	1.660E-11	6.990E-11
BREAST	1.570E-13	1.885E-11	1.938E-11	2.420E-15-1.000E+00	1.130E-11	1.540E-11
LUNGS	1.420E-13	1.846E-11	1.898E-11	2.370E-15-1.000E+00	3.010E-10	8.400E-12
RED MARR	1.420E-13	1.900E-11	1.954E-11	2.440E-15-1.000E+00	1.360E-11	1.930E-11
BONE SUR	1.950E-13	2.484E-11	2.554E-11	3.190E-15-1.000E+00	1.110E-11	7.400E-12
THYROID	1.450E-13	1.768E-11	1.818E-11	2.270E-15-1.000E+00	8.740E-12	1.160E-12
REMAINDER	1.380E-13	1.853E-11	1.906E-11	2.380E-15-1.000E+00	8.070E-11	5.200E-10
EFFECTIVE	1.440E-13	1.916E-11	1.970E-11	2.460E-15-1.000E+00	6.840E-11	1.790E-10
SKIN(FGR)	2.160E-13	9.111E-11	9.368E-11	1.170E-14-1.000E+00	0.000E+00	0.000E+00
Ce-141						
GONADS	3.380E-15	2.213E-12	4.332E-11	7.710E-17-1.000E+00	5.540E-11	1.080E-10
BREAST	3.930E-15	2.170E-12	4.247E-11	7.560E-17-1.000E+00	4.460E-11	1.110E-11
LUNGS	3.170E-15	1.951E-12	3.820E-11	6.800E-17-1.000E+00	1.670E-08	1.430E-12
RED MARR	2.830E-15	1.860E-12	3.641E-11	6.480E-17-1.000E+00	8.960E-11	3.390E-11
BONE SUR	9.410E-15	5.166E-12	1.011E-10	1.800E-16-1.000E+00	2.540E-10	2.300E-11
THYROID	3.350E-15	2.003E-12	3.922E-11	6.980E-17-1.000E+00	2.550E-11	1.800E-13
REMAINDER	2.980E-15	1.894E-12	3.708E-11	6.600E-17-1.000E+00	1.260E-09	2.500E-09
EFFECTIVE	3.430E-15	2.118E-12	4.146E-11	7.380E-17-1.000E+00	2.420E-09	7.830E-10
SKIN(FGR)	1.020E-14	3.788E-12	7.416E-11	1.320E-16-1.000E+00	0.000E+00	0.000E+00
Ce-143						
GONADS	1.280E-14	7.900E-12	4.958E-11	2.980E-16-1.000E+00	7.530E-11	2.120E-10
BREAST	1.470E-14	7.688E-12	4.825E-11	2.900E-16-1.000E+00	1.660E-11	2.320E-11
LUNGS	1.230E-14	6.893E-12	4.325E-11	2.600E-16-1.000E+00	3.880E-09	3.820E-12
RED MARR	1.170E-14	6.787E-12	4.259E-11	2.560E-16-1.000E+00	2.960E-11	5.070E-11
BONE SUR	2.520E-14	1.323E-11	8.302E-11	4.990E-16-1.000E+00	1.640E-11	1.610E-11
THYROID	1.280E-14	7.211E-12	4.525E-11	2.720E-16-1.000E+00	6.230E-12	4.350E-13
REMAINDER	1.170E-14	6.734E-12	4.226E-11	2.540E-16-1.000E+00	1.420E-09	3.890E-09
EFFECTIVE	1.290E-14	7.396E-12	4.642E-11	2.790E-16-1.000E+00	9.160E-10	1.230E-09
SKIN(FGR)	3.960E-14	1.058E-10	6.638E-10	3.990E-15-1.000E+00	0.000E+00	0.000E+00
Ce-144						
GONADS	2.725E-15	6.328E-13	1.319E-11	6.088E-17-1.000E+00	2.390E-10	6.987E-11
BREAST	3.129E-15	6.274E-13	1.307E-11	5.922E-17-1.000E+00	3.480E-10	1.223E-11
LUNGS	2.639E-15	5.228E-13	1.089E-11	5.362E-17-1.000E+00	7.911E-07	6.551E-12
RED MARR	2.507E-15	4.755E-13	9.907E-12	5.247E-17-1.000E+00	2.880E-09	8.923E-11
BONE SUR	5.441E-15	1.646E-12	3.429E-11	1.127E-16-1.000E+00	4.720E-09	1.280E-10
THYROID	2.753E-15	5.529E-13	1.152E-11	5.418E-17-1.000E+00	2.920E-10	5.154E-12
REMAINDER	2.534E-15	5.086E-13	1.060E-11	5.283E-17-1.000E+00	1.910E-08	1.890E-08
EFFECTIVE	2.773E-15	5.909E-13	1.231E-11	5.766E-17-1.000E+00	1.010E-07	5.711E-09
SKIN(FGR)	8.574E-14	7.648E-13	1.594E-11	1.250E-14-1.000E+00	0.000E+00	0.000E+00
Pr-143						
GONADS	2.130E-17	2.264E-14	4.032E-13	7.930E-19-1.000E+00	4.370E-18	8.990E-18
BREAST	2.550E-17	2.330E-14	4.149E-13	8.160E-19-1.000E+00	2.220E-18	1.090E-18
LUNGS	1.860E-17	1.642E-14	2.923E-13	5.750E-19-1.000E+00	1.330E-08	1.910E-19
RED MARR	1.620E-17	1.493E-14	2.659E-13	5.230E-19-1.000E+00	1.480E-11	1.030E-12
BONE SUR	5.930E-17	5.454E-14	9.711E-13	1.910E-18-1.000E+00	1.490E-11	1.030E-12
THYROID	2.050E-17	1.802E-14	3.208E-13	6.310E-19-1.000E+00	1.680E-18	2.660E-20
REMAINDER	1.760E-17	1.642E-14	2.923E-13	5.750E-19-1.000E+00	1.970E-09	4.220E-09
EFFECTIVE	2.100E-17	2.002E-14	3.564E-13	7.010E-19-1.000E+00	2.190E-09	1.270E-09
SKIN(FGR)	1.760E-14	5.711E-11	1.017E-09	2.000E-15-1.000E+00	0.000E+00	0.000E+00
Nd-147						
GONADS	6.130E-15	4.218E-12	7.235E-11	1.480E-16-1.000E+00	8.410E-11	1.790E-10

BREAST	7.120E-15	4.132E-12	7.088E-11	1.450E-16	-1.000E+00	3.450E-11	1.870E-11
LUNGS	5.820E-15	3.648E-12	6.257E-11	1.280E-16	-1.000E+00	1.060E-08	2.440E-12
RED MARR	5.400E-15	3.505E-12	6.013E-11	1.230E-16	-1.000E+00	9.190E-11	5.050E-11
BONE SUR	1.320E-14	8.265E-12	1.418E-10	2.900E-16	-1.000E+00	3.260E-10	2.220E-11
THYROID	6.120E-15	3.876E-12	6.648E-11	1.360E-16	-1.000E+00	1.820E-11	2.640E-13
REMAINDER	5.530E-15	3.562E-12	6.111E-11	1.250E-16	-1.000E+00	1.760E-09	3.760E-09
EFFECTIVE	6.190E-15	3.961E-12	6.795E-11	1.390E-16	-1.000E+00	1.850E-09	1.180E-09
SKIN(FGR)	1.950E-14	3.135E-11	5.377E-10	1.100E-15	-1.000E+00	0.000E+00	0.000E+00
Np-239							
GONADS	7.530E-15	4.691E-12	4.380E-11	1.710E-16	-1.000E+00	7.450E-11	1.620E-10
BREAST	8.730E-15	4.636E-12	4.329E-11	1.690E-16	-1.000E+00	1.630E-11	1.720E-11
LUNGS	7.180E-15	4.115E-12	3.842E-11	1.500E-16	-1.000E+00	2.360E-09	2.400E-12
RED MARR	6.500E-15	4.005E-12	3.740E-11	1.460E-16	-1.000E+00	2.080E-10	4.660E-11
BONE SUR	2.000E-14	1.001E-11	9.349E-11	3.650E-16	-1.000E+00	2.030E-09	3.590E-11
THYROID	7.520E-15	4.197E-12	3.919E-11	1.530E-16	-1.000E+00	7.620E-12	2.070E-13
REMAINDER	6.760E-15	4.005E-12	3.740E-11	1.460E-16	-1.000E+00	9.590E-10	2.770E-09
EFFECTIVE	7.690E-15	4.471E-12	4.175E-11	1.630E-16	-1.000E+00	6.780E-10	8.820E-10
SKIN(FGR)	1.600E-14	7.215E-12	6.737E-11	2.630E-16	-1.000E+00	0.000E+00	0.000E+00
Pu-238							
GONADS	6.560E-18	4.291E-14	9.011E-13	1.490E-18	-1.000E+00	1.040E-05	2.330E-09
BREAST	1.270E-17	5.558E-14	1.167E-12	1.930E-18	-1.000E+00	4.400E-10	1.800E-13
LUNGS	1.060E-18	2.267E-15	4.759E-14	7.870E-20	-1.000E+00	3.200E-04	8.640E-14
RED MARR	1.680E-18	5.587E-15	1.173E-13	1.940E-19	-1.000E+00	5.800E-05	1.270E-08
BONE SUR	9.300E-18	3.514E-14	7.378E-13	1.220E-18	-1.000E+00	7.250E-04	1.580E-07
THYROID	4.010E-18	9.792E-15	2.056E-13	3.400E-19	-1.000E+00	3.860E-10	7.990E-14
REMAINDER	1.990E-18	9.216E-15	1.935E-13	3.200E-19	-1.000E+00	2.740E-05	2.180E-08
EFFECTIVE	4.880E-18	2.413E-14	5.068E-13	8.380E-19	-1.000E+00	7.790E-05	1.340E-08
SKIN(FGR)	4.090E-17	2.776E-13	5.830E-12	9.640E-18	-1.000E+00	0.000E+00	0.000E+00
Pu-239							
GONADS	4.840E-18	1.768E-14	3.713E-13	6.140E-19	-1.000E+00	1.200E-05	2.640E-09
BREAST	7.550E-18	2.238E-14	4.699E-13	7.770E-19	-1.000E+00	3.990E-10	1.210E-13
LUNGS	2.650E-18	2.267E-15	4.760E-14	7.870E-20	-1.000E+00	3.230E-04	7.890E-14
RED MARR	2.670E-18	3.456E-15	7.258E-14	1.200E-19	-1.000E+00	6.570E-05	1.410E-08
BONE SUR	9.470E-18	1.673E-14	3.514E-13	5.810E-19	-1.000E+00	8.210E-04	1.760E-07
THYROID	3.880E-18	5.126E-15	1.077E-13	1.780E-19	-1.000E+00	3.750E-10	7.500E-14
REMAINDER	2.860E-18	4.838E-15	1.016E-13	1.680E-19	-1.000E+00	3.020E-05	2.120E-08
EFFECTIVE	4.240E-18	1.057E-14	2.220E-13	3.670E-19	-1.000E+00	8.330E-05	1.400E-08
SKIN(FGR)	1.860E-17	1.057E-13	2.220E-12	3.670E-18	-1.000E+00	0.000E+00	0.000E+00
Pu-240							
GONADS	6.360E-18	4.118E-14	8.649E-13	1.430E-18	-1.000E+00	1.200E-05	2.640E-09
BREAST	1.230E-17	5.328E-14	1.119E-12	1.850E-18	-1.000E+00	4.330E-10	1.730E-13
LUNGS	1.090E-18	2.249E-15	4.723E-14	7.810E-20	-1.000E+00	3.230E-04	8.220E-14
RED MARR	1.650E-18	5.386E-15	1.131E-13	1.870E-19	-1.000E+00	6.570E-05	1.410E-08
BONE SUR	9.260E-18	3.398E-14	7.137E-13	1.180E-18	-1.000E+00	8.210E-04	1.760E-07
THYROID	3.920E-18	9.446E-15	1.984E-13	3.280E-19	-1.000E+00	3.760E-10	7.510E-14
REMAINDER	1.960E-18	8.870E-15	1.863E-13	3.080E-19	-1.000E+00	3.020E-05	2.130E-08
EFFECTIVE	4.750E-18	2.313E-14	4.857E-13	8.030E-19	-1.000E+00	8.330E-05	1.400E-08
SKIN(FGR)	3.920E-17	2.644E-13	5.552E-12	9.180E-18	-1.000E+00	0.000E+00	0.000E+00
Pu-241							
GONADS	7.190E-20	6.653E-17	1.396E-15	2.310E-21	-1.000E+00	2.760E-07	5.660E-11
BREAST	8.670E-20	7.229E-17	1.517E-15	2.510E-21	-1.000E+00	2.140E-11	2.790E-15
LUNGS	6.480E-20	4.090E-17	8.584E-16	1.420E-21	-1.000E+00	3.180E-06	4.480E-15
RED MARR	5.630E-20	4.003E-17	8.403E-16	1.390E-21	-1.000E+00	1.430E-06	2.780E-10
BONE SUR	2.190E-19	1.385E-16	2.908E-15	4.810E-21	-1.000E+00	1.780E-05	3.480E-09

THYROID	6.980E-20	4.522E-17	9.491E-16	1.570E-21-1.000E+00	9.150E-12	1.010E-15
REMAINDER	6.090E-20	4.291E-17	9.007E-16	1.490E-21-1.000E+00	6.020E-07	1.850E-10
EFFECTIVE	7.250E-20	5.558E-17	1.167E-15	1.930E-21-1.000E+00	1.340E-06	2.070E-10
SKIN(FGR)	1.170E-19	2.033E-16	4.268E-15	7.060E-21-1.000E+00	0.000E+00	0.000E+00
Am-241						
GONADS	8.580E-16	9.360E-13	1.966E-11	3.250E-17-1.000E+00	3.250E-05	2.700E-07
BREAST	1.070E-15	1.014E-12	2.129E-11	3.520E-17-1.000E+00	2.670E-09	2.620E-11
LUNGS	6.740E-16	5.789E-13	1.216E-11	2.010E-17-1.000E+00	1.840E-05	3.360E-11
RED MARR	5.210E-16	4.838E-13	1.016E-11	1.680E-17-1.000E+00	1.740E-04	1.450E-06
BONE SUR	2.870E-15	2.678E-12	5.625E-11	9.300E-17-1.000E+00	2.170E-03	1.810E-05
THYROID	7.830E-16	6.365E-13	1.337E-11	2.210E-17-1.000E+00	1.600E-09	1.320E-11
REMAINDER	6.340E-16	5.933E-13	1.246E-11	2.060E-17-1.000E+00	7.820E-05	6.660E-07
EFFECTIVE	8.180E-16	7.920E-13	1.663E-11	2.750E-17-1.000E+00	1.200E-04	9.840E-07
SKIN(FGR)	1.280E-15	2.396E-12	5.032E-11	8.320E-17-1.000E+00	0.000E+00	0.000E+00
Cm-242						
GONADS	7.830E-18	4.893E-14	1.013E-12	1.700E-18-1.000E+00	5.700E-07	5.200E-09
BREAST	1.480E-17	6.159E-14	1.275E-12	2.140E-18-1.000E+00	9.440E-10	8.950E-12
LUNGS	1.130E-18	3.022E-15	6.257E-14	1.050E-19-1.000E+00	1.550E-05	8.840E-12
RED MARR	1.890E-18	6.562E-15	1.359E-13	2.280E-19-1.000E+00	3.900E-06	3.570E-08
BONE SUR	1.060E-17	4.231E-14	8.759E-13	1.470E-18-1.000E+00	4.870E-05	4.460E-07
THYROID	4.910E-18	1.261E-14	2.610E-13	4.380E-19-1.000E+00	9.410E-10	8.820E-12
REMAINDER	2.270E-18	1.079E-14	2.235E-13	3.750E-19-1.000E+00	2.450E-06	4.020E-08
EFFECTIVE	5.690E-18	2.751E-14	5.697E-13	9.560E-19-1.000E+00	4.670E-06	3.100E-08
SKIN(FGR)	4.290E-17	2.700E-13	5.589E-12	9.380E-18-1.000E+00	0.000E+00	0.000E+00
Cm-244						
GONADS	6.900E-18	4.522E-14	9.492E-13	1.570E-18-1.000E+00	1.590E-05	1.330E-07
BREAST	1.330E-17	5.702E-14	1.197E-12	1.980E-18-1.000E+00	1.040E-09	8.820E-12
LUNGS	7.080E-19	2.592E-15	5.441E-14	9.000E-20-1.000E+00	1.930E-05	8.810E-12
RED MARR	1.460E-18	5.875E-15	1.233E-13	2.040E-19-1.000E+00	9.380E-05	7.820E-07
BONE SUR	8.820E-18	3.859E-14	8.101E-13	1.340E-18-1.000E+00	1.170E-03	9.770E-06
THYROID	4.190E-18	1.146E-14	2.406E-13	3.980E-19-1.000E+00	1.010E-09	8.440E-12
REMAINDER	1.810E-18	9.821E-15	2.062E-13	3.410E-19-1.000E+00	4.780E-05	4.150E-07
EFFECTIVE	4.910E-18	2.529E-14	5.308E-13	8.780E-19-1.000E+00	6.700E-05	5.450E-07
SKIN(FGR)	3.910E-17	2.506E-13	5.260E-12	8.700E-18-1.000E+00	0.000E+00	0.000E+00
Xe-133m						
GONADS	1.420E-15	0.000E+00	0.000E+00	0.000E+00-1.000E+00	0.000E+00	0.000E+00
BREAST	1.700E-15	0.000E+00	0.000E+00	0.000E+00-1.000E+00	0.000E+00	0.000E+00
LUNGS	1.190E-15	0.000E+00	0.000E+00	0.000E+00-1.000E+00	0.000E+00	0.000E+00
RED MARR	1.100E-15	0.000E+00	0.000E+00	0.000E+00-1.000E+00	0.000E+00	0.000E+00
BONE SUR	3.230E-15	0.000E+00	0.000E+00	0.000E+00-1.000E+00	0.000E+00	0.000E+00
THYROID	1.360E-15	0.000E+00	0.000E+00	0.000E+00-1.000E+00	0.000E+00	0.000E+00
REMAINDER	1.150E-15	0.000E+00	0.000E+00	0.000E+00-1.000E+00	0.000E+00	0.000E+00
EFFECTIVE	1.370E-15	0.000E+00	0.000E+00	0.000E+00-1.000E+00	0.000E+00	0.000E+00
SKIN(FGR)	1.040E-14	0.000E+00	0.000E+00	0.000E+00-1.000E+00	0.000E+00	0.000E+00
Xe-135m						
GONADS	2.000E-14	0.000E+00	0.000E+00	0.000E+00-1.000E+00	0.000E+00	0.000E+00
BREAST	2.290E-14	0.000E+00	0.000E+00	0.000E+00-1.000E+00	0.000E+00	0.000E+00
LUNGS	1.980E-14	0.000E+00	0.000E+00	0.000E+00-1.000E+00	0.000E+00	0.000E+00
RED MARR	1.910E-14	0.000E+00	0.000E+00	0.000E+00-1.000E+00	0.000E+00	0.000E+00
BONE SUR	3.500E-14	0.000E+00	0.000E+00	0.000E+00-1.000E+00	0.000E+00	0.000E+00
THYROID	2.040E-14	0.000E+00	0.000E+00	0.000E+00-1.000E+00	0.000E+00	0.000E+00
REMAINDER	1.890E-14	0.000E+00	0.000E+00	0.000E+00-1.000E+00	0.000E+00	0.000E+00
EFFECTIVE	2.040E-14	0.000E+00	0.000E+00	0.000E+00-1.000E+00	0.000E+00	0.000E+00
SKIN(FGR)	2.970E-14	0.000E+00	0.000E+00	0.000E+00-1.000E+00	0.000E+00	0.000E+00

Xe-138

GONADS	5.590E-14	0.000E+00	0.000E+00	0.000E+00	-1.000E+00	0.000E+00	0.000E+00
BREAST	6.320E-14	0.000E+00	0.000E+00	0.000E+00	-1.000E+00	0.000E+00	0.000E+00
LUNGS	5.660E-14	0.000E+00	0.000E+00	0.000E+00	-1.000E+00	0.000E+00	0.000E+00
RED MARR	5.600E-14	0.000E+00	0.000E+00	0.000E+00	-1.000E+00	0.000E+00	0.000E+00
BONE SUR	8.460E-14	0.000E+00	0.000E+00	0.000E+00	-1.000E+00	0.000E+00	0.000E+00
THYROID	5.770E-14	0.000E+00	0.000E+00	0.000E+00	-1.000E+00	0.000E+00	0.000E+00
REMAINDER	5.490E-14	0.000E+00	0.000E+00	0.000E+00	-1.000E+00	0.000E+00	0.000E+00
EFFECTIVE	5.770E-14	0.000E+00	0.000E+00	0.000E+00	-1.000E+00	0.000E+00	0.000E+00
SKIN(FGR)	1.070E-13	0.000E+00	0.000E+00	0.000E+00	-1.000E+00	0.000E+00	0.000E+00

