Enclosure (12)

CA06422 Primary and Secondary Isotopic Calculations

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 46

DCALC No.: CA06422 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: PRIMARY AND SECONDARY ISOTOPIC CALCULATIONS

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:

Responsible Engineer:	Gerard E. Gryczkowski	3/11/2005
	Printed Name and Signature	Date
Independent Reviewer:	John. R. Massari	6/22/2005
	Ian M. Sommerville	6/22/05
	Printed Name and Signature	Date
Approval:	Phillip I. Wengloski	6/22/05
	Printed Name and Signature	Date

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.

Primary and Secondary Isotopic Calculations

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
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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								

3. REVIEWER COMMENTS

John Massari comments:

(1) RCS 1% Failed Fuel Iodine Activity Fraction (DEQI131-pri, column H) is directly related to the iodine activity fraction in the gap/initial spike rather than an RCS equilibrium for 1% failed fuel. Reg. Guide 1.183 App. E and F section 2.2 call for the use of equilibrium values, and this appears to have been done in the Fort Calhoun submittal (see Ref. 9, pp. 6-8). Fort Calhoun's method for generating these equilibrium activity fractions considered sources of iodine such as leakage from 1% failed fuel and decay of parent and second parent isotopes (Te and Sb), and iodine depletion by decay, purification and neutron absorption. The fraction of the short lived I-134 is much lower in their calculations, which causes I-131 and I-133 to be a higher fraction of the equilibrium iodine activity. An RCS equilibrium activity method similar to Fort Calhoun's was used here for CA05994, and has been applied as a check (peak 1% failure of 5% VAP fuel; neutron absorption and grandparent decay were ignored). The results are consistent with those of Fort Calhoun. Response: Corrected

(2) Comment #1 also applies to the iodine activity fractions utilized for the Secondary Iodine Activities (DEQI131-Sec, Column I). Similarly, the noble gas 1% failed fuel RCS activities (NG-pri, Column I) do not appear to be representative of RCS equilibrium conditions (note Xe-133 and Xe-138 RCS activities vs. UFSAR 14.22; Xe-138 has a very short half-life and should not have a concentration similar to Xe-133 under RCS equilibrium conditions). Response: Corrected

(3) Reference 13 is not easily retrievable. Response: See Reference 13

(4) The formula for Column G and H for the primary iodine and noble gas activity assumes two removal processes with 100% efficiency, decay and purification. This is true for the former, but not the latter (unless all letdown flow is diverted to the waste processing system). F(i) should be multiplied by a factor of (1-1/DFi) and there should be an additional factor of (1/DFi)*(feed/bleed fraction of F(i))*F(i). For the CVCS purification ion exchanger, NUREG-0017 (Table 1-4) allows a DF 100 for anions, 1 for noble gases, 2 for Cs and Rb, and 50 for other nuclides. This shouldn't really change your results for iodines. However, it may make a significant difference in noble gases since the ion exchangers do nothing to remove noble gases and the only removal mechanism other than decay is feed-and-bleed. Note however that while the above mentioned change produces a higher RCS noble gas activity with 1% failed fuel (following the branching fraction change discussed below) and is more consistent with FCS and previous CCNPP calculations, it produces a less conservative 100/Ebar □Ci/gm because the relative contribution of Kr-88 is lower (i.e., the present method is inaccurate but conservative with regards to the final result). Response: Corrected

(5) On page 8, the description of Frcs should be changed from "two" charging pumps to "1.5". Response: Corrected

(6) In the primary noble gas sheet and the decay chains on page 11, the assumption that the branching fractions are 1 for all isotopes causes some equilibrium activities to be miscalculated. For example, it is assumed that 100% of the I-135 decays to Xe-135m. However, only 15% of I-135 decays to Xe-135m, and the rest decays directly to Xe-135. Similarly, only 3% of I-133 decays to Xe-133m, and the rest decays directly to Xe-133. Finally, only 21% of Kr-85m decays to Kr-85, but this doesn't have a significant impact on the Kr-85 equilibrium activity. This is also the case on the iodine spreadsheet with Te-131m as 78% of that decays directly to I-131, but will not significantly impact the calculated I-131 equilibrium value. Response: Corrected

(7) In column M on the noble gas spreadsheet, the gamma energy for Xe-133m is listed as 0.03 MeV/dis. Lamarsh table 11.3 indicates it is 0.326 MeV/dis. All other values agree with those given in Lamarsh. You may want to check this one. I'm not sure that Lamarsh is correct since a few other references I consulted seem to support the 0.03 MeV/dis value. Response: The 0.03 value is consistent with LOCADOSE, AXIDENT, and iur previous licensing basis. In addition, use of 0.03 makes Ebar smaller, and thus 1/Ebar larger, thus more conservative.

(8) The spreadsheet should show what the actual value of Ebar and 100/Ebar □Ci/gm is based on the 1% failed fuel isotope distribution, and provide a sum of the □Ci/gm at the bottom of column Q. The □Ci/gm values listed in

column Q do indeed sum to the 100/Ebar □Ci/gm value, but this change will help future readers come to that conclusion more readily. Response: OK

(9) Change "GIS" in the iodine spreadsheet to "CIS". Response: OK

(10) Eliminate extraneous sheets from the Excel file with similar names to those used in the calc to avoid confusion.
Response: OK

Ian Sommerville comments:
(1) p. 10 & notes to Table 2; The calculation for Rs appears to be incorrect; the value should be 11.78, not 117.8. It is recommended that the calculation be performed in the spreadsheet.
Response: Corrected

(2) It is recommended that a bold border be placed around the final results.
Response: OK

(3) p. 11; Column G is for the SG, not the RCS
Response: Corrected

4. TABLE OF CONTENTS

5. INTRODUCTION

Regulatory Guides 1.183 and 1.195 (Refs.1-2) require that if no or minimal fuel damage is postulated for a particular design basis accident, the activity released should be the maximum coolant activity allowed by the technical specifications or the maximum coolant activity generated by a preexisting or concurrent iodine spike.

Calvert Cliffs Technical Specification 3.4.15 requires that in Modes 1 and 2 and in Mode 3 with RCS average temperature greater than 500°F that the Dose Equivalent I-131 (DEQ I-131) in the primary system be less than 1 μCi/gm and that the noble gas activity be less than 100/Ebar μCi/gm.

Calvert Cliffs Technical Specification 3.7.14 requires that in Modes 1-4 that the Dose Equivalent I-131 (DEQ I-131) in the secondary system be less than 0.1 μCi/gm.

Figure 3.4.15-1 of TS 3.4.15 allows the Dose Equivalent I-131 (DEQ I-131) to be less than 60 μCi/gm in the primary system for up to 100 hours at hot full power. This is the basis for the Preaccident Iodine Spike PIS, where a reactor trip has occurred prior to the postulated design basis accident and has raised the primary coolant iodine concentration to the maximum value permitted by the technical specifications.

The primary system transient associated with the Main Steam Line Break (MSLB) causes an iodine spike in the primary system. The increase in primary coolant iodine concentration is estimated using a spiking model (Concurrent Iodine Spike CIS) that assumes that the iodine release rate from the fuel rods to the primary coolant (expressed in Curies per unit time) increases to a value 500 times greater than the release rate corresponding to the iodine concentration at the equilibrium value (1 μCi/gm DEQ I-131 per TS 3.4.15). The assumed iodine spike duration should be 8 hours per Refs.1-2. A CIS need not be considered if fuel damage is postulated for the MSLB.

The primary system transient associated with the Steam Generator Tube Rupture (SGTR) causes an iodine spike in the primary system. The increase in primary coolant iodine concentration is estimated using a spiking model (Concurrent Iodine Spike CIS) that assumes that the iodine release rate from the fuel rods to the primary coolant (expressed in Curies per unit time) increases to a value 335 times greater than the release rate corresponding to the iodine concentration at the equilibrium value (1 μCi/gm DEQ I-131 per TS 3.4.15). The assumed iodine spike duration should be 8 hours per Refs.1-2. A CIS need not be considered if fuel damage is postulated for the SGTR.

Calculation of the primary iodine activities for 1% failed fuel, for a peak iodine level of 1 DEQ-I131 μCi/gm per Technical Specification (TS) 3.4.15, for a preaccident iodine spike (PIS) of 60 DEQ-I131 μCi/gm per TS 3.4.15, for a concurrent iodine spike (CIS) of 500 per Regulatory Guides 1.183 and 1.195 (Refs.1-2), and for a CIS of 335 per Regulatory Guides 1.183 and 1.195 (Refs.1-2) is detailed in Table 1. The iodine activities for the 1% failed fuel case, for the peak iodine level of 1 DEQ-I131 μCi/gm case, and for the PIS of 60 DEQ-I131 μCi/gm case are distributed instantaneously and homogeneously throughout the primary coolant at the beginning of the accident. For the CIS cases, the iodine activities can be released homogeneously and continuously over the 8 hour accident duration, at the beginning of the accident, or in steps spanning the accident duration. Calculation of the secondary iodine activities for a peak iodine level of 0.1 DEQ-I131 μCi/gm per TS 3.7.14 is depicted in Tables 2 and 3. These iodine activities are distributed instantaneously and homogeneously throughout the secondary coolant at the beginning of the accident. Calculation of the primary noble gas activities for 1% failed fuel and for a peak noble gas level of 100/Ebar μCi/gm per TS 3.4.15 is shown in Table 4. The noble gas activities for these cases are distributed instantaneously and homogeneously throughout the primary coolant at the beginning of the accident.

6. INPUT DATA, TECHNICAL ASSUMPTIONS, AND METHOD OF ANALYSIS

(6.1) SAS2H Edit Code:
The SAS2H/ORIGEN-S libraries include 689 light elements, such as clad and structural materials, 129 actinides, including fuel nuclides and their decay and activation products, and 879 fission product nuclides. It was necessary to generate SAS2H isotopics as a function of loading pattern, burnup, and enrichment; to edit each output for the specified number of actinide and fission product values; to convert the isotopic content from moles to curies/mwth; and to create a summary punch file of the results. This laborious task was simplified by writing the FORTRAN programs SAS2HED3, which accomplished all of the above.

The FORTRAN code listing for SAS2HED3.FOR is included in Attachment A. The program can be compiled and linked via the FORT51 and LINK51 batch files. A copy of FORT51.BAT and LINK51.BAT are included on the accompanying CDROM. The program executable file SAS2HED3.EXE is executed on DOS. The program queries the user for the 8 character SAS2HED3 input file name (e.g. xxxx.SED).

The SAS2HED3 program reads the following data from the input SED file (e.g. See Attachment B):
(1) The 8 character name of the summary punch file generated by SAS2HED3 (e.g. xxxx.PUN - Attachment C) in Format A8.

(2) An 8 character name in Format A8 (Not used in this program).

(3) An 8 character name in Format A8 (Not used in this program).

(4) The 8 character name of the SAS2H output file (e.g. xxxx.OUT) in Format A8.

(5) The reactor power POWER in MWth.

(6) The number of burnup steps in each of the three cycles of the SAS2H output (N1, N2, N3). The total number of burnup steps NT should correspond to the total number of burnup steps in the SAS2H execution.

(7) The number of assemblies in each of the three batches, each corresponding to a cycle (NA1, NA2, NA3). The total NAT should equal 217.

(8) 592 lines of a sample Nuclear Inventory File ANIF(K). (Not used in this program).

The SAS2HED3 program performs the following functions:

(1) SAS2HED3 edits the number of moles for the following 33 actinides and fission products at each burnup step in SAS2H {B1C(I,J), where I=1,NT; J=1,33}.

kr 85	kr 85m	kr 87	kr 88	br 85	br 87	br 88	se 85	se 87	se 88
sb132	sb133	sb134	sb135	te131	te131m	te132	te133	te133m	te134
te135	te138	i131	i132	i133	i134	i135	i138	xe133	xe133m
xe135	xe135m	xe138							

These nuclides comprise the nuclides included in the primary and secondary system and their precursors.

(2) The edited molar quantities are converted to curies/mwth via the following procedure:
(a) The edited molar quantities B1B(I,J) are converted to curies B1C(I,J) for each burnup step I=1,NT and for each isotope J=1,33 via the following algorithm:

B1C(I,J) = B1B(I,J) * (6.023E+23 atoms/mole) * CL(J) / (3.7E+10 dis/sec/Ci)

The relevant half-lives CT(I) in seconds extracted from Ref.22 are as follows:

3.3933E+08	1.6128E+04	4.5720E+03	1.0224E+04	1.7220E+02
5.5900E+01	1.6400E+01	3.2000E+01	5.8000E+00	1.5000E+00

2.5200E+02 1.5000E+02 0.8000E+00 1.7100E+00 1.5000E+03
1.1664E+05 2.7648E+05 7.4400E+02 3.3240E+03 2.5200E+03
1.9000E+01 1.4000E+00 6.9299E+05 8.2080E+03 7.4880E+04
3.1560E+03 2.3652E+04 6.5000E+00 4.5300E+05 1.8922E+05
3.2760E+04 9.1800E+02 8.4600E+02

The isotopic decay constant is defined by
CL(I) = 0.6931472/CT(I)

(b) The maximum activity in curies for each isotope J for cycle 1 (N=1,N1) is determined and designated B1D(1,J). Similarly, the maximum activity in curies for each isotope J for cycle 2 (N=N1+1,N1+N2) is determined and designated B1D(2,J). Finally, the maximum activity in curies for each isotope J for cycle 3 (N=N1+N2+1,NT) is determined and designated B1D(3,J).

(c) The activity per unit power in curies per mwth for each isotope J is then calculated via
B1E(1,J) = B1D(1,J) * NA1 / POWER for once burned fuel
B1E(2,J) = B1D(2,J) * NA2 / POWER for twice burned fuel
B1E(3,J) = B1D(3,J) * NA3 / POWER for thrice burned fuel
B1E(4,J) = B1E(1,J) + B1E(2,J) + B1E(3,J) for total core

(3) End of execution isotopics in grams was also editted from SAS2H and stored as DG(1,J) for J=1,33. The end of execution isotopics in grams was also calculated from the previously editted quantity B1B(NT,J) via the algorithm
DG(2,J) = B1B(NT,J) * CW(J) for J=1,33

where the atomic weight CW(J) is defined as
085 085 087 088 085 087 088 085 087 088
132 133 134 135 131 131 132 133 133 134
135 138 131 132 133 134 135 138 133 133
135 135 131 138

(4) End of execution isotopics in curies was also editted from SAS2H and stored as DC(1,J) for J=1,33. The end of execution isotopics in curies was also calculated from the previously editted quantity B1B(NT,J) via the algorithm
DC(2,J) = B1B(NT,J) * (6.023E+23 atoms/mole) * CL(J) / (3.7E+10 dis/sec/Ci)

(5) The SAS2HED3 code then prints a summary output file (xxx.pun) to unit 6 with the following contents:
(a) The power, the number of burnup steps per cycle, the total number of burnup steps, the number of assemblies per cycle, and the total number of assemblies.

(b) A listing of the isotopic elements.

(c) For each burnup step, the EFPD and the isotopic activity in moles.

(d) For each burnup step, the EFPD and the isotopic activity in curies.

(e) For each isotope, the isotope name, CW(J), CT(J), CL(J), DG(1,J), DG(2,J), DC(1,J), and DC(2,J).

(f) For each isotope, the isotope name, B1D(1,J), B1D(2,J), B1D(3,J), B1E(1,J), B1E(2,J), B1E(3,J), B1E(4,J)

6.2 DEQ I131 Primary Iodine Activities
Table 1 depicts the calculation of the primary iodine activities for spiking and non-spiking applications. The inputs, technical assumptions, and methodology for the calculation of the primary iodine activities are as follows:

- Pow is the peak core power level of 2754 Mwt, which includes a factor of 1.02 to incorporate instrument uncertainty (Ref.7 and UFSAR 3.2.1)

- Fcp is the charging pump letdown flow for one and a half charging pumps at 120°F and saturation (1.5*44-6=60 gpm) (UFSAR Table 9-1). Note that use of a single charging pump is normal operating procedure at CCNPP at hot full power (HFP). Two charging pumps are sometimes used during boration or dilution operations from HFP. Three charging pumps are never used at HFP and rarely used otherwise, since use of three charging pumps causes the discharge relief valves to be challenged. It is conservatively assumed that all RCS losses are made up by the flow of one and a half charging pumps operating at full capacity.

- vcp is the specific volume of 0.01620 cf/lbm at the charging pump temperature of 120°F and at saturation (UFSAR Table 9-1 and Ref. 8)

- vrcs is the specific volume of 0.022132 cf/lbm at the reactor coolant conditions of 574.5°F and 2250 psia (UFSAR Table 4.1, UFSAR Figure 4.9, Ref.8)

- Frcs=Fcp*vrcs/vcp=81.97 gpm is the charging pump letdown flow for 1.5 charging pumps at rcs conditions

- vpzr is the specific volume of 0.02703 cf/lbm at the pressurizer conditions of 653°F and 2250 psia (UFSAR Table 4.7 and Ref.8)

- vstp is the specific volume of 0.016018 cf/lbm or 1 gm/cc at standard temperature and pressure (Ref.8)

- Vrcs is the rcs volume of 9576 cf (UFSAR Table 4.1)

- Vpzr is the minimum pressurizer water volume of 600 cf (UFSAR Table 4.7)

- Vtot=Vrcs+Vpzr*vrcs/vpzr=10067.28 cf is the total rcs plus pressurizer water volume at rcs conditions of 574.5°F and 2250 psia (UFSAR Table 4.1; UFSAR Figure 4.9)

- Frcs/Vtot=1.8141E-05/sec is the charging pump constant

- Mrcs=Vtot/vrcs=454870 lbm is the rcs/pressurizer water mass

- The first section of the spreadsheet calculates the equilibrium activity per unit power via the following decay chains:
  - Te131m → Te131 → I131
  - Sb132 Te132 → I132
  - Sb133 Te133 → I133
  - Sb134 Te134 → I134
  - Sb135 Te135 → I135

- Column A: Nuclide half lives were extracted from Ref.4.

- Column B: Nuclide activity per core in Ci/Mwt was extracted from the SAS2HED3 edit of the limiting case CRCB from Ref.5.

- Column C: Fuel escape rate coefficients in 1/sec per Ref.16 Table II.

- Column D: Nuclide decay constants are defined as ln(2)/A(i).

- Column E: Equilibrium nuclide fractions are assumed to be unity; that is, all of the iodine, antimony, and tellurium isotopes are assumed to be available for release.

- Column F: The primary RCS leak and makeup rate as defined by Frcs/Vtot.

- Column G: The equilibrium isotopic activity for 1% failed fuel assuming no precursors.
  - G(i) = B(i)*E(i)*C(i)*0.01/(D(i)+F(i))

- Column H: The equilibrium isotopic activity for 1% failed fuel assuming precursors.
  - H(i) = G(i) + H(i+1)*D(i)/(D(i)+F(i)), where i+1 denotes the precursor

- Column I: Iodine dose conversion factors (DCFs) were extracted from Federal Guidance Report (FGR) 11 Table 2.1 (Ref.10). Note that Alternate Source Terms utilizing DCFs from Refs.10-11 will be utilized in all control room and offsite dose calculations, thus calculation of dose equivalent I-131 for both primary and secondary systems must also use FGR DCFs and be incorporated in Technical Specification (TS 1.1).

