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Initial issue. This document supersedes a document of the same title, DI# BBAC00000-01717-0210-00006, Revision 01, Accession # MOL.20000113.0334. This revision removes TBV-4110. The '*.cut' files of the last revision are stored on 3 compact disks as Attachment VII. The '*.source' files generated with the DATAWRITER program from the last revision are excluded from the compact disks. References have been updated and specific references added where appropriate. Changes have been made to comply with current procedures. All changes are marked with change bars. Since the DI# changed, every page will have at least one change bar for the header line. Therefore, individual page numbers with changes are not listed here. An impact review was completed on 07/17/2003. No interdisciplinary review is needed because the results of this calculation are independent of their use by other organizations outside Analysis & Component Design.

Attachments	Total Number of Pages
A total of 14 attachments. The number of pages in each is as follows: Attachment I has 16 pages, Att. II	
14 pages, Att. III 11 pages, Att. IV 10 pages, Att. V 10 pages, Att. VI 3 pages, Att. VII 3 compact disks,	
Att. VIII 10 pages, Att. IX 12 pages, Att. X 6 pages, Att. XI 1 page, Att. XII 16 pages, Att. XIII 10 pages,	
and Att. XIV, 1 page.	

RECORD OF REVISIONS

9. No.	10. Reason For Revision	11. Total # of Pgs.	12. Last Pg. #	13. Originator (Print/Sign/Date)	14. Checker (Print/Sign/Date)	15. QER (Print/Sign/Date)	16. Approved/Accepted (Print/Sign)	17. Date
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1 PURPOSE

This calculation is a revision of a previous calculation (Ref. 7.5) that bears the same title and has the document identifier BBAC00000-01717-0210-00006 REV 01. The purpose of this revision is to remove TBV (to-be-verified) –4110 associated with the output files of the previous version (Ref. 7.30). The purpose of this and the previous calculation is to generate source terms for a representative boiling water reactor (BWR) spent nuclear fuel (SNF) assembly for the first one million years after the SNF is discharged from the reactors. This calculation includes an examination of several ways to represent BWR assemblies and operating conditions in SAS2H in order to quantify the effects these representations may have on source terms. These source terms provide information characterizing the neutron and gamma spectra in particles per second, the decay heat in watts, and radionuclide inventories in curies. Source terms are generated for a range of burnups and enrichments (see Table 2) that are representative of the waste stream and stainless steel (SS) clad assemblies. During this revision, it was determined that the burnups used for the computer runs of the previous revision were actually about 1.7% less than the stated, or nominal, burnups. See Section 6.6 for a discussion of how to account for this effect before using any source terms from this calculation. The source term due to the activation of corrosion products deposited on the surfaces of the assembly from the coolant is also calculated.

The results of this calculation support many areas of the Monitored Geologic Repository (MGR), which include thermal evaluation, radiation dose determination, radiological safety analyses, surface and subsurface facility designs, and total system performance assessment. This includes MGR items classified as Quality Level 1, for example, the Uncanistered Spent Nuclear Fuel Disposal Container (Ref. 7.27, page 7). Therefore, this calculation is subject to the requirements of the Quality Assurance Requirements and Description (Ref. 7.28). The performance of the calculation and development of this document are carried out in accordance with AP-3.12Q, *Design Calculation and Analyses* (Ref. 7.29).

2 METHOD

The SAS2H sequence in SCALE 4.3 is used to calculate the thermal and radiation source terms for selected fuel assemblies as a function of assembly average burnup and cooling time. The prime functional module of the SAS2H code sequence utilized is the ORIGEN-S code. This code performs a point depletion and decay calculation of a selected fuel type with user-specified irradiation conditions and decay times. The crud (activated corrosion products) source terms are determined via a simple spreadsheet calculation in Excel.

3 ASSUMPTIONS

3.1. It is assumed that a single assembly can approximate various BWR assembly types, and that the source terms generated will not be greatly affected by this approximation in geometry. This assumption results in the path A and B representations for all assemblies in this calculation being identical to a representative assembly. Information for a General Electric (GE) 2/3 8X8 assembly is assumed to generate conservative source terms. This assumption is based on the fact that the assembly has a high initial heavy metal loading

(IHML), available operating data, and assembly hardware information. In the cases where the data on the hardware is lacking in sufficient detail to model it in SAS2H, data from other BWR assemblies are used to fill in a conservative manner. Different IHMLs can be accounted for by adjusting the fuel length, which is calculated from the IHML and the fuel density. The basis for this adjustment is that source terms are known to be sensitive to initial uranium loading and burnup (Ref. 7.3), but they are expected to be much less sensitive to variations in fuel transverse dimensions. This assumption is to be confirmed during a future sensitivity calculation concerning geometric representations in SAS2H. This assumption is used throughout Section 5.

3.2. The channel of the stainless steel (SS) clad assemblies is assumed to be Zircaloy-4. This assumption is corroborated by Ref. 7.2, which states that only the earliest versions of BWR assemblies used SS channels (those for Dresden-1, Humboldt Bay, and Big Rock Point), and that Zircaloy-4 became the standard material. Therefore, the SS clad assemblies calculated in this report use a Zircaloy-4 channel. This assumption is used throughout Section 5.

3.3. It is assumed that the flux scaling factors for the assembly hardware regions (bottom end-fitting, plenum, and top end-fitting) are 1.5 times the values (Ref. 7.6, Table S.1, p. vi) recommended by the U.S. Nuclear Regulatory Commission (NRC). The rationale is that this assumption provides about 50% margin for the neutron-activated sources in the hardware regions. This assumption is used in Section 5.2.

3.4. The clad/water rod (WR) material for SS assemblies is assumed to be SS348H. This assumption is corroborated by information in Ref. 7.15, p. 2A-16. This assumption is used in Section 5, Table 4.

3.5. The hardware parts of the BWR assembly described in Ref. 7.15, p. 2A-158, and used in Table 5 (see footnote 5), are assumed. The rationale for this assumption is that fuel assembly data are proprietary information and that the information in Ref. 7.15 is the best available. Since a 50% margin is applied to the neutron flux scaling factors (Assumption 3.3) to account for the uncertainty in the information, this assumption will result in conservative activation in the hardware regions. This assumption is used in Section 5, Table 5.

3.6. It is assumed that the ANF 9x9 JP-4 assembly will generate the bounding crud (activated corrosion products) source term and that the physical characteristics of the ANF 9x9 JP-4 assembly can be obtained from Ref. 7.2, p. 2A-24. Again, the rationale is that fuel assembly data are proprietary and the information in Ref. 7.15 is the best available technical data for this assembly. The rationale for using this assembly is that the crud source is proportional to the surface area that is exposed to coolant. Since the ANF 9x9 JP-4 assembly has a larger surface area than the GE 8x8 assembly, it will generate a more conservative (higher) crud source that will serve as the bounding crud source for the representative BWR assembly. This assumption is used in Sections 5.2 and 5.4.4, and in Attachment VI.

4 USE OF COMPUTER SOFTWARE AND MODELS

4.1 SOFTWARE APPROVED FOR QA WORK

- Program Name: SCALE
- Version/Revision Number: 4.3 Hewlett Packard (HP) 9000 Version, HP-UX V10.20
- Computer Software Configuration Identifier (CSCI) Number: 30011 V4.3 (Ref. 7.1)
- Computer Type: Hewlett Packard 9000 Series
- Computer Processing Unit Name and Civilian Radioactive Waste Management System (CRWMS) Management and Operating (M&O) Contractor Tag Number: 'Bloom,' CRWMS-M&O Tag 700887

The SAS2H computer code sequence of the SCALE V4.3 code system was developed to perform depletion analyses to obtain radiation and heat generation sources of spent fuel to be used in subsequent analyses. It is appropriate for this application, has been validated over the range it is used, and was obtained from Software Configuration Management in accordance with the appropriate procedures. The echo of the input files is contained in the *.cut files, which are listed in Attachment XII and available in the CDs of Attachment VII. The *.cut files, which consist of the input echoes and the final ORIGEN-S output, are sufficient to independently repeat the calculation.

4.2 EXEMPT SOFTWARE

4.2.1 Excel

The Microsoft Excel 97 spreadsheet program is used to perform simple calculations as documented in Section 5 of this calculation. The user-defined formulas, input, and results are documented in sufficient detail in Section 5 to allow for independent repetition of the various computations without recourse to the originator. This software is considered exempt from the requirements of AP-SI.1Q, Software Management (Ref. 7.31, Section 2.1.6).

4.2.2 Script Files

- Titles: neutrons, gammas, curies, watts
- Version/Revision Number: All are version 00

- Computer Type: HP 9000 Series

The specific task of each script is noted in Table 1. The script files are provided in Attachments VII and XI. They are executed with the 'awk' command by typing 'awk –f (script file) (input *.cut file name) > (output file name). These files are intended for use only with the appropriate *.cut SAS2H/ORIGEN-S output files listed in Attachment XII. The output of the script files has been verified by visual inspection. This software is considered exempt from the requirements of AP-SI.1Q, Software Management (Ref. 7.31, Section 2.1.1).

Table 1.Script Files

File Name	Function
neutrons	Extracts the total (alpha-n plus spontaneous fission) neutron source table from a *.cut file
gammas	Extracts the gamma source from the light element, actinide, and fission product contributions from a *.cu
watts	Extracts the total thermal output from the light element, actinide, and fission product contributions from a
curies	Extracts the tables of nuclide curies from a *.cut file for the light element, actinide, and fission product co

5 CALCULATION

5.1 REVISION HISTORY

Several calculations have been performed to provide BWR SNF source terms for shielding and thermal calculations. Ref. 7.3 was the first in a series of calculations to provide source terms, but was limited to a handful of burnups and enrichments that represented the anticipated average and bounding waste stream assemblies. The source terms represented only the first twenty-five years after discharge from the reactor. In addition, only the ORIGEN-S module was used to burn and decay the assembly. Ref. 7.4 replaced Ref. 7.3, and used the SAS2H/ORIGEN-S sequence to calculate the burnup and decay of the assembly to 1 million years. Ref. 7.4 included a wide range of burnups and enrichments, and the inclusion of a crud source. Reference 7.5 was a revision of Ref. 7.4, and was intended to provide the most complete set of conservative source terms for the SS clad and representative BWR assemblies in the expected waste stream. This calculation is a revision of Ref. 7.5 to clear TBV-4110.

The last two revisions incorporate several changes. While it had been assumed in the previous revision that increasing the fuel density slightly would have a negligible impact on the source terms, this result was not verified by the calculations in Ref. 7.4, pp. 46 and 47. Therefore, in the last two revisions, the fuel density for the waste stream is constant, and the fuel length is calculated from the heavy metal loading (see Section 5.5.2.1). Secondly, SS clad assemblies are included in this calculation. In addition, impurities are accounted for in the fuel, and the material definitions are modified slightly to increase the amounts of those elements that contribute to the source terms (particularly cobalt in steel). The number of enrichments and burnups (see Table 2) were increased, as well as the number of time steps out to 1 million years (see Table 44). The sources provided are expanded to include the inventory in curies of 61 radionuclides of interest (see Section 6.5). Calculations are performed to evaluate the effects of impurities in the fuel, and

the discussion of the ten axial node calculations is revised. Additional calculations are performed to provide radionuclide inventories for screening purposes.

5.2 SELECTION OF CONSERVATIVE PARAMETERS

The inputs for this calculation are chosen to lead to conservative source terms. This section discusses the main inputs and the reasons they are used. It covers several different parameters. The first of these is the geometry for the waste stream and SS clad assemblies.

In this calculation, the geometry used to model the assemblies in SAS2H corresponds to a GE 2/3 fuel assembly. The GE 2/3 has a high uranium loading and a large amount of assembly hardware, supporting more fission product generation and hardware activation. Therefore, this assembly provides a conservative basis for the BWR waste stream. The GE 2/3 assembly IHML is increased to 200 kg for the waste stream and SS clad assemblies to provide slightly higher source intensities.

As mentioned in Section 5.1, additional heavy metal mass is accounted for by increasing the fuel length, rather than the fuel density. A longer active fuel length and a lower density rather than a shorter fuel length and higher density decreases the fuel self-shielding. This results in a higher flux and consequently to a higher source intensity. In this calculation the IHML of the waste stream and SS clad assemblies is accounted for by the fuel length rather than the fuel density (see Section 5.5.2.1).

The irradiation of the assembly hardware is calculated by inputting the desired amount of light element material into the fuel region in SAS2H. When the sources are calculated, only the light elements are included. The SS clad assemblies use waste stream files for the bottom and top assembly regions. The hardware sources are calculated by irradiating the material in the fuel region; scaling factors (SF) are used to account for the lower flux seen in the non-fuel regions of the reactor. The SFs for the neutron flux, provided in Ref. 7.6, Table S.1, have an uncertainty of ± 50%. To generate conservative source terms for the non-fuel regions of the BWR assembly, the SFs used in this calculation represent 150% of those listed in Ref. 7.6, Table S.1, p.vi (Assumption 3.3).

Consideration has also been given to the material definitions. The compositions of Inconel X-750, Zircaloy-2 and -4, SS 304, and SS 348H are representative of materials used in the manufacture of nuclear fuel assemblies. These compositions use the maximum amounts of cobalt given by the references and a 0.08 wt% cobalt impurity (Ref. 7.7, p. 45) for the steels. The composition for SS 348H given by Ref. 7.9, Table 1, includes a 0.2 wt% cobalt content. The balance of the remaining elements are representative of the material compositions for each material, but are biased towards the maximum amount of Sn, Ni, and Nb. Impurities are also included in the fuel itself, and the concentrations are given in Table 13.

Not all the activation sources can be calculated with SAS2H. The source due to corrosion material that accumulates on the surfaces of the assembly from the flow of coolant (crud) is also calculated. A bounding crud source term is based on the Exxon ANF 9X9 JP-4 assembly

(Assumption 3.6). This representation of the ANF 9X9 JP-4 does not use GE 2/3 dimensions. The ANF 9X9 JP-4 has a greater surface area exposed to coolant, and the crud source is heavily dependent on the available surface area. This dependence comes from the source being calculated with a radioisotope activity density (Ci/cm^2). Three estimates for radioisotope densities are used, from three different sources (Ref. 7.10, 7.11, and 7.12). This calculation is discussed in detail in Section 5.5.3.

The enrichments calculated range from 0.711 wt% (natural) to 5.5 wt% (the complete list is shown in Table 2). This is done to cover the wide range seen in the waste stream and avoid the need to extrapolate for information on assemblies currently being developed. The number of time steps is increased to 180, providing more detailed information for the first 100 years after SNF is discharged from the reactors.

5.3 CALCULATION DESCRIPTION

This calculation uses SAS2H/ORIGEN-S to generate source terms for the BWR SNF. Due to the variations between BWR assembly types, calculations are performed to justify a conservative configuration in SAS2H with which to represent all BWR assemblies in the waste stream. Sections 5.5.1.1 - 5.5.1.4 develop source terms for several variations of BWR assemblies - covering a range of water rods (WRs), moderator density, and gadolinium doped rods (GDRs). Section 5.5.1.5 presents the results of this parametric study. The configuration representing a conservative combination of the number of WRs, GDRs, and thermal-hydraulic information is used in Section 5.5.2 to generate two different representations of the assembly.

The first representation determined in Section 5.5.2 uses one node to describe the fuel region. This is done for the waste stream, SS clad, and the thermal design basis fuel (DBF - the 3.74%, 48 GWd/MTU case) assemblies. The combinations for which source terms are calculated are shown in Table 2. The second representation divides the active fuel region into ten axial nodes. The ten-node calculation covers only one assembly with a 5.05% initial enrichment, all the burnups shown, and a 200 kg IHML. This is done to justify modeling a BWR assembly with one axial region; large variations in moderator density with core height require some representative density to be used for the whole core. An axial peaking factor (APF) is calculated from information in Ref. 7.13, pp. 290-544, and is intended to be applied to the one-node calculation results to compensate for under-predictions. Since the nodal burnup data from pp. 290-544 of Ref. 7.19 (a revision of Ref. 7.13) are essentially identical to the data from Ref. 7.13 (differing generally only in the 5th significant digit), APFs based on either Ref. 7.13 or Ref. 7.19 will be identical for design purposes. Section 6.1 shows a comparison of the ten-node and one-node calculation with an APF. This demonstrates the use of the APF, and addresses concerns about using a one-node representation of a BWR assembly to develop source terms.

The thermal DBF is used to illustrate the effect of fuel density on source terms. The waste stream and SS clad assembly cases are calculated with a 200 kg IHML. The thermal DBF is calculated with both 170 and 200 kg IHML. For the thermal DBF, the extra metal is accounted for by increasing the fuel density. As is seen in Section 6.2, the increased fuel density results in a less conservative source. As mentioned in Section 5.2, the waste stream and SS clad assemblies

account for the higher IHML by increasing the fuel length rather than the density. It should be noted that the cases comparing the one- and ten-node calculation, and the thermal DBF calculations (see notes in Table 2) are unchanged from Ref. 7.4, and include none of the revisions noted in Section 5.1. These cases are not to be compared directly to the waste stream and SS clad assemblies in this calculation.

Table 2.BWR Enrichments, Burnups, and IHMLs for Source Terms are Calculated[1]

Initial ^{235}U (wt%)	0.711, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5*, ***3.74***, 4.0*, 4.5, 5.0, 5.05, 5.5
Initial Heavy Metal Mass (kg)	200*, ***170***
Final Assembly Average Burnup (GWd/MTU)	0.001, 0.01, 0.1, 1*, 10*, 20*, 30*, 40*, ***49***, 50, 60, 70, 75

5.4 CALCULATION INPUTS

This section outlines the information used in the calculation of the source terms. Several parameters are listed as calculated; the calculations of these parameters are shown in the tables or in Section 5.5.

5.4.1 Physical Description of BWR Fuel Assembly

The physical characteristics of a GE 2/3 8X8 BWR fuel assembly are provided in Tables 3, 4, and 5. Figure 1 presents a general drawing of a BWR assembly. This is the information required to generate the SAS2H input files needed to create the BWR source terms. The number of digits cited herein may be a result of a calculation or may reflect the input from another source; consequently, the number of digits should not be interpreted as an indication of accuracy.

Table 3.GE 2/3 8X8 BWR General Assembly Data

Assembly Parameter	Value	Units	Reference
Total Number of Rod Positions	64	/assembly	Ref. 7.19, p. 5
Number of WRs	1, 2, or 4	/assembly	Ref. 7.19, pp. 5, 11
Number of Fueled Burnable Poison Rods	0-9	/assembly	Ref. 7.19, p. 13
Gadolinium Enrichment in the Burnable Poison Rods	3.0-4.0	wt%	
Channel Material	Zircaloy-4	NA[2]	Ref. 7.14, p. A-1

1. The parameters shown with an asterix are used for the SS clad assemblies. The entries in bold italics are used only for the thermal DBF. The 5.05 wt% enrichment is used only for the comparison between the one- and ten-node calculations. The *.cut files for the 5.05 wt% are part of Ref. 7.26.

Table 4.GE 2/3 8X8 BWR Assembly Dimensions

Assembly Parameter	Value	Units	Value	Units	Reference
Clad/WR Material	Zircaloy-2	NA	NA	NA	Ref. 7.19, p. 5
WR Outer Diameter (OD)	1.031	inches	2.6187	cm	
WR Inner Diameter (ID)	0.967	inches	2.4561	cm	
Channel Thickness	0.08-0.10	Inches	0.2032-0.254	cm	
Cladding ID	0.419	inches	1.06426	cm	
Cladding OD	0.483	inches	1.2268	cm	
Fuel Pellet OD	0.41	inches	1.0414	cm	
Fuel Rod Pitch	0.64	inches	1.6256	cm	
Channel Inner Dimension	5.278	inches	13.4061	cm	
Fuel Assembly Pitch	6.0	inches	15.24	cm	
Fuel Active Height	144	inches	365.76	cm	Ref. 7.14, p. C-12
Fuel Channel Height[3]	166.906	inches	423.941	cm	Ref. 7.14, p. C-14
Bottom End Fitting Length[4]	5.28+1.48+0.625=7.385	inches	18.7579	cm	Ref. 7.14, p. C-12
Fuel Rod Plenum Length	11.24	inches	28.5496	cm	
Top End Fitting Length[5]	6.65+0.85+0.84+0.435= 8.775	inches	22.2885	cm	
Total Assembly Length	171.40	inches	435.356	cm	
Clad/WR Material[6]	SS 348H	NA	NA	NA	Assumption 3.4

Table 5.BWR Assembly Hardware

Region	Reference	Part Name	lb/Assembly	kg/Assembly	Material
Top	Ref. 7.14, p. A-8	Tie plate	4.409	2.000	SS 304
	Assumption 3.5	Compression spring	1.279	0.580	Inconel X-750
		Channel	calculated	calculated	Zirc-4
Bottom	Ref. 7.14, p. A-8	Tie plate	10.516	4.770	SS 304
	Calculated	Channel	calculated	calculated	calculated
Plenum		Channel	calculated	calculated	Zirc-4
		Water rod	calculated	calculated	Zirc-2 / SS 348H
	Ref. 7.14, p. A-8	Getters	1.360	0.617	SS 304
		Plenum springs	3.748	1.700	SS 304 (Inconel X-750)[8]
Fuel		Channel	calculated	calculated	Zirc-4
	Ref. 7.14, p. A-8	Spacer grids[9]	4.299 / 0.717	1.950 / 0.325	Zirc-4 / Inconel X-750
		Water rod	calculated	calculated	Zirc-2 / SS 348H

3. Channel length for part 2 is used.
4. Axial dimensions are taken from a drawing in Ref. 7.14. Note that the plenum spring hardware is replaced with a more conservative material, Inconel (Table 5, footnote 8).
5. The extra 0.435 inches is taken from the fact that the dimensions on the drawing do not add up to 171.40 inches; to compensate for this, the top end fitting is adjusted to take on the extra length; because of the location, this will have negligible impact.
6. Information is used for the SS clad assemblies.
7. Information for the compression springs is taken from Ref. 7.15, p. 2A-158, and is originally given in kg.
8. Since SS304 was not the most stressing material, Inconel X-750 was substituted.

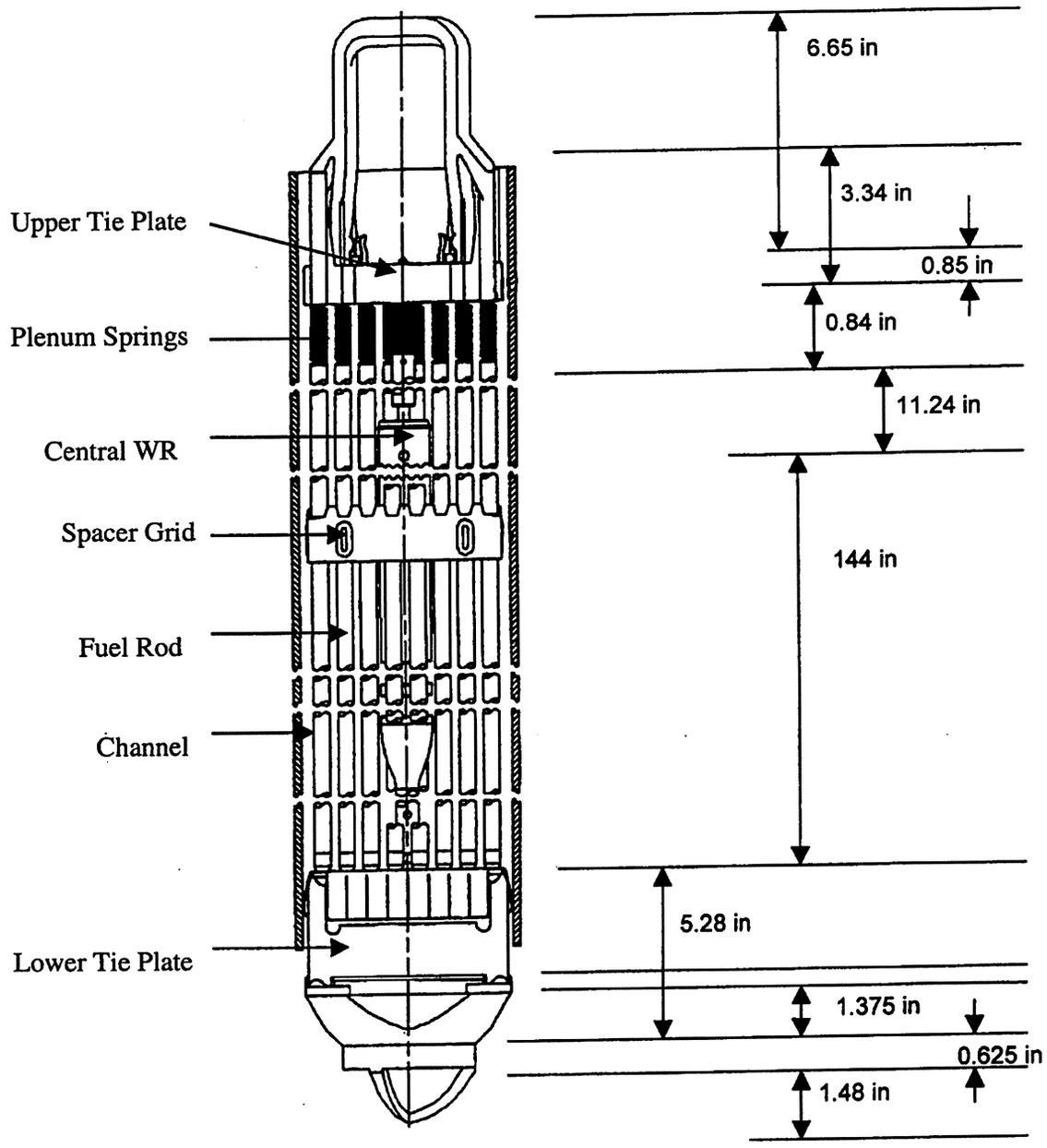

Figure 1. BWR Assembly Drawing

5.4.2 Operating Parameters

The parameters in this section, presented in Tables 6, 7, and 8 represent operating conditions for a Quad Cities, Unit 2 assembly (C3 is used, however, the choice of assembly is arbitrary). Table 6 provides general information. Information in Table 7 is required to determine the moderator temperature in Sections 5.5.1.3 and 5.5.2.2. The data in Table 8 (Ref. 7.13, pp. 333-334) are used to determine moderator density profiles, power profiles, and burnups for the parameter study, one- and ten-node comparison cases, and the thermal DBF calculations. The fuel temperatures shown in Table 9 (Ref. 7.19, pp. 333-334) are an update of those given in Table 8 (Ref. 7.13, pp. 333-334). The newer fuel temperatures are used to calculate the average fuel temperature (as done for the one-node calculations) for the waste stream and SS clad calculations. Reference 7.19 is Revision 01 of Ref. 7.13 (Revision 00). It should be noted that the ten-node water density data for assembly C3 from Ref. 7.19 are identical to the data from 7.13, and the ten-node burnup data for assembly C3 differ at most by one in the 5th significant digit. Since the temperature data from Ref. 7.13 in Table 8 are not used for the waste stream and SS clad source term calculations whose results may be used for other calculations such as waste package shielding and thermal studies, the information from Ref. 7.13 can be considered "reference only" in accordance with AP-3.15Q, *Managing Technical Product Inputs* (Ref. 7.33). The results of calculations using information available only from Ref. 7.13 are used solely internally to this document.

Table 6.Typical Assembly/Core Operating Parameters for the GE 8X8 Assembly

Parameter	Value	Units	Reference
Number of Assemblies In Core	724	NA	Ref. 7.19, p. 4
Total Core Thermal Power	2511	MWth	Ref. 7.19, p. 3
Average Assembly Power	2511/724=3.468	MW/assembly	Calculated
Cladding Temperature	620	K	Ref. 7.16, p. S2.6.12, Table S2.6.4
Operating Pressure	1020	psia	Ref. 7.19, p.5

Table 7.Steam Table Information

Temperature (°C)	Temperature (K)	Pressure (bar)	Pressure (psia)	Reference
270	543.15	55.052	798.4617	Ref. 7.18, p. 81
280	553.15	64.191	931.0117	
290	563.15	74.449	1079.7915	
300	573.15	85.917	1246.1207	

Table 8.Moderator Density, Fuel Temperature, and Burnup Profiles

Data Point	4	5	6	7	8	9	10	11	12	13
Node[10]	Water Density (g/cm^3)									
1	0.7396	0.7396	0.7396	0.7396	0.7396	0.7396	0.7396	0.7396	0.7396	0.7396
2	0.7396	0.7396	0.7396	0.7396	0.7396	0.7396	0.7396	0.7396	0.7396	0.7396
3	0.6949	0.6926	0.6930	0.6914	0.6934	0.6957	0.6959	0.6983	0.6999	0.7004
4	0.5607	0.5634	0.5658	0.5714	0.5776	0.5838	0.5845	0.5904	0.5941	0.5957
5	0.4559	0.4610	0.4587	0.4700	0.4776	0.4852	0.4860	0.4935	0.4975	0.4993
6	0.3883	0.3901	0.3851	0.3982	0.4053	0.4127	0.4134	0.4202	0.4235	0.4253
7	0.3341	0.3290	0.3242	0.3362	0.3424	0.3498	0.3504	0.3560	0.3587	0.3602
8	0.2976	0.2858	0.2827	0.2919	0.2971	0.3046	0.3051	0.3098	0.3121	0.3134
9	0.2701	0.2525	0.2509	0.2566	0.2610	0.2668	0.2672	0.2712	0.2735	0.2749
10	0.2595	0.2392	0.2383	0.2421	0.2461	0.2512	0.2516	0.2552	0.2576	0.2590
Data point	4	5	6	7	8	9	10	11	12	13
Node	Fuel Temp. (K)									
1	672.5	680.2	654.9	678.8	674.0	647.9	637.4	641.4	663.9	687.1
2	1050.0	1061.0	968.2	996.3	934.6	852.9	813.3	821.3	890.9	949.6
3	1248.3	1157.9	1141.4	1081.9	1006.6	945.0	890.7	900.5	993.7	1040.0
4	1258.2	1143.8	1252.1	1099.3	1035.0	987.4	958.1	966.6	1054.4	1058.9
5	1211.5	1142.8	1276.3	1133.7	1059.2	1006.2	1011.9	1018.5	1078.7	1065.3
6	1149.3	1151.8	1228.1	1171.9	1078.4	1019.6	1023.7	1030.9	1069.7	1067.2
7	1086.0	1152.4	1132.4	1192.7	1091.6	1052.9	1004.3	1014.0	1030.3	1050.1
8	1027.3	1130.5	1023.9	1166.2	1069.8	1095.1	963.0	969.7	960.5	995.8
9	884.2	986.1	885.8	1013.0	933.4	955.4	829.3	831.4	811.9	843.1
10	659.9	693.0	641.9	679.1	660.7	668.0	628.3	628.0	623.7	634.1
Data Point	4	5	6	7	8	9	10	11	12	13
Node	Burnup (GWd/MTU)									
1	1.371	2.983	3.922	5.898	6.786	7.372	7.415	7.875	8.51	9.208
2	5.934	12.616	16.625	23.845	26.747	28.687	28.826	30.292	32.301	34.43
3	8.332	16.304	22.009	30.642	34.1	36.647	36.829	38.738	41.37	43.992
4	8.451	16.235	23.025	31.945	35.622	38.45	38.669	40.946	43.946	46.671
5	7.887	15.657	22.684	32.173	36.037	38.99	39.238	41.805	44.952	47.712
6	7.135	15.025	21.58	31.700	35.713	38.753	39.008	41.644	44.737	47.502
7	6.369	14.268	19.885	30.347	34.462	37.722	37.966	40.509	43.363	46.039
8	5.66	13.267	17.821	27.846	31.792	35.331	35.553	37.848	40.279	42.659
9	3.929	9.611	12.811	20.304	23.195	25.81	25.959	27.48	29.01	30.558
10	1.219	3.001	3.812	5.793	6.578	7.297	7.335	7.72	8.111	8.52

Additional information regarding the final nodal burnup for all the assemblies included in Ref. 7.13 (pp. 290-544) is also used in this calculation. Due to the amount of information, it is presented in Attachment III. This information is used to generate Figure 6.

Table 9.Updated Fuel Temperature Profiles

Data Point	4	5	6	7	8	9	10	11	12	13
Node	Fuel Temp. (K)									
1	634.9	640.3	622.7	639.3	636	617.8	610.7	613.4	628.9	645.3
2	954.1	963.5	873.9	899.6	842.6	772.5	740.3	746.8	804.5	856.2
3	1116.6	982.1	967.5	914.8	853	805.8	766.4	773.4	843	879.9
4	1079	969.2	1073	929.7	875.8	838	815.7	822.1	891.8	895.5
5	1032.7	968.2	1097.5	960.1	895.7	852.7	857.2	862.5	912.1	900.8
6	974.3	976.4	1049.1	995.1	911.8	863.4	866.7	872.4	904.5	902.4
7	918.4	977	959.3	1014.5	923.1	890.7	851.2	858.9	872.1	888.2
8	869.7	957.2	867.1	989.8	904.6	926.2	819.4	824.5	817.6	844.7
9	763.3	839.7	764.2	860.8	798.9	815.5	725.1	726.6	713.5	734.7
10	618.8	638.1	608.3	629.9	619.2	623.5	600.6	600.4	598	603.9

Also required for this calculation is the height of each node in the active fuel region. This information is shown in Table 10.

Table 10. Node Heights[11]

Node	1	2	3	4	5	6	7	8	9	10
Height (cm)	15.24	30.48	30.48	45.72	30.48	45.72	45.72	45.72	64.11	15.24

11. The dimensions of the nodes shown in Table 10 (Ref. 7.13, p. 15, Fuel Type 9) do not represent all of the assembly types listed in Ref. 7.13. Fuel assemblies E-M use a slightly different node description, with nodes 9 and

Table 11 details information taken from Ref. 7.13, Table 3-8, p. 18 or from Ref. 7.19, Table 3-8, p. 18. This table lists the information on the data points (DP) and state points (SP) for which thermal hydraulic data are given in Ref. 7.13 and Ref. 7.19. The effective full power days (EFPD) are used along with the thermal hydraulic information to determine average values for the SAS2H input.

Table 11. Data Point and State Point Information

DP	Cycle	Cycle Position	Burnup	EFPD
DP1	9	BOC[12]	0	0
DP2	9	MOC[13]	2985.9 MWd/STU[14]	167.47
	9	EOC[15]	6212.4 MWd/STU	348.44
DP3	10	BOC	0	0
DP4	10	MOC	3985.1 MWd/STU	222.47
	10	EOC	8374.1 MWd/STU	467.48
DP5	11	BOC	0	0
DP6	11	MOC	3554.16 MWd/MTU[16]	180.3
	11	EOC	9544.11 MWd/MTU	484.2
DP7	12	BOC	0	0
DP8	12	MOC	2820.04 MWd/MTU	142.2
	12	EOC	5229.25 MWd/MTU	263.7
SP9	13	BOC	0	0
SP10	13	MOC	201.61 MWd/MTU	10.1
SP11	13	MOC	2257.20 MWd/MTU	112.94
DP12	13	MOC	4484.31 MWd/MTU	224.4
SP13	13	MOC	6489.46 MWd/MTU	324.73
	13	EOC	7735.18 MWd/MTU	387.07
SP14	14	BOC	0	0
DP15	14	MOC	1878.65 MWd/MTU	93.56
SP16	14	MOC	4238.45 MWd/MTU	211.09

12. BOC - Beginning of cycle
13. MOC - Middle of cycle
14. STU - Short ton uranium
15. EOC - End of cycle

5.4.3 Material Specifications

Table 12 describes the hardware materials used in this analysis. The atomic weights and isotopic abundances required to specify the fuel are given in Table 13. Table 14 provides a list of impurities that are included in the fuel composition. The compositions of the fuel rods and the GDRs are calculated in Sections 5.5.1.2 and 5.5.2.1.

Table 12. Chemical Compositions of Materials Used in SAS2H Calculations

Material	Element	Symbol	wt%	Reference
Zircaloy-2	Oxygen	O	0.12	Ref. 7.8, Table 2
	Chromium	Cr	0.1	
	Iron	Fe	0.2	
	Nickel	Ni	0.08	
	Tin	Sn	1.7	
	Zirconium	Zr	97.8	
	Density	6.56 g/cm³		
Zircaloy-4	Oxygen	O	0.12	Ref. 7.8, Table 2
	Chromium	Cr	0.1	
	Iron	Fe	0.2	
	Tin	Sn	1.7	
	Zirconium	Zr	97.88	
	Density	6.56 g/cm³		
Inconel X-750	Nickel	Ni	70.23	Ref. 7.20, p. 11
	Chromium	Cr	15	
	Iron	Fe	8	
	Niobium	Nb	1	
	Titanium	Ti	2.4	
	Aluminum	Al	0.7	
	Cobalt	Co	1	
	Manganese	Mn	0.8	
	Silicon	Si	0.4	
	Copper	Cu	0.4	
	Carbon	C	0.06	
	Sulfur	S	0.01	
SS 304	Carbon	C	0.08	Ref. 7.32, SEC IIA, SA -240, Ta
	Manganese	Mn	2	
	Phosphorus	P	0.045	
	Sulfur	S	0.03	
	Silicon	Si	0.75	
	Chromium	Cr	19	
	Nickel	Ni	10.42	
	Cobalt[17]	Co	0.08	
	Nitrogen	N	0.1	
	Iron	Fe	67.495	

Table 12. Chemical Compositions of Materials Used in SAS2H Calculations (Continued)

Material	Element	Symbol	wt%	Reference
SS 348H	Carbon	C	0.07	Ref. 7.9, Table 1
	Manganese	Mn	2	
	Silicon	Si	1	
	Chromium	Cr	18	
	Nickel	Ni	13	
	Phosphorus	P	0.045	
	Sulfur	S	0.03	
	Cobalt	Co	0.2	
	Niobium	Nb	1	
	Tantalum	Ta	0.1	
	Iron	Fe	64.555	

Table 13. Atomic Weights and Abundances Used in Fuel Material Calculations[18]

Element/Isotope	Atomic Weight	Abundance (%)
Oxygen	15.9994	-
^{234}U	234.0409	-
^{235}U	235.0439	-
^{236}U	236.0456	-
^{238}U	238.0508	-
^{152}Gd	151.9197	0.2
^{154}Gd	153.9208	2.18
^{155}Gd	154.9226	14.8
^{156}Gd	155.9221	20.47
^{157}Gd	156.9239	15.65
^{158}Gd	157.9241	24.84
^{160}Gd	159.9270	21.86

The concentrations of element impurities in fresh light water reactor fuel, in parts of element per million parts of heavy metal (ppm), are provided in Table 14. These values are provided by Ref. 7.7, Table 5.4, and reflect actual measured concentrations instead of the maximum allowable concentrations given in purity specifications.

Table 14. Nonactinide Composition of UO_2

Element	Concentration (ppm)	Element	Concentration (ppm)
Li	1.0	Mn	1.7
B	1.0	Fe	18.0
C	89.4	Co	1.0
N	25.0	Ni	24.0
F	10.7	Cu	1.0
Na	15.0	Zn	40.3
Mg	2.0	Mo	10.0
Al	16.7	Ag	0.1
Si	12.1	Cd	25.0
P	35.0	In	2.0
Cl	5.3	Sn	4.0
Ca	2.0	W	2.0
Ti	1.0	Pb	1.0
V	3.0	Bi	0.4
Cr	4.0		

5.4.4 Crud Source Inputs

In addition to the source terms for an assembly based on the actinides, fission products, and activated light elements, it is also necessary to estimate the source due to the activated corrosion products from the coolant deposited on the surfaces of the assembly (crud). These surfaces include all the areas of the assembly exposed to the flow of coolant. A bounding estimate of the BWR assembly surface area is based on an ANF 9x9 JP-4 assembly (Assumption 3.6), which has 79 fuel rods and two WRs. The information for this assembly is used due to the large array size and fuel rod size that provides a more conservative estimate of the surface area. The fuel rods for this assembly have a 0.424-inch (1.077-cm) outside diameter (OD) and a length of 163.84 inches (416.15 cm) (Ref. 7.2, p. 2A-24). Information on the size of the WRs is not included in this reference, so they are conservatively estimated to have an OD equivalent to the fuel rod pitch. Both the inner and outer surface areas of the WRs are included in the estimation of the surface area of the assembly (the WR clad is assumed to have a negligible thickness to ensure conservatism). The inner surface area of the assembly channel is also included. The channel dimensions used for calculating the surface area for crud buildup are a width of 5.44 inches (13.8176 cm) (Ref. 7.2, p. 2A-24) and a 0.08-inch (0.2032-cm) thickness (see Table 4).

Three estimates are used for the radioisotope activity density used in calculating crud sources. These are summarized in Table 15. The first estimate is from the Nuclear Regulatory Commission (NRC) NUREG-1567 (Ref. 7.10, Table 9.2) and is due solely to ^{60}Co. The second estimate from Ref. 7.11, p. 15, is also for ^{60}Co and agrees with the NRC value. The third estimate is from Ref. 7.12, Table 2. This estimate has activities for eight radionuclides and is included in this calculation for information purposes only. It is recommended that the NRC value be used for crud activity. The reason is that the ^{60}Co activity from the NRC agrees with that from Ref. 7.11 and is nearly three times that from Ref. 7.12. Emitting two very energetic photons and some beta particles, ^{60}Co is the most dominant isotope for crud. Since other radionuclides in Table 15 either have shorter half-lives or emit much lower intensity radiation, they become insignificant by the time the SNF arrives at the potential repository.

Table 15. Radioisotope Activity Densities and Half Lives Used in Crud Source Calculations

Radioisotopes	Half Life (years)	Activity Density (Ci/cm^2)	Reference
^{60}Co	5.2710	1.254E-03	7.10, Table 9.2
^{60}Co	5.2710	1.25E-03	7.11, p 15
^{51}Cr	0.0758	3.50E-05	7.12, Table 2
^{54}Mn	0.8545	1.72E-04	
^{55}Fe	2.7300	7.42E-03	
^{58}Co	0.1941	4.50E-05	
^{59}Fe	0.1219	7.20E-05	
^{60}Co	5.2710	4.77E-04	
^{63}Ni	100.00	0.00E+00	
^{65}Zn	0.6675	7.30E-05	
^{95}Zr	0.1753	5.80E-05	

5.5 CALCULATION

5.5.1 Parameter Study

Calculations are done to compare the possible combinations of WRs and GDRs in order to quantify the differences between the assembly types. For the purpose of determining a conservative configuration, one node of the active fuel region is modeled, and assembly hardware other than the WR and the channel is not included. The 44groupndf5 cross section library is used. The 'skipcellwt' and 'skipshipdata' shielding calculation options are skipped because the shielding sequence of SAS2H is unqualified. The latticecell option is used.

5.5.1.1 Path A and B Descriptions

SAS2H requires two geometric descriptions to be input. The path A description represents the fuel and moderator cell, and is used to generate cross sections that represent the fuel, clad, and moderator. The dimensions used for the path A geometry are shown in Table 16.

Table 16. SAS2H PATH A Description for Parameter Study

Variable Name	Value Used
Lattice type	Square pitch
Pitch	1.6256 cm
Fuel OD	1.0643 cm
Mfuel	1
Nmod	3
Clad OD	1.2268 cm
Mclad	2

The second geometry description required is known as the path B and represents the entire assembly. For this, parts of the assembly are represented with equivalent area concentric circles. Because there are several possibilities for the number of WR, GDRs, and moderator densities for

each assembly, comparison cases are examined in order to determine a conservative combination to use for the source term generation. The combinations examined in this calculation are taken from Ref. 7.17, pp. 50-55. The path B descriptions for these combinations are listed in Table 17. Since these descriptions are used solely internally to this calculation to determine a conservative configuration, the information taken from Ref. 7.17, can be used as "reference only."

Table 17. SAS2H PATH B Descriptions for Parameter Study[19]

Variable Name	Value Used						
	0 GDRs, 2 WRs	0 GDRs, 4 WRs	Comment	7 GDRs, 2 WRs	7 GDRs, 4 WRs	10 GDRs, 4 WRs	Comment
	Path B #1	Path B #2		Path B #4	Path B #6	Path B #8	
Mixes	7	7	WR	6	6	6	GDR
Radius, cm	1.06426	1.22805		0.53213	0.53213	0.53213	
Mixes	4	4	WR clad	2	2	2	Cladding
Radius, cm	1.2268	1.30935		0.61340	0.61340	0.613340	
Mixes	3	3	In-channel moder	3	3	3	In-cell moderator
Radius, cm	1.29704	1.83429		0.91715	0.91715	0.91715	
Mixes	500	500	Homogenized fue	500	500	500	Homogenized fuel
Radius, cm	7.33716	7.33716		2.72951	2.68513	2.24654	
Mixes	4	4	Channel	4	4	4	Channel material
Radius, cm	7.57331	7.57331		2.82015	2.77721	2.32358	
Mixes	7	7	Bypass moderato	7	7	7	Bypass, in-channel
Radius, cm	8.59824	8.59824		3.24983	3.24983	2.71900	

These path B geometries are also shown in Figures 2 and 3. In addition to the above variations, several moderator densities are examined. These are summarized in Table 18.

Table 18. Moderator Densities Used for Parameter Study

Density	Description
1	Determined from core follow data from Ref. 7.13, for node 5. These cases use multiple cycles that vary the moderator (see Table 20 for this calculation.)
2	Full reference density - 0.7396 g/cm^3 (Ref. 7.13, Table 2-2, p. 5 or Ref. 7.19, Table 2-2, p.5)
3	Low density (similar to the outlet) - 0.2 g/cm^3
4	Average density for all nodes and cycles (see Table 37) - 0.4435 g/cm^3

The path B descriptions for the assemblies containing GDRs use the scheme shown in Figure 2. The assemblies with WRs only are described by the scheme in Figure 3.

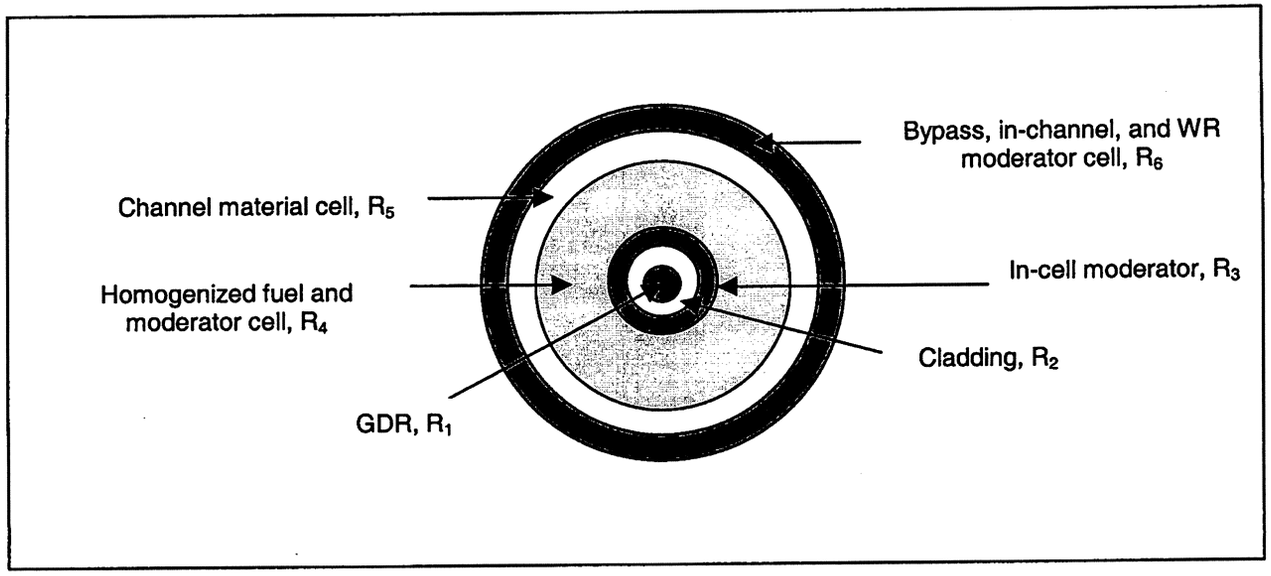

Figure 2. Path B for SAS2H Calculations, Descriptions 4, 6, and 8

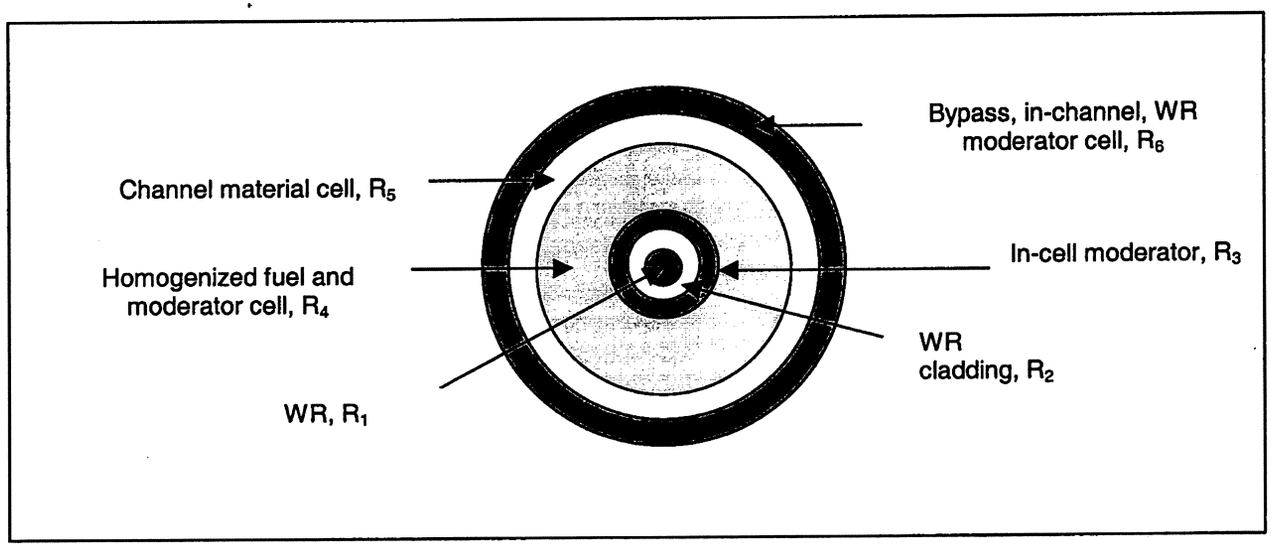

Figure 3. Path B for SAS2H Calculations, Descriptions 1 and 2

5.5.1.2 Fuel Material Specifications

This calculation requires the description of six materials: regular fuel (with no gadolinium), GDRs, cladding, in-channel moderator, bypass moderator, and channel material. The equations used to determine the isotopic wt%s of these materials are shown below. The regular fuel rods are specified with the standard composition UO_2; only the breakdown of the uranium by isotope is required as input (see Equations 1 through 3). For the GDRs, the wt%s of all the isotopes are specified. This is done by first using the information calculated with Equations 1 through 3 (Ref. 7.34, p. 20), and then determining the molecular weights of gadolinium oxide (Gd_2O_3) and UO_2 with Equation 6 (by using the values determined with Equations 4 and 5). Equations 7 and 8 determine the weight fractions of uranium, gadolinium, and oxygen. From these weight fractions, the isotopic wt% of the required isotopes of uranium and gadolinium are calculated with Equations 9 - 11.

$$wt\%\,U_{236} = 0.0046 * (wt\%\,U_{235}) \qquad \text{(Eq. 1)}$$

$$wt\%\,U_{234} = 0.007731 * (wt\%\,U_{235})^{1.0837} \qquad \text{(Eq. 2)}$$

$$wt\%\,U_{238} = 100 - (wt\%\,U_{234} + wt\%\,U_{235} + wt\%\,U_{236}) \qquad \text{(Eq. 3)}$$

$$(1/molecular\ weight)^{uranium} = 0.01 * \sum_i \left(\frac{wt\%}{atomic\ weight}\right)_i \qquad \text{(Eq. 4)}$$

$$(1/molecular\ weight)^{gadolinium} = 0.01 * \sum_i \left(\frac{wt\%}{atomic\ weight}\right)_i \qquad \text{(Eq. 5)}$$

$$(molecular\ weight)_{UO_2\ or\ Gd_2O_3} = (\#\ of\ U\ or\ Gd\ atoms) * (molecular\ weight) + (\#\ of\ O\ atoms) * (atomic\ weight)_{oxygen} \qquad \text{(Eq. 6)}$$

$$(weight\ fraction)_{U\ or\ Gd\ term} = (\#\ U\ or\ Gd\ atoms) * \left(\frac{molecular\ weight_{U\ or\ Gd\ term}}{molecular\ weight_{UO_2\ or\ Gd_2O_3}}\right) \qquad \text{(Eq. 7)}$$

$$(weight\ fraction)_{Oxygen} = 1 - (weight\ fraction)_{U\ or\ Gd\ term} \qquad \text{(Eq. 8)}$$

$$(wt\%\,Gd)_i^{GDR} = enrichment^{GDR} * (wt\%\,Gd)_i * (weight\ fraction)_{gadolinium} \qquad \text{(Eq. 9)}$$

$$(wt\%\,U)_i^{GDR} = (1 - enrichment^{GDR}) * (wt\%\,U)_i * (weight\ fraction)_U \qquad \text{(Eq. 10)}$$

$$(wt\%\ O)^{GDR} = 100 - \sum_i [(wt\%\ U)_i + (wt\%\ Gd)_i] \qquad \text{(Eq. 11)}$$

These calculations are shown in Attachment I, Worksheet 'parameter study.' The atomic weights and isotopic abundances used in this calculation are summarized in Table 13. Node 5 of assembly C3 (Ref. 7.13, Tables 3-3, 3-4, and 3-6 or Ref. 7.19, Tables 3-3, 3-4, and 3-6) is used in the study of different combinations of GDRs and WRs. For this node, the fuel is 3.2 wt% initially enriched in ^{235}U. The GDRs are 3.0 wt% enriched with gadolinium. Table 19 shows the weight percentages of the isotopes as they are described in the SAS2H files.

Table 19. Weight Percentages of Isotopes for Materials Defined in SAS2H for the Parameter Study

Isotope	SAS2H Isotope Identifier	Material					
		Fuel	GDR	Cladding	Channel	In-channel Moderator	Bypass Moderator
O	8016	11.8536	11.8952	0.12	0.12	0.8888	0.8888
^{234}U	92234	0.0240	0.0233	-	-	-	-
^{235}U	92235	2.8207	2.7361	-	-	-	-
^{236}U	92236	0.0130	0.0126	-	-	-	-
^{238}U	92238	85.2887	82.7301	-	-	-	-
^{152}Gd	64152	-	0.0052	-	-	-	-
^{154}Gd	64154	-	0.0567	-	-	-	-
^{155}Gd	64155	-	0.3852	-	-	-	-
^{156}Gd	64156	-	0.5328	-	-	-	-
^{157}Gd	64157	-	0.4073	-	-	-	-
^{158}Gd	64158	-	0.6465	-	-	-	-
^{160}Gd	64160	-	0.5690	-	-	-	-
H	1001	-	-	-	-	0.1111	0.1111
Cr	24000	-	-	0.10	0.10	-	-
Fe	26000	-	-	0.10	0.20	-	-
Ni	28000	-	-	0.05	-	-	-
Sn	50000	-	-	1.40	1.40	-	-
Zr	40000	-	-	98.23	98.18	-	-
Density (g/cm^3)[20]		9.9695	9.9695	6.56	6.56	Varied with cyc	0.7396

Because SAS2H does not permit the modeling of the gas gap between the fuel and the cladding for a central GDR, a smeared fuel density is used (the same approximation is made for the regular fuel rods as well). This has a negligible effect on the calculation, and is a common approximation. The smeared density is calculated from Equation 12:

$$\rho_{smeared} = (\%\ theoretical\ density * \rho_{theoretical}) * \left(\frac{pellet\ radius^2}{clad\ inside\ radius^2} \right) \qquad \text{(Eq. 12)}$$

Yielding:

$$\rho_{smeared} = (0.95) * (10.96\ g/cm^3) * \left(\frac{0.5207^2}{0.53213^2} \right) = 9.9695\ g/cm^3$$

5.5.1.3 Fuel Temperatures and Moderator Densities

The temperature of the cladding and channel is taken to be that of the cladding described in Table 6. This temperature is in the sample calculations for SAS2H in the SCALE manual. The fuel temperature used for all parameter study cases is a cycle weighted average (see Table 20), and is determined from the operating information presented in Tables 8 and 11. The EFPD used as a weighting factor corresponds to the MOC. For BOC data points, the difference between the EFPD given in Table 11 and the EFPD shown in Table 20 is simply the previous MOC value subtracted from the BOC value.

It is also necessary to calculate a cycle weighted moderator density (referred to as 'density 4' in Table 18), as well as moderator densities for each cycle (described as the 'density 1' case in Table 18). For the 'density 1' case, MOC values are used if possible; for cycle 13 an average is taken over the MOC values.

Table 20. Average Fuel Temperature and Moderator Densities for Parameter Study[21]

DP	EFPD from Table 11 (days)	EFPD (days)	Fuel Temperature (K)	Moderator Density (g/cm^3)	Moderator Densities for Each Cycle (g/cm^3)[22]
4	222.47	222.47	1211.5	0.4559	0.4559
5	467.48	245.01	1142.8	0.4610	
6	180.3	180.3	1276.3	0.4587	0.4587
7	484.2	303.9	1133.7	0.4700	
8	142.2	142.2	1059.2	0.4776	0.4776
9	263.7	121.5	1006.2	0.4852	
10	10.1	10.1	1011.9	0.4860	0.4964 (average over the values for th
11	112.94	102.84	1018.5	0.4935	
12	224.4	111.46	1078.7	0.4975	
13	324.73	100.33	1065.3	0.4993	
Total		1540.11			
Straight average			1100.4	0.4785	
Weighted average over all cycles			1129.2	0.4727	

$$weighted\ average = \frac{\sum_{data\ point} (EFPD_i * (Temperature\ or\ density)_i)}{Total\ EFPD} \qquad \text{(Eq. 13)}$$

21. The fuel temperature and moderator density information in Table 20 correspond to node 5 of the C3 assembly of the Quad Cities reactor (Ref. 7.13, Table 4.141, pp. 333-334).

The moderator temperatures are determined from the operating pressure given in Table 6 and the steam table information given in Table 7. The calculation is shown in Table 21.

Table 21. Moderator Temperature Calculation

Temperature (K)	Pressure (psia)
553.15	931.0117
563.15	1079.7915

$$moderator\ temperture = temperature_1 + \left(\frac{\Delta Temperature}{\Delta Pressure}\right) * (operating\ pressure - pressure_1)$$

(Eq. 14)

$$moderator\ temperature = 553.15 + \left(\frac{563.15 - 553.15}{1079.7915 - 931.0117}\right) * (1020 - 931.0117)$$

$$moderator\ temperature = 559.13\ \mathrm{K}$$

5.5.1.4 Overall Assembly Input

As previously stated, for the purposes of this parameter study, one node is examined. The selection of this node is arbitrary, and serves only to use uniform values for all the calculations. Node 5 information is used. The overall assembly information for each geometry examined is given in Table 22.

Table 22. SAS2H Assembly Input for Parameter Study

Variable Name	Path B #1	Path B #2	Path B #4	Path B #6	Path B #8
Npin/assm	62	60	62	60	60
Fuelngth	30.48	30.48	30.48	30.48	30.48
Ncycles	4	4	4	4	4
Nlib/cyc	3	3	3	3	3
Printlevel	5	5	5	5	5
Inplevel	2	2	2	2	2
Asmpitch	15.24	15.24	15.24	15.24	15.24
Numxtotal	6	6	6	6	6
Mxrepeats	1	1	1	1	1
Mixmod	3	3	3	3	3
Facmesh	1.0	1.0	1.0	1.0	1.0

The parameter study cases use a similar irradiation history as node 5 of assembly C3 of the Quad Cities reactor. The choice of this assembly is arbitrary, but is chosen because this assembly reached a high burnup. The burnup information for this node is given below in Table 23. The thermal-hydraulic information for this node is detailed in Tables 18, 20, and 21.

Table 23. Burnup Information for Parameter Study

Uranium mass in node: 14.144 kg				
	BOC 11	BOC 12	BOC 13	EOC 13
Cumulative Node Burnup (GWd/MTU)[23]	15.657	32.173	38.990	49.301
Burnup for Cycle (MWd/MTU)	15657	16516	6817	10311
EFPD for Cycle	467.48	484.2	263.7	387.07
Nodal Power (MW)	0.4737	0.4825	0.3656	0.3768

5.5.1.5 Parameter Study Results

As noted in Ref. 7.21, p. 119, it is important to "obtain a good estimate of the time-averaged moderator density at an axial location to best calculate spent fuel composition." Ref. 7.21 makes the following conclusions:

- Sensitivity to moderator changes appears to be close to linear for most of the nuclides.
- The actinides are most sensitive to changes in moderator density. Decreased moderator density results in increased quantities of actinides, and vice versa. The density decrease results in spectral hardening which in turn results in increased Pu production, and decreased ^{235}U depletion due to increased Pu fission.
- Of the fission products, only ^{149}Sm, ^{151}Sm, and ^{135}Cs are sensitive to moderator density, increasing quantities with decreasing moderator density, as the spectral hardening increases Pu fission, which produces the Sm nuclides more rapidly than U fission.

This last conclusion is demonstrated in the results of the SAS2H calculations where the grams of the mentioned isotopes are printed. This is shown in Table 24.

Table 24. Parameter Study Comparison of Fission Product Masses

Path B	Density[24]	Isotope	Grams					
			1 day	10 years	100 years	1000 years	10,000 years	100,000 years
1	2	Sm^{149}	0.0217	0.0339	0.0339	0.0339	0.0339	0.0339
		Sm^{150}	6.19	6.19	6.19	6.19	6.19	6.19
		Cs^{135}	6.26	6.27	6.27	6.26	6.25	6.08
	3	Sm^{149}	0.0316	0.0437	0.0437	0.0437	0.0437	0.0437
		Sm^{150}	6.72	6.72	6.72	6.72	6.72	6.72
		Cs^{135}	7.83	7.84	7.84	7.84	7.81	7.60
8	2	Sm^{149}	0.0205	0.0330	0.0330	0.0330	0.0330	0.0330
		Sm^{150}	6.17	6.17	6.17	6.17	6.17	6.17
		Cs^{135}	6.19	6.19	6.19	6.19	6.17	6.00
	3	Sm^{149}	0.0303	0.0427	0.0427	0.0427	0.0427	0.0427
		Sm^{150}	6.75	6.75	6.75	6.75	6.75	6.75
		Cs^{135}	7.83	7.83	7.83	7.83	7.81	7.60

These conclusions are also shown in the results of the sample cases in this calculation, with the lower outlet moderator density (at the top of the core) generating the highest source.

Tables 25 - 28 present the total gamma and neutron sources for the five BWR path B descriptions with the moderator densities described in Table 18 and at different time steps. A normalization of radiation sources to that obtained with density 1 of the moderator is provided in these tables to address the influence of moderator density on the source terms provided by the different BWR assemblies (or path B descriptions). There is little variation between the geometric models for a given moderator density as is seen from the normalized results. The information in these tables is calculated in Attachment V, Worksheet 'total.report(density)'.