ATTACHMENT E
OUTPUT FILE MHACTMT.o0

##
Cumulative Dose Summary
##

	EAB		LPZ		cr	
Time (hr)	Thyroid (rem)	TEDE (rem)	Thyroid (rem)	TEDE (rem)	Thyroid (rem)	TEDE (rem)
0.000	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.017	3.5407E-03	1.7593E-04	8.9880E-04	4.4660E-05	1.7122E-04	7.4441E-06
0.018	3.8880E-03	1.9316E-04	9.8695E-04	4.9033E-05	1.8956E-04	8.2415E-06
0.025	7.9282E-03	3.9364E-04	2.0125E-03	9.9925E-05	4.6275E-04	2.0118E-05
0.333	1.0295E+00	5.0856E-02	2.6134E-01	1.2909E-02	7.3860E-01	3.1994E-02
0.500	1.9998E+00	9.8412E-02	5.0764E-01	2.4981E-02	1.9560E+00	8.4596E-02
0.500	2.0049E+00	9.8720E-02	5.0895E-01	2.5060E-02	1.9569E+00	8.4634E-02
0.678	1.4298E+01	8.5803E-01	3.6295E+00	2.1781E-01	9.3452E+00	4.7378E-01
0.978	2.3434E+01	1.4505E+00	5.9486E+00	3.6821E-01	3.0389E+01	1.6153E+00
1.278	2.6763E+01	1.6932E+00	6.7937E+00	4.2981E-01	4.7106E+01	2.5304E+00
1.578	2.8013E+01	1.8091E+00	7.1110E+00	4.5922E-01	5.7400E+01	3.0983E+00
1.878	2.8510E+01	1.8774E+00	7.2372E+00	4.7656E-01	6.3144E+01	3.4193E+00
2.000	2.8618E+01	1.8988E+00	7.2647E+00	4.8201E-01	6.4629E+01	3.5037E+00
2.400	2.8618E+01	1.8988E+00	7.2680E+00	4.8299E-01	6.7427E+01	3.6678E+00
2.700	2.8618E+01	1.8988E+00	7.2692E+00	4.8361E-01	6.8361E+01	3.7273E+00
3.000	2.8618E+01	1.8988E+00	7.2701E+00	4.8417E-01	6.8846E+01	3.7620E+00
3.300	2.8618E+01	1.8988E+00	7.2707E+00	4.8468E-01	6.9108E+01	3.7842E+00
3.600	2.8618E+01	1.8988E+00	7.2712E+00	4.8516E-01	6.9259E+01	3.8001E+00
3.900	2.8618E+01	1.8988E+00	7.2716E+00	4.8560E-01	6.9353E+01	3.8125E+00
4.200	2.8618E+01	1.8988E+00	7.2720E+00	4.8602E-01	6.9417E+01	3.8229E+00
4.500	2.8618E+01	1.8988E+00	7.2723E+00	4.8640E-01	6.9463E+01	3.8321E+00
4.800	2.8618E+01	1.8988E+00	7.2725E+00	4.8677E-01	6.9499E+01	3.8403E+00
5.100	2.8618E+01	1.8988E+00	7.2727E+00	4.8710E-01	6.9529E+01	3.8478E+00
5.400	2.8618E+01	1.8988E+00	7.2729E+00	4.8742E-01	6.9553E+01	3.8548E+00
5.700	2.8618E+01	1.8988E+00	7.2731E+00	4.8772E-01	6.9573E+01	3.8613E+00
6.000	2.8618E+01	1.8988E+00	7.2732E+00	4.8800E-01	6.9591E+01	3.8673E+00
6.300	2.8618E+01	1.8988E+00	7.2733E+00	4.8827E-01	6.9607E+01	3.8730E+00
6.600	2.8618E+01	1.8988E+00	7.2735E+00	4.8852E-01	6.9620E+01	3.8783E+00
6.900	2.8618E+01	1.8988E+00	7.2736E+00	4.8875E-01	6.9632E+01	3.8833E+00
7.200	2.8618E+01	1.8988E+00	7.2736E+00	4.8898E-01	6.9643E+01	3.8880E+00
7.500	2.8618E+01	1.8988E+00	7.2737E+00	4.8919E-01	6.9652E+01	3.8924E+00
7.800	2.8618E+01	1.8988E+00	7.2738E+00	4.8939E-01	6.9661E+01	3.8966E+00
8.000	2.8618E+01	1.8988E+00	7.2738E+00	4.8951E-01	6.9666E+01	3.8992E+00
8.300	2.8618E+01	1.8988E+00	7.2739E+00	4.8970E-01	6.9672E+01	3.9028E+00
8.600	2.8618E+01	1.8988E+00	7.2739E+00	4.8987E-01	6.9676E+01	3.9058E+00
8.900	2.8618E+01	1.8988E+00	7.2739E+00	4.9003E-01	6.9679E+01	3.9084E+00
9.200	2.8618E+01	1.8988E+00	7.2739E+00	4.9019E-01	6.9682E+01	3.9106E+00
9.500	2.8618E+01	1.8988E+00	7.2740E+00	4.9034E-01	6.9684E+01	3.9126E+00
9.800	2.8618E+01	1.8988E+00	7.2740E+00	4.9048E-01	6.9686E+01	3.9144E+00
10.100	2.8618E+01	1.8988E+00	7.2740E+00	4.9062E-01	6.9687E+01	3.9160E+00
10.400	2.8618E+01	1.8988E+00	7.2740E+00	4.9075E-01	6.9689E+01	3.9174E+00
24.000	2.8618E+01	1.8988E+00	7.2742E+00	4.9389E-01	6.9702E+01	3.9460E+00
96.000	2.8618E+01	1.8988E+00	7.2742E+00	4.9458E-01	6.9702E+01	3.9575E+00

720.000 2.8618E+01 1.8988E+00 7.2742E+00 4.9580E-01 6.9702E+01 3.9682E+00

##
Worst Two-Hour Doses
##

EAB

Time (hr)	Whole Body (rem)	Thyroid (rem)	TEDE (rem)
0.0	3.7335E-01	2.8618E+01	1.8988E+00

ATTACHMENT F
OUTPUT FILE MHAVS.o0

##
Cumulative Dose Summary
##

	EAB		LPZ		cr	
Time (hr)	Thyroid (rem)	TEDE (rem)	Thyroid (rem)	TEDE (rem)	Thyroid (rem)	TEDE (rem)
0.000	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.017	1.5389E-04	9.8329E-06	3.6229E-05	2.3148E-06	1.0168E-05	4.4975E-07
0.018	1.6899E-04	1.0791E-05	3.9782E-05	2.5405E-06	1.1258E-05	4.9791E-07
0.025	3.4459E-04	2.1944E-05	8.1122E-05	5.1660E-06	2.7482E-05	1.2151E-06
0.333	4.4881E-02	2.9178E-03	1.0566E-02	6.8691E-04	4.3965E-02	1.9365E-03
0.500	8.7321E-02	5.6974E-03	2.0557E-02	1.3413E-03	1.1657E-01	5.1307E-03
0.500	8.7546E-02	5.7157E-03	2.0610E-02	1.3456E-03	1.1662E-01	5.1330E-03
0.678	6.2376E-01	5.4645E-02	1.4684E-01	1.2864E-02	5.5688E-01	2.8965E-02
0.978	1.0277E+00	1.0360E-01	2.4193E-01	2.4389E-02	1.8168E+00	1.0027E-01
1.278	1.1804E+00	1.3424E-01	2.7790E-01	3.1603E-02	2.8288E+00	1.6010E-01
1.578	1.2427E+00	1.5726E-01	2.9256E-01	3.7022E-02	3.4642E+00	2.0054E-01
1.878	1.2718E+00	1.7662E-01	2.9940E-01	4.1578E-02	3.8309E+00	2.2700E-01
2.000	1.2793E+00	1.8381E-01	3.0118E-01	4.3273E-02	3.9295E+00	2.3512E-01
2.400	1.2793E+00	1.8381E-01	3.0144E-01	4.3605E-02	4.1279E+00	2.5491E-01
2.700	1.2793E+00	1.8381E-01	3.0158E-01	4.3831E-02	4.2046E+00	2.6559E-01
3.000	1.2793E+00	1.8381E-01	3.0169E-01	4.4040E-02	4.2521E+00	2.7444E-01
3.300	1.2793E+00	1.8381E-01	3.0179E-01	4.4235E-02	4.2843E+00	2.8217E-01
3.600	1.2793E+00	1.8381E-01	3.0187E-01	4.4416E-02	4.3080E+00	2.8917E-01
3.900	1.2793E+00	1.8381E-01	3.0195E-01	4.4586E-02	4.3268E+00	2.9562E-01
4.200	1.2793E+00	1.8381E-01	3.0201E-01	4.4744E-02	4.3425E+00	3.0161E-01
4.500	1.2793E+00	1.8381E-01	3.0207E-01	4.4893E-02	4.3559E+00	3.0722E-01
4.800	1.2793E+00	1.8381E-01	3.0212E-01	4.5032E-02	4.3677E+00	3.1247E-01
5.100	1.2793E+00	1.8381E-01	3.0217E-01	4.5162E-02	4.3781E+00	3.1740E-01
5.400	1.2793E+00	1.8381E-01	3.0221E-01	4.5285E-02	4.3873E+00	3.2204E-01
5.700	1.2793E+00	1.8381E-01	3.0225E-01	4.5400E-02	4.3956E+00	3.2640E-01
6.000	1.2793E+00	1.8381E-01	3.0229E-01	4.5509E-02	4.4030E+00	3.3051E-01
6.300	1.2793E+00	1.8381E-01	3.0232E-01	4.5612E-02	4.4097E+00	3.3438E-01
6.600	1.2793E+00	1.8381E-01	3.0235E-01	4.5708E-02	4.4156E+00	3.3803E-01
6.900	1.2793E+00	1.8381E-01	3.0237E-01	4.5800E-02	4.4210E+00	3.4148E-01
7.200	1.2793E+00	1.8381E-01	3.0239E-01	4.5886E-02	4.4259E+00	3.4473E-01
7.500	1.2793E+00	1.8381E-01	3.0242E-01	4.5968E-02	4.4303E+00	3.4781E-01
7.800	1.2793E+00	1.8381E-01	3.0243E-01	4.6045E-02	4.4342E+00	3.5073E-01
8.000	1.2793E+00	1.8381E-01	3.0244E-01	4.6095E-02	4.4366E+00	3.5259E-01
8.300	1.2793E+00	1.8381E-01	3.0245E-01	4.6165E-02	4.4395E+00	3.5508E-01
8.600	1.2793E+00	1.8381E-01	3.0246E-01	4.6233E-02	4.4414E+00	3.5716E-01
8.900	1.2793E+00	1.8381E-01	3.0247E-01	4.6297E-02	4.4428E+00	3.5892E-01
9.200	1.2793E+00	1.8381E-01	3.0247E-01	4.6358E-02	4.4439E+00	3.6044E-01
9.500	1.2793E+00	1.8381E-01	3.0248E-01	4.6416E-02	4.4448E+00	3.6177E-01
9.800	1.2793E+00	1.8381E-01	3.0248E-01	4.6471E-02	4.4456E+00	3.6294E-01
10.100	1.2793E+00	1.8381E-01	3.0249E-01	4.6524E-02	4.4463E+00	3.6399E-01
10.400	1.2793E+00	1.8381E-01	3.0249E-01	4.6575E-02	4.4470E+00	3.6494E-01
24.000	1.2793E+00	1.8381E-01	3.0253E-01	4.7797E-02	4.4529E+00	3.8293E-01
96.000	1.2793E+00	1.8381E-01	3.0253E-01	4.8066E-02	4.4529E+00	3.9017E-01

720.000 1.2793E+00 1.8381E-01 3.0253E-01 4.8542E-02 4.4529E+00 3.9677E-01

##
Worst Two-Hour Doses
##

EAB

Time (hr)	Whole Body (rem)	Thyroid (rem)	TEDE (rem)
0.0	1.1664E-01	1.2793E+00	1.8381E-01

ATTACHMENT G
RELEASE FRACTION AND TIMING FILE MHARWT.RFT

```
Release Fraction and Timing Name:
 PWR, RG 1.183, Table 2 Section 3.2
 Duration (h):  Design Basis Accident
  0.5000E+00  0.1300E+01  0.0000E+00  0.0000E+00
 Noble Gases:
  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
 Iodine:
  0.5000E-01  0.3500E+00  0.0000E+00  0.0000E+00
 Cesium:
  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
 Tellurium:
  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
 Strontium:
  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
 Barium:
  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
 Ruthenium:
  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
 Cerium:
  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
 Lanthanum:
  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
 Non-Radioactive Aerosols (kg):
  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
 End of Release File
```

ATTACHMENT H
OUTPUT FILE MHARWT.o0

##
Cumulative Dose Summary
##

	eab		lpz		cr	
Time (hr)	Thyroid (rem)	TEDE (rem)	Thyroid (rem)	TEDE (rem)	Thyroid (rem)	TEDE (rem)
0.000	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.333	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.500	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.533	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.933	2.1444E-05	7.5637E-07	5.0484E-06	1.7806E-07	2.8127E-05	8.9224E-07
1.233	8.3988E-05	2.9410E-06	1.9772E-05	6.9237E-07	1.5907E-04	5.0391E-06
1.533	2.0850E-04	7.2542E-06	4.9084E-05	1.7078E-06	4.8709E-04	1.5412E-05
1.800	3.8707E-04	1.3397E-05	9.1123E-05	3.1539E-06	1.0247E-03	3.2391E-05
2.000	5.7048E-04	1.9676E-05	1.3430E-04	4.6321E-06	1.6243E-03	5.1311E-05
2.300	5.7048E-04	1.9676E-05	1.3975E-04	4.8177E-06	2.8040E-03	8.8498E-05
2.600	5.7048E-04	1.9676E-05	1.4668E-04	5.0525E-06	4.3163E-03	1.3612E-04
2.900	5.7048E-04	1.9676E-05	1.5509E-04	5.3357E-06	6.2106E-03	1.9571E-04
3.200	5.7048E-04	1.9676E-05	1.6494E-04	5.6664E-06	8.5087E-03	2.6794E-04
3.500	5.7048E-04	1.9676E-05	1.7624E-04	6.0438E-06	1.1219E-02	3.5304E-04
3.800	5.7048E-04	1.9676E-05	1.8896E-04	6.4673E-06	1.4343E-02	4.5107E-04
4.100	5.7048E-04	1.9676E-05	2.0309E-04	6.9362E-06	1.7880E-02	5.6198E-04
4.400	5.7048E-04	1.9676E-05	2.1862E-04	7.4500E-06	2.1828E-02	6.8567E-04
4.700	5.7048E-04	1.9676E-05	2.3553E-04	8.0082E-06	2.6183E-02	8.2204E-04
5.000	5.7048E-04	1.9676E-05	2.5382E-04	8.6101E-06	3.0942E-02	9.7096E-04
5.300	5.7048E-04	1.9676E-05	2.7347E-04	9.2553E-06	3.6101E-02	1.1323E-03
5.600	5.7048E-04	1.9676E-05	2.9447E-04	9.9433E-06	4.1657E-02	1.3060E-03
5.900	5.7048E-04	1.9676E-05	3.1680E-04	1.0674E-05	4.7607E-02	1.4919E-03
6.200	5.7048E-04	1.9676E-05	3.4046E-04	1.1446E-05	5.3946E-02	1.6899E-03
6.500	5.7048E-04	1.9676E-05	3.6543E-04	1.2259E-05	6.0673E-02	1.8998E-03
6.800	5.7048E-04	1.9676E-05	3.9170E-04	1.3114E-05	6.7782E-02	2.1216E-03
7.100	5.7048E-04	1.9676E-05	4.1926E-04	1.4009E-05	7.5272E-02	2.3552E-03
7.400	5.7048E-04	1.9676E-05	4.4811E-04	1.4945E-05	8.3138E-02	2.6004E-03
7.700	5.7048E-04	1.9676E-05	4.7822E-04	1.5920E-05	9.1378E-02	2.8572E-03
8.000	5.7048E-04	1.9676E-05	5.0960E-04	1.6935E-05	9.9989E-02	3.1254E-03
8.300	5.7048E-04	1.9676E-05	5.2637E-04	1.7497E-05	1.0735E-01	3.3546E-03
8.600	5.7048E-04	1.9676E-05	5.4379E-04	1.8078E-05	1.1291E-01	3.5276E-03
8.900	5.7048E-04	1.9676E-05	5.6183E-04	1.8680E-05	1.1766E-01	3.6756E-03
9.200	5.7048E-04	1.9676E-05	5.8051E-04	1.9302E-05	1.2211E-01	3.8139E-03
9.500	5.7048E-04	1.9676E-05	5.9980E-04	1.9943E-05	1.2647E-01	3.9496E-03
9.800	5.7048E-04	1.9676E-05	6.1972E-04	2.0604E-05	1.3087E-01	4.0864E-03
10.100	5.7048E-04	1.9676E-05	6.4024E-04	2.1284E-05	1.3536E-01	4.2259E-03
10.400	5.7048E-04	1.9676E-05	6.6137E-04	2.1983E-05	1.3996E-01	4.3689E-03
24.000	5.7048E-04	1.9676E-05	2.1965E-03	7.1616E-05	4.7922E-01	1.4857E-02
96.000	5.7048E-04	1.9676E-05	8.3368E-03	2.6201E-04	2.2601E+00	6.9322E-02
720.000	5.7048E-04	1.9676E-05	6.0210E-02	1.8560E-03	1.0811E+01	3.2979E-01

##
Worst Two-Hour Doses

##

eab

Time (hr)	Whole Body (rem)	Thyroid (rem)	TEDE (rem)
0.0	1.7537E-06	5.7048E-04	1.9676E-05

ATTACHMENT I
NUCLEAR INVENTORY FILE PRI14.NIF

```
Nuclide Inventory Name:
 Normalized MACCS Sample 3412 MWth PWR Core Inventory
 Power Level:
  0.1000E+01
 Nuclides:
  14
 Nuclide 001:
 Kr-85
   1
  0.3382974720E+09
  0.8500E+02
  7.9975E+03
 none     0.0000E+00
 none     0.0000E+00
 none     0.0000E+00
 Nuclide 002:
 Kr-85m
   1
  0.1612800000E+05
  0.8500E+02
  4.1975E+02
 Kr-85    0.2100E+00
 none     0.0000E+00
 none     0.0000E+00
 Nuclide 003:
 Kr-87
   1
  0.4578000000E+04
  0.8700E+02
  2.4238E+02
 Rb-87    0.1000E+01
 none     0.0000E+00
 none     0.0000E+00
 Nuclide 004:
 Kr-88
   1
  0.1022400000E+05
  0.8800E+02
  7.5473E+02
 Rb-88    0.1000E+01
 none     0.0000E+00
 none     0.0000E+00
 Nuclide 005:
 I-131
   2
  0.6946560000E+06
  0.1310E+03
  8.0357E+01
 Xe-131m  0.1100E-01
 none     0.0000E+00
```

```
none     0.0000E+00
Nuclide 006:
I-132
  2
 0.8280000000E+04
 0.1320E+03
 2.6686E+01
none     0.0000E+00
none     0.0000E+00
none     0.0000E+00
Nuclide 007:
I-133
  2
 0.7488000000E+05
 0.1330E+03
 1.1319E+02
Xe-133m  0.2900E-01
Xe-133   0.9700E+00
none     0.0000E+00
Nuclide 008:
I-134
  2
 0.3156000000E+04
 0.1340E+03
 1.5266E+01
none     0.0000E+00
none     0.0000E+00
none     0.0000E+00
Nuclide 009:
I-135
  2
 0.2379600000E+05
 0.1350E+03
 6.2112E+01
Xe-135m  0.1500E+00
Xe-135   0.8500E+00
none     0.0000E+00
Nuclide 010:
Xe-133
  1
 0.4531680000E+06
 0.1330E+03
 8.2574E+04
none     0.0000E+00
none     0.0000E+00
none     0.0000E+00
Nuclide 011:
Xe-135
  1
 0.3272400000E+05
 0.1350E+03
 1.9726E+03
Cs-135   0.1000E+01
none     0.0000E+00
```

```
none      0.0000E+00
Nuclide 012:
Xe-133m
  1
 0.1892200000E+06
 0.1330E+03
 1.1764E+03
Xe-133    0.1000E+01
none      0.0000E+00
none      0.0000E+00
Nuclide 013:
Xe-135m
  1
 0.9180000000E+03
 0.1350E+03
 2.5814E+02
Xe-135    0.1000E+01
none      0.0000E+00
none      0.0000E+00
Nuclide 014:
Xe-138
  1
 0.8460000000E+03
 0.1380E+03
 1.3622E+02
none      0.0000E+00
none      0.0000E+00
none      0.0000E+00
End of Nuclear Inventory File
```