- Column J: Nuclide half lives were extracted from Ref.4.

- Column K: Nuclide decay constants are defined as ln(2)/J(i).

- Column L: Equilibrium RCS source for 1% failed fuel with precursors from Column H.

- Column M: 1% equilibrium RCS nuclide activity in Ci: M(i)=L(i)*Pow

- Column N: 1% equilibrium RCS nuclide activity in Ci/cc: N(i)=M(i)/Vtot

- Column O: 1% equilibrium RCS nuclide activity in microCi/gm: O(i)=M(i)/Mrcs*1000000

- Column P: Nuclide activity fraction in RCS: P(i)=N(i)/Σ(N(i))

- Column Q: Nuclide DCF fraction: Q(i)=I(i)/I(1)

- Column R: Nuclide activity in RCS in μCi/gm for 1 μCi/gm DEQ I-131: R(i)=P(i)*1/Σ(P(i)*Q(i)) per Ref.9. The summation is Σ(Ri*Qi).

- Column T: Nuclide activity in RCS in Ci for 1 μCi/gm DEQ I-131: T(i)=R(i)*Mrcs*0.000001

- Column S: Nuclide activity in RCS in μCi/cc for 1 μCi/gm DEQ I-131: S(i)=T(i)/Vtot*1000000.

- Column U: Nuclide activity in RCS in μCi/gm for 60 Ci/gm DEQ I-31: U(i)=P(i)*60/Σ(P(i)*Q(i)) per Ref.9. The summation is Σ(Ui*Qi).

- Column W: Nuclide activity in RCS in Ci for 60 μCi/gm DEQ I-131: W(i)=U(i)*Mrcs*0.000001

- Column V: Nuclide activity in RCS in μCi/cc for 60 μCi/gm DEQ I-131: V(i)=W(i)/Vtot*1000000.

- Column X: Nuclide activity in RCS in μCi/cc for 1 μCi/gm DEQ I-131: X(i)=S(i)

- Column Y: Nuclide decay constants: Y(i)=K(i)

- Column Z: 500 CIS nuclide activity in μCi/cc/sec: Z(i)=500*(Y(i)+Frcs/Vtot)*X(i). Note that it is assumed that the charging pump makeup rate from 1.5 charging pumps bounds all RCS losses.

- Column A1: 8 hour 500 CIS nuclide activity source in Ci: A1(i)=(Z(i)*8*3600+X(i))*Vtot*0.000001

- Column B1: 335 CIS nuclide activity in μCi/cc/sec: B1(i)=335*(Y(i)+Frcs/Vtot)*X(i). Note that it is assumed that the charging pump makeup rate from 1.5 charging pumps bounds all RCS losses.

- Column C1: 8 hour 335 CIS nuclide activity source in Ci: C1(i)=(B1(i)*8*3600+X(i))*Vtot*0.000001

6.3 DEQ I131 Secondary Iodine Activities

Tables 2 and 3 depicts the calculation of the secondary iodine activities. The relevant rate equation is as follows:

$$dIs(i)/dt = Ip(i)*Rps - (\lambda(i)+Rs)*Is(i)$$

where Is(i) and Ip(i) are the secondary and primary activities for Iodine isotope i. $\lambda(i)$ is the decay constant for Iodine isotope i. Rps and Rs are the primary-to-secondary and secondary-to-external leakrates in 1/sec. The inputs, technical assumptions, and methodology for the calculation of the secondary iodine activities are as follows:

- Pow is the peak core power level of 2754 Mwt, which includes a factor of 1.02 to incorporate instrument uncertainty (Ref.7 and UFSAR 3.2.1)

- M2sg is the mass 275942 lbm of water in 2 steam generators (Ref.13).

- V2sg is the volume of the liquid in the 2 steam generators assuming a density of 1gm/cc.

- vstp is the specific volume of 0.016018 cf/lbm or 1 gm/cc at standard temperature and pressure (Ref.8)

- Vrcs is the rcs volume of 9576 cf (UFSAR Table 4.1)

- vrcs is the specific volume of 0.022132 cf/lbm at the reactor coolant conditions of 574.5°F and 2250 psia (UFSAR Table 4.1, UFSAR Figure 4.9, Ref.8)

- Vpzr is the minimum pressurizer water volume of 600 cf (UFSAR Table 4.7)

- vpzr is the specific volume of 0.02703 cf/lbm at the pressurizer conditions of 653°F and 2250 psia (UFSAR Table 4.7 and Ref.8)

- Vtot=(Vrcs+Vpzr*vrcs/vpzr)*vstp/vrcs=7286.18 cf is the total rcs plus pressurizer water volume at STP

- Rps = Primary-to-secondary leakrate in 1/sec at STP (200 gpd UFSAR 14.16 and TS 3.4.13)

- Rs = Secondary-to-external flowkrate in 1/sec. = (5.9E+6 lbm/hr/sg Ref.13)*(2 sg)*(453.592379 gm/lbm)*(1 cc/gm Ref.01) *(7.4805 gal/cf)*(0.0005 condensor partition factor UFSAR 14.16) / (60 min/hr) / (28316.85 cc/cf) = 11.783 gpm

- Column A: Iodine dose conversion factors (DCFs) were extracted from Federal Guidance Report (FGR) 11 Table 2.1 (Ref.10). Note that Alternate Source Terms utilizing DCFs from Refs.10-11 will be utilized in all control room and offsite dose calculations, thus calculation of dose equivalent I-131 for both primary and secondary systems must also use FGR DCFs and be incorporated in Technical Specification (TS 1.1).

- Column B: Nuclide DCF fraction: B(i)=A(i)/A(1)

- Column C: Nuclide half-lives were extracted from Ref.4.

- Column D: Nuclide decay constants are defined as ln(2)/C(i).

- Column E: RCS Ci DEQ I-131 source from Section 6.2 Column T.

- Column F: SG DEQ I-131 source in Ci: F(i)=E(i)*Rps/(D(i)+Rs)

- Column G: SG DEQ I-131 source in microCi/gm: G(i)=F(i)*1000000/M2sg

- Column H: SG 0.1 microCi/gm DEQ I-131 source in microCi/gm: H(i)=0.1*G(i)/Σ(B(i)*G(i))

6.4 Noble Gas Primary Activities

Table 4 depicts the calculation of the primary noble gas activities. The inputs, technical assumptions, and methodology for the calculation of the primary noble gas activities are as follows:

- Pow is the peak core power level of 2754 Mwt, which includes a factor of 1.02 to incorporate instrument uncertainty (Ref.7 and UFSAR 3.2.1)

- Fcp denotes the removal of borated RCS liquid and the insertion of unborated liquid necessary for boron rundown during a cycle. Per ANSI/ANS-18.1-1999 (Ref.17) and NUREG-0017 (Ref.20), letdown to the CVCS system removes no noble gases from the letdown stream in the ion exchangers or in the Volume Control Tank (VCT). The only removal occurs via removal of borated RCS liquid and the insertion of unborated liquid necessary for boron rundown during a cycle. Per NEOP 13 (Ref.18), the boron concentration is 1607 ppm at 0 EFPD and 5.9 ppm at 633 EFPD. The dilution rate is thus calculated via
  - $dC/dt = -F*C/V$
  - $C = Co * \exp(-t*F/V)$
  - $F = V * \ln(Co/C)/t$
  - $F = (7286.18\ ft^3) * \ln(1607/5.9) / (633 * 24 * 60) = 0.04482$ cfm = 0.3353 gpm at STP
  - F = 0.3353 * vcp / vstp = 0.3391 gpm at 120°F sat

- vcp is the specific volume of 0.01620 cf/lbm at the charging pump temperature of 120°F and at saturation (UFSAR Table 9-1 and Ref. 8)

- vrcs is the specific volume of 0.022132 cf/lbm at the reactor coolant conditions of 574.5°F and 2250 psia (UFSAR Table 4.1, UFSAR Figure 4.9, Ref.8)

- Frcs=Fcp*vrcs/vcp=0.46 is the boron letdown feed-and-bleed flow at RCS conditions

- vpzr is the specific volume of 0.02703 cf/lbm at the pressurizer conditions of 653°F and 2250 psia (UFSAR Table 4.7 and Ref.8)

- vstp is the specific volume of 0.016018 cf/lbm or 1 gm/cc at standard temperature and pressure (Ref.8)

- Vrcs is the rcs volume of 9576 cf (UFSAR Table 4.1)

- Vpzr is the minimum pressurizer water volume of 600 cf (UFSAR Table 4.7)

- Vtot=Vrcs+Vpzr*vrcs/vpzr=10067.28 cf is the total rcs plus pressurizer water volume at rcs conditions of 574.5°F and 2250 psia (UFSAR Table 4.1, UFSAR Figure 4.9)

- Frcs/Vtot=1.0280E-07/sec is the removal constant

- The first section of the spreadsheet calculates the equilibrium activity per unit power via the following decay chains and branching fractions (Ref.19):
  - Se85 → Br85 → Kr85m (0.998)
  - Kr85 (0.002)
  - Kr85m → Kr85 (0.21)
  - Se87 → Br87 → Kr87 (0.977)
  - Se88 → Br88 → Kr88 (0.957)
  - Kr87 (0.043)

- Xe133m → Xe133
- Te133m → I133 → Xe133m (0.029)
- Xe133 (0.971)
- Xe135m → Xe135
- Te135 → I135 → Xe135m (0.155)
- Xe135 (0.845)
- Te138 → I138 → Xe138

- Column A: Nuclide half lives were extracted from Ref.4.
- Column B: Nuclide activity per core in Ci/Mwt was extracted from the SAS2HED3 edit of CRCB.
- Column C: Fuel escape rate coefficients in 1/sec per Ref.16 Table II.
- Column D: Nuclide decay constants are defined as ln(2)/A(i).
- Column E: Equilibrium nuclide fractions are assumed to be unity; that is, all of the krypton, xenon, iodine, bromine, tellerium, and selenium isotopes are assumed to be available for release.
- Column F: The primary RCS leak and makeup rate as defined by Frcs/Vtot.
- Column G: The equilibrium isotopic activity for 1% failed fuel assuming no precursors.
  - G(i) = B(i)*E(i)*C(i)*0.01/(D(i)+F(i))
- Column H: The equilibrium isotopic activity for 1% failed fuel assuming precursors.
  - H(i) = G(i) + H(i+1)*D(i)/(D(i)+F(i)), where i+1 denotes the precursor
- Column I: Nuclide half-lives were extracted from Ref.4.
- Column J: Nuclide decay constants are defined as ln(2)/I(i).
- Column K: Equilibrium RCS source for 1% failed fuel with precursors from Column H.
- Column L: Equilibrium RCS source for 1% failed fuel with precursors in Ci: L(i)=K(i)*Pow
- Column M: Nuclide gamma energies in Mev/dis from Refs.14-15.
- Column N: Nuclide beta energies in Mev/dis from Refs.14-15.
- Column O: Nuclide gamma plus beta energies in Mev/dis: O(i)=M(i)+N(i). Note that the two values at the bottom of the column denote Σ(Pi*Oi) and <E>= Σ(Pi*Oi)/ Σ(Pi)
- Column P: Equilibrium RCS source for 1% failed fuel with precursors in Ci: P(i)=L(i)
- Column Q: Nuclide activity in RCS in μCi/gm for 100/Ebar: Q(i)=P(i)*100/Σ(P(i)*O(i)) per Ref.9. Note that the value at the bottom of the column denotes 100/<E>= Σ(Qi) in microCi/gm.
- Column R: Nuclide activity in RCS in μCi/cc for 100/Ebar: R(i)=Q(i)/vrcs. Note that the value at the bottom of the column denotes 100/<E>= Σ(Ri) in microCi/cc.
- Column S: Nuclide activity in RCS in Ci for 100/Ebar: S(i)=R(i)*Vtot*0.000001. Note that the value at the bottom of the column denotes 100/<E>= Σ(Si) in Ci.

7. REFERENCES

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(02) "Methods and Assumptions for Evaluating Radiological Consequences of Design Basis Accidents at Light Water Nuclear Power reactors", Regulatory Guide 1.195

(03) TID-14844, "Calculation of Distance Factors for Power and Test Reactor Sites"

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

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

(06) "Gas Gap Isotopic Fraction Calculations", CA06421

(07) "Power Levels of Nuclear Power Plants", Regulatory Guide 1.49.

(08) 1967 Steam Tables

(09) "Implementation of AST Site Boundary and Control Room Dose for Fort Calhoun Station", Stone & Webster, January 2001.

(10) Federal Guidance Report No.11: Limiting Values of Radionuclide Intake and Air Concentration and DCFs for Inhalation, Submersion, and Ingestion

(11) Federal Guidance Report No.12: External Exposure to Radionuclides in Air, Water, and Soil

(12) "Application of Technical Specification Definition of Dose Equivalent I-131", NRM 97022.

(13) CA05725, WEC-222-7811-A45 Sheet 30: RSG Parameter Listing

(14) "Determination of E-Bar", CP-828 Rev.0.

(15) "AXIDENT A Digital Computer Dose Calculation Model", NUS-1954 Rev.3

(16) CE Calculation SE-69-971: Fission Product Activity in the Reactor Coolant

(17) ANSI/ANS-18.1-1999: ANS Radioactive Source Term for Normal Operation of LWRs

(18) NEOP-13 Rev.26 Technical Data Book for Unit 1 Cycle 17

(19) LOCADOSE User's Manual

(20) NUREG-0017 Rev.1: Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from PWRs

8. DOCUMENTATION OF COMPUTER CODES

No computer codes, except for EXCEL spreadsheets, are utilized in this work.

9. CALCULATIONS, RESULTS, AND CONCLUSIONS

9.1 DEQ I131 Primary Iodine Activities

Calculation of the primary iodine activities for 1% failed fuel, for a peak iodine level of 1 DEQ-I131 μCi/gm per Technical Specification (TS) 3.4.15, for a preaccident iodine spike (PIS) of 60 DEQ-I131 μCi/gm per TS 3.4.15, for a concurrent iodine spike (CIS) of 500 per Regulatory Guides 1.183 and 1.195 (Refs.1-2), and for a CIS of 335 per Regulatory Guides 1.183 and 1.195 (Refs.1-2) is shown in Table 1. The iodine activities for the 1% failed fuel case, for the peak iodine level of 1 DEQ-I131 μCi/gm case, and for the PIS of 60 DEQ-I131 μCi/gm case are distributed instantaneously and homogeneously throughout the primary coolant at the beginning of the accident. For the CIS cases, the iodine activities can be released homogeneously and continuously over the 8 hour accident duration, at the beginning of the accident, or in steps spanning the accident duration.

Table 1: Calculation of Primary Iodine Activities for CIS and PIS

	Halflife(sec)	No(Ci/MWt)	R(/sec)	lam(/sec)	feq	F(/sec)	N1(Ci/MWt)	N2(Ci/MWt)
	A	B	C	D	E	F	G	H
I131	6.9299E+05	2.7629E+04	2.30E-08	1.0002E-06	1.00	1.8141E-05	3.3199E-01	3.3217E-01
Te131	1.5000E+03	2.2584E+04	1.40E-09	4.6210E-04	1.00	1.8141E-05	6.5837E-04	3.4935E-03
Te-131m	1.1664E+05	5.0686E+03	1.40E-09	5.9426E-06	1.00	1.8141E-05	2.9464E-03	
I132	8.2080E+03	3.9464E+04	2.30E-08	8.4448E-05	1.00	1.8141E-05	8.8477E-02	1.1031E-01
Te-132	2.7648E+05	3.9110E+04	1.40E-09	2.5070E-06	1.00	1.8141E-05	2.6518E-02	2.6526E-02
Sb-132	2.5200E+02	1.2711E+04	1.40E-09	2.7506E-03	1.00	1.8141E-05	6.4273E-05	
I133	7.4880E+04	5.5715E+04	2.30E-08	9.2568E-06	1.00	1.8141E-05	4.6772E-01	4.6789E-01
Te-133	7.4400E+02	3.1336E+04	1.40E-09	9.3165E-04	1.00	1.8141E-05	4.6190E-04	5.1800E-04
Sb-133	1.5000E+02	1.8954E+04	1.40E-09	4.6210E-03	1.00	1.8141E-05	5.7200E-05	
I134	3.1560E+03	6.2858E+04	2.30E-08	2.1963E-04	1.00	1.8141E-05	6.0804E-02	6.3104E-02
Te-134	2.5200E+03	5.2156E+04	1.40E-09	2.7506E-04	1.00	1.8141E-05	2.4904E-03	2.4905E-03
Sb-134	8.0000E-01	3.8184E+03	1.40E-09	8.6643E-01	1.00	1.8141E-05	6.1697E-08	
I135	2.3652E+04	5.2964E+04	2.30E-08	2.9306E-05	1.00	1.8141E-05	2.5674E-01	2.5675E-01
Te-135	1.9000E+01	2.7415E+04	1.40E-09	3.6481E-02	1.00	1.8141E-05	1.0515E-05	1.0569E-05
Sb-135	1.7100E+00	1.5559E+03	1.40E-09	4.0535E-01	1.00	1.8141E-05	5.3735E-08	
	Activity for 1% Failed Fuel							
	FGR-11			RCS	RCS	RCS	RCS	
	DCF	Halflife	lambda	Source	Source	Activity	Activity	
	Rem/Ci	sec	1/sec	Ci/MWt	Ci	Ci/cc	microCi/gm	
	I	J	K	L	M	N	O	
I-131	3.2893E+04	6.9299E+05	1.0002E-06	3.3217E-01	9.1480E+02	3.2090E-06	4.4337E+00	
I-132	3.8110E+02	8.2080E+03	8.4448E-05	1.1031E-01	3.0380E+02	1.0657E-06	1.4724E+00	
I-133	5.8460E+03	7.4880E+04	9.2568E-06	4.6789E-01	1.2886E+03	4.5202E-06	6.2453E+00	
I-134	1.3135E+02	3.1560E+03	2.1963E-04	6.3104E-02	1.7379E+02	6.0963E-07	8.4230E-01	
I-135	1.2284E+03	2.3652E+04	2.9306E-05	2.5675E-01	7.0709E+02	2.4804E-06	3.4270E+00	
						1.1885E-05		
	Activity for 1 and 60 MicroCi/gm DEQ I131							
			1 microCi/gm DEQ I131			60 microCi/gm DEQ I131		
	RCS	FGR-11	DEQ	DEQ	DEQ	DEQ	DEQ	DEQ
	Activity	DCF	I131	I131	I131	I131	I131	I131
	fraction	Fraction	microCi/gm	microCi/cc	Ci	microCi/gm	microCi/cc	Ci