Table 25. Comparison of Total Neutron and Gamma Sources for Different BWR Assemblies, Moderator Density 1

Total Gamma Sources Over Time					
Path B / Time (years)	1	2	4	6	8
0.00274	2.31E+16	2.33E+16	2.31E+16	2.33E+16	2.32E+16
10	1.14E+14	1.14E+14	1.14E+14	1.14E+14	1.14E+14
100	1.24E+13	1.23E+13	1.24E+13	1.23E+13	1.23E+13
1000	2.68E+11	2.56E+11	2.74E+11	2.59E+11	2.62E+11
10000	3.57E+10	3.63E+10	3.63E+10	3.66E+10	3.68E+10
100000	5.69E+09	5.51E+09	5.80E+09	5.56E+09	5.62E+09
Total Neutron Sources Over Time					
Path B / Time (years)	1	2	4	6	8
0.00274	2.56E+07	2.70E+07	2.69E+07	2.79E+07	2.83E+07
10	1.26E+07	1.37E+07	1.33E+07	1.42E+07	1.43E+07
100	6.85E+05	7.35E+05	7.21E+05	7.60E+05	7.70E+05
1000	2.03E+05	2.19E+05	2.14E+05	2.27E+05	2.31E+05
10000	7.86E+04	8.40E+04	8.18E+04	8.65E+04	8.74E+04
100000	2.40E+04	2.52E+04	2.45E+04	2.56E+04	2.57E+04

Table 26. Comparison of Total Neutron and Gamma Sources for Different BWR Assemblies, Moderator Density 2

Total Gamma Sources Over Time					
Path B Time (years)	1	2	4	6	8
0.00274	2.33E+16	2.35E+16	2.33E+16	2.35E+16	2.35E+16
10	1.14E+14	1.13E+14	1.13E+14	1.13E+14	1.13E+14
100	1.24E+13	1.23E+13	1.23E+13	1.23E+13	1.23E+13
1000	2.38E+11	2.29E+11	2.41E+11	2.31E+11	2.33E+11
10000	3.37E+10	3.45E+10	3.41E+10	3.47E+10	3.49E+10
100000	5.20E+09	5.05E+09	5.25E+09	5.09E+09	5.12E+09
Time (years)	Percentage of Moderator Density 1 Results for Gammas				
0.00274	101%	101%	101%	101%	101%
10	100%	100%	100%	100%	100%
100	99%	99%	99%	100%	99%
1000	89%	89%	88%	89%	89%
10000	95%	95%	94%	95%	95%
100000	91%	92%	90%	91%	91%
	Total Neutron Sources Over Time				
Path B Time (years)	1	2	4	6	8
0.00274	2.27E+07	2.41E+07	2.34E+07	2.46E+07	2.49E+07
10	1.11E+07	1.22E+07	1.15E+07	1.25E+07	1.26E+07
100	6.01E+05	6.47E+05	6.19E+05	6.63E+05	6.69E+05
1000	1.77E+05	1.91E+05	1.82E+05	1.96E+05	1.98E+05
10000	7.20E+04	7.67E+04	7.35E+04	7.81E+04	7.86E+04
100000	2.44E+04	2.55E+04	2.47E+04	2.58E+04	2.58E+04
Time (years)	Percentage of Moderator Density 1 Results for Neutrons				
0.00274	89%	89%	87%	88%	88%
10	88%	89%	86%	88%	88%
100	88%	88%	86%	87%	87%
1000	87%	87%	85%	86%	86%
10000	92%	91%	90%	90%	90%
100000	102%	101%	101%	101%	101%

Table 27. Comparison of Total Neutron and Gamma Sources for Different BWR Assemblies, Moderator Density 3

Total Gamma Sources Over Time					
Path B Time (years)	1	2	4	6	8
0.00274	2.32E+16	2.33E+16	2.33E+16	2.33E+16	2.33E+16
10	1.15E+14	1.15E+14	1.15E+14	1.15E+14	1.15E+14
100	1.25E+13	1.24E+13	1.25E+13	1.24E+13	1.24E+13
1000	3.08E+11	2.95E+11	3.26E+11	2.99E+11	3.05E+11
10000	3.79E+10	3.84E+10	3.90E+10	3.87E+10	3.91E+10
100000	6.35E+09	6.17E+09	6.68E+09	6.27E+09	6.38E+09
Time (years)	Percentage of Moderator Density 1 Results for Gammas				
0.00274	100%	100%	101%	100%	100%
10	101%	101%	101%	101%	101%
100	101%	101%	101%	101%	101%
1000	115%	115%	119%	115%	116%
10000	106%	106%	108%	106%	106%
100000	112%	112%	115%	113%	114%
Total Neutron Sources Over Time					
Path B Time (years)	1	2	4	6	8
0.00274	2.97E+07	3.15E+07	3.23E+07	3.29E+07	3.35E+07
10	1.49E+07	1.61E+07	1.62E+07	1.69E+07	1.72E+07
100	8.17E+05	8.76E+05	8.96E+05	9.25E+05	9.42E+05
1000	2.45E+05	2.67E+05	2.72E+05	2.86E+05	2.93E+05
10000	9.00E+04	9.69E+04	9.79E+04	1.03E+05	1.05E+05
100000	2.36E+04	2.49E+04	2.45E+04	2.57E+04	2.59E+04
Time (years)	Percentage of Moderator Density 1 Results for Neutrons				
0.00274	116%	116%	120%	118%	118%
10	118%	118%	122%	119%	120%
100	119%	119%	124%	122%	122%
1000	121%	122%	128%	126%	127%
10000	115%	115%	120%	119%	120%
100000	98%	99%	100%	101%	101%

Table 28. Comparison of Total Neutron and Gamma Sources for Different BWR Assemblies, Moderator Density 4

Total Gamma Sources Over Time					
Path B Time (years)	1	2	4	6	8
0.00274	2.32E+16	2.33E+16	2.32E+16	2.33E+16	2.33E+16
10	1.14E+14	1.14E+14	1.14E+14	1.14E+14	1.14E+14
100	1.24E+13	1.24E+13	1.24E+13	1.23E+13	1.23E+13
1000	2.74E+11	2.63E+11	2.82E+11	2.65E+11	2.69E+11
10000	3.61E+10	3.67E+10	3.67E+10	3.70E+10	3.72E+10
100000	5.77E+09	5.60E+09	5.90E+09	5.65E+09	5.71E+09
Time (years)	Percentage of Moderator Density 1 Results for Gammas				
0.00274	100%	100%	100%	100%	100%
10	100%	100%	100%	100%	100%
100	100%	100%	100%	100%	100%
1000	102%	102%	103%	102%	103%
10000	101%	101%	101%	101%	101%
100000	102%	102%	102%	102%	102%
Total Neutron Sources Over Time					
Path B Time (years)	1	2	4	6	8
0.00274	2.60E+07	2.75E+07	2.74E+07	2.84E+07	2.88E+07
10	1.29E+07	1.40E+07	1.36E+07	1.45E+07	1.47E+07
100	6.99E+05	7.50E+05	7.39E+05	7.77E+05	7.87E+05
1000	2.06E+05	2.23E+05	2.18E+05	2.32E+05	2.35E+05
10000	7.93E+04	8.48E+04	8.29E+04	8.75E+04	8.85E+04
100000	2.39E+04	2.51E+04	2.44E+04	2.55E+04	2.56E+04
Time (years)	Percentage of Moderator Density 1 Results for Neutrons				
0.00274	102%	102%	102%	102%	102%
10	102%	102%	103%	102%	102%
100	102%	102%	102%	102%	102%
1000	102%	102%	102%	102%	102%
10000	101%	101%	101%	101%	101%
100000	99%	100%	100%	100%	100%

As shown in Table 29, the results from shielding calculations (Ref. 7.22, p. 19) for the dose on the outside radial surface of a waste package indicate the neutron dose dominates on the 300 - 1000+ year time frame. At these times it represents 79 - 98% of the dose. At times greater than 30,000 years, the neutron dose on the surface of the waste package represents 5 - 6% of the total.

Table 29. Percentage of Surface Dose Due to Neutrons for the 21 PWR Waste Package[25]

Region of the Waste Package Surface	5 years	10 years	50 years	100 years	300 years	1000 years	10,000 years	30,000 years
Top section of the active fuel region	5%	8%	11%	9%	79%	96%	18%	5%
Middle section of the active fuel region	6%	9%	12%	10%	80%	97%	20%	6%
Bottom section of the active fuel region	5%	8%	11%	9%	79%	97%	18%	5%

Figure 4 and Figure 5 (generated in Attachment V, Worksheet 'Den4.%ofmod1.g') show the neutron and gamma sources over time for the five path B descriptions (at density 4). The results are shown relative to path B #1.

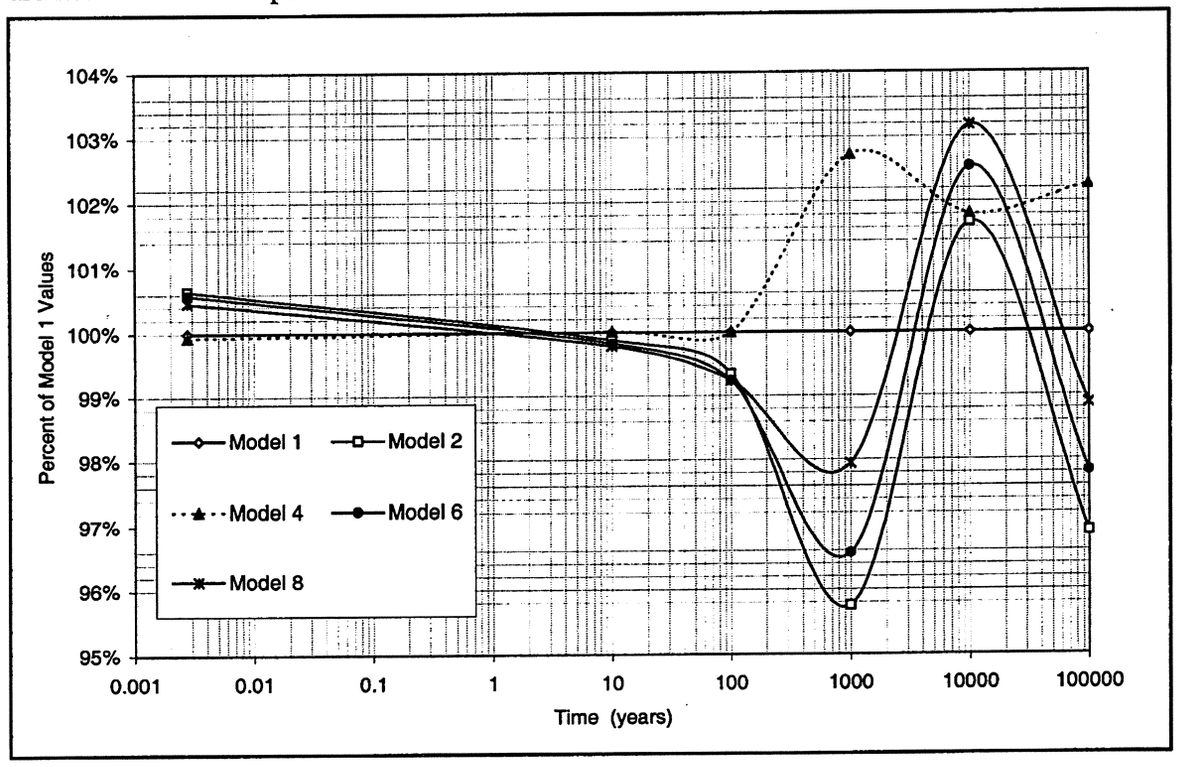

Figure 4. Percentage Results for the Gamma Sources for the Various Path B Descriptions

As seen in the Figure 4, all the assemblies are close to each other at early times, with those containing the GDRs becoming less conservative in the 300 - 1000+ years time frame. However, as time progresses, the GDR bearing assemblies again become more conservative. In all cases, the results of all the assemblies are within a few percent of each other. The graph of the neutron results (Figure 5; generated in Attachment V, Worksheet 'den4.%mod1n') is much more straight forward, with path B #8 yielding more conservative results, sometimes by as much as 14%. For these reasons, path B #8 is used in the subsequent calculations.

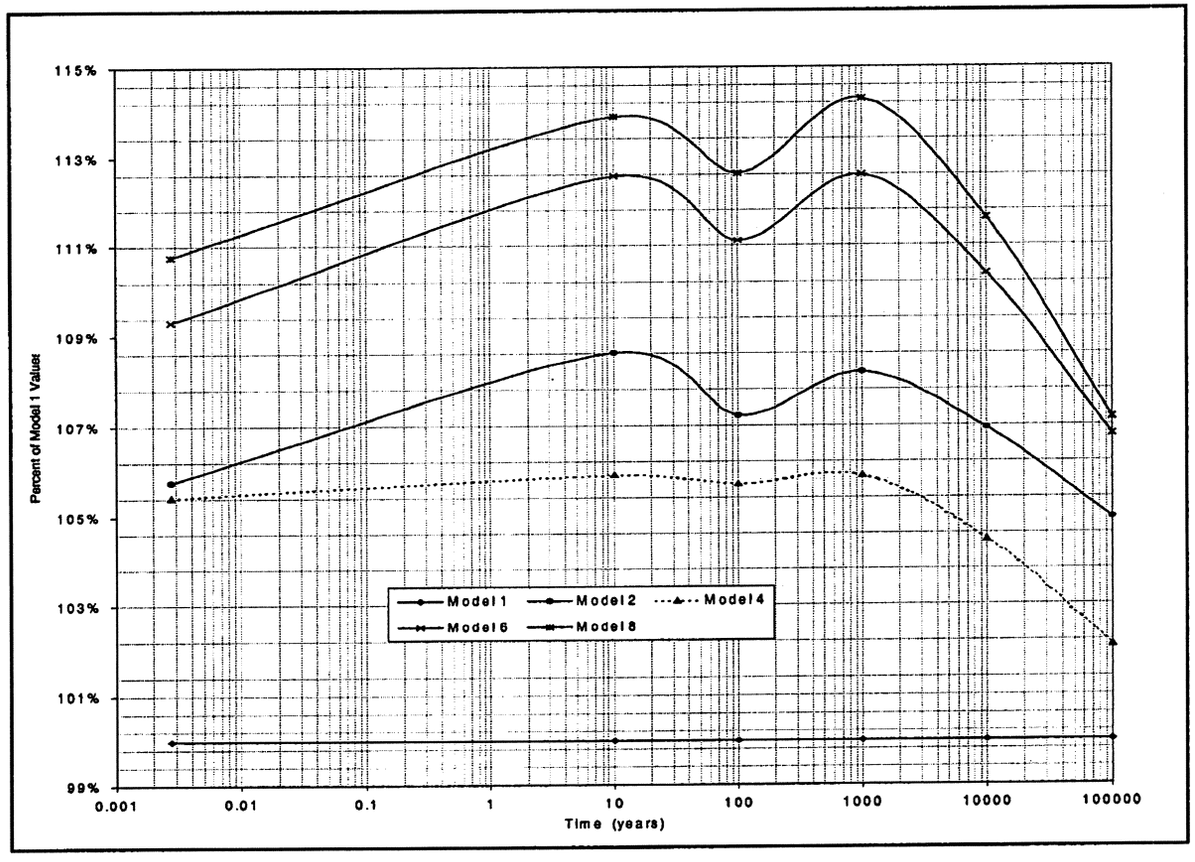

Figure 5. Percentage Results for the Neutron Sources for the Various Path B Descriptions

5.5.2 One- and Ten-Node Calculations

5.5.2.1 Material Specifications

The thermal DBF calculations use a fuel density determined from the IHML (200 or 170 kg) and the total fuel volume. This results in a density of 11.64 g/cm^3 for the 200 kg loading and 9.89 g/cm^3 for the 170 kg loading. These calculations are shown in Attachment I, worksheet 'density'. The lower density yields a higher per MTU normalized source for both gammas and neutrons, as shown in Section 6.2. Based on these results, the source terms for the waste stream calculations

of this calculation use a fuel length that has been increased to account for any additional loading desired, with the fuel density kept at 9.9695 g/cm^3 for all cases (see Attachment I, Worksheet 'length calculation'). As done in Section 5.5.1.2, the fuel specifications are determined from Equations 1 - 11. The calculations are performed in Attachment I, in Worksheets '5.5' through 'natural.' The results are summarized in Table 30.

Table 30. Weight Percents for Fuel Rods and GDRs for All Enrichments

Weight % of All Isotopes in GDRs													
Isotope or Element	5.5	5.05	5.0	4.5	4.0	3.7	3.5	3.0	2.5	2.0	1.5	1.0	Natural
O	11.8983	11.8977	11.8976	11.8969	11.8963	11.8959	11.8956	11.8950	11.8943	11.8937	11.8930	11.8923	11.8920
^{234}U	0.0419	0.0382	0.0378	0.0337	0.0297	0.0276	0.0257	0.0217	0.0178	0.0140	0.0103	0.0066	0.0046
^{235}U	4.7024	4.3177	4.2750	3.8475	3.4200	3.1977	2.9926	2.5651	2.1376	1.7101	1.2826	0.8550	0.6079
^{236}U	0.0216	0.0199	0.0197	0.0177	0.0157	0.0147	0.0138	0.0118	0.0098	0.0079	0.0059	0.0039	0.0028
^{238}U	80.7330	81.1238	81.1672	81.6014	82.0355	82.2613	82.4696	82.9037	83.3377	83.7717	84.2056	84.6393	84.8900
^{152}Gd	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052	0.0052
^{154}Gd	0.0567	0.0567	0.0567	0.0567	0.0567	0.0567	0.0567	0.0567	0.0567	0.0567	0.0567	0.0567	0.0567
^{155}Gd	0.3852	0.3852	0.3852	0.3852	0.3852	0.3852	0.3852	0.3852	0.3852	0.3852	0.3852	0.3852	0.3852
^{156}Gd	0.5328	0.5328	0.5328	0.5328	0.5328	0.5328	0.5328	0.5328	0.5328	0.5328	0.5328	0.5328	0.5328
^{157}Gd	0.4073	0.4073	0.4073	0.4073	0.4073	0.4073	0.4073	0.4073	0.4073	0.4073	0.4073	0.4073	0.4073
^{158}Gd	0.6465	0.6465	0.6465	0.6465	0.6465	0.6465	0.6465	0.6465	0.6465	0.6465	0.6465	0.6465	0.6465
^{160}Gd	0.5690	0.5690	0.5690	0.5690	0.5690	0.5690	0.5690	0.5690	0.5690	0.5690	0.5690	0.5690	0.5690
Weight % of Uranium Isotopes in Fuel Rods													
Isotope	5.5	5.05	5.0	4.5	4.0	3.7	3.5	3.0	2.5	2.0	1.5	1.0	Natural
^{234}U	0.04904	0.04471	0.04423	0.03946	0.03473	0.03229	0.03005	0.02543	0.02087	0.01639	0.012	0.00773	0.00534
^{235}U	5.5	5.05	5	4.5	4	3.74	3.5	3	2.5	2	1.5	1	0.711
^{236}U	0.0253	0.02323	0.023	0.0207	0.0184	0.0172	0.0161	0.0138	0.0115	0.0092	0.0069	0.0046	0.00327
^{238}U	94.4257	94.8821	94.9328	95.4398	95.9469	96.2105	96.4539	96.9608	97.4676	97.9744	98.4811	98.9877	99.2804

The next parameters calculated are the light element masses to be irradiated by SAS2H, representing the assembly hardware. The first step is to determine the channel mass using Equation 15 and the information from Tables 4 and 5.

$$\begin{aligned} \textit{Channel mass} &= \textit{channel height} * \\ &\left(\textit{channel outside width}^2 - \textit{channel inside width}^2\right) * \textit{channel density} \quad \text{(Eq. 15)} \\ &= 38.597\ kg \end{aligned}$$

The calculated channel mass is higher than any of the available reference values, and is therefore used. This is done to include as much tin, a gamma source for shorter cooling times, in the model as possible. Using this value, and the information in Table 4, the mass of channel in each region is calculated, as shown in Table 31, along with the mass of WR in the fuel and plenum regions. These calculations are shown in Attachment II, Worksheet 'compositions', cells F9, H9, I9, N9, P9, and J9.

Table 31. Calculation of WR and Channel Mass in Different Assembly Regions

Description	(Eq. 16)	Result: Mass (kg)
Mass of channel in top end fitting	$mass = \left(\frac{length\ in\ top\ region}{channel\ length}\right) * channel\ mass$	0.9949
Mass of channel in bottom end fi	$mass = \left(\frac{length\ in\ bottom\ region}{channel\ length}\right) * channel\ mass$	0.6512
Mass of channel in plenum regio	$mass = \left(\frac{length\ in\ plenum\ region}{channel\ length}\right) * channel\ mass$	2.6754
Mass of channel in fuel region	$mass = \left(\frac{length\ in\ fuel\ region}{channel\ length}\right) * channel\ mass$	34.276
Mass of WR in fuel region[26]	$mass = \left(\frac{length\ in\ fuel\ region}{water\ rod\ length}\right) * WR\ mass$	3.1099
Mass of water rod in plenum regi	$mass = \left(\frac{length\ in\ plenum\ region}{water\ rod\ length}\right) * WR\ mass$	0.2428

The masses of the hardware shown in Tables 5 and 31 are multiplied by the weight fractions of the constituent elements that compose the material. The calculation for the thermal DBF is performed in Attachment II, Worksheet 'compositions'. The light element calculations for the waste stream and the SS clad assemblies are performed in Worksheets '811.compositions' and '811.ssclad.compositions,' respectively. The resultant elemental mass is then multiplied by the appropriate scaling factor for a GE assembly (Ref. 7.6, Table S.1, p. vi) to account for the hardware's location in the assembly. These results are shown in Tables 32 and 33. The calculations are performed in Attachment II, Worksheet 'Table 5.3.2.1-2' for the thermal DBF, '811.lite.el.tables' for the waste stream, and '811.ssclad.lite.el.tables' for the stainless steel clad assemblies, using results taken from the '*compositions' Worksheets mentioned earlier.

Table 32. Light Element Masses Used for the Thermal DBF and One-Node Comparison Case[27]

Element	Top End Fitting Region Masses (kg) SF: 0.150		Plenum Region Masses (kg) SF: 0.300		Fuel Region Masses (kg) SF: 1.000		Bottom End Fitting Region Masses (kg) SF: 0.225	
	Thermal DBF	One-Node Case	Thermal DBF	One-Node Case	Thermal DBF	One-Node Case	Thermal DBF	One-Node Case
O	0.0002	0.0002	0.0022	0.0022	0.0977	0.0977	0.0002	0.0002
Al	0.0006	0.0006	0.0036	0.0036	0.0023	0.0023	0.0000	0.0000
C	0.0003	0.0003	0.0005	0.0005	0.0002	0.0002	0.0009	0.0009
Co	0.0009	0.0011	0.0051	0.0053	0.0033	0.0033	0.0000	0.0009
Cr	0.0702	0.0702	0.1135	0.1135	0.1302	0.1302	0.2041	0.2041
Cu	0.0003	0.0003	0.0020	0.0020	0.0013	0.0013	0.0000	0.0000
Fe	0.2135	0.2135	0.1708	0.1707	0.1468	0.1437	0.7381	0.7381
Mn	0.0067	0.0067	0.0078	0.0078	0.0026	0.0026	0.0215	0.0215
Nb	0.0009	0.0009	0.0051	0.0051	0.0033	0.0033	0.0000	0.0000
N	0.0003	0.0003	0.0002	0.0002	0.0000	0.0000	0.0011	0.0011
Ni	0.0888	0.0886	0.3758	0.3757	0.2495	0.2510	0.0993	0.0984
P	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000	0.0005	0.0005
S	0.0001	0.0001	0.0001	0.0001	0.0000	0.0000	0.0003	0.0003
Si	0.0026	0.0026	0.0034	0.0034	0.0013	0.0013	0.0080	0.0080
Sn	0.0021	0.0021	0.0261	0.0261	1.1402	1.1402	0.0021	0.0021
Ti	0.0021	0.0021	0.0122	0.0122	0.0078	0.0078	0.0000	0.0000
Zr	0.1465	0.1465	1.8280	1.8281	79.9798	79.9814	0.1439	0.1439

27. These are the light element masses calculated in Ref. 7.4, Table 5.3.2.1-1.2. They do not contain any fuel

Table 33. Light Element Masses Used for the Waste Stream and SS Assemblies[28]

Element	Waste Stream				SS Clad	
	Fuel Region Masses (kg) SF: 1.000	Plenum Region Masses (kg) SF: 0.300	Top End Fitting Region Masses (kg) SF: 0.150	Bottom End Fitting Region Masses (kg) SF: 0.225	Fuel Region Masses (kg) SF: 1.000	Plenum Region Masses (kg) SF: 0.300
Ag	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Al	0.0056	0.0036	0.0006	0.0000	0.0056	0.0036
B	0.0002	0.0000	0.0000	0.0000	0.0002	0.0000
Bi	0.0001	0.0000	0.0000	0.0000	0.0001	0.0000
C	0.0181	0.0005	0.0003	0.0009	0.0569	0.0014
Ca	0.0004	0.0000	0.0000	0.0000	0.0004	0.0000
Cd	0.0050	0.0000	0.0000	0.0000	0.0050	0.0000
Cl	0.0011	0.0000	0.0000	0.0000	0.0011	0.0000
Co	0.0035	0.0053	0.0011	0.0009	0.1142	0.0078
Cr	0.1310	0.1135	0.0702	0.2041	10.0483	0.3458
Cu	0.0015	0.0020	0.0003	0.0000	0.0015	0.0020
F	0.0021	0.0000	0.0000	0.0000	0.0021	0.0000
Fe	0.1925	0.1695	0.2097	0.7247	35.8316	1.0040
In	0.0004	0.0000	0.0000	0.0000	0.0004	0.0000
Li	0.0002	0.0000	0.0000	0.0000	0.0002	0.0000
Mg	0.0004	0.0000	0.0000	0.0000	0.0004	0.0000
Mn	0.0029	0.0078	0.0067	0.0215	1.1098	0.0337
Mo	0.0020	0.0000	0.0000	0.0000	0.0020	0.0000
N	0.0050	0.0002	0.0003	0.0011	0.0050	0.0002
Na	0.0030	0.0000	0.0000	0.0000	0.0030	0.0000
Nb	0.0033	0.0051	0.0009	0.0000	0.5568	0.0181
Ni	0.2694	0.3783	0.0924	0.1118	7.4284	0.5459
O	27.3704	0.0022	0.0002	0.0002	27.3135	0.0010
P	0.0070	0.0001	0.0001	0.0005	0.0319	0.0007
Pb	0.0002	0.0000	0.0000	0.0000	0.0002	0.0000
S	0.0000	0.0001	0.0001	0.0003	0.0166	0.0005
Si	0.0037	0.0034	0.0026	0.0080	0.5572	0.0164
Sn	1.3853	0.0317	0.0025	0.0025	0.6166	0.0137
Ta	0.0000	0.0000	0.0000	0.0000	0.0553	0.0013
Ti	0.0080	0.0122	0.0021	0.0000	0.0080	0.0122
V	0.0006	0.0000	0.0000	0.0000	0.0006	0.0000
W	0.0004	0.0000	0.0000	0.0000	0.0004	0.0000
Zn	0.0081	0.0000	0.0000	0.0000	0.0081	0.0000
Zr	79.6784	1.8211	0.1461	0.1434	35.4577	0.7856

As noted previously, there are seven spacer grids in the core. To evaluate the effect of these grids on the peaking factor determined in this calculation, the spacer grids are accounted for in the ten-node representation. This is done by determining which nodes the grids fall into (from the locations given in Ref. 7.14, p. A-8 and the node heights given in Table 10), and irradiating the material via the light element option in SAS2H, along with the channel and cladding material. The node fraction information is calculated in Attachment II, Worksheet 'ten node', cells I1 - S6, and is shown in Table 34. The fuel region light elements are shown on this worksheet in cells A4 - H25, with the final light element calculations performed in cells A26 - S120. The results are summarized in Table 35.

Table 34. Calculation of Node Fraction of Whole Active Fuel Height

Node:	1	2	3	4	5	6	7	8	9	10
Height (inches)	6	18	30	48	60	78	96	114	139.24	145.24
Percentage of Spacer Gr	0	69.231	30.769	100	100	61.538	38.46 +6	30.769	200	0
Percentage of Channel a	4.14	8.28	8.28	12.4	8.28	12.4	12.4	12.4	17.4	4.14

Table 35. Light Element Masses for Ten-Node Representation of the Active Fuel Region

Element	Light Element Masses (kg)									
	node 1	node 2	node 3	node 4	node 5	node 6	node 7	node 8	node 9	node 10
O	0.0039	0.0081	0.0080	0.0122	0.0082	0.0120	0.0122	0.0119	0.0173	0.0039
Al	0.0000	0.0002	0.0001	0.0003	0.0003	0.0002	0.0004	0.0001	0.0007	0.0000
C	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000
Co	0.0000	0.0003	0.0001	0.0005	0.0005	0.0003	0.0005	0.0001	0.0009	0.0000
Cr	0.0033	0.0116	0.0088	0.0171	0.0138	0.0143	0.0177	0.0121	0.0283	0.0033
Cu	0.0000	0.0001	0.0001	0.0002	0.0002	0.0001	0.0002	0.0001	0.0004	0.0000
Fe	0.0048	0.0126	0.0110	0.0188	0.0139	0.0171	0.0191	0.0158	0.0289	0.0048
Mn	0.0000	0.0003	0.0001	0.0004	0.0004	0.0002	0.0004	0.0001	0.0007	0.0000
Nb	0.0000	0.0003	0.0001	0.0005	0.0005	0.0003	0.0005	0.0001	0.0009	0.0000
N	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Ni	0.0009	0.0243	0.0118	0.0352	0.0344	0.0227	0.0378	0.0127	0.0689	0.0009
P	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
S	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Si	0.0000	0.0001	0.0001	0.0002	0.0002	0.0001	0.0002	0.0001	0.0004	0.0000
Sn	0.0461	0.0948	0.0933	0.1420	0.0960	0.1405	0.1423	0.1394	0.2015	0.0461
Ti	0.0000	0.0008	0.0003	0.0011	0.0011	0.0007	0.0012	0.0003	0.0022	0.0000
Zr	3.2303	6.6499	6.5447	9.9644	6.7341	9.8592	9.9854	9.7750	14.1357	3.2303

5.5.2.2 Fuel Temperatures and Moderator Densities

Weighted moderator densities and fuel temperatures are used for all one-node calculations. The weighted averages are calculated with Equation 13 as was done in Section 5.5.1.3. These calculations are shown in Attachment III, Worksheet 'C3 Average Values', cells D15 - W15, and A29 - F42. The results are summarized in Tables 36 and 37.

Table 36. Average Values of Thermal Hydraulic Parameters for Thermal DBF and One-Node Comparison Case

DP	EFPD from Table 11 (days)	EFPD (days)	Moderator Density (g/cm^3)	Fuel Temperature (K)
4	222.47	222.47	0.4403	1059.0
5	467.48	245.01	0.4351	1073.3
6	180.3	180.3	0.4333	1061.9
7	484.2	303.9	0.4402	1071.3
8	142.2	142.2	0.4450	995.0
9	263.7	121.5	0.4506	967.0
10	10.1	10.1	0.4510	910.2
11	112.94	102.84	0.4556	916.7
12	224.4	111.46	0.4580	949.1
13	324.73	100.33	0.4593	970.5
		Total EFPD (days)	Weighted Average (g/cm^3)	Weighted Average (K)
		1540.11	0.4435	1026.7

Table 37. Average Values of Thermal Hydraulic Parameters for Waste Stream and SS Clad Assemblies[29]

DP	EFPD from Table 11 (days)	EFPD (days)	Moderator Density (g/cm^3)[30]	Fuel Temperature (K)
4	222.47	222.47	0.4403	916.9
5	467.48	245.01	0.4351	920.3
6	180.3	180.3	0.4333	915.8
7	484.2	303.9	0.4402	918.2
8	142.2	142.2	0.4450	852.8
9	263.7	121.5	0.4506	829.9
10	10.1	10.1	0.4510	786.9
11	112.94	102.84	0.4556	791.9
12	224.4	111.46	0.4580	818.2
13	324.73	100.33	0.4593	834.7
		Total EFPD (days)	Weighted Average (g/cm^3)	Weighted Average (K)
		1540.11	0.4435	883.1

For the ten-node representation, cycle averaged values are used for the nodal fuel temperatures, and the moderator density is adjusted through the H_2O fraction option in SAS2H. The cycle average fuel temperatures are determined from Equation 13, except that the formula is applied to each node, rather than a weighted average over the nodes. These calculations are shown in Attachment III, Worksheet 'C3 Average Values', cells A16 - N27, and are summarized in Table 38.

29. These values are based on the updated fuel temperatures from Ref. 7.19. The calculation is shown in Worksheet

Table 38. Values of Thermal Hydraulic Parameters for Ten-Node Calculation[31]

Node	Cycle Averaged Fuel Temp. (K)	Fraction of Cycle 1 Moderator Density for DPs 4 - 13									
		4	5	6	7	8	9	10	11	12	13
1	669.1	1.0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
2	970.5	1.0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	1084.8	1.0	0.9967	0.9973	0.9950	0.9978	1.0012	1.0014	1.0049	1.0072	1.0079
4	1116.8	1.0	1.0048	1.0091	1.0191	1.0301	1.0412	1.0424	1.0530	1.0596	1.0624
5	1129.2	1.0	1.0112	1.0061	1.0309	1.0476	1.0643	1.0660	1.0825	1.0912	1.0952
6	1126.8	1.0	1.0046	0.9918	1.0255	1.0438	1.0628	1.0646	1.0822	1.0907	1.0953
7	1109.2	1.0	0.9847	0.9704	1.0063	1.0248	1.0470	1.0488	1.0655	1.0736	1.0781
8	1068.8	1.0	0.9603	0.9499	0.9808	0.9983	1.0235	1.0252	1.0410	1.0487	1.0531
9	924.4	1.0	0.9348	0.9289	0.9500	0.9663	0.9878	0.9893	1.0041	1.0126	1.0178
10	660.9	1.0	0.9218	0.9183	0.9329	0.9484	0.9680	0.9696	0.9834	0.9927	0.9981
Data Point:		4	5	6	7	8	9	10	11	12	13
EFPD (days)		222.47	245.01	180.3	303.9	142.2	121.5	10.1	102.84	111.46	100.33

5.5.2.3 Assembly Parameters

For each enrichment listed in Table 2, source terms for all burnups listed are calculated (with the exceptions previously noted). These combinations provide a sampling of the BWR waste stream for later analysis. Each combination of enrichment and burnup is then decayed with the time steps shown in Section 5.5.2.4. The average assembly power is determined in Table 39 by dividing the total MWth of the reactor by the number of assemblies in the core. The relation for determining the EFPD for the selected fuel burnups is shown by Equation 17:

$$Burnup\ (MWd\ /\ MTU) = \frac{EFPD * Assembly\ power\ (MW\ /\ assembly)}{Uranium\ Loading\ (MTU\ /\ assembly)} \qquad \text{(Eq. 17)}$$

Table 39. SAS2H Input for the Assembly Depletion/Decay Parameters

Power = 3.468 MW, IHML = 200 kg							
Burnup (GWd/MTU)	EFPD (days)	Ncycles	Length of Last Cycle (days)	Burnup (GWd/MTU)	EFPD (days)	Ncycles	Length of Last Cycle (days)
0.001	0.057	1	0.057	50	2838.0	15	38.0
0.01	0.568	1	0.568	60	3405.6	18	5.6
0.1	5.676	1	5.676	70	3973.1	20	173.1
1	56.759	1	56.759	75	4256.9	22	56.9
10	567.6	3	167.6				
20	1135.2	6	135.2				
30	1702.8	9	102.8				
40	2270.4	12	70.4				
49	2781.2	14	181.2				

Due to the error that can be incurred by using too large of a cycle time, for the one-node representations of the assemblies, the EFPD days are broken down into steps of 200 days per cycle or less. Therefore, all cycle lengths are 200 EFPD with the exception of the final cycle, which is listed in Table 39.

31. These values are based on the same fuel temperatures used for the thermal DBE and the one-node comparison

For the ten-node representation of the assembly, the EFPD and burnup data for assembly C3 are used to determine the burn history (Attachment IV, Worksheets 'burnup, pass1' and 'burnup, pass2', columns G, J, M, P, S, V, Y, AB, AE, and AH, rows 6 - 16). From this data, the power generated in each node is determined (columns E, H, K, N, Q, T, W, Z, AC, and AF, rows 6 - 16). These powers are then used to calculate the desired burnups (columns F, I, L, O, R, U, X, AA, AD, and AG, rows 6 - 16). For burnups greater than 30 GWd/MTU, the life of assembly C3 is repeated until the desired burnup is reached (the Worksheet 'burnup, pass1' is used for the 10 - 30 GWd/MTU calculations, and Worksheet 'burnup, pass2' is for the higher burnups). The final results are shown in Tables 40 and 41. Due to the difficulty in changing the fuel temperatures from cycle to cycle, the cycle averaged values are used, and maintained throughout the calculations.

Table 40. Ten-Node Burn Histories for 10, 20, and 30 GWd/MTU

DP 5		DP 7		DP 9	
MW per Node	Calculated Burnup (GWd/MTU)	MW per Node	Calculated Burnup (GWd/MTU)	MW per Node	Calculated Burnup (GWd/MTU)
0.0544	2.2921	0.0537	4.44	0.0398	6.86
0.4507	9.7521	0.3926	18.53	0.2638	26.99
0.5377	12.8872	0.4694	24.28	0.3464	34.41
0.7875	12.8988	0.7275	25.37	0.5769	35.97
0.5240	12.3268	0.5160	25.18	0.4016	36.40
0.7982	11.6434	0.8254	24.24	0.6202	36.09
0.7991	10.8825	0.8533	22.64	0.6651	34.86
0.7696	10.0067	0.8177	20.46	0.7220	32.23
0.8060	7.1757	0.8570	14.78	0.7481	23.52
0.0601	2.2372	0.0539	4.33	0.0489	6.67
	10.0		20.0		30.0
EFPD	140	EFPD	80	EFPD	15

As previously stated, after one full lifetime, the cycles are repeated until the desired burnup is reached. For these extra cycles, the power at which the nodes are burned is the same as for the previous cycles, but the length of the burn is adjusted to reach the desired assembly averaged burnup. The nodal burnup is shown in the following table along with the EFPD for the respective cycle.

Table 41. Ten-Node Burn Histories for 40 - 75 GWd/MTU

DP 4	DP 5	DP 7	DP 9	DP 12
Calculated Burnup (GWd/MTU)	Calculated Burnup (GWd/MTU)	Calculated Burnup (GWd/MTU)	Calculated Burnup (GWd/MTU)	Calculated Burnup (GWd/MTU)
39.3034	41.6224	43.74	46.15	47.35
39.9802	49.8067	58.34	66.73	70.56
40.3359	53.1261	64.23	74.35	79.37
40.3536	53.1108	65.35	76.00	81.80
40.2699	52.5368	65.22	76.47	82.74
40.1584	51.8705	64.34	76.19	82.55
40.0447	51.1109	62.77	75.04	81.27
39.9396	50.1933	60.55	72.49	78.37
39.6828	47.0874	54.62	63.48	67.47
39.2808	41.5918	43.63	46.00	47.05
40.0	50.0	60.0	70.0	75.0
EFPD=33	EFPD=175	EFPD=110	EFPD=55	EFPD=65

Table 42 summarizes the remaining information required by SAS2H.

Table 42. SAS2H Assembly Input

Variable Name	Value Used for Thermal DBF and One-Node Comparison Case	Value Used for Ten-Node Calculation	Value used for Waste Stream and SS Clad Calculations
Npin/assm	60	60	60
Fuelngth	368.91	Node height	427.11[32]
Ncycles	1 cycle	10 cycles	1 cycle
Nlib/cyc	16 libraries per cycle	3 libraries per cycle	16 libraries per cycle
Lightel	17	17	33
Printlevel	5	5	5
Inplevel	2	2	2
Asmpitch	15.24 cm	15.24 cm	15.24 cm
Numxtotal	6	6	6
Mxrepeats	1	1	1
Mixmod	3	3	3
Facmesh	1.0	1.0	1.0

5.5.2.4 Time Steps for ORIGEN-S Decay Calculations

The ten-node representation is decayed to the following times: 5, 6, 7, 8, 9, 10, 11, 15, and 20 years after discharge.[33] Table 43 lists the time steps used for the thermal DBF cases. The time steps chosen are based on the time the assembly is expected to reach a total thermal output of 400 watts, or the time when the assembly can be loaded into the waste package and are shown in Table 43.

32. Due to the results of the density comparison in Ref. 7.4 of this calculation, the fuel length is increased rather then the fuel density to account for an increased IHML. The calculation is performed in Attachment I, Worksheet 'length calculation'.

33. Other time steps were included in the ORIGEN-S case for the ten-node representation, but are unusable due to

Table 43. Time Steps Used for Decay Calculation of Thermal DBF (years)

1 day	5	6	7		8	9	10	11	
11.01	11.02	11.03	11.04	11.05	11.06	11.07	11.08	11.09	11.1
11.15	11.2	11.25	11.3	11.35	11.4	11.45	11.5	11.55	11.6
11.65	11.7	11.75	11.8	11.85	11.9	11.95	12	12.5	13
13.5	14	14.5	15	15.5	16	16.5	17	17.5	18
18.5	19	19.5	20	20.5	21	26	31	36	41
46	51	56	61	66	71	76	81	86	91
96	101	106	111	161	211	261	311	361	411
461	511	561	611	661	711	761	811	861	911
961	1011	1511	2011	2511	3011	3511	4011	4511	5011
5511	6011	6511	7011	7511	8011	8511	9011	9511	10011
15011	20011	25011	30011	35011	40011	45011	50011	55011	60011
65011	70011	75011	80011	85011	90011	95011	100011	150011	200011
250011	300011	350011	400011	450011	500011	550011	600011	650011	700011
750011	800011	850011			900011	950011	1000011		

For the waste stream and SS clad assembly calculations, the determination of the assembly loading time is left for subsequent analysis. In order to provide adequate data for future use, 180 time steps are used in the ORIGEN-S input files. These time steps are shown in Table 44.

Table 44. Time Steps Used for Decay Calculation of Waste Stream and SS Clad Assemblies (years)

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90
91	92	93	94	95	96	97	98	99	100
110	120	130	140	150	160	170	180	190	200
250	300	350	400	450	500	550	600	650	700
750	800	850	900	950	1000	1500	2000	2500	3000
3500	4000	4500	5000	5500	6000	6500	7000	7500	8000
8500	9000	9500	1.00E+04	1.50E+04	2.00E+04	2.50E+04	3.00E+04	3.50E+04	4.00E+04
4.50E+04	5.00E+04	5.50E+04	6.00E+04	6.50E+04	7.00E+04	7.50E+04	8.00E+04	8.50E+04	9.00E+04
9.50E+04	1.00E+05	1.50E+05	2.00E+05	2.50E+05	3.00E+05	3.50E+05	4.00E+05	4.50E+05	5.00E+05
5.50E+05	6.00E+05	6.50E+05	7.00E+05	7.50E+05	8.00E+05	8.50E+05	9.00E+05	9.50E+05	1.00E+06

5.5.3 Radionuclide Inventories for Performance Assessment

Several separate SAS2H/ORIGEN-S cases are provided in this calculation to determine average and bounding radionuclide inventories for specific years. The average and bounding BWR assemblies are derived from the results of Ref. 7.24 and listed below. The characteristics of the average BWR assembly are estimated based on the average BWR assembly of Case A with full inventory (83,800 MTU) in Table 5 of Ref. 7.24. For that case, the characteristics of the average BWR assembly are 3.02 wt%, 33.6 GWd/MTU, and 25.3 years old with an initial uranium

indicates that per initial MTU loading the average BWR assembly selected in this calculation is more conservative than any average BWR assembly for the scenarios in Table 5 of Ref. 7.24 (see Attachment XIV). The characteristics of the bounding BWR assembly are also derived from Ref. 7.24 (Attachment III, bin.dat files). From those files the following bounding BWR SNF characteristics are noted: initial uranium loading of 197 kg, burnup of 65.55 GWd/MTU, initial uranium enrichment of 4.28 wt%, and cooling time of 5 years. It should be noted that there is no single assembly in the waste stream with these combined characteristics. Rather, these are the bounding characteristics of each parameter in the entire waste stream. Compared to these SNF characteristics, the bounding BWR assembly selected here is more conservative. The characteristics of the average and bounding BWR SNF assemblies for this calculation are:

Average BWR assembly:	3.5%, 40 GWd/MTU, 25 years old
Maximum BWR assembly:	5.0%, 75 GWd/MTU, 5 years old

The source terms for these assemblies are generated for the years 2033, 2133, 2233, 2333, 2433, 2533, 3033, 4033, 5033, 12,033, 22,033, 32,030, 102,033, 302,033, and 1,002,033. The age mentioned above is the age at 2033. The light elements from the hardware regions are included in the fuel region, as it is not necessary to keep the assembly region separate to determine overall radionuclide inventories. The *.cut files for these cases are included in the CDs of Attachment VII. The radionuclide inventories are provided in Attachment XIII.

5.5.4 Calculation of Crud Source Terms

The activity of the crud on the surface of the BWR assemblies at time zero is determined simply by multiplying the calculated surface area by the corrosion product activity (given in per unit area of surface). The surface area is calculated in Attachment VI, and is shown in Table 45.

Table 45. BWR Surface Area for Crud Calculation

	Value	Units
Rod OD	1.07696	cm
WR OD (rod pitch)	1.45288	
# of Rods	79	(2 WRs)
Rod Length	416.1536	cm
Channel ID	13.4112	cm
Channel OD	13.8176	
Channel Length	447.548	cm
WR outside area + inside area (estimated from rod pitch)	8171.07563	
rod pitch* PI * 4; WR ID and OD conservatively approximated as fuel rod pitch		
(Data from ANF 9x9 JP-4,5 assembly)		
BWR Assembly Surf. Area	168147.97	cm^2
(Rod surface + channel inner surface + WR's inside and outside surfaces)		

The crud activity is then decayed using Equation 18.

$$N(t) = N(0)e^{\frac{-t*\ln 2}{t_{1/2}}} \qquad \text{(Eq. 18)}$$

where t_2 is the half-life and t is the decay time in years. The crud source terms are calculated in

6 RESULTS

This section presents the results of this calculation. The outputs of this calculation are reasonable compared to the inputs, and the results are suitable for the intended use. The uncertainties are taken into account by consistently using the most conservative approach; the calculations, therefore, yield a conservatively bounding set of results. Results of the parameter study are presented in Section 5.5.1.5. More information on these results is available in Attachment V.

6.1 AXIAL PEAKING FACTOR

One task of this calculation is to examine an APF to be used in future shielding calculations. The axial effects can be of great concern, for the reasons mentioned in Section 5.5.1.5. Figure 6 shows a plot of APF versus burnup for the measured data from Ref. 7.13, pp. 290-544. Since the nodal burnup data from pp. 290-544 of Ref. 7.19 (a revision of Ref. 7.13) are essentially identical to the data from Ref. 7.13 (differing generally only in the 5th significant digit), APF versus burnup data based on Ref. 7.19 would be identical for design purposes to that in Figure 6. Therefore, the conclusions about APFs are still valid.

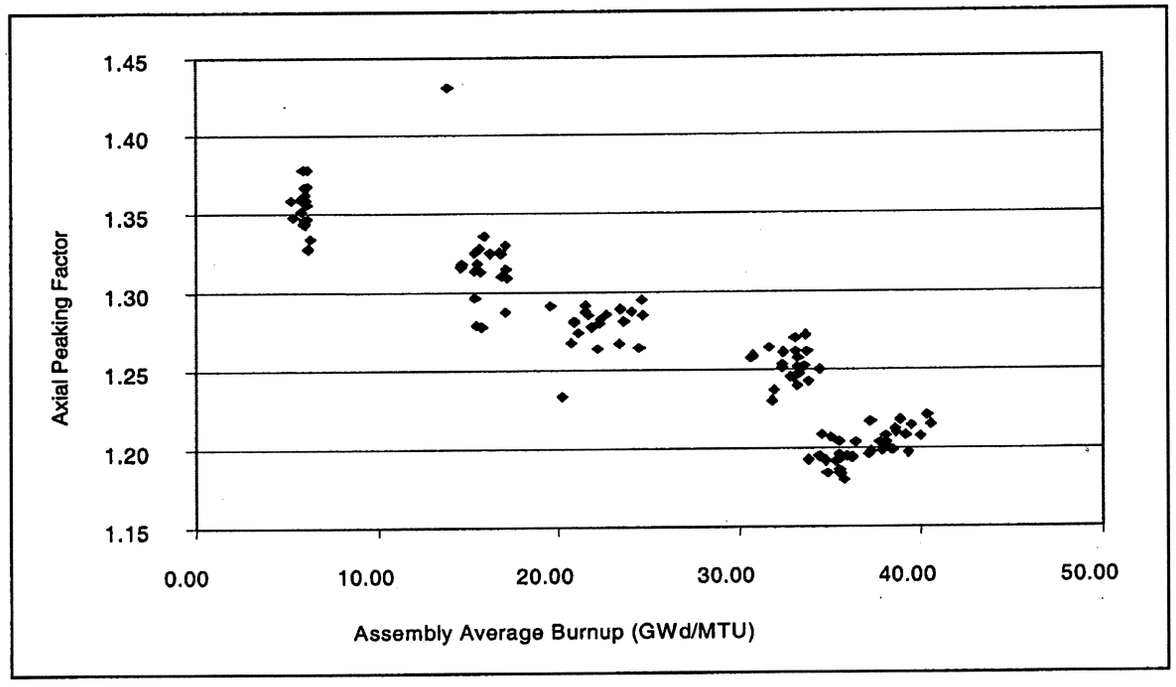

Figure 6. Axial Peaking Factor versus Assembly Average Burnup

This graph (generated in Attachment III, worksheet 'APF.vs.Burnup') indicates the maximum value of the nodal burnup divided by the average assembly burnup. The purpose of using an APF in shielding calculations is to obtain a peak surface dose without having to model many

this, the source used must encompass all the peak sources in the problem. When the one-node source is multiplied by the APF and smeared over the problem volume, it should still bound the smaller sources in the multi-node description of the problem.

The main purpose of the APF calculation is to demonstrate that a one-node model of a BWR can be used to generate source terms such that when used with an APF it will provide conservative or comparable results with a more detailed ten-node representation of the assembly. In order to compare the one- and ten-node representations of the assembly, total neutron and gamma sources from both are specified on a particle per second per unit height basis. The one-node value is multiplied by the APF, and the difference between the increased one node value and the maximum ten-node value is then divided by the one node value. These comparisons can be seen in Attachments VIII and IX in their entirety. The APF used in this comparison is 1.4 and is based on Figure 6. The results favor the one-node representation for the gamma sources, for decay times greater than five years (and are within a few percent for the five year decay time), but indicate that the ten-node model used in this calculation is more conservative for the total neutron source. Attachment IX shows the comparison of the neutron sources. It is apparent from these results that a larger APF should be considered for any analysis where the neutron dose is expected to dominate. The calculations in Attachment IX indicate that an APF of 2.0 would have been sufficient to favor the one-node representation for neutron sources.

6.2 INITIAL HEAVY METAL LOADING

The results of using different IHMLs are shown below for the thermal DBF. The data shown are for a normalized source on a per MTU basis. The calculations that generate Figures 7 and 8 are shown in Attachment X.

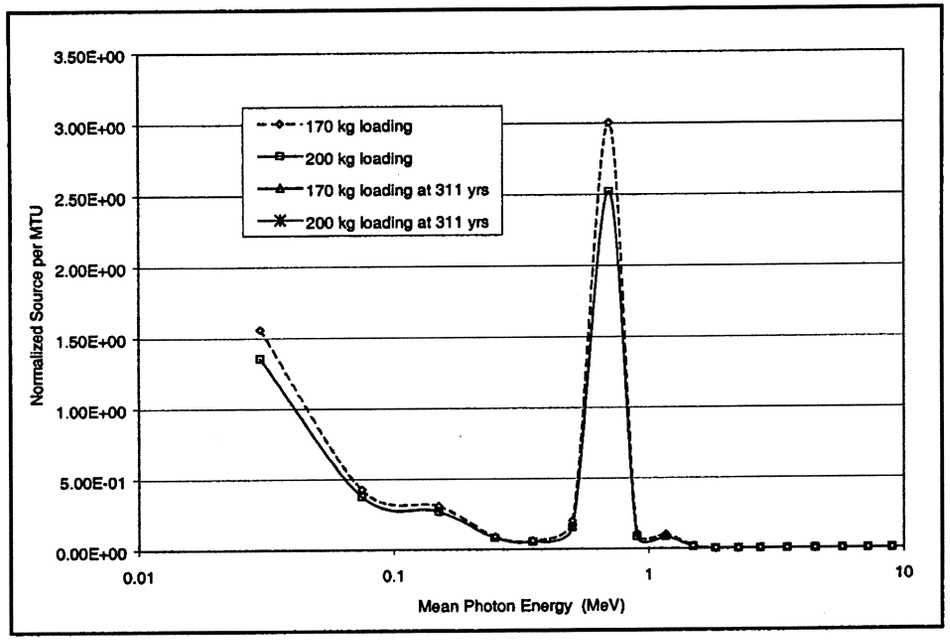

Figure 7. Normalized Gamma Source per MTU for Thermal DBF at 11 and 311 Years

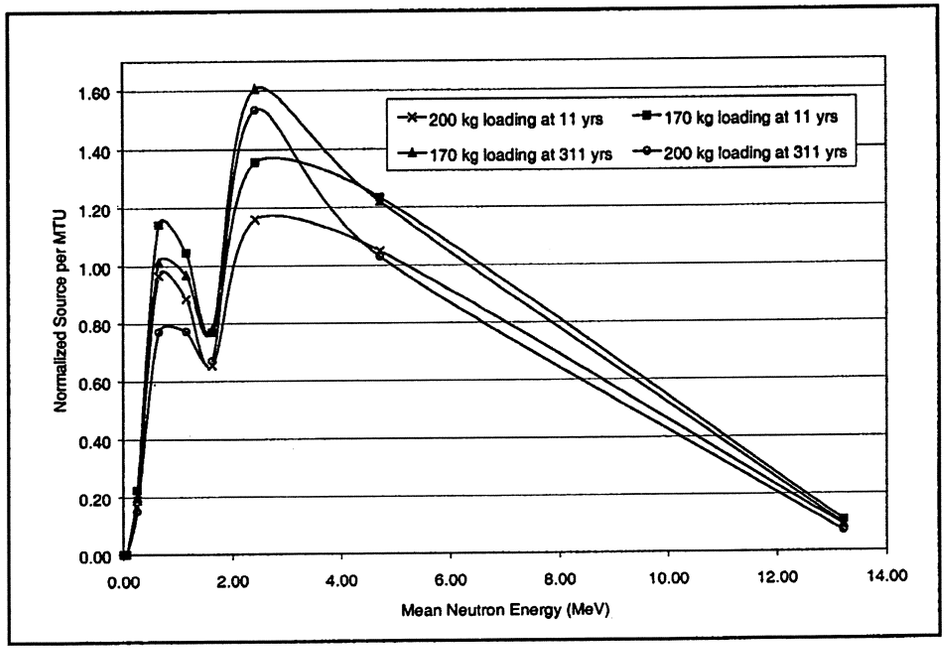

Figure 8. Normalized Neutron Source per MTU for Thermal DBF at 11 and 311 Years

6.3 EFFECTS OF FUEL IMPURITIES

Source terms for one of the cases (waste stream assembly with 3.74 wt% ^{235}U initial enrichment) are generated with and without impurities (see Table 13) in the fuel. Negligible differences in radiation spectra and thermal powers are observed. However, the results for ^{36}Cl and ^{14}C are summarized in this section. Attention is given to ^{36}Cl and ^{14}C, long-lived radionuclides with half-lives of 3.01E+05 and 5,715 years (Ref. 7.23), respectively, because of their very high solubility-limit in aqueous concentrations (Ref. 7.25, p. 6 - 7). ^{36}Cl and ^{14}C activities at discharge as a function of burnup are presented in Table 46 and are plotted in Figure 9. ^{36}Cl and ^{14}C activities vary with initial fuel enrichment, fuel burnup, and impurity content. For a given fuel enrichment and impurity content, the activities of these two radionuclides increase with fuel burnup. For a given burnup and impurity content, the activities decrease with increasing fuel enrichment. Bounding ^{36}Cl and ^{14}C activities of 1.09E-02 and 6.62E-01 Ci/assembly, respectively, are obtained for an assembly with natural uranium and 75 GWd/MTU burnup at discharge.

Table 46. ^{36}Cl and ^{14}C Activities for the Waste Stream Assembly with 3.74 wt% ^{235}U Enrichment

Burnup (GWd/MTU)	^{36}Cl (Ci/assembly)	^{36}C (Ci/ppm/assembly)	^{14}C (Ci/assembly)	^{14}C (Ci/ppm/assembly)
1	6.61E-05	1.25E-05	3.03E-03	3.39E-05
10	6.74E-04	1.27E-04	3.11E-02	3.48E-04
20	1.44E-03	2.72E-04	6.70E-02	7.49E-04
30	2.33E-03	4.40E-04	1.11E-01	1.24E-03
40	3.38E-03	6.38E-04	1.64E-01	1.83E-03
50	4.57E-03	8.62E-04	2.28E-01	2.55E-03
60	5.82E-03	1.10E-03	3.00E-01	3.36E-03
70	7.03E-03	1.33E-03	3.76E-01	4.21E-03
75	7.62E-03	1.44E-03	4.14E-01	4.63E-03

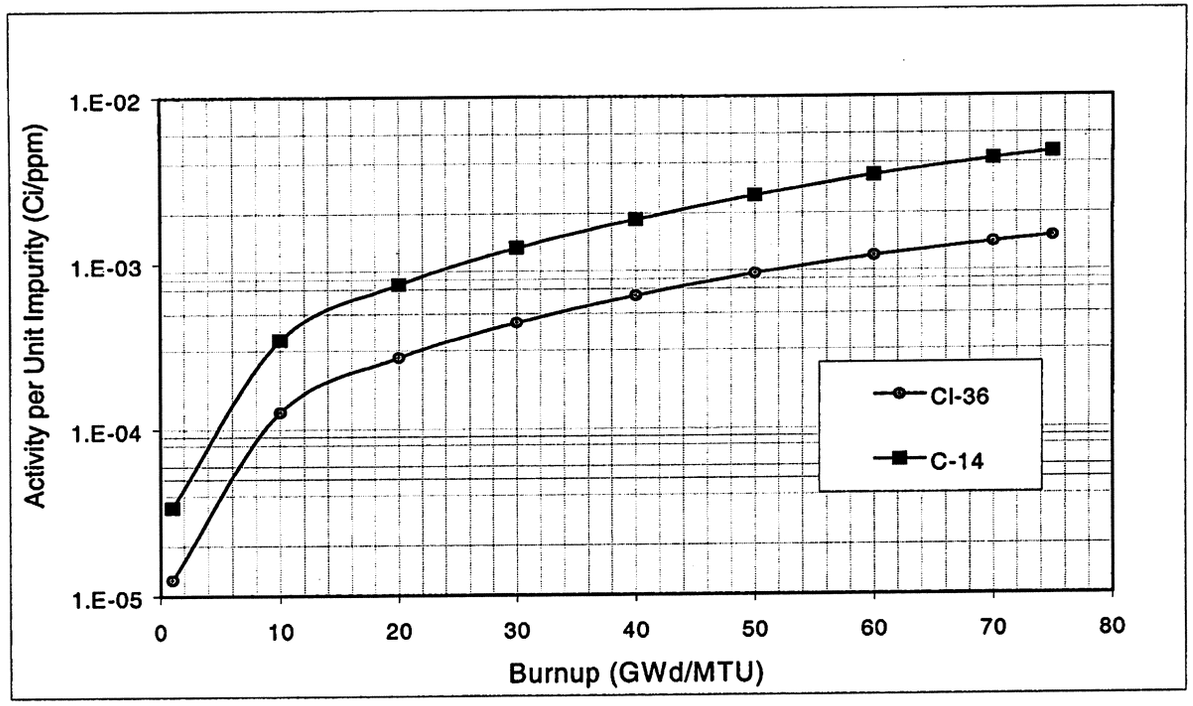

Figure 9. ^{36}Cl and ^{14}C Activities per Unit Impurity per Assembly at Discharge as a Function of Burnup for Waste Stream Assembly with 3.74 wt% ^{235}U Enrichment

6.4 CRUD SOURCES

The results of the crud source calculations are shown in Table 47. The NRC values are recommended.

6.5 WASTE STREAM AND SS CLAD SOURCE TERMS

Due to the large amount of information generated by this calculation, the results are provided as electronic files on three compact discs (CDs) (Attachment VII). These results are identical to the output files of the previous revision of this calculation (Ref. 7.30).