ATTACHMENT J
RELEASE FRACTION AND TIMING FILE MHAHP.RFT

```
Release Fraction and Timing Name:
 PWR, RG 1.183, Table 2 Section 3.2
 Duration (h):  Design Basis Accident
  0.0001E+00  0.0000E+00  0.0000E+00  0.0000E+00
 Noble Gases:
  1.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
 Iodine:
  1.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
 Cesium:
  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
 Tellurium:
  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
 Strontium:
  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
 Barium:
  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
 Ruthenium:
  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
 Cerium:
  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
 Lanthanum:
  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
 Non-Radioactive Aerosols (kg):
  0.0000E+00  0.0000E+00  0.0000E+00  0.0000E+00
 End of Release File
```

ATTACHMENT K
CONVERSION FACTORS FILE FGR14.INP

FGRDCF 10/24/95 03:24:50 beta-test version 1.10, minor FORTRAN fixes 5/4/95
Implicit daughter halflives (m) less than 90 and less than 0.100 of parent
9 ORGANS DEFINED IN THIS FILE:
GONADS
BREAST
LUNGS
RED MARR
BONE SUR
THYROID
REMAINDER
EFFECTIVE
SKIN(FGR)
14 NUCLIDES DEFINED IN THIS FILE:
Kr-85
Kr-85m
Kr-87
Kr-88
I-131 D
I-132 D
I-133 D
I-134 D
I-135 D Including:Xe-135m
Xe-133
Xe-135
Xe-133m
Xe-135m
Xe-138

	CLOUDSHINE	GROUND SHINE 8HR	GROUND SHINE 7DAY	GROUND SHINE RATE	INHALED ACUTE	INHALED CHRONIC	INGESTION
Kr-85							
GONADS	1.170E-16	8.121E-14	1.704E-12	2.820E-18	-1.000E+00	0.000E+00	0.000E+00
BREAST	1.340E-16	7.891E-14	1.656E-12	2.740E-18	-1.000E+00	0.000E+00	0.000E+00
LUNGS	1.140E-16	7.056E-14	1.481E-12	2.450E-18	-1.000E+00	0.000E+00	0.000E+00
RED MARR	1.090E-16	6.998E-14	1.469E-12	2.430E-18	-1.000E+00	0.000E+00	0.000E+00
BONE SUR	2.200E-16	1.287E-13	2.702E-12	4.470E-18	-1.000E+00	0.000E+00	0.000E+00
THYROID	1.180E-16	7.459E-14	1.565E-12	2.590E-18	-1.000E+00	0.000E+00	0.000E+00
REMAINDER	1.090E-16	6.941E-14	1.457E-12	2.410E-18	-1.000E+00	0.000E+00	0.000E+00
EFFECTIVE	1.190E-16	7.603E-14	1.596E-12	2.640E-18	-1.000E+00	0.000E+00	0.000E+00
SKIN(FGR)	1.320E-14	2.304E-11	4.835E-10	8.000E-16	-1.000E+00	0.000E+00	0.000E+00
Kr-85m							
GONADS	7.310E-15	2.594E-12	3.653E-12	1.570E-16	-1.000E+00	0.000E+00	0.000E+00
BREAST	8.410E-15	2.527E-12	3.560E-12	1.530E-16	-1.000E+00	0.000E+00	0.000E+00
LUNGS	7.040E-15	2.379E-12	3.351E-12	1.440E-16	-1.000E+00	0.000E+00	0.000E+00
RED MARR	6.430E-15	2.346E-12	3.304E-12	1.420E-16	-1.000E+00	0.000E+00	0.000E+00
BONE SUR	1.880E-14	5.286E-12	7.446E-12	3.200E-16	-1.000E+00	0.000E+00	0.000E+00
THYROID	7.330E-15	2.395E-12	3.374E-12	1.450E-16	-1.000E+00	0.000E+00	0.000E+00
REMAINDER	6.640E-15	2.313E-12	3.257E-12	1.400E-16	-1.000E+00	0.000E+00	0.000E+00
EFFECTIVE	7.480E-15	2.511E-12	3.537E-12	1.520E-16	-1.000E+00	0.000E+00	0.000E+00
SKIN(FGR)	2.240E-14	2.247E-11	3.164E-11	1.360E-15	-1.000E+00	0.000E+00	0.000E+00
Kr-87							

GONADS	4.000E-14	4.962E-12	5.026E-12	7.610E-16-1.000E+00	0.000E+00	0.000E+00
BREAST	4.500E-14	4.740E-12	4.802E-12	7.270E-16-1.000E+00	0.000E+00	0.000E+00
LUNGS	4.040E-14	4.603E-12	4.663E-12	7.060E-16-1.000E+00	0.000E+00	0.000E+00
RED MARR	4.000E-14	4.708E-12	4.769E-12	7.220E-16-1.000E+00	0.000E+00	0.000E+00
BONE SUR	6.020E-14	6.514E-12	6.598E-12	9.990E-16-1.000E+00	0.000E+00	0.000E+00
THYROID	4.130E-14	4.473E-12	4.531E-12	6.860E-16-1.000E+00	0.000E+00	0.000E+00
REMAINDER	3.910E-14	4.590E-12	4.650E-12	7.040E-16-1.000E+00	0.000E+00	0.000E+00
EFFECTIVE	4.120E-14	4.773E-12	4.835E-12	7.320E-16-1.000E+00	0.000E+00	0.000E+00
SKIN(FGR)	1.370E-13	8.802E-11	8.916E-11	1.350E-14-1.000E+00	0.000E+00	0.000E+00
Kr-88						
GONADS	9.900E-14	2.278E-11	2.655E-11	1.800E-15-1.000E+00	0.000E+00	0.000E+00
BREAST	1.110E-13	2.177E-11	2.537E-11	1.720E-15-1.000E+00	0.000E+00	0.000E+00
LUNGS	1.010E-13	2.139E-11	2.493E-11	1.690E-15-1.000E+00	0.000E+00	0.000E+00
RED MARR	1.000E-13	2.190E-11	2.552E-11	1.730E-15-1.000E+00	0.000E+00	0.000E+00
BONE SUR	1.390E-13	2.886E-11	3.363E-11	2.280E-15-1.000E+00	0.000E+00	0.000E+00
THYROID	1.030E-13	2.012E-11	2.345E-11	1.590E-15-1.000E+00	0.000E+00	0.000E+00
REMAINDER	9.790E-14	2.139E-11	2.493E-11	1.690E-15-1.000E+00	0.000E+00	0.000E+00
EFFECTIVE	1.020E-13	2.202E-11	2.567E-11	1.740E-15-1.000E+00	0.000E+00	0.000E+00
SKIN(FGR)	1.350E-13	5.607E-11	6.534E-11	4.430E-15-1.000E+00	0.000E+00	0.000E+00
I-131						
GONADS	1.780E-14	1.119E-11	1.789E-10	3.940E-16-1.000E+00	2.530E-11	4.070E-11
BREAST	2.040E-14	1.082E-11	1.730E-10	3.810E-16-1.000E+00	7.880E-11	1.210E-10
LUNGS	1.760E-14	1.016E-11	1.626E-10	3.580E-16-1.000E+00	6.570E-10	1.020E-10
RED MARR	1.680E-14	1.022E-11	1.635E-10	3.600E-16-1.000E+00	6.260E-11	9.440E-11
BONE SUR	3.450E-14	1.675E-11	2.679E-10	5.900E-16-1.000E+00	5.730E-11	8.720E-11
THYROID	1.810E-14	1.053E-11	1.685E-10	3.710E-16-1.000E+00	2.920E-07	4.760E-07
REMAINDER	1.670E-14	9.908E-12	1.585E-10	3.490E-16-1.000E+00	8.030E-11	1.570E-10
EFFECTIVE	1.820E-14	1.067E-11	1.707E-10	3.760E-16-1.000E+00	8.890E-09	1.440E-08
SKIN(FGR)	2.980E-14	1.825E-11	2.920E-10	6.430E-16-1.000E+00	0.000E+00	0.000E+00
I-132						
GONADS	1.090E-13	2.523E-11	2.771E-11	2.320E-15-1.000E+00	9.950E-12	2.330E-11
BREAST	1.240E-13	2.414E-11	2.652E-11	2.220E-15-1.000E+00	1.410E-11	2.520E-11
LUNGS	1.090E-13	2.305E-11	2.532E-11	2.120E-15-1.000E+00	2.710E-10	2.640E-11
RED MARR	1.070E-13	2.360E-11	2.592E-11	2.170E-15-1.000E+00	1.400E-11	2.460E-11
BONE SUR	1.730E-13	3.327E-11	3.655E-11	3.060E-15-1.000E+00	1.240E-11	2.190E-11
THYROID	1.120E-13	2.381E-11	2.616E-11	2.190E-15-1.000E+00	1.740E-09	3.870E-09
REMAINDER	1.050E-13	2.283E-11	2.509E-11	2.100E-15-1.000E+00	3.780E-11	1.650E-10
EFFECTIVE	1.120E-13	2.403E-11	2.640E-11	2.210E-15-1.000E+00	1.030E-10	1.820E-10
SKIN(FGR)	1.580E-13	8.199E-11	9.007E-11	7.540E-15-1.000E+00	0.000E+00	0.000E+00
I-133						
GONADS	2.870E-14	1.585E-11	6.748E-11	6.270E-16-1.000E+00	1.950E-11	3.630E-11
BREAST	3.280E-14	1.519E-11	6.468E-11	6.010E-16-1.000E+00	2.940E-11	4.680E-11
LUNGS	2.860E-14	1.446E-11	6.156E-11	5.720E-16-1.000E+00	8.200E-10	4.530E-11
RED MARR	2.770E-14	1.466E-11	6.242E-11	5.800E-16-1.000E+00	2.720E-11	4.300E-11
BONE SUR	4.870E-14	2.161E-11	9.202E-11	8.550E-16-1.000E+00	2.520E-11	4.070E-11
THYROID	2.930E-14	1.502E-11	6.393E-11	5.940E-16-1.000E+00	4.860E-08	9.100E-08
REMAINDER	2.730E-14	1.418E-11	6.038E-11	5.610E-16-1.000E+00	5.000E-11	1.550E-10
EFFECTIVE	2.940E-14	1.509E-11	6.425E-11	5.970E-16-1.000E+00	1.580E-09	2.800E-09
SKIN(FGR)	5.830E-14	1.150E-10	4.897E-10	4.550E-15-1.000E+00	0.000E+00	0.000E+00
I-134						
GONADS	1.270E-13	1.200E-11	1.202E-11	2.640E-15-1.000E+00	4.250E-12	1.100E-11
BREAST	1.440E-13	1.145E-11	1.147E-11	2.520E-15-1.000E+00	6.170E-12	1.170E-11
LUNGS	1.270E-13	1.100E-11	1.102E-11	2.420E-15-1.000E+00	1.430E-10	1.260E-11
RED MARR	1.250E-13	1.127E-11	1.129E-11	2.480E-15-1.000E+00	6.080E-12	1.090E-11

BONE SUR	1.960E-13	1.568E-11	1.571E-11	3.450E-15-1.000E+00	5.310E-12	9.320E-12
THYROID	1.300E-13	1.127E-11	1.129E-11	2.480E-15-1.000E+00	2.880E-10	6.210E-10
REMAINDER	1.220E-13	1.091E-11	1.093E-11	2.400E-15-1.000E+00	2.270E-11	1.340E-10
EFFECTIVE	1.300E-13	1.150E-11	1.152E-11	2.530E-15-1.000E+00	3.550E-11	6.660E-11
SKIN(FGR)	1.870E-13	4.477E-11	4.485E-11	9.850E-15-1.000E+00	0.000E+00	0.000E+00
I-135						
GONADS	8.078E-14	3.113E-11	5.489E-11	1.599E-15-1.000E+00	1.700E-11	3.610E-11
BREAST	9.143E-14	2.971E-11	5.240E-11	1.526E-15-1.000E+00	2.340E-11	3.850E-11
LUNGS	8.145E-14	2.886E-11	5.089E-11	1.482E-15-1.000E+00	4.410E-10	3.750E-11
RED MARR	8.054E-14	2.965E-11	5.228E-11	1.523E-15-1.000E+00	2.240E-11	3.650E-11
BONE SUR	1.184E-13	3.983E-11	7.024E-11	2.046E-15-1.000E+00	2.010E-11	3.360E-11
THYROID	8.324E-14	2.852E-11	5.030E-11	1.465E-15-1.000E+00	8.460E-09	1.790E-08
REMAINDER	7.861E-14	2.883E-11	5.084E-11	1.481E-15-1.000E+00	4.700E-11	1.540E-10
EFFECTIVE	8.294E-14	2.989E-11	5.271E-11	1.535E-15-1.000E+00	3.320E-10	6.080E-10
SKIN(FGR)	1.156E-13	9.826E-11	1.733E-10	5.047E-15-1.000E+00	0.000E+00	0.000E+00
Xe-133						
GONADS	1.610E-15	1.465E-12	2.052E-11	5.200E-17-1.000E+00	0.000E+00	0.000E+00
BREAST	1.960E-15	1.505E-12	2.107E-11	5.340E-17-1.000E+00	0.000E+00	0.000E+00
LUNGS	1.320E-15	1.045E-12	1.464E-11	3.710E-17-1.000E+00	0.000E+00	0.000E+00
RED MARR	1.070E-15	8.791E-13	1.231E-11	3.120E-17-1.000E+00	0.000E+00	0.000E+00
BONE SUR	5.130E-15	4.254E-12	5.958E-11	1.510E-16-1.000E+00	0.000E+00	0.000E+00
THYROID	1.510E-15	1.181E-12	1.653E-11	4.190E-17-1.000E+00	0.000E+00	0.000E+00
REMAINDER	1.240E-15	1.042E-12	1.460E-11	3.700E-17-1.000E+00	0.000E+00	0.000E+00
EFFECTIVE	1.560E-15	1.299E-12	1.819E-11	4.610E-17-1.000E+00	0.000E+00	0.000E+00
SKIN(FGR)	4.970E-15	1.953E-12	2.734E-11	6.930E-17-1.000E+00	0.000E+00	0.000E+00
Xe-135						
GONADS	1.170E-14	5.455E-12	1.194E-11	2.530E-16-1.000E+00	0.000E+00	0.000E+00
BREAST	1.330E-14	5.325E-12	1.166E-11	2.470E-16-1.000E+00	0.000E+00	0.000E+00
LUNGS	1.130E-14	4.959E-12	1.086E-11	2.300E-16-1.000E+00	0.000E+00	0.000E+00
RED MARR	1.070E-14	4.959E-12	1.086E-11	2.300E-16-1.000E+00	0.000E+00	0.000E+00
BONE SUR	2.570E-14	9.120E-12	1.997E-11	4.230E-16-1.000E+00	0.000E+00	0.000E+00
THYROID	1.180E-14	5.023E-12	1.100E-11	2.330E-16-1.000E+00	0.000E+00	0.000E+00
REMAINDER	1.080E-14	4.829E-12	1.058E-11	2.240E-16-1.000E+00	0.000E+00	0.000E+00
EFFECTIVE	1.190E-14	5.217E-12	1.142E-11	2.420E-16-1.000E+00	0.000E+00	0.000E+00
SKIN(FGR)	3.120E-14	4.506E-11	9.867E-11	2.090E-15-1.000E+00	0.000E+00	0.000E+00
Xe-133m						
GONADS	1.420E-15	0.000E+00	0.000E+00	0.000E+00-1.000E+00	0.000E+00	0.000E+00
BREAST	1.700E-15	0.000E+00	0.000E+00	0.000E+00-1.000E+00	0.000E+00	0.000E+00
LUNGS	1.190E-15	0.000E+00	0.000E+00	0.000E+00-1.000E+00	0.000E+00	0.000E+00
RED MARR	1.100E-15	0.000E+00	0.000E+00	0.000E+00-1.000E+00	0.000E+00	0.000E+00
BONE SUR	3.230E-15	0.000E+00	0.000E+00	0.000E+00-1.000E+00	0.000E+00	0.000E+00
THYROID	1.360E-15	0.000E+00	0.000E+00	0.000E+00-1.000E+00	0.000E+00	0.000E+00
REMAINDER	1.150E-15	0.000E+00	0.000E+00	0.000E+00-1.000E+00	0.000E+00	0.000E+00
EFFECTIVE	1.370E-15	0.000E+00	0.000E+00	0.000E+00-1.000E+00	0.000E+00	0.000E+00
SKIN(FGR)	1.040E-14	0.000E+00	0.000E+00	0.000E+00-1.000E+00	0.000E+00	0.000E+00
Xe-135m						
GONADS	2.000E-14	0.000E+00	0.000E+00	0.000E+00-1.000E+00	0.000E+00	0.000E+00
BREAST	2.290E-14	0.000E+00	0.000E+00	0.000E+00-1.000E+00	0.000E+00	0.000E+00
LUNGS	1.980E-14	0.000E+00	0.000E+00	0.000E+00-1.000E+00	0.000E+00	0.000E+00
RED MARR	1.910E-14	0.000E+00	0.000E+00	0.000E+00-1.000E+00	0.000E+00	0.000E+00
BONE SUR	3.500E-14	0.000E+00	0.000E+00	0.000E+00-1.000E+00	0.000E+00	0.000E+00
THYROID	2.040E-14	0.000E+00	0.000E+00	0.000E+00-1.000E+00	0.000E+00	0.000E+00
REMAINDER	1.890E-14	0.000E+00	0.000E+00	0.000E+00-1.000E+00	0.000E+00	0.000E+00
EFFECTIVE	2.040E-14	0.000E+00	0.000E+00	0.000E+00-1.000E+00	0.000E+00	0.000E+00

SKIN(FGR)	2.970E-14	0.000E+00	0.000E+00	0.000E+00	-1.000E+00	0.000E+00	0.000E+00
Xe-138							
GONADS	5.590E-14	0.000E+00	0.000E+00	0.000E+00	-1.000E+00	0.000E+00	0.000E+00
BREAST	6.320E-14	0.000E+00	0.000E+00	0.000E+00	-1.000E+00	0.000E+00	0.000E+00
LUNGS	5.660E-14	0.000E+00	0.000E+00	0.000E+00	-1.000E+00	0.000E+00	0.000E+00
RED MARR	5.600E-14	0.000E+00	0.000E+00	0.000E+00	-1.000E+00	0.000E+00	0.000E+00
BONE SUR	8.460E-14	0.000E+00	0.000E+00	0.000E+00	-1.000E+00	0.000E+00	0.000E+00
THYROID	5.770E-14	0.000E+00	0.000E+00	0.000E+00	-1.000E+00	0.000E+00	0.000E+00
REMAINDER	5.490E-14	0.000E+00	0.000E+00	0.000E+00	-1.000E+00	0.000E+00	0.000E+00
EFFECTIVE	5.770E-14	0.000E+00	0.000E+00	0.000E+00	-1.000E+00	0.000E+00	0.000E+00
SKIN(FGR)	1.070E-13	0.000E+00	0.000E+00	0.000E+00	-1.000E+00	0.000E+00	0.000E+00