	P	Q	R	S	T	U	V	W
I-131	0.2700	1.0000E+00	0.7789	0.5638	1.6071E+02	46.7356	33.8258	9.6428E+03
I-132	0.0897	1.1586E-02	0.2587	0.1872	5.3372E+01	15.5206	11.2333	3.2023E+03
I-133	0.3803	1.7773E-01	1.0972	0.7941	2.2638E+02	65.8314	47.6467	1.3583E+04
I-134	0.0513	3.9933E-03	0.1480	0.1071	3.0532E+01	8.8786	6.4261	1.8319E+03
I-135	0.2087	3.7345E-02	0.6021	0.4358	1.2422E+02	36.1240	26.1455	7.4534E+03
	1.0000		1.0000			60.0000		
			CIS Spiking Factor of 500		CIS Spiking Factor of 335			
	RCS		CIS	8 Hr CIS	CIS	8 Hr CIS		
	Activity	lambda	Source	Source	Source	Source		
	microCi/cc	1/sec	µCi/cc-s	Ci	µCi/cc-s	Ci		
	X	Y	Z	A1	B1	C1		
I-131	0.5638	1.0002E-06	5.3956E-03	4.4459E+04	3.6150E-03	2.9841E+04		
I-132	0.1872	8.4448E-05	9.6034E-03	7.8899E+04	6.4343E-03	5.2880E+04		
I-133	0.7941	9.2568E-06	1.0878E-02	8.9540E+04	7.2886E-03	6.0066E+04		
I-134	0.1071	2.1963E-04	1.2733E-02	1.0457E+05	8.5309E-03	7.0070E+04		
I-135	0.4358	2.9306E-05	1.0338E-02	8.4998E+04	6.9263E-03	5.6990E+04		
Pow(mwt)	2754			RG 1.49 / UFSAR 3.2.1				
Frcs(gpm-gps)	81.97	1.3662		Fcp*vrcs/vcp				
Fcp(gpm)	60			UFSAR T9.1 @ 120F saturation pressure				
vcp(cf/lbm)	0.01620			Steam Table @ 120F saturation pressure				
Vtot(cf-gal-cc)	10067.28	7.5308E+04	2.8507E+08	Vrcs+Vpzx*vrcs/vpzr @ 574.5 F and 2250 psia				
Vrcs(cf)	9576			UFSAR T4.1				
vrcs(cf/lbm)	0.022132			Steam Tables @ 574.5 F and 2250 psia - UFSAR T4.1 F4.9				
Vpzr(cf)	600			UFSAR T4.7				
vpzr(cf/lbm)	0.02703			Steam Tables @ 653 F and 2250 psia - UFSAR T4.7				
vstp(cf/lbm)	0.016018			Steam Tables @ 1 gm/cc				
Frcs/Vtot(1/sec)	1.8141E-05			Frcs/Vtot				
Mrcs(lbm-gm)	4.5487E+05	2.0633E+08		Vtot/vrcs				
C1 (cc/cf)	28316.85			Steam Tables				
C2 (gal/cf)	7.48052			Steam Tables				
C3(gm/lbm)	453.592379			Steam Tables				

9.2 DEQ I131 Secondary Iodine Activities

Calculation of the secondary iodine activities for a peak iodine level of 0.1 DEQ-I131 µCi/gm per TS 3.7.14 is shown in Table 2. These iodine activities are distributed instantaneously and homogeneously throughout the secondary coolant at the beginning of the accident. Note that the primary-to-secondary leakrate must be set to 1.58 gpm to attain a secondary equilibrium DEQ I-131 activity of 0.1 microCi/gm (Table 3). Using the TS 3.4.13 limit of 200 gpd results in a peak equilibrium DEQ I-131 activity of 0.0088 microCi/gm (Table 2).

Table 2: Calculation of Secondary Iodine Activities

					RCS			SG
					DEQ I-131	SG	SG	DEQ I-131
	FGR-11	FGR11			1 microCi/gm	DEQ I-131	DEQ I-131	0.1 microCi/gm
	DCF	DCF	Halflife	lambda	Source	Source	Source	Source

	Rem/Ci	Fraction	sec	1/sec	Ci	Ci	µCi/gm	µCi/gm
	A	B	C	D	E	F	G	H
I-131	3.2893E+04	1.0000E+00	6.9299E+05	1.0002E-6	1.6071E+02	9.8358E-1	7.8583E-3	8.9260E-02
I-132	3.8110E+02	1.1586E-02	8.2080E+03	8.4448E-5	5.3372E+01	2.5078E-2	2.0036E-4	2.2758E-03
I-133	5.8460E+03	1.7773E-01	7.4880E+04	9.2568E-6	2.2638E+02	6.3269E-1	5.0549E-3	5.7417E-02
I-134	1.3135E+02	3.9933E-03	3.1560E+03	2.1963E-4	3.0532E+01	5.7486E-3	4.5928E-5	5.2168E-04
I-135	1.2284E+03	3.7345E-02	2.3652E+04	2.9306E-5	1.2422E+02	1.4969E-1	1.1959E-3	1.3584E-02
							8.8038E-3	1.0000E-01
Pow(mwt)	2754			RG 1.49 / UFSAR 3.2.1				
Failed fuel(ff)	0.01							
M2sg(lbm-gm)	275942.00	1.2517E+08		WEC 222-7811-A45 Sheet 30				
V2sg(cf-gal-cc)	4420.1664	3.3065E+04	1.2517E+08	2SG vols at STP = M2sg * (1 cc/gm)				
vstp(cf/lbm)	0.016018			Steam Tables @ 1 gm/cc				
Vtot(cf-gal-cc)	7286.18	5.4504E+04	2.0632E+08	(Vrcs+Vpzx*vrcs/vpz)*vstp/vrrcs @ STP				
Vrcs(cf)	9576			UFSAR T4.1				
vrcs(cf/lbm)	0.022132			Steam Tables @ 574.5 F and 2250 psia - UFSAR T4.1 F4.9				
Vpzr(cf)	600			UFSAR T4.7				
vpzr(cf/lbm)	0.02703			Steam Tables @ 653 F and 2250 psia - UFSAR T4.7				
Rps(gpm-1/sec)	0.138888889	4.2470E-08		Primary-to-secondary leakrate at STP				
Rs(gpm-1/sec)	11.783	5.9393E-06		Secondary-to-outside leakrate				
C1 (cc/cf)	28316.85			Steam Tables				
C2 (gal/cf)	7.48052			Steam Tables				
C3(gm/lbm)	453.592379			Steam Tables				

Table 3: Calculation of Secondary Iodine Activities

					RCS			SG
					DEQ I-131	SG	SG	DEQ I-131
	FGR-11	FGR-11			1 microCi/gm	DEQ I-131	DEQ I-131	0.1 microCi/gm
	DCF	DCF	Halflife	lambda	Source	Source	Source	Source
	Rem/Ci	Fraction	sec	1/sec	Ci	Ci	microCi/gm	microCi/gm
	A	B	C	D	E	F	G	H
I-131	3.2893E+04	1.0000E+00	6.9299E+05	1.0002E-6	1.6071E+02	1.1189E+01	8.9395E-2	8.9260E-02
I-132	3.8110E+02	1.1586E-02	8.2080E+03	8.4448E-5	5.3372E+01	2.8529E-01	2.2793E-3	2.2758E-03
I-133	5.8460E+03	1.7773E-01	7.4880E+04	9.2568E-6	2.2638E+02	7.1975E+00	5.7504E-2	5.7417E-02
I-134	1.3135E+02	3.9933E-03	3.1560E+03	2.1963E-4	3.0532E+01	6.5396E-02	5.2248E-4	5.2168E-04
I-135	1.2284E+03	3.7345E-02	2.3652E+04	2.9306E-5	1.2422E+02	1.7028E+00	1.3605E-2	1.3584E-02
							1.0015E-1	1.0000E-01
Pow(mwt)	2754			RG 1.49 / UFSAR 3.2.1				
Failed fuel(ff)	0.01							
M2sg(lbm-gm)	275942.00	1.2517E+08		WEC 222-7811-A45 Sheet 30				
V2sg(cf-gal-cc)	4420.1664	3.3065E+04	1.2517E+08	2SG vols at STP = M2sg * (1 cc/gm)				
vstp(cf/lbm)	0.016018			Steam Tables @ 1 gm/cc				
Vtot(cf-gal-cc)	7286.18	5.4504E+04	2.0632E+08	(Vrcs+Vpzx*vrcs/vpz)*vstp/vrrcs @ STP				
Vrcs(cf)	9576			UFSAR T4.1				
vrcs(cf/lbm)	0.022132			Steam Tables @ 574.5 F and 2250 psia - UFSAR T4.1 F4.9				

Vpzr(cf)	600			UFSAR T4.7
vpzr(cf/lbm)	0.02703			Steam Tables @ 653 F and 2250 psia - UFSAR T4.7
Rps(gpm-1/sec)	1.58	4.8314E-07		Primary-to-secondary leakrate at STP
Rs(gpm-1/sec)	11.783	5.9393E-06		Secondary-to-outside leakrate
C1 (cc/cf)	28316.85			Steam Tables
C2 (gal/cf)	7.48052			Steam Tables
C3(gm/lbm)	453.592379			Steam Tables

9.3 Noble Gas Primary Activities

Calculation of the primary noble gas activities for 1% failed fuel and for a peak noble gas level of 100/Ebar μCi/gm per TS 3.4.15 is shown in Table 4. The noble gas activities for these cases are distributed instantaneously and homogeneously throughout the primary coolant at the beginning of the accident.

Table 4: Calculation of Primary Noble Gas Activities

	Halflife(sec)	No(Ci/MWt)	R(/sec)	lam(/sec)	feq	F(/sec)	N1(Ci/MWt)	N2(Ci/MWt)
	A	B	C	D	E	F	G	H
Kr-85m	1.6128E+04	7.9679E+03	6.50E-08	4.2978E-05	1.00	1.0280E-07	1.2022E-01	1.2067E-01
Br-85	1.7220E+02	7.9566E+03	2.30E-08	4.0252E-03	1.00	1.0280E-07	4.5462E-04	4.5464E-04
Se-85	3.2000E+01	3.3017E+03	1.40E-11	2.1661E-02	1.00	1.0280E-07	2.1340E-08	
Kr-85	3.3933E+08	3.7076E+02	6.50E-08	2.0427E-09	1.00	1.0280E-07	2.2986E+00	2.2991E+00
Kr-85m	1.6128E+04		6.50E-08	4.2978E-05	1.00	1.0280E-07	1.2067E-01	
Kr-87	4.5720E+03	1.6208E+04	6.50E-08	1.5161E-04	1.00	1.0280E-07	6.9443E-02	6.9679E-02
Br-87	5.5900E+01	1.2874E+04	2.30E-08	1.2400E-02	1.00	1.0280E-07	2.3879E-04	2.3880E-04
Se-87	5.8000E+00	4.6922E+03	1.40E-11	1.1951E-01	1.00	1.0280E-07	5.4968E-09	
Kr-88	1.0224E+04	2.2658E+04	6.50E-08	6.7796E-05	1.00	1.0280E-07	2.1691E-01	2.1697E-01
Br-88	1.6400E+01	1.2891E+04	2.30E-08	4.2265E-02	1.00	1.0280E-07	7.0151E-05	7.0151E-05
Se-88	1.5000E+00	2.5632E+03	1.40E-11	4.6210E-01	1.00	1.0280E-07	7.7656E-10	
Xe-133	4.5300E+05	5.5707E+04	6.50E-08	1.5301E-06	1.00	1.0280E-07	2.2175E+01	2.3739E+01
Xe-133m	1.8922E+05		6.50E-08	3.6632E-06	1.00	1.0280E-07	3.3819E-01	
Xe-133m	1.8922E+05	1.7354E+03	6.50E-08	3.6632E-06	1.00	1.0280E-07	2.9953E-01	3.3819E-01
I-133	7.4880E+04	5.5715E+04	2.30E-08	9.2568E-06	1.00	1.0280E-07	1.3691E+00	1.3708E+00
Te-133m	3.3240E+03	2.5447E+04	1.40E-09	2.0853E-04	1.00	1.0280E-07	1.7076E-03	
Xe-135	3.2760E+04	1.7708E+04	6.50E-08	2.1158E-05	1.00	1.0280E-07	5.4137E-01	5.6710E-01
Xe-135m	9.1800E+02		6.50E-08	7.5506E-04	1.00	1.0280E-07	7.4212E-02	
Xe-135m	9.1800E+02	1.1635E+04	6.50E-08	7.5506E-04	1.00	1.0280E-07	1.0015E-02	7.4212E-02
I-135	2.3652E+04	5.2964E+04	2.30E-08	2.9306E-05	1.00	1.0280E-07	4.1422E-01	4.1423E-01
Te-135	1.9000E+01	2.7415E+04	1.40E-09	3.6481E-02	1.00	1.0280E-07	1.0521E-05	
Xe138	8.4600E+02	4.9330E+04	6.50E-08	8.1932E-04	1.00	1.0280E-07	3.9130E-02	3.9160E-02
I-138	6.5000E+00	1.3523E+04	2.30E-08	1.0664E-01	1.00	1.0280E-07	2.9167E-05	2.9195E-05
Te-138	1.4000E+00	1.0113E+03	1.40E-09	4.9511E-01	1.00	1.0280E-07	2.8596E-08	
	Halflife	lambda	RCS	RCS	γ	β	Gamma+Beta	
			Source	Source	Energy	Energy	Energy	
	sec	1/sec	CI/MWT	Ci	Mev/dis	Mev/dis	Mev/dis	
	I	J	K	L	M	N	O	
Kr-85m	1.6128E+04	4.2978E-05	1.2067E-01	3.3233E+02	0.156	0.233	3.8900E-01	
Kr-85	3.3933E+08	2.0427E-09	2.2991E+00	6.3318E+03	0.0021	0.223	2.2510E-01	

Kr-87	4.5720E+03	1.5161E-04	6.9679E-02	1.9190E+02	1.375	1.050	2.4250E+00	
Kr-88	1.0224E+04	6.7796E-05	2.1697E-01	5.9754E+02	1.743	0.341	2.0840E+00	
Xe-133	4.5300E+05	1.5301E-06	2.3739E+01	6.5377E+04	0.030	0.146	1.7600E-01	
Xe-133m	1.8922E+05	3.6632E-06	3.3819E-01	9.3139E+02	0.033	0.155	1.8800E-01	
Xe-135	3.2760E+04	2.1158E-05	5.6710E-01	1.5618E+03	0.246	0.322	5.6800E-01	
Xe-135m	9.1800E+02	7.5506E-04	7.4212E-02	2.0438E+02	0.422	0.097	5.1900E-01	
Xe138	8.4600E+02	8.1932E-04	3.9160E-02	1.0785E+02	2.870	0.800	3.6700E+00	
							1.6336E+04	
	1%						2.1598E-01	
	Failed Fuel	100/Ebar	100/Ebar	100/Ebar				
	RCS Activity	Activity	Activity	Activity				
	Ci	microCi/gm	microCi/cc	Ci				
	P	Q	R	S				
Kr-85m	3.3233E+02	2.0344E+00	1.4724E+00	4.1975E+02				
Kr-85	6.3318E+03	3.8761E+01	2.8054E+01	7.9975E+03				
Kr-87	1.9190E+02	1.1747E+00	8.5022E-01	2.4238E+02				
Kr-88	5.9754E+02	3.6579E+00	2.6475E+00	7.5473E+02				
Xe-133	6.5377E+04	4.0021E+02	2.8966E+02	8.2574E+04				
Xe-133m	9.3139E+02	5.7016E+00	4.1266E+00	1.1764E+03				
Xe-135	1.5618E+03	9.5607E+00	6.9197E+00	1.9726E+03				
Xe-135m	2.0438E+02	1.2511E+00	9.0553E-01	2.5814E+02				
Xe138	1.0785E+02	6.6019E-01	4.7782E-01	1.3622E+02				
	7.5636E+04	4.6301E+02	3.3511E+02	9.5532E+04				
100/Ebar	4.6301E+02							
Ebar	2.1598E-01							
Pow(mwt)	2754							
Vtot(cf-gal-cc)	10067.28	7.5308E+04	2.8507E+08	Vrcs+Vpzx*vrcs/vpzr @ 574.5 F and 2250 psia				
Vrcs(cf)	9576			UFSAR T4.1				
vrcs(cf/lbm-cc/gm)	0.022132	1.381656		Steam Tables @ 574.5 F and 2250 psia				
Vpzr(cf)	600			UFSAR T4.7				
vpzr(cf/lbm)	0.02703			Steam Tables @ 653 F and 2250 psia				
vstp(cf/lbm)	0.016018			Steam Tables @ 1 gm/cc				
Fcp(gpm)	0.34			UFSAR T9.1 @ 120F saturation pressure				
vcp(cf/lbm)	0.01620			Steam Table @ 120F saturation pressure				
Frcs(gpm-gps)	0.46	0.0077		Fcp*vrcs/vcp				
Frcs/Vtot(1/sec)	1.0280E-07			Frcs/Vtot				
C1 (cc/cf)	28316.85			Steam Tables				
C2 (gal/cf)	7.48052			Steam Tables				
C3(gm/lbm)	453.592379			Steam Tables				