Table 47. Crud Sources

Fuel Age (years)	Ref. 7.11 ^{60}Co Values (Ci)	NRC (Ref. 7.10) ^{60}Co Values (Ci)	Crud (Ci) for Assembly, Ref. 7.12 Values								
			^{51}Cr	^{54}Mn	^{55}Fe	^{58}Co	^{59}Fe	^{60}Co	^{63}Ni	^{65}Zn	^{95}Zr
0	2.102E+02	2.109E+02	5.885E+00	2.892E+01	1.247E+03	7.567E+00	1.211E+01	8.021E+01	0.000E+00	1.227E+01	9.753E+00
5	1.089E+02	1.093E+02	8.402E-20	5.009E-01	3.503E+02	1.327E-07	5.392E-12	4.156E+01	0.000E+00	6.824E-02	2.523E-08
6	9.549E+01	9.579E+01	0.000E+00	2.226E-01	2.718E+02	3.728E-09	1.826E-14	3.644E+01	0.000E+00	2.416E-02	4.835E-10
7	8.372E+01	8.399E+01	0.000E+00	9.889E-02	2.108E+02	1.048E-10	6.183E-17	3.195E+01	0.000E+00	8.552E-03	9.268E-12
8	7.340E+01	7.364E+01	0.000E+00	4.394E-02	1.636E+02	2.945E-12	2.094E-19	2.801E+01	0.000E+00	3.028E-03	1.776E-13
9	6.436E+01	6.456E+01	0.000E+00	1.952E-02	1.269E+02	8.276E-14	0.000E+00	2.456E+01	0.000E+00	1.072E-03	3.405E-15
10	5.643E+01	5.661E+01	0.000E+00	8.675E-03	9.843E+01	2.326E-15	0.000E+00	2.153E+01	0.000E+00	3.794E-04	6.525E-17
11	4.947E+01	4.963E+01	0.000E+00	3.855E-03	7.636E+01	6.537E-17	0.000E+00	1.888E+01	0.000E+00	1.343E-04	1.251E-18
15	2.924E+01	2.933E+01	0.000E+00	1.502E-04	2.766E+01	0.000E+00	0.000E+00	1.116E+01	0.000E+00	2.109E-06	0.000E+00
20	1.515E+01	1.520E+01	0.000E+00	2.602E-06	7.771E+00	0.000E+00	0.000E+00	5.781E+00	0.000E+00	1.173E-08	0.000E+00
25	7.849E+00	7.875E+00	0.000E+00	4.507E-08	2.183E+00	0.000E+00	0.000E+00	2.995E+00	0.000E+00	6.520E-11	0.000E+00
30	4.067E+00	4.080E+00	0.000E+00	7.805E-10	6.135E-01	0.000E+00	0.000E+00	1.552E+00	0.000E+00	3.625E-13	0.000E+00
35	2.107E+00	2.114E+00	0.000E+00	1.352E-11	1.724E-01	0.000E+00	0.000E+00	8.042E-01	0.000E+00	2.016E-15	0.000E+00
40	1.092E+00	1.095E+00	0.000E+00	2.341E-13	4.843E-02	0.000E+00	0.000E+00	4.167E-01	0.000E+00	1.121E-17	0.000E+00
45	5.657E-01	5.676E-01	0.000E+00	4.055E-15	1.361E-02	0.000E+00	0.000E+00	2.159E-01	0.000E+00	6.230E-20	0.000E+00
50	2.931E-01	2.941E-01	0.000E+00	7.022E-17	3.823E-03	0.000E+00	0.000E+00	1.119E-01	0.000E+00	0.000E+00	0.000E+00
55	1.519E-01	1.524E-01	0.000E+00	1.216E-18	1.074E-03	0.000E+00	0.000E+00	5.796E-02	0.000E+00	0.000E+00	0.000E+00
60	7.870E-02	7.895E-02	0.000E+00	0.000E+00	3.018E-04	0.000E+00	0.000E+00	3.003E-02	0.000E+00	0.000E+00	0.000E+00
65	4.078E-02	4.091E-02	0.000E+00	0.000E+00	8.481E-05	0.000E+00	0.000E+00	1.556E-02	0.000E+00	0.000E+00	0.000E+00
70	2.113E-02	2.120E-02	0.000E+00	0.000E+00	2.383E-05	0.000E+00	0.000E+00	8.062E-03	0.000E+00	0.000E+00	0.000E+00
75	1.095E-02	1.098E-02	0.000E+00	0.000E+00	6.695E-06	0.000E+00	0.000E+00	4.177E-03	0.000E+00	0.000E+00	0.000E+00
80	5.672E-03	5.690E-03	0.000E+00	0.000E+00	1.881E-06	0.000E+00	0.000E+00	2.165E-03	0.000E+00	0.000E+00	0.000E+00
85	2.939E-03	2.948E-03	0.000E+00	0.000E+00	5.285E-07	0.000E+00	0.000E+00	1.122E-03	0.000E+00	0.000E+00	0.000E+00
90	1.523E-03	1.528E-03	0.000E+00	0.000E+00	1.485E-07	0.000E+00	0.000E+00	5.811E-04	0.000E+00	0.000E+00	0.000E+00
95	7.890E-04	7.916E-04	0.000E+00	0.000E+00	4.173E-08	0.000E+00	0.000E+00	3.011E-04	0.000E+00	0.000E+00	0.000E+00
100	4.088E-04	4.101E-04	0.000E+00	0.000E+00	1.172E-08	0.000E+00	0.000E+00	1.560E-04	0.000E+00	0.000E+00	0.000E+00
200	7.952E-10	7.978E-10	0.000E+00	0.000E+00	1.102E-19	0.000E+00	0.000E+00	3.035E-10	0.000E+00	0.000E+00	0.000E+00
300	1.547E-15	1.552E-15	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	5.902E-16	0.000E+00	0.000E+00	0.000E+00

6.6 USE OF SOURCE TERMS

During the revision and checking of this calculation, it was discovered that the actual values of burnup, based on the input for the SAS2H/ORIGEN-S runs, were about 1.7% less than the nominal values of burnup stated in Table 2. The SAS2H/ORIGEN-S runs are valid, but the source term information (e.g., radionuclide masses and activities; decay heat generation rates; and neutron and gamma sources) contained in the '*.cut' files on the compact discs of Appendix VII should be taken to correspond to the actual burnups from the SAS2H/ORIGEN-S cases, rather than the stated, or nominal, burnups. To use the source term information, determine the stated, or nominal, burnup from the first part of the '*.cut' file name as explained in Attachment XII. Then, associate the information from that '*.cut' file with the actual burnup in Table 48 before using the source term information.

Table 48. Stated and Actual Values of Burnup Associated with '*.cut' Files

Burnup (GWd/MTU)	
Stated	Actual
0.001	0.0009876
0.01	0.009841
0.1	0.09834
1	0.9834
10	9.834
20	19.67
30	29.50
40	39.34
50	49.17
60	59.00
70	68.84
75	73.75

Source term information from the '*.cut' and '*.output' files of the SAS2H/ORIGEN-S runs in the folders "Impurity_study," "parameter_study_output," "ten_node_output," and "THERMAL_DBF_output"on compact disc one of Attachment VII should not be used for assemblies expected to be received at a potential repository. Those cases were run solely to form the basis for deciding what kinds of cases to be run for BWR assemblies in an expected waste stream. Furthermore, the '*.cut' files in folder "ten_node_output" and the '*.output' files in folder "parameter_study_output" on compact disc one of Attachment VII cannot be considered product output in accordance with AP-3.15Q, *Managing Technical Product Inputs* (Ref. 7.33), since some information (Table 8 and Table 17) for those runs was taken from Ref. 7.13, pp. 333-334, and Ref. 7.17, pp. 50-55, which are "reference only." Therefore, the information in the '*.cut' files of folder "ten_node_output" and the '*.output' files of folder "parameter_study_output" on compact disc one of Attachment VII should not be used for any other calculations or analyses.

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8 ATTACHMENTS

The hardcopy attachments are listed in Table 49. Attachment VII is a CD containing output files, '*.cut' files, and script files. The contents of Attachment VII are listed in Attachment XII.

Table 49. Attachments Supporting Documentation of Source Term Generation and Evaluation

Description	Attachment Number	No. of Pages
Wt% calculations for fuel	I	16
Light element mass calculations	II	14
Operating conditions	III	11
Burnup history calculation	IV	10
Parameter study results	V	10
Crud source term calculations	VI	3
Electronic copies of files, including "*.cut" files and script files	VII	3 CDs
10-node gamma source vs. 1-node gamma source calculations	VIII	10
10-node neutron source vs. 1-node neutron source calculations	IX	12
Initial heavy metal loading comparison calculations, and ^{36}Cl and ^{14}C fuel impurity graph	X	6
Script files	XI	1
SAS2H/ORIGEN-S *.cut files and output files	XII	16
Radionuclide inventories for Performance Assessment	XIII	10
Comparison of Source Terms per MTU of 4 Average BWR SNF Assemblies	XIV	1

lculations for length of fuel region to obtain desired heavy metal loading
ınt to get the smear density- modify the fuel length to model assemblies with extra UO2 in them

Element/Isotope	Atomic weight (Ref. 7.23, pp. 48-49)	WT%		
Oxygen	15.9994	100	15.9994	Note for 000-00C-MGR0-00200-000-00A:
U-234	234.0409	0.04423	1.88981E-06	Corrected formula for U weight fraction in UO2;
U-235	235.0439	5	0.000212726	No effect on final length estimates.
U-236	236.0456	0.023	9.74388E-07	
U-238	238.0508	94.9328	0.003987921	
			237.8963629	**U weight fraction in UO2**
				0.881439891

Fuel rod area (using clad inner diameter)		**10.96**	**theoretical density**	
0.889580717	smear density			
total fuel cross sectional area in assembly	9.9695			
53.37484304			227.2727273	**kg UO2 required for 200 kg U loading**
			227272.7273	**in grams**
			22796.80298	**cubic centimeters required**
ıel length required =	427.1076349	cm		

uel rod volume (using clad inner diameter)		**10.96**	**theoretical density**	
0.889580717	smear density			
total fuel cross sectional area in assembly	9.9695			
53.37484304			193.1818182	**kg UO2 required for 170 kg U loading**
			193181.8182	**in grams**
			19377.28253	**cubic centimeters required**
ıel length required =	363.0414897	cm		

:alculations for Fuel Density. Calculation of wt%'s for SAS2H input.

Element/Isotope	Atomic weight (Ref. 7.23, pp. 48-49)	WT%		
Oxygen	15.9994	100	15.9994	Note for 000-00C-MGR0-00200-000-00A:
U-234	234.0409	0.04423	1.88981E-06	Corrected formula for U weight fraction in UO2;
U-235	235.0439	5	0.000212726	No effect on final density estimates.
U-236	236.0456	0.023	9.74388E-07	
U-238	238.0508	94.9328	0.003987921	
			237.8963629	**U weight fraction in UO2**
				0.881439891

Fuel rod volume (using clad inner diameter) **10.96** **theoretical density**

325.3730432
total fuel volume in assembly
19522.38259

smear density
9.9695
mass in assembly
194628.3932
in kg
194.6283932

227.2727273 **kg UO2 required for 200 kg U loading**

227.2727273
227272.7273 **For regular fuel rods:**

11.64164908 density required to yield a 200 kg loading or U for model 8

Fuel rod volume (using clad inner diameter) **10.96** **theoretical density**

325.3730432
total fuel volume in assembly
19522.38259

smear density
9.9695
mass in assembly
194628.3932
in kg
194.6284

193.1818182 **kg UO2 required for 170 kg U loading**

193.1818182
193181.8182 For regular fuel rods:

9.895401715 density required to yield a 170 kg loading of U for model 8

Calculation of wt%'s for SAS2H Input for Parameter Study

Element/Isotope	Atomic weight (Ref. 7.23, pp. 36-37; 48-49)	WT%	wt%/atomic wt%
Oxygen	15.9994	100	-
U-234 (From Eq. 2)	234.0409	0.02726884	0.000116513
U-235	235.0439	3.2	0.013614478
U-236 (From Eq. 1)	236.0456	0.01472	6.23608E-05
U-238 (From Eq. 3)	238.0508	96.7580112	0.406459509
Gd-152	151.9197	0.2	0.001316485
Gd-154	153.9208	2.18	0.014163128
Gd-155	154.9226	14.8	0.095531575
Gd-156	155.9221	20.47	0.131283506
Gd-157	156.9239	15.65	0.099729869
Gd-158	157.9241	24.84	0.157290749
Gd-160	159.927	21.86	0.136687364

Eq. 4:	0.004202529
	237.9519793
Eq. 5:	0.006360027
	157.2320428

Calculations for parametric study: 3.2 initial U-235 enrichment and gad rods with 3.0 wt% initial enrichment of gadolinium

WITH GADOLINIUM:

Molecular weight of uranium oxide and gadolinium oxide

Eq. 6: (uranium oxide)	269.9507793
Eq. 6: (gadolinium oxide)	362.4622855

Weight fraction of uranium or gadolinium in uranium or gadolinium oxide

Eq. 7 (uranium)	0.881464317
Eq. 7 (gadolinium)	0.867577395

Weight fraction of oxygen in uranium and gadolinium oxide

Eq. 8 (uranium oxide)	0.118535683
Eq. 8 (gadolinium oxide)	0.132422605

Weight recents of all isotopes in gad doped fuel rods

Isotope/Element	Value	Eq. Used
Oxygen	11.8952	11
U-234	0.0233	10
U-235	2.7361	10
U-236	0.0126	10
U-238	82.7301	10
Gd-152	0.0052	9
Gd-154	0.0567	9
Gd-155	0.3852	9
Gd-156	0.5328	9
Gd-157	0.4073	9
Gd-158	0.6465	9
Gd-160	0.5690	9

WITHOUT GADOLINIUM:

Isotope/Element	Value	Eq. Used
Oxygen	11.8536	13
U-234	0.0240	7
U-235	2.8207	7
U-236	0.0130	7
U-238	85.2887	7
	100.0000	

Calculation of wt%'s for SAS2H input.

Element/Isotope	Atomic weight (Ref. 7.23, pp. 36-37; 48-49)	WT%	wt%/atomic wt%		
				Eq. 4:	0.004203784
Oxygen	15.9994	100	-		237.8809143
U-234 (From Eq. 2)	234.0409	0.04904184	0.000209544		
U-235	235.0439	5.5	0.023399884		
U-236 (From Eq. 1)	236.0456	0.0253	0.000107183		
U-238 (From Eq. 3)	238.0508	94.4256582	0.396661797		
Gd-152	151.9197	0.2	0.001316485	Eq. 5:	0.006360027
Gd-154	153.9208	2.18	0.014163128		157.2320428
Gd-155	154.9226	14.8	0.095531575		
Gd-156	155.9221	20.47	0.131283506		
Gd-157	156.9239	15.65	0.099729869		
Gd-158	157.9241	24.84	0.157290749		
Gd-160	159.927	21.86	0.136687364		

5.5 Initial U-235 enrichment and gad rods with 3.0 wt% initial enrichment of gadolinium

WITH GADOLINIUM:

Molecular weight of uranium oxide and gadolinium oxide

Eq. 6: (uranium oxide)	269.8797143
Eq. 6: (gadolinium oxide)	362.4622855

Weight fraction of uranium or gadolinium in uranium or gadolinium oxide

Eq. 7 (uranium)	0.881433104
Eq. 7 (gadolinium)	0.867577395

Weight fraction of oxygen in uranium and gadolinium oxide

Eq. 8 (uranium oxide)	0.118566896
Eq. 8 (gadolinium oxide)	0.132422605

Weight % of all isotopes in gad doped fuel rods

Isotope/Element	Value	Eq. Used
Oxygen	11.8983	11
U-234	0.0419	10
U-235	4.7024	10
U-236	0.0216	10
U-238	80.7330	10
Gd-152	0.0052	9
Gd-154	0.0567	9
Gd-155	0.3852	9
Gd-156	0.5328	9
Gd-157	0.4073	9
Gd-158	0.6465	9
Gd-160	0.5690	9

Calculation of wt%'s for SAS2H input.

Element/Isotope	Atomic weight (Ref. 7.23, pp. 36-37; 48-49)	WT%	wt%/atomic wt%		
Oxygen	15.9994	100	-	Eq. 4:	0.004203538
U-234 (From Eq. 2)	234.0409	0.04470875	0.00019103		237.894818
U-235	235.0439	5.05	0.021485348		
U-236 (From Eq. 1)	236.0456	0.02323	9.84132E-05		
U-238 (From Eq. 3)	238.0508	94.8820612	0.398579048		
Gd-152	151.9197	0.2	0.001316485	Eq. 5:	0.006360027
Gd-154	153.9208	2.18	0.014163128		157.2320428
Gd-155	154.9226	14.8	0.095531575		
Gd-156	155.9221	20.47	0.131283506		
Gd-157	156.9239	15.65	0.099729869		
Gd-158	157.9241	24.84	0.157290749		
Gd-160	159.927	21.86	0.136687364		

Calculations for one- and ten-node comparison cases: 5.05 initial U-235 enrichment and gad rods with 3.0 wt% initial enrichment of gadolinium

WITH GADOLINIUM:

Molecular weight of uranium oxide and gadolinium oxide

Eq. 6: (uranium oxide)	269.893618
Eq. 6: (gadolinium oxide)	362.4622855

Weight fraction of uranium or gadolinium in uranium or gadolinium oxide

Eq. 7 (uranium)	0.881439212
Eq. 7 (gadolinium)	0.867577395

Weight fraction of oxygen in uranium and gadolinium oxide

Eq. 8 (uranium oxide)	0.118560788
Eq. 8 (gadolinium oxide)	0.132422605

Weight % of all isotopes in gad doped fuel rods

Isotope/Element	Value	Eq. Used
Oxygen	11.8977	11
U-234	0.0382	10
U-235	4.3177	10
U-236	0.0199	10
U-238	81.1238	10
Gd-152	0.0052	9
Gd-154	0.0567	9
Gd-155	0.3852	9
Gd-156	0.5328	9
Gd-157	0.4073	9
Gd-158	0.6465	9
Gd-160	0.5690	9

Calculation of wt%'s for SAS2H input.

Element/Isotope	Atomic weight (Ref. 7.23, pp. 36-37; 48-49)	WT%	wt%/atomic wt%		
Oxygen	15.9994	100	-	Eq. 4:	0.004203511
U-234 (From Eq. 2)	234.0409	0.04422924	0.000188981		237.8963629
U-235	235.0439	5	0.021272622		
U-236 (From Eq. 1)	236.0456	0.023	9.74388E-05		
U-238 (From Eq. 3)	238.0508	94.9327708	0.398792068		
Gd-152	151.9197	0.2	0.001316485	Eq. 5:	0.006360027
Gd-154	153.9208	2.18	0.014163128		157.2320428
Gd-155	154.9226	14.8	0.095531575		
Gd-156	155.9221	20.47	0.131283506		
Gd-157	156.9239	15.65	0.099729869		
Gd-158	157.9241	24.84	0.157290749		
Gd-160	159.927	21.86	0.136687364		

Calculations for one- and ten-node comparison cases: 5.05 initial U-235 enrichment and gad rods with 3.0 wt% initial enrichment of gadolinium

WITH GADOLINIUM:

Molecular weight of uranium oxide and gadolinium oxide

Eq. 6: (uranium oxide)	269.8951629
Eq. 6: (gadolinium oxide)	362.4622855

Weight fraction of uranium or gadolinium in uranium or gadolinium oxide

Eq. 7 (uranium)	0.881439891
Eq. 7 (gadolinium)	0.867577395

Weight fraction of oxygen in uranium and gadolinium oxide

Eq. 8 (uranium oxide)	0.118560109
Eq. 8 (gadolinium oxide)	0.132422605

Weight % of all isotopes in gad doped fuel rods

Isotope/Element	Value	Eq. Used
Oxygen	11.8976	11
U-234	0.0378	10
U-235	4.2750	10
U-236	0.0197	10
U-238	81.1672	10
Gd-152	0.0052	9
Gd-154	0.0567	9
Gd-155	0.3852	9
Gd-156	0.5328	9
Gd-157	0.4073	9
Gd-158	0.6465	9
Gd-160	0.5690	9

Calculation of wt%'s for SAS2H input.

Element/Isotope	Atomic weight (Ref. 7.23, pp. 36-37; 48-49)	WT%	wt%/atomic wt%		
				Eq. 4:	0.004203238
Oxygen	15.9994	100	-		237.9118118
U-234 (From Eq. 2)	234.0409	0.03945682	0.000168589		
U-235	235.0439	4.5	0.01914536		
U-236 (From Eq. 1)	236.0456	0.0207	8.76949E-05		
U-238 (From Eq. 3)	238.0508	95.4398432	0.400922169		
Gd-152	151.9197	0.2	0.001316485	Eq. 5:	0.006360027
Gd-154	153.9208	2.18	0.014163128		157.2320428
Gd-155	154.9226	14.8	0.095531575		
Gd-156	155.9221	20.47	0.131283506		
Gd-157	156.9239	15.65	0.099729869		
Gd-158	157.9241	24.84	0.157290749		
Gd-160	159.927	21.86	0.136687364		

4.5 Initial U-235 enrichment and gad rods with 3.0 wt% initial enrichment of gadolinium

WITH GADOLINIUM:

Molecular weight of uranium oxide and gadolinium oxide

Eq. 6: (uranium oxide)	269.9106118
Eq. 6: (gadolinium oxide)	362.4622855

Weight fraction of uranium or gadolinium in uranium or gadolinium oxide

Eq. 7 (uranium)	0.881446677
Eq. 7 (gadolinium)	0.867577395

Weight fraction of oxygen in uranium and gadolinium oxide

Eq. 8 (uranium oxide)	0.118553323
Eq. 8 (gadolinium oxide)	0.132422605

Weight % of all isotopes in gad doped fuel rods

Isotope/Element	Value	Eq. Used
Oxygen	11.8969	11
U-234	0.0337	10
U-235	3.8475	10
U-236	0.0177	10
U-238	81.6014	10
Gd-152	0.0052	9
Gd-154	0.0567	9
Gd-155	0.3852	9
Gd-156	0.5328	9
Gd-157	0.4073	9
Gd-158	0.6465	9
Gd-160	0.5690	9

Calculation of wt%'s for SAS2H Input.

Element/Isotope	Atomic weight (Ref. 7.23, pp. 36-37; 48-49)	WT%	wt%/atomic wt%
Oxygen	15.9994	100	-
U-234 (From Eq. 2)	234.0409	0.03472866	0.000148387
U-235	235.0439	4	0.017018097
U-236 (From Eq. 1)	236.0456	0.0184	7.7951E-05
U-238 (From Eq. 3)	238.0508	95.9468713	0.403052085
Gd-152	151.9197	0.2	0.001316485
Gd-154	153.9208	2.18	0.014163128
Gd-155	154.9226	14.8	0.095531575
Gd-156	155.9221	20.47	0.131283506
Gd-157	156.9239	15.65	0.099729869
Gd-158	157.9241	24.84	0.157290749
Gd-160	159.927	21.86	0.136687364

Eq. 4:	0.004202965
	237.9272609
Eq. 5:	0.006360027
	157.2320428

4.0 Initial U-235 enrichment and gad rods with 3.0 wt% initial enrichment of gadolinium

WITH GADOLINIUM:

Molecular weight of uranium oxide and gadolinium oxide

Eq. 6: (uranium oxide)	269.9260609
Eq. 6: (gadolinium oxide)	362.4622855

Weight fraction of uranium or gadolinium in uranium or gadolinium oxide

Eq. 7 (uranium)	0.881453462
Eq. 7 (gadolinium)	0.867577395

Weight fraction of oxygen in uranium and gadolinium oxide

Eq. 8 (uranium oxide)	0.118546538
Eq. 8 (gadolinium oxide)	0.132422605

Weight % of all isotopes in gad doped fuel rods

Isotope/Element	Value	Eq. Used
Oxygen	11.8963	11
U-234	0.0297	10
U-235	3.4200	10
U-236	0.0157	10
U-238	82.0355	10
Gd-152	0.0052	9
Gd-154	0.0567	9
Gd-155	0.3852	9
Gd-156	0.5328	9
Gd-157	0.4073	9
Gd-158	0.6465	9
Gd-160	0.5690	9

Calculation of wt%'s for SAS2H input.

Element/Isotope	Atomic weight (Ref. 7.23, pp. 36-37; 48-49)	WT%	wt%/atomic wt%
Oxygen	15.9994	100	-
U-234 (From Eq. 2)	234.0409	0.03228915	0.000137964
U-235	235.0439	3.74	0.015911921
U-236 (From Eq. 1)	236.0456	0.017204	7.28842E-05
U-238 (From Eq. 3)	238.0508	96.2105068	0.404159561
Gd-152	151.9197	0.2	0.001316485
Gd-154	153.9208	2.18	0.014163128
Gd-155	154.9226	14.8	0.095531575
Gd-156	155.9221	20.47	0.131283506
Gd-157	156.9239	15.65	0.099729869
Gd-158	157.9241	24.84	0.157290749
Gd-160	159.927	21.86	0.136687364

Eq. 4:	0.004202823
	237.9352945
Eq. 5:	0.006360027
	157.2320428

3.74 initial U-235 enrichment and gad rods with 3.0 wt% initial enrichment of gadolinium

WITH GADOLINIUM:

Molecular weight of uranium oxide and gadolinium oxide

Eq. 6: (uranium oxide)	269.9340945
Eq. 6: (gadolinium oxide)	362.4622855

Weight fraction of uranium or gadolinium in uranium or gadolinium oxide

Eq. 7 (uranium)	0.88145699
Eq. 7 (gadolinium)	0.867577395

Weight fraction of oxygen in uranium and gadolinium oxide

Eq. 8 (uranium oxide)	0.11854301
Eq. 8 (gadolinium oxide)	0.132422605

Weight % of all isotopes in gad doped fuel rods

Isotope/Element	Value	Eq. Used
Oxygen	11.8959	11
U-234	0.0276	10
U-235	3.1977	10
U-236	0.0147	10
U-238	82.2613	10
Gd-152	0.0052	9
Gd-154	0.0567	9
Gd-155	0.3852	9
Gd-156	0.5328	9
Gd-157	0.4073	9
Gd-158	0.6465	9
Gd-160	0.5690	9

Calculation of wt%'s for SAS2H input.

Element/Isotope	Atomic weight (Ref. 7.23, pp. 36-37; 48-49)	WT%	wt%/atomic wt%
Oxygen	15.9994	100	-
U-234 (From Eq. 2)	234.0409	0.03004984	0.000128396
U-235	235.0439	3.5	0.014890835
U-236 (From Eq. 1)	236.0456	0.0161	6.82072E-05
U-238 (From Eq. 3)	238.0508	96.4538502	0.405181794
Gd-152	151.9197	0.2	0.001316485
Gd-154	153.9208	2.18	0.014163128
Gd-155	154.9226	14.8	0.095531575
Gd-156	155.9221	20.47	0.131283506
Gd-157	156.9239	15.65	0.099729869
Gd-158	157.9241	24.84	0.157290749
Gd-160	159.927	21.86	0.136687364

Eq. 4:	0.004202692
	237.9427101
Eq. 5:	0.006360027
	157.2320428

3.5 Initial U-235 enrichment and gad rods with 3.0 wt% initial enrichment of gadolinium

WITH GADOLINIUM:

Molecular weight of uranium oxide and gadolinium oxide

Eq. 6: (uranium oxide)	269.9415101
Eq. 6: (gadolinium oxide)	362.4622855

Weight fraction of uranium or gadolinium in uranium or gadolinium oxide

Eq. 7 (uranium)	0.881460247
Eq. 7 (gadolinium)	0.867577395

Weight fraction of oxygen in uranium and gadolinium oxide

Eq. 8 (uranium oxide)	0.118539753
Eq. 8 (gadolinium oxide)	0.132422605

Weight % of all isotopes in gad doped fuel rods

Isotope/Element	Value	Eq. Used
Oxygen	11.8956	11
U-234	0.0257	10
U-235	2.9926	10
U-236	0.0138	10
U-238	82.4696	10
Gd-152	0.0052	9
Gd-154	0.0567	9
Gd-155	0.3852	9
Gd-156	0.5328	9
Gd-157	0.4073	9
Gd-158	0.6465	9
Gd-160	0.5690	9

Calculation of wt%'s for SAS2H Input.

Element/Isotope	Atomic weight (Ref. 7.23, pp. 36-37; 48-49)	WT%	wt%/atomic wt%
Oxygen	15.9994	100	-
U-234 (From Eq. 2)	234.0409	0.02542682	0.000108643
U-235	235.0439	3	0.012763573
U-236 (From Eq. 1)	236.0456	0.0138	5.84633E-05
U-238 (From Eq. 3)	238.0508	96.9607732	0.407311268
Gd-152	151.9197	0.2	0.001316485
Gd-154	153.9208	2.18	0.014163128
Gd-155	154.9226	14.8	0.095531575
Gd-156	155.9221	20.47	0.131283506
Gd-157	156.9239	15.65	0.099729869
Gd-158	157.9241	24.84	0.157290749
Gd-160	159.927	21.86	0.136687364

Eq. 4:	0.004202419
	237.9581589
Eq. 5:	0.006360027
	157.2320428

3.0 initial U-235 enrichment and gad rods with 3.0 wt% initial enrichment of gadolinium

WITH GADOLINIUM:

Molecular weight of uranium oxide and gadolinium oxide

Eq. 6: (uranium oxide)	269.9569589
Eq. 6: (gadolinium oxide)	362.4622855

Weight fraction of uranium or gadolinium in uranium or gadolinium oxide

Eq. 7 (uranium)	0.88146703
Eq. 7 (gadolinium)	0.867577395

Weight fraction of oxygen in uranium and gadolinium oxide

Eq. 8 (uranium oxide)	0.11853297
Eq. 8 (gadolinium oxide)	0.132422605

Weight % of all isotopes in gad doped fuel rods

Isotope/Element	Value	Eq. Used
Oxygen	11.8950	11
U-234	0.0217	10
U-235	2.5651	10
U-236	0.0118	10
U-238	82.9037	10
Gd-152	0.0052	9
Gd-154	0.0567	9
Gd-155	0.3852	9
Gd-156	0.5328	9
Gd-157	0.4073	9
Gd-158	0.6465	9
Gd-160	0.5690	9

Calculation of wt%'s for SAS2H Input.

Element/Isotope	Atomic weight (Ref. 7.23, pp. 36-37; 48-49)	WT%	wt%/atomic wt%		
Oxygen	15.9994	100	-	Eq. 4:	0.004202147
U-234 (From Eq. 2)	234.0409	0.02086812	8.91644E-05		237.9736072
U-235	235.0439	2.5	0.010636311		
U-236 (From Eq. 1)	236.0456	0.0115	4.87194E-05		
U-238 (From Eq. 3)	238.0508	97.4676319	0.409440472		
Gd-152	151.9197	0.2	0.001316485	Eq. 5:	0.006360027
Gd-154	153.9208	2.18	0.014163128		157.2320428
Gd-155	154.9226	14.8	0.095531575		
Gd-156	155.9221	20.47	0.131283506		
Gd-157	156.9239	15.65	0.099729869		
Gd-158	157.9241	24.84	0.157290749		
Gd-160	159.927	21.86	0.136687364		

2.5 Initial U-235 enrichment and gad rods with 3.0 wt% initial enrichment of gadolinium

WITH GADOLINIUM:

Molecular weight of uranium oxide and gadolinium oxide

Eq. 6: (uranium oxide)	269.9724072
Eq. 6: (gadolinium oxide)	362.4622855

Weight fraction of uranium or gadolinium in uranium or gadolinium oxide

Eq. 7 (uranium)	0.881473813
Eq. 7 (gadolinium)	0.867577395

Weight fraction of oxygen in uranium and gadolinium oxide

Eq. 8 (uranium oxide)	0.118526187
Eq. 8 (gadolinium oxide)	0.132422605

Weight % of all isotopes in gad doped fuel rods

Isotope/Element	Value	Eq. Used
Oxygen	11.8943	11
U-234	0.0178	10
U-235	2.1376	10
U-236	0.0098	10
U-238	83.3377	10
Gd-152	0.0052	9
Gd-154	0.0567	9
Gd-155	0.3852	9
Gd-156	0.5328	9
Gd-157	0.4073	9
Gd-158	0.6465	9
Gd-160	0.5690	9

Calculation of wt%'s for SAS2H Input.

Element/Isotope	Atomic weight (Ref. 7.23, pp. 36-37; 48-49)	WT%	wt%/atomic wt%		
				Eq. 4:	0.004201874
Oxygen	15.9994	100	-		237.9890543
U-234 (From Eq. 2)	234.0409	0.01638558	7.00116E-05		
U-235	235.0439	2	0.008509049		
U-236 (From Eq. 1)	236.0456	0.0092	3.89755E-05		
U-238 (From Eq. 3)	238.0508	97.9744144	0.411569356		
Gd-152	151.9197	0.2	0.001316485	Eq. 5:	0.006360027
Gd-154	153.9208	2.18	0.014163128		157.2320428
Gd-155	154.9226	14.8	0.095531575		
Gd-156	155.9221	20.47	0.131283506		
Gd-157	156.9239	15.65	0.099729869		
Gd-158	157.9241	24.84	0.157290749		
Gd-160	159.927	21.86	0.136687364		

2.0 Initial U-235 enrichment and gad rods with 3.0 wt% initial enrichment of gadolinium

WITH GADOLINIUM:

Molecular weight of uranium oxide and gadolinium oxide

Eq. 6: (uranium oxide)	269.9878543
Eq. 6: (gadolinium oxide)	362.4622855

Weight fraction of uranium or gadolinium in uranium or gadolinium oxide

Eq. 7 (uranium)	0.881480594
Eq. 7 (gadolinium)	0.867577395

Weight fraction of oxygen in uranium and gadolinium oxide

Eq. 8 (uranium oxide)	0.118519406
Eq. 8 (gadolinium oxide)	0.132422605

Weight % of all isotopes in gad doped fuel rods

Isotope/Element	Value	Eq. Used
Oxygen	11.8937	11
U-234	0.0140	10
U-235	1.7101	10
U-236	0.0079	10
U-238	83.7717	10
Gd-152	0.0052	9
Gd-154	0.0567	9
Gd-155	0.3852	9
Gd-156	0.5328	9
Gd-157	0.4073	9
Gd-158	0.6465	9
Gd-160	0.5690	9

Calculation of wt%'s for SAS2H Input.

Element/Isotope	Atomic weight (Ref. 7.23, pp. 36-37; 48-49)	WT%	wt%/atomic wt%
Oxygen	15.9994	100	-
U-234 (From Eq. 2)	234.0409	0.01199681	5.12595E-05
U-235	235.0439	1.5	0.006381787
U-236 (From Eq. 1)	236.0456	0.0069	2.92316E-05
U-238 (From Eq. 3)	238.0508	98.4811032	0.413697846
Gd-152	151.9197	0.2	0.001316485
Gd-154	153.9208	2.18	0.014163128
Gd-155	154.9226	14.8	0.095531575
Gd-156	155.9221	20.47	0.131283506
Gd-157	156.9239	15.65	0.099729869
Gd-158	157.9241	24.84	0.157290749
Gd-160	159.927	21.86	0.136687364

Eq. 4:	0.004201601
	238.0044997
Eq. 5:	0.006360027
	157.2320428

1.5 initial U-235 enrichment and gad rods with 3.0 wt% initial enrichment of gadolinium

WITH GADOLINIUM:

Molecular weight of uranium oxide and gadolinium oxide

Eq. 6: (uranium oxide)	270.0032997
Eq. 6: (gadolinium oxide)	362.4622855

Weight fraction of uranium or gadolinium in uranium or gadolinium oxide

Eq. 7 (uranium)	0.881487374
Eq. 7 (gadolinium)	0.867577395

Weight fraction of oxygen in uranium and gadolinium oxide

Eq. 8 (uranium oxide)	0.118512626
Eq. 8 (gadolinium oxide)	0.132422605

Weight % of all isotopes in gad doped fuel rods

Isotope/Element	Value	Eq. Used
Oxygen	11.8930	11
U-234	0.0103	10
U-235	1.2826	10
U-236	0.0059	10
U-238	84.2056	10
Gd-152	0.0052	9
Gd-154	0.0567	9
Gd-155	0.3852	9
Gd-156	0.5328	9
Gd-157	0.4073	9
Gd-158	0.6465	9
Gd-160	0.5690	9

Calculation of wt%'s for SAS2H input.

Element/Isotope	Atomic weight (Ref. 7.23, pp. 36-37; 48-49)	WT%	wt%/atomic wt%
Oxygen	15.9994	100	-
U-234 (From Eq. 2)	234.0409	0.007731	3.30327E-05
U-235	235.0439	1	0.004254524
U-236 (From Eq. 1)	236.0456	0.0046	1.94878E-05
U-238 (From Eq. 3)	238.0508	98.987669	0.41582582
Gd-152	151.9197	0.2	0.001316485
Gd-154	153.9208	2.18	0.014163128
Gd-155	154.9226	14.8	0.095531575
Gd-156	155.9221	20.47	0.131283506
Gd-157	156.9239	15.65	0.099729869
Gd-158	157.9241	24.84	0.157290749
Gd-160	159.927	21.86	0.136687364

Eq. 4:	0.004201329
	238.019942
Eq. 5:	0.006360027
	157.2320428

1.0 Initial U-235 enrichment and gad rods with 3.0 wt% initial enrichment of gadolinium

WITH GADOLINIUM:

Molecular weight of uranium oxide and gadolinium oxide

Eq. 6: (uranium oxide)	270.018742
Eq. 6: (gadolinium oxide)	362.4622855

Weight fraction of uranium or gadolinium in uranium or gadolinium oxide

Eq. 7 (uranium)	0.881494152
Eq. 7 (gadolinium)	0.867577395

Weight fraction of oxygen in uranium and gadolinium oxide

Eq. 8 (uranium oxide)	0.118505848
Eq. 8 (gadolinium oxide)	0.132422605

Weight % of all isotopes in gad doped fuel rods

Isotope/Element	Value	Eq. Used
Oxygen	11.8923	11
U-234	0.0066	10
U-235	0.8550	10
U-236	0.0039	10
U-238	84.6393	10
Gd-152	0.0052	9
Gd-154	0.0567	9
Gd-155	0.3852	9
Gd-156	0.5328	9
Gd-157	0.4073	9
Gd-158	0.6465	9
Gd-160	0.5690	9

Calculation of wt%'s for SAS2H input.

Element/Isotope	Atomic weight (Ref. 7.23, pp. 36-37; 48-49)	WT%	wt%/atomic wt%		
Oxygen	15.9994	100	-	Eq. 4:	0.004201171
U-234 (From Eq. 2)	234.0409	0.00534204	2.28252E-05		238.0288654
U-235	235.0439	0.711	0.003024967		
U-236 (From Eq. 1)	236.0456	0.0032706	1.38558E-05		
U-238 (From Eq. 3)	238.0508	99.2803874	0.417055466		
Gd-152	151.9197	0.2	0.001316485	Eq. 5:	0.006360027
Gd-154	153.9208	2.18	0.014163128		157.2320428
Gd-155	154.9226	14.8	0.095531575		
Gd-156	155.9221	20.47	0.131283506		
Gd-157	156.9239	15.65	0.099729869		
Gd-158	157.9241	24.84	0.157290749		
Gd-160	159.927	21.86	0.136687364		

0.711 initial U-235 enrichment and gad rods with 3.0 wt% initial enrichment of gadolinium

WITH GADOLINIUM:

Molecular weight of uranium oxide and gadolinium oxide

Eq. 6: (uranium oxide)	270.0276654
Eq. 6: (gadolinium oxide)	362.4622855

Weight fraction of uranium or gadolinium in uranium or gadolinium oxide

Eq. 7 (uranium)	0.881498068
Eq. 7 (gadolinium)	0.867577395

Weight fraction of oxygen in uranium and gadolinium oxide

Eq. 8 (uranium oxide)	0.118501932
Eq. 8 (gadolinium oxide)	0.132422605

Weight % of all isotopes in gad doped fuel rods

Isotope/Element	Value	Eq. Used
Oxygen	11.8920	11
U-234	0.0046	10
U-235	0.6079	10
U-236	0.0028	10
U-238	84.8900	10
Gd-152	0.0052	9
Gd-154	0.0567	9
Gd-155	0.3852	9
Gd-156	0.5328	9
Gd-157	0.4073	9
Gd-158	0.6465	9
Gd-160	0.5690	9

annel lume m^3)	5883.737	Water rod volume (2 water rods)	511.089	Cladding volume	6919.51
el mass kg)	38.597	Water rods mass	3.353	Cladding mass	45.392
channel ass	29.937 kg				

Channel fractions in the various regions		
	top	0.0258
	plenum	0.0693
	fuel	0.8880
	bottom	0.0169

cladding fractions in the various regions	
fuel	0.928
plenum	0.072

		hardware	Tie plate	Top compression spring	channel	tie plate	Bottom channel	Plenum channel	water rods	getters	cladding	plenum springs	Fuel channel	spacer grids	water rods	cladding
		material	ss304	Inconel	zirc4	ss 304	zirc4	zirc 4	zirc 4	ss 304	zirc2	inconel	zirc 4	zirc 4/inconel	zirc 4	zirc 2
		mass	1.99989	0.58	0.9949	4.7700	0.6512	2.6754	0.2428	0.616886	3.286561	1.7	34.276	1.9499 / 0.32523	3.110	42.105
aterial	Symbol	Wt%														
caloy-2	O	0.12									0.0039					0.0505
	Cr	0.1									0.0033					0.0421
	Fe	0.1									0.0033					0.0421
	Ni	0.05									0.0016					0.0211
	Sn	1.4									0.0460					0.5895
	Zr	98.23									3.2284					41.3601
	6.56 Mg/m3															
caloy-4	O	0.12			0.0012		0.0008	0.0032	0.0003				0.0411	0.0023	0.0037	
	Cr	0.1			0.0010		0.0007	0.0027	0.0002				0.0343	0.0019	0.0031	
	Fe	0.2			0.0020		0.0013	0.0054	0.0005				0.0686	0.0039	0.0062	
	Sn	1.4			0.0139		0.0091	0.0375	0.0034				0.4799	0.0273	0.0435	
	Zr	98.18			0.9768		0.6394	2.6267	0.2383				33.6519	1.9144	3.0534	
	6.56 Mg/m3															
nel X-750	Ni	70.23		0.4073								1.1939		0.2284		
	Cr	15		0.0870								0.2550		0.0488		
	Fe	8		0.0464								0.1360		0.0260		
	Nb	1		0.0058								0.0170		0.0033		
	Ti	2.4		0.0139								0.0408		0.0078		
	Al	0.7		0.0041								0.0119		0.0023		
	Co	1		0.0058								0.0170		0.0033		
	Mn	0.8		0.0046								0.0136		0.0026		
	Si	0.4		0.0023								0.0068		0.0013		
	Cu	0.4		0.0023								0.0068		0.0013		
	C	0.06		0.0003								0.0010		0.0002		
	S	0.01		0.0001								0.0002		0.0000		
ss 304	C	0.08	0.0016			0.0038				0.0005						
	Mn	2	0.0400			0.0954				0.0123						
	P	0.045	0.0009			0.0021				0.0003						
	S	0.03	0.0006			0.0014				0.0002						
	Si	0.75	0.0150			0.0358				0.0046						
	Cr	19	0.3800			0.9063				0.1172						
	Ni	9.25	0.1850			0.4412				0.0571						
	N	0.1	0.0020			0.0048				0.0006						
	Fe	68.745	1.3748			3.2791				0.4241						

top end fitting regions			Scale factor =		0.15
	channel	compression spring	tie plate	raw	scaled
O	0.0012			0.0012	0.0002
Al		0.0041		0.0041	0.0006
C		0.0003	0.0016	0.0019	0.0003
Co		0.0058		0.0058	0.0009
Cr	0.0010	0.087	0.38	0.4680	0.0702
Cu		0.0023		0.0023	0.0003
Fe	0.0020	0.0464	1.3748	1.4232	0.2135
Mn		0.0046	0.04	0.0446	0.0067
Nb		0.0058		0.0058	0.0009
N			0.002	0.0020	0.0003
Ni		0.4073	0.185	0.5923	0.0888
P			0.0009	0.0009	0.0001
S		0.0001	0.0006	0.0007	0.0001
Si		0.0023	0.015	0.0173	0.0026
Sn	0.0139			0.0139	0.0021
Ti		0.0139		0.0139	0.0021
Zr	0.9768			0.9768	0.1465

			plenum	Scale factor =		0.3
	cladding	channel	getters	water rods	plenum springs	raw	scaled
O	0.003944	0.00321		0.000291		0.0074	0.0022
Al					0.0119	0.0119	0.0036
C			0.0005		0.0010	0.0015	0.0005
Co					0.0170	0.0170	0.0051
Cr	0.003287	0.002675	0.1172	0.000243	0.2550	0.3784	0.1135
Cu					0.0068	0.0068	0.0020
Fe	0.003287	0.005351	0.4241	0.000486	0.1360	0.5692	0.1708
Mn			0.0123		0.0136	0.0259	0.0078
Nb					0.0170	0.0170	0.0051
N			0.0006			0.0006	0.0002
Ni	0.001643		0.0571		1.1939	1.2527	0.3758
P			0.0003			0.0003	0.0001
S			0.0002		0.0002	0.0004	0.0001
Si			0.0046		0.0068	0.0114	0.0034
Sn	0.046012	0.037456		0.003399		0.0869	0.0261
Ti					0.0408	0.0408	0.0122
Zr	3.228389	2.626718		0.238334		6.0934	1.8280

bottom end fitting		Scale factor =		0.225
	channel	tie plate	raw	scaled
O	0.000781486		0.0008	0.0002
Al			0.0000	0.0000
C		0.003815984	0.0038	0.0009
Co			0.0000	0.0000
Cr	0.000651239	0.9062962	0.9069	0.2041
Cu			0.0000	0.0000
Fe	0.001302477	3.279122751	3.2804	0.7381
Mn		0.0953996	0.0954	0.0215
Nb			0.0000	0.0000
N		0.00476998	0.0048	0.0011
Ni		0.44122315	0.4412	0.0993
P		0.002146491	0.0021	0.0005
S		0.001430994	0.0014	0.0003
Si		0.03577485	0.0358	0.0080
Sn	0.009117341		0.0091	0.0021
Ti			0.0000	0.0000
Zr	0.639386099		0.6394	0.1439

			fuel region	one node		
	cladding	channel	spacers	water rods	spacers	raw
O	0.050526	0.041131	0.00234	0.003732		0.0977
Al					0.002277	0.0023
C					0.000195	0.0002
Co					0.003252	0.0033
Cr	0.042105	0.034276	0.00195	0.00311	0.048785	0.1302
Cu					0.001301	0.0013
Fe	0.042105	0.068551	0.0039	0.00622	0.026018	0.1468
Mn					0.002602	0.0026
Nb					0.003252	0.0033
N						0.0000
Ni	0.021053				0.228409	0.2495
P						0.0000
S					3.25E-05	0.0000
Si					0.001301	0.0013
Sn	0.589476	0.47986	0.027299	0.04354		1.1402
Ti					0.007806	0.0078
Zr	41.36014	33.6519	1.914412	3.053391		79.9798

Spacer?	no	yes	yes	yes	yes	yes	yes	yes	yes	no
% of 1 spacer	0.000%	69.231%	30.769%	100.000%	100.000%	61.538%	107.691%	30.769%	200.000%	0.000%
NODE:	1	2	3	4	5	6	7	8	9	10
dimension	6	12	12	18	12	18	18	18	25.24	6
fraction of fuel	0.04137931	0.082759	0.082759	0.1241379	0.08275862	0.124138	0.1241379	0.124138	0.174069	0.041379

el region
ne node

	cladding	channel	spacers	water rods	spacers	raw
O	0.050526	0.041131	0.00234	0.003732		0.0977
Al					0.00227661	0.0023
C					0.00019514	0.0002
Co					0.0032523	0.0033
Cr	0.042105	0.034276	0.00195	0.00311	0.0487845	0.1302
Cu					0.00130092	0.0013
Fe	0.042105	0.068551	0.0039	0.00622	0.0260184	0.1468
Mn					0.00260184	0.0026
Nb					0.0032523	0.0033
N						0.0000
Ni	0.021053				0.22840903	0.2495
P						0.0000
S					3.2523E-05	0.0000
Si					0.00130092	0.0013
Sn	0.589476	0.47986	0.027299	0.04354		1.1402
Ti					0.00780552	0.0078
Zr	41.36014	33.6519	1.914412	3.053391		79.9798

light elements are determined by multiplying the hardware by the percent in the fuel region takining the spacer material, dividing by the number of spacers and thenmultipling by the percentage of one spacer in that node

ode 1	cladding	channel	water rods	raw	nodal adjustment
O	0.050526	0.041131	0.003732	0.0954	0.00394715
Al				0.0000	0
C				0.0000	0
Co				0.0000	0
Cr	0.042105	0.034276	0.00311	0.0795	0.00328929
Cu				0.0000	0
Fe	0.042105	0.068551	0.00622	0.1169	0.00483628
Mn				0.0000	0
Nb				0.0000	0
N				0.0000	0
Ni	0.021053			0.0211	0.00087115
P				0.0000	0
S				0.0000	0
Si				0.0000	0
Sn	0.589476	0.47986	0.04354	1.1129	0.04605003
Ti				0.0000	0
Zr	41.36014	33.6519	3.053391	78.0654	3.23029386

node 2	cladding	channel	spacers	water rods	spacers	clad, wr, and channel	spacers	total
O	0.050526492	0.041130862	0.00234	0.003732		0.0079	0.000231	0.0081
Al					0.0022766	0.0000	0.000225	0.0002
C					0.0001951	0.0000	1.93E-05	0.0000
Co					0.0032523	0.0000	0.000322	0.0003
Cr	0.04210541	0.034275718	0.00195	0.00311	0.0487845	0.0066	0.005018	0.0116
Cu					0.0013009	0.0000	0.000129	0.0001
Fe	0.04210541	0.068551436	0.0039	0.00622	0.0260184	0.0097	0.002959	0.0126
Mn					0.0026018	0.0000	0.000257	0.0003
Nb					0.0032523	0.0000	0.000322	0.0003
N						0.0000	0	0.0000
Ni	0.021052705				0.228409	0.0017	0.02259	0.0243
P						0.0000	0	0.0000
S					3.252E-05	0.0000	3.22E-06	0.0000
Si					0.0013009	0.0000	0.000129	0.0001
Sn	0.589475737	0.479860052	0.027299	0.04354		0.0921	0.0027	0.0948
Ti					0.0078055	0.0000	0.000772	0.0008
Zr	41.36014401	33.65189993	1.914412	3.053391		6.4606	0.189338	6.6499

node 3	cladding	channel	spacers	water rods	spacers	clad, wr, and channel	spacers	total
O	0.050526	0.041131	0.00234	0.003732		0.0079	0.000103	0.0080
Al					0.00227661	0.0000	0.0001	0.0001
C					0.00019514	0.0000	8.58E-06	0.0000
Co					0.0032523	0.0000	0.000143	0.0001
Cr	0.042105	0.034276	0.00195	0.00311	0.0487845	0.0066	0.00223	0.0088
Cu					0.00130092	0.0000	5.72E-05	0.0001
Fe	0.042105	0.068551	0.0039	0.00622	0.0260184	0.0097	0.001315	0.0110
Mn					0.00260184	0.0000	0.000114	0.0001
Nb					0.0032523	0.0000	0.000143	0.0001
N						0.0000	0	0.0000
Ni	0.021053				0.22840903	0.0017	0.01004	0.0118
P						0.0000	0	0.0000
S					3.2523E-05	0.0000	1.43E-06	0.0000
Si					0.00130092	0.0000	5.72E-05	0.0001
Sn	0.589476	0.47986	0.027299	0.04354		0.0921	0.0012	0.0933
Ti					0.00780552	0.0000	0.000343	0.0003
Zr	41.36014	33.6519	1.914412	3.053391		6.4606	0.084149	6.5447

node 4	cladding	channel	spacers	water rods	spacers	clad, wr, and channel	spacers	total
O	0.050526	0.0411309	0.00233988	0.003732		0.0118	0.0003343	0.0122
Al					0.0022766	0.0000	0.0003252	0.0003
C					0.0001951	0.0000	2.788E-05	0.0000
Co					0.0032523	0.0000	0.0004646	0.0005
Cr	0.042105	0.0342757	0.0019499	0.00311	0.0487845	0.0099	0.0072478	0.0171
Cu					0.0013009	0.0000	0.0001858	0.0002
Fe	0.042105	0.0685514	0.0038998	0.00622	0.0260184	0.0145	0.004274	0.0188
Mn					0.0026018	0.0000	0.0003717	0.0004
Nb					0.0032523	0.0000	0.0004646	0.0005
N						0.0000	0	0.0000
Ni	0.021053				0.228409	0.0026	0.0326299	0.0352
P						0.0000	0	0.0000
S					3.252E-05	0.0000	4.646E-06	0.0000
Si					0.0013009	0.0000	0.0001858	0.0002
Sn	0.589476	0.4798601	0.0272986	0.04354		0.1382	0.0038998	0.1420
Ti					0.0078055	0.0000	0.0011151	0.0011
Zr	41.36014	33.6519	1.91441182	3.053391		9.6909	0.2734874	9.9644

node 5	cladding	channel	spacers	water rods	spacers	clad, wr, and channel	spacers	total
O	0.050526	0.041131	0.00234	0.003732		0.0079	0.000334	0.0082
Al					0.00227661	0.0000	0.000325	0.0003
C					0.00019514	0.0000	2.79E-05	0.0000
Co					0.0032523	0.0000	0.000465	0.0005
Cr	0.042105	0.034276	0.00195	0.00311	0.0487845	0.0066	0.007248	0.0138
Cu					0.00130092	0.0000	0.000186	0.0002
Fe	0.042105	0.068551	0.0039	0.00622	0.0260184	0.0097	0.004274	0.0139
Mn					0.00260184	0.0000	0.000372	0.0004
Nb					0.0032523	0.0000	0.000465	0.0005
N						0.0000	0	0.0000
Ni	0.021053				0.22840903	0.0017	0.03263	0.0344
P						0.0000	0	0.0000
S					3.2523E-05	0.0000	4.65E-06	0.0000
Si					0.00130092	0.0000	0.000186	0.0002
Sn	0.589476	0.47986	0.027299	0.04354		0.0921	0.0039	0.0960
Ti					0.00780552	0.0000	0.001115	0.0011
Zr	41.36014	33.6519	1.914412	3.053391		6.4606	0.273487	6.7341

node 6	cladding	channel	spacers	water rods	spacers	clad, wr, and channel	spacers	total
O	0.050526	0.0411309	0.00233988	0.003732		0.0118	0.0002057	0.0120
Al					0.0022766	0.0000	0.0002001	0.0002
C					0.0001951	0.0000	1.715E-05	0.0000
Co					0.0032523	0.0000	0.0002859	0.0003
Cr	0.042105	0.0342757	0.0019499	0.00311	0.0487845	0.0099	0.0044601	0.0143
Cu					0.0013009	0.0000	0.0001144	0.0001
Fe	0.042105	0.0685514	0.0038998	0.00622	0.0260184	0.0145	0.0026302	0.0171
Mn					0.0026018	0.0000	0.0002287	0.0002
Nb					0.0032523	0.0000	0.0002859	0.0003
N						0.0000	0	0.0000
Ni	0.021053				0.228409	0.0026	0.0200798	0.0227
P						0.0000	0	0.0000
S					3.252E-05	0.0000	2.859E-06	0.0000
Si					0.0013009	0.0000	0.0001144	0.0001
Sn	0.589476	0.4798601	0.0272986	0.04354		0.1382	0.0023999	0.1405
Ti					0.0078055	0.0000	0.0006862	0.0007
Zr	41.36014	33.6519	1.91441182	3.053391		9.6909	0.1682987	9.8592

de 7	cladding	channel	spacers	water rods	spacers	clad, wr, and channel	spacers	total
O	0.050526	0.041131	0.00234	0.003732		0.0118	0.00036	0.0122
Al					0.00227661	0.0000	0.00035	0.0004
C					0.00019514	0.0000	3E-05	0.0000
Co					0.0032523	0.0000	0.0005	0.0005
Cr	0.042105	0.034276	0.00195	0.00311	0.0487845	0.0099	0.007805	0.0177
Cu					0.00130092	0.0000	0.0002	0.0002
Fe	0.042105	0.068551	0.0039	0.00622	0.0260184	0.0145	0.004603	0.0191
Mn					0.00260184	0.0000	0.0004	0.0004
Nb					0.0032523	0.0000	0.0005	0.0005
N						0.0000	0	0.0000
Ni	0.021053				0.22840903	0.0026	0.035139	0.0378
P						0.0000	0	0.0000
S					3.2523E-05	0.0000	5E-06	0.0000
Si					0.00130092	0.0000	0.0002	0.0002
Sn	0.589476	0.47986	0.027299	0.04354		0.1382	0.0042	0.1423
Ti					0.00780552	0.0000	0.001201	0.0012
Zr	41.36014	33.6519	1.914412	3.053391		9.6909	0.294521	9.9854

node 8	cladding	channel	spacers	water rods	spacers	clad, wr, and channel	spacers	total
O	0.050526	0.0411309	0.00233988	0.003732		0.0118	0.0001029	0.0119
Al					0.0022766	0.0000	0.0001001	0.0001
C					0.0001951	0.0000	8.577E-06	0.0000
Co					0.0032523	0.0000	0.000143	0.0001
Cr	0.042105	0.0342757	0.0019499	0.00311	0.0487845	0.0099	0.0022301	0.0121
Cu					0.0013009	0.0000	5.718E-05	0.0001
Fe	0.042105	0.0685514	0.0038998	0.00622	0.0260184	0.0145	0.0013151	0.0158
Mn					0.0026018	0.0000	0.0001144	0.0001
Nb					0.0032523	0.0000	0.000143	0.0001
N						0.0000	0	0.0000
Ni	0.021053				0.228409	0.0026	0.0100399	0.0127
P						0.0000	0	0.0000
S					3.252E-05	0.0000	1.43E-06	0.0000
Si					0.0013009	0.0000	5.718E-05	0.0001
Sn	0.589476	0.4798601	0.0272986	0.04354		0.1382	0.0011999	0.1394
Ti					0.0078055	0.0000	0.0003431	0.0003
Zr	41.36014	33.6519	1.91441182	3.053391		9.6909	0.0841493	9.7750

ode 9	cladding	channel	spacers	water rods	spacers	clad, wr, and channel	spacers	total
O	0.050526	0.041131	0.00234	0.003732		0.0166	0.000669	0.0173
Al					0.00227661	0.0000	0.00065	0.0007
C					0.00019514	0.0000	5.58E-05	0.0001
Co					0.0032523	0.0000	0.000929	0.0009
Cr	0.042105	0.034276	0.00195	0.00311	0.0487845	0.0138	0.014496	0.0283
Cu					0.00130092	0.0000	0.000372	0.0004
Fe	0.042105	0.068551	0.0039	0.00622	0.0260184	0.0203	0.008548	0.0289
Mn					0.00260184	0.0000	0.000743	0.0007
Nb					0.0032523	0.0000	0.000929	0.0009
N						0.0000	0	0.0000
Ni	0.021053				0.22840903	0.0037	0.06526	0.0689
P						0.0000	0	0.0000
S					3.2523E-05	0.0000	9.29E-06	0.0000
Si					0.00130092	0.0000	0.000372	0.0004
Sn	0.589476	0.47986	0.027299	0.04354		0.1937	0.0078	0.2015
Ti					0.00780552	0.0000	0.00223	0.0022
Zr	41.36014	33.6519	1.914412	3.053391		13.5888	0.546975	14.1357

node 10	cladding	channel	spacers	water rods	spacers	clad, wr, and channel	spacers	total
O	0.050526	0.0411309	0.00233988	0.003732		0.0039	0	0.0039
Al					0.0022766	0.0000	0	0.0000
C					0.0001951	0.0000	0	0.0000
Co					0.0032523	0.0000	0	0.0000
Cr	0.042105	0.0342757	0.0019499	0.00311	0.0487845	0.0033	0	0.0033
Cu					0.0013009	0.0000	0	0.0000
Fe	0.042105	0.0685514	0.0038998	0.00622	0.0260184	0.0048	0	0.0048
Mn					0.0026018	0.0000	0	0.0000
Nb					0.0032523	0.0000	0	0.0000
N						0.0000	0	0.0000
Ni	0.021053				0.228409	0.0009	0	0.0009
P						0.0000	0	0.0000
S					3.252E-05	0.0000	0	0.0000
Si					0.0013009	0.0000	0	0.0000
Sn	0.589476	0.4798601	0.0272986	0.04354		0.0461	0	0.0461
Ti					0.0078055	0.0000	0	0.0000
Zr	41.36014	33.6519	1.91441182	3.053391		3.2303	0	3.2303

.3.2.1. Specification of materials used in SAS2H and MCNP calculations

n red indicates those these
nts that have been elements has
dified in REV01. been adjusted
to increase

nnel volume (cm^3)	5883.737	Water rod volume (2 water rods)	511.0692
annel mass (kg)	38.597	Water rods ma	3.353
en channel mass	29.937 kg		

		Cladding volume	6919.5078
		Cladding mas	45.392

Channel fractions in the various regions		
	top	0.0258
	plenum	0.0693
	fuel	0.8880
	bottom	0.0169

cladding fractions in the various regions	
fuel	0.928
plenum	0.072

		hardware	Tie plate	Top pression sp	channel	tie plate	Bottom channel	Plenum channel	water rods	getters	cladding	enum spring	Fuel channel	spacer grids	water rods	cladding	Oxygen from fuel
		material mass	ss304 1.99989	inconel 0.58	zirc4 0.9949479	ss 304 4.76998	zirc4 0.6512386	zirc 4 2.67541021	zirc 2 0.24275222	ss 304 0.616886	zirc2 3.286561	inconel 1.7	zirc 4 34.275718	zirc 4/inconel 9499 / 0.3252	zirc 2 3.109993	zirc 2 42.10541	Oxygen from fuel 27.2727273
Material	Symbol	Wt%															
Zircaloy-2	O	0.12							0.00029		0.0039				0.00373	0.0505	27.2727273
	Cr	0.1							0.00024		0.0033				0.00311	0.0421	
	Fe	0.2							0.00049		0.0066				0.00622	0.0842	
	Ni	0.08							0.00019		0.0026				0.00249	0.0337	
	Sn	1.7							0.00413		0.0559				0.05287	0.7158	
	Zr	97.8							0.23741		3.2143				3.04157	41.1791	
	6.55 g/cm3																
Zircaloy-4	O	0.12			0.0012		0.0008	0.0032					0.0411	0.0023			
	Cr	0.1			0.0010		0.0007	0.0027					0.0343	0.0019			
	Fe	0.2			0.0020		0.0013	0.0054					0.0686	0.0039			
	Sn	1.7			0.0169		0.0111	0.0455					0.5827	0.0331			
	Zr	97.88			0.9739		0.6374	2.6187					33.5491	1.9086			
	6.56 Mg/m3																
Inconel X-750	Ni	70.23		0.4073								1.1939		0.2284			
	Cr	15		0.0870								0.2550		0.0488			
	Fe	8		0.0464								0.1360		0.0260			
	Nb	1		0.0058								0.0170		0.0033			
	Ti	2.4		0.0139								0.0408		0.0078			
	Al	0.7		0.0041								0.0119		0.0023			
	Co	1		0.0058								0.0170		0.0033			
	Mn	0.8		0.0046								0.0136		0.0026			
	Si	0.4		0.0023								0.0068		0.0013			
	Cu	0.4		0.0023								0.0068		0.0013			
	C	0.06		0.0003								0.0010		0.0002			
	S	0.01		0.0001								0.0002		0.0000			
ss 304	C	0.08	0.0016			0.0038				0.0005							
	Mn	2	0.0400			0.0954				0.0123							
	P	0.045	0.0009			0.0021				0.0003							
	S	0.03	0.0006			0.0014				0.0002							
	Si	0.75	0.0150			0.0358				0.0046							
	Cr	19	0.3800			0.9063				0.1172							
	Ni	10.42	0.2084			0.4970				0.0643							
	Co	0.08	0.0016			0.0038				0.0005							
	N	0.1	0.0020			0.0048				0.0006							
	Fe	67.495	1.3498			3.2195				0.4164							

ollowing section has been added to account for the inpurities in the fuel meat itself.									
PWR U mass (g)		475000		PWR mass (k	539.77273				
BWR U mass (g)		200000							
assembly volume (cc)			54194.05						
assembly volume (cc)			19522.38						
npurities in the fuel:									
			PWR		BWR				
Impurities	atomic mass (g/g-atom) (Ref. 7.23, p. 60)	ppm/U	mass (kg)	at dens	mass (kg)	at dens			
Li	6.941	1	0.000475	7.604E-07	0.0002	8.888E-07		Li	0.0002
B	10.811	1	0.000475	4.882E-07	0.0002	5.707E-07		B	0.0002
C	12.0107	89.4	0.042465	3.929E-05	0.01788	4.592E-05		C	0.01788
N	14.00674	25	0.011875	9.421E-06	0.005	1.101E-05		N	0.005
F	18.9984032	10.7	0.005083	2.973E-06	0.00214	3.475E-06		F	0.00214
Na	22.98977	15	0.007125	3.444E-06	0.003	4.025E-06		Na	0.003
Mg	24.305	2	0.00095	4.343E-07	0.0004	5.077E-07		Mg	0.0004
Al	26.981538	16.7	0.007933	3.267E-06	0.00334	3.818E-06		Al	0.00334
Si	28.0855	12.1	0.005748	2.274E-06	0.00242	2.658E-06		Si	0.00242
P	30.973761	35	0.016625	5.964E-06	0.007	6.971E-06		P	0.007
Cl	35.4527	5.3	0.002518	7.891E-07	0.00106	9.223E-07		Cl	0.00106
Ca	40.078	2	0.00095	2.634E-07	0.0004	3.079E-07		Ca	0.0004
Ti	47.867	1	0.000475	1.103E-07	0.0002	1.289E-07		Ti	0.0002
V	50.9415	3	0.001425	3.108E-07	0.0006	3.633E-07		V	0.0006
Cr	51.9961	4	0.0019	4.06E-07	0.0008	4.746E-07		Cr	0.0008
Mn	54.938049	1.7	0.000808	1.633E-07	0.00034	1.909E-07		Mn	0.00034
Fe	55.845	18	0.00855	1.701E-06	0.0036	1.989E-06		Fe	0.0036
Co	58.9332	1	0.000475	8.956E-08	0.0002	1.047E-07		Co	0.0002
Ni	58.6934	24	0.0114	2.158E-06	0.0048	2.523E-06		Ni	0.0048
Cu	63.546	1	0.000475	8.306E-08	0.0002	9.708E-08		Cu	0.0002
Zn	65.39	40.3	0.019143	3.253E-06	0.00806	3.802E-06		Zn	0.00806
Mo	95.94	10	0.00475	5.502E-07	0.002	6.43E-07		Mo	0.002
Ag	107.8682	0.1	4.75E-05	4.893E-09	0.00002	5.719E-09		Ag	0.00002
Cd	112.411	25	0.011875	1.174E-06	0.005	1.372E-06		Cd	0.005
In	114.818	2	0.00095	9.194E-08	0.0004	1.075E-07		In	0.0004
Sn	118.71	4	0.0019	1.779E-07	0.0008	2.079E-07		Sn	0.0008
W	183.84	2	0.00095	5.742E-08	0.0004	6.712E-08		W	0.0004
Pb	207.2	1	0.000475	2.547E-08	0.0002	2.977E-08		Pb	0.0002
Bi	208.98038	0.4	0.00019	1.01E-08	0.00008	1.181E-08		Bi	0.00008
Total			0.168008		0.07074				

IWR light elements (kg)								
	From hardware	dd impurities		Zn mass (g)	8.06			
element	mass (kg)	mass (kg)			at mass (g)	wt fr	at dens	
O	0.097729225	27.370456		Zn-64	63.929146	0.4751	1.848E-06	
Al	0.00227661	0.0056166		Zn-66	65.926036	0.28126	1.061E-06	
C	0.000195138	0.0180751		Zn-67	66.927131	0.04196	1.559E-07	
Co	0.0032523	0.0034523		Zn-68	67.924847	0.19527	7.147E-07	
Cr	0.130225521	0.1310255		Zn-70	69.925325	0.00642	2.283E-08	
Cu	0.0013	0.0015				1.00001	3.802E-06	
Fe	0.146795032	0.150395		Ag mass (g)	0.02			
Mn	0.00260184	0.0029418			at mass (g)	wt fr		
Nb	0.0032523	0.0032523		Ag-107	106.90509	0.51377	2.965E-09	
N	0	0.005		Ag-109	108.90476	0.48623	2.754E-09	
Ni	0.249461734	0.2542617				1	5.719E-09	
P	0	0.007		In mass (g)	0.4			
S	0.000032523	3.252E-05			at mass (g)	wt fr		
Si	0.00130092	0.0037209		In-113	112.90406	0.04228	4.621E-09	
Sn	1.140174289	1.1409743		In-115	114.90388	0.95772	1.028E-07	
Ti	0.00780552	0.0080055				1	1.075E-07	
Zr	79.97984679	79.979847		Sn mass (g)	0.8			
li		0.0002			at mass (g)	wt fr		
b		0.0002		Sn-112	111.90482	0.00914	2.016E-09	
f		0.00214		Sn-114	113.90278	0.00624	1.352E-09	
na		0.003		Sn-115	114.90335	0.00348	7.474E-10	
mg		0.0004		Sn-116	115.90175	0.14186	3.02E-08	
cl		0.00106		Sn-117	116.90296	0.07563	1.596E-08	
ca		0.0004		Sn-118	117.90161	0.24055	5.035E-08	
v		0.0006		Sn-119	118.90331	0.08594	1.784E-08	
zn		0.00806		Sn-120	119.9022	0.32917	6.775E-08	
mo		0.002		Sn-122	121.90344	0.04755	9.626E-09	
ag		0.00002		Sn-124	123.90527	0.06043	1.204E-08	
cd		0.005				0.99999	2.079E-07	
in		0.0004						
sn		0.0008		B mass (g)	0.2			
w		0.0004			at mass (g)	wt fr		
pb		0.0002		b-10	10.012937	0.18431	1.136E-07	
bi		0.00008		b-11	11.009306	0.81569	4.571E-07	
							5.707E-07	
				Li mass (g)	0.2			
					at mass (g)	wt fr		
				li-6	6.015122	0.065	6.667E-08	
				li-7	7.016004	0.935	8.222E-07	
							8.888E-07	

5.3.2.1. Specification of ials used in SAS2H and ICNP calculations

Hardware is the same as ie Waste Stream cases. information is taken from 1.compositions worksheet· ie water rods and cladding are calculated here

Stainless Steel Clad assemblies : fuel and plenum region only.