ATTACHMENT L
OUTPUT FILE MHAHP.o0

##
Cumulative Dose Summary
##

	eab		lpz		cr	
Time (hr)	Thyroid (rem)	TEDE (rem)	Thyroid (rem)	TEDE (rem)	Thyroid (rem)	TEDE (rem)
0.000	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
0.008	2.6607E-04	6.4918E-05	6.2637E-05	1.5283E-05	9.2724E-06	4.0590E-07
0.333	2.6607E-04	6.4918E-05	6.2637E-05	1.5283E-05	6.5925E-04	2.8660E-05
0.733	2.6607E-04	6.4918E-05	6.2637E-05	1.5283E-05	1.1150E-03	4.9979E-05
1.033	2.6607E-04	6.4918E-05	6.2637E-05	1.5283E-05	1.2591E-03	5.8429E-05
1.333	2.6607E-04	6.4918E-05	6.2637E-05	1.5283E-05	1.3289E-03	6.3691E-05
1.633	2.6607E-04	6.4918E-05	6.2637E-05	1.5283E-05	1.3627E-03	6.7160E-05
1.933	2.6607E-04	6.4918E-05	6.2637E-05	1.5283E-05	1.3791E-03	6.9563E-05
2.000	2.6607E-04	6.4918E-05	6.2637E-05	1.5283E-05	1.3814E-03	6.9996E-05
2.300	2.6607E-04	6.4918E-05	6.2637E-05	1.5283E-05	1.3881E-03	7.1615E-05
2.600	2.6607E-04	6.4918E-05	6.2637E-05	1.5283E-05	1.3914E-03	7.2825E-05
2.900	2.6607E-04	6.4918E-05	6.2637E-05	1.5283E-05	1.3930E-03	7.3746E-05
3.200	2.6607E-04	6.4918E-05	6.2637E-05	1.5283E-05	1.3937E-03	7.4457E-05
3.500	2.6607E-04	6.4918E-05	6.2637E-05	1.5283E-05	1.3941E-03	7.5011E-05
3.800	2.6607E-04	6.4918E-05	6.2637E-05	1.5283E-05	1.3943E-03	7.5445E-05
4.100	2.6607E-04	6.4918E-05	6.2637E-05	1.5283E-05	1.3944E-03	7.5786E-05
4.400	2.6607E-04	6.4918E-05	6.2637E-05	1.5283E-05	1.3944E-03	7.6055E-05
4.700	2.6607E-04	6.4918E-05	6.2637E-05	1.5283E-05	1.3944E-03	7.6267E-05
5.000	2.6607E-04	6.4918E-05	6.2637E-05	1.5283E-05	1.3945E-03	7.6435E-05
5.300	2.6607E-04	6.4918E-05	6.2637E-05	1.5283E-05	1.3945E-03	7.6568E-05
5.600	2.6607E-04	6.4918E-05	6.2637E-05	1.5283E-05	1.3945E-03	7.6674E-05
5.900	2.6607E-04	6.4918E-05	6.2637E-05	1.5283E-05	1.3945E-03	7.6758E-05
6.200	2.6607E-04	6.4918E-05	6.2637E-05	1.5283E-05	1.3945E-03	7.6824E-05
6.500	2.6607E-04	6.4918E-05	6.2637E-05	1.5283E-05	1.3945E-03	7.6877E-05
6.800	2.6607E-04	6.4918E-05	6.2637E-05	1.5283E-05	1.3945E-03	7.6919E-05
7.100	2.6607E-04	6.4918E-05	6.2637E-05	1.5283E-05	1.3945E-03	7.6952E-05
7.400	2.6607E-04	6.4918E-05	6.2637E-05	1.5283E-05	1.3945E-03	7.6979E-05
7.700	2.6607E-04	6.4918E-05	6.2637E-05	1.5283E-05	1.3945E-03	7.7000E-05
8.000	2.6607E-04	6.4918E-05	6.2637E-05	1.5283E-05	1.3945E-03	7.7017E-05
8.300	2.6607E-04	6.4918E-05	6.2637E-05	1.5283E-05	1.3945E-03	7.7031E-05
8.600	2.6607E-04	6.4918E-05	6.2637E-05	1.5283E-05	1.3945E-03	7.7041E-05
8.900	2.6607E-04	6.4918E-05	6.2637E-05	1.5283E-05	1.3945E-03	7.7050E-05
9.200	2.6607E-04	6.4918E-05	6.2637E-05	1.5283E-05	1.3945E-03	7.7057E-05
9.500	2.6607E-04	6.4918E-05	6.2637E-05	1.5283E-05	1.3945E-03	7.7062E-05
9.800	2.6607E-04	6.4918E-05	6.2637E-05	1.5283E-05	1.3945E-03	7.7067E-05
10.100	2.6607E-04	6.4918E-05	6.2637E-05	1.5283E-05	1.3945E-03	7.7070E-05
10.400	2.6607E-04	6.4918E-05	6.2637E-05	1.5283E-05	1.3945E-03	7.7073E-05
24.000	2.6607E-04	6.4918E-05	6.2637E-05	1.5283E-05	1.3945E-03	7.7084E-05
96.000	2.6607E-04	6.4918E-05	6.2637E-05	1.5283E-05	1.3945E-03	7.7084E-05
720.000	2.6607E-04	6.4918E-05	6.2637E-05	1.5283E-05	1.3945E-03	7.7084E-05

##
Worst Two-Hour Doses

##

eab

Time (hr)	Whole Body (rem)	Thyroid (rem)	TEDE (rem)
0.0	5.6658E-05	2.6607E-04	6.4918E-05

ATTACHMENT M
ETP-97-064R CONTROL ROOM INLEAKAGE RESULTS

CA06449 Rev. 0
Page 90

CONTROLLED
COPY

4730
MU44

CALVERT CLIFFS NUCLEAR POWER PLANT

TECHNICAL PROCEDURE

ENGINEERING TEST PROCEDURE

UNIT 0

ETP 97-064R

CONTROL ROOM HVAC SYSTEM INLEAKAGE TEST

REVISION 0

Effective Date 11/11/1997

Safety Related X
Non-Safety Related ______

Writer: D. T. McElheny

Sponsor: V. P. Spunar

Approved ____________________ 11/11/97
Date

CONTROLLED
COPY

FT-86 (Rev. 1 10/97) ACU #11

NUCON International, Inc.

Decay Test Data

Estimated duration of test: 2 hours
Beginning concentration (CI): 19.0 ppb
Ending concentration (C(O)): 2.7 ppb
Time at start of test: Time "zero" for decay test was at 01:15 hours on 18 Nov 97.
Time at end of test: 03:12 hours on 19 Nov 97
Sample time intervals: 15 minute, except for last sample

Time / Sample Concentration

Time/Conc.	Time/Conc.	Time/Conc.	Time/Conc.
01:15 / 19.0	/	/	/
01:30 / 14.8	/	/	/
01:45 / 12.1	/	/	/
02:00 / 8.3	/	/	/
02:15 / 6.7	/	/	/
02:30 / 5.1	/	/	/
03:12 / 2.7	/	/	/

(A) Air Change Rate (1/min)

0.0170

(Q) Inleakage Flow Rate (CFM)

4300

95% Confidence Limit

(A) = 0.0170 ± 0.0012

95% Confidence Interval

4000 < Q < 4600

Comments: Decay samples taken at a sample port on the discharge of #11 return fan. All sample concentrations in the ppb range.

Walt O. Wiboff W. Peter Freeman

Test personnel signature(s) and date: NUCON International Inc.

NUCON International, Inc.

Decay Test Data

Estimated duration of test: 1.4 hours
Beginning concentration (*Ct*): 40.5 ppb
Ending concentration (*C(O)*): 14.2 ppb
Time at start of test: Time "zero" for decay test was at 23:16 hours on 19 Nov 97.
Time at end of test: 00:46 hours on 20 Nov 97
Sample time intervals: 15 minute

Time / Sample Concentration

Time/Conc.	Time/Conc.	Time/Conc.	Time/Conc.
23:16 / 40.5	/	/	/
23:31 / 35.2	/	/	/
23:46 / 21.2	/	/	/
00:01 / 26.7	/	/	/
00:16 / 20.3	/	/	/
00:31 / 16.7	/	/	/
00:46 / 14.2	/	/	/

(*A*) Air Change Rate (1/min)

0.0118

(*Q*) Inleakage Flow Rate (CFM)

3000

95% Confidence Limit

(*A*) = 0.0118 ± 0.0012

95% Confidence Interval

2900 < *Q* < 3300

Comments: Decay samples taken at a sample port on the discharge of #12 return fan. These samples were taken in conjunction with samples taken in CAS and on both CSR return ducts. The decay sample taken at 23:46 hours was disregarded due to a faulty gas sample bag.

Walt O. Wikoff   W. Peter Freeman

Test personnel signature(s) and date: NUCON International Inc.

CA06449 Rev.0
Page 93

CALVERT CLIFFS NUCLEAR POWER PLANT

TECHNICAL PROCEDURE

ENGINEERING TEST PROCEDURE

UNIT 0

ETP 97-064R

CONTROL ROOM HVAC SYSTEM INLEAKAGE TEST

REVISION 0

3rd Run of ETP

Effective Date 11/11/1997

Safety Related X

Non-Safety Related ________

CONTROLLED COPY

Writer: D. T. McElheny

Sponsor: V. P. Spunar

Approved ________________________ 11/11/97
Date

Att. 1 Chron Log
Page 3 of 7

CA06449 Rev. 0
Page 94

NUCON International, Inc.
P.O. BOX 29151 7000 HUNTLEY ROAD
COLUMBUS, OHIO 43229 U.S.A.

TELEPHONE: (614) 846-5710
OUTSIDE OHIO: 1-800-992-5192
FAX: (614) 431-0858

Control Room Inleakage Test Report

performed for:

Baltimore Gas and Electric Company
Calvert Cliffs Nuclear Power Station
1850 Calvert Cliffs Pkwy.
Lusby, Maryland
20657

P.O. No. 16582

20 April 1998

Distribution:

BG&E:
Dale McElheny (1)

NUCON:
12BG847 MF (1)
Field Test (1)
QA (1)
Marketing (1)

NUCON 12BG847 /02

Decay Test Data

Estimated duration of test: 120 minutes
Beginning concentration (*Ct*): 25.0 ppb
Ending concentration (*C(O)*): 4.1 ppb
Time at start of test: Time "zero" for decay test was at 22:03 hrs. on 10 Feb 98
Time at end of test: 00:03 hrs. on 11 Feb 98
Sample time intervals: 20 minutes apart

Time / Sample Concentration

Time/Conc.	Time/Conc.	Time/Conc.	Time/Conc.
22:03 / 25.0	/	/	/
22:23 / 17.9	/	/	/
22:43 / 11.9	/	/	/
23:03 / 9.7	/	/	/
23:23 / 9.0	/	/	/
23:43 / 5.7	/	/	/
00:03 / 4.1	/	/	/

(*A*) Air Change Rate (1/min)

0.0143

(*Q*) Inleakage Flow Rate (CFM)

3,600

95% Confidence Limit

(*A*) = 0.0143 ± 0.0025

95% Confidence Interval

3000 < *Q* < ~~4300~~ 4200 * DTM

Comments: Decay samples taken at a sample port on the discharge of #11 return fan. All sample concentrations in the ppb range.

* Per conversation w/ Pete Freeman 5/27/98. DTM

Test personnel signature(s) and date: NUCON International Inc.

Decay Test Data

Estimated duration of test: 120 minutes
Beginning concentration (*Ct*): 47 ppb
Ending concentration (*C(O)*): 12.6 ppb
Time at start of test: Time "zero" for decay test was at 02:05 hrs. on 11 Feb 98
Time at end of test: 04:05 hrs. on 11 Feb 98
Sample time intervals: 20 minutes apart

Time / Sample Concentration

Time/Conc.	Time/Conc.	Time/Conc.	Time/Conc.
02:05 / 47.0	/	/	/
02:25 / 33.2	/	/	/
02:45 / 27.4	/	/	/
03:05 / 24.8	/	/	/
03:25 / 21.4	/	/	/
03:45 / 16.1	/	/	/
04:05 / 12.6	/	/	/

(*A*) Air Change Rate (1/min)

0.0101

(*Q*) Inleakage Flow Rate (CFM)

2550

95% Confidence Limit

(*A*) = 0.0101 ± 0.0018

95% Confidence Interval

2100 < *Q* < 3000

Comments: Decay samples taken at a sample port on the discharge of #12 return fan. All sample concentrations in the ppb range.

Test personnel signature(s) and date: NUCON International Inc.

CA06449 Rev. 0
Page 97

CALVERT CLIFFS NUCLEAR POWER PLANT
TECHNICAL PROCEDURE
ENGINEERING TEST PROCEDURE

UNIT 0

ETP 97-064R

CONTROL ROOM HVAC SYSTEM INLEAKAGE TEST

REVISION 0

4th Run of ETP

Effective Date 11/11/1997

Safety Related X
Non-Safety Related ______

CONTROLLED COPY

Writer: D. T. McElheny

Sponsor: V. P. Spunar

Approved ______ 11/11/97 Date

Att. 1. Chron. Log

Page 3 of 11

CA06449 Rev.0
Page 98

NUCON International, Inc.
P.O. BOX 29151 7000 HUNTLEY ROAD
COLUMBUS, OHIO 43229 U.S.A.

TELEPHONE: (614) 846-5710
OUTSIDE OHIO: 1-800-992-5192
FAX: (614) 431-0858

Control Room Inleakage Test Report

performed for:

Baltimore Gas and Electric Company
Calvert Cliffs Nuclear Power Station
1850 Calvert Cliffs Pkwy.
Lusby, Maryland
20657

P.O. No. 16582

20 April 1998

Distribution:

BG&E:
Dale McElheny (1)

NUCON:

12BG847 MF	(1)
Field Test	(1)
QA	(1)
Marketing	(1)

NUCON 12BG847 /02

Decay Test Data

Estimated duration of test: 120 minutes
Beginning concentration (Ct): 37.5 ppb
Ending concentration ($C(O)$): 9.2 ppb
Time at start of test: Time "zero" for decay test was at 01:15 hrs on 12 Feb 98
Time at end of test: 03:15 hrs on 12 Feb 98
Sample time intervals: 20 minutes apart

Time / Sample Concentration

Time/Conc.	Time/Conc.	Time/Conc.	Time/Conc.
1:15 / 37.5	/	/	/
1:35 / 28.1	/	/	/
1:55 / 24.7	/	/	/
2:15 / 19.3	/	/	/
2:35 / 15.7	/	/	/
~~2:55 / 11.7~~	/	/	/
3:15 / 9.2	/	/	/

(A) Air Change Rate (min^{-1})

0.0115

(Q) Inleakage Flow Rate (CFM)

2,900

95% Confidence Limit

(A) = 0.0115 ± .0010

95% Confidence Interval

2650 < Q < 3150

Comments: Decay samples taken at a sample port on the discharge of #11 return fan. All sample concentrations in the ppb range.

Test personnel signature(s) and date: NUCON International Inc.

Decay Test Data

Estimated duration of test: 120 minutes
Beginning concentration (*Ct*): 37.5 ppb
Ending concentration (*C(O)*): 9.2 ppb
Time at start of test: Time "zero" for decay test was at 21:25 hrs. on 11 Feb 98
Time at end of test: 23:25 hrs. on 11 Feb 98
Sample time intervals: 20 minutes apart

Time / Sample Concentration

Time/Conc.	Time/Conc.	Time/Conc.	Time/Conc.
21:25 / 37.6	/	/	/
21:45 / 30.2	/	/	/
22:05 / 25.2	/	/	/
22:25 / 22.7	/	/	/
22:45 / 15.5	/	/	/
23:05 / 13.4	/	/	/
23:25 / 10.5	/	/	/

(*A*) Air Change Rate (1/min)

0.0109

(*Q*) Inleakage Flow Rate (CFM)

2,750

95% Confidence Limit

$(A) = 0.0109 \pm .0015$

95% Confidence Interval

$2370 < Q < 3130$

Comments: Decay samples taken at a sample port on the discharge of #12 return fan. All sample concentrations in the ppb range.

Test personnel signature(s) and date: NUCON International Inc.

CA06449 Rev.0
PAGE 101

CALVERT CLIFFS NUCLEAR POWER PLANT
TECHNICAL PROCEDURE
ENGINEERING TEST PROCEDURE
UNIT 0
ETP 97-064R
CONTROL ROOM HVAC SYSTEM INLEAKAGE TEST
REVISION 1

x4688 -183
Kevin Spr1744
x 5901 - Al.

Effective Date 1/18/00

Safety Related X
Non-Safety Related ______

CONTROLLED COPY

Writer: D. T. McElheny

Sponsor: T. R. Lupold

Approved ______ 1/18/00
Date

CA06449 Rev 0
PAGE 102
ETP 97-064R
Rev 1

Attachment 1
Page 2 of 14

NUCON International, Inc.
P.O. BOX 29151 7000 HUNTLEY ROAD
COLUMBUS, OHIO 43229 U.S.A.

TELEPHONE: (614) 846-5710
TOLL FREE: 1-800-992-5192
FAX: (614) 431-0858
WEB SITE: www.nucon-int.com

Control Room Inleakage Test Report

performed for:

Baltimore Gas and Electric Company
Calvert Cliffs Nuclear Power Station
1850 Calvert Cliffs Pkwy.
Lusby, Maryland
20657

P.O. No. 16582

3 March 2000

Distribution:

BG&E:
Dale McElheny (1)

NUCON:

12BG658 MF	(1)
Field Test	(1)
QA	(1)
Marketing	(1)

NUCON 12BG658 /01

Decay Test Data

Estimated duration of test: 180 minutes
Beginning concentration (*Ct*): 51.4 ppb
Ending concentration (*C(O)*): 13.2 ppb
Time at start of test: Time "zero" for decay test was at 01:05 hrs. on 26 Jan 00
Time at end of test: 04:05 hrs. on 26 Jan 00
Sample time intervals: 15 minutes apart

Time / Sample Concentration

Time/Conc.	Time/Conc.	Time/Conc.	Time/Conc.
/	120/23.8	/	/
30/ 51.4	135/21.0	/	/
45/ 47.6	150/17.8	/	/
60/ 41.9	165/16.4	/	/
75/ 33.0	180/13.2	/	/
90/ 30.7	/	/	/
105/ 29.3	/	/	/

(*A*) Air Change Rate (1/min)

0.00896

(*Q*) Inleakage Flow Rate (CFM)

2600

95% Confidence Limit

(*A*) = 0.00896 ± 0.00065

95 % Confidence Interval

2400 < *Q* < 2800

Comments: Decay samples taken at a sample port on the discharge of #12 return fan. All sample concentrations in the ppb range.

W. Peter Freeman Eric N Banks 3 March 00

Test personnel signature(s) and date: NUCON International Inc

Decay Test Data

Estimated duration of test: 180 minutes
Beginning concentration (*Ct*): 59.2 ppb @ 15 minutes into test
Ending concentration (*C(O)*): 8.8 ppb @ 195 minutes into test
Time at start of test: Time "zero" for decay test was at 23:35 hrs. on 26 Jan 00
Time at end of test: 03:00 hrs. on 27 Jan 00
Sample time intervals: 15 minutes apart to 105 minutes then @ 140, 165, and 195 minutes

Time / Sample Concentration

Time/Conc.	Time/Conc.	Time/Conc.	Time/Conc.
15/59.2	165/13.8	/	/
30/52.5	195/8.8	/	/
45/42.8	/	/	/
60/40.2	/	/	/
75/36.1	/	/	/
105 /26.2	/	/	/
140/ 17.4	/	/	/

(*A*) Air Change Rate (1/min)

0.0103

(*Q*) Inleakage Flow Rate (CFM)

3000

95% Confidence Limit

(*A*) = 0.0103 ± 0.00085

95 % Confidence Interval

2750 < *Q* < 3250

Comments: Decay samples taken at a sample port on the discharge of #11 return fan. All sample concentrations in the ppb range.

W. Peter Meiman Eric M Banks 3 March 00
Test personnel signature(s) and date: NUCON International Inc.

ATTACHMENT N
ETP 01-035R PERFLUOROCARBON TRACER GAS TESTING

CA06449 Rev. 0
PAGE 106

CALVERT CLIFFS NUCLEAR POWER PLANT

TECHNICAL PROCEDURE

ENGINEERING TEST PROCEDURE

UNIT 0

ETP 01-035R

PERFLUOROCARBON TRACER GAS TESTING

REVISION 0

CONTROLLED COPY

Effective Date 5/1/02

Safety Related X
Non-Safety Related ____

Writer: D. T. McElheny

Sponsor: M. A. Junge

Approved Richard L. [signature] 5-1-02
Date

CA06449 Rev 0
PAGE 107

TRACER TECHNOLOGY CENTER
BROOKHAVEN NATIONAL LABORATORY

FACSIMILE

DATE: July 29, 2002

TO: John E. Wynn Jr.
Aux Systems Engr Unit
Calvert Cliffs Nuclear Power Plant
Lusby, MD 20657

FAX NO: (410) 495 - 4727

MESSAGE:

John,

I'm on vacation this week but wanted to send you the final results but without my final assessment. Remarkably, total inleakage was 2930 ± 185 cfm. Other flows, in cfm, were:

Zone	From/To	CR Inleakage	% of total	CR Outleakage	% of total
0	Outside	275 ± 185	9	1866 ± 470	64
2	AB	436 ± 157	15	366 ± 248	13
3	TB	466 ± 172	16	599 ± 415	20
4	MSIVs	272 ± 134	9	44 ± 33	2
5	AC11	274 ± 33	9	19 ± 3	1
6	AC13	387 ± 38	13	11 ± 8	0
7	SWGRs	818 ± 114	28	21 ± 10	1

More next week. I'll put a copy in the mail also.