10. ATTACHMENTS

ATTACHMENT A
PROGRAM SAS2HED3

```
      PROGRAM SAS2HED3
C*********************************************************************
C*      D:\CRHVAC\SAS2HED\SAS2HED3.FOR
C*      COMPILE COMMAND IS   FORT51 SAS2HED3
C*                           LINK51 SAS2HED3
C*   EDIT SAS2H OUTPUT FOR MOLES OF ACTIVITY
C*   CONVERT MOLES TO CURIES/MWTH
C*   PRINT INPUT FOR RADTRAD
C*********************************************************************
      DIMENSION A1A(33),B1A(50),B1B(50,33),B2A(8),XX(8),B1C(50,33)
      DIMENSION CW(33),CL(33),CT(33),DG(2,33),DC(2,33),B1D(3,33)
      DIMENSION B1E(4,33),ANIF(592)
      CHARACTER A1A*8,A1B*8,A1C*14,A1D*9,A1E*16,A1F*34,A1G*31
      CHARACTER A2A*8,A2C*14,A2D*9,A2E*16,A2F*34,A2G*31
      CHARACTER A1I*29,A2I*29,A1J*29,A2J*29,A1K*30,A2K*30,A1L*8
      CHARACTER B1A*10,B2A*10,B3A*10,ANIF*80
      DATA A1A/' kr 85 ',' kr 85m',' kr 87 ',' kr 88 ',' br 85 ',
     1      ' br 87 ',' br 88 ',' se 85 ',' se 87 ',' se 88 ',
     2      ' sb132 ',' sb133 ',' sb134 ',' sb135 ',' te131 ',
     3      ' te131m',' te132 ',' te133 ',' te133m',' te134 ',
     4      ' te135 ',' te138 ',' i131 ',' i132 ',' i133 ',
     5      ' i134 ',' i135 ',' i138 ',' xe133 ',' xe133m',
     6      ' xe135 ',' xe135m',' xe138 '/
      DATA CT/3.3933E+08,1.6128E+04,4.5720E+03,1.0224E+04,1.7220E+02
     1,     5.5900E+01,1.6400E+01,3.2000E+01,5.8000E+00,1.5000E+00
     2;     2.5200E+02,1.5000E+02,0.8000E+00,1.7100E+00,1.5000E+03
     3,     1.1664E+05,2.7648E+05,7.4400E+02,3.3240E+03,2.5200E+03
     4,     1.9000E+01,1.4000E+00,6.9299E+05,8.2080E+03,7.4880E+04
     5,     3.1560E+03,2.3652E+04,6.5000E+00,4.5300E+05,1.8922E+05
     6,     3.2760E+04,9.1800E+02,8.4600E+02/
      DATA CW/085.,085.,087.,088.,085.,087.,088.,085.,087.,088.
     1,     132.,133.,134.,135.,131.,131.,132.,133.,133.,134.
     2,     135.,138.,131.,132.,133.,134.,135.,138.,133.,133.
     3,     135.,135.,131.,138./
      DATA A1B/'totals '/
      DATA A1C/'light elements'/
      DATA A1D/'actinides'/
      DATA A1E/'fission products'/
      DATA A1F/'nuclide concentrations, gram atoms'/
      DATA A1G/'basis = single reactor assembly'/
      DATA A1H/'       '/
      DATA A1I/'nuclide concentrations, grams'/
      DATA A1J/'nuclide radioactivity, curies'/
      DATA A1K/'basis =single reactor assembly'/
      DATA A1L/'total  '/
      DATA B3A/'       '/
      DATA CA/6.023E+23/,CC/3.7E+10/
      CALL START
C*********************************************************************
C* OPEN ALL FILES TO BE USED:                                        *
C*      6 = PRINTED OUTPUT       (OPENED IN SUBROUTINE START)  *
C*      7 = PUNCH OUTPUT FOR EXCEL (OPENED IN SUBROUTINE START)  *
C*      8 = PUNCH OUTPUT FOR NIF  (OPENED IN SUBROUTINE START)  *
C*      9 = SAS2H OUTPUT FILE     (OPENED IN SUBROUTINE START)  *
C*     10 = INPUT FILE          (OPENED IN SUBROUTINE START)  *
C*********************************************************************
C    READ INPUT DATA
      READ(10,*) POWER
      WRITE(6,500) POWER
      READ(10,*) N1,N2,N3
      NT=N1+N2+N3
```

```
      WRITE(6,501) N1,N2,N3,NT
      READ(10,*) NA1,NA2,NA3
      NAT=NA1+NA2+NA3
      WRITE(6,502) NA1,NA2,NA3,NAT
      READ(10,503) (ANIF(I),I=1,592)
  500 FORMAT(2X,'POWER = ',F8.3,' MWTH')
  501 FORMAT(2X,'N1   = ',I8/,2X,'N2   = ',I8/
     1,2X,'N3   = ',I8/,2X,'NT   = ',I8)
  502 FORMAT(2X,'NA1  = ',I8/,2X,'NA2  = ',I8/
     1,2X,'NA3  = ',I8/,2X,'NAT  = ',I8)
  503 FORMAT(A80)
C*********************************************************************
C     INITIALIZE VARIABLES
      DO 10 I=1,50
      DO 10 J=1,33
      B1B(I,J)=0.0
   10 B1C(I,J)=0.0
      DO 11 J=1,33
   11 CL(J)=0.6931472/CT(J)
      DO 12 I=1,2
      DO 12 J=1,33
      DG(I,J)=0.0
   12 DC(I,J)=0.0
      DO 13 I=1,3
      DO 13 J=1,33
   13 B1D(I,J)=0.0
      IN=0
C*********************************************************************
C     READ LIGHT ELEMENTS GRAM ATOM SAS2H DATA
   20 READ(9,520,END=990) A2C
      IF(A2C.NE.A1C) GO TO 20
  520 FORMAT(96X,A14)
      READ(9,521,END=990) A2F
      IF(A2F.NE.A1F) GO TO 20
  521 FORMAT(//,43X,A34)
      READ(9,522,END=990) A2G
      IF(A2G.NE.A1G) GO TO 20
  522 FORMAT(43X,A31)
      READ(9,530) (B2A(I),I=1,8)
      DO 30 I=1,8
      IF(B2A(I).NE.B3A) GO TO 30
      IX=I-1
      GO TO 31
   30 CONTINUE
      WRITE(6,531)
      CALL EXIT
   31 CONTINUE
  530 FORMAT(10X,8A10)
  531 FORMAT(2X,'ERROR CODE 524')
      IN=IN+1
      B1A(IN)=B2A(IX)
   38 CONTINUE
      DO 32 K=1,51
      READ(9,532) A2A,(XX(I),I=1,IX)
  532 FORMAT(2X,A8,8E10.2)
      IF(A2A.EQ.A1B) GO TO 39
      DO 33 JN=1,33
      IF(A2A.NE.A1A(JN)) GO TO 33
      B1B(IN,JN)=B1B(IN,JN)+XX(IX)
      GO TO 32
   33 CONTINUE
   32 CONTINUE
      READ(9,525)
  525 FORMAT(/////)
      GO TO 38
   39 CONTINUE
C*********************************************************************
C     READ ACTINIDE GRAM ATOM SAS2H DATA
```

```
 40 READ(9,540,END=990) A2D
    IF(A2D.NE.A1D) GO TO 40
540 FORMAT(101X,A9)
    READ(9,541,END=990) A2F
    IF(A2F.NE.A1F) GO TO 40
541 FORMAT(//,43X,A34)
    READ(9,542,END=990) A2G
    IF(A2G.NE.A1G) GO TO 40
542 FORMAT(43X,A31)
    READ(9,543)
543 FORMAT(1X)
 58 CONTINUE
    DO 52 K=1,51
    READ(9,552) A2A,(XX(I),I=1,IX)
552 FORMAT(2X,A8,8E10.2)
    IF(A2A.EQ.A1B) GO TO 59
    DO 53 JN=1,33
    IF(A2A.NE.A1A(JN)) GO TO 53
    B1B(IN,JN)=B1B(IN,JN)+XX(IX)
    GO TO 52
 53 CONTINUE
 52 CONTINUE
    READ(9,555)
555 FORMAT(/////)
    GO TO 58
 59 CONTINUE
C*********************************************************************
C    READ FISSION PRODUCT GRAM ATOM DATA
 60 READ(9,560,END=990) A2E
    IF(A2E.NE.A1E) GO TO 60
560 FORMAT(94X,A16)
    READ(9,561,END=990) A2F
    IF(A2F.NE.A1F) GO TO 60
561 FORMAT(//,43X,A34)
    READ(9,562,END=990) A2G
    IF(A2G.NE.A1G) GO TO 60
562 FORMAT(43X,A31)
    READ(9,563)
563 FORMAT(1X)
 78 CONTINUE
    DO 72 K=1,51
    READ(9,572) A2A,(XX(I),I=1,IX)
572 FORMAT(2X,A8,8E10.2)
    IF(A2A.EQ.A1B) GO TO 79
    DO 73 JN=1,33
    IF(A2A.NE.A1A(JN)) GO TO 73
    B1B(IN,JN)=B1B(IN,JN)+XX(IX)
    GO TO 72
 73 CONTINUE
 72 CONTINUE
    READ(9,575)
575 FORMAT(/////)
    GO TO 78
 79 CONTINUE
    IF(IN.LT.NT) GO TO 20
C*********************************************************************
C    READ LIGHT ELEMENTS GRAM SAS2H DATA
 80 READ(9,580,END=990) A2C
    IF(A2C.NE.A1C) GO TO 80
580 FORMAT(96X,A14)
    READ(9,581,END=990) A2I
    IF(A2I.NE.A1I) GO TO 80
581 FORMAT(//,44X,A29)
    READ(9,582,END=990) A2K
    IF(A2K.NE.A1K) GO TO 80
582 FORMAT(44X,A30)
    READ(9,583)
583 FORMAT(1X)
```

```
  85 CONTINUE
     DO 86 K=1,53
     READ(9,584) A2A,XX(1)
  584 FORMAT(2X,A8,E10.2)
     IF(A2A.EQ.A1L) GO TO 89
     DO 87 JN=1,33
     IF(A2A.NE.A1A(JN)) GO TO 87
     DG(1,JN)=DG(1,JN)+XX(1)
     GO TO 86
   87 CONTINUE
   86 CONTINUE
     READ(9,585)
  585 FORMAT(/////)
     GO TO 85
   89 CONTINUE
C*********************************************************************
C    READ LIGHT ELEMENTS CURIE SAS2H DATA
   90 READ(9,590,END=990) A2C
     IF(A2C.NE.A1C) GO TO 90
  590 FORMAT(96X,A14)
     READ(9,591,END=990) A2J
     IF(A2J.NE.A1J) GO TO 90
  591 FORMAT(//,46X,A29)
     READ(9,592,END=990) A2K
     IF(A2K.NE.A1K) GO TO 90
  592 FORMAT(46X,A30)
     READ(9,593)
  593 FORMAT(1X)
   95 CONTINUE
     DO 96 K=1,53
     READ(9,594) A2A,XX(1)
  594 FORMAT(2X,A8,E10.2)
     IF(A2A.EQ.A1L) GO TO 99
     DO 97 JN=1,33
     IF(A2A.NE.A1A(JN)) GO TO 97
     DC(1,JN)=DC(1,JN)+XX(1)
     GO TO 96
   97 CONTINUE
   96 CONTINUE
     READ(9,595)
  595 FORMAT(/////)
     GO TO 95
   99 CONTINUE
C*********************************************************************
C    READ ACTINIDE GRAM SAS2H DATA
  100 READ(9,600,END=990) A2D
     IF(A2D.NE.A1D) GO TO 100
  600 FORMAT(101X,A9)
     READ(9,601,END=990) A2I
     IF(A2I.NE.A1I) GO TO 100
  601 FORMAT(//,44X,A29)
     READ(9,602,END=990) A2K
     IF(A2K.NE.A1K) GO TO 100
  602 FORMAT(44X,A30)
     READ(9,603)
  603 FORMAT(1X)
  105 CONTINUE
     DO 106 K=1,53
     READ(9,604) A2A,XX(1)
  604 FORMAT(2X,A8,E10.2)
     IF(A2A.EQ.A1L) GO TO 109
     DO 107 JN=1,33
     IF(A2A.NE.A1A(JN)) GO TO 107
     DG(1,JN)=DG(1,JN)+XX(1)
     GO TO 106
  107 CONTINUE
  106 CONTINUE
     READ(9,605)
```

```
 605 FORMAT(/////)
     GO TO 105
 109 CONTINUE
C*********************************************************************
C    READ ACTINIDE CURIE SAS2H DATA
 110 READ(9,610,END=990) A2D
     IF(A2D.NE.A1D) GO TO 110
 610 FORMAT(101X,A9)
     READ(9,611,END=990) A2J
     IF(A2J.NE.A1J) GO TO 110
 611 FORMAT(//,46X,A29)
     READ(9,612,END=990) A2K
     IF(A2K.NE.A1K) GO TO 110
 612 FORMAT(46X,A30)
     READ(9,613)
 613 FORMAT(1X)
 115 CONTINUE
     DO 116 K=1,53
     READ(9,614) A2A,XX(1)
 614 FORMAT(2X,A8,E10.2)
     IF(A2A.EQ.A1L) GO TO 119
     DO 117 JN=1,33
     IF(A2A.NE.A1A(JN)) GO TO 117
     DC(1,JN)=DC(1,JN)+XX(1)
     GO TO 116
 117 CONTINUE
 116 CONTINUE
     READ(9,615)
 615 FORMAT(/////)
     GO TO 115
 119 CONTINUE
C*********************************************************************
C    READ FISSION PRODUCT GRAM SAS2H DATA
 120 READ(9,620,END=990) A2E
     IF(A2E.NE.A1E) GO TO 120
 620 FORMAT(94X,A16)
     READ(9,621,END=990) A2I
     IF(A2I.NE.A1I) GO TO 120
 621 FORMAT(//,44X,A29)
     READ(9,622,END=990) A2K
     IF(A2K.NE.A1K) GO TO 120
 622 FORMAT(44X,A30)
     READ(9,623)
 623 FORMAT(1X)
 125 CONTINUE
     DO 126 K=1,53
     READ(9,624) A2A,XX(1)
 624 FORMAT(2X,A8,E10.2)
     IF(A2A.EQ.A1L) GO TO 129
     DO 127 JN=1,33
     IF(A2A.NE.A1A(JN)) GO TO 127
     DG(1,JN)=DG(1,JN)+XX(1)
     GO TO 126
 127 CONTINUE
 126 CONTINUE
     READ(9,625)
 625 FORMAT(/////)
     GO TO 125
 129 CONTINUE
C*********************************************************************
C    READ FISSION PRODUCTS CURIE SAS2H DATA
 130 READ(9,630,END=990) A2E
     IF(A2E.NE.A1E) GO TO 130
 630 FORMAT(94X,A16)
     READ(9,631,END=990) A2J
     IF(A2J.NE.A1J) GO TO 130
 631 FORMAT(//,46X,A29)
     READ(9,632,END=990) A2K
```

```
      IF(A2K.NE.A1K) GO TO 130
  632 FORMAT(46X,A30)
      READ(9,633)
  633 FORMAT(1X)
  135 CONTINUE
      DO 136 K=1,53
      READ(9,634) A2A,XX(1)
  634 FORMAT(2X,A8,E10.2)
      IF(A2A.EQ.A1L) GO TO 139
      DO 137 JN=1,33
      IF(A2A.NE.A1A(JN)) GO TO 137
      DC(1,JN)=DC(1,JN)+XX(1)
      GO TO 136
  137 CONTINUE
  136 CONTINUE
      READ(9,635)
  635 FORMAT(/////)
      GO TO 135
  139 CONTINUE
C*********************************************************************
C     CALCULATE GRAM DATA
  990 CONTINUE
      DO 140 J=1,33
  140 DG(2,J)=B1B(NT,J)*CW(J)
C*********************************************************************
C     CALCULATE CURIE DATA
      DO 150 J=1,33
  150 DC(2,J)=B1B(NT,J)*CL(J)*CA/CC
C*********************************************************************
C     CALCULATE DETAILED CURIE DATA
      DO 160 I=1,NT
      DO 160 J=1,33
  160 B1C(I,J)=B1B(I,J)*CL(J)*CA/CC
      DO 170 J=1,33
      XX(1)=B1C(1,J)
      DO 171 I=2,N1
  171 IF(XX(1).LT.B1C(I,J)) XX(1)=B1C(I,J)
      B1D(1,J)=XX(1)
      IF(N2.EQ.0) GO TO 170
      NX=N1+1
      NX1=NX+1
      NY=N1+N2
      XX(2)=B1C(NX,J)
      DO 172 I=NX1,NY
  172 IF(XX(2).LT.B1C(I,J)) XX(2)=B1C(I,J)
      B1D(2,J)=XX(2)
      IF(N3.EQ.0) GO TO 170
      NX=N1+N2+1
      NX1=NX+1
      NY=N1+N2+N3
      XX(3)=B1C(NX,J)
      DO 173 I=NX1,NY
  173 IF(XX(3).LT.B1C(I,J)) XX(3)=B1C(I,J)
      B1D(3,J)=XX(3)
  170 CONTINUE
      DO 175 J=1,33
      B1E(1,J)=B1D(1,J)*NA1/POWER
      B1E(2,J)=B1D(2,J)*NA2/POWER
      B1E(3,J)=B1D(3,J)*NA3/POWER
      B1E(4,J)=B1E(1,J)+B1E(2,J)+B1E(3,J)
  175 CONTINUE
C*********************************************************************
C     PRINT DATA TO UNIT 6
      WRITE(6,352) A1A
      WRITE(6,353)
      DO 300 I=1,IN
      WRITE(6,350) B1A(I)
      WRITE(6,351) (B1B(I,J),J=1,33)
```

```
 300 CONTINUE
     WRITE(6,354)
     DO 305 I=1,NT
     WRITE(6,350) B1A(I)
     WRITE(6,351) (B1C(I,J),J=1,33)
 305 CONTINUE
 350 FORMAT(/,2X,A10)
 351 FORMAT(2X,1P12E10.2)
 352 FORMAT(12(2X,A8))
 353 FORMAT(/,2X,'ASSEMBLY ISOTOPIC DATA IN GRAM ATOMS')
 354 FORMAT(/,2X,'ASSEMBLY ISOTOPIC DATA IN CURIES')
     WRITE(6,355)
     DO 310 J=1,33
 310 WRITE(6,356) A1A(J), CW(J),CT(J),CL(J)
    1,DG(1,J),DG(2,J),DC(1,J),DC(2,J)
 355 FORMAT(//,3X,'ISOTOPE',7X,'AT WT',' DECAY(SEC)',' LAMBDA(1/S)'
    1,'  SAS2H GRAMS','   CALC GRAMS'
    2,'  SAS2H CURIES','   CALC CURIES')
 356 FORMAT(2X,A8,F12.2,1P2E12.2,1P4E15.4)
     WRITE(6,370)
     DO 320 J=1,33
 320 WRITE(6,371) A1A(J),(B1D(I,J),I=1,3),(B1E(I,J),I=1,4)
 370 FORMAT(//,3X,'ISOTOPE',6X,'ASSM CI 1',6X,'ASSM CI 2'
    1,6X,'ASSM CI 3',2X,'BATCH CI/MW 1',2X,'BATCH CI/MW 2'
    2,2X,'BATCH CI/MW 3',2X,'BATCH CI/MW T')
 371 FORMAT(2X,A8,1P7E15.4)
C*********************************************************************
C    PRINT DATA TO UNIT 7 FOR EXCEL
c    DO 330 J=1,65
c 330 WRITE(7,380) B1E(4,J)
c 380 FORMAT(1PE15.5)
C*********************************************************************
C    PRINT DATA IN UNIT 8 FOR RADTRAD
c    DO 340 K=1,6
c 340 WRITE(8,390) ANIF(K)
c    KT=6
c    DO 342 J=1,65
c    DO 343 K=1,5
c    KT=KT+1
c 343 WRITE(8,390) ANIF(KT)
c    KT=KT+1
c    WRITE(8,392) B1E(4,J)
c    DO 344 K=1,3
c    KT=KT+1
c 344 WRITE(8,390) ANIF(KT)
c 342 CONTINUE
c    WRITE(8,390) ANIF(592)
c 390 FORMAT(A80)
c 392 FORMAT(2X,1PE10.4)
C*********************************************************************
C    END OF PROGRAM
 995 CONTINUE
     CLOSE(6)
c    CLOSE(7)
c    CLOSE(8)
     CLOSE(9)
     CLOSE(10)
     STOP
     END
     SUBROUTINE START
C
C*********************************************************************
C*                                                                   *
C*  ROUTINE TO GET THE REQUIRED DATA TO GET STARTED                  *
C*                                                                   *
C*********************************************************************
C
     CHARACTER INFP*8,INFE*8,INFN*8,INFO*8,INFI*8
```

```
  10 CONTINUE
     PRINT 11
  11 FORMAT(/////,2X,'WHAT IS THE NAME OF THE INPUT FILE ',
     +      '(8 CHARACTERS LENGTH)'/,'  ? ')
     READ(*,50) INFI
  50 FORMAT(A8)
     IF(IERROR .EQ. 0) GO TO 12
     PRINT 60
  60 FORMAT('  CANNOT FIND FILE       PLEASE TRY AGAIN'///)
     GO TO 10
  12 OPEN(10,FILE=INFI,STATUS='OLD',IOSTAT=IERROR)
     READ(10,50) INFP
     READ(10,50) INFE
     READ(10,50) INFN
     READ(10,50) INFO
     OPEN(6,FILE=INFP,STATUS='UNKNOWN')
c    OPEN(7,FILE=INFE,STATUS='UNKNOWN')
c    OPEN(8,FILE=INFN,STATUS='UNKNOWN')
     OPEN(9,FILE=INFO,STATUS='OLD',IOSTAT=IERROR)
     RETURN
     END
```