								Channel fractions in the various regions	top	0.0258	cladding fractions in the various regions	
hannel volume (cm^3)	5883.737		Water rod volume (2 water rods)	511.0891957	Cladding volume	6919.507762			plenum	0.0693	fuel	0.928
channel mass (kg)	38.597		Water rods mass	4.104	Cladding mass	55.564			fuel	0.8880	plenum	0.072
Given channel mass	29.937 kg		PLENUM		FUEL				bottom	0.0169		
		hardware	water rods	cladding	water rods	cladding						
		material	ss 348H	ss 348H	ss 348H	ss 348H						
		mass	0.297149444	4.023031409	3.806896797	51.54061592	59.66769	59.668				
Material	Symbol	Wt%										
ss 348H	c	0.07	0.00021	0.00282	0.0027	0.0361						
density=8.03	mn	2	0.00594	0.08046	0.0761	1.0308						
	si	1	0.00297	0.04023	0.0381	0.5154						
	cr	18	0.05349	0.72415	0.6852	9.2773						
	ni	13	0.03863	0.52299	0.4949	6.7003						
	p	0.045	0.00013	0.00181	0.0017	0.0232						
	s	0.03	0.00009	0.00121	0.0011	0.0155						
	co	0.2	0.00059	0.00805	0.0076	0.1031						
	nb	1	0.00297	0.04023	0.0381	0.5154						
	ta	0.1	0.00030	0.00402	0.0038	0.0515						
	fe	64.555	0.19182	2.59707	2.4575	33.2720						

end fitting regions			Scale factor =		0.15
	channel	compression spring	tie plate	raw	scaled
O	0.0012			0.0012	0.0002
Al		0.0041		0.0041	0.0006
C		0.0003	0.0016	0.0019	0.0003
Co		0.0058	0.0016	0.0074	0.0011
Cr	0.0010	0.087	0.38	0.4680	0.0702
Cu		0.0023		0.0023	0.0003
Fe	0.0020	0.0464	1.3748	1.4232	0.2135
Mn		0.0046	0.04	0.0446	0.0067
Nb		0.0058		0.0058	0.0009
N			0.002	0.0020	0.0003
Ni		0.4073	0.1834	0.5907	0.0886
P			0.0009	0.0009	0.0001
S		0.0001	0.0006	0.0007	0.0001
Si		0.0023	0.015	0.0173	0.0026
Sn	0.0139			0.0139	0.0021
Ti		0.0139		0.0139	0.0021
Zr	0.9768			0.9768	0.1465

ttom end fitting		Scale factor =		0.225
	channel	tie plate	raw	scaled
O	0.000781486		0.0008	0.0002
Al			0.0000	0.0000
C		0.0038	0.0038	0.0009
Co		0.0038	0.0038	0.0009
Cr	0.000651239	0.9062962	0.9069	0.2041
Cu			0.0000	0.0000
Fe	0.001302477	3.279122751	3.2804	0.7381
Mn		0.0953996	0.0954	0.0215
Nb			0.0000	0.0000
N		0.00476998	0.0048	0.0011
Ni		0.4374	0.4374	0.0984
P		0.002146491	0.0021	0.0005
S		0.001430994	0.0014	0.0003
Si		0.03577485	0.0358	0.0080
Sn	0.009117341		0.0091	0.0021
Ti			0.0000	0.0000
Zr	0.639386099		0.6394	0.1439

			plenum		Scale factor =		0.3
	cladding	channel	getters	water rods	plenum springs	raw	scaled
O	0.003944	0.00321		0.000291		0.0074	0.0022
Al					0.0119	0.0119	0.0036
C			0.0005		0.0010	0.0015	0.0005
Co			0.0005		0.0170	0.0175	0.0053
Cr	0.003287	0.002675	0.1172	0.000243	0.2550	0.3784	0.1135
Cu					0.0068	0.0068	0.0020
Fe	0.003287	0.005351	0.4241	0.000243	0.1360	0.5690	0.1707
Mn			0.0123		0.0136	0.0259	0.0078
Nb					0.0170	0.0170	0.0051
N			0.0006			0.0006	0.0002
Ni	0.001643		0.0566	0.00012	1.1939	1.2523	0.3757
P			0.0003			0.0003	0.0001
S			0.0002		0.0002	0.0004	0.0001
Si			0.0046		0.0068	0.0114	0.0034
Sn	0.046012	0.037456		0.003399		0.0869	0.0261
Ti					0.0408	0.0408	0.0122
Zr	3.228389	2.626718		0.23846		6.0936	1.8281

		fuel region		one node		
	cladding	channel	spacers	water rods	spacers	raw
O	0.050526	0.041131	0.00234	0.003732		0.0977
Al					0.002277	0.0023
C					0.000195	0.0002
Co					0.003252	0.0033
Cr	0.042105	0.034276	0.00195	0.00311	0.048785	0.1302
Cu					0.001301	0.0013
Fe	0.042105	0.068551	0.0039	0.00311	0.026018	0.1437
Mn					0.002602	0.0026
Nb					0.003252	0.0033
N						0.0000
Ni	0.021053			0.00155	0.228409	0.2510
P						0.0000
S					3.25E-05	0.0000
Si					0.001301	0.0013
Sn	0.589476	0.47986	0.027299	0.04354		1.1402
Ti					0.007806	0.0078
Zr	41.36014	33.6519	1.914412	3.05495		79.9814

top end fitting regions — **Scale factor =** 0.15

	channel	compression spring	tie plate	raw		scaled
O	0.0012			0.0012	O	0.0002
Al		0.0041		0.0041	Al	0.0006
C		0.0003	0.0016	0.0019	C	0.0003
Co		0.0058	0.0016	0.0074	Co	0.0011
Cr	0.0010	0.087	0.38	0.4680	Cr	0.0702
Cu		0.0023		0.0023	Cu	0.0003
Fe	0.0020	0.0464	1.3498	1.3982	Fe	0.2097
Mn		0.0046	0.04	0.0446	Mn	0.0067
Nb		0.0058		0.0058	Nb	0.0009
N			0.002	0.0020	N	0.0003
Ni		0.4073	0.2084	0.6157	Ni	0.0924
P			0.0009	0.0009	P	0.0001
S		0.0001	0.0006	0.0007	S	0.0001
Si		0.0023	0.015	0.0173	Si	0.0026
Sn	0.0169			0.0169	Sn	0.0025
Ti		0.0139		0.0139	Ti	0.0021
Zr	0.9739			0.9739	Zr	0.1461

plenum — **Scale factor =** 0.3

	cladding	channel	getters	water rods	plenum springs	raw		scaled
O	0.0039	0.0032		0.000291		0.0074	O	0.0022
Al					0.0119	0.0119	Al	0.0036
C			0.0005		0.0010	0.0015	C	0.0005
Co			0.0005		0.0170	0.0175	Co	0.0053
Cr	0.0033	0.0027	0.1172	0.000243	0.2550	0.3784	Cr	0.1135
Cu					0.0068	0.0068	Cu	0.0020
Fe	0.0066	0.0054	0.4164	0.00049	0.1360	0.5649	Fe	0.1695
Mn			0.0123		0.0136	0.0259	Mn	0.0078
Nb					0.0170	0.0170	Nb	0.0051
N			0.0006			0.0006	N	0.0002
Ni	0.0026		0.0643	0.00019	1.1939	1.2610	Ni	0.3783
P			0.0003			0.0003	P	0.0001
S			0.0002		0.0002	0.0004	S	0.0000
Si			0.0046		0.0068	0.0114	Si	0.0034
Sn	0.0559	0.0455		0.00413		0.1055	Sn	0.0316
Ti					0.0408	0.0408	Ti	0.0122
Zr	3.2143	2.6187		0.23741		6.0704	Zr	1.8211

bottom end fitting — **Scale factor =** 0.225

	channel	tie plate	raw		scaled
O	0.0008		0.0008	O	0.0002
Al			0.0000	Al	0.0000
C		0.0038	0.0038	C	0.0009
Co		0.0038	0.0038	Co	0.0009
Cr	0.0007	0.9063	0.9069	Cr	0.2041
Cu			0.0000	Cu	0.0000
Fe	0.0013	3.2195	3.2208	Fe	0.7247
Mn		0.0954	0.0954	Mn	0.0215
Nb			0.0000	Nb	0.0000
N		0.0048	0.0048	N	0.0011
Ni		0.4970	0.4970	Ni	0.1118
P		0.0021	0.0021	P	0.0005
S		0.0014	0.0014	S	0.0003
Si		0.0358	0.0358	Si	0.0080
Sn	0.0111		0.0111	Sn	0.0025
Ti			0.0000	Ti	0.0000
Zr	0.6374		0.6374	Zr	0.1434

fuel region — **one node**

	fuel pellets	cladding	channel	spacers	water rods	spacers	impurities	raw
O	27.2727	0.050526	0.041131	0.00234	0.003732			27.3704
Al						0.002277		0.0023
C						0.000195		0.0002
Co						0.003252		0.0033
Cr		0.042105	0.034276	0.00195	0.00311	0.048785		0.1302
Cu						0.001301		0.0013
Fe		0.0842	0.068551	0.0039	0.00622	0.026018		0.1889
Mn						0.002602		0.0026
Nb						0.003252		0.0033
N								0.0000
Ni		0.0337			0.00249	0.228409		0.2646
P								0.0000
S						3.25E-05		0.0000
Si						0.001301		0.0013
Sn		0.7158	0.5827	0.0331	0.05287			1.3845
Ti						0.007806		0.0078
Zr		41.1791	33.5491	1.9086	3.04157			79.678

Adding the fuel region hardware and impurities:							
	impurities:	Hardware	total	FUEL	PLENUM	top	bottom
Ag	0.00002		Ag	0.0000	0.0000	0.0000	0.0000
Al	0.00334	0.00227661	Al	0.0056	0.0036	0.0006	0.0000
B	0.0002		B	0.0002	0.0000	0.0000	0.0000
Bi	0.00008		Bi	0.0001	0.0000	0.0000	0.0000
C	0.01788	0.00019514	C	0.0181	0.0005	0.0003	0.0009
Ca	0.0004		Ca	0.0004	0.0000	0.0000	0.0000
Cd	0.005		Cd	0.0050	0.0000	0.0000	0.0000
Cl	0.00106		Cl	0.0011	0.0000	0.0000	0.0000
Co	0.0002	0.0032523	Co	0.0035	0.0053	0.0011	0.0009
Cr	0.0008	0.13022552	Cr	0.1310	0.1135	0.0702	0.2041
Cu	0.0002	0.00130092	Cu	0.0015	0.0020	0.0003	0.0000
F	0.00214		F	0.0021	0.0000	0.0000	0.0000
Fe	0.0036	0.1889	Fe	0.1925	0.1695	0.2097	0.7247
In	0.0004		In	0.0004	0.0000	0.0000	0.0000
Li	0.0002		Li	0.0002	0.0000	0.0000	0.0000
Mg	0.0004		Mg	0.0004	0.0000	0.0000	0.0000
Mn	0.00034	0.00260184	Mn	0.0029	0.0078	0.0067	0.0215
Mo	0.002		Mo	0.0020	0.0000	0.0000	0.0000
N	0.005	0	N	0.0050	0.0002	0.0003	0.0011
Na	0.003		Na	0.0030	0.0000	0.0000	0.0000
nb		0.0032523	Nb	0.0033	0.0051	0.0009	0.0000
Ni	0.0048	0.2646	Ni	0.2694	0.3783	0.0924	0.1118
O		27.3704292	O	27.3704	0.0022	0.0002	0.0002
P	0.007	0	P	0.0070	0.0001	0.0001	0.0005
Pb	0.0002		Pb	0.0002	0.0000	0.0000	0.0000
S		3.2523E-05	S	0.0000	0.0001	0.0001	0.0003
Si	0.00242	0.00130092	Si	0.0037	0.0034	0.0026	0.0080
Sn	0.0008	1.3845	Sn	1.3853	0.0317	0.0025	0.0025
Ti	0.0002	0.00780552	Ti	0.0080	0.0122	0.0021	0.0000
V	0.0006		V	0.0006	0.0000	0.0000	0.0000
W	0.0004		W	0.0004	0.0000	0.0000	0.0000
Zn	0.00806		Zn	0.0081	0.0000	0.0000	0.0000
Zr		79.6784	Zr	79.6784	1.8211	0.1461	0.1434

	top	bottom
Al	0.0006	0
C	0.0003	0.000855
Co	0.0011	0.000855
Cr	0.0702	0.204063
Cu	0.0003	0
Fe	0.2097	0.724681
Mn	0.0067	0.021465
N	0.0003	0.001073
Nb	0.0009	0
Ni	0.0924	0.111825
O	0.0002	0.000176
P	0.0001	0.000483
S	0.0001	0.000322
Si	0.0026	0.008049
Sn	0.0025	0.002498
Ti	0.0021	0
Zr	0.1461	0.143415

				plenum	Scale factor =		0.3
	water rods	channel	getters	cladding	plenum springs	raw	scaled
O		0.00321				0.0032	0.0010
Al					0.0119	0.0119	0.0036
C	0.00021		0.0005	0.00282	0.0010	0.0046	0.0014
Co	0.00059		0.0005	0.00805	0.0170	0.0261	0.0078
Cr	0.05349	0.002675	0.1172	0.72415	0.2550	1.1525	0.3458
Cu					0.0068	0.0068	0.0020
Fe	0.19182	0.005351	0.4164	2.59707	0.1360	3.3466	1.0040
Mn	0.00594		0.0123	0.08046	0.0156	0.1123	0.0337
Nb	0.00297			0.04023	0.0170	0.0602	0.0181
N			0.0006			0.0006	0.0002
Ni	0.03863		0.0643	0.52299	1.1939	1.8198	0.5459
P	0.00013		0.0003	0.00181		0.0022	0.0007
S	0.00009		0.0002	0.00121	0.0002	0.0017	0.0005
Si	0.00297		0.0046	0.04023	0.0068	0.0546	0.0164
Sn		0.0455				0.0455	0.0137
Ti					0.0408	0.0408	0.0122
Zr		2.6187				2.6187	0.7856
Ta	0.0003			0.00402		0.0043	0.0013

		fuel region		one node		
	water rods	channel	spacers	cladding	spacers	raw
O	27.27	0.041131	0.00234			27.3135
Al					0.002277	0.0023
C	0.0027			0.0361	0.000195	0.0390
Co	0.0076			0.1031	0.003252	0.1140
Cr	0.6852	0.034276	0.00195	9.2773	0.048785	10.0475
Cu					0.001301	0.0013
Fe	2.4575	0.068551	0.0039	33.272	0.026018	35.8280
Mn	0.0761			1.0308	0.002602	1.1095
Nb	0.0381			0.5154	0.003252	0.5568
N						0.0000
Ni	0.4949			6.7003	0.228409	7.4236
P	0.0017			0.0232		0.0249
S	0.0011			0.0155	3.25E-05	0.0166
Si	0.0381			0.5154	0.001301	0.5548
Sn		0.5827	0.0331			0.6158
Ti					0.007806	0.0078
Zr		33.5491	1.9086			35.4577
Ta	0.0038			0.0515		0.0553

****Heav oxygen content in water rods actually for the oxygen in the fuel

	plenum	fuel	hardware	Impurities		total fuel	plenum
	0	Ag		0.00002	Ag	0.0000	0.0000
Al	0.0036	Al	0.0023	0.00334	Al	0.0056	0.0036
	0	B		0.0002	B	0.0002	0.0000
	0	Bi		0.00008	Bi	0.0001	0.0000
C	0.0014	C	0.0390	0.01788	C	0.0569	0.0014
	0	Ca		0.0004	Ca	0.0004	0.0000
	0	Cd		0.005	Cd	0.0050	0.0000
	0	Cl		0.00106	Cl	0.0011	0.0000
Co	0.0078	Co	0.1140	0.0002	Co	0.1142	0.0078
Cr	0.3458	Cr	10.0475	0.0008	Cr	10.0483	0.3458
Cu	0.0020	Cu	0.0013	0.0002	Cu	0.0015	0.0020
	0	F		0.00214	F	0.0021	0.0000
Fe	1.0040	Fe	35.8280	0.0036	Fe	35.8316	1.0040
	0	In		0.0004	In	0.0004	0.0000
	0	Li		0.0002	Li	0.0002	0.0000
	0	Mg		0.0004	Mg	0.0004	0.0000
Mn	0.0337	Mn	1.1095	0.00034	Mn	1.1098	0.0337
	0	Mo		0.002	Mo	0.0020	0.0000
N	0.0002	N	0.0000	0.005	N	0.0050	0.0002
	0	Na		0.003	Na	0.0030	0.0000
Nb	0.0181	nb	0.5568		nb	0.5568	0.0181
Ni	0.5459	Ni	7.4236	0.0048	Ni	7.4284	0.5459
O	0.0010	O	27.3135		O	27.3135	0.0010
P	0.0007	P	0.0249	0.007	P	0.0319	0.0007
	0	Pb		0.0002	Pb	0.0002	0.0000
S	0.0005	S	0.0166		S	0.0166	0.0005
Si	0.0164	Si	0.5548	0.00242	Si	0.5572	0.0164
Sn	0.0137	Sn	0.6158	0.0008	Sn	0.6166	0.0137
Ta	0.0013	Ta	0.0553		Ta	0.0553	0.0013
Ti	0.0122	Ti	0.0078	0.0002	Ti	0.0080	0.0122
	0	V		0.0006	V	0.0006	0.0000
	0	W		0.0004	W	0.0004	0.0000
	0	Zn		0.00806	Zn	0.0081	0.0000
Zr	0.7856	Zr	35.4577		Zr	35.4577	0.7856

Thermal Hydraulic information for assembly C3

		Data point 4		Data point 5		Data point 6		Data point 7		Data point 8		Data point 9		Data point 10		Data point 11		Data point 12		Data point 13		
	Node	Water density	Fuel temp	Water density	Fuel temp	Water density	Fuel temp	Water density	Fuel temp	Water density	Fuel temp	Water density	Fuel temp	Water density	Fuel temp	Water density	Fuel temp	Water density	Fuel temp	Water density	Fuel temp	
15.24	1	0.7396	672.5	0.7396	680.2	0.7396	654.9	0.7396	678.8	0.7396	674	0.7396	647.9	0.7396	637.4	0.7396	641.4	0.7396	663.9	0.7396	687.1	
30.48	2	0.7396	1050	0.7396	1061	0.7396	968.2	0.7396	996.3	0.7396	934.6	0.7396	852.9	0.7396	813.3	0.7396	821.3	0.7396	890.9	0.7396	949.6	
30.48	3	0.6949	1248.3	0.6926	1157.9	0.693	1141.4	0.6914	1081.9	0.6934	1006.6	0.6957	945	0.6959	890.7	0.6983	900.5	0.6999	993.7	0.7004	1040	
45.72	4	0.5607	1258.2	0.5634	1143.8	0.5658	1252.1	0.5714	1099.3	0.5776	1035	0.5838	987.4	0.5845	958.1	0.5904	966.6	0.5941	1054.4	0.5957	1058.9	
30.48	5	0.4559	1211.5	0.461	1142.8	0.4587	1276.3	0.47	1133.7	0.4776	1059.2	0.4852	1006.2	0.486	1011.9	0.4935	1018.5	0.4975	1078.7	0.4993	1065.3	
45.72	6	0.3883	1149.3	0.3901	1151.8	0.3851	1228.1	0.3982	1171.9	0.4053	1078.4	0.4127	1019.6	0.4134	1023.7	0.4202	1030.9	0.4235	1069.7	0.4253	1067.2	
45.72	7	0.3341	1086	0.329	1152.4	0.3242	1132.4	0.3362	1192.7	0.3424	1091.6	0.3498	1052.9	0.3504	1004.3	0.356	1014	0.3587	1030.3	0.3602	1050.1	
45.72	8	0.2976	1027.3	0.2858	1130.5	0.2827	1023.9	0.2919	1166.2	0.2971	1069.8	0.3046	1095.1	0.3051	963	0.3098	969.7	0.3121	960.5	0.3134	995.8	
64.11	9	0.2701	884.2	0.2525	986.1	0.2509	885.8	0.2566	1013	0.261	933.4	0.2668	955.4	0.2672	829.3	0.2712	831.4	0.2735	811.9	0.2749	843.1	
15.24	10	0.2595	659.9	0.2392	693	0.2383	641.9	0.2421	679.1	0.2461	660.7	0.2512	668	0.2516	628.3	0.2552	628	0.2576	623.7	0.259	634.1	
Averages:			0.4403	1059.0	0.4351	1073.3	0.4333	1061.9	0.4402	1071.3	0.4450	995.0	0.4506	967.0	0.4510	910.2	0.4556	916.7	0.4580	949.1	0.4593	970.5

FOR TEN NODE MODEL

Data point	EFPD	Node	Cycle averaged Fuel temps	H2Ofrac 4	5	6	7	8	9	10	11	12	13
4	222.47	1	669.1	1.0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	245.01	2	970.5	1.0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	180.3	3	1084.8	1.0	0.9967	0.9973	0.9950	0.9978	1.0012	1.0014	1.0049	1.0072	1.0079
7	303.9	4	1116.8	1.0	1.0048	1.0091	1.0191	1.0301	1.0412	1.0424	1.0530	1.0596	1.0624
8	142.2	5	1129.2	1.0	1.0112	1.0061	1.0309	1.0476	1.0643	1.0660	1.0825	1.0912	1.0952
9	121.5	6	1126.8	1.0	1.0046	0.9918	1.0255	1.0438	1.0628	1.0646	1.0822	1.0907	1.0953
10	10.1	7	1109.2	1.0	0.9847	0.9704	1.0063	1.0248	1.0470	1.0488	1.0655	1.0736	1.0781
11	102.84	8	1068.8	1.0	0.9603	0.9499	0.9808	0.9983	1.0235	1.0252	1.0410	1.0487	1.0531
12	111.46	9	924.4	1.0	0.9348	0.9289	0.9500	0.9663	0.9878	0.9893	1.0041	1.0126	1.0178
13	100.33	10	660.9	1.0	0.9218	0.9183	0.9329	0.9484	0.9680	0.9696	0.9834	0.9927	0.9981
	1540.11												

FOR PARAMETRIC STUDIES AND ONE NODE MODEL

Data point		EFPD	Averages: Moderator densities	Fuel temp			Node 5 only		5	
4	222.47	222.47	0.4403	1059.0			1211.5	1211.5	0.4559	0.4559
5	467.48	245.01	0.4351	1073.3			1142.8		0.461	
6	180.3	180.3	0.4333	1061.9			1276.3	1276.3	0.4587	0.4587
7	484.2	303.9	0.4402	1071.3			1133.7		0.47	
8	142.2	142.2	0.4450	995.0			1059.2	1059.2	0.4776	0.4776
9	263.7	121.5	0.4506	967.0			1006.2		0.4852	
10	10.1	10.1	0.4510	910.2	324.73		1011.9	1053.42	0.486	0.49643
11	112.94	102.84	0.4556	916.7			1018.5		0.4935	
12	224.4	111.46	0.4580	949.1			1078.7		0.4975	
13	324.73	100.33	0.4593	970.5			1065.3		0.4993	
	2432.52	1540.11	0.4468	997.4			1100.4		0.47847	
wted			0.4435	1026.7			1129.2		0.47268	

Final Assembly burnup by node and assembly

APFs:		A1	A2	A3	A4	A5	A6	A7	A8
1	15.24	7.68	7.99	7.52	7.43	8.10	8.26	7.02	7.73
2	30.48	29.24	30.37	28.85	28.60	30.88	30.82	27.39	29.42
3	30.48	36.82	38.34	36.83	36.47	39.22	38.31	34.99	37.42
4	45.72	39.44	40.65	39.91	40.15	41.63	40.37	37.66	40.29
5	30.48	40.72	41.84	41.03	42.02	42.83	41.46	39.29	41.68
6	45.72	41.31	42.14	41.48	42.50	43.01	42.14	40.06	42.14
7	45.72	41.13	41.69	41.20	42.03	42.21	42.24	40.37	41.79
8	45.72	39.50	40.38	39.37	40.82	40.08	40.67	39.71	40.15
9	64.11	31.03	30.77	30.25	31.71	30.50	31.44	30.39	30.86
10	15.24	8.55	8.33	8.32	8.58	8.15	8.66	7.92	8.20
	average	34.88	35.58	34.80	35.53	35.99	35.80	33.85	35.36
	max apf	1.18	1.18	1.19	1.20	1.20	1.18	1.19	1.19

		B1	B2	B3	B4	B5
1	15.24	7.78	7.85	7.23	8.20	7.70
2	30.48	29.49	29.64	28.67	30.96	29.33
3	30.48	37.53	37.42	37.06	39.16	37.45
4	45.72	40.47	39.63	40.19	41.29	40.72
5	30.48	42.09	40.66	42.13	42.09	41.91
6	45.72	43.17	41.50	42.32	42.17	42.15
7	45.72	43.26	42.45	41.58	41.51	41.68
8	45.72	41.40	41.31	39.43	39.41	40.58
9	64.11	32.54	31.89	30.19	30.12	31.53
10	15.24	9.18	8.92	8.26	8.19	8.80
	average	36.23	35.57	35.06	35.55	35.61
	max apf	1.19	1.19	1.21	1.19	1.18

		C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14
1	15.24	9.50	9.08	9.62	8.58	8.39	9.01	8.86	7.53	8.55	8.74	7.16	8.01	8.35	8.53
2	30.48	35.28	33.92	35.62	32.29	32.01	33.55	33.66	28.89	32.77	32.95	28.04	30.43	31.44	32.66
3	30.48	45.18	43.26	45.39	41.44	41.01	42.73	43.44	36.97	42.06	42.27	38.37	38.77	39.71	42.00
4	45.72	48.02	46.32	48.14	44.69	44.04	45.67	46.22	39.85	44.38	45.27	39.32	41.65	42.20	44.37
5	30.48	49.28	47.79	49.30	46.54	45.63	47.01	47.38	41.47	45.25	46.79	41.01	43.30	43.56	45.31
6	45.72	49.22	47.99	49.23	46.79	46.01	47.34	47.26	42.16	45.11	46.71	41.73	43.85	44.44	45.19
7	45.72	47.87	46.96	47.87	46.73	45.41	46.61	46.08	42.75	43.75	46.32	41.77	43.45	44.65	43.87
8	45.72	44.15	43.64	44.46	43.69	42.79	43.67	42.82	41.55	40.53	43.00	39.76	41.21	42.55	40.63
9	64.11	31.31	31.78	31.82	31.55	31.57	31.89	30.46	30.77	29.15	30.70	29.26	30.80	31.86	29.16
10	15.24	8.65	9.01	8.86	8.68	8.78	8.99	8.28	8.44	7.84	8.47	7.87	8.67	9.09	7.85
	average	40.37	39.51	40.57	38.67	38.09	39.19	38.89	35.50	37.20	38.59	34.56	36.42	37.28	37.23
	max apf	1.22	1.21	1.22	1.21	1.21	1.21	1.22	1.20	1.22	1.21	1.21	1.20	1.20	1.22

		D1	D2	D3	D4	D5	D6	D7	D8	D9	D10
1	15.24	8.86	8.89	8.43	7.53	8.38	8.48	9.03	7.96	8.13	7.87
2	30.48	33.83	34.21	32.26	29.67	32.38	32.45	34.33	30.90	31.68	30.96
3	30.48	42.67	43.56	40.58	37.63	41.12	40.73	43.25	39.35	40.37	39.80
4	45.72	45.05	46.22	43.47	39.64	43.51	42.98	45.71	42.60	43.09	42.42
5	30.48	45.97	47.80	45.18	40.77	44.97	44.10	46.76	44.42	44.36	43.73
6	45.72	46.16	48.29	46.00	41.14	45.84	44.44	47.09	45.36	45.13	44.57
7	45.72	45.45	47.63	46.02	40.78	45.61	43.86	46.54	45.61	45.39	45.43
8	45.72	42.71	44.81	43.72	38.78	43.04	41.54	43.93	43.78	43.33	44.14
9	64.11	31.31	32.88	32.78	28.85	31.85	30.86	32.34	33.35	32.43	32.85
10	15.24	8.56	8.83	9.05	7.51	8.57	8.23	8.80	9.16	8.81	8.90
	average	38.51	39.99	38.38	34.44	38.08	37.16	39.34	37.96	37.88	37.74
	max apf	1.20	1.21	1.20	1.19	1.20	1.20	1.20	1.20	1.20	1.20

		E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12	E13	E14
1	15.24	7.74	7.66	7.54	7.62	7.26	7.48	7.13	7.02	7.38	7.28	6.97	7.74	7.32	6.90
2	30.48	30.56	30.28	29.85	30.04	28.63	29.33	28.73	28.33	29.37	28.92	28.25	30.59	29.26	27.71
3	30.48	38.98	38.71	38.06	38.32	36.10	37.16	37.45	37.18	37.68	37.12	36.68	39.26	38.15	35.97
4	45.72	40.61	40.50	39.96	40.02	37.73	39.19	39.81	39.89	39.88	39.32	38.78	41.32	40.60	38.64
5	30.48	42.09	42.04	41.63	41.60	39.50	41.21	41.82	42.04	41.79	41.22	40.59	43.09	42.59	40.93
6	45.72	41.69	41.86	41.28	41.35	39.61	41.26	41.69	41.87	41.53	41.05	40.40	42.91	42.43	40.91
7	45.72	40.26	40.92	39.92	40.11	38.55	40.10	40.81	40.50	40.11	39.93	39.56	41.92	41.23	39.58
8	45.72	36.63	37.42	36.63	36.65	35.52	36.78	37.03	36.48	36.32	37.11	36.02	38.19	37.32	36.03
9	48.97	27.67	28.25	27.73	27.77	27.27	28.00	27.47	27.10	27.29	28.21	26.94	28.48	27.71	27.42
10	30.48	7.96	8.21	7.94	8.03	7.84	8.16	7.71	7.80	7.75	8.10	7.50	8.11	8.02	7.90
	average	33.60	33.83	33.25	33.35	31.93	33.10	33.25	33.09	33.12	33.08	32.38	34.47	33.76	32.45
	max apf	1.26	1.24	1.25	1.25	1.24	1.25	1.26	1.27	1.26	1.25	1.25	1.25	1.26	1.26

		F1	F2	F3	F4	F5	F6	F7	F8	F9	F10
1	15.24	7.01	7.62	7.22	6.68	6.88	7.48	6.69	7.52	7.45	6.90
2	30.48	27.33	29.39	28.04	26.45	27.02	28.84	26.53	29.20	28.76	27.10
3	30.48	35.45	37.93	36.42	34.34	35.17	37.12	34.53	38.06	37.22	35.42
4	45.72	37.99	40.05	38.92	36.56	37.28	39.33	36.77	40.74	39.32	38.00
5	30.48	40.25	41.87	40.90	38.54	39.06	41.19	38.73	42.86	41.07	40.02
6	45.72	40.52	41.91	40.91	38.57	39.16	41.15	38.72	42.64	41.06	40.00
7	45.72	40.00	40.88	39.93	37.38	38.48	40.15	37.47	40.87	40.13	38.63
8	45.72	36.69	36.99	36.83	33.91	36.28	37.41	33.95	36.78	36.71	34.83
9	48.97	27.69	27.60	28.15	25.76	28.15	28.42	25.74	27.51	27.64	26.20
10	30.48	8.13	8.18	8.47	7.44	8.45	8.43	7.44	8.11	8.28	7.75
	average	32.38	33.48	32.85	30.66	31.82	33.22	30.76	33.69	32.99	31.65
	max apf	1.25	1.25	1.25	1.26	1.23	1.24	1.26	1.27	1.24	1.26

		G1	G2	G3	G4	G5	G6	G7	G8	G9	G10	G11
1	15.24	4.65	4.85	3.95	4.88	4.66	4.80	4.58	5.43	5.24	4.88	4.33
2	30.48	19.13	19.70	16.67	19.90	19.16	19.48	18.97	22.02	21.08	19.73	17.78
3	30.48	25.08	25.83	22.65	26.13	25.10	25.50	25.22	29.05	27.53	25.51	23.21
4	45.72	25.99	27.50	24.11	27.48	25.99	27.16	26.68	30.20	28.99	26.71	23.97
5	30.48	26.77	28.77	25.27	28.67	26.78	28.51	27.88	31.01	30.25	27.94	24.95
6	45.72	26.22	28.45	24.89	28.29	26.23	28.27	27.46	30.30	29.81	27.66	24.90
7	45.72	25.05	27.34	23.82	27.17	25.09	27.24	26.44	28.85	28.38	26.55	24.60
8	45.72	22.38	24.51	21.34	24.27	22.42	24.46	23.64	25.60	25.20	23.72	22.73
9	48.97	16.10	17.59	15.52	17.38	16.12	17.58	16.90	18.16	18.02	17.12	17.24
10	30.48	4.18	4.73	4.04	4.63	4.19	4.73	4.45	5.01	4.92	4.58	4.73
	average	20.89	22.42	19.56	22.35	20.91	22.27	21.67	24.08	23.48	21.87	20.23
	max apf	1.28	1.28	1.29	1.28	1.28	1.28	1.29	1.29	1.29	1.28	1.23

		H1	H2	H3	H4	H5	H6	H7	H8	H9	H10	H11
1	15.24	4.57	5.02	5.18	5.36	5.59	5.51	4.90	4.71	4.26	5.70	4.58
2	30.48	18.89	20.60	21.09	21.83	22.64	22.34	20.01	19.19	17.65	22.80	18.94
3	30.48	25.41	27.22	27.61	28.71	29.65	29.73	26.22	24.85	23.68	29.93	25.46
4	45.72	26.76	28.36	28.69	29.67	30.44	31.07	27.25	25.85	25.06	31.01	26.73
5	30.48	27.78	29.17	29.67	30.33	30.98	31.93	28.04	26.91	26.27	31.75	27.72
6	45.72	27.22	28.54	29.26	29.65	30.25	31.15	27.44	26.56	26.04	31.01	27.21
7	45.72	25.93	27.33	28.36	28.53	29.22	29.58	26.32	25.48	25.27	29.53	26.00
8	45.72	23.40	24.54	25.86	25.54	26.84	26.37	24.50	23.14	23.28	26.42	23.46
9	48.97	16.56	17.06	18.22	17.53	18.86	18.25	17.85	16.46	16.82	18.41	16.59
10	30.48	4.38	4.50	4.90	4.62	5.14	5.02	4.83	4.35	4.57	5.11	4.39
	average	21.51	22.66	23.41	23.67	24.51	24.65	22.18	21.12	20.72	24.70	21.53
	max apf	1.29	1.29	1.27	1.28	1.26	1.30	1.26	1.27	1.27	1.29	1.29

		J1	J2	J3	J4	J5	J6	J7	J8	J9	J10	J11	J12	J13	J14	J15	J16
1	15.24	3.70	3.35	3.30	3.17	3.51	3.73	3.03	2.90	3.61	3.64	3.13	3.69	3.31	3.28	3.23	3.03
2	30.48	15.63	14.03	13.84	13.18	14.65	15.55	12.53	12.12	14.99	15.10	13.02	15.42	13.86	13.73	13.57	12.56
3	30.48	21.33	19.31	19.18	18.22	20.01	21.21	17.42	17.29	20.46	20.59	18.22	21.21	19.13	19.07	18.58	17.57
4	45.72	21.85	19.95	20.46	19.22	20.92	22.01	18.49	18.45	21.46	21.57	19.46	22.17	20.08	20.03	19.27	18.88
5	30.48	22.09	20.44	21.23	19.94	21.50	22.49	19.30	19.20	22.19	22.29	20.33	22.73	20.77	20.58	19.77	19.83
6	45.72	21.28	19.90	20.69	19.58	20.87	21.79	18.93	18.82	21.64	21.73	19.86	22.03	20.27	19.93	19.26	19.41
7	45.72	20.06	18.68	19.34	18.86	19.58	20.56	17.92	17.85	20.29	20.38	18.71	20.61	18.99	18.83	18.61	18.19
8	45.72	17.82	16.39	16.88	17.00	17.12	18.14	15.89	15.78	17.67	17.76	16.61	17.90	16.55	16.95	17.56	15.92
9	48.97	11.61	10.66	10.97	11.38	11.13	11.85	10.50	10.77	11.55	11.62	11.03	11.58	10.75	11.30	11.60	10.44
10	30.48	2.95	2.72	2.60	2.93	2.86	3.07	2.74	2.87	3.03	3.05	2.91	3.01	2.77	2.90	2.91	2.73
	average	16.85	15.51	15.89	15.38	16.23	17.10	14.64	14.59	16.74	16.83	15.34	17.09	15.64	15.67	15.46	13.86
	max apf	1.31	1.32	1.34	1.30	1.32	1.31	1.32	1.32	1.33	1.32	1.32	1.33	1.33	1.31	1.28	1.43

		K1	K2	K3	K4
1	15.24	3.71	3.11	3.74	3.22
2	30.48	16.30	13.76	16.37	14.23
3	30.48	21.44	18.57	21.67	18.98
4	45.72	21.76	19.50	22.16	19.65
5	30.48	22.01	20.15	22.50	20.15
6	45.72	21.31	19.66	21.75	19.59
7	45.72	20.18	18.54	20.37	18.76
8	45.72	18.21	16.41	17.96	17.70
9	48.97	12.48	11.06	12.00	12.03
10	30.48	3.05	2.72	2.93	2.92
	average	17.09	15.34	17.18	15.76
	max apf	1.29	1.31	1.31	1.28

		L1	L2
1	15.24	1.13	1.22
2	30.48	5.05	5.64
3	30.48	7.29	8.08
4	45.72	7.94	8.21
5	30.48	8.37	8.20
6	45.72	8.04	7.67
7	45.72	7.38	7.02
8	45.72	6.37	6.12
9	48.97	4.15	3.93
10	30.48	0.98	0.92
	average	6.07	6.06
	max apf	1.38	1.36

		M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16
1	15.24	1.08	1.34	1.05	1.01	1.19	1.24	0.94	1.10	1.13	1.33	1.21	1.11	1.20	1.22	1.17	1.20
2	30.48	4.58	5.74	4.47	4.25	5.05	5.30	3.99	4.67	4.87	5.83	5.45	4.81	5.41	5.32	5.14	5.35
3	30.48	6.57	7.92	6.39	5.98	7.04	7.42	5.70	6.64	7.01	8.19	7.91	6.94	7.91	7.65	7.49	7.81
4	45.72	7.37	8.09	7.19	6.65	7.56	7.83	6.48	7.31	7.66	8.38	8.22	7.65	8.18	8.12	7.95	8.13
5	30.48	7.96	8.14	7.80	7.18	7.90	8.04	7.08	7.78	8.00	8.36	8.23	8.05	8.14	8.30	8.09	8.14
6	45.72	7.87	7.75	7.71	7.09	7.68	7.71	7.02	7.59	7.71	7.91	7.76	7.76	7.64	7.90	7.68	7.66
7	45.72	7.42	7.17	7.24	6.65	7.15	7.14	6.58	7.05	7.13	7.30	7.14	7.11	7.01	7.21	7.02	6.99
8	45.72	6.51	6.27	6.34	5.83	6.23	6.23	5.75	6.12	6.20	6.41	6.27	6.11	6.13	6.18	6.04	6.03
9	48.97	4.39	4.20	4.27	3.90	4.14	4.15	3.84	4.06	4.12	4.25	4.13	4.00	3.99	4.02	3.94	3.91
10	30.48	1.10	1.03	1.05	0.94	1.01	1.01	0.93	0.99	1.00	1.04	1.00	0.97	0.96	0.98	0.96	0.94
	average	5.91	6.13	5.77	5.33	5.88	5.98	5.21	5.72	5.88	6.27	6.11	5.84	6.02	6.07	5.92	5.98
	max apf	1.35	1.33	1.35	1.35	1.34	1.34	1.36	1.36	1.36	1.33	1.35	1.38	1.36	1.37	1.37	1.36

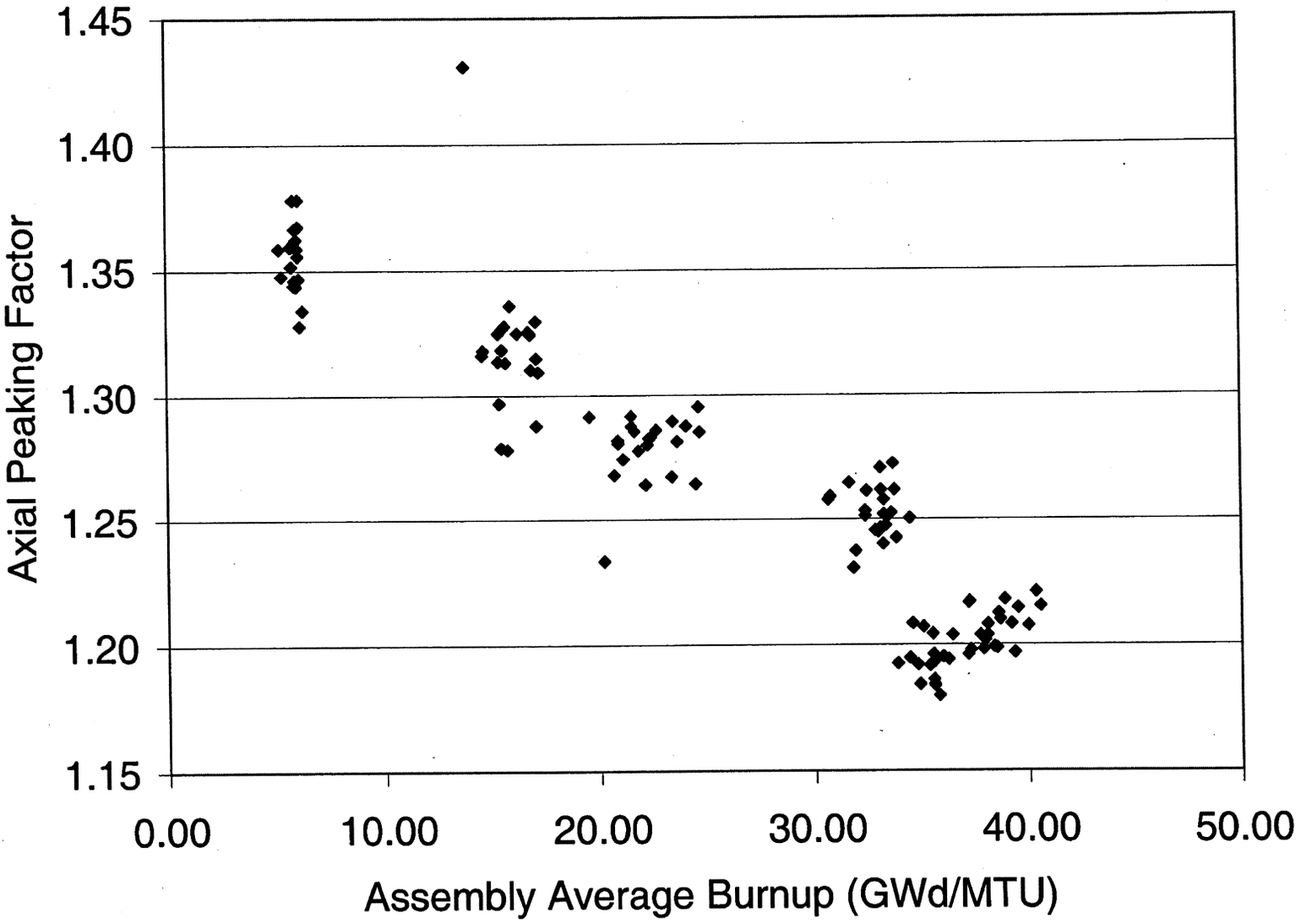
Thermal Hydraulic Information for assembly C3

	Node	Data point 4 water density	Fuel temp	Data point 5 water density	Fuel temp	Data point 6 water density	Fuel temp	Data point 7 water density	Fuel temp	Data point 8 water density	Fuel temp	Data point 9 water density	Fuel temp	Data point 10 water density	Fuel temp	Data point 11 water density	Fuel temp	Data point 12 water density	Fuel temp	Data point 13 water density	Fuel temp
15.24	1	0.7396	672.5	0.7396	680.2	0.7396	654.9	0.7396	678.8	0.7396	674	0.7396	647.9	0.7396	637.4	0.7396	641.4	0.7396	663.9	0.7396	687.1
30.48	2	0.7396	1050	0.7396	1061	0.7396	968.2	0.7396	996.3	0.7396	934.6	0.7396	852.9	0.7396	813.3	0.7396	821.3	0.7396	890.9	0.7396	949.6
30.48	3	0.6949	1248.3	0.6926	1157.9	0.693	1141.4	0.6914	1081.9	0.6934	1006.6	0.6957	945	0.6959	890.7	0.6983	900.5	0.6999	993.7	0.7004	1040
45.72	4	0.5607	1258.2	0.5634	1143.8	0.5658	1252.1	0.5714	1099.3	0.5776	1035	0.5838	987.4	0.5845	958.1	0.5904	966.6	0.5941	1054.4	0.5957	1058.9
30.48	5	0.4559	1211.5	0.461	1142.8	0.4587	1276.3	0.47	1133.7	0.4776	1059.2	0.4852	1006.2	0.486	1011.9	0.4935	1018.5	0.4975	1078.7	0.4993	1065.3
45.72	6	0.3883	1149.3	0.3901	1151.8	0.3851	1228.1	0.3982	1171.9	0.4053	1078.4	0.4127	1019.6	0.4134	1023.7	0.4202	1030.9	0.4235	1069.7	0.4253	1067.2
45.72	7	0.3341	1086	0.329	1152.4	0.3242	1132.4	0.3362	1192.7	0.3424	1091.6	0.3498	1052.9	0.3504	1004.3	0.356	1014	0.3587	1030.3	0.3602	1050.1
45.72	8	0.2976	1027.3	0.2858	1130.5	0.2827	1023.9	0.2919	1166.2	0.2971	1069.8	0.3046	1095.1	0.3051	963	0.3098	969.7	0.3121	960.5	0.3134	995.8
64.11	9	0.2701	884.2	0.2525	986.1	0.2509	885.8	0.2566	1013	0.261	933.4	0.2668	955.4	0.2672	829.3	0.2712	831.4	0.2735	811.9	0.2749	843.1
15.24	10	0.2595	659.9	0.2392	693	0.2383	641.9	0.2421	679.1	0.2461	660.7	0.2512	668	0.2516	628.3	0.2552	628	0.2576	623.7	0.259	634.1
Averages:		0.4403	1059.0	0.4351	1073.3	0.4333	1061.9	0.4402	1071.3	0.4450	995.0	0.4506	967.0	0.4510	910.2	0.4556	916.7	0.4580	949.1	0.4593	970.5
																	Data point 11		Data point 12		Data point 1

DP	EFPD	Node	Cycle averaged Fuel temps	H2Ofrac 4	5	6	7	8	9	10	11	12	13
4	222.47	1	669.1	1.0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	245.01	2	970.5	1.0	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	180.3	3	1084.8	1.0	0.9967	0.9973	0.9950	0.9978	1.0012	1.0014	1.0049	1.0072	1.0079
7	303.9	4	1116.8	1.0	1.0048	1.0091	1.0191	1.0301	1.0412	1.0424	1.0530	1.0596	1.0624
8	142.2	5	1129.2	1.0	1.0112	1.0061	1.0309	1.0476	1.0643	1.0660	1.0825	1.0912	1.0952
9	121.5	6	1126.8	1.0	1.0046	0.9918	1.0255	1.0438	1.0628	1.0646	1.0822	1.0907	1.0953
10	10.1	7	1109.2	1.0	0.9847	0.9704	1.0063	1.0248	1.0470	1.0488	1.0655	1.0736	1.0781
11	102.84	8	1068.8	1.0	0.9603	0.9499	0.9808	0.9983	1.0235	1.0252	1.0410	1.0487	1.0531
12	111.46	9	924.4	1.0	0.9348	0.9289	0.9500	0.9663	0.9878	0.9893	1.0041	1.0126	1.0178
13	100.33	10	660.9	1.0	0.9218	0.9183	0.9329	0.9484	0.9680	0.9696	0.9834	0.9927	0.9981
	1540.11												

Data point		EFPD	Averages : water density	Fuel temp	
4	222.47	222.47	0.4403	1059.0	
5	467.48	245.01	0.4351	1073.3	
6	180.3	180.3	0.4333	1061.9	
7	484.2	303.9	0.4402	1071.3	
8	142.2	142.2	0.4450	995.0	
9	263.7	121.5	0.4506	967.0	
10	10.1	10.1	0.4510	910.2	324.73
11	112.94	102.84	0.4556	916.7	
12	224.4	111.46	0.4580	949.1	
13	324.73	100.33	0.4593	970.5	
	2432.52	1540.11	0.4468	997.4	
wted			0.4435	1026.7	

Node 5 only		5	
1211.5	1211.5	0.4559	0.4559
1142.8		0.461	
1276.3	1276.3	0.4587	0.4587
1133.7		0.47	
1059.2	1059.2	0.4776	0.4776
1006.2		0.4852	
1011.9	1053.42	0.486	0.49643
1018.5		0.4935	
1078.7		0.4975	
1065.3		0.4993	
1100.4		0.47847	
1129.2		0.47268	


1.45
1.40
1.35
1.30
1.25
1.20
1.15
Axial Peaking Factor
0.00
10.00
20.00
30.00
40.00
50.00
Assembly Average Burnup (GWd/MTU)

Average Burnup	APF	Assembly
34.88	1.18	A1
35.58	1.18	A2
34.80	1.19	A3
35.53	1.20	A4
35.99	1.20	A5
35.80	1.18	A6
33.85	1.19	A7
35.36	1.19	A8
36.23	1.19	B1
35.57	1.19	B2
35.06	1.21	B3
35.55	1.19	B4
35.61	1.18	B5
40.37	1.22	C1
39.51	1.21	C2
40.57	1.22	C3
38.67	1.21	C4
38.09	1.21	C5
39.19	1.21	C6
38.89	1.22	C7
35.50	1.20	C8
37.20	1.22	C9
38.59	1.21	C10
34.56	1.21	C11
36.42	1.20	C12
37.28	1.20	C13
37.23	1.22	C14
38.51	1.20	D1
39.99	1.21	D2
38.38	1.20	D3
34.44	1.19	D4
38.08	1.20	D5
37.16	1.20	D6
39.34	1.20	D7
37.96	1.20	D8
37.88	1.20	D9
37.74	1.20	D10
33.60	1.25	E1
33.83	1.24	E2
33.25	1.25	E3
33.35	1.25	E4
31.93	1.24	E5
33.10	1.25	E6
33.25	1.26	E7
33.09	1.27	E8
33.12	1.26	E9
33.08	1.25	E10
32.38	1.25	E11
34.47	1.25	E12
33.76	1.26	E13

32.45	1.26	E14
32.38	1.25	F1
33.48	1.25	F2
32.85	1.25	F3
30.66	1.26	F4
31.82	1.23	F5
33.22	1.24	F6
30.76	1.26	F7
33.69	1.27	F8
32.99	1.24	F9
31.65	1.26	F10
20.89	1.28	G1
22.42	1.28	G2
19.56	1.29	G3
22.35	1.28	G4
20.91	1.28	G5
22.27	1.28	G6
21.67	1.29	G7
24.08	1.29	G8
23.46	1.29	G9
21.87	1.28	G10
20.23	1.23	G11
21.51	1.29	H1
22.68	1.29	H2
23.41	1.27	H3
23.67	1.28	H4
24.51	1.26	H5
24.65	1.30	H6
22.18	1.26	H7
21.12	1.27	H8
20.72	1.27	H9
24.70	1.29	H10
21.53	1.29	H11
16.85	1.31	J1
15.51	1.32	J2
15.89	1.34	J3
15.38	1.30	J4
16.23	1.32	J5
17.10	1.31	J6
14.64	1.32	J7
14.59	1.32	J8
16.74	1.33	J9
16.83	1.32	J10
15.34	1.32	J11
17.09	1.33	J12
15.64	1.33	J13
15.67	1.31	J14
15.46	1.28	J15
13.86	1.43	J16
17.09	1.29	K1
15.34	1.31	K2
17.18	1.31	K3

15.76	1.28	K4
6.07	1.38	L1
6.06	1.36	L2
5.91	1.35	M1
6.13	1.33	M2
5.77	1.35	M3
5.33	1.35	M4
5.88	1.34	M5
5.98	1.34	M6
5.21	1.36	M7
5.72	1.36	M8
5.88	1.36	M9
6.27	1.33	M10
6.11	1.35	M11
5.84	1.38	M12
6.02	1.36	M13
6.07	1.37	M14
5.92	1.37	M15
5.98	1.36	M16

Thermal Hydraulic Information for assembly C3
THIS INFORMATION IS THE UPDATE FROM THE QUAD CITIES SUMMARY OF REACTOR CRITICALS: REF. 7.19, PP. 333-334

	Node	Data point 4 water density	Fuel temp	Data point 5 water density	Fuel temp	Data point 6 water density	Fuel temp	Data point 7 water density	Fuel temp	Data point 8 water density	Fuel temp	Data point 9 water density	Fuel temp	Data point 10 water density	Fuel temp	Data point 11 water density	Fuel temp	Data point 12 water density	Fuel temp	Data point 13 water density	Fuel temp
15.24	1	0.7396	634.9	0.7396	640.3	0.7396	622.7	0.7396	639.3	0.7396	636.0	0.7396	617.8	0.7396	610.7	0.7396	613.4	0.7396	628.9	0.7396	645.3
30.48	2	0.7396	954.1	0.7396	963.5	0.7396	873.9	0.7396	899.6	0.7396	842.6	0.7396	772.5	0.7396	740.3	0.7396	746.8	0.7396	804.5	0.7396	856.2
30.48	3	0.6949	1116.6	0.6926	982.1	0.6930	967.5	0.6914	914.8	0.6934	853.0	0.6957	805.8	0.6959	766.4	0.6983	773.4	0.6999	843.0	0.7004	879.9
45.72	4	0.5607	1079.0	0.5634	969.2	0.5658	1073.0	0.5714	929.7	0.5776	875.8	0.5838	838.0	0.5845	815.7	0.5904	822.1	0.5941	891.8	0.5957	895.5
30.48	5	0.4559	1032.7	0.4610	968.2	0.4587	1097.5	0.4700	960.1	0.4776	895.7	0.4852	852.7	0.4860	857.2	0.4935	862.5	0.4975	912.1	0.4993	900.8
45.72	6	0.3883	974.3	0.3901	976.4	0.3851	1049.1	0.3982	995.1	0.4053	911.8	0.4127	863.4	0.4134	866.7	0.4202	872.4	0.4235	904.5	0.4253	902.4
45.72	7	0.3341	918.4	0.3290	977.0	0.3242	959.3	0.3362	1014.5	0.3424	923.1	0.3498	890.7	0.3504	851.2	0.3560	858.9	0.3587	872.1	0.3602	888.2
45.72	8	0.2976	869.7	0.2858	957.2	0.2827	867.1	0.2919	989.8	0.2971	904.6	0.3046	926.2	0.3051	819.4	0.3098	824.5	0.3121	817.6	0.3134	844.7
64.11	9	0.2701	763.3	0.2525	839.7	0.2509	764.2	0.2566	860.8	0.2610	798.9	0.2668	815.5	0.2672	725.1	0.2712	726.6	0.2735	713.5	0.2749	734.7
15.24	10	0.2595	618.8	0.2392	638.1	0.2383	608.3	0.2421	629.9	0.2461	619.2	0.2512	623.5	0.2516	600.6	0.2552	600.4	0.2576	598.0	0.2590	603.9
ıverages:		0.4403	916.9	0.4351	920.3	0.4333	915.8	0.4402	918.2	0.4450	852.8	0.4506	829.9	0.4510	786.9	0.4556	791.9	0.4580	818.2	0.4593	834.7

FOR ONE NODE MODEL			Averages:		
DP		EFPD	Moderator densities	Fuel temp	
4	222.47	222.47	0.4403	916.9	
5	467.48	245.01	0.4351	920.3	
6	180.3	180.3	0.4333	915.8	
7	484.2	303.9	0.4402	918.2	
8	142.2	142.2	0.4450	852.8	
9	263.7	121.5	0.4506	829.9	
10	10.1	10.1	0.4510	786.9	324.73
11	112.94	102.84	0.4556	791.9	
12	224.4	111.46	0.4580	818.2	
13	324.73	100.33	0.4593	834.7	
sum	2432.52	1540.11	0.4468	858.6	averages
weighted averages			0.4435	883.1	

Determination of burn histories
Thermal Hydraulic information for assembly C3
for the original forms, see spreadsheet operatinng.conditiond.xls

368.91	0.542137649	kg U per cm height

Node height in cm	node mass- determined by height*mass U per cm height	height in the reactor	Node	Data point 4: MW per node; determined from C3 data and calculated node mass	Data point 4: Calculated burnup	Data point 4: Burnup (GWd/MTU)	Data point 5: MW per node	Data point 5: Calculated burnup	Data point 5: Burnup (GWd/MTU)
15.24	8.262	15.24	1	0.0509	1.1401	1.371	0.0544	2.2921	2.983
30.48	16.524	45.72	2	0.4408	4.9346	5.934	0.4507	9.7521	12.616
30.48	16.524	76.2	3	0.6189	6.9287	8.332	0.5377	12.8872	16.304
45.72	24.787	121.92	4	0.9416	7.0276	8.451	0.7875	12.8988	16.235
30.48	16.524	152.4	5	0.5858	6.5586	7.887	0.5240	12.3268	15.657
45.72	24.787	198.12	6	0.7949	5.9333	7.135	0.7982	11.6434	15.025
45.72	24.787	243.84	7	0.7096	5.2963	6.369	0.7991	10.8825	14.268
45.72	24.787	289.56	8	0.6306	4.7067	5.66	0.7696	10.0067	13.267
64.11	34.756	353.67	9	0.6138	3.2672	3.929	0.8060	7.1757	9.611
15.24	8.262	368.91	10	0.0453	1.0137	1.219	0.0601	2.2372	3.001
Averages:				5.4322	5.0	6.04	5.5872	10.0	12.89

from dictionary=	1 ton	1016 kg	200kg=0.196841	
Assembly power used for one node calcs:	3.468	0.001	200kg=0.196841	0.196850394

Note for 000-00C-MGR0-00200-000-00A: Use of 1016 kg (long ton) instead of 1000 kg (metric tonne) is the main cause of the discrepancy in burnups discussed in Section 6.6.