Russ

Total no. of pages including this cover page: 4

From: Russell N. Dietz – Head
Tracer Technology Center
Atmospheric Sciences Division
Brookhaven National Laboratory
Bldg 815E
Upton, NY 11973-5000

Telephone: (631) 344-3059
Fax: (631) 344-2887
Confirmation: (631) 344-3275
Email: dietz@bnl.gov
Secretary: Barbara J. Roland
Secretary's email: roland@bnl.gov

Q006449 Rev.0
PAGE 108

BNL—AIMS 12:36:28 07-26-2002

PROJECT: CALVERT CLIFFS START: 09:00 (06-06-1902) BNL CODE: CAL1A0
HOUSE: CALVERT CLIFFS STOP: 10:00 (06-18-1902) ANALYZED: 06-27-1902

************************************** RATES **************************************

OVERALL INFILTRATION RATE = %515878.1 g 85892.1(m^3/h)
OVERALL AIR EXCHANGE RATE = 1.461 g 0.251(1/h)

ZONE	LOCATION	SOURCE RATE @25C (nL/m)	QTY	@T (nL/h)	EXFILTRATION RATE (m^3/h)	SD	INFILTRATION RATE (m^3/h)	SD	ACH (/h)	SD
1	CR	%663.0	1	41812	3170.4	787.9	464.8	379.6	0.055	0.04
2	AB	%3858.0	4	973219	30896.3	11048.8	32707.5	11645.0	0.680	0.2
3	TB	%3870.0	12	%3399361	411130.1	88819.1	419373.8	90345.6	1.482	0
4	MSIVs	%458.0	4	189594	22087.4	10568.3	5694.9	8281.4	4.658	6.77
5	No.11 AC	%2150.0	1	132691	30819.8	3244.6	32226.2	3348.5	19.042	2.1
6	No.13 AC	6.4	30	12620	14492.4	1194.7	8912.2	1907.4	2.480	0.541
7	SWGRs	9.2	10	6435	3381.7	10458.4	16598.8	1527.7	2.348	0.246

ONE-ZONE	RATE	g SD (m^3/h)	ZONE-ZONE	RATE	g SD (m^3/h)
1 - 2	622.2	421.7	2 - 1	741.3	267.9
1 - 3	1018.1	704.6	3 - 1	792.5	292.2
1 - 4	74.5	56.7	4 - 1	462.9	227.2
1 - 5	32.3	5.2	5 - 1	464.8	56.1
1 - 6	19.4	13.7	6 - 1	657.3	64.0
1 - 7	36.5	16.9	7 - 1	1389.7	193.2
2 - 3	2870.3	1460.4	3 - 2	145.4	465.7
2 - 4	31.1	69.4	4 - 2	378.6	448.3
2 - 5	12.0	6.0	5 - 2	334.8	258.1
2 - 6	11.2	21.7	6 - 2	314.4	243.9
2 - 7	552.1	220.7	7 - 2	611.4	556.4
3 - 4	17034.4	%11524.3	4 - 3	154.4	133.2
3 - 5	163.4	115.6	5 - 3	807.0	235.2
3 - 6	8416.2	1965.2	6 - 3	1002.9	424.6
3 - 7	215.4	133.1	7 - 3	12671.2	%11138.9
4 - 5	80.1	35.6	5 - 4	138.1	86.7
- 6	12.7	6.5	6 - 4	755.3	506.8
- 7	30.9	19.1	7 - 4	-541.5	547.4
5 - 6	60.8	11.3	6 - 5	125.9	120.7
5 - 7	22.3	7.0	7 - 5	27.6	62.7
6 - 7	91.1	20.9	7 - 6	7.0	214.7

TOTAL FLOW IN OR OUT

ZONE	RATE g SD (m^3/h)		ACH g SD(/h)		ZONE	RATE g SD (m^3/h)		ACH g SD(/h)	
1	4873.4 ± 310.5		0.586	0.047	2	35114.3	%12483.9	0.730	0.262
3	%437897.5	%93722.6	1.547	0.340	4	23186.9	%11083.4	18.966	9.
5	32647.6	3389.9	19.291	2.223	6	17439.5	1095.1	4.814	0.386
7	17547.1	1595.5	2.480	0.257					

************************************** ANALYSIS **************************************

Total infiltration (m^3/h) = 2930 ± 185 cfm

OL	SOURCE TYPE	ptPDCH		PMCP		PDCB		I-PTCH		PMCH		ocPDCH		iPPCH	
190	ptPDCH	3.447 g	0.403	4.466 g	0.173	2.352 g	0.111	0.786 g	0.076	0.396 g	0.014	0.101 g	0.005	0.106 g	0
10	PMCP	0.151 g	0.086	27.815 g	9.791	0.174 g	0.065	0.103 g	0.090	0.046 g	0.026	0.009 g	0.004	0.008 g	0
00	PDCB	0.021 g	0.013	0.219 g	0.049	7.784 g	1.632	0.006 g	0.001	0.009 g	0.001	0.002 g	0.001	0.011 g	0
23	I-PTCH	0.043 g	0.011	0.196 g	0.026	5.846 g	2.452	8.164 g	3.895	0.033 g	0.009	0.025 g	0.011	0.000 g	0
92	PMCH	0.009 g	0.001	0.017 g	0.003	0.067 g	0.021	0.016 g	0.005	4.065 g	0.389	0.008 g	0.008	0.000 g	0
22	ocPDCH	0.020 g	0.001	0.129 g	0.010	3.764 g	0.299	0.010 g	0.001	0.019 g	0.002	0.725 g	0.035	0.006 g	0
5	iPPCH	0.023 g	0.007	0.888 g	0.148	0.136 g	0.054	0.019 g	0.005	0.008 g	0.001	0.004 g	0.001	0.387 g	0

AVG TRACER CONC. (pL/L) g SD

CA06449 Rev.0
PAGE 109

CATS#	ptPDCH	PMCP	PDCB	I-PTCH	PMCH	ocPDCH	1PPCH	otPDCH	mtPDCH	mPDCH	2-PTCH	
4277	7.147	3.899	2.686	0.637	0.375	0.096	0.083	0.000	8.273	7.315	6.191	DELETED
580	7.742	4.690	2.584	1.290	0.335	0.090	0.115	0.000	9.085	8.045	0.400	DELETED
8149	8.107	4.402	2.249	0.733	0.399	0.097	0.098	0.000	9.463	8.384	0.223	
12400	9.277	4.810	2.428	0.808	0.315	0.109	0.107	0.000	10.964	9.738	0.244	
12921	8.890	4.691	2.825	0.794	0.391	0.106	0.109	0.000	10.546	9.361	0.238	
12055	8.689	4.280	2.432	0.804	0.393	0.104	0.122	0.000	10.329	9.185	0.241	
12631	8.324	4.340	2.500	0.777	0.379	0.101	0.123	0.000	9.886	8.765	0.292	
10181	8.262	4.382	2.327	0.758	0.425	0.107	0.103	0.000	9.774	8.664	0.232	
12057	8.446	4.598	2.370	0.978	0.389	0.101	0.105	0.000	10.017	8.883	0.304	
11079	7.998	4.410	2.484	0.712	0.394	0.096	0.096	0.000	9.357	8.289	0.218	
1823	8.082	4.327	2.169	0.721	0.383	0.093	0.100	0.000	9.420	8.346	0.221	
938	8.415	4.409	2.298	0.777	0.382	0.100	0.105	0.000	9.924	8.800	0.237	
520	7.126	3.865	2.295	0.657	0.804	0.101	0.089	0.000	8.413	7.441	0.198	DELETED
2268	6.923	4.160	2.469	0.644	0.528	0.110	0.087	0.000	8.174	7.227	0.194	DELETED
2198	7.555	4.335	2.589	0.698	0.559	0.118	0.096	0.000	8.920	7.896	0.211	DELETED
3644	3.586	2.498	3.554	0.326	0.184	0.145	0.052	0.000	4.003	3.510	0.094	DELETED
12390	0.204	0.418	15.834	0.020	0.015	0.002	0.007	0.000	0.187	0.164	0.006	DELETED
12036	5.449	3.128	7.235	0.502	0.276	0.067	0.065	0.000	6.274	5.527	0.149	DELETED
12302	5.119	2.808	5.224	0.475	0.475	0.140	0.062	0.000	5.907	5.200	0.139	DELETED
12083	1.035	0.619	3.481	0.090	0.876	0.310	0.018	0.000	1.259	1.098	0.025	DELETED
4779	0.031	0.098	2.728	0.014	1.359	0.490	0.005	0.000	0.459	0.400	0.005	DELETED
4627	3.552	2.287	1.977	0.323	1.448	0.122	0.043	0.000	3.944	3.458	0.083	DELETED
12497	2.791	1.837	1.829	0.249	1.879	0.106	0.034	0.000	3.014	2.637	0.070	DELETED
12189	0.030	11.417	0.020	0.002	0.009	0.001	0.003	0.000	0.000	0.000	0.000	DELETED
12063	0.028	10.242	0.141	0.001	0.014	0.002	0.007	0.000	0.000	0.000	0.000	DELETED
12393	0.028	1.611	1.856	0.088	1.488	0.338	0.005	0.000	0.330	0.289	0.028	DELETED
12009	0.072	16.480	0.089	0.076	0.035	0.011	0.014	0.000	0.000	0.000	0.021	
12264	0.143	35.832	0.214	0.203	0.057	0.013	0.008	0.000	0.000	0.000	0.056	
12376	0.167	43.634	0.244	0.257	0.030	0.006	0.008	0.000	0.000	0.000	0.072	
12297	0.523	14.879	1.321	0.682	0.536	0.119	0.009	0.000	0.641	0.560	0.201	DELETED
12191	0.169	16.464	1.166	0.638	0.538	0.118	0.008	0.000	0.308	0.269	0.188	DELETED
12379	0.335	30.172	0.222	0.061	0.088	0.012	0.005	0.000	0.408	0.357	0.017	
12012	1.489	20.586	0.519	0.175	0.285	0.030	0.018	0.000	1.561	1.362	0.049	DELETED
12244	0.112	25.193	0.138	0.061	0.069	0.003	0.003	0.000	0.182	0.160	0.017	
12155	0.107	26.430	0.094	0.044	0.031	0.003	0.003	0.000	0.181	0.159	0.012	
12384	0.507	0.312	4.404	0.044	0.923	0.253	0.011	0.000	0.688	0.600	0.012	DELETED
11218	4.134	2.583	1.088	0.367	0.203	0.049	0.067	0.000	4.586	4.026	0.107	DELETED
561	0.055	3.165	0.464	0.092	0.219	0.070	0.008	0.000	0.124	0.109	0.025	DELETED
2018	0.122	16.860	0.214	0.018	0.014	0.012	0.016	0.000	0.177	0.155	0.006	
11161	0.018	0.204	5.908	0.005	0.010	0.002	0.026	0.000	0.020	0.018	0.002	
9590	0.019	0.397	7.035	0.005	0.009	0.002	0.008	0.000	0.025	0.022	0.002	
12402	0.020	0.176	7.297	0.006	0.010	0.002	0.009	0.000	0.026	0.023	0.002	
12337	0.014	0.156	6.492	0.004	0.009	0.003	0.004	0.000	0.020	0.018	0.002	
12417	0.017	0.235	9.217	0.007	0.009	0.003	0.008	0.000	0.024	0.022	0.002	
12425	0.030	0.205	8.388	0.008	0.010	0.003	0.005	0.000	0.038	0.034	0.003	
12488	0.062	0.381	15.438	0.009	0.009	0.004	0.008	0.000	0.064	0.057	0.003	DELETED
12383	0.015	0.195	6.342	0.005	0.007	0.001	0.011	0.000	0.021	0.019	0.002	
12203	0.055	0.320	10.741	0.008	0.009	0.003	0.004	0.000	0.056	0.050	0.003	
12178	0.013	0.279	9.691	0.006	0.009	0.001	0.005	0.000	0.019	0.017	0.002	
12288	0.031	0.382	12.712	0.013	0.008	0.002	0.011	0.000	0.035	0.031	0.004	DELETED
12269	0.018	0.221	6.731	0.006	0.007	0.002	0.029	0.000	0.025	0.022	0.002	
12022	0.051	0.215	7.580	6.430	0.026	0.018	0.000	0.000	0.000	0.000	1.799	
12156	0.036	0.177	4.112	10.938	0.039	0.033	0.000	0.000	0.000	0.000	3.610	
1818	0.009	0.019	0.081	0.020	4.340	0.005	0.001	0.000	0.019	0.017	0.006	
8706	0.008	0.015	0.052	0.012	3.780	0.001	0.000	0.000	0.014	0.012	0.004	
1319	0.020	0.189	3.849	0.011	0.018	0.761	0.006	0.000	0.877	0.591	0.004	
707	0.020	0.128	4.011	0.009	0.021	0.685	0.006	0.000	0.612	0.534	0.004	
1281	0.019	0.120	3.432	0.009	0.017	0.739	0.005	0.000	0.667	0.582	0.004	
12340	0.013	0.970	0.178	0.023	0.010	0.004	0.325	0.000	0.027	0.025	0.006	
12502	0.016	1.129	0.203	0.027	0.009	0.005	0.378	0.000	0.034	0.031	0.008	
12307	0.024	0.751	0.080	0.015	0.007	0.004	0.399	0.000	0.040	0.035	0.005	
12300	0.031	0.880	0.095	0.019	0.008	0.004	0.385	0.000	0.046	0.041	0.006	
2158	0.019	0.963	0.182	0.022	0.007	0.005	0.392	0.000	0.038	0.034	0.007	
6706	0.017	0.942	0.173	0.022	0.008	0.005	0.389	0.000	0.037	0.033	0.007	
7750	0.029	0.728	0.084	0.013	0.007	0.003	0.332	0.000	0.044	0.039	0.004	
10831	0.031	0.732	0.085	0.015	0.006	0.003	0.339	0.000	0.043	0.038	0.005	

PDCB	PMCP	PMCH	ocPDCH	ptPDCH	mPDCH	PTCH
0.74	0.74	0.82	0.62	0.65	0.88	0.71

COEFFICIENTS FILE
6C177

*********************************** NOTES *************************************

gas volumes are reported at 21.5 C. and 1 atm.
standard deviation in the source strength has been set at 4 %.
standard deviation in the volume measurement has been set at 5 %.
overall normalized condition number (K(C)/N^1.5)= 0.429
)/N = 1.136
1 condition numbers are:

	FLOW-RATIOS	STD.DEV.
TRN/EXFILTRN		
1	0.147	0.1142
2	1.059	0.0455
3	1.020	0.0363
4	0.258	0.3540
5	1.046	0.0108
6	0.615	0.1209
7	4.908	15.1200
ZONAL		
2- 1	0.639	0.4851
3- 1	1.285	0.9277
4- 1	0.161	0.0969
5- 1	0.069	0.0093
6- 1	0.029	0.0209
7- 1	0.026	0.0122
3- 2	-19.743	62.9947
4- 2	0.082	0.1957
5- 2	0.036	0.0273
6- 2	0.036	0.0723
7- 2	0.903	0.7688
4- 3	110.358	89.8471
5- 3	0.203	0.1401
6- 3	8.392	3.1448
7- 3	0.017	0.0174
- 4	0.435	0.2269
6- 4	0.017	0.0085
7- 4	-0.057	0.0552
6- 5	0.483	0.4655
7- 5	0.809	1.8474
7- 6	12.975	396.7011

RD DEVIATION OF ptPDCH IN ZONE 2 IS GREATER THAN 25 %
RD DEVIATION OF ptPDCH IN ZONE 3 IS GREATER THAN 25 %
RD DEVIATION OF ptPDCH IN ZONE 4 IS GREATER THAN 25 %
RD DEVIATION OF ptPDCH IN ZONE 7 IS GREATER THAN 25 %
RD DEVIATION OF PMCP IN ZONE 2 IS GREATER THAN 25 %
RD DEVIATION OF PDCB IN ZONE 2 IS GREATER THAN 25 %
RD DEVIATION OF PDCB IN ZONE 4 IS GREATER THAN 25 %
RD DEVIATION OF PDCB IN ZONE 5 IS GREATER THAN 25 %
RD DEVIATION OF PDCB IN ZONE 7 IS GREATER THAN 25 %
RD DEVIATION OF T-PTCH IN ZONE 2 IS GREATER THAN 25 %
RD DEVIATION OF T-PTCH IN ZONE 4 IS GREATER THAN 25 %
RD DEVIATION OF T-PTCH IN ZONE 5 IS GREATER THAN 25 %
RD DEVIATION OF PMCH IN ZONE 2 IS GREATER THAN 25 %
RD DEVIATION OF PMCH IN ZONE 4 IS GREATER THAN 25 %
D DEVIATION OF ocPDCH IN ZONE 2 IS GREATER THAN 25 %
D DEVIATION OF ocPDCH IN ZONE 3 IS GREATER THAN 25 %
D DEVIATION OF ocPDCH IN ZONE 4 IS GREATER THAN 25 %
D DEVIATION OF ocPDCH IN ZONE 5 IS GREATER THAN 25 %
D DEVIATION OF iPPCH IN ZONE 2 IS GREATER THAN 25 %
D DEVIATION OF iPPCH IN ZONE 3 IS GREATER THAN 25 %
D DEVIATION OF iPPCH IN ZONE 5 IS GREATER THAN 25 %

ATTACHMENT O
CONTAINMENT TO PENETRATION ROOM LEAKAGE CALCULATION

To calculate the fraction of containment leakage discharging into the penetration rooms, the area of the containment surface adjacent to the penetration rooms is compared against the area of the contrainment adjacent to the external environment and to the penetration rooms.

The containment is divided vertically into five sections:

(1) The first section are the penetration rooms.

- Per Ref.45, the piping penetration rooms include the 5' west and east penetration rooms: Rooms 221 and 227 for Unit 1 and Rooms 211 and 206 for Unit 2. These rooms extend from 5' to 27' elevation.
- Per Ref.46, the penetration rooms include the 27' west and east piping penetration rooms: Rooms 326 and 316 for Unit 1 and Rooms 321 and 310 for Unit 2. These rooms extend from 27' to 45' elevation.
- Per Ref.47, the penetration rooms include the 45' west and ease electrical penetration rooms: Rooms 423 and 429 for Unit 1 and Rooms 414 and 404 for Unit 2. These rooms extend from 45' to 69' elevation.
- Per Ref.48, rooms 221/326, 227/316, 211/321, and 206/310 are separated by metal gratings and are thus usually evaluated as single rooms.
- Some additional areas in containment are adjacent to auxiliary building rooms, which are not directly serviced by the penetration room ventilation systems. During an MHA with a LOOP, any leakage from the containment into these auxiliary building rooms would either remain stagnant in those rooms or be drawn into the penetration rooms due to the negative pressure requirement. If auxiliary building ventilation was available, the activity would also be filtered and exit the auxiliary building out the ventilation stack. It is conservatively assumed in this work that all containment leakage to the auxiliary building passes through the penetration rooms and exits via the vent stacks.to the environment.
- A5 = (215/360)*2*π*65*(69-5) + (165/360)*2*π*65*(91.5-69) = 19821.92 ft^2

(2) The area of the containment against the external environment from ground level at 45' to the 69' level can be deduced from the drawings in Ref.19. This area encompasses 145° of the circumference.

- A4 = (145/360)*2*π*65*(69-45) = 3947.94 ft^2

(3) The area of the containment against the external environment from the 69' level to the 91.5' level can be deduced from the drawings in Ref.19. This area encompasses 195° of the circumference.

- A3 = (195/360)*2*π*65*(91.5-69) = 4977.46 ft^2

(4) The area of the containment against the external environment from the 91.5' level to the 125.1042' level can be deduced from the drawings in Ref.19. This area encompasses 360° of the circumference.

- A2 = (360/360)*2*π*65*(125.1042-91.5) = 13724.18 ft^2

(5) The area of the containment against the external environment from the 125.1042' level to the 190.1042' level can be deduced from the drawings in Refs.19 and 44. This area encompasses a hemisphere of ~ 65' radius.

- A1 = 2*π*65*65 = 26546.46 ft^2

(6) Thus, the fraction of the containment leakage which leaks into the penetration rooms is

- f = A5 / (A1 + A2 + A3 + A4 + A5) = 0.2872

ATTACHMENT P
LOCAL LEAKRATE TEST RESULTS

Per UFSAR 6.6.2, experience has shown that containment leakage is more likely at penetrations rather than through liner plates or weld joints. Penetration rooms are built adjacent to the outside surface of each containment and enclose the areas around the majority of the penetrations. The only penetrations which do not pass through these areas are:

- the two main steam lines
- the two main feedwater lines
- the refueling tube
- penetration #67 the equipment hatch
- penetration #68 the personnel air lock (PAL)
- penetration # 69 the emergency air lock (EAL)
- penetration #13 the purge air inlet
- penetration # 14 the purge air outlet

Per UFSAR 6.6.2, the main steam and feedwater lines are welded to the liner plate and are thus not considered as a source of leakage.

The refueling tube is valved on one end and blind flanged on the other end. Leakage through a blind flange is negligible.

Per UFSAR 5.1.4.4, the ventilation system purge penetrations are equipped with a testable double O-ring blind flange used for isolation purposes. The blind flange is used to provide containment integrity during Modes 1-4. The valve is manually opened for containment purging in Modes 5-6. Thus, containment leakage through the ventilation system purge penetrations in Modes 1-4 is negligible.

Leakage through the Personnel Air Lock, penetration # 68, is governed by TS 3.6.2, Containment Air Locks, which requires air lock leakage rate testing in accordance with the Containment Leakage Rate Testing Program. The Containment Leakage Rate Testing Program is described in TS 5.5.16 and requires an overall air lock leakage rate less than 0.05 of La, when tested at peak containment pressure.