ATTACHMENT B
FILE CRCB.SED

```
CRCB.PUN
CRCB.XLS
CRCB.NIF
CRCB.OUT
 2754.0
 15 11  7
 73 72 72
Nuclide Inventory Name:
Normalized MACCS Sample 3412 MWth PWR Core Inventory
Power Level:
 0.1000E+01
Nuclides:
 65
Nuclide 001:
Co-58
  7
 0.6117120000E+07
 0.5800E+02
 0.2553E+03
none    0.0000E+00
none    0.0000E+00
none    0.0000E+00
Nuclide 002:
Co-60
  7
 0.1663401096E+09
 0.6000E+02
 0.1953E+03
none    0.0000E+00
none    0.0000E+00
none    0.0000E+00
Nuclide 003:
Kr-85
  1
 0.3382974720E+09
 0.8500E+02
 0.1960E+03
none    0.0000E+00
none    0.0000E+00
none    0.0000E+00
Nuclide 004:
Kr-85m
  1
 0.1612800000E+05
 0.8500E+02
 0.9181E+04
Kr-85   0.2100E+00
none    0.0000E+00
none    0.0000E+00
Nuclide 005:
Kr-87
  1
 0.4578000000E+04
 0.8700E+02
 0.1678E+05
Rb-87   0.1000E+01
none    0.0000E+00
none    0.0000E+00
Nuclide 006:
Kr-88
  1
 0.1022400000E+05
 0.8800E+02
```

0.2269E+05
Rb-88 0.1000E+01
none 0.0000E+00
none 0.0000E+00
Nuclide 007:
Rb-86
3
0.1612224000E+07
0.8600E+02
0.1496E+02
none 0.0000E+00
none 0.0000E+00
none 0.0000E+00
Nuclide 008:
Sr-89
5
0.4363200000E+07
0.8900E+02
0.2844E+05
none 0.0000E+00
none 0.0000E+00
none 0.0000E+00
Nuclide 009:
Sr-90
5
0.9189573120E+09
0.9000E+02
0.1535E+04
Y-90 0.1000E+01
none 0.0000E+00
none 0.0000E+00
Nuclide 010:
Sr-91
5
0.3420000000E+05
0.9100E+02
0.3656E+05
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
0.3805E+05
Y-92 0.1000E+01
none 0.0000E+00
none 0.0000E+00
Nuclide 012:
Y-90
9
0.2304000000E+06
0.9000E+02
0.1647E+04
none 0.0000E+00
none 0.0000E+00
none 0.0000E+00
Nuclide 013:
Y-91
9
0.5055264000E+07
0.9100E+02
0.3465E+05
none 0.0000E+00
none 0.0000E+00
none 0.0000E+00
Nuclide 014:

Y-92
9
0.1274400000E+05
0.9200E+02
0.3819E+05
none 0.0000E+00
none 0.0000E+00
none 0.0000E+00
Nuclide 015:
Y-93
9
0.3636000000E+05
0.9300E+02
0.4320E+05
Zr-93 0.1000E+01
none 0.0000E+00
none 0.0000E+00
Nuclide 016:
Zr-95
9
0.5527872000E+07
0.9500E+02
0.4377E+05
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
0.4562E+05
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
0.4138E+05
none 0.0000E+00
none 0.0000E+00
none 0.0000E+00
Nuclide 019:
Mo-99
7
0.2376000000E+06
0.9900E+02
0.4830E+05
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
0.4169E+05
Tc-99 0.1000E+01
none 0.0000E+00
none 0.0000E+00
Nuclide 021:
Ru-103
7
0.3393792000E+07
0.1030E+03
0.3598E+05

Rh-103m 0.1000E+01
none 0.0000E+00
none 0.0000E+00
Nuclide 022:
Ru-105
7
0.1598400000E+05
0.1050E+03
0.2340E+05
Rh-105 0.1000E+01
none 0.0000E+00
none 0.0000E+00
Nuclide 023:
Ru-106
7
0.3181248000E+08
0.1060E+03
0.8175E+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
0.1621E+05
none 0.0000E+00
none 0.0000E+00
none 0.0000E+00
Nuclide 025:
Sb-127
4
0.3326400000E+06
0.1270E+03
0.2208E+04
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
0.7820E+04
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
0.2132E+04
none 0.0000E+00
none 0.0000E+00
none 0.0000E+00
Nuclide 028:
Te-127m
4
0.9417600000E+07
0.1270E+03
0.2823E+03
Te-127 0.9800E+00
none 0.0000E+00
none 0.0000E+00
Nuclide 029:
Te-129

4
0.4176000000E+04
0.1290E+03
0.7341E+04
I-129 0.1000E+01
none 0.0000E+00
none 0.0000E+00
Nuclide 030:
Te-129m
4
0.2903040000E+07
0.1290E+03
0.1935E+04
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
0.3707E+04
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
0.3690E+05
I-132 0.1000E+01
none 0.0000E+00
none 0.0000E+00
Nuclide 033:
I-131
2
0.6946560000E+06
0.1310E+03
0.2540E+05
Xe-131m 0.1100E-01
none 0.0000E+00
none 0.0000E+00
Nuclide 034:
I-132
2
0.8280000000E+04
0.1320E+03
0.3743E+05
none 0.0000E+00
none 0.0000E+00
none 0.0000E+00
Nuclide 035:
I-133
2
0.7488000000E+05
0.1330E+03
0.5370E+05
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
0.5893E+05
none 0.0000E+00

none 0.0000E+00
none 0.0000E+00
Nuclide 037:
I-135
2
0.2379600000E+05
0.1350E+03
0.5063E+05
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
0.5372E+05
none 0.0000E+00
none 0.0000E+00
none 0.0000E+00
Nuclide 039:
Xe-135
1
0.3272400000E+05
0.1350E+03
0.1008E+05
Cs-135 0.1000E+01
none 0.0000E+00
none 0.0000E+00
Nuclide 040:
Cs-134
3
0.6507177120E+08
0.1340E+03
0.3425E+04
none 0.0000E+00
none 0.0000E+00
none 0.0000E+00
Nuclide 041:
Cs-136
3
0.1131840000E+07
0.1360E+03
0.1042E+04
none 0.0000E+00
none 0.0000E+00
none 0.0000E+00
Nuclide 042:
Cs-137
3
0.9467280000E+09
0.1370E+03
0.1915E+04
Ba-137m 0.9500E+00
none 0.0000E+00
none 0.0000E+00
Nuclide 043:
Ba-139
6
0.4962000000E+04
0.1390E+03
0.4976E+05
none 0.0000E+00
none 0.0000E+00
none 0.0000E+00
Nuclide 044:
Ba-140
6

0.1100736000E+07
0.1400E+03
0.4924E+05
La-140 0.1000E+01
none 0.0000E+00
none 0.0000E+00
Nuclide 045:
La-140
9
0.1449792000E+06
0.1400E+03
0.5032E+05
none 0.0000E+00
none 0.0000E+00
none 0.0000E+00
Nuclide 046:
La-141
9
0.1414800000E+05
0.1410E+03
0.4615E+05
Ce-141 0.1000E+01
none 0.0000E+00
none 0.0000E+00
Nuclide 047:
La-142
9
0.5550000000E+04
0.1420E+03
0.4449E+05
none 0.0000E+00
none 0.0000E+00
none 0.0000E+00
Nuclide 048:
Ce-141
8
0.2808086400E+07
0.1410E+03
0.4476E+05
none 0.0000E+00
none 0.0000E+00
none 0.0000E+00
Nuclide 049:
Ce-143
8
0.1188000000E+06
0.1430E+03
0.4352E+05
Pr-143 0.1000E+01
none 0.0000E+00
none 0.0000E+00
Nuclide 050:
Ce-144
8
0.2456352000E+08
0.1440E+03
0.2697E+05
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
0.4273E+05
none 0.0000E+00
none 0.0000E+00

none 0.0000E+00
Nuclide 052:
Nd-147
9
0.9486720000E+06
0.1470E+03
0.1911E+05
Pm-147 0.1000E+01
none 0.0000E+00
none 0.0000E+00
Nuclide 053:
Np-239
8
0.2034720000E+06
0.2390E+03
0.5120E+06
Pu-239 0.1000E+01
none 0.0000E+00
none 0.0000E+00
Nuclide 054:
Pu-238
8
0.2768863824E+10
0.2380E+03
0.2902E+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
0.6545E+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
0.8254E+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
0.1390E+04
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
0.9181E+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
0.3514E+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
0.2056E+02
Pu-240 0.1000E+01
none 0.0000E+00
none 0.0000E+00
Nuclide 061:
Kr-83m
1
6.6960000000E+03
0.8300E+02
1.0000E+00
Kr-83 0.1000E+01
none 0.0000E+00
none 0.0000E+00
Nuclide 062:
Xe-131m
1
1.0282000000E+06
0.1310E+03
1.0000E+00
Xe-131 0.1000E+01
none 0.0000E+00
none 0.0000E+00
Nuclide 063:
Xe-133m
1
1.8922000000E+05
0.1330E+03
1.0000E+00
Xe-133 0.1000E+01
none 0.0000E+00
none 0.0000E+00
Nuclide 064:
Xe-135m
1
9.1800000000E+02
0.1350E+03
1.0000E+00
Xe-135 0.1000E+01
none 0.0000E+00
none 0.0000E+00
Nuclide 065:
Xe-138
1
8.4600000000E+02
0.1380E+03
1.0000E+00
none 0.0000E+00
none 0.0000E+00
none 0.0000E+00
End of Nuclear Inventory File

ATTACHMENT C
FILE CRCB.PUN

POWER = 2754.000 MWTH
N1 = 15
N2 = 11
N3 = 7
NT = 33
NA1 = 73
NA2 = 72
NA3 = 72
NAT = 217
kr 85 kr 85m kr 87 kr 88 br 85 br 87 br 88 se 85 se 87 se 88 sb132 sb133
sb134 sb135 te131 te131m te132 te133 te133m te134 te135 te138 i131 i132
i133 i134 i135 i138 xe133 xe133m xe135 xe135m xe138

ASSEMBLY ISOTOPIC DATA IN GRAM ATOMS

46.2 d
9.23E-03 2.47E-04 1.44E-04 4.54E-04 2.64E-06 1.41E-06 4.23E-07 2.06E-07 5.45E-08 7.46E-09 4.51E-06 4.89E-06
5.42E-09 4.25E-09 5.25E-05 5.90E-04 1.64E-02 3.85E-05 1.40E-04 2.27E-04 8.50E-07 2.12E-09 2.67E-02 4.84E-04
6.68E-03 3.24E-04 1.99E-03 1.43E-07 3.80E-02 4.51E-04 8.26E-04 1.45E-05 7.02E-05

92.4 d
1.81E-02 2.38E-04 1.39E-04 4.37E-04 2.55E-06 1.35E-06 4.04E-07 1.98E-07 5.20E-08 7.13E-09 4.58E-06 4.76E-06
5.23E-09 4.15E-09 5.27E-05 6.37E-04 1.65E-02 3.80E-05 1.39E-04 2.23E-04 8.38E-07 2.09E-09 2.75E-02 4.88E-04
6.66E-03 3.21E-04 1.99E-03 1.41E-07 3.81E-02 4.55E-04 8.31E-04 1.48E-05 6.92E-05

138.6 d
2.67E-02 2.31E-04 1.34E-04 4.22E-04 2.47E-06 1.31E-06 3.89E-07 1.91E-07 5.00E-08 6.86E-09 4.64E-06 4.66E-06
5.08E-09 4.08E-09 5.29E-05 6.75E-04 1.66E-02 3.77E-05 1.38E-04 2.19E-04 8.28E-07 2.06E-09 2.78E-02 4.91E-04
6.65E-03 3.19E-04 1.98E-03 1.40E-07 3.80E-02 4.58E-04 8.31E-04 1.50E-05 6.83E-05

184.8 d
3.49E-02 2.25E-04 1.30E-04 4.09E-04 2.40E-06 1.27E-06 3.75E-07 1.85E-07 4.82E-08 6.63E-09 4.69E-06 4.58E-06
4.96E-09 4.03E-09 5.30E-05 7.06E-04 1.67E-02 3.74E-05 1.37E-04 2.15E-04 8.21E-07 2.04E-09 2.81E-02 4.94E-04
6.64E-03 3.18E-04 1.98E-03 1.38E-07 3.80E-02 4.61E-04 8.28E-04 1.52E-05 6.76E-05

230.9 d
4.29E-02 2.19E-04 1.27E-04 3.97E-04 2.34E-06 1.23E-06 3.63E-07 1.80E-07 4.65E-08 6.42E-09 4.73E-06 4.51E-06
4.85E-09 3.99E-09 5.31E-05 7.33E-04 1.68E-02 3.71E-05 1.36E-04 2.13E-04 8.15E-07 2.03E-09 2.83E-02 4.96E-04
6.63E-03 3.16E-04 1.98E-03 1.37E-07 3.80E-02 4.63E-04 8.21E-04 1.54E-05 6.70E-05

277.1 d
5.05E-02 2.14E-04 1.23E-04 3.86E-04 2.28E-06 1.19E-06 3.52E-07 1.75E-07 4.51E-08 6.24E-09 4.77E-06 4.45E-06
4.76E-09 3.96E-09 5.32E-05 7.56E-04 1.68E-02 3.69E-05 1.35E-04 2.10E-04 8.10E-07 2.02E-09 2.84E-02 4.98E-04
6.61E-03 3.15E-04 1.97E-03 1.36E-07 3.79E-02 4.64E-04 8.13E-04 1.56E-05 6.64E-05

323.3 d
5.80E-02 2.09E-04 1.20E-04 3.76E-04 2.23E-06 1.16E-06 3.42E-07 1.71E-07 4.37E-08 6.07E-09 4.80E-06 4.40E-06
4.68E-09 3.93E-09 5.32E-05 7.76E-04 1.68E-02 3.66E-05 1.34E-04 2.08E-04 8.05E-07 2.02E-09 2.86E-02 5.00E-04
6.60E-03 3.13E-04 1.97E-03 1.36E-07 3.79E-02 4.66E-04 8.02E-04 1.57E-05 6.59E-05

369.5 d
6.52E-02 2.04E-04 1.17E-04 3.67E-04 2.17E-06 1.13E-06 3.32E-07 1.67E-07 4.25E-08 5.91E-09 4.83E-06 4.35E-06
4.61E-09 3.91E-09 5.33E-05 7.94E-04 1.69E-02 3.65E-05 1.33E-04 2.05E-04 8.02E-07 2.02E-09 2.87E-02 5.01E-04
6.59E-03 3.12E-04 1.97E-03 1.35E-07 3.78E-02 4.67E-04 7.89E-04 1.58E-05 6.55E-05

415.7 d
7.22E-02 1.99E-04 1.15E-04 3.58E-04 2.13E-06 1.11E-06 3.23E-07 1.63E-07 4.13E-08 5.76E-09 4.86E-06 4.31E-06
4.54E-09 3.90E-09 5.33E-05 8.10E-04 1.69E-02 3.63E-05 1.33E-04 2.04E-04 7.99E-07 2.02E-09 2.88E-02 5.02E-04
6.58E-03 3.11E-04 1.97E-03 1.35E-07 3.78E-02 4.68E-04 7.75E-04 1.59E-05 6.50E-05

461.9 d
7.90E-02 1.95E-04 1.12E-04 3.50E-04 2.08E-06 1.08E-06 3.15E-07 1.59E-07 4.02E-08 5.62E-09 4.88E-06 4.28E-06
4.49E-09 3.89E-09 5.33E-05 8.24E-04 1.69E-02 3.61E-05 1.32E-04 2.02E-04 7.96E-07 2.02E-09 2.89E-02 5.03E-04

6.57E-03 3.10E-04 1.97E-03 1.34E-07 3.77E-02 4.69E-04 7.59E-04 1.60E-05 6.46E-05

508.1 d
8.55E-02 1.91E-04 1.10E-04 3.42E-04 2.04E-06 1.06E-06 3.07E-07 1.56E-07 3.92E-08 5.49E-09 4.90E-06 4.24E-06
4.43E-09 3.88E-09 5.33E-05 8.37E-04 1.69E-02 3.60E-05 1.32E-04 2.00E-04 7.94E-07 2.02E-09 2.90E-02 5.04E-04
6.56E-03 3.09E-04 1.96E-03 1.34E-07 3.77E-02 4.70E-04 7.43E-04 1.61E-05 6.43E-05

554.3 d
9.19E-02 1.87E-04 1.07E-04 3.34E-04 2.00E-06 1.03E-06 2.99E-07 1.52E-07 3.82E-08 5.37E-09 4.92E-06 4.21E-06
4.38E-09 3.88E-09 5.33E-05 8.48E-04 1.70E-02 3.58E-05 1.31E-04 1.98E-04 7.92E-07 2.03E-09 2.91E-02 5.04E-04
6.55E-03 3.08E-04 1.96E-03 1.34E-07 3.76E-02 4.71E-04 7.25E-04 1.62E-05 6.39E-05

600.5 d
9.81E-02 1.83E-04 1.05E-04 3.26E-04 1.96E-06 1.01E-06 2.92E-07 1.49E-07 3.72E-08 5.25E-09 4.94E-06 4.18E-06
4.34E-09 3.88E-09 5.33E-05 8.59E-04 1.70E-02 3.57E-05 1.31E-04 1.97E-04 7.91E-07 2.04E-09 2.91E-02 5.05E-04
6.54E-03 3.07E-04 1.96E-03 1.33E-07 3.76E-02 4.72E-04 7.07E-04 1.63E-05 6.36E-05

646.7 d
1.04E-01 1.80E-04 1.03E-04 3.19E-04 1.92E-06 9.87E-07 2.85E-07 1.46E-07 3.63E-08 5.13E-09 4.95E-06 4.15E-06
4.30E-09 3.88E-09 5.33E-05 8.70E-04 1.70E-02 3.55E-05 1.30E-04 1.95E-04 7.89E-07 2.04E-09 2.92E-02 5.05E-04
6.53E-03 3.06E-04 1.96E-03 1.33E-07 3.75E-02 4.72E-04 6.89E-04 1.64E-05 6.32E-05