Data point	EFPD used for calculated burnups shown above	EFPD from Quad Cities data
4	185	222.47
5	140	245.01
6	180.3	180.3
7	80	303.9
8	142.2	142.2
9	15	121.5
10	10.1	10.1
11	102.84	102.84
12	111.46	111.46
13	100.33	100.33
	sum:	1540.11

Average burnups assemblies need to see	EFPD for one node model
10	567.6
20	1135.2
30	1702.8
40	2270.4
50	2838.0
60	3405.6
70	3973.1
75	4256.9
0.001	0.057
0.01	0.568
0.1	5.676
1	56.759

Pass 2

Cycle	Burnup calculated from C3 data	Desired burnups	
4	6.04		6.04
5	12.9	10	6.86
6	17.8		4.9
7	26.3	20	8.5
8	29.6		3.3
9	32.3	30	2.7
10	32.5		0.2
11	34.5		2
12	36.9		2.4
13	39.1		2.2
4	45.14	40	0.9
5	52	50	4.86
6	56.9		
7	65.4	60	
8	68.7		
9	71.4	70	
10	71.6		
11	73.6		
12	76	75	
13	78.2		

Data point 6			Data point 7			Data point 8			Data point 9		
MW per node	Calculated burnup	Burnup (GWd/MTU)	MW per node	Calculated burnup	Burnup (GWd/MTU)	MW per node	Calculated burnup	Burnup (GWd/MTU)	MW per node	Calculated burnup	Burnup (GWd/MTU)
0.0430	3.9220	3.922	0.0537	4.4422	5.898	0.0516	6.7860	6.786	0.0398	6.8583	7.372
0.3674	16.6250	16.625	0.3926	18.5256	23.845	0.3372	26.7470	26.747	0.2638	26.9865	28.687
0.5229	22.0090	22.009	0.4694	24.2816	30.642	0.4018	34.1000	34.1	0.3464	34.4144	36.647
0.9334	23.0250	23.025	0.7275	25.3731	31.945	0.6409	35.6220	35.622	0.5769	35.9711	38.45
0.6440	22.6840	22.684	0.5160	25.1819	32.173	0.4490	36.0370	36.037	0.4016	36.4016	38.99
0.9011	21.5800	21.58	0.8254	24.2440	31.7	0.6995	35.7130	35.713	0.6202	36.0883	38.753
0.7722	19.8850	19.885	0.8533	22.6391	30.347	0.7173	34.4620	34.462	0.6651	34.8645	37.722
0.6261	17.8210	17.821	0.8177	20.4600	27.846	0.6878	31.7920	31.792	0.7220	32.2289	35.331
0.6169	12.8110	12.811	0.8570	14.7835	20.304	0.7066	23.1950	23.195	0.7481	23.5178	25.81
0.0372	3.8120	3.812	0.0539	4.3335	5.793	0.0456	6.5780	6.578	0.0489	6.6668	7.297
5.4642	17.8	17.81	5.5664	20.0	26.27	4.7374	29.6	29.64	4.3929	30.0	32.33

Data point 10			Data point 11			Data point 12			Data point 13		
MW per node	Calculated burnup	Burnup (GWd/MTU)	MW per node	Calculated burnup	Burnup (GWd/MTU)	MW per node	Calculated burnup	Burnup (GWd/MTU)	MW per node	Calculated burnup	Burnup (GWd/MTU)
0.0352	7.4150	7.415	0.0370	7.8750	7.875	0.0471	8.5100	8.51	0.0575	9.2080	9.208
0.2274	28.8260	28.826	0.2356	30.2920	30.292	0.2978	32.3010	32.301	0.3506	34.4300	34.43
0.2978	36.8290	36.829	0.3067	38.7380	38.738	0.3902	41.3700	41.37	0.4318	43.9920	43.992
0.5375	38.6690	38.669	0.5488	40.9460	40.946	0.6671	43.9460	43.946	0.6732	46.6710	46.671
0.4057	39.2380	39.238	0.4125	41.8050	41.805	0.4666	44.9520	44.952	0.4546	47.7120	47.712
0.6258	39.0080	39.008	0.6353	41.6440	41.644	0.6878	44.7370	44.737	0.6831	47.5020	47.502
0.5988	37.9660	37.966	0.6129	40.5090	40.509	0.6347	43.3630	43.363	0.6611	46.0390	46.039
0.5448	35.5530	35.553	0.5531	37.8480	37.848	0.5406	40.2790	40.279	0.5880	42.6590	42.659
0.5127	25.9590	25.959	0.5140	27.4800	27.48	0.4771	29.0100	29.01	0.5363	30.5580	30.558
0.0311	7.3350	7.335	0.0309	7.7200	7.72	0.0290	8.1110	8.111	0.0337	8.5200	8.52
3.7816	32.5	32.53	3.8869	34.5	34.52	4.2380	36.9	36.89	4.4699	39.1	39.13

Determination of burn histories
Thermal Hydraulic information for assembly C3
for the original forms, see spreadsheet operating.conditiond.xls

368.91	0.542137649	kg U per cm height

				Data point 4			Data point 5		
Node height in cm	node mass- determined by height*mass U per cm height	height in the reactor	Node	MW per node; determined from C3 data and calculated node mass	Calculated burnup	Burnup (GWd/MTU)	MW per node	Calculated burnup	Burnup (GWd/MTU)
15.24	8.262	15.24	1	0.0509	1.1401	1.371	0.0544	2.2921	2.983
30.48	16.524	45.72	2	0.4408	4.9346	5.934	0.4507	9.7521	12.616
30.48	16.524	76.2	3	0.6189	6.9287	8.332	0.5377	12.8872	16.304
45.72	24.787	121.92	4	0.9416	7.0276	8.451	0.7875	12.8988	16.235
30.48	16.524	152.4	5	0.5858	6.5586	7.887	0.5240	12.3268	15.657
45.72	24.787	198.12	6	0.7949	5.9333	7.135	0.7982	11.6434	15.025
45.72	24.787	243.84	7	0.7096	5.2963	6.369	0.7991	10.8825	14.268
45.72	24.787	289.56	8	0.6306	4.7067	5.66	0.7696	10.0067	13.267
64.11	34.756	353.67	9	0.6138	3.2672	3.929	0.8060	7.1757	9.611
15.24	8.262	368.91	10	0.0453	1.0137	1.219	0.0601	2.2372	3.001
Averages:				5.4322	5.0	6.04	5.5872	10.0	12.89

from dictionary=	1 ton	1016 kg	200kg=0.196841	
Assembly power used for one node calcs:	3.468	0.001	200kg=0.196841	0.196850394

Note for 000-00C-MGR0-00200-000-00A: Use of 1016 kg (long ton) instead of 1000 kg (metric tonne) is the main cause of the discrepancy in burnups discussed in Section 6.6.

Data point	EFPD used for calculated burnups shown above	EFPD from Quad Cities data
4	185	222.47
5	140	245.01
6	180.3	180.3
7	80	303.9
8	142.2	142.2
9	15	121.5
10	10.1	10.1
11	102.84	102.84
12	111.46	111.46
13	100.33	100.33
	sum:	1540.11

Average burnups assemblies need to see	EFPD for one node model
10	567.6
20	1135.2
30	1702.8
40	2270.4
50	2838.0
60	3405.6
70	3973.1
75	4256.9

Pass 2
** see pass 2 worksheet

Cycle	Burnup calculated from C3 data	Desired burnups	
4	6.04		6.04
5	12.9	10	6.86
6	17.8		4.9
7	26.3	20	8.5
8	29.6		3.3
9	32.3	30	2.7
10	32.5		0.2
11	34.5		2
12	36.9		2.4
13	39.1		2.2
4	45.14	40	0.9
5	52	50	4.86
6	56.9		
7	65.4	60	
8	68.7		
9	71.4	70	
10	71.6		
11	73.6		
12	76	75	
13	78.2		

Data point 6			Data point 7			Data point 8			Data point 9		
MW per node	Calculated burnup	Burnup (GWd/MTU)	MW per node	Calculated burnup	Burnup (GWd/MTU)	MW per node	Calculated burnup	Burnup (GWd/MTU)	MW per node	Calculated burnup	Burnup (GWd/MTU)
0.0430	3.9220	3.922	0.0537	4.4422	5.898	0.0516	6.7860	6.786	0.0398	6.8583	7.372
0.3674	16.6250	16.625	0.3926	18.5256	23.845	0.3372	26.7470	26.747	0.2638	26.9865	28.687
0.5229	22.0090	22.009	0.4694	24.2816	30.642	0.4018	34.1000	34.1	0.3464	34.4144	36.647
0.9334	23.0250	23.025	0.7275	25.3731	31.945	0.6409	35.6220	35.622	0.5769	35.9711	38.45
0.6440	22.6840	22.684	0.5160	25.1819	32.173	0.4490	36.0370	36.037	0.4016	36.4016	38.99
0.9011	21.5800	21.58	0.8254	24.2440	31.7	0.6995	35.7130	35.713	0.6202	36.0883	38.753
0.7722	19.8850	19.885	0.8533	22.6391	30.347	0.7173	34.4620	34.462	0.6651	34.8645	37.722
0.6261	17.8210	17.821	0.8177	20.4600	27.846	0.6878	31.7920	31.792	0.7220	32.2289	35.331
0.6169	12.8110	12.811	0.8570	14.7835	20.304	0.7066	23.1950	23.195	0.7481	23.5178	25.81
0.0372	3.8120	3.812	0.0539	4.3335	5.793	0.0456	6.5780	6.578	0.0489	6.6668	7.297
5.4642	17.8	17.81	5.5664	20.0	26.27	4.7374	29.6	29.64	4.3929	30.0	32.33

Data point 10			Data point 11			Data point 12			Data point 13		
MW per node	Calculated burnup	Burnup (GWd/MTU)	MW per node	Calculated burnup	Burnup (GWd/MTU)	MW per node	Calculated burnup	Burnup (GWd/MTU)	MW per node	Calculated burnup	Burnup (GWd/MTU)
0.0352	7.4150	7.415	0.0370	7.8750	7.875	0.0471	8.5100	8.51	0.0575	9.2080	9.208
0.2274	28.8260	28.826	0.2356	30.2920	30.292	0.2978	32.3010	32.301	0.3506	34.4300	34.43
0.2978	36.8290	36.829	0.3067	38.7380	38.738	0.3902	41.3700	41.37	0.4318	43.9920	43.992
0.5375	38.6690	38.669	0.5488	40.9460	40.946	0.6671	43.9460	43.946	0.6732	46.6710	46.671
0.4057	39.2380	39.238	0.4125	41.8050	41.805	0.4666	44.9520	44.952	0.4546	47.7120	47.712
0.6258	39.0080	39.008	0.6353	41.6440	41.644	0.6878	44.7370	44.737	0.6831	47.5020	47.502
0.5988	37.9660	37.966	0.6129	40.5090	40.509	0.6347	43.3630	43.363	0.6611	46.0390	46.039
0.5448	35.5530	35.553	0.5531	37.8480	37.848	0.5406	40.2790	40.279	0.5880	42.6590	42.659
0.5127	25.9590	25.959	0.5140	27.4800	27.48	0.4771	29.0100	29.01	0.5363	30.5580	30.558
0.0311	7.3350	7.335	0.0309	7.7200	7.72	0.0290	8.1110	8.111	0.0337	8.5200	8.52
3.7816	32.5	32.53	3.8869	34.5	34.52	4.2380	36.9	36.89	4.4699	39.1	39.13

Determination of burn histories for long burns
Thermal Hydraulic information for assembly C3

BURNUPS FOR 2nd PASS				Data point 4			Data point 5		
	node mass- determined by height*mass U per cm height	height in the reactor	Node	MW per node	Calculated burnup	Burnup (GWd/MTU)	MW per node	Calculated burnup	Burnup (GWd/MTU)
15.2400	8.2622	15.24	1.0000	0.0509	39.3034	1.371	0.0544	41.6224	2.983
30.4800	16.5244	45.72	2.0000	0.4408	39.9802	5.934	0.4507	49.8067	12.616
30.4800	16.5244	76.2	3.0000	0.6189	40.3359	8.332	0.5377	53.1261	16.304
45.7200	24.7865	121.92	4.0000	0.9416	40.3536	8.451	0.7875	53.1108	16.235
30.4800	16.5244	152.4	5.0000	0.5858	40.2699	7.887	0.5240	52.5368	15.657
45.7200	24.7865	198.12	6.0000	0.7949	40.1584	7.135	0.7982	51.8705	15.025
45.7200	24.7865	243.84	7.0000	0.7096	40.0447	6.369	0.7991	51.1109	14.268
45.7200	24.7865	289.56	8.0000	0.6306	39.9396	5.66	0.7696	50.1933	13.267
64.1100	34.7564	353.67	9.0000	0.6138	39.6828	3.929	0.8060	47.0874	9.611
15.2400	8.2622	368.91	10.0000	0.0453	39.2808	1.219	0.0601	41.5918	3.001
Averages:				5.4322	40.0	6.04	5.5872	50.0	12.89
from dictionary=	1 ton	1000kg	200kg=0.196841						
Assembly power used for one node calcs:	3.468	0.001	200kg=0.196841						

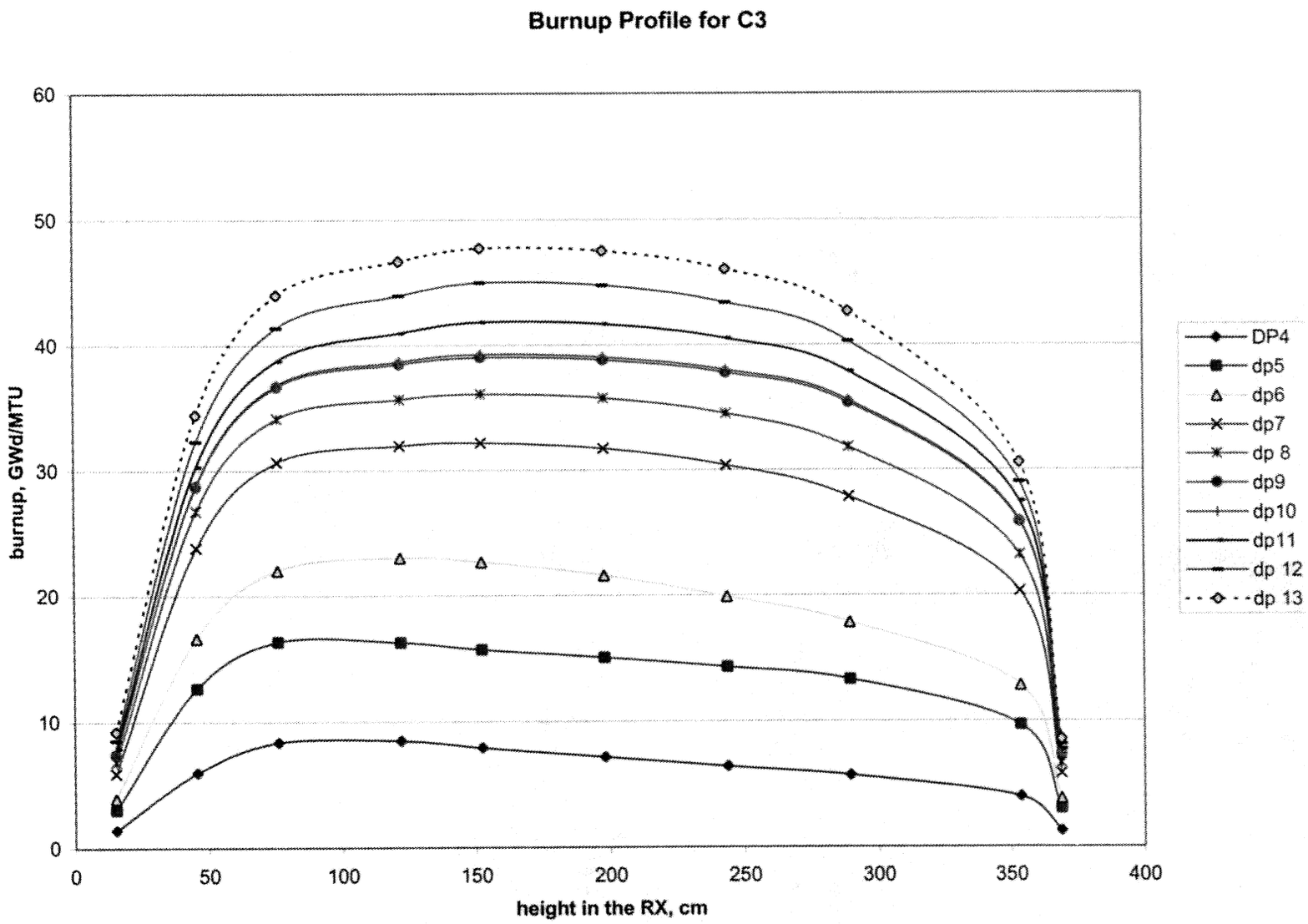
Note for 000-00C-MGR0-00200-000-00A: Use of 1016 kg (long ton) instead of 1000 kg (metric tonne) is the main cause of the discrepancy in burnups discussed in Section 6.6.

Data point	EFPD used for calculated burnup	ORIGINALEFPD	Average burnups assemblies need to see	EFPD for one node model
4	33	222.47	10	567.6
5	175	245.01	20	1135.2
6	180.3	180.3	30	1702.8
7	110	303.9	40	2270.4
8	142.2	142.2	50	2838.0
9	55	121.5	60	3405.6
10	10.1	10.1	70	3973.1
11	102.84	102.84	75	4256.9
12	65	111.46		
13	100.33	100.33		
	sum:	1540.11		

	Cycle	Bumup	Desired burnups	
	4	6.04		6.04
	5	12.9	10	6.86
	6	17.8		4.9
	7	26.3	20	8.5
	8	29.6		3.3
	9	32.3	30	2.7
	10	32.5		0.2
	11	34.5		2
	12	36.9		2.4
	13	39.1		2.2
Pass 2	4	45.14	40	0.9
	5	52	50	4.86
	6	56.9		
	7	65.4	60	3.1
	8	68.7		
	9	71.4	70	1.3
	10	71.6		
	11	73.6		
	12	76	75	
	13	78.2		

Data point 6			Data point 7			Data point 8			Data point 9		
MW per node	Calculated burnup	Burnup (GWd/MTU)	MW per node	Calculated burnup	Burnup (GWd/MTU)	MW per node	Calculated burnup	Burnup (GWd/MTU)	MW per node	Calculated burnup	Burnup (GWd/MTU)
0.0430	43.0220	3.922	0.0537	43.7372	5.898	0.0516	45.8860	6.786	0.0398	46.1513	7.372
0.3674	55.7250	16.625	0.3926	58.3384	23.845	0.3372	65.8470	26.747	0.2638	66.7252	28.687
0.5229	61.1090	22.009	0.4694	64.2338	30.642	0.4018	73.2000	34.1	0.3464	74.3530	36.647
0.9334	62.1250	23.025	0.7275	65.3537	31.945	0.6409	74.7220	35.622	0.5769	76.0022	38.45
0.6440	61.7840	22.684	0.5160	65.2186	32.173	0.4490	75.1370	36.037	0.4016	76.4737	38.99
0.9011	60.6800	21.58	0.8254	64.3430	31.7	0.6995	74.8130	35.713	0.6202	76.1891	38.753
0.7722	58.9850	19.885	0.8533	62.7718	30.347	0.7173	73.5620	34.462	0.6651	75.0377	37.722
0.6261	56.9210	17.821	0.8177	60.5497	27.846	0.6878	70.8920	31.792	0.7220	72.4940	35.331
0.6169	51.9110	12.811	0.8570	54.6232	20.304	0.7066	62.2950	23.195	0.7481	63.4787	25.81
0.0372	42.9120	3.812	0.0539	43.6290	5.793	0.0456	45.6780	6.578	0.0489	46.0035	7.297
5.4642	56.9	17.81	5.5664	60.0	26.27	4.7374	68.7	29.64	4.3929	70.0	32.33

Data point 10			Data point 11			Data point 12			Data point 13		
MW per node	Calculated burnup	Burnup (GWd/MTU)	MW per node	Calculated burnup	Burnup (GWd/MTU)	MW per node	Calculated burnup	Burnup (GWd/MTU)	MW per node	Calculated burnup	Burnup (GWd/MTU)
0.0352	46.5150	7.415	0.0370	46.9750	7.875	0.0471	47.3453	8.51	0.0575	9.2080	9.208
0.2274	67.9260	28.826	0.2356	69.3920	30.292	0.2978	70.5636	32.301	0.3506	34.4300	34.43
0.2978	75.9290	36.829	0.3067	77.8380	38.738	0.3902	79.3729	41.37	0.4318	43.9920	43.992
0.5375	77.7690	38.669	0.5488	80.0460	40.946	0.6671	81.7955	43.946	0.6732	46.6710	46.671
0.4057	78.3380	39.238	0.4125	80.9050	41.805	0.4666	82.7402	44.952	0.4546	47.7120	47.712
0.6258	78.1080	39.008	0.6353	80.7440	41.644	0.6878	82.5477	44.737	0.6831	47.5020	47.502
0.5988	77.0660	37.966	0.6129	79.6090	40.509	0.6347	81.2734	43.363	0.6611	46.0390	46.039
0.5448	74.6530	35.553	0.5531	76.9480	37.848	0.5406	78.3657	40.279	0.5880	42.6590	42.659
0.5127	65.0590	25.959	0.5140	66.5800	27.48	0.4771	67.4722	29.01	0.5363	30.5580	30.558
0.0311	46.4350	7.335	0.0309	46.8200	7.72	0.0290	47.0480	8.111	0.0337	8.5200	8.52
3.7816	71.6	32.53	3.8869	73.6	34.52	4.2380	75.0	36.89	4.4699	39.1	39.13


Burnup Profile for C3
burnup, GWd/MTU
height in the RX, cm
0
10
20
30
40
50
60
0
50
100
150
200
250
300
350
400
DP4
dp5
dp6
dp7
dp 8
dp9
dp10
dp11
dp 12
dp 13

Density 1	time, years	model: 1	model : 2	model: 4	model: 6	model: 8		Percentages of model 1 values				
Gamma	0.002739726	2.3119E+16	2.3286E+16	2.3088E+16	2.3269E+16	2.3236E+16	0.00274	100%	101%	100%	101%	101%
	10	1.1393E+14	1.1379E+14	1.1390E+14	1.1371E+14	1.1365E+14	10	100%	100%	100%	100%	100%
	100	1.2421E+13	1.2341E+13	1.2418E+13	1.2327E+13	1.2326E+13	100	100%	99%	100%	99%	99%
	1000	2.6785E+11	2.5645E+11	2.7431E+11	2.5857E+11	2.6206E+11	1000	100%	96%	102%	97%	98%
	10000	3.5656E+10	3.6271E+10	3.6270E+10	3.6582E+10	3.6802E+10	10000	100%	102%	102%	103%	103%
	100000	5.6873E+09	5.5105E+09	5.8024E+09	5.5600E+09	5.6169E+09	100000	100%	97%	102%	98%	99%
Neutron	1	2.5560E+07	2.7030E+07	2.6850E+07	2.7890E+07	2.8250E+07	0.00274	100%	106%	105%	109%	111%
	10	1.2600E+07	1.3690E+07	1.3290E+07	1.4170E+07	1.4330E+07	10	100%	109%	105%	112%	114%
	100	6.8500E+05	7.3460E+05	7.2120E+05	7.6000E+05	7.6970E+05	100	100%	107%	105%	111%	112%
	1000	2.0250E+05	2.1890E+05	2.1350E+05	2.2730E+05	2.3050E+05	1000	100%	108%	105%	112%	114%
	10000	7.8580E+04	8.3960E+04	8.1830E+04	8.6480E+04	8.7400E+04	10000	100%	107%	104%	110%	111%
	100000	2.4000E+04	2.5170E+04	2.4480E+04	2.5580E+04	2.5670E+04	100000	100%	105%	102%	107%	107%
Density 2		model: 1	model : 2	model: 4	model: 6	model: 8						
Gamma	0.002739726	2.3331E+16	2.3543E+16	2.3299E+16	2.3514E+16	2.3481E+16	0.00274	100%	101%	100%	101%	101%
	10	1.1359E+14	1.1346E+14	1.1347E+14	1.1333E+14	1.1325E+14	10	100%	100%	100%	100%	100%
	100	1.2357E+13	1.2279E+13	1.2346E+13	1.2266E+13	1.2262E+13	100	100%	99%	100%	99%	99%
	1000	2.3810E+11	2.2922E+11	2.4055E+11	2.3120E+11	2.3321E+11	1000	100%	96%	101%	97%	98%
	10000	3.3733E+10	3.4474E+10	3.4050E+10	3.4729E+10	3.4871E+10	10000	100%	102%	101%	103%	103%
	100000	5.1999E+09	5.0462E+09	5.2451E+09	5.0855E+09	5.1191E+09	100000	100%	97%	101%	98%	98%
Neutron	0.002739726	2.2670E+07	2.4050E+07	2.3350E+07	2.4630E+07	2.4860E+07	0.00274	100%	106%	103%	109%	110%
	10	1.1120E+07	1.2170E+07	1.1480E+07	1.2480E+07	1.2580E+07	10	100%	109%	103%	112%	113%
	100	6.0080E+05	6.4690E+05	6.1850E+05	6.6290E+05	6.6860E+05	100	100%	108%	103%	110%	111%
	1000	1.7680E+05	1.9090E+05	1.8180E+05	1.9570E+05	1.9750E+05	1000	100%	108%	103%	111%	112%
	10000	7.1960E+04	7.6670E+04	7.3470E+04	7.8110E+04	7.8620E+04	10000	100%	107%	102%	109%	109%
	100000	2.4380E+04	2.5520E+04	2.4660E+04	2.5750E+04	2.5800E+04	100000	100%	105%	101%	106%	106%
Density 3		model: 1	model : 2	model: 4	model: 6	model: 8						
Gamma	0.002739726	2.3198E+16	2.3280E+16	2.3267E+16	2.3301E+16	2.3296E+16	0.00274	100%	100%	100%	100%	100%
	10	1.1489E+14	1.1475E+14	1.1530E+14	1.1489E+14	1.1491E+14	10	100%	100%	100%	100%	100%
	100	1.2511E+13	1.2433E+13	1.2540E+13	1.2423E+13	1.2429E+13	100	100%	99%	100%	99%	99%
	1000	3.0765E+11	2.9505E+11	3.2571E+11	2.9852E+11	3.0485E+11	1000	100%	96%	106%	97%	99%
	10000	3.7919E+10	3.8410E+10	3.8995E+10	3.8731E+10	3.9052E+10	10000	100%	101%	103%	102%	103%
	100000	6.3520E+09	6.1696E+09	6.6753E+09	6.2712E+09	6.3759E+09	100000	100%	97%	105%	99%	100%
Neutron	0.002739726	2.9720E+07	3.1480E+07	3.2250E+07	3.2900E+07	3.3470E+07	0.00274	100%	106%	109%	111%	113%
	10	1.4900E+07	1.6090E+07	1.6240E+07	1.6900E+07	1.7170E+07	10	100%	108%	109%	113%	115%
	100	8.1720E+05	8.7550E+05	8.9590E+05	9.2450E+05	9.4190E+05	100	100%	107%	110%	113%	115%
	1000	2.4530E+05	2.6690E+05	2.7240E+05	2.8620E+05	2.9260E+05	1000	100%	109%	111%	117%	119%
	10000	9.0020E+04	9.6940E+04	9.7880E+04	1.0260E+05	1.0450E+05	10000	100%	108%	109%	114%	116%
	100000	2.3560E+04	2.4940E+04	2.4540E+04	2.5740E+04	2.5940E+04	100000	100%	106%	104%	109%	110%
Density 4		model: 1	model : 2	model: 4	model: 6	model: 8						
Gamma	0.002739726	2.3189E+16	2.3339E+16	2.3173E+16	2.3325E+16	2.3297E+16	0.00274	100%	101%	100%	101%	100%
	10	1.1410E+14	1.1396E+14	1.1411E+14	1.1390E+14	1.1385E+14	10	100%	100%	100%	100%	100%
	100	1.2440E+13	1.2359E+13	1.2440E+13	1.2345E+13	1.2345E+13	100	100%	99%	100%	99%	99%
	1000	2.7428E+11	2.6263E+11	2.8176E+11	2.6487E+11	2.6864E+11	1000	100%	96%	103%	97%	98%
	10000	3.6092E+10	3.6701E+10	3.6748E+10	3.7009E+10	3.7239E+10	10000	100%	102%	102%	103%	103%
	100000	5.7740E+09	5.5953E+09	5.9044E+09	5.6482E+09	5.7091E+09	100000	100%	97%	102%	98%	99%
Neutron	0.002739726	2.6020E+07	2.7520E+07	2.7430E+07	2.8440E+07	2.8820E+07	0.00274	100%	106%	105%	109%	111%
	10	1.2880E+07	1.3990E+07	1.3640E+07	1.4500E+07	1.4670E+07	10	100%	109%	106%	113%	114%
	100	6.9910E+05	7.4950E+05	7.3900E+05	7.7680E+05	7.8730E+05	100	100%	107%	106%	111%	113%
	1000	2.0570E+05	2.2250E+05	2.1780E+05	2.3160E+05	2.3510E+05	1000	100%	108%	106%	113%	114%
	10000	7.9320E+04	8.4810E+04	8.2860E+04	8.7540E+04	8.8530E+04	10000	100%	107%	104%	110%	112%
	100000	2.3870E+04	2.5050E+04	2.4370E+04	2.5490E+04	2.5580E+04	100000	100%	105%	102%	107%	107%

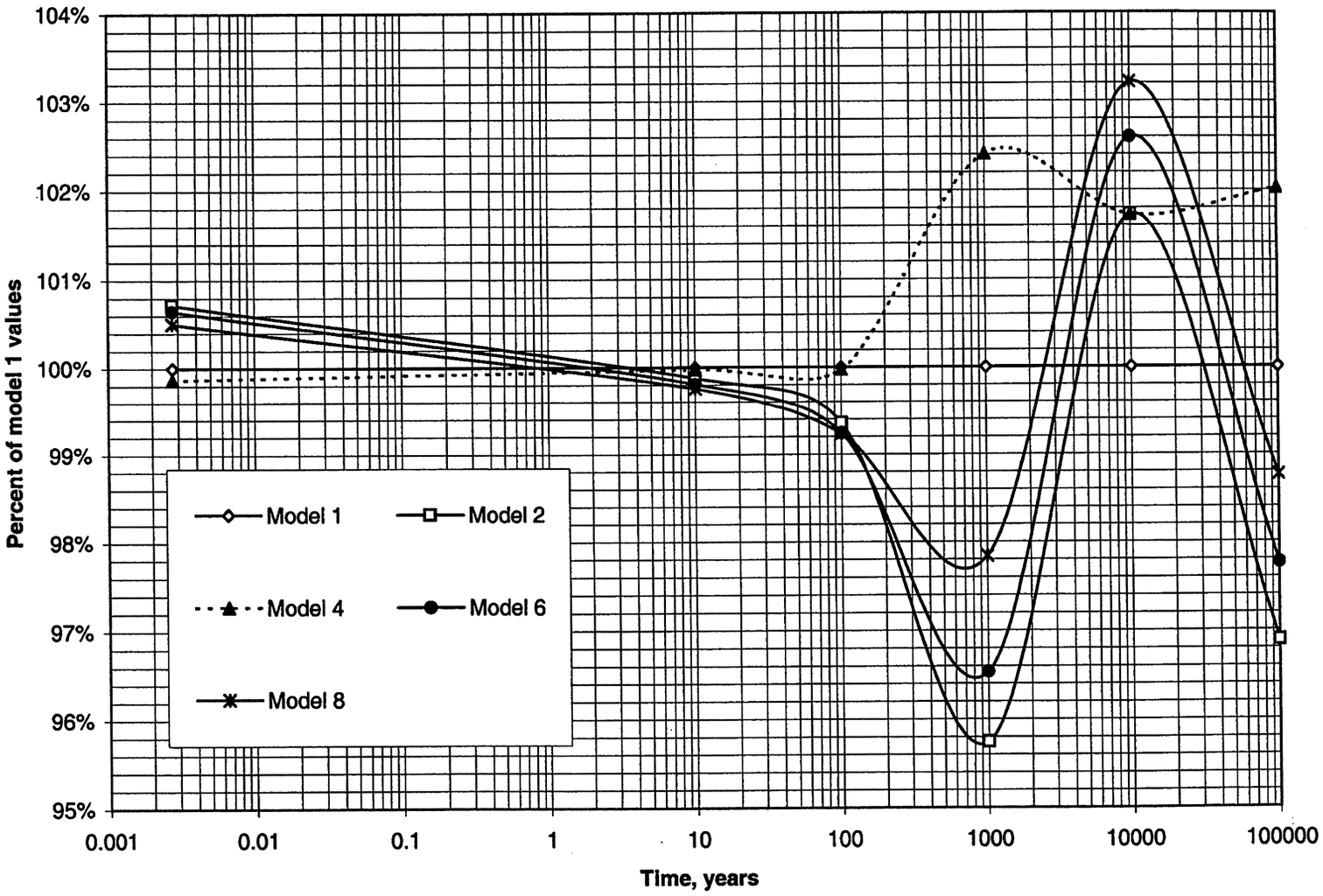
Density 1	time, years	model: 1	model : 2	model: 4	model: 6	model: 8	
Gamma	0.002739726	2.3119E+16	2.3286E+16	2.3088E+16	2.3269E+16	2.3236E+16	0.00274
	10	1.1393E+14	1.1379E+14	1.1390E+14	1.1371E+14	1.1365E+14	10
	100	1.2421E+13	1.2341E+13	1.2418E+13	1.2327E+13	1.2326E+13	100
	1000	2.6785E+11	2.5645E+11	2.7431E+11	2.5857E+11	2.6206E+11	1000
	10000	3.5656E+10	3.6271E+10	3.6270E+10	3.6582E+10	3.6802E+10	10000
	100000	5.6873E+09	5.5105E+09	5.8024E+09	5.5600E+09	5.6169E+09	100000
Neutron	1	2.5560E+07	2.7030E+07	2.6850E+07	2.7890E+07	2.8250E+07	0.00274
	10	1.2600E+07	1.3690E+07	1.3290E+07	1.4170E+07	1.4330E+07	10
	100	6.8500E+05	7.3460E+05	7.2120E+05	7.6000E+05	7.6970E+05	100
	1000	2.0250E+05	2.1890E+05	2.1350E+05	2.2730E+05	2.3050E+05	1000
	10000	7.8580E+04	8.3960E+04	8.1830E+04	8.6480E+04	8.7400E+04	10000
	100000	2.4000E+04	2.5170E+04	2.4480E+04	2.5580E+04	2.5670E+04	100000

Density 2		model: 1	model : 2	model: 4	model: 6	model: 8		Percentage of density 1 values				
Gamma	0.002739726	2.3331E+16	2.3543E+16	2.3299E+16	2.3514E+16	2.3481E+16	0.00274	101%	101%	101%	101%	101%
	10	1.1359E+14	1.1346E+14	1.1347E+14	1.1333E+14	1.1325E+14	10	100%	100%	100%	100%	100%
	100	1.2357E+13	1.2279E+13	1.2346E+13	1.2266E+13	1.2262E+13	100	99%	99%	99%	100%	99%
	1000	2.3810E+11	2.2922E+11	2.4055E+11	2.3120E+11	2.3321E+11	1000	89%	89%	88%	89%	89%
	10000	3.3733E+10	3.4474E+10	3.4050E+10	3.4729E+10	3.4871E+10	10000	95%	95%	94%	95%	95%
	100000	5.1999E+09	5.0462E+09	5.2451E+09	5.0855E+09	5.1191E+09	100000	91%	92%	90%	91%	91%
Neutron	0.002739726	2.2670E+07	2.4050E+07	2.3350E+07	2.4630E+07	2.4860E+07	0.00274	89%	89%	87%	88%	88%
	10	1.1120E+07	1.2170E+07	1.1480E+07	1.2480E+07	1.2580E+07	10	88%	89%	86%	88%	88%
	100	6.0080E+05	6.4690E+05	6.1850E+05	6.6290E+05	6.6860E+05	100	88%	88%	86%	87%	87%
	1000	1.7680E+05	1.9090E+05	1.8180E+05	1.9570E+05	1.9750E+05	1000	87%	87%	85%	86%	86%
	10000	7.1960E+04	7.6670E+04	7.3470E+04	7.8110E+04	7.8620E+04	10000	92%	91%	90%	90%	90%
	100000	2.4380E+04	2.5520E+04	2.4660E+04	2.5750E+04	2.5800E+04	100000	102%	101%	101%	101%	101%

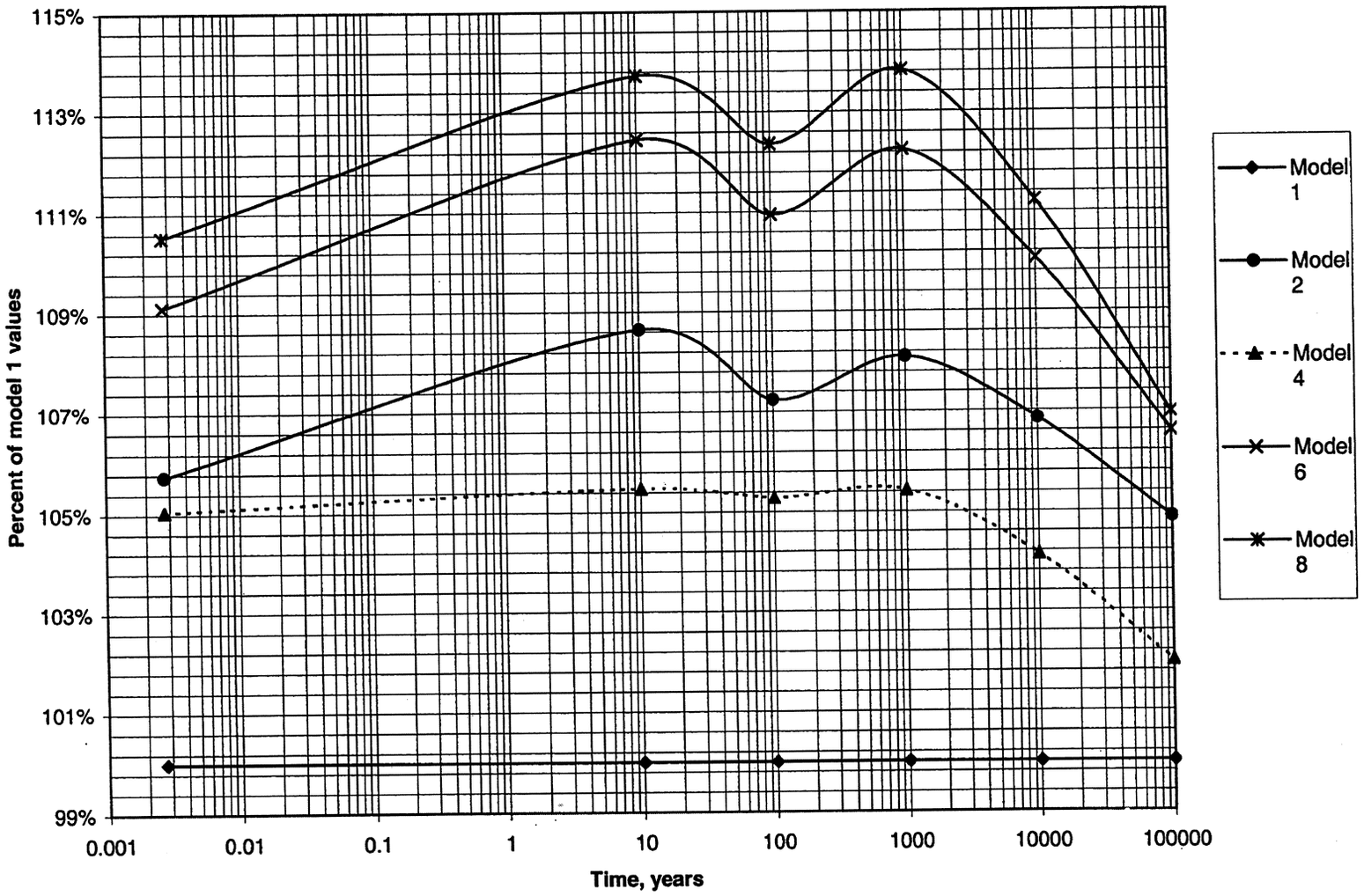
Density 3		model: 1	model : 2	model: 4	model: 6	model: 8						
Gamma	0.002739726	2.3198E+16	2.3280E+16	2.3267E+16	2.3301E+16	2.3296E+16	0.00274	100%	100%	101%	100%	100%
	10	1.1489E+14	1.1475E+14	1.1530E+14	1.1489E+14	1.1491E+14	10	101%	101%	101%	101%	101%
	100	1.2511E+13	1.2433E+13	1.2540E+13	1.2423E+13	1.2429E+13	100	101%	101%	101%	101%	101%
	1000	3.0765E+11	2.9505E+11	3.2571E+11	2.9852E+11	3.0485E+11	1000	115%	115%	119%	115%	116%
	10000	3.7919E+10	3.8410E+10	3.8995E+10	3.8731E+10	3.9052E+10	10000	106%	106%	108%	106%	106%
	100000	6.3520E+09	6.1696E+09	6.6753E+09	6.2712E+09	6.3759E+09	100000	112%	112%	115%	113%	114%
Neutron	0.002739726	2.9720E+07	3.1480E+07	3.2250E+07	3.2900E+07	3.3470E+07		116%	116%	120%	118%	118%
	10	1.4900E+07	1.6090E+07	1.6240E+07	1.6900E+07	1.7170E+07		118%	118%	122%	119%	120%
	100	8.1720E+05	8.7550E+05	8.9590E+05	9.2450E+05	9.4190E+05		119%	119%	124%	122%	122%
	1000	2.4530E+05	2.6690E+05	2.7240E+05	2.8620E+05	2.9260E+05		121%	122%	128%	126%	127%
	10000	9.0020E+04	9.6940E+04	9.7880E+04	1.0260E+05	1.0450E+05		115%	115%	120%	119%	120%
	100000	2.3560E+04	2.4940E+04	2.4540E+04	2.5740E+04	2.5940E+04		98%	99%	100%	101%	101%

Density 4		model: 1	model : 2	model: 4	model: 6	model: 8						
Gamma	0.002739726	2.3189E+16	2.3339E+16	2.3173E+16	2.3325E+16	2.3297E+16	0.00274	100%	100%	100%	100%	100%
	10	1.1410E+14	1.1396E+14	1.1411E+14	1.1390E+14	1.1385E+14	10	100%	100%	100%	100%	100%
	100	1.2440E+13	1.2359E+13	1.2440E+13	1.2345E+13	1.2345E+13	100	100%	100%	100%	100%	100%
	1000	2.7428E+11	2.6263E+11	2.8176E+11	2.6487E+11	2.6864E+11	1000	102%	102%	103%	102%	103%
	10000	3.6092E+10	3.6701E+10	3.6748E+10	3.7009E+10	3.7239E+10	10000	101%	101%	101%	101%	101%
	100000	5.7740E+09	5.5953E+09	5.9044E+09	5.6482E+09	5.7091E+09	100000	102%	102%	102%	102%	102%
Neutron	0.002739726	2.6020E+07	2.7520E+07	2.7430E+07	2.8440E+07	2.8820E+07	0.00274	102%	102%	102%	102%	102%
	10	1.2880E+07	1.3990E+07	1.3640E+07	1.4500E+07	1.4670E+07	10	102%	102%	103%	102%	102%
	100	6.9910E+05	7.4950E+05	7.3900E+05	7.7680E+05	7.8730E+05	100	102%	102%	102%	102%	102%
	1000	2.0570E+05	2.2250E+05	2.1780E+05	2.3160E+05	2.3510E+05	1000	102%	102%	102%	102%	102%
	10000	7.9320E+04	8.4810E+04	8.2860E+04	8.7540E+04	8.8530E+04	10000	101%	101%	101%	101%	101%
	100000	2.3870E+04	2.5050E+04	2.4370E+04	2.5490E+04	2.5580E+04	100000	99%	100%	100%	100%	100%

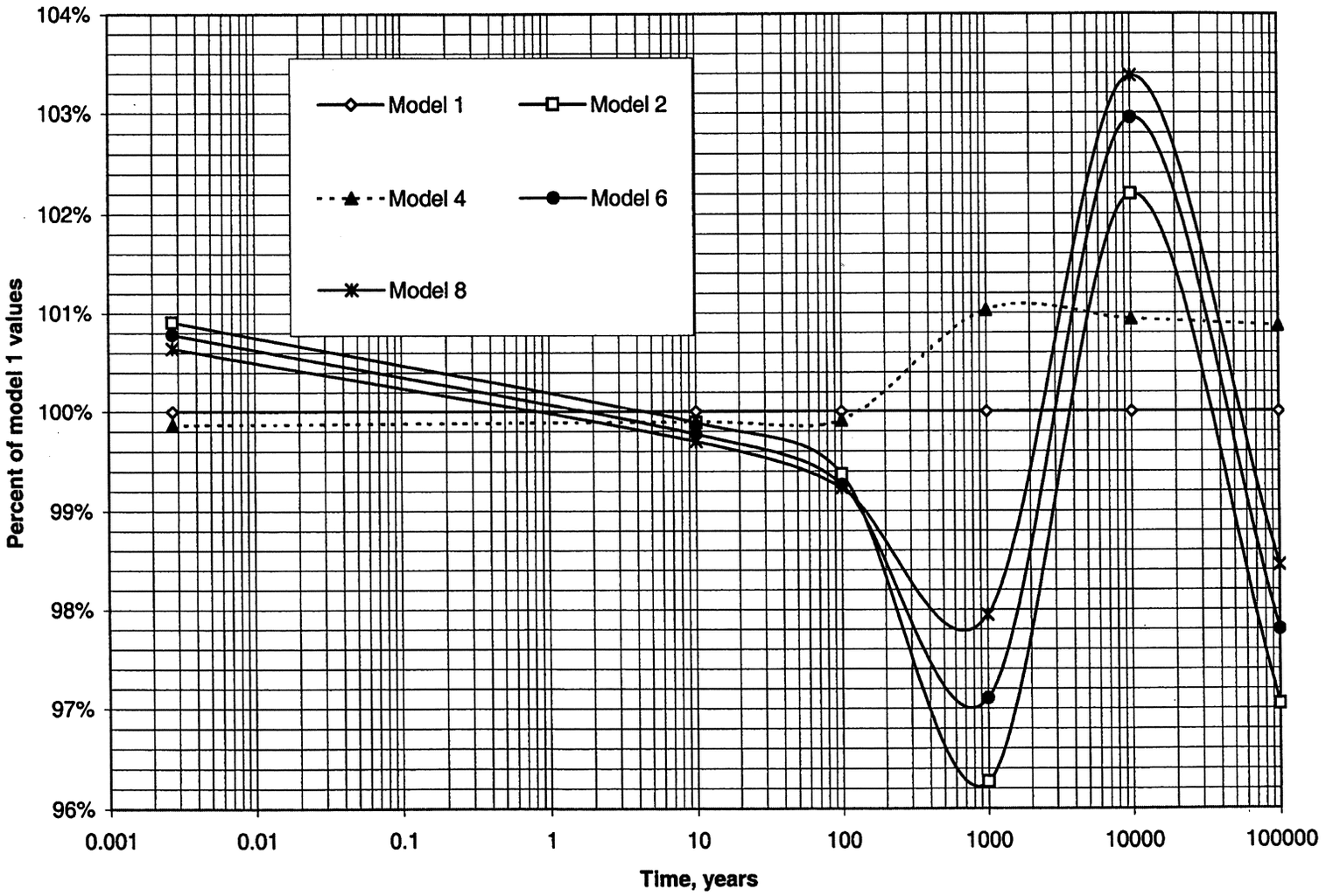
Density 1: Percent of model 1 values for gamma sources



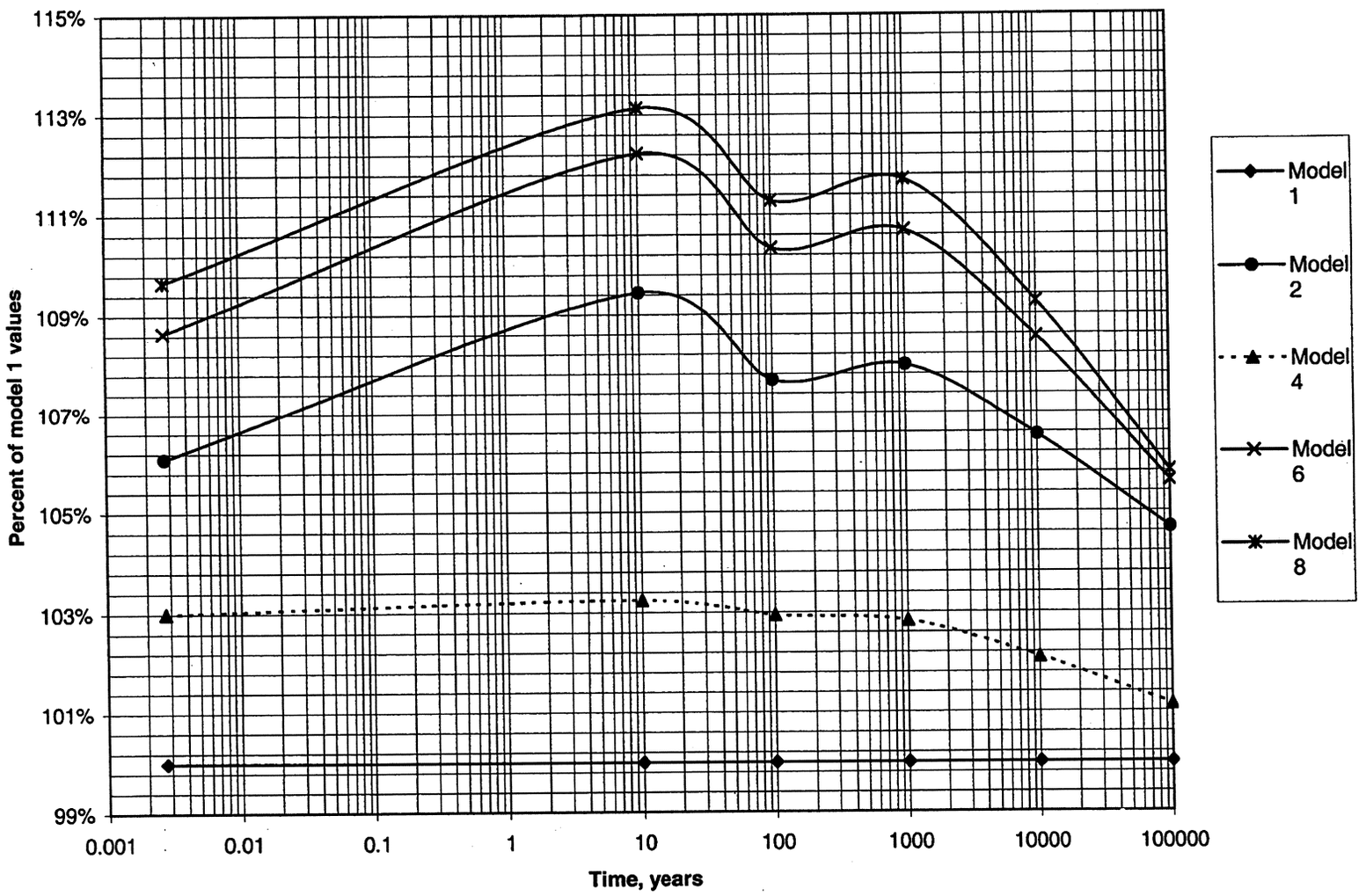
Density 1: Percent of model 1 values for neutron sources



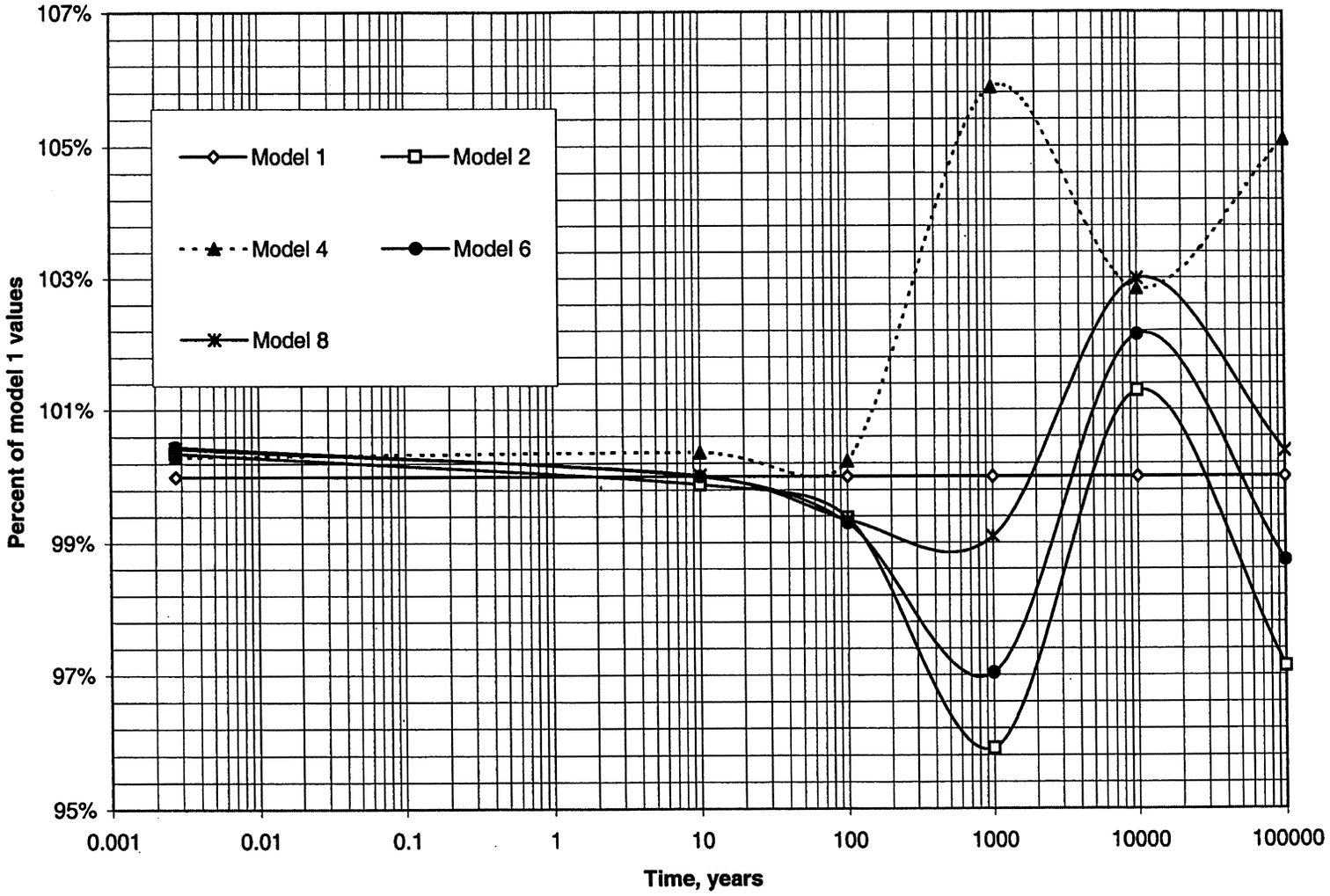
Density 2: Percent of model 1 values for gamma sources



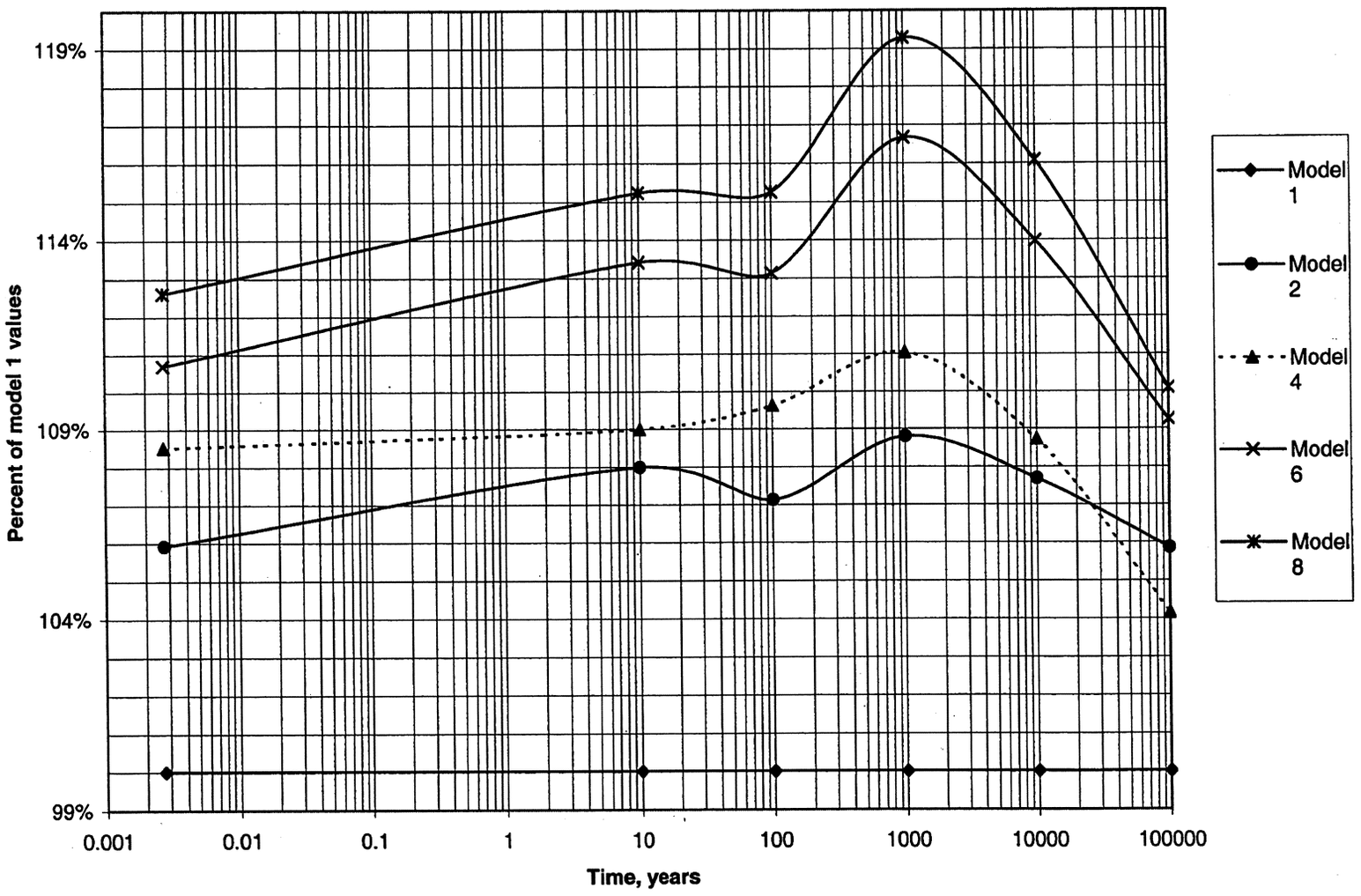
Density 2: Percent of model 1 values for neutron sources



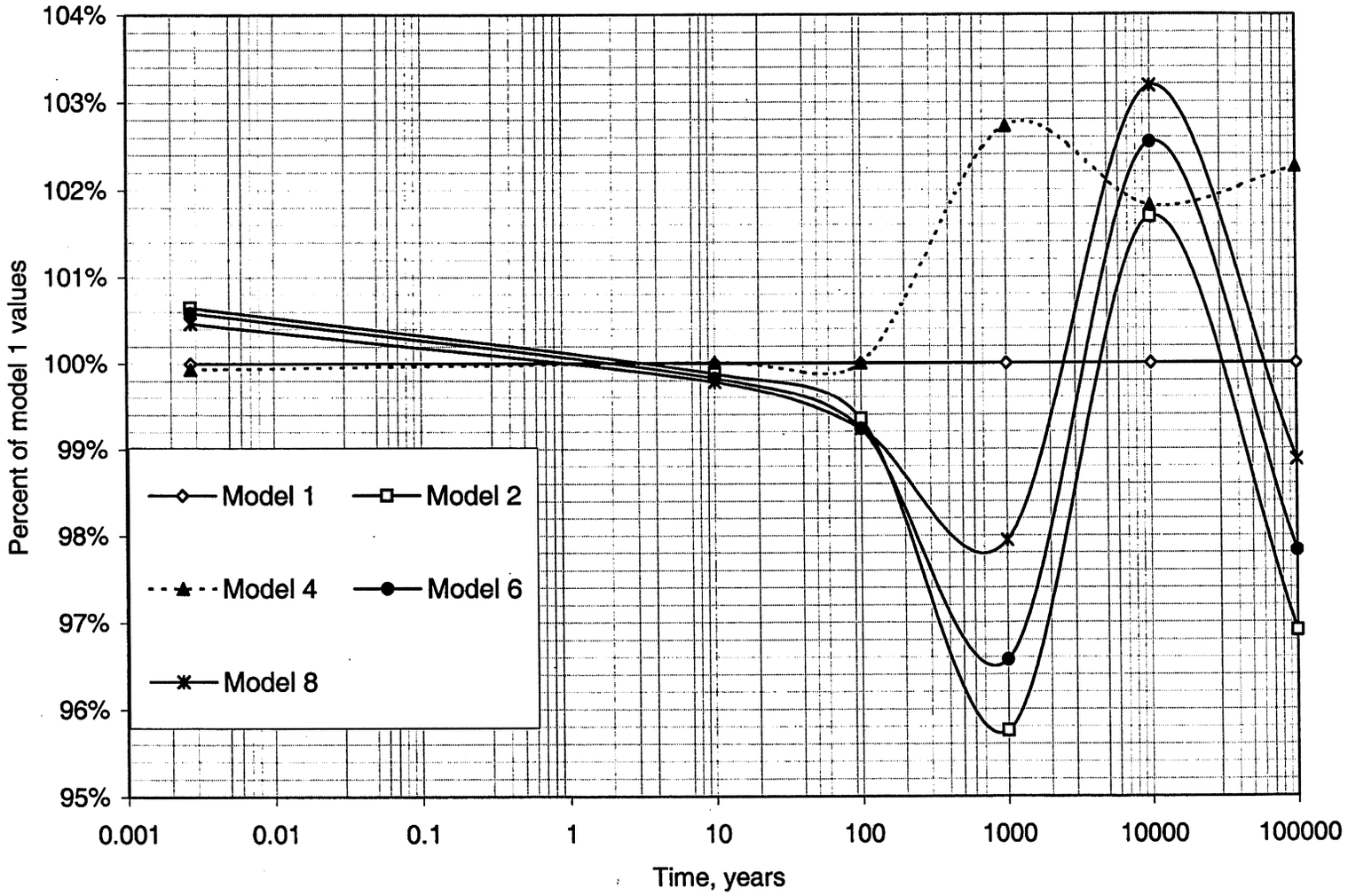
Density 3: Percent of model 1 values for gamma sources