Local Leakage Rate Testing (LLRT) is performed per the Containment Leakage Rate Testing Program (TS 5.5.16). The results are listed below for the containment equipment hatch and for the EAL (Refs.49-58)

		Penetration # 67	Penetration #69
		Equipment Hatch	Emergency Air Lock
		sccm	sccm
Unit 1	1975	0.0	1058.0
	1976	0.0	3699.0
	1977	8175.0	0.0
	1978	0.0	0.0
	1982	17.1	924.7
	1985	73.6	7397.9
	1988	38.6	7397.9
	1992	27.4	9710.0
Unit 2	1979	5.6	2747.0
	1982	4.0	905.0
	1985	21.8	1850.0
	1987	90.0	2312.0

	1989	7.0	2774.0
	1991	20.0	1387.0
Maximum	Value	8175.0	9710.0

Based on a containmemt volume of 1.989E+06 ft^3 (6B.08), a containment peak pressure of 50 psig (Refs.50-58), and a leakrate of 0.2%/day (Refs.50-58), the TS allowable containment leakrate La can be calculated to be 344370 sccm.

Thus, the maximum leak rates from the major penetrations to the environment can be summarized as

- 3% for penetration #67 the equipment hatch
- 5% for penetration #68 the personnel air lock (PAL)
- 3% for penetration # 69 the emergency air lock (EAL)
- 0% for penetration #13/14 the purge air inlet/outlet
- 0% for the main steam lines
- 0% for the main feedwater lines
- 0% for the refueling tube

Thus, leakage from the containment to the environment has not exceeded 6% for the EH and EAL and is limited to 5% for the PAL. Even doubling these values for conservatism, it can be reasonably argued that 75% of containment leakage would wind up in the Auxiliary Building Penetration Rooms.

ATTACHMENT Q
MICROSHIELD CONTAINMENT SHINE SOURCE TERM

MICROSHIELD Source Terms			
MWt	2754		
	CRCB	Release	CRCB
	Ci/MWt	Fraction	Ci
Am-241	7.3183E+00	0.0002	4.0309E+00
Ba-139	5.1001E+04	0.0200	2.8092E+06
Ba-140	5.2928E+04	0.0200	2.9153E+06
Ce-141	5.1883E+04	0.0005	7.1443E+04
Ce-143	4.4327E+04	0.0005	6.1039E+04
Ce-144	4.2317E+04,	0.0005	5.8270E+04
Cm-242	2.0078E+03	0.0002	1.1059E+03
Cm-244	3.1650E+02	0.0002	1.7433E+02
Co-58	8.0013E+02	0.0025	5.5089E+03
Co-60	9.8625E+02	0.0025	6.7903E+03
Cs-134	7.1917E+03	0.3000	5.9417E+06
Cs-136	1.7111E+03	0.3000	1.4137E+06
Cs-137	4.7857E+03	0.3000	3.9540E+06
I-131	2.7562E+04	0.4000	3.0363E+07
I-132	3.9464E+04	0.4000	4.3473E+07
I-133	5.5715E+04	0.4000	6.1376E+07
I-134	6.2858E+04	0.4000	6.9244E+07
I-135	5.2964E+04	0.4000	5.8345E+07
Kr-85	3.7180E+02	1.0000	1.0239E+06
Kr-85m	7.9679E+03	1.0000	2.1944E+07
Kr-87	1.6208E+04	1.0000	4.4636E+07
Kr-88	2.2658E+04	1.0000	6.2400E+07
La-140	5.4255E+04	0.0002	2.9884E+04
La-141	4.6433E+04	0.0002	2.5576E+04
La-142	4.4898E+04	0.0002	2.4730E+04
Mo-99	5.0834E+04	0.0025	3.4999E+05
Nb-95	6.0839E+04	0.0002	3.3510E+04
Nd-147	1.9151E+04	0.0002	1.0548E+04
Np-239	5.5833E+05	0.0005	7.6881E+05
Pr-143	4.6905E+04	0.0002	2.5835E+04
Pu-238	1.7259E+02	0.0005	2.3766E+02
Pu-239	1.1469E+01	0.0005	1.5793E+01
Pu-240	2.0026E+01	0.0005	2.7576E+01
Pu-241	4.9593E+03	0.0005	6.8289E+03
Rb-86	5.9034E+01	0.3000	4.8774E+04
Rh-105	2.8507E+04	0.0025	1.9627E+05
Ru-103	4.8774E+04	0.0025	3.3581E+05
Ru-105	3.1455E+04	0.0025	2.1656E+05

Ru-106	1.9695E+04	0.0025	1.3560E+05
Sb-127	2.4299E+03	0.0500	3.3460E+05
Sb-129	8.7888E+03	0.0500	1.2102E+06
Sr-89	3.3293E+04	0.0200	1.8338E+06
Sr-90	3.1769E+03	0.0200	1.7498E+05
Sr-91	3.8931E+04	0.0200	2.1443E+06
Sr-92	4.0190E+04	0.0200	2.2137E+06
Tc-99m	4.5425E+04	0.0025	3.1275E+05
Te-127	2.4665E+03	0.0500	3.3963E+05
Te-127m	4.6272E+02	0.0500	6.3716E+04
Te-129	8.4012E+03	0.0500	1.1569E+06
Te-129m	1.8872E+03	0.0500	2.5986E+05
Te-131m	5.0686E+03	0.0500	6.9795E+05
Te-132	3.8391E+04	0.0500	5.2864E+06
Xe-133	5.5707E+04	1.0000	1.5342E+08
Xe-133m	1.7354E+03	1.0000	4.7793E+06
Xe-135	1.7708E+04	1.0000	4.8767E+07
Xe-135m	1.1635E+04	1.0000	3.2043E+07
Xe-138	4.9330E+04	1.0000	1.3585E+08
Y-90	3.4567E+03	0.0002	1.9040E+03
Y-91	4.2527E+04	0.0002	2.3424E+04
Y-92	4.0519E+04	0.0002	2.2318E+04
Y-93	2.9622E+04	0.0002	1.6316E+04
Zr-95	5.8246E+04	0.0002	3.2082E+04
Zr-97	4.9425E+04	0.0002	2.7223E+04

ATTACHMENT R
MICROSHIELD PLUME SHINE SOURCE TERM

MICROSHIELD Plume Source Terms			
MWt	2754		
Fraction	0.0248		
	CRCB	Release	CRCB
	Ci/MWt	Fraction	Ci
Am-241	7.3183E+00	0.0002	9.9967E-02
Ba-139	5.1001E+04	0.0200	6.9667E+04
Ba-140	5.2928E+04	0.0200	7.2299E+04
Ce-141	5.1883E+04	0.0005	1.7718E+03
Ce-143	4.4327E+04	0.0005	1.5138E+03
Ce-144	4.2317E+04	0.0005	1.4451E+03
Cm-242	2.0078E+03	0.0002	2.7426E+01
Cm-244	3.1650E+02	0.0002	4.3233E+00
Co-58	8.0013E+02	0.0025	1.3662E+02
Co-60	9.8625E+02	0.0025	1.6840E+02
Cs-134	7.1917E+03	0.3000	1.4736E+05
Cs-136	1.7111E+03	0.3000	3.5060E+04
Cs-137	4.7857E+03	0.3000	9.8058E+04
I-131	2.7562E+04	0.4000	7.5299E+05
I-132	3.9464E+04	0.4000	1.0781E+06
I-133	5.5715E+04	0.4000	1.5221E+06
I-134	6.2858E+04	0.4000	1.7173E+06
I-135	5.2964E+04	0.4000	1.4470E+06
Kr-85	3.7180E+02	1.0000	2.5393E+04
Kr-85m	7.9679E+03	1.0000	5.4420E+05
Kr-87	1.6208E+04	1.0000	1.1070E+06
Kr-88	2.2658E+04	1.0000	1.5475E+06
La-140	5.4255E+04	0.0002	7.4112E+02
La-141	4.6433E+04	0.0002	6.3427E+02
La-142	4.4898E+04	0.0002	6.1330E+02
Mo-99	5.0834E+04	0.0025	8.6798E+03
Nb-95	6.0839E+04	0.0002	8.3104E+02
Nd-147	1.9151E+04	0.0002	2.6160E+02
Np-239	5.5833E+05	0.0005	1.9067E+04
Pr-143	4.6905E+04	0.0002	6.4071E+02
Pu-238	1.7259E+02	0.0005	5.8939E+00
Pu-239	1.1469E+01	0.0005	3.9167E-01
Pu-240	2.0026E+01	0.0005	6.8389E-01
Pu-241	4.9593E+03	0.0005	1.6936E+02
Rb-86	5.9034E+01	0.3000	1.2096E+03
Rh-105	2.8507E+04	0.0025	4.8676E+03
Ru-103	4.8774E+04	0.0025	8.3280E+03
Ru-105	3.1455E+04	0.0025	5.3708E+03

Ru-106	1.9695E+04	0.0025	3.3628E+03
Sb-127	2.4299E+03	0.0500	8.2980E+03
Sb-129	8.7888E+03	0.0500	3.0013E+04
Sr-89	3.3293E+04	0.0200	4.5478E+04
Sr-90	3.1769E+03	0.0200	4.3396E+03
Sr-91	3.8931E+04	0.0200	5.3180E+04
Sr-92	4.0190E+04	0.0200	5.4899E+04
Tc-99m	4.5425E+04	0.0025	7.7561E+03
Te-127	2.4665E+03	0.0500	8.4228E+03
Te-127m	4.6272E+02	0.0500	1.5802E+03
Te-129	8.4012E+03	0.0500	2.8690E+04
Te-129m	1.8872E+03	0.0500	6.4446E+03
Te-131m	5.0686E+03	0.0500	1.7309E+04
Te-132	3.8391E+04	0.0500	1.3110E+05
Xe-133	5.5707E+04	1.0000	3.8048E+06
Xe-133m	1.7354E+03	1.0000	1.1853E+05
Xe-135	1.7708E+04	1.0000	1.2094E+06
Xe-135m	1.1635E+04	1.0000	7.9466E+05
Xe-138	4.9330E+04	1.0000	3.3692E+06
Y-90	3.4567E+03	0.0002	4.7218E+01
Y-91	4.2527E+04	0.0002	5.8091E+02
Y-92	4.0519E+04	0.0002	5.5348E+02
Y-93	2.9622E+04	0.0002	4.0464E+02
Zr-95	5.8246E+04	0.0002	7.9563E+02
Zr-97	4.9425E+04	0.0002	6.7513E+02

ATTACHMENT S
MICROSHIELD CONTROL ROOM FILTER SHINE SOURCE TERM

MICROSHIELD Filter Source Terms			
MWt	2754		
Fraction	1		
	CRCB	Release	CRCB
	Ci/MWt	Fraction	Ci
Am-241	7.3183E+00	0.0002	4.0309E+00
Ba-139	5.1001E+04	0.0200	2.8092E+06
Ba-140	5.2928E+04	0.0200	2.9153E+06
Ce-141	5.1883E+04	0.0005	7.1443E+04
Ce-143	4.4327E+04	0.0005	6.1039E+04
Ce-144	4.2317E+04	0.0005	5.8270E+04
Cm-242	2.0078E+03	0.0002	1.1059E+03
Cm-244	3.1650E+02	0.0002	1.7433E+02
Co-58	8.0013E+02	0.0025	5.5089E+03
Co-60	9.8625E+02	0.0025	6.7903E+03
Cs-134	7.1917E+03	0.3000	5.9417E+06
Cs-136	1.7111E+03	0.3000	1.4137E+06
Cs-137	4.7857E+03	0.3000	3.9540E+06
I-131	2.7562E+04	0.4000	3.0363E+07
I-132	3.9464E+04	0.4000	4.3473E+07
I-133	5.5715E+04	0.4000	6.1376E+07
I-134	6.2858E+04	0.4000	6.9244E+07
I-135	5.2964E+04	0.4000	5.8345E+07
Kr-85	3.7180E+02	0.0000	0.0000E+00
Kr-85m	7.9679E+03	0.0000	0.0000E+00
Kr-87	1.6208E+04	0.0000	0.0000E+00
Kr-88	2.2658E+04	0.0000	0.0000E+00
La-140	5.4255E+04	0.0002	2.9884E+04
La-141	4.6433E+04	0.0002	2.5576E+04
La-142	4.4898E+04	0.0002	2.4730E+04
Mo-99	5.0834E+04	0.0025	3.4999E+05
Nb-95	6.0839E+04	0.0002	3.3510E+04
Nd-147	1.9151E+04	0.0002	1.0548E+04
Np-239	5.5833E+05	0.0005	7.6881E+05
Pr-143	4.6905E+04	0.0002	2.5835E+04
Pu-238	1.7259E+02	0.0005	2.3766E+02
Pu-239	1.1469E+01	0.0005	1.5793E+01
Pu-240	2.0026E+01	0.0005	2.7576E+01
Pu-241	4.9593E+03	0.0005	6.8289E+03
Rb-86	5.9034E+01	0.3000	4.8774E+04
Rh-105	2.8507E+04	0.0025	1.9627E+05
Ru-103	4.8774E+04	0.0025	3.3581E+05
Ru-105	3.1455E+04	0.0025	2.1656E+05

Ru-106	1.9695E+04	0.0025	1.3560E+05
Sb-127	2.4299E+03	0.0500	3.3460E+05
Sb-129	8.7888E+03	0.0500	1.2102E+06
Sr-89	3.3293E+04	0.0200	1.8338E+06
Sr-90	3.1769E+03	0.0200	1.7498E+05
Sr-91	3.8931E+04	0.0200	2.1443E+06
Sr-92	4.0190E+04	0.0200	2.2137E+06
Tc-99m	4.5425E+04	0.0025	3.1275E+05
Te-127	2.4665E+03	0.0500	3.3963E+05
Te-127m	4.6272E+02	0.0500	6.3716E+04
Te-129	8.4012E+03	0.0500	1.1569E+06
Te-129m	1.8872E+03	0.0500	2.5986E+05
Te-131m	5.0686E+03	0.0500	6.9795E+05
Te-132	3.8391E+04	0.0500	5.2864E+06
Xe-133	5.5707E+04	0.0000	0.0000E+00
Xe-133m	1.7354E+03	0.0000	0.0000E+00
Xe-135	1.7708E+04	0.0000	0.0000E+00
Xe-135m	1.1635E+04	0.0000	0.0000E+00
Xe-138	4.9330E+04	0.0000	0.0000E+00
Y-90	3.4567E+03	0.0002	1.9040E+03
Y-91	4.2527E+04	0.0002	2.3424E+04
Y-92	4.0519E+04	0.0002	2.2318E+04
Y-93	2.9622E+04	0.0002	1.6316E+04
Zr-95	5.8246E+04	0.0002	3.2082E+04
Zr-97	4.9425E+04	0.0002	2.7223E+04

ATTACHMENT T
MICROSHIELD CONTROL ROOM FILTER DOSES - PARTICULATE

Microshield Control Room Filter Doses - Particulate								
Filter	9000	cfm						
Inflow	3500	cfm						
Time	X/Q	Fi	Fc	alpha	fraction	fraction	DoseRates	Dose
Hr	sec/m3	cfm	per day	per hr	f1	f2	mR/hr	Rem
A	B	C	D	E	F	G	H	I
0	1.11E-03	3500	0.0016	1.2223E-07	1	0.0000E+00	2.9060E+07	0.0000E+00
0.3333	1.11E-03	3500	0.0016	1.2223E-07	0.231420171	1.5405E-08	2.9060E+07	1.4920E-04
0.5	1.11E-03	3500	0.0016	1.2223E-07	0.111302896	1.7812E-08	2.9060E+07	2.3549E-04
0.75	1.11E-03	3500	0.0016	1.2223E-07	0.037132971	1.9299E-08	2.9060E+07	3.7570E-04
1	1.11E-03	3500	0.0016	1.2223E-07	0.012388335	1.9795E-08	2.1390E+07	4.8155E-04
2	1.11E-03	3500	0.0016	1.2223E-07	0.000153471	2.0040E-08	1.6960E+07	8.2143E-04
3	7.29E-04	3500	0.0016	8.0278E-08	1.90125E-06	2.0042E-08	1.4170E+07	1.1054E-03
4	7.29E-04	3500	0.0016	8.0278E-08	2.35533E-08	2.0042E-08	1.2230E+07	1.3505E-03
5	7.29E-04	3500	0.0016	8.0278E-08	2.91786E-10	2.0042E-08	1.0770E+07	1.5664E-03
6	7.29E-04	3500	0.0016	8.0278E-08	3.61474E-12	2.0042E-08	9.6070E+06	1.7589E-03
7	7.29E-04	3500	0.0016	8.0278E-08	4.47807E-14	2.0042E-08	8.6420E+06	1.9321E-03
8	7.29E-04	3500	0.0016	8.0278E-08	5.54758E-16	2.0042E-08	7.8200E+06	2.0889E-03
9	3.19E-04	3500	0.0016	3.5129E-08	6.87253E-18	2.0042E-08	7.1110E+06	2.2314E-03
12	3.19E-04	3500	0.0016	3.5129E-08	1.30664E-23	2.0042E-08	5.4650E+06	2.5600E-03
18	3.19E-04	3500	0.0016	3.5129E-08	4.72316E-35	2.0042E-08	3.5060E+06	2.9816E-03
24	3.19E-04	3500	0.0016	3.5129E-08	1.7073E-46	2.0042E-08	2.4910E+06	3.2811E-03
25	2.36E-04	3500	0.0008	1.2994E-08	2.11506E-48	2.0042E-08	2.3760E+06	3.3287E-03
48	2.36E-04	3500	0.0008	1.2994E-08	2.91488E-92	2.0042E-08	1.4110E+06	3.9792E-03
72	2.36E-04	3500	0.0008	1.2994E-08	4.9766E-138	2.0042E-08	1.2950E+06	4.6021E-03
96	2.36E-04	3500	0.0008	1.2994E-08	8.4965E-184	2.0042E-08	1.2550E+06	5.2057E-03
97	1.98E-04	3500	0.0008	1.0902E-08	1.0526E-185	2.0042E-08	1.2530E+06	5.2308E-03
120	1.98E-04	3500	0.0008	1.0902E-08	1.4506E-229	2.0042E-08	1.2140E+06	5.7904E-03
240	1.98E-04	3500	0.0008	1.0902E-08	0	2.0042E-08	9.7470E+05	8.1346E-03
480	1.98E-04	3500	0.0008	1.0902E-08	0	2.0042E-08	6.2460E+05	1.1139E-02
720	1.98E-04	3500	0.0008	1.0902E-08	0	2.0042E-08	4.3690E+05	1.3241E-02

ATTACHMENT U
MICROSHIELD CONTROL ROOM FILTER DOSES - ELEMENTAL

Microshield Control Room Filter Doses - Elemental								
Filter	9000	cfm						
Inflow	3500	cfm						
Time	X/Q	Fi	Fc	alpha	fraction	fraction	DoseRates	Dose
Hr	sec/m3	cfm	per day	per hr	f1	f2	mR/hr	Rem
A	B	C	D	E	F	G	H	I
0	1.11E-03	3500	0.0016	1.2223E-07	0.0485	0.0000E+00	2.8040E+07	0.0000E+00
0.25	1.11E-03	3500	0.0016	1.2223E-07	3.7990E-02	9.4678E-10	2.8040E+07	6.6369E-06
0.5	1.11E-03	3500	0.0016	1.2223E-07	2.9757E-02	1.6884E-09	2.8040E+07	1.8472E-05
0.75	1.11E-03	3500	0.0016	1.2223E-07	2.3308E-02	2.2693E-09	2.8040E+07	3.4380E-05
1	1.11E-03	3500	0.0016	1.2223E-07	1.8257E-02	2.7243E-09	2.8040E+07	5.3477E-05
2	1.11E-03	3500	0.0016	1.2223E-07	6.8727E-03	3.7498E-09	1.5910E+07	1.1314E-04
3	7.29E-04	3500	0.0016	8.0278E-08	2.5872E-03	4.0033E-09	1.3110E+07	1.6562E-04
4	7.29E-04	3500	0.0016	8.0278E-08	9.7391E-04	4.0988E-09	1.1170E+07	2.1140E-04
5	7.29E-04	3500	0.0016	8.0278E-08	3.6662E-04	4.1347E-09	1.1170E+07	2.5759E-04
6	7.29E-04	3500	0.0016	8.0278E-08	1.3801E-04	4.1482E-09	8.5570E+06	2.9309E-04
7	7.29E-04	3500	0.0016	8.0278E-08	5.1952E-05	4.1533E-09	8.5570E+06	3.2863E-04
8	7.29E-04	3500	0.0016	8.0278E-08	1.9557E-05	4.1553E-09	6.7750E+06	3.5678E-04
9	3.19E-04	3500	0.0016	3.5129E-08	7.3619E-06	4.1556E-09	6.0670E+06	3.8199E-04
12	3.19E-04	3500	0.0016	3.5129E-08	3.9271E-07	4.1557E-09	4.4220E+06	4.3712E-04
18	3.19E-04	3500	0.0016	3.5129E-08	1.1175E-09	4.1558E-09	2.4460E+06	4.9811E-04
24	3.19E-04	3500	0.0016	3.5129E-08	3.1798E-12	4.1558E-09	1.4060E+06	5.3317E-04
25	2.36E-04	3500	0.0008	1.2994E-08	1.1970E-12	4.1558E-09	1.2870E+06	5.3852E-04
48	2.36E-04	3500	0.0008	1.2994E-08	2.0848E-22	4.1558E-09	2.3840E+05	5.6130E-04
72	2.36E-04	3500	0.0008	1.2994E-08	1.3669E-32	4.1558E-09	8.6230E+04	5.6990E-04
96	2.36E-04	3500	0.0008	1.2994E-08	8.9618E-43	4.1558E-09	4.7010E+04	5.7459E-04
97	1.98E-04	3500	0.0008	1.0902E-08	3.3736E-43	4.1558E-09	4.6050E+04	5.7478E-04
120	1.98E-04	3500	0.0008	1.0902E-08	5.8757E-53	4.1558E-09	3.0920E+04	5.7774E-04
240	1.98E-04	3500	0.0008	1.0902E-08	7.1182E-104	4.1558E-09	1.2960E+04	5.8420E-04
480	1.98E-04	3500	0.0008	1.0902E-08	1.0447E-205	4.1558E-09	5.3860E+03	5.8957E-04
720	1.98E-04	3500	0.0008	1.0902E-08	1.5333E-307	4.1558E-09	2.2740E+03	5.9184E-04