668.3 d
1.07E-01 1.78E-04 1.02E-04 3.16E-04 1.90E-06 9.77E-07 2.81E-07 1.44E-07 3.59E-08 5.09E-09 4.97E-06 4.15E-06
4.29E-09 3.89E-09 5.33E-05 8.75E-04 1.70E-02 3.55E-05 1.30E-04 1.95E-04 7.90E-07 2.06E-09 2.92E-02 5.09E-04
6.50E-03 3.06E-04 1.96E-03 1.33E-07 3.94E-02 5.15E-04 6.83E-04 1.64E-05 6.31E-05

702.7 d
1.10E-01 1.25E-04 7.12E-05 2.21E-04 1.33E-06 6.85E-07 1.97E-07 1.01E-07 2.53E-08 3.66E-09 3.54E-06 2.98E-06
3.11E-09 2.90E-09 3.81E-05 6.27E-04 1.21E-02 2.53E-05 9.20E-05 1.38E-04 5.67E-07 1.58E-09 2.13E-02 3.62E-04
4.63E-03 2.18E-04 1.40E-03 9.58E-08 2.83E-02 3.68E-04 6.54E-04 1.17E-05 4.48E-05

767.4 d
1.15E-01 1.22E-04 6.94E-05 2.15E-04 1.29E-06 6.67E-07 1.91E-07 9.86E-08 2.45E-08 3.56E-09 3.55E-06 2.95E-06
3.07E-09 2.89E-09 3.81E-05 6.38E-04 1.21E-02 2.52E-05 9.15E-05 1.37E-04 5.65E-07 1.58E-09 2.07E-02 3.61E-04
4.64E-03 2.17E-04 1.40E-03 9.56E-08 2.67E-02 3.44E-04 6.44E-04 1.18E-05 4.45E-05

832.0 d
1.20E-01 1.19E-04 6.77E-05 2.09E-04 1.26E-06 6.50E-07 1.86E-07 9.62E-08 2.38E-08 3.47E-09 3.56E-06 2.93E-06
3.03E-09 2.89E-09 3.81E-05 6.46E-04 1.21E-02 2.51E-05 9.12E-05 1.36E-04 5.64E-07 1.58E-09 2.07E-02 3.61E-04
4.63E-03 2.16E-04 1.39E-03 9.54E-08 2.67E-02 3.44E-04 6.33E-04 1.18E-05 4.43E-05

896.7 d
1.25E-01 1.16E-04 6.61E-05 2.04E-04 1.24E-06 6.34E-07 1.81E-07 9.40E-08 2.32E-08 3.39E-09 3.57E-06 2.91E-06
3.00E-09 2.88E-09 3.81E-05 6.53E-04 1.21E-02 2.50E-05 9.08E-05 1.35E-04 5.63E-07 1.58E-09 2.08E-02 3.62E-04
4.62E-03 2.15E-04 1.39E-03 9.52E-08 2.67E-02 3.45E-04 6.20E-04 1.19E-05 4.40E-05

961.4 d
1.29E-01 1.14E-04 6.47E-05 1.99E-04 1.21E-06 6.19E-07 1.76E-07 9.18E-08 2.25E-08 3.31E-09 3.59E-06 2.89E-06
2.97E-09 2.88E-09 3.81E-05 6.60E-04 1.21E-02 2.49E-05 9.04E-05 1.34E-04 5.62E-07 1.59E-09 2.08E-02 3.62E-04
4.62E-03 2.14E-04 1.39E-03 9.50E-08 2.66E-02 3.45E-04 6.06E-04 1.19E-05 4.38E-05

1026.0 d
1.34E-01 1.11E-04 6.32E-05 1.95E-04 1.19E-06 6.05E-07 1.71E-07 8.98E-08 2.19E-08 3.23E-09 3.60E-06 2.87E-06
2.94E-09 2.88E-09 3.80E-05 6.66E-04 1.21E-02 2.48E-05 9.01E-05 1.33E-04 5.61E-07 1.59E-09 2.08E-02 3.62E-04
4.61E-03 2.14E-04 1.39E-03 9.49E-08 2.66E-02 3.45E-04 5.92E-04 1.20E-05 4.36E-05

1090.7 d
1.38E-01 1.09E-04 6.19E-05 1.90E-04 1.16E-06 5.92E-07 1.67E-07 8.79E-08 2.14E-08 3.16E-09 3.60E-06 2.86E-06
2.92E-09 2.87E-09 3.80E-05 6.71E-04 1.21E-02 2.47E-05 8.98E-05 1.32E-04 5.60E-07 1.59E-09 2.08E-02 3.62E-04
4.60E-03 2.13E-04 1.39E-03 9.48E-08 2.66E-02 3.46E-04 5.77E-04 1.20E-05 4.34E-05

1155.4 d
1.42E-01 1.07E-04 6.06E-05 1.86E-04 1.14E-06 5.79E-07 1.63E-07 8.60E-08 2.08E-08 3.09E-09 3.61E-06 2.84E-06
2.89E-09 2.87E-09 3.80E-05 6.77E-04 1.21E-02 2.46E-05 8.95E-05 1.31E-04 5.59E-07 1.59E-09 2.09E-02 3.62E-04
4.59E-03 2.13E-04 1.39E-03 9.46E-08 2.65E-02 3.46E-04 5.62E-04 1.21E-05 4.32E-05

1220.1 d

1.46E-01 1.05E-04 5.93E-05 1.82E-04 1.12E-06 5.66E-07 1.59E-07 8.42E-08 2.03E-08 3.02E-09 3.62E-06 2.82E-06
2.87E-09 2.87E-09 3.80E-05 6.82E-04 1.21E-02 2.46E-05 8.91E-05 1.30E-04 5.58E-07 1.59E-09 2.09E-02 3.62E-04
4.59E-03 2.12E-04 1.39E-03 9.45E-08 2.65E-02 3.46E-04 5.46E-04 1.21E-05 4.30E-05

1284.7 d
1.50E-01 1.03E-04 5.81E-05 1.78E-04 1.09E-06 5.54E-07 1.55E-07 8.25E-08 1.98E-08 2.96E-09 3.63E-06 2.81E-06
2.84E-09 2.87E-09 3.79E-05 6.86E-04 1.21E-02 2.45E-05 8.88E-05 1.30E-04 5.57E-07 1.59E-09 2.09E-02 3.62E-04
4.58E-03 2.11E-04 1.39E-03 9.44E-08 2.65E-02 3.46E-04 5.30E-04 1.21E-05 4.29E-05

1336.6 d
1.53E-01 1.01E-04 5.71E-05 1.75E-04 1.08E-06 5.44E-07 1.52E-07 8.11E-08 1.94E-08 2.92E-09 3.63E-06 2.80E-06
2.84E-09 2.88E-09 3.79E-05 6.90E-04 1.21E-02 2.44E-05 8.86E-05 1.29E-04 5.57E-07 1.61E-09 2.09E-02 3.62E-04
4.57E-03 2.11E-04 1.38E-03 9.45E-08 2.64E-02 3.42E-04 5.22E-04 1.22E-05 4.27E-05

1358.0 d
1.53E-01 6.02E-05 3.40E-05 1.04E-04 6.38E-07 3.25E-07 9.08E-08 4.83E-08 1.17E-08 1.81E-09 2.17E-06 1.70E-06
1.75E-09 1.81E-09 2.27E-05 4.09E-04 7.32E-03 1.47E-05 5.28E-05 7.74E-05 3.37E-07 1.04E-09 1.40E-02 2.20E-04
2.72E-03 1.26E-04 8.29E-04 5.72E-08 1.73E-02 2.22E-04 4.70E-04 7.27E-06 2.55E-05

1465.7 d
1.56E-01 5.88E-05 3.32E-05 1.01E-04 6.24E-07 3.16E-07 8.81E-08 4.71E-08 1.14E-08 1.75E-09 2.17E-06 1.69E-06
1.72E-09 1.80E-09 2.27E-05 4.14E-04 7.27E-03 1.46E-05 5.26E-05 7.68E-05 3.36E-07 1.03E-09 1.25E-02 2.17E-04
2.73E-03 1.26E-04 8.28E-04 5.70E-08 1.59E-02 2.22E-04 4.63E-04 7.29E-06 2.54E-05

1573.5 d
1.58E-01 5.77E-05 3.25E-05 9.90E-05 6.11E-07 3.09E-07 8.57E-08 4.61E-08 1.10E-08 1.71E-09 2.18E-06 1.67E-06
1.70E-09 1.79E-09 2.27E-05 4.18E-04 7.27E-03 1.45E-05 5.24E-05 7.62E-05 3.35E-07 1.02E-09 1.26E-02 2.17E-04
2.73E-03 1.25E-04 8.27E-04 5.68E-08 1.59E-02 2.23E-04 4.54E-04 7.32E-06 2.53E-05

1681.3 d
1.60E-01 5.66E-05 3.18E-05 9.68E-05 6.00E-07 3.02E-07 8.35E-08 4.52E-08 1.07E-08 1.67E-09 2.18E-06 1.66E-06
1.68E-09 1.77E-09 2.27E-05 4.21E-04 7.27E-03 1.45E-05 5.23E-05 7.57E-05 3.34E-07 1.02E-09 1.26E-02 2.17E-04
2.72E-03 1.25E-04 8.26E-04 5.66E-08 1.59E-02 2.23E-04 4.44E-04 7.34E-06 2.52E-05

1789.1 d
1.62E-01 5.56E-05 3.12E-05 9.49E-05 5.89E-07 2.96E-07 8.15E-08 4.43E-08 1.05E-08 1.63E-09 2.19E-06 1.65E-06
1.67E-09 1.76E-09 2.27E-05 4.24E-04 7.27E-03 1.44E-05 5.21E-05 7.53E-05 3.33E-07 1.01E-09 1.26E-02 2.17E-04
2.72E-03 1.25E-04 8.25E-04 5.65E-08 1.59E-02 2.23E-04 4.33E-04 7.36E-06 2.51E-05

1896.9 d
1.63E-01 5.47E-05 3.06E-05 9.30E-05 5.79E-07 2.90E-07 7.96E-08 4.35E-08 1.02E-08 1.59E-09 2.19E-06 1.64E-06
1.65E-09 1.75E-09 2.27E-05 4.26E-04 7.26E-03 1.44E-05 5.20E-05 7.49E-05 3.32E-07 9.99E-10 1.26E-02 2.17E-04
2.71E-03 1.24E-04 8.24E-04 5.64E-08 1.59E-02 2.23E-04 4.21E-04 7.38E-06 2.50E-05

2004.9 d
1.65E-01 5.38E-05 3.01E-05 9.12E-05 5.69E-07 2.85E-07 7.79E-08 4.27E-08 9.99E-09 1.57E-09 2.19E-06 1.64E-06
1.64E-09 1.76E-09 2.26E-05 4.27E-04 7.26E-03 1.44E-05 5.18E-05 7.45E-05 3.32E-07 1.01E-09 1.26E-02 2.17E-04
2.71E-03 1.24E-04 8.23E-04 5.64E-08 1.58E-02 2.23E-04 4.15E-04 7.38E-06 2.49E-05

ASSEMBLY ISOTOPIC DATA IN CURIES

46.2 d
3.07E+02 1.73E+05 3.55E+05 5.01E+05 1.73E+05 2.85E+05 2.91E+05 7.26E+04 1.06E+05 5.61E+04 2.02E+05 3.68E+05
7.64E+04 2.80E+04 3.95E+05 5.71E+04 6.69E+05 5.84E+05 4.75E+05 1.02E+06 5.05E+05 1.71E+04 4.35E+05 6.65E+05
1.01E+06 1.16E+06 9.49E+05 2.48E+05 9.47E+05 2.69E+04 2.84E+05 1.78E+05 9.36E+05

92.4 d
6.02E+02 1.67E+05 3.43E+05 4.82E+05 1.67E+05 2.72E+05 2.78E+05 6.98E+04 1.01E+05 5.36E+04 2.05E+05 3.58E+05
7.38E+04 2.74E+04 3.96E+05 6.16E+04 6.73E+05 5.76E+05 4.72E+05 9.98E+05 4.98E+05 1.68E+04 4.48E+05 6.71E+05
1.00E+06 1.15E+06 9.49E+05 2.45E+05 9.49E+05 2.71E+04 2.86E+05 1.82E+05 9.23E+05

138.6 d
8.88E+02 1.62E+05 3.31E+05 4.66E+05 1.62E+05 2.64E+05 2.68E+05 6.73E+04 9.73E+04 5.16E+04 2.08E+05 3.51E+05
7.16E+04 2.69E+04 3.98E+05 6.53E+04 6.77E+05 5.72E+05 4.68E+05 9.81E+05 4.92E+05 1.66E+04 4.53E+05 6.75E+05
1.00E+06 1.14E+06 9.45E+05 2.43E+05 9.47E+05 2.73E+04 2.86E+05 1.84E+05 9.11E+05

184.8 d
1.16E+03 1.57E+05 3.21E+05 4.51E+05 1.57E+05 2.56E+05 2.58E+05 6.52E+04 9.38E+04 4.99E+04 2.10E+05 3.45E+05

7.00E+04 2.66E+04 3.99E+05 6.83E+04 6.82E+05 5.67E+05 4.65E+05 9.63E+05 4.88E+05 1.64E+04 4.58E+05 6.79E+05
1.00E+06 1.14E+06 9.45E+05 2.40E+05 9.47E+05 2.75E+04 2.85E+05 1.87E+05 9.02E+05

230.9 d
1.43E+03 1.53E+05 3.13E+05 4.38E+05 1.53E+05 2.48E+05 2.50E+05 6.35E+04 9.05E+04 4.83E+04 2.12E+05 3.39E+05
6.84E+04 2.63E+04 3.99E+05 7.09E+04 6.86E+05 5.63E+05 4.62E+05 9.54E+05 4.84E+05 1.64E+04 4.61E+05 6.82E+05
9.99E+05 1.13E+06 9.45E+05 2.38E+05 9.47E+05 2.76E+04 2.83E+05 1.89E+05 8.94E+05

277.1 d
1.68E+03 1.50E+05 3.04E+05 4.26E+05 1.49E+05 2.40E+05 2.42E+05 6.17E+04 8.77E+04 4.69E+04 2.14E+05 3.35E+05
6.71E+04 2.61E+04 4.00E+05 7.31E+04 6.86E+05 5.60E+05 4.58E+05 9.40E+05 4.81E+05 1.63E+04 4.62E+05 6.85E+05
9.96E+05 1.13E+06 9.40E+05 2.36E+05 9.44E+05 2.77E+04 2.80E+05 1.92E+05 8.86E+05

323.3 d
1.93E+03 1.46E+05 2.96E+05 4.15E+05 1.46E+05 2.34E+05 2.35E+05 6.03E+04 8.50E+04 4.57E+04 2.15E+05 3.31E+05
6.60E+04 2.59E+04 4.00E+05 7.51E+04 6.86E+05 5.55E+05 4.55E+05 9.31E+05 4.78E+05 1.63E+04 4.66E+05 6.87E+05
9.95E+05 1.12E+06 9.40E+05 2.36E+05 9.44E+05 2.78E+04 2.76E+05 1.93E+05 8.79E+05

369.5 d
2.17E+03 1.43E+05 2.89E+05 4.05E+05 1.42E+05 2.28E+05 2.28E+05 5.89E+04 8.27E+04 4.45E+04 2.16E+05 3.27E+05
6.50E+04 2.58E+04 4.01E+05 7.68E+04 6.90E+05 5.54E+05 4.51E+05 9.18E+05 4.76E+05 1.63E+04 4.67E+05 6.89E+05
9.93E+05 1.12E+06 9.40E+05 2.34E+05 9.42E+05 2.78E+04 2.72E+05 1.94E+05 8.74E+05

415.7 d
2.40E+03 1.39E+05 2.84E+05 3.95E+05 1.40E+05 2.24E+05 2.22E+05 5.75E+04 8.03E+04 4.33E+04 2.18E+05 3.24E+05
6.40E+04 2.57E+04 4.01E+05 7.84E+04 6.90E+05 5.51E+05 4.51E+05 9.13E+05 4.74E+05 1.63E+04 4.69E+05 6.90E+05
9.92E+05 1.11E+06 9.40E+05 2.34E+05 9.42E+05 2.79E+04 2.67E+05 1.95E+05 8.67E+05

461.9 d
2.63E+03 1.36E+05 2.76E+05 3.86E+05 1.36E+05 2.18E+05 2.17E+05 5.61E+04 7.82E+04 4.23E+04 2.19E+05 3.22E+05
6.33E+04 2.57E+04 4.01E+05 7.97E+04 6.90E+05 5.47E+05 4.48E+05 9.04E+05 4.73E+05 1.63E+04 4.71E+05 6.91E+05
9.90E+05 1.11E+06 9.40E+05 2.33E+05 9.39E+05 2.80E+04 2.61E+05 1.97E+05 8.62E+05

508.1 d
2.84E+03 1.34E+05 2.71E+05 3.77E+05 1.34E+05 2.14E+05 2.11E+05 5.50E+04 7.63E+04 4.13E+04 2.19E+05 3.19E+05
6.25E+04 2.56E+04 4.01E+05 8.10E+04 6.90E+05 5.46E+05 4.48E+05 8.96E+05 4.72E+05 1.63E+04 4.72E+05 6.93E+05
9.88E+05 1.10E+06 9.35E+05 2.33E+05 9.39E+05 2.80E+04 2.56E+05 1.98E+05 8.58E+05

554.3 d
3.06E+03 1.31E+05 2.64E+05 3.69E+05 1.31E+05 2.08E+05 2.06E+05 5.36E+04 7.43E+04 4.04E+04 2.20E+05 3.17E+05
6.18E+04 2.56E+04 4.01E+05 8.20E+04 6.94E+05 5.43E+05 4.45E+05 8.87E+05 4.70E+05 1.64E+04 4.74E+05 6.93E+05
9.87E+05 1.10E+06 9.35E+05 2.33E+05 9.37E+05 2.81E+04 2.50E+05 1.99E+05 8.52E+05

600.5 d
3.26E+03 1.28E+05 2.59E+05 3.60E+05 1.28E+05 2.04E+05 2.01E+05 5.25E+04 7.24E+04 3.95E+04 2.21E+05 3.14E+05
6.12E+04 2.56E+04 4.01E+05 8.31E+04 6.94E+05 5.41E+05 4.45E+05 8.82E+05 4.70E+05 1.64E+04 4.74E+05 6.94E+05
9.85E+05 1.10E+06 9.35E+05 2.31E+05 9.37E+05 2.81E+04 2.44E+05 2.00E+05 8.48E+05