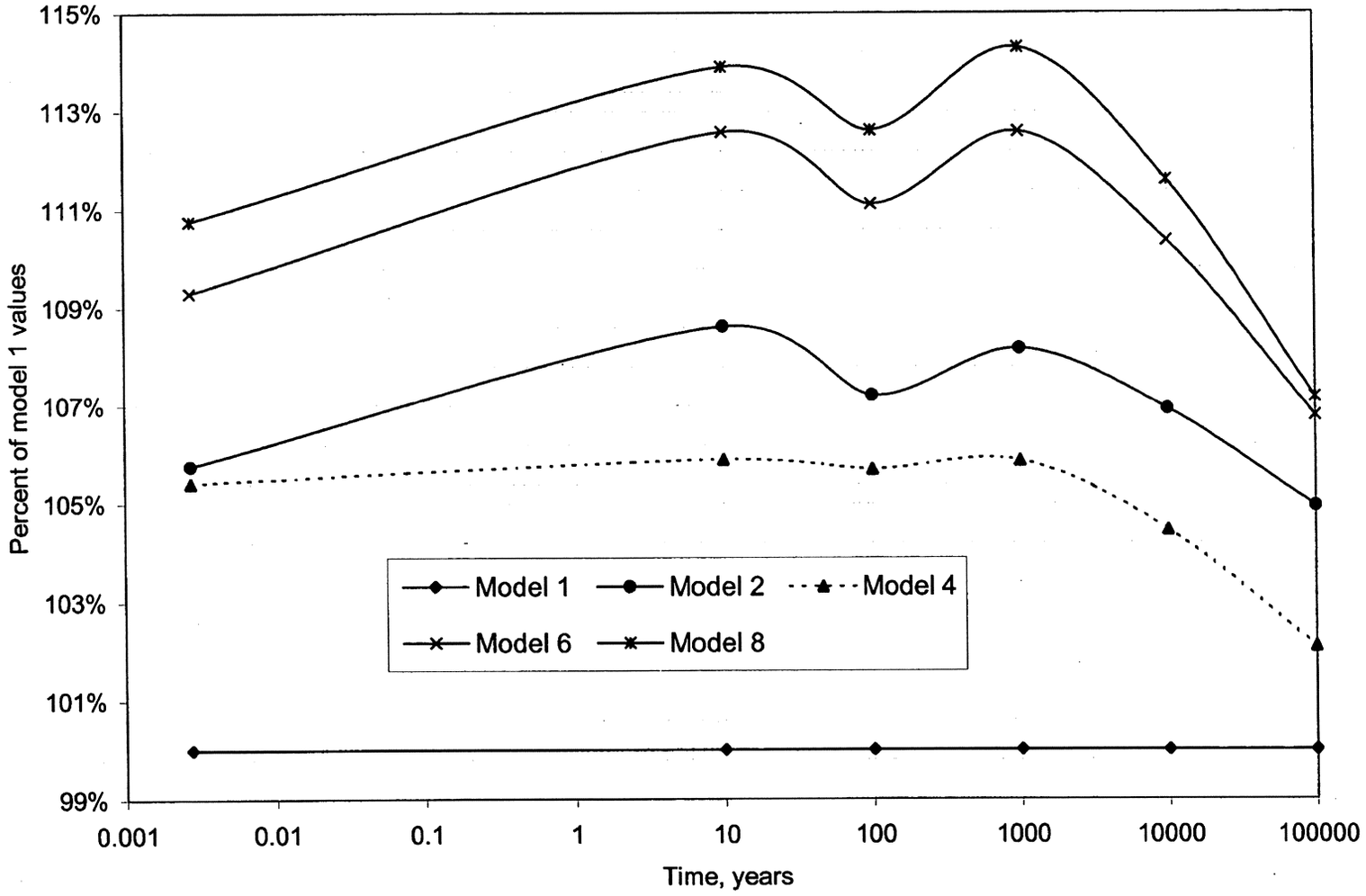
Density 3: Percent of model 1 values for neutron sources



Density 4: Percent of model 1 values for gamma sources



Density 4: Percent of model 1 values for neutron sources



BWR assembly parameters to maximize surface area		
Rod OD	1.07696	cm
Water rod OD (rod pitch)	1.45288	
# of Rods	79	(2 Water rods)
Rod Length	416.1536	cm
Channel ID	13.4112	cm
Channel OD	13.8176	
Channel Length	447.548	cm
Water rod outside area+ inside area (estimated from rod pitch	8171.075627	
rod pitch* PI * 4; WR inside and outside diameters conservatively approximated as fuel rod pitch		
(Data from ANF 9x9 JP-4,5 assembly		
BWR Assembly Surf. Area	168147.97	cm^2
(Rod surface + channel inner surface + WR's inside and outside surfaces		

Crud per unit area				
Co-60	1.25E-03	Ci/cm^2		
(from SAND88-1358, Ref. 7.11, p. 15)				
NRC recommended value:	1.25E-03	Ci/cm^2		
From Jones report, Table 2, p. 7				
Cr 51	3.50E-05	Ci/cm^2		
Mn 54	1.72E-04	Ci/cm^2		
Fe 55	7.42E-03	Ci/cm^2		
Co 58	4.50E-05	Ci/cm^2		
Fe 59	7.20E-05	Ci/cm^2		
Co 60	4.77E-04	Ci/cm^2		
Ni 63	0.00E+00	Ci/cm^2		
Zn 65	7.30E-05	Ci/cm^2		
Zr 95	5.80E-05	Ci/cm^2		
Half Life information (Ref. 7.23, pp. 24, 25, 28				
Cr 51	27.70	days	0.0758	years
Mn 54	312.10	days	0.8545	years
Fe 55	2.73	years	2.7300	years
Co 58	70.88	days	0.1941	years
Fe 59	44.51	days	0.1219	years
Co 60	5.27	years	5.2710	years
Ni 63	100.00	years	100.00	years
Zn 65	243.80	days	0.6675	years
Zr 95	64.02	days	0.1753	years

Fuel Age, years since reactor discharge	Crud (Ci) for regular assembly, using SAND88-1358 Co 60 value (Ref. 7.11, p.15)	Crud (Ci) for regular assembly, using NRC Co 60 values (Ref. 7.10, Table 9.2)
0	210.18	210.86
5	108.91	109.25
6	95.49	95.79
7	83.72	83.99
8	73.40	73.64
9	64.36	64.56
10	56.43	56.61
11	49.47	49.63
15	29.24	29.33
20	15.15	15.20
25	7.85	7.87
30	4.07	4.08
35	2.11	2.11
40	1.09	1.10
45	0.57	0.57
50	0.29	0.29
55	0.15	0.15
60	0.08	0.08
65	0.04	0.04
70	0.02	0.02
75	0.01	0.01
80	0.01	0.01
85	0.00	0.00
90	0.00	0.00
95	0.00	0.00
100	0.00	0.00
200	0.00	0.00
300	0.00	0.00

Fuel Age, years since reactor discharge	Crud (Ci) for assembly, using Jones values (Ref. 7.12, Table 2)								
	Cr 51	Mn 54	Fe 55	Co 58	Fe 59	Co 60	Ni 63	Zn 65	Zr 95
0	5.89	28.92	1246.82	7.57	12.11	80.21	0.00	12.27	9.75
5	0.00	0.50	350.32	0.00	0.00	41.56	0.00	0.07	0.00
6	0.00	0.22	271.77	0.00	0.00	36.44	0.00	0.02	0.00
7	0.00	0.10	210.83	0.00	0.00	31.95	0.00	0.01	0.00
8	0.00	0.04	163.55	0.00	0.00	28.01	0.00	0.00	0.00
9	0.00	0.02	126.88	0.00	0.00	24.56	0.00	0.00	0.00
10	0.00	0.01	98.43	0.00	0.00	21.53	0.00	0.00	0.00
11	0.00	0.00	76.36	0.00	0.00	18.88	0.00	0.00	0.00
15	0.00	0.00	27.66	0.00	0.00	11.16	0.00	0.00	0.00
20	0.00	0.00	7.77	0.00	0.00	5.78	0.00	0.00	0.00
25	0.00	0.00	2.18	0.00	0.00	3.00	0.00	0.00	0.00
30	0.00	0.00	0.61	0.00	0.00	1.55	0.00	0.00	0.00
35	0.00	0.00	0.17	0.00	0.00	0.80	0.00	0.00	0.00
40	0.00	0.00	0.05	0.00	0.00	0.42	0.00	0.00	0.00
45	0.00	0.00	0.01	0.00	0.00	0.22	0.00	0.00	0.00
50	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.00
55	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.00	0.00
60	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00
65	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00
70	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00
75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
300	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

		Raw	Data								
		6	18	30	48	60	78	96	114	139.24	145.24
		Node 1	Node 2	Node 3	Node 4	Node 5	Node 6	Node 7	Node 8	Node 9	Node10
	Time, years	6	12	12	18	12	18	18	18	25.24	6
10 GWd/MTU	0.002739726	3.33E+15	2.09E+16	2.53E+16	3.77E+16	2.53E+16	3.86E+16	3.88E+16	3.75E+16	3.93E+16	3.81E+15
	5	4.94E+12	4.36E+13	5.85E+13	8.88E+13	5.70E+13	8.02E+13	7.53E+13	6.85E+13	6.79E+13	4.88E+12
	6	4.08E+12	3.66E+13	4.90E+13	7.43E+13	4.76E+13	6.69E+13	6.28E+13	5.71E+13	5.69E+13	4.00E+12
	7	3.63E+12	3.29E+13	4.37E+13	6.63E+13	4.24E+13	5.96E+13	5.59E+13	5.09E+13	5.10E+13	3.54E+12
	8	3.36E+12	3.06E+13	4.06E+13	6.13E+13	3.92E+13	5.52E+13	5.17E+13	4.71E+13	4.74E+13	3.27E+12
	9	3.18E+12	2.90E+13	3.84E+13	5.79E+13	3.71E+13	5.21E+13	4.88E+13	4.45E+13	4.49E+13	3.09E+12
	10	3.06E+12	2.78E+13	3.67E+13	5.54E+13	3.54E+13	4.98E+13	4.67E+13	4.26E+13	4.30E+13	2.96E+12
	11	2.95E+12	2.69E+13	3.54E+13	5.33E+13	3.41E+13	4.79E+13	4.49E+13	4.10E+13	4.15E+13	2.86E+12
	15	2.63E+12	2.39E+13	3.14E+13	4.72E+13	3.01E+13	4.24E+13	3.97E+13	3.64E+13	3.68E+13	2.55E+12
	20	2.32E+12	2.10E+13	2.76E+13	4.14E+13	2.64E+13	3.73E+13	3.49E+13	3.20E+13	3.24E+13	2.24E+12

		Raw	Data								
		6	18	30	48	60	78	96	114	139.24	145.24
		Node 1	Node 2	Node 3	Node 4	Node 5	Node 6	Node 7	Node 8	Node 9	Node10
	Time, years	6	12	12	18	12	18	18	18	25.24	6
20 GWd/MTU	0.002739726	3.28E+15	1.89E+16	2.40E+16	3.74E+16	2.67E+16	4.23E+16	4.32E+16	4.09E+16	4.21E+16	3.39E+15
	5	9.12E+12	8.11E+13	1.39E+14	1.77E+14	1.19E+14	1.71E+14	1.60E+14	1.41E+14	1.39E+14	8.97E+12
data for node 3	6	7.66E+12	6.93E+13	1.18E+14	1.49E+14	1.00E+14	1.44E+14	1.34E+14	1.19E+14	1.18E+14	7.50E+12
of this burn	7	6.84E+12	6.25E+13	1.06E+14	1.33E+14	8.89E+13	1.28E+14	1.19E+14	1.06E+14	1.06E+14	6.68E+12
is incorrect	8	6.33E+12	5.81E+13	9.72E+13	1.22E+14	8.16E+13	1.17E+14	1.09E+14	9.76E+13	9.81E+13	6.17E+12
(see	9	5.99E+12	5.50E+13	9.13E+13	1.15E+14	7.64E+13	1.10E+14	1.03E+14	9.17E+13	9.26E+13	5.82E+12
highlighted	10	5.73E+12	5.25E+13	8.67E+13	1.09E+14	7.25E+13	1.04E+14	9.74E+13	8.72E+13	8.84E+13	5.56E+12
information);	11	5.53E+12	5.05E+13	8.29E+13	1.04E+14	6.93E+13	9.96E+13	9.32E+13	8.36E+13	8.49E+13	5.36E+12
it is not used	15	4.91E+12	4.46E+13	7.24E+13	9.11E+13	6.04E+13	8.69E+13	8.13E+13	7.32E+13	7.47E+13	4.75E+12
for the comparison	20	4.32E+12	3.91E+13	6.33E+13	7.96E+13	5.27E+13	7.59E+13	7.10E+13	6.41E+13	6.54E+13	4.18E+12

		Raw	Data								
		6	18	30	48	60	78	96	114	139.24	145.24
		Node 1	Node 2	Node 3	Node 4	Node 5	Node 6	Node 7	Node 8	Node 9	Node10
	Time, years	6	12	12	18	12	18	18	18	25.24	6
30 GWd/MTU	0.002739726	2.64E+15	1.44E+16	1.89E+16	3.15E+16	2.22E+16	3.46E+16	3.66E+16	3.82E+16	3.86E+16	3.10E+15
	5	1.37E+13	1.17E+14	1.54E+14	2.48E+14	1.71E+14	2.56E+14	2.50E+14	2.27E+14	2.22E+14	1.34E+13
	6	1.16E+13	1.01E+14	1.32E+14	2.11E+14	1.45E+14	2.16E+14	2.11E+14	1.92E+14	1.90E+14	1.13E+13
	7	1.04E+13	9.09E+13	1.18E+14	1.88E+14	1.29E+14	1.92E+14	1.86E+14	1.70E+14	1.70E+14	1.01E+13
	8	9.58E+12	8.43E+13	1.09E+14	1.73E+14	1.18E+14	1.75E+14	1.70E+14	1.56E+14	1.57E+14	9.32E+12
	9	9.04E+12	7.95E+13	1.02E+14	1.61E+14	1.10E+14	1.63E+14	1.58E+14	1.45E+14	1.48E+14	8.78E+12
	10	8.63E+12	7.58E+13	9.67E+13	1.53E+14	1.04E+14	1.54E+14	1.49E+14	1.37E+14	1.40E+14	8.37E+12
	11	8.30E+12	7.27E+13	9.25E+13	1.46E+14	9.89E+13	1.47E+14	1.42E+14	1.31E+14	1.34E+14	8.04E+12
	15	7.34E+12	6.38E+13	8.06E+13	1.26E+14	8.55E+13	1.27E+14	1.23E+14	1.13E+14	1.17E+14	7.09E+12
	20	6.46E+12	5.58E+13	7.03E+13	1.10E+14	7.42E+13	1.10E+14	1.07E+14	9.87E+13	1.02E+14	6.23E+12

		Raw	Data								
		6	18	30	48	60	78	96	114	139.24	145.24
		Node 1	Node 2	Node 3	Node 4	Node 5	Node 6	Node 7	Node 8	Node 9	Node10
	Time, years	6	12	12	18	12	18	18	18	25.24	6
40 GWd/MTU	**0.002739726**	3.22E+15	2.18E+16	3.17E+16	4.97E+16	3.18E+16	4.40E+16	3.97E+16	3.50E+16	3.24E+16	2.81E+15
	5	1.80E+13	1.49E+14	2.01E+14	3.30E+14	2.29E+14	3.41E+14	3.31E+14	3.00E+14	2.82E+14	1.63E+13
	6	1.54E+13	1.30E+14	1.73E+14	2.81E+14	1.95E+14	2.90E+14	2.81E+14	2.56E+14	2.45E+14	1.41E+13
	7	1.38E+13	1.17E+14	1.54E+14	2.50E+14	1.72E+14	2.56E+14	2.49E+14	2.27E+14	2.21E+14	1.27E+13
	8	1.28E+13	1.09E+14	1.41E+14	2.28E+14	1.57E+14	2.33E+14	2.27E+14	2.08E+14	2.04E+14	1.18E+13
	9	1.21E+13	1.02E+14	1.32E+14	2.12E+14	1.46E+14	2.16E+14	2.10E+14	1.93E+14	1.92E+14	1.11E+13
	10	1.15E+13	9.74E+13	1.25E+14	2.00E+14	1.37E+14	2.03E+14	1.98E+14	1.82E+14	1.82E+14	1.06E+13
	11	1.11E+13	9.33E+13	1.19E+14	1.90E+14	1.30E+14	1.93E+14	1.88E+14	1.73E+14	1.74E+14	1.02E+13
	15	9.75E+12	8.14E+13	1.03E+14	1.64E+14	1.11E+14	1.66E+14	1.61E+14	1.49E+14	1.51E+14	8.98E+12
	20	8.56E+12	7.11E+13	8.96E+13	1.42E+14	9.64E+13	1.43E+14	1.39E+14	1.29E+14	1.32E+14	7.88E+12
		Raw	**Data**								
		6	18	30	48	60	78	96	114	139.24	145.24
		Node 1	Node 2	Node 3	Node 4	Node 5	Node 6	Node 7	Node 8	Node 9	Node10
	Time, years	6	12	12	18	12	18	18	18	25.24	6
50 GWd/MTU	**0.002739726**	3.44E+15	2.44E+16	3.13E+16	4.68E+16	3.12E+16	4.73E+16	4.69E+16	4.45E+16	4.41E+16	3.83E+15
	5	2.21E+13	1.98E+14	2.71E+14	4.35E+14	2.95E+14	4.33E+14	4.17E+14	3.78E+14	3.56E+14	2.09E+13
	6	1.90E+13	1.71E+14	2.30E+14	3.67E+14	2.49E+14	3.65E+14	3.52E+14	3.21E+14	3.07E+14	1.79E+13
	7	1.70E+13	1.53E+14	2.02E+14	3.22E+14	2.18E+14	3.21E+14	3.10E+14	2.83E+14	2.76E+14	1.61E+13
	8	1.57E+13	1.40E+14	1.83E+14	2.91E+14	1.97E+14	2.90E+14	2.80E+14	2.57E+14	2.53E+14	1.48E+13
	9	1.48E+13	1.31E+14	1.70E+14	2.69E+14	1.82E+14	2.67E+14	2.58E+14	2.38E+14	2.37E+14	1.39E+13
	10	1.41E+13	1.24E+14	1.59E+14	2.51E+14	1.70E+14	2.50E+14	2.42E+14	2.23E+14	2.24E+14	1.33E+13
	11	1.35E+13	1.18E+14	1.51E+14	2.38E+14	1.60E+14	2.36E+14	2.29E+14	2.11E+14	2.13E+14	1.27E+13
	15	1.19E+13	1.02E+14	1.29E+14	2.02E+14	1.36E+14	2.01E+14	1.94E+14	1.80E+14	1.84E+14	1.12E+13
	20	1.04E+13	8.89E+13	1.12E+14	1.74E+14	1.17E+14	1.73E+14	1.67E+14	1.56E+14	1.60E+14	9.77E+12
		Raw	**Data**								
		6	18	30	48	60	78	96	114	139.24	145.24
		Node 1	Node 2	Node 3	Node 4	Node 5	Node 6	Node 7	Node 8	Node 9	Node10
	Time, years	6	12	12	18	12	18	18	18	25.24	6
60 GWd/MTU	**0.002739726**	3.40E+15	2.25E+16	2.93E+16	4.61E+16	3.26E+16	5.13E+16	5.20E+16	4.87E+16	4.79E+16	3.44E+15
	5	2.54E+13	2.37E+14	3.25E+14	5.28E+14	3.61E+14	5.31E+14	5.07E+14	4.54E+14	4.29E+14	2.42E+13
	6	2.19E+13	2.03E+14	2.74E+14	4.43E+14	3.03E+14	4.45E+14	4.26E+14	3.84E+14	3.69E+14	2.09E+13
	7	1.97E+13	1.81E+14	2.40E+14	3.86E+14	2.64E+14	3.88E+14	3.72E+14	3.37E+14	3.30E+14	1.88E+13
	8	1.83E+13	1.66E+14	2.16E+14	3.47E+14	2.36E+14	3.48E+14	3.34E+14	3.04E+14	3.02E+14	1.73E+13
	9	1.72E+13	1.54E+14	1.99E+14	3.18E+14	2.17E+14	3.19E+14	3.07E+14	2.80E+14	2.81E+14	1.63E+13
	10	1.63E+13	1.45E+14	1.86E+14	2.97E+14	2.02E+14	2.97E+14	2.86E+14	2.62E+14	2.65E+14	1.55E+13
	11	1.57E+13	1.38E+14	1.76E+14	2.79E+14	1.90E+14	2.79E+14	2.70E+14	2.47E+14	2.52E+14	1.48E+13
	15	1.37E+13	1.19E+14	1.49E+14	2.36E+14	1.59E+14	2.35E+14	2.27E+14	2.10E+14	2.17E+14	1.30E+13
	20	1.20E+13	1.03E+14	1.29E+14	2.03E+14	1.37E+14	2.02E+14	1.95E+14	1.81E+14	1.88E+14	1.13E+13

		Raw	Data								
		6	18	30	48	60	78	96	114	139.24	145.24
		Node 1	Node 2	Node 3	Node 4	Node 5	Node 6	Node 7	Node 8	Node 9	Node10
	Time, years	6	12	12	18	12	18	18	18	25.24	6
70 GWd/MTU	0.002739726	2.66E+15	1.67E+16	2.32E+16	3.84E+16	2.67E+16	4.10E+16	4.32E+16	4.53E+16	4.41E+16	3.17E+15
	5	2.93E+13	2.70E+14	3.62E+14	5.84E+14	4.03E+14	6.02E+14	5.88E+14	5.39E+14	5.16E+14	2.82E+13
	6	2.53E+13	2.32E+14	3.06E+14	4.92E+14	3.39E+14	5.05E+14	4.94E+14	4.54E+14	4.42E+14	2.43E+13
	7	2.28E+13	2.06E+14	2.68E+14	4.30E+14	2.95E+14	4.40E+14	4.30E+14	3.97E+14	3.93E+14	2.19E+13
	8	2.11E+13	1.88E+14	2.41E+14	3.86E+14	2.65E+14	3.94E+14	3.86E+14	3.56E+14	3.58E+14	2.02E+13
	9	1.98E+13	1.75E+14	2.22E+14	3.54E+14	2.42E+14	3.61E+14	3.53E+14	3.27E+14	3.32E+14	1.90E+13
	10	1.88E+13	1.64E+14	2.07E+14	3.30E+14	2.25E+14	3.35E+14	3.28E+14	3.04E+14	3.12E+14	1.80E+13
	11	1.80E+13	1.56E+14	1.95E+14	3.10E+14	2.12E+14	3.15E+14	3.09E+14	2.87E+14	2.96E+14	1.72E+13
	15	1.58E+13	1.34E+14	1.65E+14	2.61E+14	1.78E+14	2.65E+14	2.59E+14	2.42E+14	2.53E+14	1.50E+13
	20	1.38E+13	1.16E+14	1.43E+14	2.24E+14	1.52E+14	2.27E+14	2.22E+14	2.08E+14	2.18E+14	1.31E+13

		Raw	Data								
		6	18	30	48	60	78	96	114	139.24	145.24
		Node 1	Node 2	Node 3	Node 4	Node 5	Node 6	Node 7	Node 8	Node 9	Node10
	Time, years	6	12	12	18	12	18	18	18	25.24	6
75 GWd/MTU	0.002739726	3.02E+15	1.84E+16	2.54E+16	4.34E+16	3.03E+16	4.47E+16	4.14E+16	3.54E+16	2.99E+16	1.98E+15
	5	3.06E+13	2.79E+14	3.73E+14	6.08E+14	4.22E+14	6.30E+14	6.16E+14	5.65E+14	5.38E+14	2.90E+13
	6	2.66E+13	2.41E+14	3.17E+14	5.14E+14	3.56E+14	5.31E+14	5.19E+14	4.77E+14	4.64E+14	2.53E+13
	7	2.41E+13	2.15E+14	2.78E+14	4.50E+14	3.11E+14	4.63E+14	4.53E+14	4.18E+14	4.13E+14	2.29E+13
	8	2.23E+13	1.96E+14	2.51E+14	4.05E+14	2.79E+14	4.16E+14	4.06E+14	3.76E+14	3.77E+14	2.12E+13
	9	2.10E+13	1.82E+14	2.31E+14	3.71E+14	2.55E+14	3.80E+14	3.72E+14	3.45E+14	3.50E+14	1.99E+13
	10	1.99E+13	1.72E+14	2.16E+14	3.46E+14	2.38E+14	3.54E+14	3.46E+14	3.22E+14	3.29E+14	1.90E+13
	11	1.91E+13	1.63E+14	2.04E+14	3.26E+14	2.23E+14	3.33E+14	3.26E+14	3.03E+14	3.13E+14	1.82E+13
	15	1.67E+13	1.40E+14	1.73E+14	2.74E+14	1.87E+14	2.79E+14	2.73E+14	2.55E+14	2.67E+14	1.59E+13
	20	1.46E+13	1.21E+14	1.49E+14	2.36E+14	1.61E+14	2.40E+14	2.34E+14	2.20E+14	2.31E+14	1.39E+13

Values per inch

0

	Time, years	6	18	30	48	60	78	96	114	139.24	145.24	APF
0 GWd/MTU	0.002739726	5.56E+14	1.74E+15	2.11E+15	2.10E+15	2.11E+15	2.15E+15	2.16E+15	2.08E+15	1.56E+15	6.36E+14	1.25E+00
	5	8.23E+11	3.63E+12	4.88E+12	4.94E+12	4.75E+12	4.46E+12	4.18E+12	3.80E+12	2.69E+12	8.13E+11	1.41E+00
	6	6.80E+11	3.05E+12	4.08E+12	4.13E+12	3.97E+12	3.72E+12	3.49E+12	3.17E+12	2.26E+12	6.67E+11	1.41E+00
	7	6.04E+11	2.74E+12	3.65E+12	3.68E+12	3.54E+12	3.31E+12	3.11E+12	2.83E+12	2.02E+12	5.90E+11	1.41E+00
	8	5.60E+11	2.55E+12	3.38E+12	3.41E+12	3.27E+12	3.06E+12	2.87E+12	2.62E+12	1.88E+12	5.45E+11	1.41E+00
	9	5.31E+11	2.42E+12	3.20E+12	3.22E+12	3.09E+12	2.89E+12	2.71E+12	2.47E+12	1.78E+12	5.15E+11	1.41E+00
	10	5.09E+11	2.32E+12	3.06E+12	3.08E+12	2.95E+12	2.77E+12	2.59E+12	2.37E+12	1.71E+12	4.94E+11	1.41E+00
	11	4.92E+11	2.24E+12	2.95E+12	2.96E+12	2.84E+12	2.66E+12	2.50E+12	2.28E+12	1.64E+12	4.76E+11	1.41E+00
	15	4.39E+11	1.99E+12	2.62E+12	2.62E+12	2.51E+12	2.36E+12	2.21E+12	2.02E+12	1.46E+12	4.24E+11	1.41E+00
	20	3.87E+11	1.75E+12	2.30E+12	2.30E+12	2.20E+12	2.07E+12	1.94E+12	1.78E+12	1.28E+12	3.74E+11	1.40E+00

Values per inch

0

	Time, years	6	18	30	48	60	78	96	114	139.24	145.24
0 GWd/MTU	0.002739726	5.47E+14	1.58E+15	2.00E+15	2.08E+15	2.22E+15	2.35E+15	2.40E+15	2.27E+15	1.67E+15	5.66E+14
	5	1.52E+12	6.75E+12	1.16E+13	9.85E+12	9.94E+12	9.52E+12	8.88E+12	7.85E+12	5.49E+12	1.50E+12
lata for node 3	6	1.28E+12	5.78E+12	9.85E+12	8.30E+12	8.35E+12	7.99E+12	7.46E+12	6.62E+12	4.67E+12	1.25E+12
ıf this burn	7	1.14E+12	5.21E+12	8.80E+12	7.39E+12	7.41E+12	7.09E+12	6.62E+12	5.89E+12	4.19E+12	1.11E+12
s incorrect	8	1.06E+12	4.84E+12	8.10E+12	6.79E+12	6.80E+12	6.50E+12	6.08E+12	5.42E+12	3.89E+12	1.03E+12
see	9	9.99E+11	4.58E+12	7.60E+12	6.37E+12	6.37E+12	6.09E+12	5.70E+12	5.10E+12	3.67E+12	9.70E+11
ıighlighted	10	9.56E+11	4.38E+12	7.22E+12	6.05E+12	6.04E+12	5.78E+12	5.41E+12	4.85E+12	3.50E+12	9.27E+11
nformation);	11	9.21E+11	4.21E+12	6.91E+12	5.80E+12	5.78E+12	5.53E+12	5.18E+12	4.64E+12	3.36E+12	8.93E+11
t is not used	15	8.18E+11	3.72E+12	6.04E+12	5.06E+12	5.03E+12	4.83E+12	4.52E+12	4.07E+12	2.96E+12	7.91E+11
or the comparison	20	7.21E+11	3.26E+12	5.27E+12	4.42E+12	4.39E+12	4.22E+12	3.94E+12	3.56E+12	2.59E+12	6.97E+11

Values per inch

0

	Time, years	6	18	30	48	60	78	96	114	139.24	145.24	
30 GWd/MTU	0.002739726	4.40E+14	1.20E+15	1.58E+15	1.75E+15	1.85E+15	1.92E+15	2.03E+15	2.12E+15	1.53E+15	5.16E+14	1.42E+00
	5	2.28E+12	9.71E+12	1.29E+13	1.38E+13	1.43E+13	1.42E+13	1.39E+13	1.26E+13	8.80E+12	2.23E+12	1.36E+00
	6	1.93E+12	8.39E+12	1.10E+13	1.17E+13	1.21E+13	1.20E+13	1.17E+13	1.07E+13	7.52E+12	1.89E+12	1.36E+00
	7	1.73E+12	7.57E+12	9.84E+12	1.05E+13	1.07E+13	1.06E+13	1.04E+13	9.46E+12	6.74E+12	1.68E+12	1.36E+00
	8	1.60E+12	7.03E+12	9.08E+12	9.60E+12	9.83E+12	9.72E+12	9.45E+12	8.65E+12	6.22E+12	1.55E+12	1.35E+00
	9	1.51E+12	6.63E+12	8.50E+12	8.97E+12	9.16E+12	9.06E+12	8.80E+12	8.07E+12	5.84E+12	1.46E+12	1.35E+00
	10	1.44E+12	6.32E+12	8.08E+12	8.49E+12	8.65E+12	8.55E+12	8.30E+12	7.63E+12	5.55E+12	1.40E+12	1.34E+00
	11	1.38E+12	6.06E+12	7.71E+12	8.10E+12	8.25E+12	8.15E+12	7.91E+12	7.27E+12	5.32E+12	1.34E+12	1.34E+00
	15	1.22E+12	5.32E+12	6.72E+12	7.02E+12	7.12E+12	7.04E+12	6.82E+12	6.30E+12	4.64E+12	1.18E+12	1.33E+00
	20	1.08E+12	4.65E+12	5.86E+12	6.11E+12	6.19E+12	6.12E+12	5.93E+12	5.48E+12	4.05E+12	1.04E+12	1.33E+00

Values per inch

0

	Time, years	6	18	30	48	60	78	96	114	139.24	145.24	APF
40 GWd/MTU	0.002739726	5.37E+14	1.82E+15	2.64E+15	2.76E+15	2.65E+15	2.44E+15	2.20E+15	1.94E+15	1.29E+15	4.69E+14	1.47E+00
	5	3.00E+12	1.24E+13	1.68E+13	1.83E+13	1.91E+13	1.89E+13	1.84E+13	1.67E+13	1.12E+13	2.71E+12	1.39E+00
	6	2.57E+12	1.08E+13	1.44E+13	1.56E+13	1.62E+13	1.61E+13	1.56E+13	1.42E+13	9.71E+12	2.34E+12	1.38E+00
	7	2.31E+12	9.79E+12	1.28E+13	1.39E+13	1.44E+13	1.42E+13	1.38E+13	1.26E+13	8.75E+12	2.11E+12	1.37E+00
	8	2.14E+12	9.07E+12	1.18E+13	1.27E+13	1.31E+13	1.30E+13	1.26E+13	1.15E+13	8.09E+12	1.96E+12	1.36E+00
	9	2.01E+12	8.53E+12	1.10E+13	1.18E+13	1.21E+13	1.20E+13	1.17E+13	1.07E+13	7.60E+12	1.85E+12	1.36E+00
	10	1.92E+12	8.12E+12	1.04E+13	1.11E+13	1.14E+13	1.13E+13	1.10E+13	1.01E+13	7.21E+12	1.77E+12	1.35E+00
	11	1.84E+12	7.77E+12	9.92E+12	1.06E+13	1.08E+13	1.07E+13	1.04E+13	9.61E+12	6.89E+12	1.70E+12	1.35E+00
	15	1.63E+12	6.79E+12	8.58E+12	9.09E+12	9.29E+12	9.20E+12	8.93E+12	8.27E+12	6.00E+12	1.50E+12	1.34E+00
	20	1.43E+12	5.92E+12	7.46E+12	7.88E+12	8.03E+12	7.97E+12	7.73E+12	7.17E+12	5.22E+12	1.31E+12	1.34E+00

Values per inch

0

	Time, years	6	18	30	48	60	78	96	114	139.24	145.24	
50 GWd/MTU	0.002739726	5.73E+14	2.03E+15	2.61E+15	2.60E+15	2.60E+15	2.63E+15	2.61E+15	2.47E+15	1.75E+15	6.38E+14	1.28E+00
	5	3.69E+12	1.65E+13	2.26E+13	2.41E+13	2.46E+13	2.41E+13	2.32E+13	2.10E+13	1.41E+13	3.48E+12	1.39E+00
	6	3.16E+12	1.42E+13	1.91E+13	2.04E+13	2.07E+13	2.03E+13	1.96E+13	1.78E+13	1.22E+13	2.98E+12	1.38E+00
	7	2.84E+12	1.27E+13	1.69E+13	1.79E+13	1.82E+13	1.78E+13	1.72E+13	1.57E+13	1.09E+13	2.68E+12	1.37E+00
	8	2.62E+12	1.17E+13	1.53E+13	1.62E+13	1.64E+13	1.61E+13	1.56E+13	1.43E+13	1.00E+13	2.47E+12	1.36E+00
	9	2.47E+12	1.09E+13	1.41E+13	1.49E+13	1.51E+13	1.48E+13	1.44E+13	1.32E+13	9.38E+12	2.32E+12	1.35E+00
	10	2.35E+12	1.03E+13	1.33E+13	1.40E+13	1.41E+13	1.39E+13	1.34E+13	1.24E+13	8.87E+12	2.21E+12	1.35E+00
	11	2.25E+12	9.85E+12	1.26E+13	1.32E+13	1.34E+13	1.31E+13	1.27E+13	1.17E+13	8.46E+12	2.12E+12	1.35E+00
	15	1.98E+12	8.52E+12	1.07E+13	1.12E+13	1.13E+13	1.11E+13	1.08E+13	1.00E+13	7.31E+12	1.86E+12	1.33E+00
	20	1.74E+12	7.41E+12	9.29E+12	9.68E+12	9.76E+12	9.61E+12	9.30E+12	8.65E+12	6.34E+12	1.63E+12	1.33E+00

Values per inch

0

	Time, years	6	18	30	48	60	78	96	114	139.24	145.24	APF
60 GWd/MTU	0.002739726	5.67E+14	1.87E+15	2.44E+15	2.56E+15	2.71E+15	2.85E+15	2.89E+15	2.70E+15	1.90E+15	5.74E+14	1.37E+00
	5	4.24E+12	1.97E+13	2.71E+13	2.93E+13	3.01E+13	2.95E+13	2.81E+13	2.52E+13	1.70E+13	4.03E+12	1.40E+00
	6	3.66E+12	1.69E+13	2.28E+13	2.46E+13	2.52E+13	2.47E+13	2.37E+13	2.13E+13	1.46E+13	3.48E+12	1.39E+00
	7	3.29E+12	1.51E+13	2.00E+13	2.15E+13	2.20E+13	2.15E+13	2.07E+13	1.87E+13	1.31E+13	3.13E+12	1.38E+00
	8	3.04E+12	1.38E+13	1.80E+13	1.93E+13	1.97E+13	1.93E+13	1.86E+13	1.69E+13	1.20E+13	2.89E+12	1.37E+00
	9	2.86E+12	1.28E+13	1.66E+13	1.77E+13	1.81E+13	1.77E+13	1.70E+13	1.56E+13	1.11E+13	2.71E+12	1.37E+00
	10	2.72E+12	1.21E+13	1.55E+13	1.65E+13	1.68E+13	1.65E+13	1.59E+13	1.45E+13	1.05E+13	2.58E+12	1.36E+00
	11	2.61E+12	1.15E+13	1.46E+13	1.55E+13	1.58E+13	1.55E+13	1.50E+13	1.37E+13	9.99E+12	2.47E+12	1.35E+00
	15	2.29E+12	9.90E+12	1.24E+13	1.31E+13	1.33E+13	1.31E+13	1.26E+13	1.16E+13	8.58E+12	2.16E+12	1.34E+00
	20	2.00E+12	8.59E+12	1.07E+13	1.13E+13	1.14E+13	1.12E+13	1.08E+13	1.00E+13	7.43E+12	1.89E+12	1.34E+00

Values per inch

0

	Time, years	6	18	30	48	60	78	96	114	139.24	145.24	APF
70 GWd/MTU	**0.002739726**	4.43E+14	1.40E+15	1.93E+15	2.13E+15	2.22E+15	2.28E+15	2.40E+15	2.52E+15	1.75E+15	5.28E+14	1.43E+00
	5	4.88E+12	2.25E+13	3.01E+13	3.24E+13	3.36E+13	3.34E+13	3.27E+13	3.00E+13	2.04E+13	4.70E+12	1.37E+00
	6	4.22E+12	1.93E+13	2.55E+13	2.73E+13	2.82E+13	2.81E+13	2.74E+13	2.52E+13	1.75E+13	4.06E+12	1.36E+00
	7	3.80E+12	1.72E+13	2.23E+13	2.39E+13	2.46E+13	2.44E+13	2.39E+13	2.20E+13	1.56E+13	3.65E+12	1.36E+00
	8	3.51E+12	1.57E+13	2.01E+13	2.15E+13	2.21E+13	2.19E+13	2.14E+13	1.98E+13	1.42E+13	3.37E+12	1.35E+00
	9	3.30E+12	1.46E+13	1.85E+13	1.97E+13	2.02E+13	2.00E+13	1.96E+13	1.82E+13	1.32E+13	3.16E+12	1.34E+00
	10	3.14E+12	1.37E+13	1.73E+13	1.83E+13	1.88E+13	1.86E+13	1.82E+13	1.69E+13	1.24E+13	3.00E+12	1.34E+00
	11	3.01E+12	1.30E+13	1.63E+13	1.72E+13	1.77E+13	1.75E+13	1.71E+13	1.59E+13	1.17E+13	2.87E+12	1.33E+00
	15	2.63E+12	1.11E+13	1.38E+13	1.45E+13	1.48E+13	1.47E+13	1.44E+13	1.34E+13	1.00E+13	2.51E+12	1.32E+00
	20	2.30E+12	9.64E+12	1.19E+13	1.25E+13	1.27E+13	1.26E+13	1.23E+13	1.15E+13	8.65E+12	2.19E+12	1.32E+00

Values per inch

0

	Time, years	6	18	30	48	60	78	96	114	139.24	145.24	
75 GWd/MTU	**0.002739726**	5.03E+14	1.53E+15	2.12E+15	2.41E+15	2.53E+15	2.49E+15	2.30E+15	1.97E+15	1.19E+15	3.29E+14	1.46E+00
	5	5.10E+12	2.33E+13	3.11E+13	3.38E+13	3.51E+13	3.50E+13	3.42E+13	3.14E+13	2.13E+13	4.84E+12	1.38E+00
	6	4.44E+12	2.01E+13	2.64E+13	2.85E+13	2.96E+13	2.95E+13	2.88E+13	2.65E+13	1.84E+13	4.22E+12	1.37E+00
	7	4.01E+12	1.79E+13	2.32E+13	2.50E+13	2.59E+13	2.57E+13	2.52E+13	2.32E+13	1.64E+13	3.82E+12	1.36E+00
	8	3.72E+12	1.64E+13	2.09E+13	2.25E+13	2.32E+13	2.31E+13	2.26E+13	2.09E+13	1.49E+13	3.53E+12	1.35E+00
	9	3.50E+12	1.52E+13	1.93E+13	2.06E+13	2.13E+13	2.11E+13	2.07E+13	1.92E+13	1.39E+13	3.32E+12	1.35E+00
	10	3.32E+12	1.43E+13	1.80E+13	1.92E+13	1.98E+13	1.97E+13	1.92E+13	1.79E+13	1.31E+13	3.16E+12	1.34E+00
	11	3.18E+12	1.36E+13	1.70E+13	1.81E+13	1.86E+13	1.85E+13	1.81E+13	1.68E+13	1.24E+13	3.03E+12	1.34E+00
	15	2.78E+12	1.16E+13	1.44E+13	1.52E+13	1.56E+13	1.55E+13	1.52E+13	1.42E+13	1.06E+13	2.64E+12	1.33E+00
	20	2.44E+12	1.01E+13	1.24E+13	1.31E+13	1.34E+13	1.33E+13	1.30E+13	1.22E+13	9.13E+12	2.31E+12	1.32E+00

Gamma totals from 1 node case	Source * APF 1.4	Source*APF/145.24, Source per unit height	1 node source per unit height- max ten node source per unit height	difference/source per unit height for 1 node		Time, years
1.70E+17	2.37E+17	1.63E+15	-5.21E+14	-32%	10 GWd/MTU	0.002739726
5.14E+14	7.20E+14	4.96E+12	2.29E+10	0%		5
4.39E+14	6.14E+14	4.23E+12	1.01E+11	2%		6
3.96E+14	5.55E+14	3.82E+12	1.38E+11	4%		7
3.70E+14	5.17E+14	3.56E+12	1.56E+11	4%		8
3.51E+14	4.91E+14	3.38E+12	1.64E+11	5%		9
3.37E+14	4.71E+14	3.25E+12	1.68E+11	5%		10
3.25E+14	4.55E+14	3.13E+12	1.68E+11	5%		11
2.88E+14	4.04E+14	2.78E+12	1.60E+11	6%		15
2.54E+14	3.55E+14	2.44E+12	1.44E+11	6%		20

Gamma totals from 1 node case	Source * APF 1.4	Source*APF/145.24, Source per unit height	1 node source per unit height- max ten node source per unit height	difference/source per unit height for 1 node		Time, years
1.75E+17	2.45E+17	1.69E+15	-7.12E+14	-42%	20 GWd/MTU	0.002739726
1.01E+15	1.41E+15	9.71E+12	-2.26E+11	-2%		5
8.73E+14	1.22E+15	8.41E+12	6.03E+10	1%		6
7.91E+14	1.11E+15	7.63E+12	2.13E+11	3%		7
7.37E+14	1.03E+15	7.10E+12	2.98E+11	4%		8
6.97E+14	9.75E+14	6.72E+12	3.43E+11	5%		9
6.66E+14	9.32E+14	6.42E+12	3.63E+11	6%		10
6.40E+14	8.96E+14	6.17E+12	3.73E+11	6%		11
5.64E+14	7.89E+14	5.43E+12	3.70E+11	7%		15
4.94E+14	6.92E+14	4.76E+12	3.39E+11	7%		20

data for node 3 of this burn is incorrect (see highlighted information); it is not used for the comparison

Gamma totals from 1 node case	Source * APF 1.4	Source*APF/145.24, Source per unit height	1 node source per unit height- max ten node source per unit height	difference/source per unit height for 1 node		Time, years
1.82E+17	2.55E+17	1.75E+15	-3.69E+14	-21%	30 GWd/MTU	0.002739726
1.50E+15	2.10E+15	1.45E+13	1.86E+11	1%		5
1.31E+15	1.83E+15	1.26E+13	4.94E+11	4%		6
1.18E+15	1.66E+15	1.14E+13	6.62E+11	6%		7
1.10E+15	1.54E+15	1.06E+13	7.56E+11	7%		8
1.03E+15	1.45E+15	9.97E+12	8.08E+11	8%		9
9.85E+14	1.38E+15	9.49E+12	8.37E+11	9%		10
9.44E+14	1.32E+15	9.09E+12	8.50E+11	9%		11
8.25E+14	1.16E+15	7.95E+12	8.32E+11	10%		15
7.21E+14	1.01E+15	6.95E+12	7.61E+11	11%		20

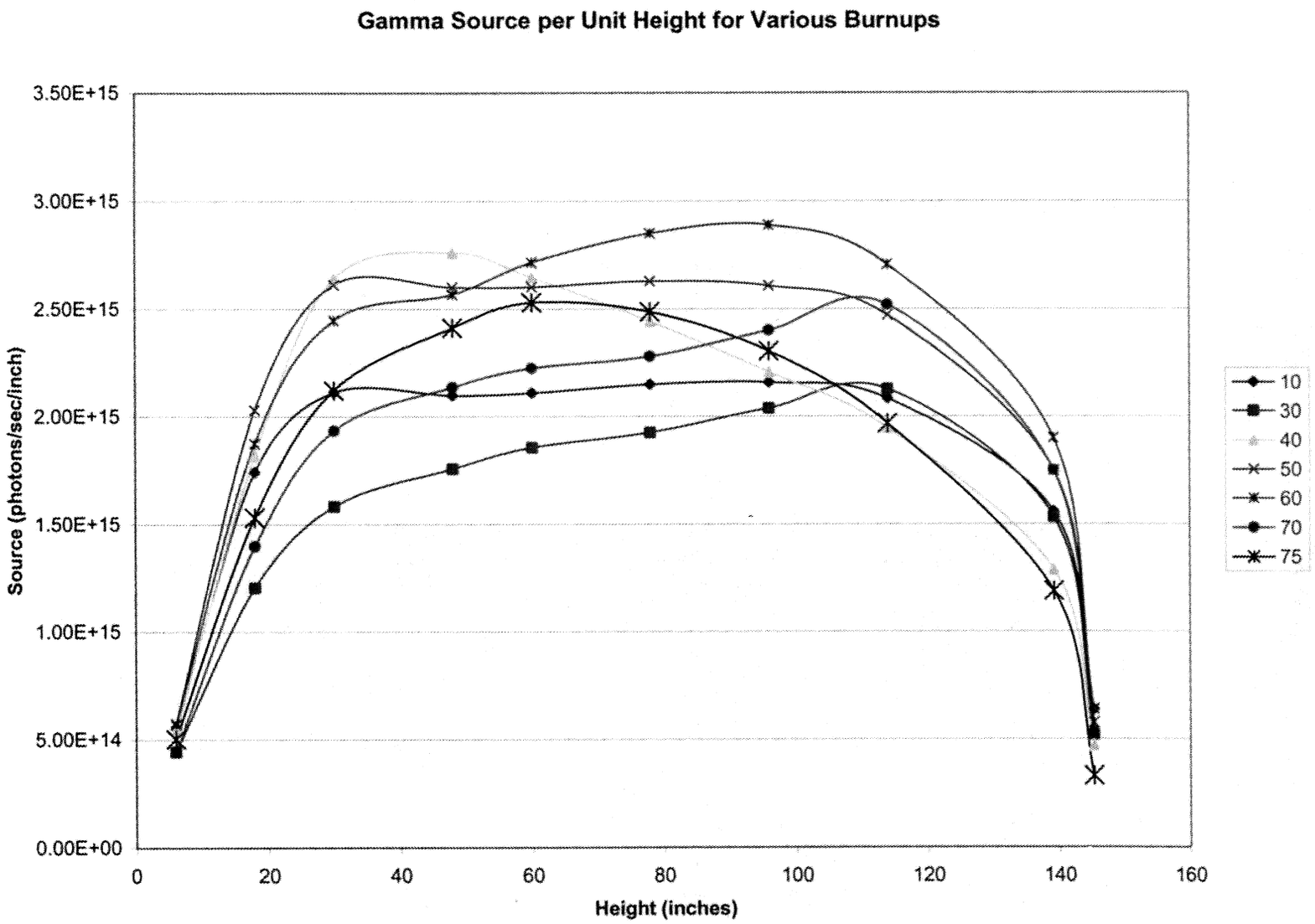
Gamma totals from 1 node case	Source * APF 1.4	Source*APF/145.24, Source per unit height	1 node source per unit height- max ten node source per unit height	difference/source per unit height for 1 node		Time, years
1.90E+17	2.66E+17	1.83E+15	-9.32E+14	-51%	40 GWd/MTU	0.002739726
1.99E+15	2.79E+15	1.92E+13	1.14E+11	1%		5
1.74E+15	2.43E+15	1.67E+13	5.11E+11	3%		6
1.57E+15	2.19E+15	1.51E+13	7.44E+11	5%		7
1.45E+15	2.03E+15	1.40E+13	8.84E+11	6%		8
1.36E+15	1.90E+15	1.31E+13	9.69E+11	7%		9
1.29E+15	1.81E+15	1.24E+13	1.02E+12	8%		10
1.23E+15	1.73E+15	1.19E+13	1.04E+12	9%		11
1.07E+15	1.50E+15	1.03E+13	1.04E+12	10%		15
9.33E+14	1.31E+15	8.99E+12	9.58E+11	11%		20

Gamma totals from 1 node case	Source * APF 1.4	Source*APF/145.24, Source per unit height	1 node source per unit height- max ten node source per unit height	difference/source per unit height for 1 node		Time, years
1.98E+17	2.78E+17	1.91E+15	-7.15E+14	-37%	50 GWd/MTU	0.002739726
2.48E+15	3.47E+15	2.39E+13	-7.02E+11	-3%		5
2.16E+15	3.02E+15	2.08E+13	5.60E+10	0%		6
1.94E+15	2.72E+15	1.87E+13	5.13E+11	3%		7
1.79E+15	2.50E+15	1.72E+13	7.96E+11	5%		8
1.67E+15	2.34E+15	1.61E+13	9.72E+11	6%		9
1.58E+15	2.21E+15	1.52E+13	1.08E+12	7%		10
1.51E+15	2.11E+15	1.45E+13	1.15E+12	8%		11
1.30E+15	1.82E+15	1.25E+13	1.21E+12	10%		15
1.13E+15	1.58E+15	1.09E+13	1.13E+12	10%		20

Gamma totals from 1 node case	Source * APF 1.4	Source*APF/145.24, Source per unit height	1 node source per unit height- max ten node source per unit height	difference/source per unit height for 1 node		Time, years
2.06E+17	2.89E+17	1.99E+15	-8.99E+14	-45%	60 GWd/MTU	0.002739726
2.95E+15	4.13E+15	2.84E+13	-1.68E+12	-6%		5
2.56E+15	3.58E+15	2.47E+13	-5.44E+11	-2%		6
2.30E+15	3.21E+15	2.21E+13	1.51E+11	1%		7
2.11E+15	2.95E+15	2.03E+13	5.88E+11	3%		8
1.96E+15	2.75E+15	1.89E+13	8.67E+11	5%		9
1.85E+15	2.59E+15	1.78E+13	1.05E+12	6%		10
1.76E+15	2.47E+15	1.70E+13	1.16E+12	7%		11
1.51E+15	2.12E+15	1.46E+13	1.30E+12	9%		15
1.31E+15	1.84E+15	1.26E+13	1.23E+12	10%		20

Gamma totals from 1 node case	Source * APF 1.4	Source*APF/145.24, Source per unit height	1 node source per unit height- max ten node source per unit height	difference/source per unit height for 1 node		Time, years
2.17E+17	3.04E+17	2.09E+15	-4.25E+14	-20%	70 GWd/MTU	0.002739726
3.40E+15	4.76E+15	3.28E+13	-7.90E+11	-2%		5
2.94E+15	4.12E+15	2.84E+13	1.57E+11	1%		6
2.63E+15	3.68E+15	2.54E+13	7.41E+11	3%		7
2.40E+15	3.37E+15	2.32E+13	1.11E+12	5%		8
2.23E+15	3.13E+15	2.15E+13	1.34E+12	6%		9
2.10E+15	2.94E+15	2.03E+13	1.49E+12	7%		10
2.00E+15	2.79E+15	1.92E+13	1.57E+12	8%		11
1.71E+15	2.39E+15	1.65E+13	1.65E+12	10%		15
1.48E+15	2.07E+15	1.42E+13	1.53E+12	11%		20

Gamma totals from 1 node case	Source * APF 1.4	Source*APF/145.24, Source per unit height	1 node source per unit height- max ten node source per unit height	difference/source per unit height for 1 node		Time, years
2.21E+17	3.09E+17	2.13E+15	-4.02E+14	-19%	75 GWd/MTU	0.002739726
3.62E+15	5.06E+15	3.49E+13	-2.92E+11	-1%		5
3.13E+15	4.38E+15	3.01E+13	4.96E+11	2%		6
2.79E+15	3.90E+15	2.69E+13	9.86E+11	4%		7
2.55E+15	3.56E+15	2.45E+13	1.30E+12	5%		8
2.36E+15	3.31E+15	2.28E+13	1.49E+12	7%		9
2.22E+15	3.11E+15	2.14E+13	1.61E+12	8%		10
2.11E+15	2.95E+15	2.03E+13	1.68E+12	8%		11
1.80E+15	2.52E+15	1.73E+13	1.72E+12	10%		15
1.55E+15	2.18E+15	1.50E+13	1.59E+12	11%		20


Gamma Source per Unit Height for Various Burnups
3.50E+15
3.00E+15
2.50E+15
2.00E+15
1.50E+15
1.00E+15
5.00E+14
0.00E+00
Source (photons/sec/inch)
0
20
40
60
80
100
120
140
160
Height (inches)
10
30
40
50
60
70
75

		RAW Node 1	DATA Node 2	Node 3	Node 4	Node 5	Node 6	Node 7	Node 8	Node 9	Node10	
	Time, years	6	18	30	48	60	78	96	114	139.24	145.24	
10 GWd/MTU	0.002739726	8.22E+03	4.79E+04	1.18E+05	2.02E+05	1.29E+05	1.72E+05	1.46E+05	1.16E+05	6.12E+04	9.45E+03	1.01E+06
	5	3.36E+03	1.33E+04	2.65E+04	4.51E+04	2.93E+04	4.03E+04	3.55E+04	2.97E+04	2.08E+04	3.57E+03	2.47E+05
	6	3.39E+03	1.34E+04	2.65E+04	4.50E+04	2.92E+04	4.02E+04	3.56E+04	2.98E+04	2.10E+04	3.60E+03	2.48E+05
	7	3.41E+03	1.35E+04	2.65E+04	4.49E+04	2.92E+04	4.02E+04	3.56E+04	2.99E+04	2.12E+04	3.63E+03	2.48E+05
	8	3.44E+03	1.36E+04	2.65E+04	4.48E+04	2.91E+04	4.02E+04	3.56E+04	3.00E+04	2.13E+04	3.66E+03	2.48E+05
	9	3.46E+03	1.37E+04	2.64E+04	4.47E+04	2.91E+04	4.01E+04	3.57E+04	3.01E+04	2.15E+04	3.69E+03	2.48E+05
	10	3.49E+03	1.37E+04	2.64E+04	4.46E+04	2.90E+04	4.01E+04	3.57E+04	3.02E+04	2.17E+04	3.71E+03	2.49E+05
	11	3.51E+03	1.38E+04	2.64E+04	4.46E+04	2.90E+04	4.01E+04	3.57E+04	3.02E+04	2.18E+04	3.74E+03	2.49E+05
	15	3.58E+03	1.41E+04	2.63E+04	4.42E+04	2.88E+04	3.99E+04	3.57E+04	3.04E+04	2.23E+04	3.83E+03	2.49E+05
	20	3.66E+03	1.43E+04	2.62E+04	4.36E+04	2.84E+04	3.96E+04	3.56E+04	3.05E+04	2.28E+04	3.91E+03	2.49E+05

		RAW Node 1	DATA Node 2	Node 3	Node 4	Node 5	Node 6	Node 7	Node 8	Node 9	Node10	
	Time, years	6	18	30	48	60	78	96	114	139.24	145.24	
20 GWd/MTU	0.002739726	7.29E+04	5.01E+05	2.84E+06	2.33E+06	1.65E+06	2.36E+06	2.03E+06	1.58E+06	8.24E+05	8.33E+04	1.42E+07
NOTE: node 3 info is incorrect; it is not used in the final comparison to determine % difference from one node	5	1.03E+04	8.09E+04	7.75E+05	5.82E+05	4.35E+05	6.14E+05	4.96E+05	3.41E+05	1.38E+05	1.22E+04	3.48E+06
	6	1.03E+04	7.95E+04	7.49E+05	5.64E+05	4.22E+05	5.95E+05	4.82E+05	3.32E+05	1.36E+05	1.22E+04	3.38E+06
	7	1.03E+04	7.82E+04	7.25E+05	5.48E+05	4.09E+05	5.77E+05	4.68E+05	3.24E+05	1.34E+05	1.22E+04	3.29E+06
	8	1.04E+04	7.70E+04	7.01E+05	5.32E+05	3.97E+05	5.60E+05	4.55E+05	3.15E+05	1.33E+05	1.22E+04	3.19E+06
	9	1.04E+04	7.58E+04	6.79E+05	5.17E+05	3.85E+05	5.44E+05	4.42E+05	3.07E+05	1.31E+05	1.21E+04	3.10E+06
	10	1.04E+04	7.47E+04	6.57E+05	5.02E+05	3.74E+05	5.28E+05	4.30E+05	3.00E+05	1.29E+05	1.21E+04	3.02E+06
	11	1.04E+04	7.36E+04	6.36E+05	4.88E+05	3.63E+05	5.13E+05	4.18E+05	2.92E+05	1.27E+05	1.21E+04	2.93E+06
	15	1.05E+04	6.96E+04	5.61E+05	4.36E+05	3.24E+05	4.58E+05	3.75E+05	2.65E+05	1.21E+05	1.20E+04	2.63E+06
	20	1.05E+04	6.52E+04	4.60E+05	3.81E+05	2.82E+05	4.00E+05	3.30E+05	2.36E+05	1.15E+05	1.19E+04	2.31E+06

		RAW Node 1	DATA Node 2	Node 3	Node 4	Node 5	Node 6	Node 7	Node 8	Node 9	Node10	
	Time, years	6	18	30	48	60	78	96	114	139.24	145.24	
30 GWd/MTU	0.002739726	2.71E+05	1.84E+06	4.18E+06	8.00E+06	6.02E+06	9.32E+06	8.81E+06	7.13E+06	3.75E+06	2.97E+05	4.96E+07
	5	3.28E+04	3.97E+05	1.33E+06	2.87E+06	2.30E+06	3.65E+06	3.38E+06	2.52E+06	8.97E+05	4.37E+04	1.74E+07
	6	3.22E+04	3.85E+05	1.29E+06	2.77E+06	2.22E+06	3.52E+06	3.26E+06	2.43E+06	8.69E+05	4.27E+04	1.68E+07
	7	3.17E+04	3.74E+05	1.24E+06	2.67E+06	2.14E+06	3.39E+06	3.15E+06	2.34E+06	8.44E+05	4.19E+04	1.62E+07
	8	3.13E+04	3.63E+05	1.20E+06	2.58E+06	2.07E+06	3.27E+06	3.04E+06	2.26E+06	8.19E+05	4.11E+04	1.57E+07
	9	3.09E+04	3.52E+05	1.16E+06	2.49E+06	2.00E+06	3.16E+06	2.93E+06	2.19E+06	7.95E+05	4.04E+04	1.51E+07
	10	3.05E+04	3.42E+05	1.12E+06	2.41E+06	1.93E+06	3.05E+06	2.83E+06	2.11E+06	7.72E+05	3.96E+04	1.46E+07
	11	3.01E+04	3.32E+05	1.08E+06	2.32E+06	1.86E+06	2.94E+06	2.73E+06	2.04E+06	7.49E+05	3.89E+04	1.41E+07
	15	2.86E+04	2.97E+05	9.47E+05	2.02E+06	1.62E+06	2.56E+06	2.38E+06	1.78E+06	6.68E+05	3.63E+04	1.23E+07
	20	2.70E+04	2.59E+05	8.03E+05	1.71E+06	1.36E+06	2.15E+06	2.00E+06	1.51E+06	5.82E+05	3.35E+04	1.04E+07

		Node 1	Node 2	Node 3	Node 4	Node 5	Node 6	Node 7	Node 8	Node 9	Node10	
	Time, years	6	18	30	48	60	78	96	114	139.24	145.24	
40 GWd/MTU	0.002739726	7.07E+05	5.06E+06	1.19E+07	2.34E+07	1.77E+07	2.71E+07	2.50E+07	1.97E+07	9.31E+06	5.98E+05	1.40E+08
	5	1.02E+05	1.40E+06	4.84E+06	1.07E+07	8.60E+06	1.35E+07	1.24E+07	9.26E+06	3.05E+06	1.13E+05	6.39E+07
	6	9.88E+04	1.35E+06	4.66E+06	1.03E+07	8.29E+06	1.30E+07	1.19E+07	8.93E+06	2.95E+06	1.10E+05	6.16E+07
	7	9.61E+04	1.30E+06	4.50E+06	9.94E+06	7.98E+06	1.25E+07	1.15E+07	8.60E+06	2.85E+06	1.07E+05	5.93E+07
	8	9.36E+04	1.26E+06	4.33E+06	9.58E+06	7.69E+06	1.20E+07	1.11E+07	8.29E+06	2.75E+06	1.04E+05	5.72E+07
	9	9.12E+04	1.21E+06	4.18E+06	9.23E+06	7.41E+06	1.16E+07	1.07E+07	7.99E+06	2.66E+06	1.01E+05	5.51E+07
	10	8.89E+04	1.17E+06	4.03E+06	8.90E+06	7.14E+06	1.12E+07	1.03E+07	7.71E+06	2.57E+06	9.83E+04	5.32E+07
	11	8.67E+04	1.13E+06	3.89E+06	8.58E+06	6.88E+06	1.08E+07	9.91E+06	7.43E+06	2.48E+06	9.57E+04	5.12E+07
	15	7.86E+04	9.90E+05	3.36E+06	7.41E+06	5.94E+06	9.29E+06	8.56E+06	6.42E+06	2.17E+06	8.62E+04	4.43E+07
	20	6.99E+04	8.39E+05	2.81E+06	6.18E+06	4.95E+06	7.74E+06	7.13E+06	5.36E+06	1.84E+06	7.62E+04	3.70E+07
		RAW	DATA									
		Node 1	Node 2	Node 3	Node 4	Node 5	Node 6	Node 7	Node 8	Node 9	Node10	
	Time, years	6	18	30	48	60	78	96	114	139.24	145.24	
50 GWd/MTU	0.002739726	1.25E+06	1.19E+07	2.86E+07	5.38E+07	3.91E+07	5.84E+07	5.35E+07	4.27E+07	2.13E+07	1.36E+06	3.12E+08
	5	2.42E+05	4.55E+06	1.57E+07	3.15E+07	2.32E+07	3.44E+07	3.06E+07	2.29E+07	7.88E+06	2.79E+05	1.71E+08
	6	2.34E+05	4.39E+06	1.51E+07	3.03E+07	2.23E+07	3.31E+07	2.95E+07	2.21E+07	7.60E+06	2.70E+05	1.65E+08
	7	2.26E+05	4.23E+06	1.46E+07	2.92E+07	2.15E+07	3.18E+07	2.83E+07	2.13E+07	7.33E+06	2.61E+05	1.59E+08
	8	2.19E+05	4.08E+06	1.40E+07	2.81E+07	2.07E+07	3.06E+07	2.73E+07	2.05E+07	7.07E+06	2.53E+05	1.53E+08
	9	2.13E+05	3.93E+06	1.35E+07	2.70E+07	1.99E+07	2.95E+07	2.63E+07	1.97E+07	6.82E+06	2.45E+05	1.47E+08
	10	2.06E+05	3.79E+06	1.30E+07	2.60E+07	1.92E+07	2.84E+07	2.53E+07	1.90E+07	6.58E+06	2.37E+05	1.42E+08
	11	2.00E+05	3.66E+06	1.25E+07	2.51E+07	1.85E+07	2.73E+07	2.44E+07	1.83E+07	6.34E+06	2.30E+05	1.36E+08
	15	1.77E+05	3.16E+06	1.08E+07	2.16E+07	1.59E+07	2.35E+07	2.10E+07	1.58E+07	5.50E+06	2.03E+05	1.18E+08
	20	1.53E+05	2.64E+06	8.99E+06	1.79E+07	1.32E+07	1.95E+07	1.74E+07	1.31E+07	4.61E+06	1.74E+05	9.78E+07
		RAW	DATA									
		Node 1	Node 2	Node 3	Node 4	Node 5	Node 6	Node 7	Node 8	Node 9	Node10	
	Time, years	6	18	30	48	60	78	96	114	139.24	145.24	
60 GWd/MTU	0.002739726	1.83E+06	2.04E+07	5.37E+07	1.07E+08	7.93E+07	1.17E+08	1.03E+08	7.79E+07	3.74E+07	1.91E+06	5.99E+08
	5	4.66E+05	1.04E+07	3.50E+07	7.03E+07	5.16E+07	7.53E+07	6.50E+07	4.73E+07	1.71E+07	5.33E+05	3.73E+08
	6	4.50E+05	1.00E+07	3.36E+07	6.73E+07	4.94E+07	7.20E+07	6.22E+07	4.54E+07	1.65E+07	5.14E+05	3.57E+08
	7	4.35E+05	9.63E+06	3.23E+07	6.46E+07	4.73E+07	6.89E+07	5.97E+07	4.36E+07	1.59E+07	4.97E+05	3.43E+08
	8	4.20E+05	9.28E+06	3.11E+07	6.20E+07	4.54E+07	6.61E+07	5.73E+07	4.19E+07	1.53E+07	4.80E+05	3.29E+08
	9	4.06E+05	8.94E+06	2.99E+07	5.96E+07	4.36E+07	6.34E+07	5.50E+07	4.03E+07	1.47E+07	4.64E+05	3.16E+08
	10	3.93E+05	8.61E+06	2.88E+07	5.73E+07	4.18E+07	6.09E+07	5.29E+07	3.88E+07	1.42E+07	4.48E+05	3.04E+08
	11	3.80E+05	8.30E+06	2.77E+07	5.51E+07	4.02E+07	5.86E+07	5.08E+07	3.73E+07	1.37E+07	4.33E+05	2.92E+08
	15	3.32E+05	7.16E+06	2.38E+07	4.73E+07	3.45E+07	5.02E+07	4.36E+07	3.21E+07	1.18E+07	3.78E+05	2.51E+08
	20	2.82E+05	5.96E+06	1.98E+07	3.92E+07	2.86E+07	4.16E+07	3.62E+07	2.66E+07	9.86E+06	3.21E+05	2.08E+08
		RAW	DATA									