ATTACHMENT V
MICROSHIELD CONTROL ROOM FILTER DOSES - ORGANIC

Microshield Control Room Filter Doses - Organic								
Filter	9000	cfm						
Inflow	3500	cfm						
Time	X/Q	Fi	Fc	alpha	fraction	fraction	DoseRates	Dose
Hr	sec/m3	cfm	per day	per hr	f1	f2	mR/hr	Rem
A	B	C	D	E	F	G	H	I
0	1.11E-03	3500	0.0016	1.2223E-07	0.0015	0.0000E+00	2.8040E+07	0.0000E+00
0.25	1.11E-03	3500	0.0016	1.2223E-07	1.3826E-03	3.1694E-11	2.8040E+07	2.2218E-07
0.5	1.11E-03	3500	0.0016	1.2223E-07	1.2744E-03	6.0908E-11	2.8040E+07	6.4914E-07
0.75	1.11E-03	3500	0.0016	1.2223E-07	1.1746E-03	8.7835E-11	2.8040E+07	1.2649E-06
1	1.11E-03	3500	0.0016	1.2223E-07	1.0827E-03	1.1265E-10	2.8040E+07	2.0546E-06
2	1.11E-03	3500	0.0016	1.2223E-07	7.8150E-04	1.9397E-10	1.5910E+07	5.1406E-06
3	7.29E-04	3500	0.0016	8.0278E-08	5.6409E-04	2.3252E-10	1.3110E+07	8.1889E-06
4	7.29E-04	3500	0.0016	8.0278E-08	4.0717E-04	2.6034E-10	1.1170E+07	1.1097E-05
5	7.29E-04	3500	0.0016	8.0278E-08	2.9389E-04	2.8042E-10	1.1170E+07	1.4229E-05
6	7.29E-04	3500	0.0016	8.0278E-08	2.1213E-04	2.9492E-10	8.5570E+06	1.6753E-05
7	7.29E-04	3500	0.0016	8.0278E-08	1.5312E-04	3.0538E-10	8.5570E+06	1.9366E-05
8	7.29E-04	3500	0.0016	8.0278E-08	1.1052E-04	3.1294E-10	6.7750E+06	2.1486E-05
9	3.19E-04	3500	0.0016	3.5129E-08	7.9776E-05	3.1532E-10	6.0670E+06	2.3399E-05
12	3.19E-04	3500	0.0016	3.5129E-08	3.0001E-05	3.1918E-10	4.4220E+06	2.7633E-05
18	3.19E-04	3500	0.0016	3.5129E-08	4.2428E-06	3.2118E-10	2.4460E+06	3.2347E-05
24	3.19E-04	3500	0.0016	3.5129E-08	6.0003E-07	3.2146E-10	1.4060E+06	3.5059E-05
25	2.36E-04	3500	0.0008	1.2994E-08	4.3310E-07	3.2147E-10	1.2870E+06	3.5473E-05
48	2.36E-04	3500	0.0008	1.2994E-08	2.4002E-10	3.2148E-10	2.3840E+05	3.7235E-05
72	2.36E-04	3500	0.0008	1.2994E-08	9.6013E-14	3.2148E-10	8.6230E+04	3.7901E-05
96	2.36E-04	3500	0.0008	1.2994E-08	3.8407E-17	3.2148E-10	4.7010E+04	3.8263E-05
97	1.98E-04	3500	0.0008	1.0902E-08	2.7722E-17	3.2148E-10	4.6050E+04	3.8278E-05
120	1.98E-04	3500	0.0008	1.0902E-08	1.5364E-20	3.2148E-10	3.0920E+04	3.8507E-05
240	1.98E-04	3500	0.0008	1.0902E-08	1.5736E-37	3.2148E-10	1.2960E+04	3.9007E-05
480	1.98E-04	3500	0.0008	1.0902E-08	1.6508E-71	3.2148E-10	5.3860E+03	3.9422E-05
720	1.98E-04	3500	0.0008	1.0902E-08	1.7318E-105	3.2148E-10	2.2740E+03	3.9598E-05

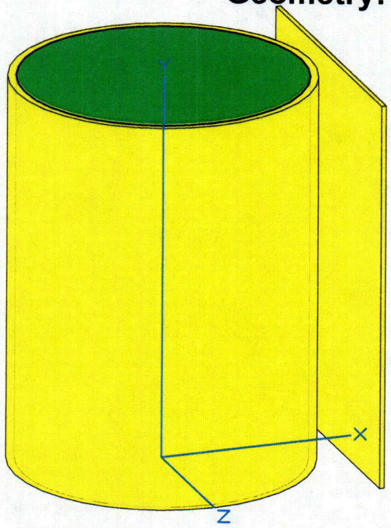
ATTACHMENT W
MICROSHIELD CONTAINMENT SHINE OUTPUT FILES

MicroShield v5.05 (5.05-00299)
CALVERT CLIFFS NUCLEAR POWER PLANT

Page : 1
DOS File : MHA000.MS5
Run Date: July 20, 2005
Run Time: 3:43:37 PM
Duration : 00:00:07

File Ref: ______
Date: ______
By: ______
Checked: ______

Case Title: MHA Shine
Description: MHA Shine outside containment
Geometry: 7 - Cylinder Volume - Side Shields



Source Dimensions

Height	5.5e+3 cm	181 ft 7.7 in
Radius	2.0e+3 cm	65 ft 0.0 in

Dose Points

	X	Y	Z
# 1	2712.72 cm	2773.68 cm	0 cm
	89 ft	91 ft	0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	2.41e+06 ft³	Air	0.00122
Shield 1	.021 ft	Iron	7.86
Shield 2	3.75 ft	Concrete	2.35
Transition	9.15 ft	Air	0.00122
Shield 4	2.0 ft	Concrete	2.35
Air Gap		Air	0.00122

Source Input
Grouping Method : Standard Indices
Number of Groups : 25
Lower Energy Cutoff : 0.015
Photons < 0.015 : Excluded
Library : Grove

Nuclide	curies	becquerels	μCi/cm³	Bq/cm³
Am-241	4.0309e+000	1.4914e+011	5.9041e-005	2.1845e+000
Ba-137m	3.7405e+006	1.3840e+017	5.4787e+001	2.0271e+006
Ba-139	2.8092e+006	1.0394e+017	4.1147e+001	1.5224e+006
Ba-140	2.9153e+006	1.0787e+017	4.2701e+001	1.5799e+006
Ce-141	7.1443e+004	2.6434e+015	1.0464e+000	3.8718e+004
Ce-143	6.1039e+004	2.2584e+015	8.9405e-001	3.3080e+004
Ce-144	5.8270e+004	2.1560e+015	8.5349e-001	3.1579e+004
Cm-242	1.1059e+003	4.0918e+013	1.6198e-002	5.9934e+002
Cm-244	1.7433e+002	6.4502e+012	2.5534e-003	9.4477e+001
Co-58	5.5089e+003	2.0383e+014	8.0690e-002	2.9855e+003
Co-60	6.7903e+003	2.5124e+014	9.9459e-002	3.6800e+003
Cs-134	5.9417e+006	2.1984e+017	8.7029e+001	3.2201e+006
Cs-136	1.4137e+006	5.2307e+016	2.0707e+001	7.6615e+005
Cs-137	3.9540e+006	1.4630e+017	5.7915e+001	2.1428e+006
I-131	3.0363e+007	1.1234e+018	4.4473e+002	1.6455e+007

Page : 2
DOS File : MHA000.MS5
Run Date: July 20, 2005
Run Time: 3:43:37 PM
Duration : 00:00:07

CA06449 Rev.0
Page 125

Nuclide	curies	becquerels	µCi/cm³	Bq/cm³
I-132	4.3473e+007	1.6085e+018	6.3676e+002	2.3560e+007
I-133	6.1376e+007	2.2709e+018	8.9898e+002	3.3262e+007
I-134	6.9244e+007	2.5620e+018	1.0142e+003	3.7526e+007
I-135	5.8345e+007	2.1588e+018	8.5459e+002	3.1620e+007
Kr-85	1.0239e+006	3.7884e+016	1.4997e+001	5.5490e+005
Kr-85m	2.1944e+007	8.1193e+017	3.2142e+002	1.1892e+007
Kr-87	4.4636e+007	1.6515e+018	6.5379e+002	2.4190e+007
Kr-88	6.2400e+007	2.3088e+018	9.1398e+002	3.3817e+007
La-140	2.9884e+004	1.1057e+015	4.3772e-001	1.6195e+004
La-141	2.5576e+004	9.4631e+014	3.7462e-001	1.3861e+004
La-142	2.4730e+004	9.1501e+014	3.6222e-001	1.3402e+004
Mo-99	3.4999e+005	1.2950e+016	5.1264e+000	1.8968e+005
Nb-95	3.3510e+004	1.2399e+015	4.9083e-001	1.8161e+004
Nd-147	1.0548e+004	3.9028e+014	1.5450e-001	5.7164e+003
Np-239	7.6881e+005	2.8446e+016	1.1261e+001	4.1665e+005
Pr-143	2.5835e+004	9.5590e+014	3.7841e-001	1.4001e+004
Pr-144	5.7437e+004	2.1252e+015	8.4128e-001	3.1128e+004
Pu-238	2.3766e+002	8.7934e+012	3.4810e-003	1.2880e+002
Pu-239	1.5793e+001	5.8434e+011	2.3132e-004	8.5589e+000
Pu-240	2.7576e+001	1.0203e+012	4.0391e-004	1.4945e+001
Pu-241	6.8289e+003	2.5267e+014	1.0002e-001	3.7009e+003
Rb-86	4.8774e+004	1.8046e+015	7.1440e-001	2.6433e+004
Rh-103m	3.3493e+005	1.2392e+016	4.9057e+000	1.8151e+005
Rh-105	1.9627e+005	7.2620e+015	2.8748e+000	1.0637e+005
Rh-106	1.3560e+005	5.0172e+015	1.9862e+000	7.3488e+004
Ru-103	3.3581e+005	1.2425e+016	4.9187e+000	1.8199e+005
Ru-105	2.1656e+005	8.0127e+015	3.1720e+000	1.1736e+005
Ru-106	1.3560e+005	5.0172e+015	1.9862e+000	7.3488e+004
Sb-127	3.3460e+005	1.2380e+016	4.9009e+000	1.8133e+005
Sb-129	1.2102e+006	4.4777e+016	1.7726e+001	6.5586e+005
Sr-89	1.8338e+006	6.7851e+016	2.6860e+001	9.9382e+005
Sr-90	1.7498e+005	6.4743e+015	2.5630e+000	9.4829e+004
Sr-91	2.1443e+006	7.9339e+016	3.1408e+001	1.1621e+006
Sr-92	2.2137e+006	8.1907e+016	3.2424e+001	1.1997e+006
Tc-99m	3.1275e+005	1.1572e+016	4.5809e+000	1.6949e+005
Te-127	3.3963e+005	1.2566e+016	4.9746e+000	1.8406e+005
Te-127m	6.3716e+004	2.3575e+015	9.3326e-001	3.4531e+004
Te-129	1.1569e+006	4.2805e+016	1.6945e+001	6.2698e+005
Te-129m	2.5986e+005	9.6148e+015	3.8062e+000	1.4083e+005
Te-131m	6.9795e+005	2.5824e+016	1.0223e+001	3.7825e+005
Te-132	5.2864e+006	1.9560e+017	7.7431e+001	2.8649e+006
Xe-133	1.5342e+008	5.6765e+018	2.2472e+003	8.3145e+007
Xe-133m	4.7793e+006	1.7683e+017	7.0003e+001	2.5901e+006
Xe-135	4.8767e+007	1.8044e+018	7.1430e+002	2.6429e+007
Xe-135m	3.2043e+007	1.1856e+018	4.6934e+002	1.7366e+007
Xe-138	1.3585e+008	5.0265e+018	1.9898e+003	7.3623e+007

Page : 3
DOS File : MHA000.MS5
Run Date: July 20, 2005
Run Time: 3:43:37 PM
Duration : 00:00:07

CA06449 Rev.0
Page 126

Nuclide	curies	becquerels	µCi/cm³	Bq/cm³
Y-90	1.9040e+003	7.0448e+013	2.7888e-002	1.0319e+003
Y-91	2.3424e+004	8.6669e+014	3.4309e-001	1.2695e+004
Y-92	2.2318e+004	8.2577e+014	3.2690e-001	1.2095e+004
Y-93	1.6316e+004	6.0369e+014	2.3898e-001	8.8424e+003
Zr-95	3.2082e+004	1.1870e+015	4.6991e-001	1.7387e+004
Zr-97	2.7223e+004	1.0073e+015	3.9874e-001	1.4753e+004

Buildup
The material reference is : Shield 2

Integration Parameters

Radial	10
Circumferential	10
Y Direction (axial)	20

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.015	1.575e+12	0.000e+00	2.300e-24	0.000e+00	1.973e-25
0.02	2.389e+15	0.000e+00	5.490e-21	0.000e+00	1.902e-22
0.03	3.602e+18	3.783e-216	1.830e-17	3.749e-218	1.814e-19
0.04	7.380e+15	6.031e-106	9.944e-20	2.667e-108	4.398e-22
0.05	2.572e+16	4.128e-65	1.133e-18	1.100e-67	3.019e-21
0.06	7.288e+15	1.121e-47	2.304e-18	2.226e-50	4.577e-21
0.08	2.117e+18	2.627e-30	1.593e-15	4.157e-33	2.520e-18
0.1	3.517e+16	4.338e-26	1.223e-16	6.637e-29	1.871e-19
0.15	1.163e+18	1.806e-18	2.286e-14	2.973e-21	3.765e-17
0.2	2.742e+18	3.687e-15	7.552e-12	6.507e-18	1.333e-14
0.3	2.005e+18	8.576e-12	1.168e-08	1.627e-14	2.215e-11
0.4	3.780e+18	3.042e-09	2.330e-06	5.926e-12	4.540e-09
0.5	3.979e+18	1.524e-07	7.030e-05	2.991e-10	1.380e-07
0.6	3.598e+18	2.831e-06	8.479e-04	5.526e-09	1.655e-06
0.8	7.259e+18	5.393e-04	8.346e-02	1.026e-06	1.587e-04
1.0	3.092e+18	6.436e-03	6.020e-01	1.186e-05	1.110e-03
1.5	2.409e+18	1.287e+00	5.308e+01	2.166e-03	8.930e-02
2.0	4.033e+18	6.568e+01	1.673e+03	1.016e-01	2.587e+00
3.0	2.491e+17	2.309e+02	3.267e+03	3.132e-01	4.432e+00
4.0	2.402e+13	2.319e-01	2.309e+00	2.869e-04	2.856e-03
TOTALS:	4.011e+19	2.981e+02	4.995e+03	4.173e-01	7.112e+00

ATTACHMENT X
MICROSHIELD PLUME SHINE OUTPUT FILES

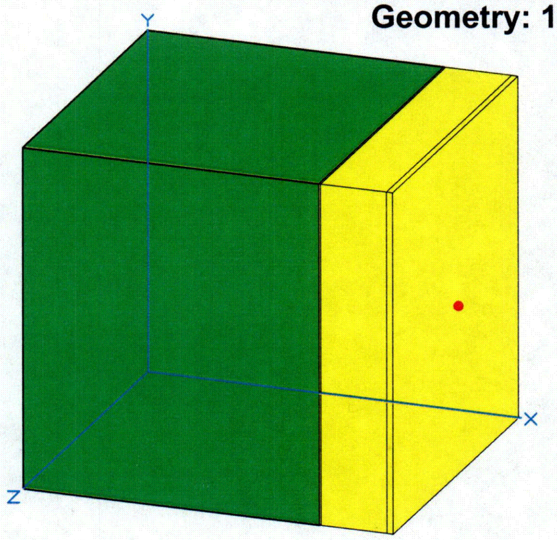
CA06449 Rev. 0
Page 128

MicroShield v5.05 (5.05-00299)
CALVERT CLIFFS NUCLEAR POWER PLANT

Page : 1
DOS File : MHC000.MS5
Run Date : July 22, 2005
Run Time : 10:40:11 AM
Duration : 00:00:12

File Ref: ________
Date: ________
By: ________
Checked: ________

Case Title: Case 1
Description: Case 1 Containment Plume Dose
Geometry: 13 - Rectangular Volume



Source Dimensions

Length	3.0e+3 cm	98 ft 7.8 in
Width	3.5e+3 cm	114 ft 7.8 in
Height	3.5e+3 cm	114 ft 7.8 in

Dose Points

	X	Y	Z
# 1	3779.52 cm	1737.36 cm	1737.36 cm
	124 ft	57 ft 0.0 in	57 ft 0.0 in

Shields

Shield Name	Dimension	Material	Density
Source	1.30e+06 ft³	Air	0.00122
Shield 1	.5 ft	Concrete	2.35
Shield 2	22.0 ft	Air	0.00122
Shield 3	2.0 ft	Concrete	2.35
Air Gap		Air	0.00122

Source Input
Grouping Method : Standard Indices
Number of Groups : 25
Lower Energy Cutoff : 0.015
Photons < 0.015 : Excluded
Library : Grove

Nuclide	curies	becquerels	μCi/cm³	Bq/cm³
Am-241	9.9967e-002	3.6988e+009	2.7225e-006	1.0073e-001
Ba-137m	9.2763e+004	3.4322e+015	2.5263e+000	9.3473e+004
Ba-139	6.9667e+004	2.5777e+015	1.8973e+000	7.0200e+004
Ba-140	7.2299e+004	2.6751e+015	1.9690e+000	7.2852e+004
Ce-141	1.7718e+003	6.5557e+013	4.8253e-002	1.7854e+003
Ce-143	1.5138e+003	5.6011e+013	4.1227e-002	1.5254e+003
Ce-144	1.4451e+003	5.3469e+013	3.9356e-002	1.4562e+003
Cm-242	2.7426e+001	1.0148e+012	7.4692e-004	2.7636e+001
Cm-244	4.3233e+000	1.5996e+011	1.1774e-004	4.3564e+000
Co-58	1.3662e+002	5.0549e+012	3.7207e-003	1.3767e+002
Co-60	1.6840e+002	6.2308e+012	4.5862e-003	1.6969e+002
Cs-134	1.4736e+005	5.4523e+015	4.0132e+000	1.4849e+005
Cs-136	3.5060e+004	1.2972e+015	9.5482e-001	3.5328e+004
Cs-137	9.8058e+004	3.6281e+015	2.6705e+000	9.8809e+004
I-131	7.5299e+005	2.7861e+016	2.0507e+001	7.5875e+005

C02

Page : 2
DOS File : MHC000.MS5
Run Date: July 22, 2005
Run Time: 10:40:11 AM
Duration : 00:00:12