646.7 d
3.46E+03 1.26E+05 2.54E+05 3.52E+05 1.26E+05 1.99E+05 1.96E+05 5.15E+04 7.06E+04 3.86E+04 2.22E+05 3.12E+05
6.06E+04 2.56E+04 4.01E+05 8.42E+04 6.94E+05 5.38E+05 4.41E+05 8.73E+05 4.69E+05 1.64E+04 4.75E+05 6.94E+05
9.84E+05 1.09E+06 9.35E+05 2.31E+05 9.34E+05 2.81E+04 2.37E+05 2.02E+05 8.43E+05

668.3 d
3.56E+03 1.25E+05 2.52E+05 3.49E+05 1.24E+05 1.97E+05 1.93E+05 5.08E+04 6.98E+04 3.83E+04 2.23E+05 3.12E+05
6.05E+04 2.57E+04 4.01E+05 8.46E+04 6.94E+05 5.38E+05 4.41E+05 8.73E+05 4.69E+05 1.66E+04 4.75E+05 7.00E+05
9.79E+05 1.09E+06 9.35E+05 2.31E+05 9.81E+05 3.07E+04 2.35E+05 2.02E+05 8.42E+05

702.7 d
3.66E+03 8.75E+04 1.76E+05 2.44E+05 8.71E+04 1.38E+05 1.36E+05 3.56E+04 4.92E+04 2.75E+04 1.59E+05 2.24E+05
4.39E+04 1.91E+04 2.87E+05 6.07E+04 4.94E+05 3.84E+05 3.12E+05 6.18E+05 3.37E+05 1.27E+04 3.47E+05 4.98E+05
6.98E+05 7.79E+05 6.68E+05 1.66E+05 7.05E+05 2.19E+04 2.25E+05 1.44E+05 5.98E+05

767.4 d
3.82E+03 8.54E+04 1.71E+05 2.37E+05 8.45E+04 1.35E+05 1.31E+05 3.48E+04 4.77E+04 2.68E+04 1.59E+05 2.22E+05
4.33E+04 1.91E+04 2.87E+05 6.17E+04 4.94E+05 3.82E+05 3.11E+05 6.13E+05 3.36E+05 1.27E+04 3.37E+05 4.96E+05
6.99E+05 7.76E+05 6.68E+05 1.66E+05 6.65E+05 2.05E+04 2.22E+05 1.45E+05 5.94E+05

832.0 d
3.99E+03 8.33E+04 1.67E+05 2.31E+05 8.26E+04 1.31E+05 1.28E+05 3.39E+04 4.63E+04 2.61E+04 1.59E+05 2.20E+05
4.27E+04 1.91E+04 2.87E+05 6.25E+04 4.94E+05 3.81E+05 3.10E+05 6.09E+05 3.35E+05 1.27E+04 3.37E+05 4.96E+05
6.98E+05 7.72E+05 6.63E+05 1.66E+05 6.65E+05 2.05E+04 2.18E+05 1.45E+05 5.91E+05

896.7 d
4.16E+03 8.12E+04 1.63E+05 2.25E+05 8.13E+04 1.28E+05 1.25E+05 3.31E+04 4.51E+04 2.55E+04 1.60E+05 2.19E+05
4.23E+04 1.90E+04 2.87E+05 6.32E+04 4.94E+05 3.79E+05 3.08E+05 6.04E+05 3.34E+05 1.27E+04 3.39E+05 4.98E+05
6.96E+05 7.69E+05 6.63E+05 1.65E+05 6.65E+05 2.06E+04 2.14E+05 1.46E+05 5.87E+05

961.4 d
4.29E+03 7.98E+04 1.60E+05 2.20E+05 7.93E+04 1.25E+05 1.21E+05 3.24E+04 4.38E+04 2.49E+04 1.61E+05 2.17E+05
4.19E+04 1.90E+04 2.87E+05 6.38E+04 4.94E+05 3.78E+05 3.07E+05 6.00E+05 3.34E+05 1.28E+04 3.39E+05 4.98E+05
6.96E+05 7.65E+05 6.63E+05 1.65E+05 6.63E+05 2.06E+04 2.09E+05 1.46E+05 5.84E+05

1026.0 d
4.46E+03 7.77E+04 1.56E+05 2.15E+05 7.80E+04 1.22E+05 1.18E+05 3.17E+04 4.26E+04 2.43E+04 1.61E+05 2.16E+05
4.15E+04 1.90E+04 2.86E+05 6.44E+04 4.94E+05 3.76E+05 3.06E+05 5.96E+05 3.33E+05 1.28E+04 3.39E+05 4.98E+05
6.95E+05 7.65E+05 6.63E+05 1.65E+05 6.63E+05 2.06E+04 2.04E+05 1.47E+05 5.82E+05

1090.7 d
4.59E+03 7.63E+04 1.53E+05 2.10E+05 7.60E+04 1.19E+05 1.15E+05 3.10E+04 4.16E+04 2.38E+04 1.61E+05 2.15E+05
4.12E+04 1.89E+04 2.86E+05 6.49E+04 4.94E+05 3.75E+05 3.05E+05 5.91E+05 3.33E+05 1.28E+04 3.39E+05 4.98E+05
6.93E+05 7.62E+05 6.63E+05 1.65E+05 6.63E+05 2.06E+04 1.99E+05 1.47E+05 5.79E+05

1155.4 d
4.72E+03 7.49E+04 1.50E+05 2.05E+05 7.47E+04 1.17E+05 1.12E+05 3.03E+04 4.05E+04 2.32E+04 1.62E+05 2.14E+05
4.08E+04 1.89E+04 2.86E+05 6.55E+04 4.94E+05 3.73E+05 3.04E+05 5.87E+05 3.32E+05 1.28E+04 3.40E+05 4.98E+05
6.92E+05 7.62E+05 6.63E+05 1.64E+05 6.60E+05 2.06E+04 1.94E+05 1.49E+05 5.76E+05

1220.1 d
4.85E+03 7.35E+04 1.46E+05 2.01E+05 7.34E+04 1.14E+05 1.09E+05 2.97E+04 3.95E+04 2.27E+04 1.62E+05 2.12E+05
4.05E+04 1.89E+04 2.86E+05 6.60E+04 4.94E+05 3.73E+05 3.02E+05 5.82E+05 3.31E+05 1.28E+04 3.40E+05 4.98E+05
6.92E+05 7.58E+05 6.63E+05 1.64E+05 6.60E+05 2.06E+04 1.88E+05 1.49E+05 5.74E+05

1284.7 d
4.99E+03 7.21E+04 1.43E+05 1.96E+05 7.14E+04 1.12E+05 1.07E+05 2.91E+04 3.85E+04 2.23E+04 1.63E+05 2.11E+05
4.01E+04 1.89E+04 2.85E+05 6.64E+04 4.94E+05 3.72E+05 3.01E+05 5.82E+05 3.31E+05 1.28E+04 3.40E+05 4.98E+05
6.90E+05 7.54E+05 6.63E+05 1.64E+05 6.60E+05 2.06E+04 1.83E+05 1.49E+05 5.72E+05

1336.6 d
5.09E+03 7.07E+04 1.41E+05 1.93E+05 7.08E+04 1.10E+05 1.05E+05 2.86E+04 3.77E+04 2.20E+04 1.63E+05 2.11E+05
4.01E+04 1.90E+04 2.85E+05 6.67E+04 4.94E+05 3.70E+05 3.01E+05 5.78E+05 3.31E+05 1.30E+04 3.40E+05 4.98E+05
6.89E+05 7.54E+05 6.58E+05 1.64E+05 6.58E+05 2.04E+04 1.80E+05 1.50E+05 5.70E+05

1358.0 d
5.09E+03 4.21E+04 8.39E+04 1.15E+05 4.18E+04 6.56E+04 6.25E+04 1.70E+04 2.28E+04 1.36E+04 9.72E+04 1.28E+05
2.47E+04 1.19E+04 1.71E+05 3.96E+04 2.99E+05 2.23E+05 1.79E+05 3.47E+05 2.00E+05 8.38E+03 2.28E+05 3.02E+05
4.10E+05 4.50E+05 3.95E+05 9.93E+04 4.31E+05 1.32E+04 1.62E+05 8.94E+04 3.40E+05

1465.7 d
5.19E+03 4.11E+04 8.19E+04 1.11E+05 4.09E+04 6.38E+04 6.06E+04 1.66E+04 2.22E+04 1.32E+04 9.72E+04 1.27E+05
2.43E+04 1.19E+04 1.71E+05 4.00E+04 2.97E+05 2.21E+05 1.79E+05 3.44E+05 2.00E+05 8.30E+03 2.04E+05 2.98E+05
4.11E+05 4.50E+05 3.95E+05 9.89E+04 3.96E+05 1.32E+04 1.59E+05 8.96E+04 3.39E+05

1573.5 d
5.25E+03 4.04E+04 8.02E+04 1.09E+05 4.00E+04 6.24E+04 5.90E+04 1.63E+04 2.14E+04 1.29E+04 9.76E+04 1.26E+05
2.40E+04 1.18E+04 1.71E+05 4.04E+04 2.97E+05 2.20E+05 1.78E+05 3.41E+05 1.99E+05 8.22E+03 2.05E+05 2.98E+05
4.11E+05 4.47E+05 3.95E+05 9.86E+04 3.96E+05 1.33E+04 1.56E+05 9.00E+04 3.37E+05

1681.3 d
5.32E+03 3.96E+04 7.85E+04 1.07E+05 3.93E+04 6.10E+04 5.74E+04 1.59E+04 2.08E+04 1.26E+04 9.76E+04 1.25E+05
2.37E+04 1.17E+04 1.71E+05 4.07E+04 2.97E+05 2.20E+05 1.78E+05 3.39E+05 1.98E+05 8.22E+03 2.05E+05 2.98E+05
4.10E+05 4.47E+05 3.94E+05 9.83E+04 3.96E+05 1.33E+04 1.53E+05 9.02E+04 3.36E+05

1789.1 d
5.39E+03 3.89E+04 7.70E+04 1.05E+05 3.86E+04 5.97E+04 5.61E+04 1.56E+04 2.04E+04 1.23E+04 9.81E+04 1.24E+05
2.36E+04 1.16E+04 1.71E+05 4.10E+04 2.97E+05 2.18E+05 1.77E+05 3.37E+05 1.98E+05 8.14E+03 2.05E+05 2.98E+05

4.10E+05 4.47E+05 3.94E+05 9.81E+04 3.96E+05 1.33E+04 1.49E+05 9.05E+04 3.35E+05

1896.9 d
5.42E+03 3.83E+04 7.55E+04 1.03E+05 3.79E+04 5.85E+04 5.48E+04 1.53E+04 1.98E+04 1.20E+04 9.81E+04 1.23E+05
2.33E+04 1.15E+04 1.71E+05 4.12E+04 2.96E+05 2.18E+05 1.77E+05 3.35E+05 1.97E+05 8.05E+03 2.05E+05 2.98E+05
4.08E+05 4.43E+05 3.93E+05 9.79E+04 3.96E+05 1.33E+04 1.45E+05 9.07E+04 3.33E+05

2004.9 d
5.49E+03 3.76E+04 7.43E+04 1.01E+05 3.73E+04 5.75E+04 5.36E+04 1.51E+04 1.94E+04 1.18E+04 9.81E+04 1.23E+05
2.31E+04 1.16E+04 1.70E+05 4.13E+04 2.96E+05 2.18E+05 1.76E+05 3.34E+05 1.97E+05 8.14E+03 2.05E+05 2.98E+05
4.08E+05 4.43E+05 3.93E+05 9.79E+04 3.94E+05 1.33E+04 1.43E+05 9.07E+04 3.32E+05

ISOTOPE	AT WT	DECAY(SEC)	LAMBDA(1/S)	SAS2H GRAMS	CALC GRAMS	SAS2H CURIES	CALC CURIES
kr 85	85.00	3.39E+08	2.04E-09	1.4000E+01	1.4025E+01	5.5100E+03	5.4865E+03
kr 85m	85.00	1.61E+04	4.30E-05	4.5700E-03	4.5730E-03	3.7600E+04	3.7639E+04
kr 87	87.00	4.57E+03	1.52E-04	2.6200E-03	2.6187E-03	7.4100E+04	7.4284E+04
kr 88	88.00	1.02E+04	6.78E-05	8.0200E-03	8.0256E-03	1.0100E+05	1.0065E+05
br 85	85.00	1.72E+02	4.03E-03	4.8400E-05	4.8365E-05	3.7300E+04	3.7283E+04
br 87	87.00	5.59E+01	1.24E-02	2.4800E-05	2.4795E-05	5.7700E+04	5.7527E+04
br 88	88.00	1.64E+01	4.23E-02	6.8500E-06	6.8552E-06	5.3300E+04	5.3596E+04
se 85	85.00	3.20E+01	2.17E-02	3.6300E-06	3.6295E-06	1.5200E+04	1.5056E+04
se 87	87.00	5.80E+00	1.20E-01	8.6900E-07	8.6913E-07	2.0100E+04	1.9435E+04
se 88	88.00	1.50E+00	4.62E-01	1.3800E-07	1.3816E-07	1.1800E+04	1.1810E+04
sb132	132.00	2.52E+02	2.75E-03	2.8900E-04	2.8908E-04	9.8100E+04	9.8057E+04
sb133	133.00	1.50E+02	4.62E-03	2.1800E-04	2.1812E-04	1.2300E+05	1.2336E+05
sb134	134.00	8.00E-01	8.66E-01	2.2000E-07	2.1976E-07	2.1800E+04	2.3131E+04
sb135	135.00	1.71E+00	4.05E-01	2.3800E-07	2.3760E-07	1.1600E+04	1.1613E+04
te131	131.00	1.50E+03	4.62E-04	2.9600E-03	2.9606E-03	1.7000E+05	1.7000E+05
te131m	131.00	1.17E+05	5.94E-06	5.6000E-02	5.5937E-02	4.4700E+04	4.1306E+04
te132	132.00	2.76E+05	2.51E-06	9.5800E-01	9.5832E-01	2.9100E+05	2.9628E+05
te133	133.00	7.44E+02	9.32E-04	1.9100E-03	1.9152E-03	2.1600E+05	2.1839E+05
te133m	133.00	3.32E+03	2.09E-04	6.8900E-03	6.8894E-03	1.7600E+05	1.7584E+05
te134	134.00	2.52E+03	2.75E-04	9.9800E-03	9.9830E-03	3.3500E+05	3.3357E+05
te135	135.00	1.90E+01	3.65E-02	4.4800E-05	4.4820E-05	1.9700E+05	1.9716E+05
te138	138.00	1.40E+00	4.95E-01	1.3900E-07	1.3938E-07	8.1400E+03	8.1401E+03
i131	131.00	6.93E+05	1.00E-06	1.6500E+00	1.6506E+00	2.0400E+05	2.0515E+05
i132	132.00	8.21E+03	8.44E-05	2.8600E-02	2.8644E-02	2.9800E+05	2.9830E+05
i133	133.00	7.49E+04	9.26E-06	3.6000E-01	3.6043E-01	4.0800E+05	4.0836E+05
i134	134.00	3.16E+03	2.20E-04	1.6600E-02	1.6616E-02	4.4400E+05	4.4332E+05
i135	135.00	2.37E+04	2.93E-05	1.1100E-01	1.1110E-01	3.9300E+05	3.9262E+05
i138	138.00	6.50E+00	1.07E-01	7.7800E-06	7.7832E-06	9.8000E+04	9.7904E+04
xe133	133.00	4.53E+05	1.53E-06	2.1000E+00	2.1014E+00	3.9400E+05	3.9355E+05
xe133m	133.00	1.89E+05	3.66E-06	2.9600E-02	2.9659E-02	1.3300E+04	1.3298E+04
xe135	135.00	3.28E+04	2.12E-05	5.6100E-02	5.6025E-02	1.4200E+05	1.4294E+05
xe135m	135.00	9.18E+02	7.55E-04	9.9700E-04	9.9630E-04	9.0800E+04	9.0709E+04
xe138	131.00	8.46E+02	8.19E-04	3.4300E-03	3.2619E-03	3.3200E+05	3.3210E+05

ISOTOPE	ASSM CI 1	ASSM CI 2	ASSM CI 3	BATCH CI/MW 1	BATCH CI/MW 2	BATCH CI/MW 3	BATCH CI/MW T
kr 85	3.5579E+03	5.0875E+03	5.4865E+03	9.4310E+01	1.3301E+02	1.4344E+02	3.7076E+02
kr 85m	1.7280E+05	8.7451E+04	4.2117E+04	4.5805E+03	2.2863E+03	1.1011E+03	7.9679E+03
kr 87	3.5538E+05	1.7572E+05	8.3909E+04	9.4200E+03	4.5939E+03	2.1937E+03	1.6208E+04
kr 88	5.0104E+05	2.4390E+05	1.1478E+05	1.3281E+04	6.3764E+03	3.0007E+03	2.2658E+04
br 85	1.7298E+05	8.7148E+04	4.1805E+04	4.5853E+03	2.2784E+03	1.0929E+03	7.9566E+03
br 87	2.8461E+05	1.3827E+05	6.5601E+04	7.5440E+03	3.6148E+03	1.7150E+03	1.2874E+04
br 88	2.9103E+05	1.3554E+05	6.2471E+04	7.7142E+03	3.5435E+03	1.6332E+03	1.2891E+04
se 85	7.2636E+04	3.5613E+04	1.7031E+04	1.9254E+03	9.3106E+02	4.4525E+02	3.3017E+03
se 87	1.0602E+05	4.9219E+04	2.2761E+04	2.8104E+03	1.2868E+03	5.9506E+02	4.6922E+03
se 88	5.6116E+04	2.7531E+04	1.3615E+04	1.4875E+03	7.1977E+02	3.5595E+02	2.5632E+03
sb132	2.2253E+05	1.6253E+05	9.8057E+04	5.8986E+03	4.2492E+03	2.5636E+03	1.2711E+04
sb133	3.6784E+05	2.2416E+05	1.2788E+05	9.7502E+03	5.8604E+03	3.3432E+03	1.8954E+04
sb134	7.6444E+04	4.3864E+04	2.4682E+04	2.0263E+03	1.1468E+03	6.4529E+02	3.8184E+03
sb135	2.8043E+04	1.9135E+04	1.1943E+04	7.4334E+02	5.0027E+02	3.1224E+02	1.5559E+03
te131	4.0093E+05	2.8660E+05	1.7075E+05	1.0628E+04	7.4927E+03	4.4642E+03	2.2584E+04
te131m	8.4644E+04	6.6748E+04	4.1306E+04	2.2437E+03	1.7450E+03	1.0799E+03	5.0686E+03
te132	6.9378E+05	4.9381E+05	2.9873E+05	1.8390E+04	1.2910E+04	7.8100E+03	3.9110E+04
te133	5.8388E+05	3.8369E+05	2.2294E+05	1.5477E+04	1.0031E+04	5.8284E+03	3.1336E+04

te133m	4.7523E+05	3.1229E+05	1.7923E+05	1.2597E+04	8.1645E+03	4.6857E+03	2.5447E+04
te134	1.0164E+06	6.1790E+05	3.4656E+05	2.6941E+04	1.6154E+04	9.0604E+03	5.2156E+04
te135	5.0478E+05	3.3672E+05	2.0013E+05	1.3380E+04	8.8031E+03	5.2322E+03	2.7415E+04
te138	1.7086E+04	1.2976E+04	8.3819E+03	4.5290E+02	3.3924E+02	2.1913E+02	1.0113E+03
i131	4.7544E+05	3.4681E+05	2.2795E+05	1.2602E+04	9.0669E+03	5.9595E+03	2.7629E+04
i132	6.9971E+05	4.9763E+05	3.0243E+05	1.8547E+04	1.3010E+04	7.9066E+03	3.9464E+04
i133	1.0066E+06	6.9918E+05	4.1137E+05	2.6681E+04	1.8279E+04	1.0755E+04	5.5715E+04
i134	1.1584E+06	7.7939E+05	4.5047E+05	3.0705E+04	2.0376E+04	1.1777E+04	6.2858E+04
i135	9.4934E+05	6.6788E+05	3.9548E+05	2.5164E+04	1.7461E+04	1.0339E+04	5.2964E+04
i138	2.4823E+05	1.6630E+05	9.9293E+04	6.5799E+03	4.3477E+03	2.5959E+03	1.3523E+04
xe133	9.8137E+05	7.0490E+05	4.3091E+05	2.6013E+04	1.8429E+04	1.1266E+04	5.5707E+04
xe133m	3.0710E+04	2.1944E+04	1.3298E+04	8.1402E+02	5.7370E+02	3.4765E+02	1.7354E+03
xe135	2.8622E+05	2.2525E+05	1.6188E+05	7.5867E+03	5.8890E+03	4.2321E+03	1.7708E+04
xe135m	2.0158E+05	1.4995E+05	9.0709E+04	5.3431E+03	3.9203E+03	2.3715E+03	1.1635E+04
xe138	9.3627E+05	5.9751E+05	3.4010E+05	2.4818E+04	1.5621E+04	8.8915E+03	4.9330E+04

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Enclosure (13)

Compact Disk Containing Input Data for DBA Calculations

Calvert Cliffs Nuclear Power, Inc.
November 3, 2005

ATTACHMENT (2)

MARKED-UP TECHNICAL SPECIFICATION PAGES

iii
1.1-3
3.4.15-1
3.4.15-3
3.4.15-4
3.7.10-1
3.7.10-2
3.7.11-1
3.7.11-2
3.9.3-1
5.5-18
5.5-19
5.5-20
5.5-24

INSERT 1

The TEDE (Total Effective Dose Equivalent) inhalation dose conversion factors used for this calculation shall be those listed in Table 2.1 in the column headed "effective" of Federal Guidance Report 11, ORNL, 1988, "Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion."