		Node 1	Node 2	Node 3	Node 4	Node 5	Node 6	Node 7	Node 8	Node 9	Node10	
	Time, years	6	18	30	48	60	78	96	114	139.24	145.24	
70 GWd/MTU	0.002739726	2.67E+06	3.36E+07	9.32E+07	1.89E+08	1.46E+08	2.24E+08	2.01E+08	1.48E+08	6.46E+07	2.85E+06	1.11E+09
	5	8.74E+05	2.05E+07	6.36E+07	1.25E+08	9.30E+07	1.40E+08	1.26E+08	9.37E+07	3.56E+07	9.92E+05	6.98E+08
	6	8.43E+05	1.97E+07	6.08E+07	1.18E+08	8.79E+07	1.32E+08	1.19E+08	8.91E+07	3.42E+07	9.56E+05	6.62E+08
	7	8.13E+05	1.90E+07	5.82E+07	1.13E+08	8.33E+07	1.25E+08	1.13E+08	8.50E+07	3.29E+07	9.22E+05	6.30E+08
	8	7.85E+05	1.83E+07	5.57E+07	1.08E+08	7.93E+07	1.19E+08	1.07E+08	8.13E+07	3.17E+07	8.90E+05	6.01E+08
	9	7.57E+05	1.76E+07	5.35E+07	1.03E+08	7.56E+07	1.13E+08	1.02E+08	7.78E+07	3.05E+07	8.59E+05	5.75E+08
	10	7.31E+05	1.69E+07	5.13E+07	9.85E+07	7.22E+07	1.08E+08	9.76E+07	7.46E+07	2.94E+07	8.29E+05	5.50E+08
	11	7.06E+05	1.63E+07	4.93E+07	9.45E+07	6.91E+07	1.03E+08	9.34E+07	7.15E+07	2.83E+07	8.00E+05	5.27E+08
	15	6.13E+05	1.41E+07	4.22E+07	8.05E+07	5.87E+07	8.76E+07	7.93E+07	6.11E+07	2.44E+07	6.94E+05	4.49E+08
	20	5.16E+05	1.17E+07	3.50E+07	6.66E+07	4.85E+07	7.23E+07	6.55E+07	5.06E+07	2.03E+07	5.83E+05	3.72E+08

RAW DATA

		Node 1	Node 2	Node 3	Node 4	Node 5	Node 6	Node 7	Node 8	Node 9	Node10	
	Time, years	6	18	30	48	60	78	96	114	139.24	145.24	
75 GWd/MTU	0.002739726	3.07E+06	4.17E+07	1.23E+08	2.64E+08	2.11E+08	3.26E+08	2.89E+08	2.04E+08	7.77E+07	3.01E+06	1.54E+09
	5	1.15E+06	2.70E+07	8.29E+07	1.66E+08	1.26E+08	1.91E+08	1.71E+08	1.26E+08	4.70E+07	1.25E+06	9.39E+08
	6	1.11E+06	2.60E+07	7.88E+07	1.56E+08	1.18E+08	1.78E+08	1.60E+08	1.19E+08	4.52E+07	1.21E+06	8.83E+08
	7	1.07E+06	2.50E+07	7.51E+07	1.48E+08	1.11E+08	1.67E+08	1.50E+08	1.13E+08	4.35E+07	1.17E+06	8.34E+08
	8	1.03E+06	2.41E+07	7.18E+07	1.40E+08	1.05E+08	1.57E+08	1.42E+08	1.08E+08	4.19E+07	1.12E+06	7.91E+08
	9	9.92E+05	2.32E+07	6.87E+07	1.34E+08	9.91E+07	1.49E+08	1.34E+08	1.03E+08	4.03E+07	1.08E+06	7.52E+08
	10	9.57E+05	2.23E+07	6.58E+07	1.27E+08	9.43E+07	1.41E+08	1.28E+08	9.79E+07	3.88E+07	1.05E+06	7.17E+08
	11	9.24E+05	2.15E+07	6.31E+07	1.22E+08	8.98E+07	1.35E+08	1.22E+08	9.37E+07	3.74E+07	1.01E+06	6.85E+08
	15	8.01E+05	1.85E+07	5.39E+07	1.03E+08	7.55E+07	1.13E+08	1.02E+08	7.95E+07	3.22E+07	8.74E+05	5.79E+08
	20	6.72E+05	1.54E+07	4.46E+07	8.51E+07	6.22E+07	9.27E+07	8.42E+07	6.57E+07	2.67E+07	7.33E+05	4.78E+08

		6	18	30	48	60	78	96	114	139.24	145.24	
		data per inch										
	Time, years	6	12	12	18	12	18	18	18	25.24	6	APF
10 GWd/MTU	0.002739726	1.37E+03	3.99E+03	9.87E+03	1.12E+04	1.07E+04	9.56E+03	8.12E+03	6.47E+03	2.42E+03	1.57E+03	1.72E+00
	5	5.60E+02	1.11E+03	2.21E+03	2.51E+03	2.44E+03	2.24E+03	1.97E+03	1.65E+03	8.24E+02	5.95E+02	1.56E+00
	6	5.65E+02	1.11E+03	2.20E+03	2.50E+03	2.44E+03	2.23E+03	1.98E+03	1.66E+03	8.31E+02	6.00E+02	1.55E+00
	7	5.69E+02	1.12E+03	2.20E+03	2.49E+03	2.43E+03	2.23E+03	1.98E+03	1.66E+03	8.38E+02	6.05E+02	1.55E+00
	8	5.73E+02	1.13E+03	2.20E+03	2.49E+03	2.43E+03	2.23E+03	1.98E+03	1.67E+03	8.45E+02	6.10E+02	1.54E+00
	9	5.77E+02	1.14E+03	2.20E+03	2.49E+03	2.42E+03	2.23E+03	1.98E+03	1.67E+03	8.52E+02	6.15E+02	1.54E+00
	10	5.81E+02	1.15E+03	2.20E+03	2.48E+03	2.42E+03	2.23E+03	1.98E+03	1.68E+03	8.59E+02	6.19E+02	1.53E+00
	11	5.85E+02	1.15E+03	2.20E+03	2.48E+03	2.42E+03	2.23E+03	1.98E+03	1.68E+03	8.65E+02	6.23E+02	1.53E+00
	15	5.97E+02	1.17E+03	2.20E+03	2.45E+03	2.40E+03	2.22E+03	1.98E+03	1.69E+03	8.85E+02	6.38E+02	1.51E+00
	20	6.09E+02	1.20E+03	2.18E+03	2.42E+03	2.37E+03	2.20E+03	1.98E+03	1.70E+03	9.03E+02	6.52E+02	1.50E+00
		6	18	30	48	60	78	96	114	139.24	145.24	
		data per inch										
	Time, years	6	12	12	18	12	18	18	18	25.24	6	
20 GWd/MTU	0.002739726	1.22E+04	4.17E+04	2.37E+05	1.29E+05	1.38E+05	1.31E+05	1.13E+05	8.66E+04	3.26E+04	1.39E+04	1.78E+00
	5	1.72E+03	6.74E+03	6.46E+04	3.23E+04	3.63E+04	3.41E+04	2.76E+04	1.90E+04	5.48E+03	2.04E+03	1.98E+00
	6	1.72E+03	6.62E+03	6.24E+04	3.14E+04	3.52E+04	3.31E+04	2.68E+04	1.85E+04	5.39E+03	2.03E+03	1.97E+00
	7	1.72E+03	6.52E+03	6.04E+04	3.04E+04	3.41E+04	3.21E+04	2.60E+04	1.80E+04	5.32E+03	2.03E+03	1.97E+00
	8	1.73E+03	6.42E+03	5.84E+04	2.95E+04	3.31E+04	3.11E+04	2.53E+04	1.75E+04	5.25E+03	2.03E+03	1.96E+00
	9	1.73E+03	6.32E+03	5.66E+04	2.87E+04	3.21E+04	3.02E+04	2.46E+04	1.71E+04	5.18E+03	2.02E+03	1.95E+00
	10	1.73E+03	6.22E+03	5.48E+04	2.79E+04	3.12E+04	2.94E+04	2.39E+04	1.66E+04	5.11E+03	2.02E+03	1.95E+00
	11	1.74E+03	6.13E+03	5.30E+04	2.71E+04	3.03E+04	2.85E+04	2.32E+04	1.62E+04	5.05E+03	2.02E+03	1.94E+00
	15	1.75E+03	5.80E+03	4.67E+04	2.42E+04	2.70E+04	2.55E+04	2.09E+04	1.47E+04	4.81E+03	2.00E+03	1.92E+00
	20	1.75E+03	5.43E+03	4.00E+04	2.11E+04	2.35E+04	2.22E+04	1.83E+04	1.31E+04	4.54E+03	1.98E+03	1.89E+00
		6	18	30	48	60	78	96	114	139.24	145.24	
		data per inch										
	Time, years	6	12	12	18	12	18	18	18	25.24	6	
30 GWd/MTU	0.002739726	4.51E+04	1.53E+05	3.48E+05	4.44E+05	5.02E+05	5.18E+05	4.89E+05	3.98E+05	1.49E+05	4.95E+04	1.67E+00
	5	5.46E+03	3.31E+04	1.11E+05	1.60E+05	1.92E+05	2.03E+05	1.88E+05	1.40E+05	3.55E+04	7.28E+03	1.89E+00
	6	5.37E+03	3.21E+04	1.07E+05	1.54E+05	1.85E+05	1.95E+05	1.81E+05	1.35E+05	3.44E+04	7.12E+03	1.88E+00
	7	5.29E+03	3.11E+04	1.04E+05	1.49E+05	1.79E+05	1.88E+05	1.75E+05	1.30E+05	3.34E+04	6.99E+03	1.88E+00
	8	5.22E+03	3.02E+04	1.00E+05	1.43E+05	1.72E+05	1.82E+05	1.69E+05	1.26E+05	3.24E+04	6.85E+03	1.88E+00
	9	5.15E+03	2.94E+04	9.67E+04	1.38E+05	1.66E+05	1.76E+05	1.63E+05	1.22E+05	3.15E+04	6.73E+03	1.88E+00
	10	5.08E+03	2.85E+04	9.35E+04	1.34E+05	1.61E+05	1.69E+05	1.57E+05	1.17E+05	3.06E+04	6.61E+03	1.88E+00
	11	5.01E+03	2.77E+04	9.03E+04	1.29E+05	1.55E+05	1.64E+05	1.52E+05	1.13E+05	2.97E+04	6.49E+03	1.88E+00
	15	4.76E+03	2.47E+04	7.90E+04	1.12E+05	1.35E+05	1.42E+05	1.32E+05	9.89E+04	2.65E+04	6.05E+03	1.87E+00
	20	4.50E+03	2.16E+04	6.69E+04	9.48E+04	1.13E+05	1.20E+05	1.11E+05	8.36E+04	2.31E+04	5.59E+03	1.86E+00
		6	18	30	48	60	78	96	114	139.24	145.24	

NOTE: node 3 info is incorrect; it is not used in the final comparison to determine % difference from one node

		data per inch										
	Time, years	6	12	12	18	12	18	18	18	25.24	6	APF
40 GWd/MTU	0.002739726	1.18E+05	4.22E+05	9.92E+05	1.30E+06	1.48E+06	1.50E+06	1.39E+06	1.09E+06	3.69E+05	9.97E+04	1.72E+00
	5	1.69E+04	1.16E+05	4.03E+05	5.95E+05	7.17E+05	7.47E+05	6.88E+05	5.15E+05	1.21E+05	1.88E+04	1.90E+00
	6	1.65E+04	1.12E+05	3.89E+05	5.73E+05	6.90E+05	7.19E+05	6.62E+05	4.96E+05	1.17E+05	1.83E+04	1.90E+00
	7	1.60E+04	1.08E+05	3.75E+05	5.52E+05	6.65E+05	6.93E+05	6.38E+05	4.78E+05	1.13E+05	1.78E+04	1.90E+00
	8	1.56E+04	1.05E+05	3.61E+05	5.32E+05	6.41E+05	6.68E+05	6.15E+05	4.61E+05	1.09E+05	1.73E+04	1.89E+00
	9	1.52E+04	1.01E+05	3.48E+05	5.13E+05	6.18E+05	6.44E+05	5.93E+05	4.44E+05	1.05E+05	1.68E+04	1.89E+00
	10	1.48E+04	9.78E+04	3.36E+05	4.94E+05	5.95E+05	6.21E+05	5.71E+05	4.28E+05	1.02E+05	1.64E+04	1.89E+00
	11	1.44E+04	9.44E+04	3.24E+05	4.76E+05	5.74E+05	5.98E+05	5.51E+05	4.13E+05	9.83E+04	1.60E+04	1.89E+00
	15	1.31E+04	8.25E+04	2.80E+05	4.12E+05	4.95E+05	5.16E+05	4.75E+05	3.57E+05	8.59E+04	1.44E+04	1.89E+00
	20	1.17E+04	6.99E+04	2.34E+05	3.43E+05	4.13E+05	4.30E+05	3.96E+05	2.98E+05	7.28E+04	1.27E+04	1.89E+00
		6	18	30	48	60	78	96	114	139.24	145.24	
		data per inch										
	Time, years	6	12	12	18	12	18	18	18	25.24	6	
50 GWd/MTU	0.002739726	2.08E+05	9.88E+05	2.38E+06	2.99E+06	3.26E+06	3.25E+06	2.97E+06	2.37E+06	8.42E+05	2.27E+05	1.67E+00
	5	4.03E+04	3.79E+05	1.31E+06	1.75E+06	1.93E+06	1.91E+06	1.70E+06	1.27E+06	3.12E+05	4.65E+04	1.81E+00
	6	3.90E+04	3.66E+05	1.26E+06	1.68E+06	1.86E+06	1.84E+06	1.64E+06	1.23E+06	3.01E+05	4.50E+04	1.81E+00
	7	3.77E+04	3.52E+05	1.21E+06	1.62E+06	1.79E+06	1.77E+06	1.57E+06	1.18E+06	2.90E+05	4.35E+04	1.81E+00
	8	3.66E+04	3.40E+05	1.17E+06	1.56E+06	1.72E+06	1.70E+06	1.52E+06	1.14E+06	2.80E+05	4.21E+04	1.81E+00
	9	3.54E+04	3.28E+05	1.13E+06	1.50E+06	1.66E+06	1.64E+06	1.46E+06	1.09E+06	2.70E+05	4.08E+04	1.81E+00
	10	3.43E+04	3.16E+05	1.09E+06	1.45E+06	1.60E+06	1.58E+06	1.41E+06	1.05E+06	2.61E+05	3.95E+04	1.81E+00
	11	3.33E+04	3.05E+05	1.05E+06	1.39E+06	1.54E+06	1.52E+06	1.35E+06	1.02E+06	2.51E+05	3.83E+04	1.81E+00
	15	2.95E+04	2.64E+05	9.01E+05	1.20E+06	1.32E+06	1.31E+06	1.17E+06	8.76E+05	2.18E+05	3.38E+04	1.81E+00
	20	2.54E+04	2.20E+05	7.49E+05	9.97E+05	1.10E+06	1.09E+06	9.69E+05	7.28E+05	1.83E+05	2.90E+04	1.81E+00
		6	18	30	48	60	78	96	114	139.24	145.24	
		data per inch										
	Time, years	6	12	12	18	12	18	18	18	25.24	6	
60 GWd/MTU	0.002739726	3.05E+05	1.70E+06	4.48E+06	5.92E+06	6.61E+06	6.51E+06	5.73E+06	4.33E+06	1.48E+06	3.18E+05	1.77E+00
	5	7.77E+04	8.65E+05	2.92E+06	3.91E+06	4.30E+06	4.18E+06	3.61E+06	2.63E+06	6.77E+05	8.88E+04	1.85E+00
	6	7.50E+04	8.33E+05	2.80E+06	3.74E+06	4.12E+06	4.00E+06	3.46E+06	2.52E+06	6.53E+05	8.57E+04	1.85E+00
	7	7.25E+04	8.03E+05	2.69E+06	3.59E+06	3.94E+06	3.83E+06	3.32E+06	2.42E+06	6.29E+05	8.28E+04	1.84E+00
	8	7.00E+04	7.73E+05	2.59E+06	3.45E+06	3.78E+06	3.67E+06	3.18E+06	2.33E+06	6.06E+05	8.00E+04	1.84E+00
	9	6.77E+04	7.45E+05	2.49E+06	3.31E+06	3.63E+06	3.52E+06	3.06E+06	2.24E+06	5.84E+05	7.73E+04	1.84E+00
	10	6.54E+04	7.18E+05	2.40E+06	3.18E+06	3.49E+06	3.39E+06	2.94E+06	2.15E+06	5.63E+05	7.47E+04	1.84E+00
	11	6.33E+04	6.92E+05	2.31E+06	3.06E+06	3.35E+06	3.25E+06	2.82E+06	2.07E+06	5.42E+05	7.22E+04	1.84E+00
	15	5.54E+04	5.97E+05	1.98E+06	2.63E+06	2.87E+06	2.79E+06	2.42E+06	1.78E+06	4.69E+05	6.31E+04	1.83E+00
	20	4.70E+04	4.97E+05	1.65E+06	2.18E+06	2.38E+06	2.31E+06	2.01E+06	1.48E+06	3.91E+05	5.34E+04	1.83E+00
		6	18	30	48	60	78	96	114	139.24	145.24	

		data per inch										
	Time, years	6	12	12	18	12	18	18	18	25.24	6	APF
70 GWd/MTU	0.002739726	4.45E+05	2.80E+06	7.76E+06	1.05E+07	1.22E+07	1.24E+07	1.12E+07	8.24E+06	2.56E+06	4.74E+05	1.81E+00
	5	1.46E+05	1.71E+06	5.30E+06	6.93E+06	7.75E+06	7.77E+06	6.97E+06	5.21E+06	1.41E+06	1.65E+05	1.79E+00
	6	1.40E+05	1.64E+06	5.07E+06	6.58E+06	7.32E+06	7.33E+06	6.59E+06	4.95E+06	1.35E+06	1.59E+05	1.78E+00
	7	1.36E+05	1.58E+06	4.85E+06	6.27E+06	6.94E+06	6.94E+06	6.25E+06	4.72E+06	1.30E+06	1.54E+05	1.77E+00
	8	1.31E+05	1.52E+06	4.65E+06	5.98E+06	6.61E+06	6.59E+06	5.95E+06	4.51E+06	1.26E+06	1.48E+05	1.77E+00
	9	1.26E+05	1.47E+06	4.46E+06	5.72E+06	6.30E+06	6.28E+06	5.67E+06	4.32E+06	1.21E+06	1.43E+05	1.76E+00
	10	1.22E+05	1.41E+06	4.28E+06	5.47E+06	6.02E+06	6.00E+06	5.42E+06	4.14E+06	1.16E+06	1.38E+05	1.76E+00
	11	1.18E+05	1.36E+06	4.11E+06	5.25E+06	5.76E+06	5.74E+06	5.19E+06	3.97E+06	1.12E+06	1.33E+05	1.76E+00
	15	1.02E+05	1.17E+06	3.52E+06	4.47E+06	4.89E+06	4.87E+06	4.41E+06	3.39E+06	9.67E+05	1.16E+05	1.75E+00
	20	8.60E+04	9.73E+05	2.92E+06	3.70E+06	4.04E+06	4.02E+06	3.64E+06	2.81E+06	8.04E+05	9.72E+04	1.75E+00
		6	18	30	48	60	78	96	114	139.24	145.24	
		data per inch										
	Time, years	6	12	12	18	12	18	18	18	25.24	6	
75 GWd/MTU	0.002739726	5.11E+05	3.48E+06	1.03E+07	1.47E+07	1.76E+07	1.81E+07	1.60E+07	1.13E+07	3.08E+06	5.02E+05	1.90E+00
	5	1.91E+05	2.25E+06	6.91E+06	9.23E+06	1.05E+07	1.06E+07	9.48E+06	7.02E+06	1.86E+06	2.09E+05	1.82E+00
	6	1.84E+05	2.17E+06	6.57E+06	8.69E+06	9.83E+06	9.87E+06	8.86E+06	6.63E+06	1.79E+06	2.01E+05	1.80E+00
	7	1.78E+05	2.08E+06	6.26E+06	8.22E+06	9.23E+06	9.26E+06	8.33E+06	6.28E+06	1.72E+06	1.94E+05	1.79E+00
	8	1.72E+05	2.01E+06	5.98E+06	7.79E+06	8.72E+06	8.73E+06	7.86E+06	5.97E+06	1.66E+06	1.87E+05	1.78E+00
	9	1.65E+05	1.93E+06	5.72E+06	7.42E+06	8.26E+06	8.26E+06	7.46E+06	5.69E+06	1.60E+06	1.81E+05	1.77E+00
	10	1.60E+05	1.86E+06	5.48E+06	7.08E+06	7.85E+06	7.84E+06	7.09E+06	5.44E+06	1.54E+06	1.74E+05	1.76E+00
	11	1.54E+05	1.79E+06	5.26E+06	6.77E+06	7.49E+06	7.47E+06	6.76E+06	5.20E+06	1.48E+06	1.68E+05	1.76E+00
	15	1.34E+05	1.54E+06	4.49E+06	5.73E+06	6.30E+06	6.27E+06	5.68E+06	4.42E+06	1.27E+06	1.46E+05	1.75E+00
	20	1.12E+05	1.28E+06	3.72E+06	4.73E+06	5.18E+06	5.15E+06	4.68E+06	3.65E+06	1.06E+06	1.22E+05	1.75E+00

	6.97E+03 Neutron totals from 1 node case	1.400	145.24	Difference	% difference		Time, years
						10 GWd/MTU	
	1.01E+06	1.42E+06	9.75E+03	-1.45E+03	-15%		0.002739726
	2.04E+05	2.85E+05	1.96E+03	-5.42E+02	-28%		5
	2.05E+05	2.87E+05	1.97E+03	-5.26E+02	-27%		6
	2.06E+05	2.88E+05	1.98E+03	-5.11E+02	-26%		7
	2.07E+05	2.90E+05	1.99E+03	-4.96E+02	-25%		8
	2.08E+05	2.91E+05	2.00E+03	-4.82E+02	-24%		9
	2.09E+05	2.92E+05	2.01E+03	-4.68E+02	-23%		10
	2.10E+05	2.93E+05	2.02E+03	-4.56E+02	-23%		11
	2.12E+05	2.97E+05	2.05E+03	-4.07E+02	-20%		15
	2.14E+05	3.00E+05	2.07E+03	-3.56E+02	-17%		20

	7.70E+04 Neutron totals from 1 node case	1.400	145.24	Difference	% difference		Time, years
						20 GWd/MTU	
	1.12E+07	1.57E+07	1.08E+05	-2.99E+04	-28%		0.002739726
NOTE:	1.82E+06	2.55E+06	1.76E+04	-1.87E+04	-106%		5
node 3	1.78E+06	2.49E+06	1.72E+04	-1.80E+04	-105%		6
info	1.74E+06	2.44E+06	1.68E+04	-1.73E+04	-103%		7
is incorrect;	1.70E+06	2.38E+06	1.64E+04	-1.67E+04	-102%		8
it is not used	1.67E+06	2.33E+06	1.60E+04	-1.61E+04	-100%		9
in the final	1.63E+06	2.28E+06	1.57E+04	-1.55E+04	-99%		10
comparison	1.60E+06	2.23E+06	1.54E+04	-1.49E+04	-97%		11
to determine	1.47E+06	2.06E+06	1.42E+04	-1.28E+04	-91%		15
% difference	1.33E+06	1.87E+06	1.28E+04	-1.06E+04	-83%		20
from one node							

	2.93E+05 Neutron totals from 1 node case	1.400	145.24	Difference	% difference		Time, years
						30 GWd/MTU	
	4.25E+07	5.95E+07	4.10E+05	-1.08E+05	-26%		0.002739726
	1.07E+07	1.50E+07	1.03E+05	-9.92E+04	-96%		5
	1.04E+07	1.45E+07	9.99E+04	-9.55E+04	-96%		6
	1.00E+07	1.40E+07	9.66E+04	-9.19E+04	-95%		7
	9.69E+06	1.36E+07	9.34E+04	-8.84E+04	-95%		8
	9.38E+06	1.31E+07	9.04E+04	-8.51E+04	-94%		9
	9.08E+06	1.27E+07	8.75E+04	-8.19E+04	-94%		10
	8.79E+06	1.23E+07	8.47E+04	-7.88E+04	-93%		11
	7.73E+06	1.08E+07	7.45E+04	-6.77E+04	-91%		15
	6.61E+06	9.26E+06	6.37E+04	-5.59E+04	-88%		20

7.44E+05 Neutron totals from 1 node case	1.400	145.24	Difference	% difference		Time, years
					40	
1.08E+08	1.51E+08	1.04E+06	-4.61E+05	-44%	GWd/MTU	0.002739726
3.95E+07	5.53E+07	3.81E+05	-3.66E+05	-96%		5
3.81E+07	5.33E+07	3.67E+05	-3.52E+05	-96%		6
3.67E+07	5.14E+07	3.54E+05	-3.39E+05	-96%		7
3.54E+07	4.96E+07	3.42E+05	-3.26E+05	-96%		8
3.42E+07	4.79E+07	3.29E+05	-3.14E+05	-95%		9
3.30E+07	4.62E+07	3.18E+05	-3.03E+05	-95%		10
3.18E+07	4.45E+07	3.07E+05	-2.91E+05	-95%		11
2.76E+07	3.87E+07	2.66E+05	-2.50E+05	-94%		15
2.32E+07	3.24E+07	2.23E+05	-2.07E+05	-93%		20

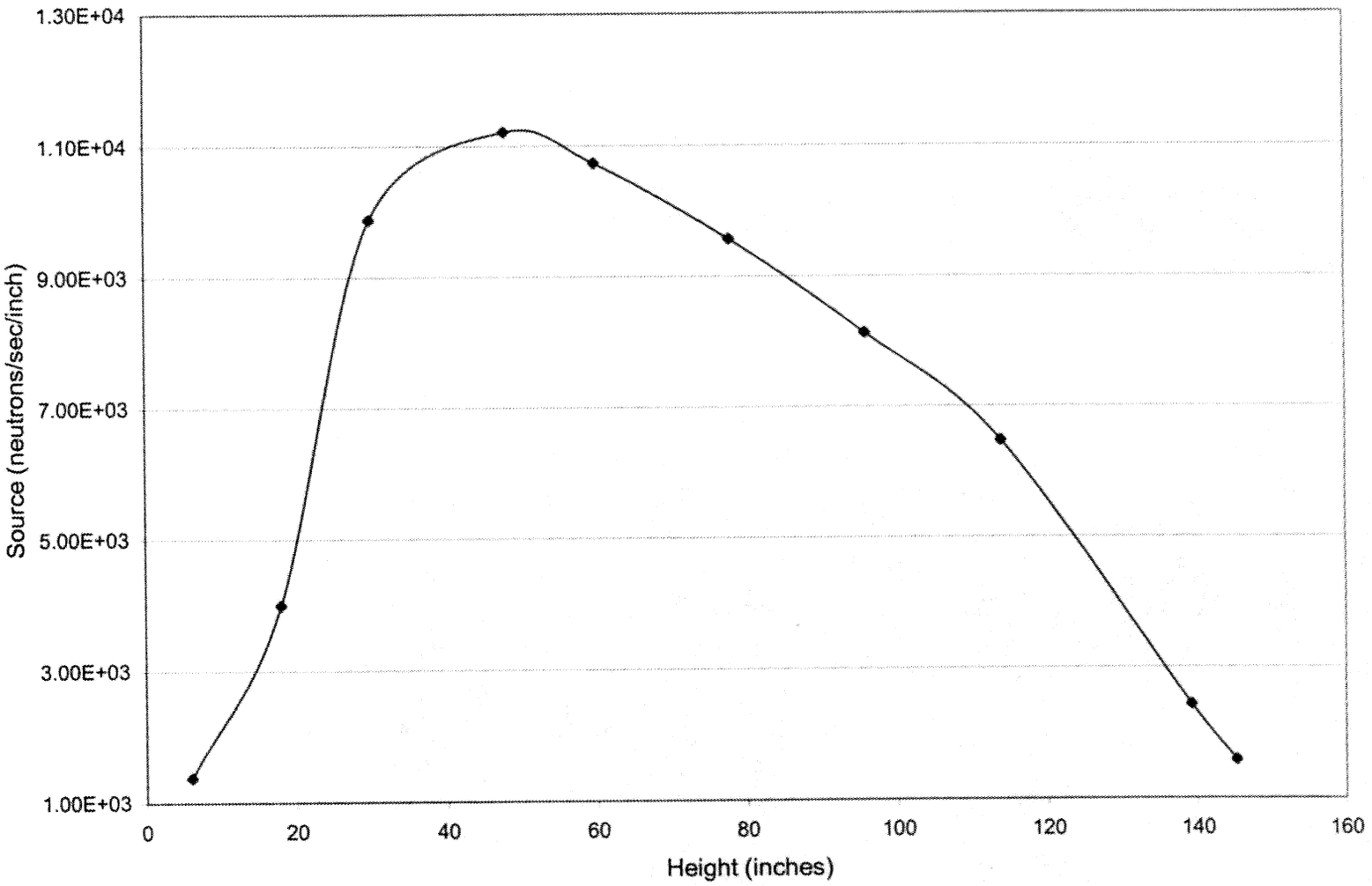
1.55E+06 Neutron totals from 1 node case	1.400	145.24	Difference	% difference		Time, years
					50	
2.25E+08	3.14E+08	2.16E+06	-1.09E+06	-50%	GWd/MTU	0.002739726
1.07E+08	1.50E+08	1.03E+06	-9.05E+05	-88%		5
1.03E+08	1.44E+08	9.91E+05	-8.69E+05	-88%		6
9.91E+07	1.39E+08	9.55E+05	-8.35E+05	-87%		7
9.55E+07	1.34E+08	9.20E+05	-8.02E+05	-87%		8
9.20E+07	1.29E+08	8.87E+05	-7.72E+05	-87%		9
8.87E+07	1.24E+08	8.55E+05	-7.42E+05	-87%		10
8.55E+07	1.20E+08	8.24E+05	-7.14E+05	-87%		11
7.38E+07	1.03E+08	7.11E+05	-6.12E+05	-86%		15
6.15E+07	8.61E+07	5.93E+05	-5.07E+05	-86%		20

2.85E+06 Neutron totals from 1 node case	1.400	145.24	Difference	% difference		Time, years
					60	
4.13E+08	5.79E+08	3.98E+06	-2.62E+06	-66%	GWd/MTU	0.002739726
2.35E+08	3.29E+08	2.26E+06	-2.04E+06	-90%		5
2.26E+08	3.16E+08	2.18E+06	-1.94E+06	-89%		6
2.17E+08	3.04E+08	2.10E+06	-1.85E+06	-88%		7
2.09E+08	2.93E+08	2.02E+06	-1.76E+06	-87%		8
2.02E+08	2.82E+08	1.94E+06	-1.69E+06	-87%		9
1.94E+08	2.72E+08	1.87E+06	-1.62E+06	-86%		10
1.87E+08	2.62E+08	1.80E+06	-1.55E+06	-86%		11
1.61E+08	2.26E+08	1.55E+06	-1.32E+06	-85%		15
1.34E+08	1.88E+08	1.29E+06	-1.09E+06	-84%		20

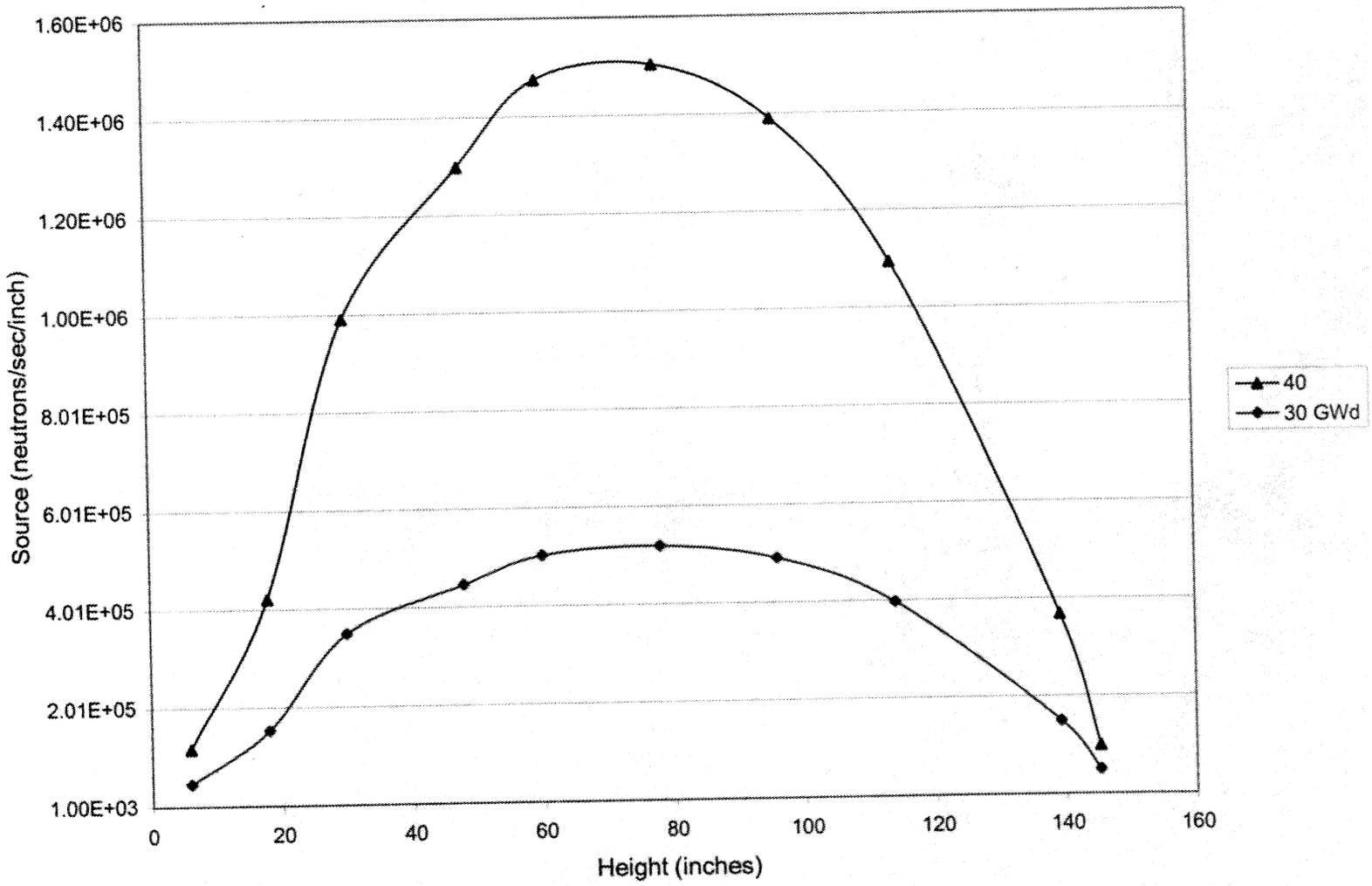
4.88E+06 Neutron totals from 1 node case	1.400	145.24	Difference	% difference		Time, years
					70 GWd/MTU	
7.08E+08	9.91E+08	6.83E+06	-5.61E+06	-82%		0.002739726
4.47E+08	6.26E+08	4.31E+06	-3.47E+06	-80%		5
4.29E+08	6.00E+08	4.13E+06	-3.19E+06	-77%		6
4.12E+08	5.77E+08	3.97E+06	-2.97E+06	-75%		7
3.96E+08	5.55E+08	3.82E+06	-2.79E+06	-73%		8
3.81E+08	5.33E+08	3.67E+06	-2.63E+06	-72%		9
3.66E+08	5.13E+08	3.53E+06	-2.49E+06	-70%		10
3.53E+08	4.94E+08	3.40E+06	-2.36E+06	-69%		11
3.03E+08	4.24E+08	2.92E+06	-1.97E+06	-67%		15
2.52E+08	3.53E+08	2.43E+06	-1.61E+06	-66%		20

6.30E+06 Neutron totals from 1 node case	1.400	145.24	Difference	% difference		Time, years
					75 GWd/MTU	
9.15E+08	1.28E+09	8.82E+06	-9.28E+06	-105%		0.002739726
5.93E+08	8.30E+08	5.71E+06	-4.88E+06	-85%		5
5.67E+08	7.94E+08	5.47E+06	-4.40E+06	-81%		6
5.44E+08	7.62E+08	5.24E+06	-4.02E+06	-77%		7
5.22E+08	7.31E+08	5.03E+06	-3.70E+06	-73%		8
5.01E+08	7.02E+08	4.83E+06	-3.43E+06	-71%		9
4.82E+08	6.75E+08	4.65E+06	-3.21E+06	-69%		10
4.63E+08	6.49E+08	4.47E+06	-3.02E+06	-68%		11
3.98E+08	5.57E+08	3.83E+06	-2.46E+06	-64%		15
3.30E+08	4.62E+08	3.18E+06	-2.00E+06	-63%		20

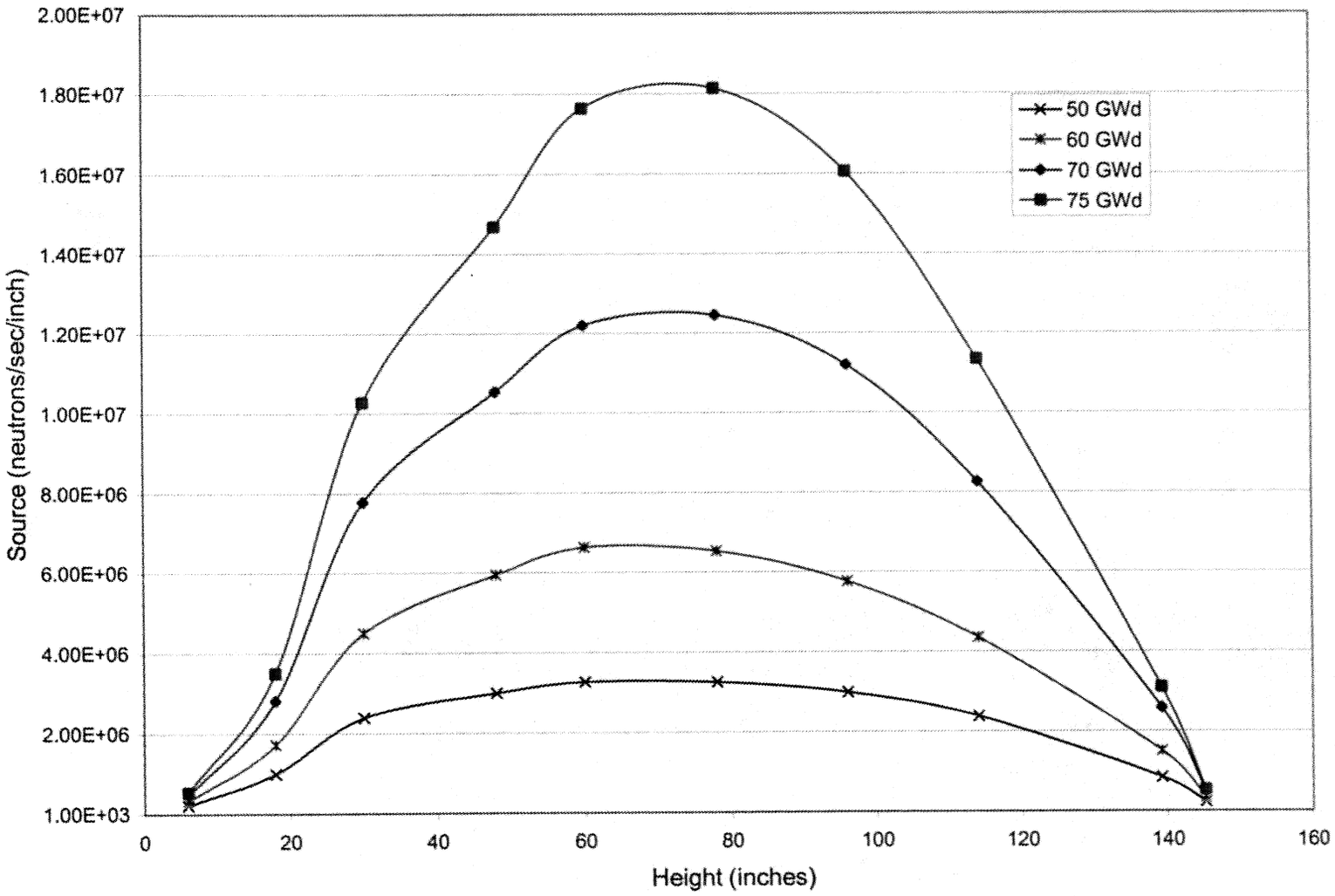
Neutron Source per unit Height for 10 GWd/MTU



Neutron Source per unit Height for 30-40 GWd/MTU



Neutron Source per unit Height for 50 -75 GWd/MTU



Neutrons

Min	Max	Mean	3.74%.11yrs	3.74%.170kg.11yrs	raw, 200/170	Normalized, 200 kg	Normalized, 170 kg	normalized source/per mtu, 200 kg	normalized source/per mtu, 170 kg
6.43E+00	2.00E+01	1.32E+01	2.71E+06	4.19E+06	65%	1.85E-02	1.86E-02	9.25E-02	1.09E-01
3.00E+00	6.43E+00	4.72E+00	3.08E+07	4.74E+07	65%	2.10E-01	2.10E-01	1.05E+00	1.23E+00
1.85E+00	3.00E+00	2.43E+00	3.40E+07	5.20E+07	65%	2.32E-01	2.31E-01	1.16E+00	1.36E+00
1.40E+00	1.85E+00	1.63E+00	1.92E+07	2.95E+07	65%	1.31E-01	1.31E-01	6.55E-01	7.70E-01
9.00E-01	1.40E+00	1.15E+00	2.60E+07	4.01E+07	65%	1.77E-01	1.78E-01	8.87E-01	1.05E+00
4.00E-01	9.00E-01	6.50E-01	2.84E+07	4.38E+07	65%	1.94E-01	1.94E-01	9.68E-01	1.14E+00
1.00E-01	4.00E-01	2.50E-01	5.55E+06	8.58E+06	65%	3.79E-02	3.80E-02	1.89E-01	2.24E-01
1.70E-02	1.00E-01	5.85E-02	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00
3.00E-03	1.70E-02	1.00E-02	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00
5.50E-04	3.00E-03	1.78E-03	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00
1.00E-04	5.50E-04	3.25E-04	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00
3.00E-05	1.00E-04	6.50E-05	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00
1.00E-05	3.00E-05	2.00E-05	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00
3.05E-06	1.00E-05	6.53E-06	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00
1.77E-06	3.05E-06	2.41E-06	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00
1.30E-06	1.77E-06	1.54E-06	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00
1.13E-06	1.30E-06	1.22E-06	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00
1.00E-06	1.13E-06	1.07E-06	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00
8.00E-07	1.00E-06	9.00E-07	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00
4.00E-07	8.00E-07	6.00E-07	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00
3.25E-07	4.00E-07	3.63E-07	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00
2.25E-07	3.25E-07	2.75E-07	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00
1.00E-07	2.25E-07	1.63E-07	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00
5.00E-08	1.00E-07	7.50E-08	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00
3.00E-08	5.00E-08	4.00E-08	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00
1.00E-08	3.00E-08	2.00E-08	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00
1.00E-11	1.00E-08	5.01E-09	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00
			1.47E+08	2.26E+08	65%	1.00E+00	1.00E+00		

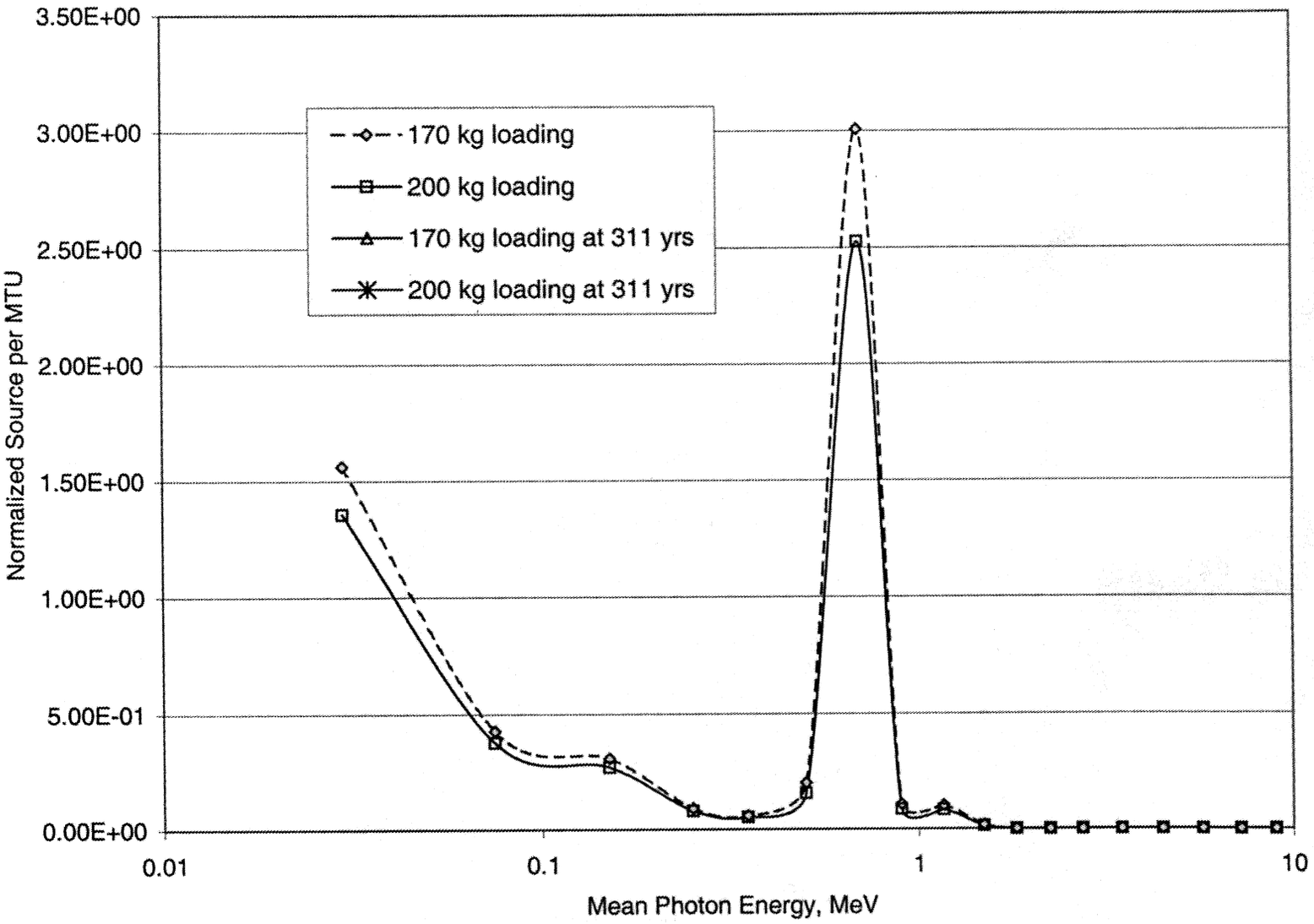
Neutrons: Thermal DBF at 311 years

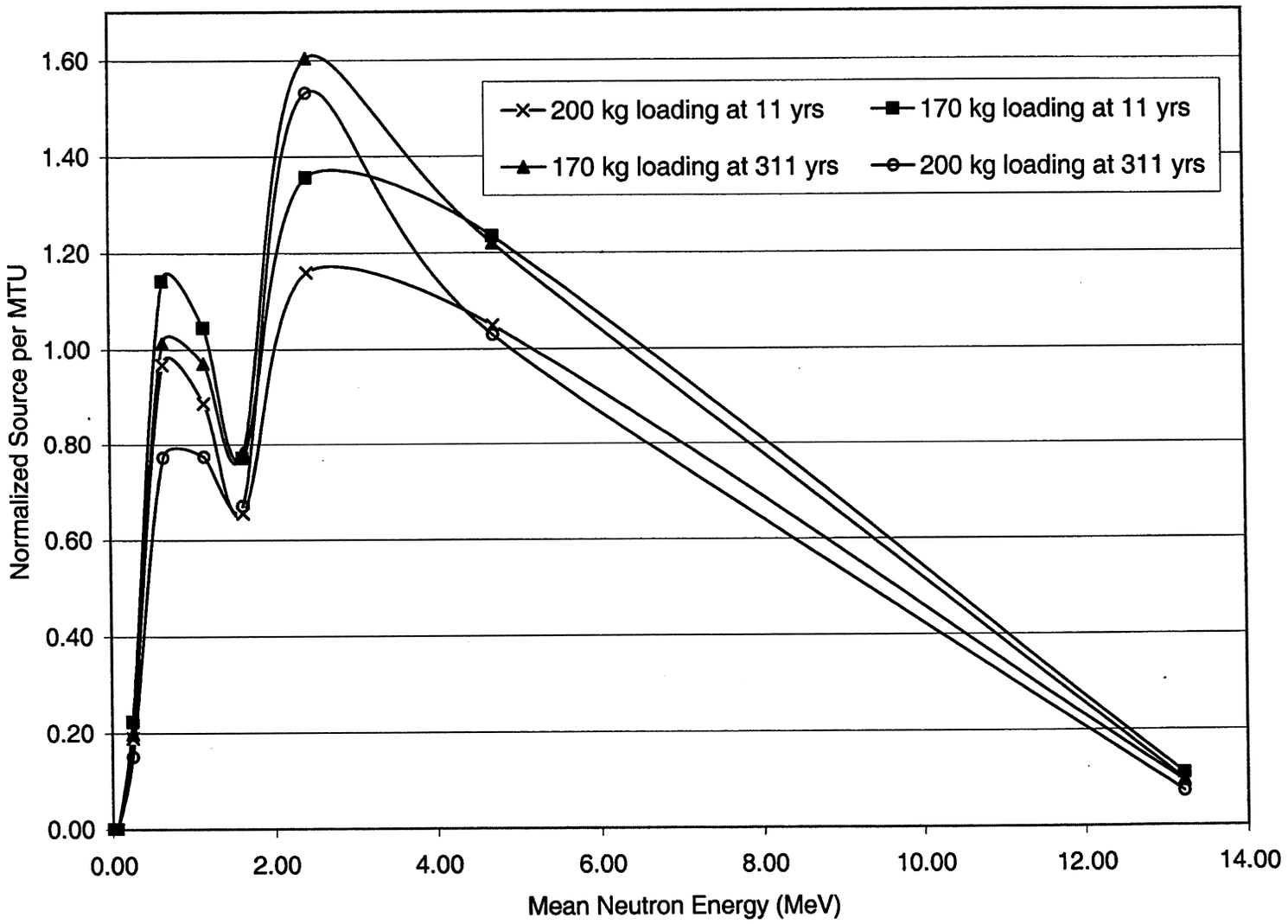
Min	Max	Mean	3.74%.170kg.311yrs	3.74%.200kg.311yrs	raw, 200/170	normalized source/per mtu, 170 kg	normalized source/per mtu, 200 kg	Percentage of 170kg loading value
		1.32E+01	7.64E+04	4.59E+04	60%	9.53E-02	7.14E-02	75%
		4.72E+00	9.77E+05	6.62E+05	68%	1.22E+00	1.03E+00	84%
		2.43E+00	1.29E+06	9.85E+05	77%	1.60E+00	1.53E+00	96%
		1.63E+00	6.25E+05	4.31E+05	69%	7.81E-01	6.71E-01	86%
		1.15E+00	7.77E+05	4.97E+05	64%	9.70E-01	7.73E-01	80%
		6.50E-01	8.12E+05	4.96E+05	61%	1.01E+00	7.72E-01	76%
		2.50E-01	1.59E+05	9.68E+04	61%	1.98E-01	1.51E-01	76%
		5.85E-02	0.00E+00	0.00E+00		0.00E+00	0.00E+00	
		1.00E-02	0.00E+00	0.00E+00		0.00E+00	0.00E+00	
		1.78E-03	0.00E+00	0.00E+00		0.00E+00	0.00E+00	
		3.25E-04	0.00E+00	0.00E+00		0.00E+00	0.00E+00	
		6.50E-05	0.00E+00	0.00E+00		0.00E+00	0.00E+00	
		2.00E-05	0.00E+00	0.00E+00		0.00E+00	0.00E+00	
		6.53E-06	0.00E+00	0.00E+00		0.00E+00	0.00E+00	
		2.41E-06	0.00E+00	0.00E+00		0.00E+00	0.00E+00	
		1.54E-06	0.00E+00	0.00E+00		0.00E+00	0.00E+00	
		1.22E-06	0.00E+00	0.00E+00		0.00E+00	0.00E+00	
		1.07E-06	0.00E+00	0.00E+00		0.00E+00	0.00E+00	
		9.00E-07	0.00E+00	0.00E+00		0.00E+00	0.00E+00	
		6.00E-07	0.00E+00	0.00E+00		0.00E+00	0.00E+00	
		3.63E-07	0.00E+00	0.00E+00		0.00E+00	0.00E+00	
		2.75E-07	0.00E+00	0.00E+00		0.00E+00	0.00E+00	
		1.63E-07	0.00E+00	0.00E+00		0.00E+00	0.00E+00	
		7.50E-08	0.00E+00	0.00E+00		0.00E+00	0.00E+00	
		4.00E-08	0.00E+00	0.00E+00		0.00E+00	0.00E+00	
		2.00E-08	0.00E+00	0.00E+00		0.00E+00	0.00E+00	
		5.01E-09	0.00E+00	0.00E+00		0.00E+00	0.00E+00	
			4.71E+06	3.21E+06	68%			

% of 170kg loading value	mean energy	3.74%.170kg.49GWd.11y	3.74%.49GWd.11y	Raw: % of 170kg loading value	Normalized: 3.74%.170kg.49GWd.11y	Normalized: 3.74%.49GWd.11y	Normalized, per MTU: 3.74%.170kg.49GWd.11y	Normalized, per MTU: 3.74%.49GWd.11y	% of 170kg loading value, normalized sources per mtu
85%	0.03	3.82E+14	3.93E+14	103%	2.65E-01	2.71E-01	1.56E+00	1.36E+00	87%
85%	7.50E-02	1.04E+14	1.09E+14	105%	7.25E-02	7.53E-02	4.26E-01	3.77E-01	88%
85%	1.50E-01	7.54E+13	7.85E+13	104%	5.24E-02	5.42E-02	3.08E-01	2.71E-01	88%
85%	2.50E-01	2.23E+13	2.33E+13	104%	1.55E-02	1.61E-02	9.11E-02	8.03E-02	88%
85%	3.50E-01	1.46E+13	1.52E+13	105%	1.01E-02	1.05E-02	5.95E-02	5.26E-02	88%
85%	5.00E-01	4.92E+13	4.53E+13	92%	3.42E-02	3.13E-02	2.01E-01	1.56E-01	78%
85%	7.00E-01	7.36E+14	7.32E+14	99%	5.11E-01	5.05E-01	3.01E+00	2.52E+00	84%
	9.00E-01	2.64E+13	2.48E+13	94%	1.83E-02	1.71E-02	1.08E-01	8.57E-02	79%
	1.17E+00	2.50E+13	2.38E+13	95%	1.74E-02	1.65E-02	1.02E-01	8.23E-02	81%
	1.50E+00	4.43E+12	3.85E+12	87%	3.08E-03	2.66E-03	1.81E-02	1.33E-02	73%
	1.83E+00	4.18E+10	4.32E+10	103%	2.91E-05	2.98E-05	1.71E-04	1.49E-04	87%
	2.25E+00	7.13E+09	6.94E+09	97%	4.95E-06	4.79E-06	2.91E-05	2.40E-05	82%
	2.75E+00	5.62E+08	5.12E+08	91%	3.90E-07	3.53E-07	2.29E-06	1.77E-06	77%
	3.50E+00	7.63E+07	6.30E+07	83%	5.30E-08	4.35E-08	3.12E-07	2.18E-07	70%
	4.50E+00	7.67E+06	4.97E+06	65%	5.33E-09	3.43E-09	3.13E-08	1.71E-08	55%
	5.75E+00	3.08E+06	1.99E+06	65%	2.14E-09	1.38E-09	1.26E-08	6.88E-09	55%
	7.25E+00	6.04E+05	3.91E+05	65%	4.19E-10	2.70E-10	2.47E-09	1.35E-09	55%
	9.00E+00	1.28E+05	8.30E+04	65%	8.90E-11	5.73E-11	5.24E-10	2.86E-10	55%
		1.44E+15	1.45E+15	101%	1.00E+00	1.00E+00	5.88E+00	5.00E+00	

Normalized per mtu

mean energy	3.74%.170kg.49GWd.311y	3.74%.49GWd.311y	3.74%.170kg.49GWd.311y	3.74%.49GWd.311y	% of 170kg loading value (normalized sources per mtu)	Raw % of 170kg loading value
0.03	3.06E+12	3.50E+12	1.69E+00	1.43E+00	85%	114%
7.50E-02	5.90E+12	7.09E+12	3.25E+00	2.90E+00	89%	120%
1.50E-01	2.81E+11	2.42E+11	1.55E-01	9.89E-02	64%	86%
2.50E-01	1.52E+11	1.25E+11	8.37E-02	5.11E-02	61%	82%
3.50E-01	3.37E+10	3.16E+10	1.86E-02	1.29E-02	70%	94%
5.00E-01	1.68E+10	1.70E+10	9.25E-03	6.94E-03	75%	101%
7.00E-01	1.23E+12	1.23E+12	6.78E-01	5.02E-01	74%	100%
9.00E-01	2.98E+09	2.98E+09	1.64E-03	1.22E-03	74%	100%
1.17E+00	1.44E+09	1.51E+09	7.93E-04	6.17E-04	78%	105%
1.50E+00	2.63E+08	2.72E+08	1.45E-04	1.11E-04	77%	103%
1.83E+00	4.51E+07	4.70E+07	2.48E-05	1.92E-05	77%	104%
2.25E+00	3.11E+06	2.95E+06	1.71E-06	1.21E-06	70%	95%
2.75E+00	8.67E+06	8.52E+06	4.78E-06	3.48E-06	73%	98%
3.50E+00	4.12E+05	2.60E+05	2.27E-07	1.06E-07	47%	63%
4.50E+00	1.39E+05	8.69E+04	7.66E-08	3.55E-08	46%	63%
5.75E+00	5.55E+04	3.47E+04	3.06E-08	1.42E-08	46%	63%
7.25E+00	1.09E+04	6.78E+03	6.00E-09	2.77E-09	46%	62%
9.00E+00	2.30E+03	1.43E+03	1.27E-09	5.84E-10	46%	62%
	1.07E+13	1.22E+13				


3.50E+00
3.00E+00
2.50E+00
2.00E+00
1.50E+00
1.00E+00
5.00E-01
0.00E+00
Normalized Source per MTU
170 kg loading
200 kg loading
170 kg loading at 311 yrs
200 kg loading at 311 yrs
0.01
0.1
1
10
Mean Photon Energy, MeV


200 kg loading at 11 yrs
170 kg loading at 11 yrs
170 kg loading at 311 yrs
200 kg loading at 311 yrs
Normalized Source per MTU
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
Mean Neutron Energy (MeV)

neutron REM/HR
Per source particle

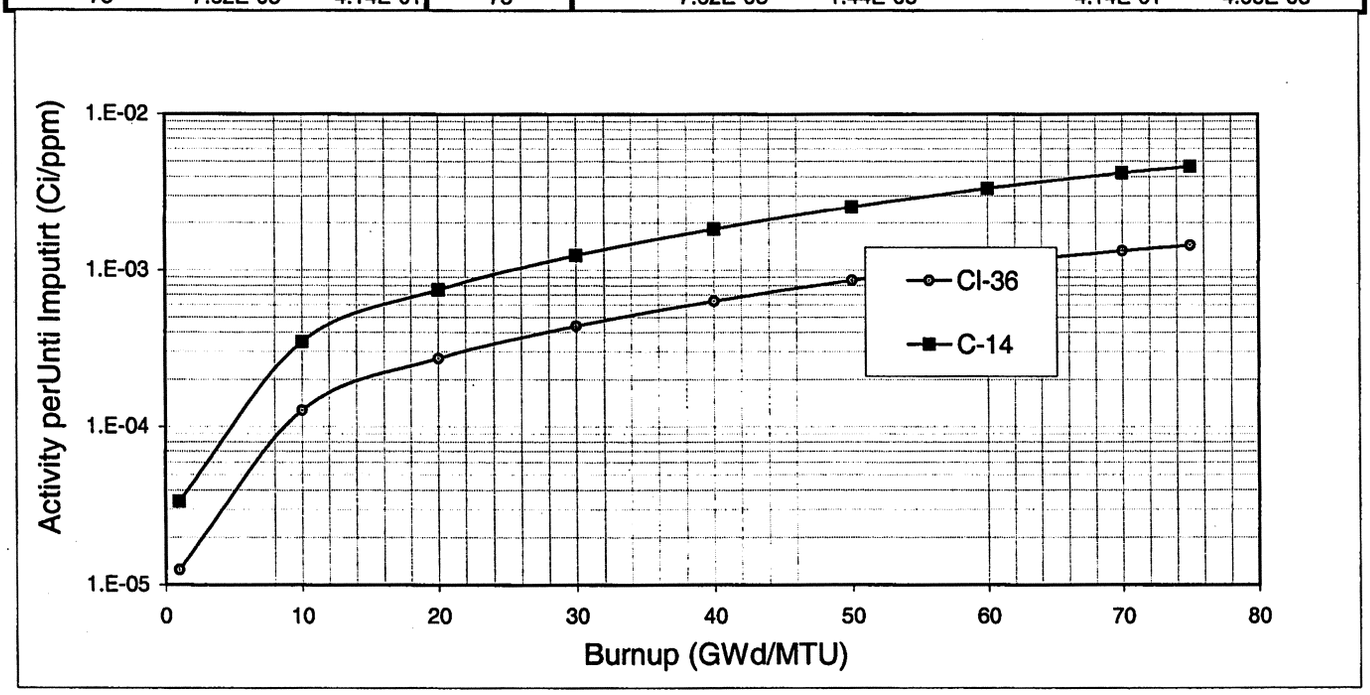
surface 1 segment: energy	dose	fuel region error	% of total	surface 3 segment: energy	dose	fuel region error	
2.50E-08	0.00E+00	0	0%	2.50E-08	0.00E+00	0	0%
1.00E-07	0.00E+00	0	0%	1.00E-07	1.09E-18	1	0%
1.00E-06	1.70E-15	0.2542	0%	1.00E-06	9.37E-16	0.0672	0%
1.00E-05	3.82E-14	0.0816	0%	1.00E-05	2.24E-14	0.0176	0%
1.00E-04	2.91E-13	0.0347	0%	1.00E-04	1.32E-13	0.0103	0%
1.00E-03	2.83E-12	0.0153	0%	1.00E-03	3.28E-13	0.0076	0%
1.00E-02	1.65E-11	0.0076	1%	1.00E-02	7.86E-13	0.0061	0%
1.00E-01	1.77E-10	0.0052	6%	1.00E-01	1.97E-11	0.0042	5%
5.00E-01	9.12E-10	0.0044	31%	5.00E-01	1.59E-10	0.0034	37%
1.00E+00	9.08E-10	0.0051	31%	1.00E+00	1.58E-10	0.0039	37%
2.50E+00	6.40E-10	0.006	22%	2.50E+00	7.14E-11	0.0046	17%
5.00E+00	2.15E-10	0.0093	7%	5.00E+00	1.15E-11	0.0082	3%
7.00E+00	5.63E-11	0.0201	2%	7.00E+00	2.47E-12	0.0171	1%
1.00E+01	5.62E-12	0.0527	0%	1.00E+01	3.57E-13	0.0434	0%
1.40E+01	4.03E-12	0.0811	0%	1.40E+01	2.75E-13	0.0604	0%
2.00E+01	6.52E-12	0.0776	0%	2.00E+01	4.69E-13	0.0583	0%
total	2.94E-09	0.0034	100%	total	4.24E-10	0.003	100%

Gammas for f1o

surface 1 segment: energy	-19	-8 -16 15		surface 3 segment: energy	-19	8 -16 15	
2.00E-02	3.57E+02	0.1731	0%	2.00E-02	4.61E-02	0.6174	0%
3.00E-02	2.29E+01	0.2925	0%	3.00E-02	1.54E-02	0.5331	0%
5.00E-02	3.81E+01	0.1633	0%	5.00E-02	1.50E-02	0.3661	0%
7.00E-02	9.29E+01	0.0804	0%	7.00E-02	2.18E-02	0.2334	0%
1.00E-01	9.12E+02	0.0389	1%	1.00E-01	4.77E-01	0.0863	0%
1.50E-01	7.59E+02	0.0353	0%	1.50E-01	4.58E+00	0.0315	2%
3.00E-01	7.44E+03	0.0116	5%	3.00E-01	3.99E+01	0.0158	13%
4.50E-01	1.07E+04	0.0166	7%	4.50E-01	5.85E+01	0.0141	19%
7.00E-01	5.33E+04	0.0105	34%	7.00E-01	8.80E+01	0.0127	29%
1.00E+00	5.68E+04	0.0115	37%	1.00E+00	5.91E+01	0.0174	19%
1.50E+00	2.10E+04	0.0211	14%	1.50E+00	4.54E+01	0.0271	15%
2.00E+00	3.45E+03	0.0586	2%	2.00E+00	7.45E+00	0.0739	2%
2.50E+00	2.25E+02	0.2012	0%	2.50E+00	1.26E+00	0.2796	0%
3.00E+00	2.34E+01	0.737	0%	3.00E+00	0.00E+00	0	0%
4.00E+00	0.00E+00	0	0%	4.00E+00	0.00E+00	0	0%
6.00E+00	0.00E+00	0	0%	6.00E+00	0.00E+00	0	0%
8.00E+00	0.00E+00	0	0%	8.00E+00	0.00E+00	0	0%
1.40E+01	0.00E+00	0	0%	1.40E+01	0.00E+00	0	0%
total	1.55E+05	0.007	100%	total	3.05E+02	0.0119	100%

BWR Fuel Impurity calculations for Cl-36 and C-14

RAW DATA				curies per ppm			
Burnup	Cl36 (5.3 ppm)	C14	Burnup (GWd/MTU)	CL36 (5.3ppm)	Cl36 5.3 ppm value/5.3	C-14 (Ci/assembly)	C14 89.4 ppm value/89.4
1	6.61E-05	3.03E-03	1	6.61E-05	1.25E-05	3.03E-03	3.39E-05
10	6.74E-04	3.11E-02	10	6.74E-04	1.27E-04	3.11E-02	3.48E-04
20	1.44E-03	6.70E-02	20	1.44E-03	2.72E-04	6.70E-02	7.49E-04
30	2.33E-03	1.11E-01	30	2.33E-03	4.40E-04	1.11E-01	1.24E-03
40	3.38E-03	1.64E-01	40	3.38E-03	6.38E-04	1.64E-01	1.83E-03
50	4.57E-03	2.28E-01	50	4.57E-03	8.62E-04	2.28E-01	2.55E-03
60	5.82E-03	3.00E-01	60	5.82E-03	1.10E-03	3.00E-01	3.36E-03
70	7.03E-03	3.76E-01	70	7.03E-03	1.33E-03	3.76E-01	4.21E-03
75	7.62E-03	4.14E-01	75	7.62E-03	1.44E-03	4.14E-01	4.63E-03



Script File: gammas

```
BEGIN {insas=0 && intable=0}
/halt feature/{insas=1}
/gamma source spectrum/ {if (insas) intable=1; print $0}
/ to  / {if (insas && intable) print $0}
/totals/ {intable=0}
```

Script File: neutrons

```
BEGIN { intable=0}
/alpha-n plus/ {intable=1; print $0}
/yr/{if (intable) print $0}
/E/ {if (intable) print $0}
/ gamma sources determined / {intable=0}
```

Script File: curies

```
BEGIN {intable=0 && insas=0 }
/halt feature/ {insas=1}
/nuclide radioactivity/{if (insas) print $0; intable=1}
/initial/ {if (insas && intable) print $0}
/charge/ {if (insas && intable) print $0}
/E/ {if (insas && intable) print $0}
/total/ {intable=0}
```

Script File: watts

```
BEGIN {intable=0 && insas=0 }
/halt feature/ {insas=1}
/nuclide thermal power, watts/{if (insas) print $0; intable=1}
/charge/ {if (insas && intable) print $0}
/initial/ {if (insas && intable) print $0}
/E/ {if (insas && intable) print $0}
/total/ {intable=0}
```

This attachment lists the all the files on Attachment VII, including the '*.cut' files produced by the last revision of this calculation. The '*.cut' files are the sections of the SAS2H/ORIGEN-S output files that contain the input echoes and the final ORIGEN-S output. Other intermediate calculations and information generated by SAS2H and included in the output files have been removed. In the '*.cut' file name, the initial enrichment of the fuel appears first, followed by the '%' symbol. The files listed as 'BWR.max.2.cut', 'BWR.min.2.cut', 'BWR.max.3.cut', and 'BWR.min.3.cut' are used to generate radionuclide inventories for specific years (see Section 5.5). The '*.2.cut' files generate the information for the years up to and including 12033. The '*.3.cut' files generate the information for the years 12033 to 1002033. The files listed as 'bwr_imp_BU#.cut' and 'bwr_cl2_BU#.cut' are the SAS2H/ORIGEN-S output files used to demonstrate the effect of fuel impurities on the source terms. The 'BU#' indicates the burnup for that particular case, with "BU4" being the lowest calculated burnup, and "BU13" being the highest. The files 'outbwr_imp_5.5_75.out' and 'outbwr_imp_bound.out' demonstrate the effect of enrichment on activity from fuel impurities.