CA06449 Rev.0
Page 129

Nuclide	curies	becquerels	µCi/cm³	Bq/cm³
I-132	1.0781e+006	3.9890e+016	2.9361e+001	1.0864e+006
I-133	1.5221e+006	5.6318e+016	4.1453e+001	1.5338e+006
I-134	1.7173e+006	6.3540e+016	4.6769e+001	1.7304e+006
I-135	1.4470e+006	5.3539e+016	3.9407e+001	1.4581e+006
Kr-85	2.5393e+004	9.3954e+014	6.9155e-001	2.5587e+004
Kr-85m	5.4420e+005	2.0135e+016	1.4821e+001	5.4837e+005
Kr-87	1.1070e+006	4.0959e+016	3.0148e+001	1.1155e+006
Kr-88	1.5475e+006	5.7258e+016	4.2144e+001	1.5593e+006
La-140	7.4112e+002	2.7421e+013	2.0184e-002	7.4679e+002
La-141	6.3427e+002	2.3468e+013	1.7274e-002	6.3912e+002
La-142	6.1330e+002	2.2692e+013	1.6703e-002	6.1799e+002
Mo-99	8.6798e+003	3.2115e+014	2.3638e-001	8.7462e+003
Nb-95	8.3104e+002	3.0748e+013	2.2632e-002	8.3740e+002
Nd-147	2.6160e+002	9.6792e+012	7.1244e-003	2.6360e+002
Np-239	1.9067e+004	7.0548e+014	5.1927e-001	1.9213e+004
Pr-143	6.4071e+002	2.3706e+013	1.7449e-002	6.4561e+002
Pr-144	1.4244e+003	5.2704e+013	3.8793e-002	1.4353e+003
Pu-238	5.8939e+000	2.1807e+011	1.6051e-004	5.9390e+000
Pu-239	3.9167e-001	1.4492e+010	1.0667e-005	3.9467e-001
Pu-240	6.8389e-001	2.5304e+010	1.8625e-005	6.8912e-001
Pu-241	1.6936e+002	6.2663e+012	4.6123e-003	1.7066e+002
Rb-86	1.2096e+003	4.4755e+013	3.2942e-002	1.2189e+003
Rh-103m	8.3061e+003	3.0733e+014	2.2621e-001	8.3697e+003
Rh-105	4.8676e+003	1.8010e+014	1.3256e-001	4.9049e+003
Rh-106	3.3628e+003	1.2442e+014	9.1582e-002	3.3885e+003
Ru-103	8.3280e+003	3.0814e+014	2.2680e-001	8.3917e+003
Ru-105	5.3708e+003	1.9872e+014	1.4627e-001	5.4119e+003
Ru-106	3.3628e+003	1.2442e+014	9.1582e-002	3.3885e+003
Sb-127	8.2980e+003	3.0703e+014	2.2599e-001	8.3615e+003
Sb-129	3.0013e+004	1.1105e+015	8.1737e-001	3.0243e+004
Sr-89	4.5478e+004	1.6827e+015	1.2385e+000	4.5826e+004
Sr-90	4.3396e+003	1.6057e+014	1.1818e-001	4.3728e+003
Sr-91	5.3180e+004	1.9677e+015	1.4483e+000	5.3587e+004
Sr-92	5.4899e+004	2.0313e+015	1.4951e+000	5.5319e+004
Tc-99m	7.7561e+003	2.8698e+014	2.1123e-001	7.8155e+003
Te-127	8.4228e+003	3.1164e+014	2.2939e-001	8.4873e+003
Te-127m	1.5802e+003	5.8467e+013	4.3035e-002	1.5923e+003
Te-129	2.8690e+004	1.0615e+015	7.8134e-001	2.8910e+004
Te-129m	6.4446e+003	2.3845e+014	1.7551e-001	6.4939e+003
Te-131m	1.7309e+004	6.4043e+014	4.7139e-001	1.7441e+004
Te-132	1.3110e+005	4.8507e+015	3.5704e+000	1.3210e+005
Xe-133	3.8048e+006	1.4078e+017	1.0362e+002	3.8339e+006
Xe-133m	1.1853e+005	4.3856e+015	3.2280e+000	1.1944e+005
Xe-135	1.2094e+006	4.4748e+016	3.2937e+001	1.2187e+006
Xe-135m	7.9466e+005	2.9402e+016	2.1642e+001	8.0074e+005
Xe-138	3.3692e+006	1.2466e+017	9.1756e+001	3.3950e+006

CA06449 Rev. 0
Page 130

Nuclide	curies	becquerels	µCi/cm³	Bq/cm³
Y-90	4.7218e+001	1.7471e+012	1.2859e-003	4.7579e+001
Y-91	5.8091e+002	2.1494e+013	1.5820e-002	5.8536e+002
Y-92	5.5348e+002	2.0479e+013	1.5073e-002	5.5772e+002
Y-93	4.0464e+002	1.4972e+013	1.1020e-002	4.0774e+002
Zr-95	7.9563e+002	2.9438e+013	2.1668e-002	8.0172e+002
Zr-97	6.7513e+002	2.4980e+013	1.8386e-002	6.8030e+002

Buildup
The material reference is : Shield 3

Integration Parameters

X Direction	10
Y Direction	20
Z Direction	20

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.015	3.906e+10	0.000e+00	8.373e-26	0.000e+00	7.182e-27
0.02	5.925e+13	1.598e-272	1.999e-22	5.537e-274	6.923e-24
0.03	8.932e+16	3.615e-84	6.663e-19	3.583e-86	6.603e-21
0.04	1.830e+14	1.024e-41	3.620e-21	4.529e-44	1.601e-23
0.05	6.379e+14	4.939e-25	4.125e-20	1.316e-27	1.099e-22
0.06	1.807e+14	2.437e-18	9.867e-17	4.840e-21	1.960e-19
0.08	5.251e+16	8.335e-10	5.980e-08	1.319e-12	9.463e-11
0.1	8.722e+14	4.389e-09	6.346e-07	6.714e-12	9.709e-10
0.15	2.885e+16	6.449e-05	1.723e-02	1.062e-07	2.837e-05
0.2	6.800e+16	3.282e-03	9.564e-01	5.793e-06	1.688e-03
0.3	4.973e+16	1.028e-01	2.128e+01	1.950e-04	4.036e-02
0.4	9.375e+16	2.301e+00	3.110e+02	4.483e-03	6.059e-01
0.5	9.868e+16	1.522e+01	1.418e+03	2.987e-02	2.783e+00
0.6	8.924e+16	5.843e+01	3.961e+03	1.141e-01	7.731e+00
0.8	1.800e+17	1.051e+03	4.321e+04	2.000e+00	8.218e+01
1.0	7.668e+16	2.250e+03	6.339e+04	4.147e+00	1.168e+02
1.5	5.975e+16	2.647e+04	3.962e+05	4.453e+01	6.665e+02
2.0	1.000e+17	2.424e+05	2.486e+06	3.748e+02	3.845e+03
3.0	6.177e+15	1.166e+05	7.531e+05	1.582e+02	1.022e+03
4.0	5.957e+11	3.820e+01	1.861e+02	4.726e-02	2.303e-01
TOTALS:	9.947e+17	3.888e+05	3.748e+06	5.838e+02	5.743e+03

ATTACHMENT Y
MICROSHIELD CONTROL ROOM FILTER OUTPUT FILES

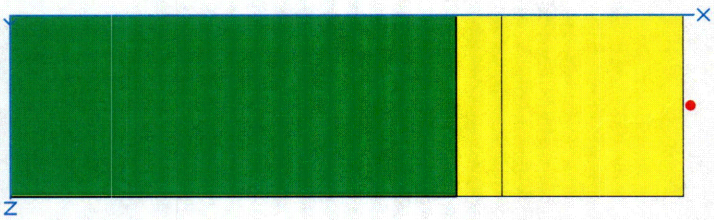
CA06449 Rev. 0
Page 132

MicroShield v5.05 (5.05-00299)
CALVERT CLIFFS NUCLEAR POWER PLANT

Page : 1
DOS File : MHF000.MS5
Run Date : July 23, 2005
Run Time : 9:54:20 AM
Duration : 00:00:12

File Ref: ________
Date: ________
By: ________
Checked: ________

Case Title: Case 1
Description: Case 1 ~~Containment~~ Filter Dose
Geometry: 13 - Rectangular Volume



Source Dimensions

Length	149.86 cm	4 ft 11.0 in
Width	60.96 cm	2 ft
Height	83.82 cm	2 ft 9.0 in

Dose Points

	X	Y	Z
# 1	228.6 cm	41.91 cm	30.48 cm
	7 ft 6.0 in	1 ft 4.5 in	1 ft

Shields

Shield Name	Dimension	Material	Density
Source	4.67e+04 in^3	Carbon	2.25
Shield 1	6.0 in	Air	0.00122
Shield 2	24.0 in	Concrete	2.35
Air Gap		Air	0.00122

Source Input
Grouping Method : Standard Indices
Number of Groups : 25
Lower Energy Cutoff : 0.015
Photons < 0.015 : Excluded
Library : Grove

Nuclide	curies	becquerels	$\mu Ci/cm^3$	Bq/cm^3
Am-241	4.0309e+000	1.4914e+011	5.2641e+000	1.9477e+005
Ba-137m				
Ba-139	2.8092e+006	1.0394e+017	3.6686e+006	1.3574e+011
Ba-140	2.9153e+006	1.0787e+017	3.8072e+006	1.4087e+011
Ce-141	7.1443e+004	2.6434e+015	9.3300e+004	3.4521e+009
Ce-143	6.1039e+004	2.2584e+015	7.9713e+004	2.9494e+009
Ce-144	5.8270e+004	2.1560e+015	7.6097e+004	2.8156e+009
Cm-242	1.1059e+003	4.0918e+013	1.4442e+003	5.3437e+007
Cm-244	1.7433e+002	6.4502e+012	2.2766e+002	8.4236e+006
Co-58	5.5089e+003	2.0383e+014	7.1943e+003	2.6619e+008
Co-60	6.7903e+003	2.5124e+014	8.8677e+003	3.2810e+008
Cs-134	5.9417e+006	2.1984e+017	7.7595e+006	2.8710e+011
Cs-136	1.4137e+006	5.2307e+016	1.8462e+006	6.8309e+010
Cs-137	3.9540e+006	1.4630e+017	5.1637e+006	1.9106e+011
I-131	3.0363e+007	1.1234e+018	3.9652e+007	1.4671e+012
I-132	4.3473e+007	1.6085e+018	5.6773e+007	2.1006e+012

C03

Page : 2
DOS File : MHF000.MS5
Run Date: July 23, 2005
Run Time: 9:54:20 AM
Duration : 00:00:12

CA06449 Rev.0
Page 133

Nuclide	curies	becquerels	µCi/cm³	Bq/cm³
I-133	6.1376e+007	2.2709e+018	8.0153e+007	2.9657e+012
I-134	6.9244e+007	2.5620e+018	9.0428e+007	3.3458e+012
I-135	5.8345e+007	2.1588e+018	7.6195e+007	2.8192e+012
Kr-85				
Kr-85m				
Kr-87				
Kr-88				
La-140	2.9884e+004	1.1057e+015	3.9027e+004	1.4440e+009
La-141	2.5576e+004	9.4631e+014	3.3401e+004	1.2358e+009
La-142	2.4730e+004	9.1501e+014	3.2296e+004	1.1949e+009
Mo-99	3.4999e+005	1.2950e+016	4.5706e+005	1.6911e+010
Nb-95	3.3510e+004	1.2399e+015	4.3762e+004	1.6192e+009
Nd-147	1.0548e+004	3.9028e+014	1.3775e+004	5.0968e+008
Np-239	7.6881e+005	2.8446e+016	1.0040e+006	3.7149e+010
Pr-143	2.5835e+004	9.5590e+014	3.3739e+004	1.2483e+009
Pr-144				
Pu-238	2.3766e+002	8.7934e+012	3.1037e+002	1.1484e+007
Pu-239	1.5793e+001	5.8434e+011	2.0625e+001	7.6311e+005
Pu-240	2.7576e+001	1.0203e+012	3.6012e+001	1.3325e+006
Pu-241	6.8289e+003	2.5267e+014	8.9181e+003	3.2997e+008
Rb-86	4.8774e+004	1.8046e+015	6.3696e+004	2.3567e+009
Rh-103m				
Rh-105	1.9627e+005	7.2620e+015	2.5632e+005	9.4837e+009
Rh-106				
Ru-103	3.3581e+005	1.2425e+016	4.3855e+005	1.6226e+010
Ru-105	2.1656e+005	8.0127e+015	2.8281e+005	1.0464e+010
Ru-106	1.3560e+005	5.0172e+015	1.7708e+005	6.5521e+009
Sb-127	3.3460e+005	1.2380e+016	4.3697e+005	1.6168e+010
Sb-129	1.2102e+006	4.4777e+016	1.5804e+006	5.8476e+010
Sr-89	1.8338e+006	6.7851e+016	2.3948e+006	8.8608e+010
Sr-90	1.7498e+005	6.4743e+015	2.2851e+005	8.4550e+009
Sr-91	2.1443e+006	7.9339e+016	2.8003e+006	1.0361e+011
Sr-92	2.2137e+006	8.1907e+016	2.8909e+006	1.0697e+011
Tc-99m	3.1275e+005	1.1572e+016	4.0843e+005	1.5112e+010
Te-127	3.3963e+005	1.2566e+016	4.4353e+005	1.6411e+010
Te-127m	6.3716e+004	2.3575e+015	8.3209e+004	3.0787e+009
Te-129	1.1569e+006	4.2805e+016	1.5108e+006	5.5901e+010
Te-129m	2.5986e+005	9.6148e+015	3.3936e+005	1.2556e+010
Te-131m	6.9795e+005	2.5824e+016	9.1148e+005	3.3725e+010
Te-132	5.2864e+006	1.9560e+017	6.9037e+006	2.5544e+011
Xe-133				
Xe-133m				
Xe-135				
Xe-135m				
Xe-138				
Y-90	1.9040e+003	7.0448e+013	2.4865e+003	9.2001e+007

Page : 3
DOS File : MHF000.MS5
Run Date: July 23, 2005
Run Time: 9:54:20 AM
Duration : 00:00:12

CAW6449 Rev.0
Page 134

Nuclide	curies	becquerels	µCi/cm³	Bq/cm³
Y-91	2.3424e+004	8.6669e+014	3.0590e+004	1.1318e+009
Y-92	2.2318e+004	8.2577e+014	2.9146e+004	1.0784e+009
Y-93	1.6316e+004	6.0369e+014	2.1308e+004	7.8838e+008
Zr-95	3.2082e+004	1.1870e+015	4.1897e+004	1.5502e+009
Zr-97	2.7223e+004	1.0073e+015	3.5551e+004	1.3154e+009

Buildup
The material reference is : Shield 2

Integration Parameters

X Direction	10
Y Direction	20
Z Direction	20

Results

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.015	1.575e+12	0.000e+00	9.515e-22	0.000e+00	8.161e-23
0.02	1.437e+15	1.304e-214	1.366e-18	4.517e-216	4.732e-20
0.03	2.901e+17	5.506e-64	6.099e-16	5.457e-66	6.045e-18
0.04	5.447e+15	1.668e-29	3.037e-17	7.378e-32	1.343e-19
0.05	2.572e+16	7.463e-16	7.957e-15	1.988e-18	2.120e-17
0.06	7.288e+15	1.447e-10	4.032e-09	2.873e-13	8.009e-12
0.08	3.388e+16	5.466e-05	3.091e-03	8.650e-08	4.891e-06
0.1	3.062e+16	5.378e-03	5.661e-01	8.228e-06	8.660e-04
0.15	1.735e+17	4.655e+00	8.410e+02	7.665e-03	1.385e+00
0.2	3.161e+17	1.111e+02	2.131e+04	1.961e-01	3.761e+01
0.3	2.754e+17	2.314e+03	3.211e+05	4.390e+00	6.090e+02
0.4	1.410e+18	9.713e+04	9.129e+06	1.893e+02	1.779e+04
0.5	2.964e+18	9.805e+05	6.539e+07	1.925e+03	1.284e+05
0.6	3.346e+18	3.821e+06	1.901e+08	7.457e+03	3.711e+05
0.8	6.737e+18	5.052e+07	1.583e+09	9.609e+04	3.010e+06
1.0	2.531e+18	7.664e+07	1.696e+09	1.413e+05	3.126e+06
1.5	1.909e+18	6.143e+08	7.588e+09	1.034e+06	1.277e+07
2.0	4.979e+17	7.154e+08	6.220e+09	1.106e+06	9.618e+06
3.0	2.901e+14	2.616e+06	1.482e+07	3.550e+03	2.010e+04
4.0	2.402e+13	6.610e+05	2.879e+06	8.177e+02	3.562e+03
TOTALS:	2.055e+19	1.465e+09	1.737e+10	2.391e+06	2.906e+07

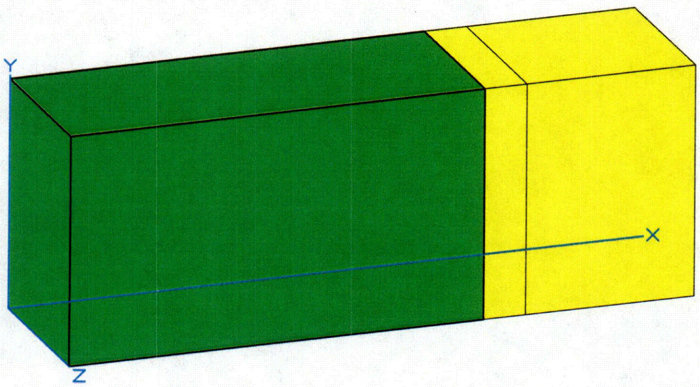
ATTACHMENT Z
MICROSHIELD CONTROL ROOM FILTER OUTPUT FILES - IODINE ONLY

MicroShield v5.05 (5.05-00299)
CALVERT CLIFFS NUCLEAR POWER PLANT

Page : 1
DOS File : MHG000.MS5
Run Date: July 23, 2005
Run Time: 3:22:38 PM
Duration : 00:00:07

File Ref: ____________
Date: ____________
By: ____________
Checked: ____________

Case Title: Case 1
Description: Case 1 Containment Filter Dose
Geometry: 13 - Rectangular Volume



Source Dimensions

Length	149.86 cm	4 ft 11.0 in
Width	60.96 cm	2 ft
Height	83.82 cm	2 ft 9.0 in

Dose Points

	X	Y	Z
# 1	228.6 cm	41.91 cm	30.48 cm
	7 ft 6.0 in	1 ft 4.5 in	1 ft

Shields

Shield Name	Dimension	Material	Density
Source	7.66e+05 cm³	Carbon	2.25
Shield 1	15.24 cm	Air	0.00122
Shield 2	60.96 cm	Concrete	2.35
Air Gap		Air	0.00122

Source Input
Grouping Method : Standard Indices
Number of Groups : 25
Lower Energy Cutoff : 0.015
Photons < 0.015 : Excluded
Library : Grove

Nuclide	curies	becquerels	μCi/cm³	Bq/cm³
I-131	3.0363e+007	1.1234e+018	3.9652e+007	1.4671e+012
I-132	4.3473e+007	1.6085e+018	5.6773e+007	2.1006e+012
I-133	6.1376e+007	2.2709e+018	8.0153e+007	2.9657e+012
I-134	6.9244e+007	2.5620e+018	9.0428e+007	3.3458e+012
I-135	5.8345e+007	2.1588e+018	7.6195e+007	2.8192e+012

Buildup
The material reference is : Shield 2

Integration Parameters

X Direction	10
Y Direction	20
Z Direction	20

Results

Page : 2
DOS File : MHG000.MS5
Run Date: July 23, 2005
Run Time: 3:22:38 PM
Duration : 00:00:07

Energy MeV	Activity photons/sec	Fluence Rate MeV/cm²/sec No Buildup	Fluence Rate MeV/cm²/sec With Buildup	Exposure Rate mR/hr No Buildup	Exposure Rate mR/hr With Buildup
0.03	1.191e+17	2.260e-64	2.504e-16	2.240e-66	2.481e-18
0.08	2.941e+16	4.745e-05	2.683e-03	7.509e-08	4.246e-06
0.15	1.270e+17	3.409e+00	6.159e+02	5.614e-03	1.014e+00
0.2	1.229e+17	4.321e+01	8.286e+03	7.626e-02	1.462e+01
0.3	2.203e+17	1.851e+03	2.568e+05	3.511e+00	4.871e+02
0.4	1.396e+18	9.619e+04	9.040e+06	1.874e+02	1.761e+04
0.5	2.901e+18	9.596e+05	6.400e+07	1.884e+03	1.256e+05
0.6	3.050e+18	3.483e+06	1.733e+08	6.798e+03	3.383e+05
0.8	6.396e+18	4.796e+07	1.502e+09	9.122e+04	2.858e+06
1.0	2.408e+18	7.291e+07	1.613e+09	1.344e+05	2.974e+06
1.5	1.817e+18	5.848e+08	7.223e+09	9.838e+05	1.215e+07
2.0	4.957e+17	7.122e+08	6.192e+09	1.101e+06	9.575e+06
TOTALS:	1.908e+19	1.422e+09	1.678e+10	2.320e+06	2.804e+07