INSERT 2

---NOTE---

Penetration flow path(s) providing direct access from the containment atmosphere to the outside atmosphere may be unisolated under administrative controls.

Deleted

1.1 Definitions

DOSE EQUIVALENT I-131	DOSE EQUIVALENT I-131 shall be that concentration of I-131 (microcuries/gram) that alone would produce the same thyroid dose as the quantity and isotopic mixture of I-131, I-132, I-133, I-134, and I-135 actually present. ~~The thyroid dose conversion factors used for this calculation shall be those listed in Table III of TID-14844, AEC, 1962, "Calculation of Distance Factors for Power and Test Reactor Sites."~~
$\bar{E}$-AVERAGE DISINTEGRATION ENERGY	$\bar{E}$ shall be the average (weighted in proportion to the concentration of each radionuclide in the reactor coolant at the time of sampling) of the sum of the average beta and gamma energies per disintegration (in MeV) for isotopes, other than iodines, with half lives > 15 minutes, making up at least 95% of the total non-iodine activity in the coolant.
ENGINEERED SAFETY FEATURE (ESF) RESPONSE TIME	The ESF RESPONSE TIME shall be that time interval from when the monitored parameter exceeds its ESF actuation setpoint at the channel sensor until the ESF equipment is capable of performing its safety function (i.e., the valves travel to their required positions, pump discharge pressures reach their required values, etc.). Times shall include diesel generator starting and sequence loading delays, where applicable. The response time may be measured by means of any series of sequential, overlapping, or total steps so that the entire response time is measured. In lieu of measurement, response time may be verified for selected components provided that the components and methodology for verification have been previously reviewed and approved by the NRC.
L_a	The maximum allowable containment leakage rate, L_a, shall be ~~0.20%~~ 0.16% of containment air weight per day at the calculated peak containment pressure (P_a).

3.4 REACTOR COOLANT SYSTEM (RCS)

3.4.15 RCS Specific Activity

LCO 3.4.15 The specific activity of the reactor coolant shall be within limits.

APPLICABILITY: MODES 1 and 2,
MODE 3 with RCS average temperature (T_{avg}) ≥ 500°F.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. DOSE EQUIVALENT I-131 > ~~1.0~~ 0.5 μCi/gm.	---------- NOTE ---------- LCO 3.0.4 is not applicable. ---------- A.1 Verify DOSE EQUIVALENT I-131 within the acceptable region of Figure 3.4.15-1. AND A.2 Restore DOSE EQUIVALENT I-131 to within limit.	Once per 4 hours 100 hours

SURVEILLANCE REQUIREMENTS (continued)

SURVEILLANCE		FREQUENCY
SR 3.4.15.2	----------NOTE---------- Only required to be performed in MODE 1. ----------	
	Verify reactor coolant DOSE EQUIVALENT I-131 specific activity ≤ ~~1.0~~ 0.5 μCi/gm.	14 days AND Between 2 and 6 hours after THERMAL POWER change of ≥ 15% RTP within a 1 hour period
SR 3.4.15.3	----------NOTE---------- Not required to be performed until 31 days after a minimum of 2 effective full power days and 20 days of MODE 1 operation have elapsed since the reactor was last subcritical for ≥ 48 hours. ----------	
	Determine $\bar{E}$ from a sample taken in MODE 1 after a minimum of 2 effective full power days and 20 days of MODE 1 operation have elapsed since the reactor was last subcritical for ≥ 48 hours.	184 days

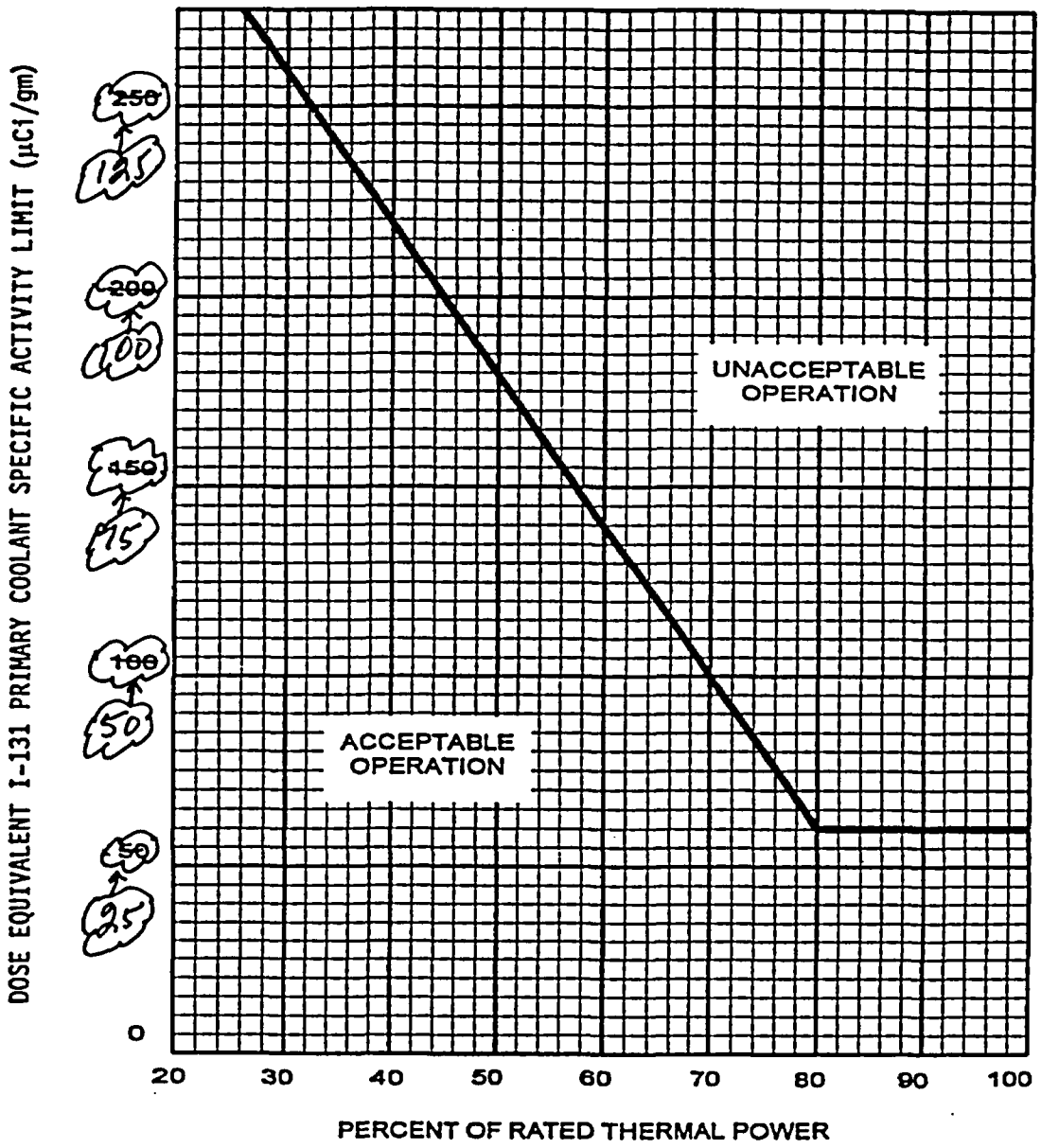

Figure 3.4.15-1 (page 1 of 1)
Reactor Coolant DOSE EQUIVALENT I-131 Specific Activity Limit
Versus Percent of RATED THERMAL POWER With Reactor Coolant
Specific Activity ≥ 1.0 0.5 µCi/gm DOSE EQUIVALENT I-131

3.7 PLANT SYSTEMS

3.7.10 Emergency Core Cooling System (ECCS) Pump Room Exhaust Filtration System (PREFS)

LCO 3.7.10 ECCS PREFS shall be OPERABLE.

APPLICABILITY: MODES 1, 2, 3, and 4.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. One ECCS PREFS exhaust fan inoperable.	A.1 Restore ECCS PREFS exhaust fan to OPERABLE status.	7 days
B. ECCS PREFS inoperable for reasons other than Condition A.	B.1 Restore ECCS PREFS to OPERABLE status.	24 hours
C. Required Action and associated Completion Time not met.	C.1 Be in MODE 3. AND C.2 Be in MODE 5.	6 hours 36 hours

SURVEILLANCE REQUIREMENTS

	SURVEILLANCE	FREQUENCY
SR 3.7.10.1	Operate ECCS PREFS for ≥ 15 minutes.	31 days
SR 3.7.10.2	Perform required ECCS PREFS filter testing in accordance with the Ventilation Filter Testing Program (VFTP).	In accordance with the VFTP

3.7 PLANT SYSTEMS

3.7.11 Spent Fuel Pool Exhaust Ventilation System (SFPEVS)

LCO 3.7.11 The SFPEVS shall be OPERABLE and in operation.

APPLICABILITY: During movement of recently irradiated fuel assemblies in the Auxiliary Building.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. ~~One SFPEVS charcoal adsorber bank inoperable.~~ ~~OR~~ One SFPEVS exhaust fan inoperable. ~~OR~~ ~~One SFPEVS charcoal adsorber bank and one SFPEVS exhaust fan inoperable.~~	A.1 Verify OPERABLE SFPEVS train is in operation. OR A.2 Suspend movement of recently irradiated fuel assemblies in the Auxiliary Building.	Immediately Immediately
B. No OPERABLE SFPEVS train. OR No OPERABLE SFPEVS train in operation.	B.1 Suspend movement of recently irradiated fuel assemblies in the Auxiliary Building.	Immediately

SURVEILLANCE REQUIREMENTS

SURVEILLANCE		FREQUENCY
SR 3.7.11.1	Verify an OPERABLE SFPEVS train is in operation.	12 hours
SR 3.7.11.2	~~Perform required SFPEVS filter testing in accordance with the Ventilation Filter Testing Program.~~ Deleted	~~In accordance with the Ventilation Filter Testing Program~~
SR 3.7.11.3	Verify each SFPEVS fan can maintain a measurable negative pressure with respect to atmospheric pressure.	24 months

3.9 REFUELING OPERATIONS

3.9.3 Containment Penetrations

LCO 3.9.3 The containment penetrations shall be in the following status:

a. 1. The equipment hatch closed and held in place by a minimum of four bolts, or

2. The containment outage door is capable of being closed under administrative control;

b. One door in the emergency air lock is closed;

---------- NOTE ----------
The emergency air lock temporary closure device can be used in place of an emergency air lock door.
---

c. The personnel air lock shall be either:

1. closed by one personnel air lock door, or

2. capable of being closed by an OPERABLE personnel air lock door under administrative control.

d. Each penetration providing direct access from the containment atmosphere to the outside atmosphere either:

1. closed by a manual or automatic isolation valve, blind flange, or equivalent, or

2. capable of being closed by an OPERABLE Containment Purge Valve Isolation System.

Insert 2 →

APPLICABILITY: During CORE ALTERATIONS,
During movement of irradiated fuel assemblies within containment.

5.5 Programs and Manuals

chemical release in any ventilation zone communicating with the system.

Tests described in Specification 5.5.11.c shall be performed once per 18 months for ventilation systems other than the IRS and 24 months for the IRS; after 720 hours of system operation; after any structural maintenance on the HEPA filter or charcoal adsorber housing; and following painting, fire, or chemical release in any ventilation zone communicating with the system.

Tests described in Specification 5.5.11.d shall be performed once per 18 months for ventilation systems other than the IRS and 24 months for the IRS.

The provisions of SR 3.0.2 and SR 3.0.3 are applicable to the Ventilation Filter Testing Program test frequencies.

a. Demonstrate for each of the ESF systems that an inplace test of the HEPA filters shows a penetration and system bypass ≤ 1.0% when tested in accordance with Regulatory Positions C.5.a and C.5.c of Regulatory Guide 1.52, Revision 2, and ANSI N510-1975, at the system flowrate specified as follows ± 10%:

ESF Ventilation System	Flowrate
Control Room Emergency Ventilation System (CREVS)	~~2,000~~ 10,000 cfm
~~Emergency Core Cooling System (ECCS) Pump Room Exhaust Filtration System (PREFS)~~	~~3,000 cfm~~
Penetration Room Exhaust Ventilation System (PREVS)	2,000 cfm
~~Spent Fuel Pool Exhaust Ventilation System (SFPEVS)~~	~~32,000 cfm~~
IRS	20,000 cfm

b. Demonstrate for each of the ESF systems that an inplace test of the charcoal adsorber shows a penetration and system bypass ≤ 1.0% when tested in accordance with Regulatory Positions C.5.a and C.5.d of Regulatory Guide 1.52,

5.5 Programs and Manuals

Revision 2, and ANSI N510-1975, at the system flowrate specified as follows ± 10%:

ESF Ventilation System	Flowrate
CREVS	~~2,000~~ 10,000 cfm
~~ECCS PREFS~~	~~3,000 cfm~~
PREVS	2,000 cfm
~~SFP Ventilation System~~	~~32,000 cfm~~
IRS	20,000 cfm

c. Demonstrate for each of the ESF systems within 31 days after removal that a laboratory test of a sample of the charcoal adsorber, when obtained as described in Regulatory Position C.6.b of Regulatory Guide 1.52, Revision 2, shows the methyl iodide penetration less than the value specified below when tested in accordance with ASTM D3803-1989 at a temperature of 30°C and greater than or equal to the relative humidity specified as follows:

ESF Ventilation System	Penetrations	RH
CREVS	5%	70%
~~ECCS PREFS~~	~~50%~~	~~95%~~
PREVS	35%	95%
~~SFP Ventilation System~~	~~15%~~	~~95%~~
IRS	35%	95%

d. For each of the ESF systems, demonstrate the pressure drop across the combined HEPA filters, the prefilters, and the charcoal adsorbers is less than the value specified below when tested in accordance with Regulatory Guide 1.52,

5.5 Programs and Manuals

Revision 2, and ANSI N510-1975 at the system flowrate specified as follows ± 10%:

ESF Ventilation System	Delta P	Flowrate
CREVS	4 inwg	~~2,000~~ 10,000 cfm
~~ECCS PREFS~~	~~4 inwg~~	~~3,000 cfm~~
PREVS	6 inwg	2,000 cfm
~~SFP Ventilation System~~	~~4 inwg~~	~~32,000 cfm~~
IRS	6 inwg	20,000 cfm

5.5.12 Explosive Gas and Storage Tank Radioactivity Monitoring Program

This program provides control for potentially explosive gas mixtures contained in the Waste Gas Holdup System and the quantity of radioactivity contained in gas storage tanks. The gaseous radioactivity quantities shall be determined following the methodology in the ODCM.

The program shall include:

a. The limits for concentrations of oxygen in the Waste Gas Holdup System and a surveillance program to ensure the limits are maintained. Such limits shall be appropriate to the system's design criteria (i.e., whether or not the system is designed to withstand a hydrogen explosion); and

b. A surveillance program to ensure that the quantity of radioactivity contained in each gas storage tank is less than or equal to 58,500 curies noble gases (considered as Xe-133).

The provisions of SR 3.0.2 and SR 3.0.3 are applicable to the Explosive Gas and Storage Tank Radioactivity Monitoring Program surveillance Frequencies.

5.5 Programs and Manuals

1992 Type A test shall be performed no later than June 14, 2007.

b. Unit 1 is excepted from post-modification integrated leakage rate testing requirements associated with steam generator replacement.

c. Unit 2 is excepted from post-modification integrated leakage rate testing requirements associated with steam generator replacement.

The peak calculated containment internal pressure for the design basis loss-of-coolant accident, P_a, is 49.4 psig. The containment design pressure is 50 psig.

The maximum allowable containment leakage rate, L_a, shall be ~~0.20~~ 0.16 percent of containment air weight per day at P_a.

Leakage rate acceptance criteria are:

a. Containment leakage rate acceptance criterion is $\leq 1.0\ L_a$. During the first unit startup following testing, in accordance with this program, the leakage rate acceptance criterion are $\leq 0.60\ L_a$ for Types B and C tests and $\leq 0.75\ L_a$ for Type A tests.

b. Air lock testing acceptance criteria are:

   1. Overall air lock leakage rate is $\leq 0.05\ L_a$ when tested at $\geq P_a$.

   2. For each door, leakage rate is $\leq 0.0002\ L_a$ when pressurized to ≥ 15 psig.

The provisions of SR 3.0.2 do not apply to the test frequencies specified in the Containment Leakage Rate Testing Program.

The provisions of SR 3.0.3 are applicable to the Containment Leakage Rate Testing Program.