Source term information from the '*.cut' and '*.output' files of the SAS2H/ORIGEN-S runs in the folders "Impurity_study," "parameter_study_output," "ten_node_output," and "THERMAL_DBF_output"on compact disc one should not be used for assemblies expected to be received at a potential repository. Those cases were run solely to form the basis for deciding what kinds of cases to be run for BWR assemblies in an expected waste stream. Furthermore, the '*.cut' files in folder "ten_node_output" and the '*.output' files in folder "parameter_study_output" on compact disc one cannot be considered product output in accordance with AP-3.15Q, *Managing Technical Product Inputs* (Ref. 7.33), since some information (Table 8 and Table 17) for those runs was taken from Ref. 7.13, pp. 333-334 and Ref. 7.17, pp. 50-55, which are "reference only." Therefore, the information in the '*.cut' files of folder "ten_node_output" and the '*.output' files of folder "parameter_study_output" on compact disc one should not be used for any other calculations or analyses.

CD 1			
File Size (bytes)	Date of Transfer	Time of Transfer	FILE NAME
Folder: cut_files_for_0.7%_and_1%			
2,180,169	10/31/2002	11:37a	0.7%.100MWd.bottom.cut
2,366,251	9/20/1999	07:04a	0.7%.100MWd.fuel.cut
2,220,219	9/20/1999	07:16a	0.7%.100MWd.plenum.cut
2,198,825	9/20/1999	07:16a	0.7%.100MWd.top.cut
2,492,014	9/20/1999	07:02a	0.7%.10GWd.bottom.cut
2,726,172	9/20/1999	06:21a	0.7%.10GWd.fuel.cut
2,533,942	9/20/1999	06:59a	0.7%.10GWd.plenum.cut
2,509,846	9/20/1999	07:00a	0.7%.10GWd.top.cut
2,058,921	9/20/1999	07:24a	0.7%.10MWd.bottom.cut
2,235,687	9/20/1999	07:15a	0.7%.10MWd.fuel.cut
2,084,893	9/20/1999	07:23a	0.7%.10MWd.plenum.cut
2,075,493	9/20/1999	07:23a	0.7%.10MWd.top.cut
2,320,930	9/20/1999	07:13a	0.7%.1GWd.bottom.cut
2,519,406	9/20/1999	06:59a	0.7%.1GWd.fuel.cut
2,355,206	9/20/1999	07:04a	0.7%.1GWd.plenum.cut
2,342,904	9/20/1999	07:12a	0.7%.1GWd.top.cut
1,983,474	9/20/1999	07:27a	0.7%.1MWd.bottom.cut
2,145,862	9/20/1999	07:20a	0.7%.1MWd.fuel.cut
2,013,606	9/20/1999	07:26a	0.7%.1MWd.plenum.cut
2,002,074	9/20/1999	07:26a	0.7%.1MWd.top.cut
2,586,845	9/20/1999	06:57a	0.7%.20GWd.bottom.cut
2,826,529	9/20/1999	06:01a	0.7%.20GWd.fuel.cut
2,635,887	9/20/1999	06:33a	0.7%.20GWd.plenum.cut
2,606,349	9/20/1999	06:55a	0.7%.20GWd.top.cut
2,627,525	9/20/1999	06:34a	0.7%.30GWd.bottom.cut
2,866,187	9/20/1999	06:00a	0.7%.30GWd.fuel.cut
2,672,409	9/20/1999	06:29a	0.7%.30GWd.plenum.cut
2,647,417	9/20/1999	06:32a	0.7%.30GWd.top.cut
2,656,978	9/20/1999	06:31a	0.7%.40GWd.bottom.cut
2,896,946	9/20/1999	05:59a	0.7%.40GWd.fuel.cut
2,703,168	9/20/1999	06:25a	0.7%.40GWd.plenum.cut
2,680,574	9/20/1999	06:29a	0.7%.40GWd.top.cut
2,684,838	9/20/1999	06:28a	0.7%.50GWd.bottom.cut
2,930,750	9/20/1999	05:57a	0.7%.50GWd.fuel.cut
2,730,618	9/20/1999	06:09a	0.7%.50GWd.plenum.cut
2,707,656	9/20/1999	06:24a	0.7%.50GWd.top.cut
2,703,487	9/20/1999	06:24a	0.7%.60GWd.bottom.cut
2,953,347	9/20/1999	05:56a	0.7%.60GWd.fuel.cut
2,751,385	9/20/1999	06:06a	0.7%.60GWd.plenum.cut
2,728,423	9/20/1999	06:20a	0.7%.60GWd.top.cut
2,721,846	9/20/1999	06:22a	0.7%.70GWd.bottom.cut
2,977,790	9/20/1999	05:55a	0.7%.70GWd.fuel.cut
2,766,354	9/20/1999	06:05a	0.7%.70GWd.plenum.cut

CD 1			
File Size (bytes)	Date of Transfer	Time of Transfer	FILE NAME
2,743,784	9/20/1999	06:08a	0.7%.70GWd.top.cut
2,733,145	9/20/1999	06:09a	0.7%.75GWd.bottom.cut
2,986,391	9/20/1999	05:54a	0.7%.75GWd.fuel.cut
2,779,831	9/20/1999	06:03a	0.7%.75GWd.plenum.cut
2,754,513	9/20/1999	06:06a	0.7%.75GWd.top.cut
2,173,888	9/20/1999	07:18a	1.0%.100MWd.bottom.cut
2,360,922	9/20/1999	07:04a	1.0%.100MWd.fuel.cut
2,215,118	9/20/1999	07:16a	1.0%.100MWd.plenum.cut
2,191,090	9/20/1999	07:17a	1.0%.100MWd.top.cut
2,487,896	9/20/1999	07:02a	1.0%.10GWd.bottom.cut
2,718,438	9/20/1999	06:22a	1.0%.10GWd.fuel.cut
2,524,210	9/20/1999	06:59a	1.0%.10GWd.plenum.cut
2,505,346	9/20/1999	07:01a	1.0%.10GWd.top.cut
2,054,416	9/20/1999	07:25a	1.0%.10MWd.bottom.cut
2,231,286	9/20/1999	07:16a	1.0%.10MWd.fuel.cut
2,080,274	9/20/1999	07:23a	1.0%.10MWd.plenum.cut
2,071,122	9/20/1999	07:24a	1.0%.10MWd.top.cut
2,317,422	9/20/1999	07:14a	1.0%.1GWd.bottom.cut
2,515,020	9/20/1999	07:00a	1.0%.1GWd.fuel.cut
2,352,338	9/20/1999	07:04a	1.0%.1GWd.plenum.cut
2,339,510	9/20/1999	07:12a	1.0%.1GWd.top.cut
1,985,211	9/20/1999	07:27a	1.0%.1MWd.bottom.cut
2,145,863	9/20/1999	07:20a	1.0%.1MWd.fuel.cut
2,014,227	9/20/1999	07:26a	1.0%.1MWd.plenum.cut
2,001,951	9/20/1999	07:26a	1.0%.1MWd.top.cut
Folder: Impurity_study			
232,600	11/11/1999	03:02a	bwr_imp_BU5.cut
245,543	11/11/1999	03:02a	bwr_imp_BU6.cut
255,849	11/11/1999	03:02a	bwr_imp_BU7.cut
266,109	11/11/1999	03:02a	bwr_imp_BU8.cut
275,063	11/11/1999	03:02a	bwr_imp_BU10.cut
285,312	11/11/1999	03:02a	bwr_imp_BU11.cut
291,998	11/11/1999	03:02a	bwr_imp_BU12.cut
298,025	11/11/1999	03:02a	bwr_imp_BU13.cut
206,934	11/11/1999	03:02a	bwr_imp_BU4.cut
48,221,732	11/11/1999	03:05a	outpbwr_imp_bound.out
48,082,956	11/11/1999	03:09a	outpbwr_imp_5.5_75.out
Folder: parameter_study_output			
10,570,169	2/24/1999	02:01a	1.den1.output
10,589,423	2/24/1999	02:01a	1.den2.output
10,464,603	2/24/1999	02:02a	1.den3.output
10,563,627	2/24/1999	02:01a	1.den4.output
10,660,383	2/24/1999	02:01a	2.den1.output
10,684,741	2/24/1999	02:00a	2.den2.output
10,558,555	2/24/1999	02:02a	2.den3.output

CD 1

File Size (bytes)	Date of Transfer	Time of Transfer	FILE NAME
10,660,514	2/24/1999	02:01a	2.den4.output
11,580,632	2/24/1999	01:59a	4.den1.output
11,604,374	2/24/1999	01:58a	4.den2.output
11,487,893	2/24/1999	02:00a	4.den3.output
11,581,115	2/24/1999	01:59a	4.den4.output
11,582,053	2/24/1999	01:59a	6.den1.output
11,605,046	2/24/1999	01:58a	6.den2.output
11,487,183	2/24/1999	02:00a	6.den3.output
11,582,654	2/24/1999	01:59a	6.den4.output
11,510,874	2/24/1999	02:00a	8.den1.output
11,532,190	2/24/1999	01:59a	8.den2.output
11,416,229	2/24/1999	02:00a	8.den3.output
11,511,241	2/24/1999	02:00a	8.den4.output
Folder: Performance_Assessment			
174,898	11/4/1999	12:49a	BWR.ave.3.cut
233,861	11/4/1999	12:49a	BWR.ave.2.cut
199,861	11/4/1999	12:49a	BWR.max.3.cut
274,606	11/4/1999	12:49a	BWR.max.2.cut
Folder: ten_node_output			
855,883	2/24/1999	01:52a	node.10.50GWd.cut
865,551	2/24/1999	01:52a	node.10.60GWd.cut
864,541	2/24/1999	01:52a	node.10.75GWd.cut
875,146	2/24/1999	01:52a	node.10.70GWd.cut
786,499	2/24/1999	01:52a	node.10.10GWd.cut
802,903	2/24/1999	01:52a	node.10.20GWd.cut
819,694	2/24/1999	01:52a	node.10.30GWd.cut
844,864	2/24/1999	01:52a	node.10.40GWd.cut
1,520,079	2/24/1999	01:50a	node.1.10GWd.cut
794,333	2/24/1999	01:51a	node.1.20GWd.cut
817,038	2/24/1999	01:51a	node.1.30GWd.cut
843,162	2/24/1999	01:51a	node.1.40GWd.cut
851,435	2/24/1999	01:51a	node.1.50GWd.cut
859,800	2/24/1999	01:51a	node.1.60GWd.cut
867,272	2/24/1999	01:51a	node.1.70GWd.cut
856,667	2/24/1999	01:51a	node.1.75GWd.cut
847,636	2/24/1999	01:51a	node.2.10GWd.cut
869,935	2/24/1999	01:51a	node.2.20GWd.cut
889,794	2/24/1999	01:51a	node.2.30GWd.cut
915,762	2/24/1999	01:51a	node.2.40GWd.cut
928,724	2/24/1999	01:51a	node.2.50GWd.cut
941,769	2/24/1999	01:51a	node.2.60GWd.cut
950,690	2/24/1999	01:51a	node.2.70GWd.cut
942,269	2/24/1999	01:51a	node.2.75GWd.cut
854,033	2/24/1999	01:52a	node.3.10GWd.cut
888,734	2/24/1999	01:52a	node.3.20GWd.cut

CD 1

File Size (bytes)	Date of Transfer	Time of Transfer	FILE NAME
898,118	2/24/1999	01:52a	node.3.30GWd.cut
926,763	2/24/1999	01:52a	node.3.40GWd.cut
937,885	2/24/1999	01:52a	node.3.50GWd.cut
950,025	2/24/1999	01:52a	node.3.60GWd.cut
962,621	2/24/1999	01:52a	node.3.70GWd.cut
953,338	2/24/1999	01:52a	node.3.75GWd.cut
862,899	2/24/1999	01:53a	node.4.10GWd.cut
892,726	2/24/1999	01:53a	node.4.20GWd.cut
909,014	2/24/1999	01:53a	node.4.30GWd.cut
938,547	2/24/1999	01:53a	node.4.40GWd.cut
949,640	2/24/1999	01:53a	node.4.50GWd.cut
963,179	2/24/1999	01:53a	node.4.60GWd.cut
973,204	2/24/1999	01:53a	node.4.70GWd.cut
966,717	2/24/1999	01:53a	node.4.75GWd.cut
857,072	2/24/1999	01:53a	node.5.10GWd.cut
887,536	2/24/1999	01:53a	node.5.20GWd.cut
903,556	2/24/1999	01:53a	node.5.30GWd.cut
933,880	2/24/1999	01:53a	node.5.40GWd.cut
943,643	2/24/1999	01:53a	node.5.50GWd.cut
958,567	2/24/1999	01:53a	node.5.60GWd.cut
970,720	2/24/1999	01:53a	node.5.70GWd.cut
963,014	2/24/1999	01:53a	node.5.75GWd.cut
861,376	2/24/1999	01:54a	node.6.10GWd.cut
892,929	2/24/1999	01:54a	node.6.20GWd.cut
910,154	2/24/1999	01:54a	node.6.30GWd.cut
938,557	2/24/1999	01:54a	node.6.40GWd.cut
950,087	2/24/1999	01:54a	node.6.50GWd.cut
964,233	2/24/1999	01:54a	node.6.60GWd.cut
976,727	2/24/1999	01:54a	node.6.70GWd.cut
969,255	2/24/1999	01:54a	node.6.75GWd.cut
861,570	2/24/1999	01:54a	node.7.10GWd.cut
893,134	2/24/1999	01:54a	node.7.20GWd.cut
911,809	2/24/1999	01:54a	node.7.30GWd.cut
939,217	2/24/1999	01:54a	node.7.40GWd.cut
951,932	2/24/1999	01:54a	node.7.50GWd.cut
965,350	2/24/1999	01:54a	node.7.60GWd.cut
977,944	2/24/1999	01:54a	node.7.70GWd.cut
970,205	2/24/1999	01:54a	node.7.75GWd.cut
859,348	2/24/1999	01:55a	node.8.10GWd.cut
888,850	2/24/1999	01:55a	node.8.20GWd.cut
908,435	2/24/1999	01:55a	node.8.30GWd.cut
934,373	2/24/1999	01:55a	node.8.40GWd.cut
946,211	2/24/1999	01:55a	node.8.50GWd.cut
959,797	2/24/1999	01:55a	node.8.60GWd.cut
971,866	2/24/1999	01:55a	node.8.70GWd.cut

CD 1

File Size (bytes)	Date of Transfer	Time of Transfer	FILE NAME
963,098	2/24/1999	01:55a	node.8.75GWd.cut
858,462	2/24/1999	01:55a	node.9.10GWd.cut
886,150	2/24/1999	01:55a	node.9.20GWd.cut
907,182	2/24/1999	01:55a	node.9.30GWd.cut
933,402	2/24/1999	01:55a	node.9.40GWd.cut
944,360	2/24/1999	01:55a	node.9.50GWd.cut
959,017	2/24/1999	01:55a	node.9.60GWd.cut
973,525	2/24/1999	01:55a	node.9.70GWd.cut
962,434	2/24/1999	01:55a	node.9.75GWd.cut
Folder: THERMAL_DBF_output			
2,328,690	2/24/1999	02:08a	3.74%.170kg.60GWd.fuel.cut
2,142,897	2/24/1999	02:09a	3.74%.no.hardware.50GWd.fuel.cut
2,122,146	2/24/1999	02:07a	3.74%.10GWd.fuel.cut
2,121,402	2/24/1999	02:08a	3.74%.170kg.10GWd.fuel.cut
2,179,387	2/24/1999	02:08a	3.74%.170kg.20GWd.fuel.cut
2,232,863	2/24/1999	02:08a	3.74%.170kg.30GWd.fuel.cut
2,294,945	2/24/1999	02:08a	3.74%.170kg.40GWd.fuel.cut
2,178,921	2/24/1999	02:07a	3.74%.20GWd.fuel.cut
2,231,407	2/24/1999	02:07a	3.74%.30GWd.fuel.cut
2,287,590	2/24/1999	02:07a	3.74%.40GWd.fuel.cut
2,287,590	2/24/1999	06:30a	3.74%.49GWd.fuel.cut
2,287,590	2/24/1999	02:07a	3.74%.50GWd.fuel.cut
2,316,609	2/24/1999	02:07a	3.74%.60GWd.fuel.cut
2,345,584	2/24/1999	02:07a	3.74%.70GWd.fuel.cut
2,355,307	2/24/1999	02:07a	3.74%.75GWd.fuel.cut
1,986,076	2/24/1999	02:09a	3.74%.no.hardware.10GWd.fuel.cut
2,042,577	2/24/1999	02:09a	3.74%.no.hardware.20GWd.fuel.cut
2,091,463	2/24/1999	02:09a	3.74%.no.hardware.30GWd.fuel.cut
2,122,067	2/24/1999	02:09a	3.74%.no.hardware.40GWd.fuel.cut
2,349,235	2/24/1999	02:08a	3.74%.170kg.70GWd.fuel.cut
2,364,663	2/24/1999	02:08a	3.74%.170kg.75GWd.fuel.cut
2,151,447	2/24/1999	02:09a	3.74%.no.hardware.60GWd.fuel.cut
2,294,945	2/24/1999	06:30a	3.74%.170kg.49GWd.fuel.cut
2,178,808	2/24/1999	02:09a	3.74%.no.hardware.70GWd.fuel.cut
2,189,439	2/24/1999	02:09a	3.74%.no.hardware.75GWd.fuel.cut
2,294,945	2/24/1999	02:08a	3.74%.170kg.50GWd.fuel.cut
2,287,590	2/24/1999	06:31a	3.74%.no.hardware.49GWd.fuel.cut
Folder: UNIX-script			
261	10/8/1999	04:31a	curies
177	10/8/1999	04:07a	gammas
158	10/8/1999	04:31a	neutrons
268	10/8/1999	04:31a	watts

CD 2			
File Size (bytes)	Date of Transfer	Time of Transfer	File Name
Folder: 1%_through_3.5%_cut_files			
2,582,590	9/20/1999	05:57a	1.0%.20GWd.bottom.cut
2,822,016	9/20/1999	06:01a	1.0%.20GWd.fuel.cut
2,631,240	9/20/1999	06:34a	1.0%.20GWd.plenum.cut
2,599,460	9/20/1999	06:56a	1.0%.20GWd.top.cut
2,625,521	9/20/1999	06:54a	1.0%.30GWd.bottom.cut
2,865,537	9/20/1999	06:00a	1.0%.30GWd.fuel.cut
2,672,523	9/20/1999	06:29a	1.0%.30GWd.plenum.cut
2,644,149	9/20/1999	06:33a	1.0%.30GWd.top.cut
2,654,566	9/20/1999	06:32a	1.0%.40GWd.bottom.cut
2,894,028	9/20/1999	05:59a	1.0%.40GWd.fuel.cut
2,700,880	9/20/1999	06:25a	1.0%.40GWd.plenum.cut
2,678,038	9/20/1999	06:29a	1.0%.40GWd.top.cut
2,683,382	9/20/1999	06:28a	1.0%.50GWd.bottom.cut
2,930,002	9/20/1999	05:57a	1.0%.50GWd.fuel.cut
2,730,624	9/20/1999	06:09a	1.0%.50GWd.plenum.cut
2,707,092	9/20/1999	06:24a	1.0%.50GWd.top.cut
2,699,644	9/20/1999	06:25a	1.0%.60GWd.bottom.cut
2,949,370	9/20/1999	05:56a	1.0%.60GWd.fuel.cut
2,747,790	9/20/1999	06:06a	1.0%.60GWd.plenum.cut
2,722,462	9/20/1999	06:21a	1.0%.60GWd.top.cut
2,727,178	9/20/1999	06:20a	1.0%.70GWd.bottom.cut
2,978,638	9/20/1999	05:54a	1.0%.70GWd.fuel.cut
2,770,074	9/20/1999	06:04a	1.0%.70GWd.plenum.cut
2,748,992	9/20/1999	06:06a	1.0%.70GWd.top.cut
2,733,313	9/20/1999	06:09a	1.0%.75GWd.bottom.cut
2,988,989	9/20/1999	05:53a	1.0%.75GWd.fuel.cut
2,782,285	9/20/1999	06:02a	1.0%.75GWd.plenum.cut
2,755,251	9/20/1999	06:05a	1.0%.75GWd.top.cut
2,168,985	9/20/1999	07:18a	1.5%.100MWd.bottom.cut
2,352,299	9/20/1999	07:04a	1.5%.100MWd.fuel.cut
2,206,465	9/20/1999	07:16a	1.5%.100MWd.plenum.cut
2,186,063	9/20/1999	07:17a	1.5%.100MWd.top.cut
2,484,072	9/20/1999	07:02a	1.5%.10GWd.bottom.cut
2,714,614	9/20/1999	06:23a	1.5%.10GWd.fuel.cut
2,522,256	9/20/1999	06:59a	1.5%.10GWd.plenum.cut
2,501,264	9/20/1999	07:01a	1.5%.10GWd.top.cut
2,055,396	9/20/1999	07:24a	1.5%.10MWd.bottom.cut
2,232,638	9/20/1999	07:15a	1.5%.10MWd.fuel.cut
2,081,760	9/20/1999	07:23a	1.5%.10MWd.plenum.cut
2,072,856	9/20/1999	07:24a	1.5%.10MWd.top.cut
2,315,908	9/20/1999	07:14a	1.5%.1GWd.bottom.cut
2,507,648	9/20/1999	07:00a	1.5%.1GWd.fuel.cut
2,350,804	9/20/1999	07:04a	1.5%.1GWd.plenum.cut
2,337,614	9/20/1999	07:12a	1.5%.1GWd.top.cut
1,987,442	9/20/1999	07:27a	1.5%.1MWd.bottom.cut
2,146,110	9/20/1999	07:20a	1.5%.1MWd.fuel.cut
2,012,118	9/20/1999	07:26a	1.5%.1MWd.plenum.cut

File Size (bytes)	Date of Transfer	Time of Transfer	File Name
2,005,050	9/20/1999	07:26a	1.5%.1MWd.top.cut
2,575,093	9/20/1999	06:57a	1.5%.20GWd.bottom.cut
2,814,097	9/20/1999	06:02a	1.5%.20GWd.fuel.cut
2,622,513	9/20/1999	06:54a	1.5%.20GWd.plenum.cut
2,594,403	9/20/1999	06:56a	1.5%.20GWd.top.cut
2,617,506	9/20/1999	06:55a	1.5%.30GWd.bottom.cut
2,859,030	9/20/1999	06:00a	1.5%.30GWd.fuel.cut
2,669,136	9/20/1999	06:30a	1.5%.30GWd.plenum.cut
2,637,038	9/20/1999	06:33a	1.5%.30GWd.top.cut
2,649,254	9/20/1999	06:32a	1.5%.40GWd.bottom.cut
2,887,396	9/20/1999	05:59a	1.5%.40GWd.fuel.cut
2,695,756	9/20/1999	06:26a	1.5%.40GWd.plenum.cut
2,669,582	9/20/1999	06:30a	1.5%.40GWd.top.cut
2,681,631	9/20/1999	06:28a	1.5%.50GWd.bottom.cut
2,923,529	9/20/1999	05:57a	1.5%.50GWd.fuel.cut
2,727,623	9/20/1999	06:20a	1.5%.50GWd.plenum.cut
2,705,093	9/20/1999	06:24a	1.5%.50GWd.top.cut
2,701,633	9/20/1999	06:25a	1.5%.60GWd.bottom.cut
2,950,025	9/20/1999	05:56a	1.5%.60GWd.fuel.cut
2,749,903	9/20/1999	06:06a	1.5%.60GWd.plenum.cut
2,724,575	9/20/1999	06:21a	1.5%.60GWd.top.cut
2,723,351	9/20/1999	06:21a	1.5%.70GWd.bottom.cut
2,974,051	9/20/1999	05:55a	1.5%.70GWd.fuel.cut
2,767,719	9/20/1999	06:04a	1.5%.70GWd.plenum.cut
2,746,751	9/20/1999	06:07a	1.5%.70GWd.top.cut
2,736,394	9/20/1999	06:08a	1.5%.75GWd.bottom.cut
2,992,586	9/20/1999	05:53a	1.5%.75GWd.fuel.cut
2,781,150	9/20/1999	06:02a	1.5%.75GWd.plenum.cut
2,758,580	9/20/1999	06:05a	1.5%.75GWd.top.cut
2,166,839	9/20/1999	07:19a	2.0%.100MWd.bottom.cut
2,346,899	9/20/1999	07:11a	2.0%.100MWd.fuel.cut
2,201,447	9/20/1999	07:16a	2.0%.100MWd.plenum.cut
2,183,783	9/20/1999	07:18a	2.0%.100MWd.top.cut
2,482,814	9/20/1999	07:03a	2.0%.10GWd.bottom.cut
2,707,270	9/20/1999	06:24a	2.0%.10GWd.fuel.cut
2,518,042	9/20/1999	06:59a	2.0%.10GWd.plenum.cut
2,499,510	9/20/1999	07:01a	2.0%.10GWd.top.cut
2,054,614	9/20/1999	07:24a	2.0%.10MWd.bottom.cut
2,233,116	9/20/1999	07:15a	2.0%.10MWd.fuel.cut
2,082,590	9/20/1999	07:23a	2.0%.10MWd.plenum.cut
2,073,324	9/20/1999	07:23a	2.0%.10MWd.top.cut
2,309,672	9/20/1999	07:14a	2.0%.1GWd.bottom.cut
2,498,034	9/20/1999	07:01a	2.0%.1GWd.fuel.cut
2,343,794	9/20/1999	07:12a	2.0%.1GWd.plenum.cut
2,328,754	9/20/1999	07:13a	2.0%.1GWd.top.cut
1,989,053	9/20/1999	07:27a	2.0%.1MWd.bottom.cut
2,146,853	9/20/1999	07:20a	2.0%.1MWd.fuel.cut
2,011,497	9/20/1999	07:26a	2.0%.1MWd.plenum.cut
2,006,661	9/20/1999	07:26a	2.0%.1MWd.top.cut

File Size (bytes)	Date of Transfer	Time of Transfer	File Name
2,566,105	9/20/1999	06:58a	2.0%.20GWd.bottom.cut
2,805,987	9/20/1999	06:02a	2.0%.20GWd.fuel.cut
2,614,171	9/20/1999	06:55a	2.0%.20GWd.plenum.cut
2,584,795	9/20/1999	06:57a	2.0%.20GWd.top.cut
2,609,804	9/20/1999	06:55a	2.0%.30GWd.bottom.cut
2,851,710	9/20/1999	06:00a	2.0%.30GWd.fuel.cut
2,659,362	9/20/1999	06:31a	2.0%.30GWd.plenum.cut
2,632,922	9/20/1999	06:34a	2.0%.30GWd.top.cut
2,645,748	9/20/1999	06:33a	2.0%.40GWd.bottom.cut
2,882,530	9/20/1999	05:59a	2.0%.40GWd.fuel.cut
2,692,760	9/20/1999	06:26a	2.0%.40GWd.plenum.cut
2,665,382	9/20/1999	06:30a	2.0%.40GWd.top.cut
2,674,674	9/20/1999	06:29a	2.0%.50GWd.bottom.cut
2,914,187	9/20/1999	05:58a	2.0%.50GWd.fuel.cut
2,718,424	9/20/1999	06:22a	2.0%.50GWd.plenum.cut
2,698,384	9/20/1999	06:26a	2.0%.50GWd.top.cut
2,699,251	9/20/1999	06:25a	2.0%.60GWd.bottom.cut
2,945,659	9/20/1999	05:56a	2.0%.60GWd.fuel.cut
2,747,273	9/20/1999	06:07a	2.0%.60GWd.plenum.cut
2,722,069	9/20/1999	06:21a	2.0%.60GWd.top.cut
2,723,466	9/20/1999	06:21a	2.0%.70GWd.bottom.cut
2,971,294	9/20/1999	05:55a	2.0%.70GWd.fuel.cut
2,767,710	9/20/1999	06:04a	2.0%.70GWd.plenum.cut
2,744,376	9/20/1999	06:07a	2.0%.70GWd.top.cut
2,733,400	9/20/1999	06:08a	2.0%.75GWd.bottom.cut
2,983,610	9/20/1999	05:54a	2.0%.75GWd.fuel.cut
2,776,554	9/20/1999	06:03a	2.0%.75GWd.plenum.cut
2,755,462	9/20/1999	06:05a	2.0%.75GWd.top.cut
2,171,572	9/20/1999	07:18a	2.5%.100MWd.bottom.cut
2,351,126	9/20/1999	07:04a	2.5%.100MWd.fuel.cut
2,205,272	9/20/1999	07:16a	2.5%.100MWd.plenum.cut
2,188,114	9/20/1999	07:17a	2.5%.100MWd.top.cut
2,483,304	9/20/1999	07:02a	2.5%.10GWd.bottom.cut
2,701,892	9/20/1999	06:25a	2.5%.10GWd.fuel.cut
2,518,656	9/20/1999	06:59a	2.5%.10GWd.plenum.cut
2,500,000	9/20/1999	07:01a	2.5%.10GWd.top.cut
2,059,089	9/20/1999	07:24a	2.5%.10MWd.bottom.cut
2,236,341	9/20/1999	07:15a	2.5%.10MWd.fuel.cut
2,087,313	9/20/1999	07:22a	2.5%.10MWd.plenum.cut
2,078,037	9/20/1999	07:23a	2.5%.10MWd.top.cut
2,303,085	9/20/1999	07:14a	2.5%.1GWd.bottom.cut
2,490,291	9/20/1999	07:02a	2.5%.1GWd.fuel.cut
2,337,207	9/20/1999	07:12a	2.5%.1GWd.plenum.cut
2,321,775	9/20/1999	07:13a	2.5%.1GWd.top.cut
1,995,005	9/20/1999	07:27a	2.5%.1MWd.bottom.cut
2,152,185	9/20/1999	07:19a	2.5%.1MWd.fuel.cut
2,016,953	9/20/1999	07:25a	2.5%.1MWd.plenum.cut
2,012,365	9/20/1999	07:26a	2.5%.1MWd.top.cut
2,561,055	9/20/1999	06:58a	2.5%.20GWd.bottom.cut

File Size (bytes)	Date of Transfer	Time of Transfer	File Name
2,566,105	9/20/1999	06:58a	2.0%.20GWd.bottom.cut
2,805,987	9/20/1999	06:02a	2.0%.20GWd.fuel.cut
2,614,171	9/20/1999	06:55a	2.0%.20GWd.plenum.cut
2,584,795	9/20/1999	06:57a	2.0%.20GWd.top.cut
2,609,804	9/20/1999	06:55a	2.0%.30GWd.bottom.cut
2,851,710	9/20/1999	06:00a	2.0%.30GWd.fuel.cut
2,659,362	9/20/1999	06:31a	2.0%.30GWd.plenum.cut
2,632,922	9/20/1999	06:34a	2.0%.30GWd.top.cut
2,645,748	9/20/1999	06:33a	2.0%.40GWd.bottom.cut
2,882,530	9/20/1999	05:59a	2.0%.40GWd.fuel.cut
2,692,760	9/20/1999	06:26a	2.0%.40GWd.plenum.cut
2,665,382	9/20/1999	06:30a	2.0%.40GWd.top.cut
2,674,674	9/20/1999	06:29a	2.0%.50GWd.bottom.cut
2,914,187	9/20/1999	05:58a	2.0%.50GWd.fuel.cut
2,718,424	9/20/1999	06:22a	2.0%.50GWd.plenum.cut
2,698,384	9/20/1999	06:26a	2.0%.50GWd.top.cut
2,699,251	9/20/1999	06:25a	2.0%.60GWd.bottom.cut
2,945,659	9/20/1999	05:56a	2.0%.60GWd.fuel.cut
2,747,273	9/20/1999	06:07a	2.0%.60GWd.plenum.cut
2,722,069	9/20/1999	06:21a	2.0%.60GWd.top.cut
2,723,466	9/20/1999	06:21a	2.0%.70GWd.bottom.cut
2,971,294	9/20/1999	05:55a	2.0%.70GWd.fuel.cut
2,767,710	9/20/1999	06:04a	2.0%.70GWd.plenum.cut
2,744,376	9/20/1999	06:07a	2.0%.70GWd.top.cut
2,733,400	9/20/1999	06:08a	2.0%.75GWd.bottom.cut
2,983,610	9/20/1999	05:54a	2.0%.75GWd.fuel.cut
2,776,554	9/20/1999	06:03a	2.0%.75GWd.plenum.cut
2,755,462	9/20/1999	06:05a	2.0%.75GWd.top.cut
2,171,572	9/20/1999	07:18a	2.5%.100MWd.bottom.cut
2,351,126	9/20/1999	07:04a	2.5%.100MWd.fuel.cut
2,205,272	9/20/1999	07:16a	2.5%.100MWd.plenum.cut
2,188,114	9/20/1999	07:17a	2.5%.100MWd.top.cut
2,483,304	9/20/1999	07:02a	2.5%.10GWd.bottom.cut
2,701,892	9/20/1999	06:25a	2.5%.10GWd.fuel.cut
2,518,656	9/20/1999	06:59a	2.5%.10GWd.plenum.cut
2,500,000	9/20/1999	07:01a	2.5%.10GWd.top.cut
2,059,089	9/20/1999	07:24a	2.5%.10MWd.bottom.cut
2,236,341	9/20/1999	07:15a	2.5%.10MWd.fuel.cut
2,087,313	9/20/1999	07:22a	2.5%.10MWd.plenum.cut
2,078,037	9/20/1999	07:23a	2.5%.10MWd.top.cut
2,303,085	9/20/1999	07:14a	2.5%.1GWd.bottom.cut
2,490,291	9/20/1999	07:02a	2.5%.1GWd.fuel.cut
2,337,207	9/20/1999	07:12a	2.5%.1GWd.plenum.cut
2,321,775	9/20/1999	07:13a	2.5%.1GWd.top.cut
1,995,005	9/20/1999	07:27a	2.5%.1MWd.bottom.cut
2,152,185	9/20/1999	07:19a	2.5%.1MWd.fuel.cut
2,016,953	9/20/1999	07:25a	2.5%.1MWd.plenum.cut
2,012,365	9/20/1999	07:26a	2.5%.1MWd.top.cut
2,561,055	9/20/1999	06:58a	2.5%.20GWd.bottom.cut

CD 2

File Size (bytes)	Date of Transfer	Time of Transfer	File Name
2,795,079	9/20/1999	06:02a	2.5%.20GWd.fuel.cut
2,602,649	9/20/1999	06:55a	2.5%.20GWd.plenum.cut
2,577,875	9/20/1999	06:57a	2.5%.20GWd.top.cut
2,608,409	9/20/1999	06:55a	2.5%.30GWd.bottom.cut
2,849,933	9/20/1999	06:00a	2.5%.30GWd.fuel.cut
2,655,695	9/20/1999	06:31a	2.5%.30GWd.plenum.cut
2,631,527	9/20/1999	06:34a	2.5%.30GWd.top.cut
2,644,200	9/20/1999	06:33a	2.5%.40GWd.bottom.cut
2,881,096	9/20/1999	05:59a	2.5%.40GWd.fuel.cut
2,691,202	9/20/1999	06:27a	2.5%.40GWd.plenum.cut
2,664,826	9/20/1999	06:30a	2.5%.40GWd.top.cut
2,671,355	9/20/1999	06:30a	2.5%.50GWd.bottom.cut
2,906,745	9/20/1999	05:58a	2.5%.50GWd.fuel.cut
2,715,105	9/20/1999	06:23a	2.5%.50GWd.plenum.cut
2,694,941	9/20/1999	06:26a	2.5%.50GWd.top.cut
2,696,048	9/20/1999	06:26a	2.5%.60GWd.bottom.cut
2,941,304	9/20/1999	05:57a	2.5%.60GWd.fuel.cut
2,745,284	9/20/1999	06:07a	2.5%.60GWd.plenum.cut
2,719,634	9/20/1999	06:22a	2.5%.60GWd.top.cut
2,715,038	9/20/1999	06:23a	2.5%.70GWd.bottom.cut
2,966,614	9/20/1999	05:55a	2.5%.70GWd.fuel.cut
2,763,308	9/20/1999	06:05a	2.5%.70GWd.plenum.cut
2,737,856	9/20/1999	06:08a	2.5%.70GWd.top.cut
2,730,060	9/20/1999	06:20a	2.5%.75GWd.bottom.cut
2,977,878	9/20/1999	05:55a	2.5%.75GWd.fuel.cut
2,774,552	9/20/1999	06:04a	2.5%.75GWd.plenum.cut
2,751,094	9/20/1999	06:06a	2.5%.75GWd.top.cut
2,167,994	9/20/1999	07:18a	3.0%.100MWd.bottom.cut
2,347,300	9/20/1999	07:11a	3.0%.100MWd.fuel.cut
2,199,556	9/20/1999	07:16a	3.0%.100MWd.plenum.cut
2,184,412	9/20/1999	07:17a	3.0%.100MWd.top.cut
2,479,926	9/20/1999	07:03a	3.0%.10GWd.bottom.cut
2,697,264	9/20/1999	06:26a	3.0%.10GWd.fuel.cut
2,515,164	9/20/1999	07:00a	3.0%.10GWd.plenum.cut
2,496,166	9/20/1999	07:01a	3.0%.10GWd.top.cut
2,056,243	9/20/1999	07:24a	3.0%.10MWd.bottom.cut
2,233,867	9/20/1999	07:15a	3.0%.10MWd.fuel.cut
2,086,699	9/20/1999	07:22a	3.0%.10MWd.plenum.cut
2,075,067	9/20/1999	07:23a	3.0%.10MWd.top.cut
2,302,553	9/20/1999	07:14a	3.0%.1GWd.bottom.cut
2,485,667	9/20/1999	07:02a	3.0%.1GWd.fuel.cut
2,336,933	9/20/1999	07:12a	3.0%.1GWd.plenum.cut
2,320,881	9/20/1999	07:13a	3.0%.1GWd.top.cut
1,992,416	9/20/1999	07:27a	3.0%.1MWd.bottom.cut
2,151,580	9/20/1999	07:20a	3.0%.1MWd.fuel.cut
2,016,224	9/20/1999	07:25a	3.0%.1MWd.plenum.cut
2,012,008	9/20/1999	07:26a	3.0%.1MWd.top.cut
2,551,604	9/20/1999	06:58a	3.0%.20GWd.bottom.cut
2,785,008	9/20/1999	06:02a	3.0%.20GWd.fuel.cut

CD 2

File Size (bytes)	Date of Transfer	Time of Transfer	File Name
2,592,702	9/20/1999	06:56a	3.0%.20GWd.plenum.cut
2,567,050	9/20/1999	06:57a	3.0%.20GWd.top.cut
2,605,177	9/20/1999	06:55a	3.0%.30GWd.bottom.cut
2,844,344	9/20/1999	06:01a	3.0%.30GWd.fuel.cut
2,652,319	9/20/1999	06:32a	3.0%.30GWd.plenum.cut
2,624,725	9/20/1999	06:54a	3.0%.30GWd.top.cut
2,638,930	9/20/1999	06:33a	3.0%.40GWd.bottom.cut
2,881,942	9/20/1999	05:59a	3.0%.40GWd.fuel.cut
2,692,172	9/20/1999	06:27a	3.0%.40GWd.plenum.cut
2,663,386	9/20/1999	06:30a	3.0%.40GWd.top.cut
2,671,192	9/20/1999	06:30a	3.0%.50GWd.bottom.cut
2,907,578	9/20/1999	05:58a	3.0%.50GWd.fuel.cut
2,717,694	9/20/1999	06:22a	3.0%.50GWd.plenum.cut
2,694,406	9/20/1999	06:26a	3.0%.50GWd.top.cut
2,698,497	9/20/1999	06:25a	3.0%.60GWd.bottom.cut
2,943,515	9/20/1999	05:57a	3.0%.60GWd.fuel.cut
2,744,737	9/20/1999	06:07a	3.0%.60GWd.plenum.cut
2,722,331	9/20/1999	06:21a	3.0%.60GWd.top.cut
2,721,161	9/20/1999	06:22a	3.0%.70GWd.bottom.cut
2,970,669	9/20/1999	05:55a	3.0%.70GWd.fuel.cut
2,769,307	9/20/1999	06:04a	3.0%.70GWd.plenum.cut
2,743,979	9/20/1999	06:07a	3.0%.70GWd.top.cut
2,734,208	9/20/1999	06:08a	3.0%.75GWd.bottom.cut
2,982,710	9/20/1999	05:54a	3.0%.75GWd.fuel.cut
2,779,022	9/20/1999	06:03a	3.0%.75GWd.plenum.cut
2,755,812	9/20/1999	06:05a	3.0%.75GWd.top.cut
2,166,856	9/20/1999	07:18a	3.5%.100MWd.bottom.cut
2,345,760	9/20/1999	07:12a	3.5%.100MWd.fuel.cut
2,198,056	9/20/1999	07:16a	3.5%.100MWd.plenum.cut
2,182,902	9/20/1999	07:18a	3.5%.100MWd.top.cut
2,483,276	9/20/1999	07:02a	3.5%.10GWd.bottom.cut
2,700,356	9/20/1999	06:25a	3.5%.10GWd.fuel.cut
2,518,638	9/20/1999	06:59a	3.5%.10GWd.plenum.cut
2,499,640	9/20/1999	07:01a	3.5%.10GWd.top.cut
2,057,607	9/20/1999	07:24a	3.5%.10MWd.bottom.cut
2,235,107	9/20/1999	07:15a	3.5%.10MWd.fuel.cut
2,088,177	9/20/1999	07:22a	3.5%.10MWd.plenum.cut
2,076,555	9/20/1999	07:23a	3.5%.10MWd.top.cut
2,300,542	9/20/1999	07:14a	3.5%.1GWd.bottom.cut
2,482,054	9/20/1999	07:03a	3.5%.1GWd.fuel.cut
2,335,314	9/20/1999	07:12a	3.5%.1GWd.plenum.cut
2,318,756	9/20/1999	07:13a	3.5%.1GWd.top.cut
1,994,028	9/20/1999	07:27a	3.5%.1MWd.bottom.cut
2,153,068	9/20/1999	07:19a	3.5%.1MWd.fuel.cut
2,017,588	9/20/1999	07:25a	3.5%.1MWd.plenum.cut
2,013,496	9/20/1999	07:26a	3.5%.1MWd.top.cut
2,547,236	9/20/1999	06:59a	3.5%.20GWd.bottom.cut
2,782,138	9/20/1999	06:02a	3.5%.20GWd.fuel.cut
2,589,238	9/20/1999	06:56a	3.5%.20GWd.plenum.cut

CD 2			
File Size (bytes)	Date of Transfer	Time of Transfer	File Name
2,564,676	9/20/1999	06:58a	3.5%.20GWd.top.cut
2,603,543	9/20/1999	06:55a	3.5%.30GWd.bottom.cut
2,844,903	9/20/1999	06:00a	3.5%.30GWd.fuel.cut
2,653,259	9/20/1999	06:32a	3.5%.30GWd.plenum.cut
2,625,665	9/20/1999	06:54a	3.5%.30GWd.top.cut
2,636,164	9/20/1999	06:33a	3.5%.40GWd.bottom.cut
2,877,936	9/20/1999	05:59a	3.5%.40GWd.fuel.cut
2,687,090	10/31/2002	11:39a	3.5%.40GWd.plenum.cut
2,659,540	10/31/2002	11:36a	3.5%.40GWd.top.cut
2,665,214	10/31/2002	11:39a	3.5%.50GWd.bottom.cut
2,903,752	10/31/2002	11:36a	3.5%.50GWd.fuel.cut
2,714,230	10/31/2002	11:39a	3.5%.50GWd.plenum.cut
2,686,346	10/31/2002	11:36a	3.5%.50GWd.top.cut
2,696,603	10/31/2002	11:39a	3.5%.60GWd.bottom.cut
2,936,239	10/31/2002	11:36a	3.5%.60GWd.fuel.cut
2,742,595	10/31/2002	11:39a	3.5%.60GWd.plenum.cut
2,720,189	10/31/2002	11:36a	3.5%.60GWd.top.cut
2,721,739	10/31/2002	11:39a	3.5%.70GWd.bottom.cut
2,968,395	10/31/2002	11:36a	3.5%.70GWd.fuel.cut
2,769,761	10/31/2002	11:38a	3.5%.70GWd.plenum.cut
2,744,557	10/31/2002	11:36a	3.5%.70GWd.top.cut
2,731,677	10/31/2002	11:39a	3.5%.75GWd.bottom.cut
2,980,679	10/31/2002	11:36a	3.5%.75GWd.fuel.cut
2,780,071	10/31/2002	11:39a	3.5%.75GWd.plenum.cut
2,754,619	9/20/1999	06:05a	3.5%.75GWd.top.cut

CD 3			
File Size (bytes)	Date of Transfer	Time of Transfer	File Name
Folder: 4.0%_through_5.5%_and_SS_clad			
2,164,211	9/20/1999	07:19a	4.0%.100MWd.bottom.cut
2,346,359	9/20/1999	07:11a	4.0%.100MWd.fuel.cut
2,196,775	9/20/1999	07:17a	4.0%.100MWd.plenum.cut
2,183,739	9/20/1999	07:18a	4.0%.100MWd.top.cut
2,479,639	9/20/1999	07:03a	4.0%.10GWd.bottom.cut
2,698,207	9/20/1999	06:26a	4.0%.10GWd.fuel.cut
2,515,011	9/20/1999	07:00a	4.0%.10GWd.plenum.cut
2,496,261	9/20/1999	07:01a	4.0%.10GWd.top.cut
2,058,599	9/20/1999	07:24a	4.0%.10MWd.bottom.cut
2,235,831	9/20/1999	07:15a	4.0%.10MWd.fuel.cut
2,089,035	9/20/1999	07:20a	4.0%.10MWd.plenum.cut
2,077,671	9/20/1999	07:23a	4.0%.10MWd.top.cut
2,300,650	9/20/1999	07:14a	4.0%.1GWd.bottom.cut
2,480,292	9/20/1999	07:03a	4.0%.1GWd.fuel.cut
2,335,670	9/20/1999	07:12a	4.0%.1GWd.plenum.cut
2,318,740	9/20/1999	07:13a	4.0%.1GWd.top.cut
1,995,145	9/20/1999	07:27a	4.0%.1MWd.bottom.cut
2,154,309	9/20/1999	07:19a	4.0%.1MWd.fuel.cut

CD 3			
File Size (bytes)	Date of Transfer	Time of Transfer	File Name
2,018,457	9/20/1999	07:25a	4.0%.1MWd.plenum.cut
2,014,737	9/20/1999	07:25a	4.0%.1MWd.top.cut
2,546,626	9/20/1999	06:59a	4.0%.20GWd.bottom.cut
2,778,646	9/20/1999	06:03a	4.0%.20GWd.fuel.cut
2,588,430	9/20/1999	06:57a	4.0%.20GWd.plenum.cut
2,563,942	9/20/1999	06:58a	4.0%.20GWd.top.cut
2,604,783	9/20/1999	06:55a	4.0%.30GWd.bottom.cut
2,844,893	9/20/1999	06:01a	4.0%.30GWd.fuel.cut
2,654,251	9/20/1999	06:32a	4.0%.30GWd.plenum.cut
2,626,533	9/20/1999	06:34a	4.0%.30GWd.top.cut
2,633,254	9/20/1999	06:33a	4.0%.40GWd.bottom.cut
2,872,784	9/20/1999	06:00a	4.0%.40GWd.fuel.cut
2,684,046	9/20/1999	06:28a	4.0%.40GWd.plenum.cut
2,656,630	9/20/1999	06:31a	4.0%.40GWd.top.cut
2,662,834	9/20/1999	06:30a	4.0%.50GWd.bottom.cut
2,902,870	9/20/1999	05:58a	4.0%.50GWd.fuel.cut
2,712,842	9/20/1999	06:23a	4.0%.50GWd.plenum.cut
2,684,626	9/20/1999	06:28a	4.0%.50GWd.top.cut
2,691,347	9/20/1999	06:27a	4.0%.60GWd.bottom.cut
2,926,851	9/20/1999	05:57a	4.0%.60GWd.fuel.cut
2,734,973	9/20/1999	06:08a	4.0%.60GWd.plenum.cut
2,714,809	9/20/1999	06:23a	4.0%.60GWd.top.cut
2,720,493	9/20/1999	06:22a	4.0%.70GWd.bottom.cut
2,965,873	9/20/1999	05:56a	4.0%.70GWd.fuel.cut
2,769,357	9/20/1999	06:04a	4.0%.70GWd.plenum.cut
2,744,451	9/20/1999	06:07a	4.0%.70GWd.top.cut
2,731,234	9/20/1999	06:09a	4.0%.75GWd.bottom.cut
2,980,638	9/20/1999	05:54a	4.0%.75GWd.fuel.cut
2,779,256	9/20/1999	06:03a	4.0%.75GWd.plenum.cut
2,754,052	9/20/1999	06:06a	4.0%.75GWd.top.cut
2,164,946	9/20/1999	07:19a	4.5%.100MWd.bottom.cut
2,347,476	9/20/1999	07:11a	4.5%.100MWd.fuel.cut
2,197,396	9/20/1999	07:17a	4.5%.100MWd.plenum.cut
2,184,340	9/20/1999	07:17a	4.5%.100MWd.top.cut
2,476,164	9/20/1999	07:03a	4.5%.10GWd.bottom.cut
2,691,930	9/20/1999	06:27a	4.5%.10GWd.fuel.cut
2,511,804	9/20/1999	07:00a	4.5%.10GWd.plenum.cut
2,492,930	9/20/1999	07:02a	4.5%.10GWd.top.cut
2,057,996	9/20/1999	07:24a	4.5%.10MWd.bottom.cut
2,235,352	9/20/1999	07:15a	4.5%.10MWd.fuel.cut
2,088,308	9/20/1999	07:22a	4.5%.10MWd.plenum.cut
2,076,810	9/20/1999	07:23a	4.5%.10MWd.top.cut
2,299,411	9/20/1999	07:14a	4.5%.1GWd.bottom.cut
2,481,161	9/20/1999	07:03a	4.5%.1GWd.fuel.cut
2,334,307	9/20/1999	07:13a	4.5%.1GWd.plenum.cut
2,317,501	9/20/1999	07:14a	4.5%.1GWd.top.cut
1,996,386	9/20/1999	07:27a	4.5%.1MWd.bottom.cut
2,155,302	9/20/1999	07:19a	4.5%.1MWd.fuel.cut
2,017,962	9/20/1999	07:25a	4.5%.1MWd.plenum.cut

CD 3			
File Size (bytes)	Date of Transfer	Time of Transfer	File Name
2,016,226	9/20/1999	07:25a	4.5%.1MWd.top.cut
2,548,621	9/20/1999	06:58a	4.5%.20GWd.bottom.cut
2,775,557	9/20/1999	06:03a	4.5%.20GWd.fuel.cut
2,590,043	9/20/1999	06:56a	4.5%.20GWd.plenum.cut
2,565,947	9/20/1999	06:58a	4.5%.20GWd.top.cut
2,602,026	9/20/1999	06:56a	4.5%.30GWd.bottom.cut
2,841,526	9/20/1999	06:01a	4.5%.30GWd.fuel.cut
2,650,488	9/20/1999	06:32a	4.5%.30GWd.plenum.cut
2,623,082	9/20/1999	06:54a	4.5%.30GWd.top.cut
2,633,213	9/20/1999	06:34a	4.5%.40GWd.bottom.cut
2,874,355	9/20/1999	05:59a	4.5%.40GWd.fuel.cut
2,680,365	9/20/1999	06:29a	4.5%.40GWd.plenum.cut
2,656,341	9/20/1999	06:31a	4.5%.40GWd.top.cut
2,660,821	9/20/1999	06:30a	4.5%.50GWd.bottom.cut
2,899,597	9/20/1999	05:58a	4.5%.50GWd.fuel.cut
2,709,559	9/20/1999	06:23a	4.5%.50GWd.plenum.cut
2,683,729	9/20/1999	06:28a	4.5%.50GWd.top.cut
2,686,888	9/20/1999	06:27a	4.5%.60GWd.bottom.cut
2,921,608	9/20/1999	05:58a	4.5%.60GWd.fuel.cut
2,731,828	9/20/1999	06:09a	4.5%.60GWd.plenum.cut
2,710,648	9/20/1999	06:23a	4.5%.60GWd.top.cut
2,717,321	9/20/1999	06:23a	4.5%.70GWd.bottom.cut
2,962,205	9/20/1999	05:56a	4.5%.70GWd.fuel.cut
2,765,555	9/20/1999	06:05a	4.5%.70GWd.plenum.cut
2,740,907	9/20/1999	06:08a	4.5%.70GWd.top.cut
2,729,846	9/20/1999	06:20a	4.5%.75GWd.bottom.cut
2,977,404	9/20/1999	05:55a	4.5%.75GWd.fuel.cut
2,778,884	9/20/1999	06:03a	4.5%.75GWd.plenum.cut
2,753,358	9/20/1999	06:06a	4.5%.75GWd.top.cut
2,163,695	9/20/1999	07:19a	5.0%.100MWd.bottom.cut
2,345,977	9/20/1999	07:12a	5.0%.100MWd.fuel.cut
2,196,145	9/20/1999	07:17a	5.0%.100MWd.plenum.cut
2,181,591	9/20/1999	07:18a	5.0%.100MWd.top.cut
2,477,536	9/20/1999	07:03a	5.0%.10GWd.bottom.cut
2,692,538	9/20/1999	06:27a	5.0%.10GWd.fuel.cut
2,513,176	9/20/1999	07:00a	5.0%.10GWd.plenum.cut
2,494,044	9/20/1999	07:01a	5.0%.10GWd.top.cut
2,056,374	9/20/1999	07:24a	5.0%.10MWd.bottom.cut
2,230,744	9/20/1999	07:16a	5.0%.10MWd.fuel.cut
2,086,686	9/20/1999	07:22a	5.0%.10MWd.plenum.cut
2,073,442	9/20/1999	07:23a	5.0%.10MWd.top.cut
2,298,772	9/20/1999	07:15a	5.0%.1GWd.bottom.cut
2,480,904	9/20/1999	07:03a	5.0%.1GWd.fuel.cut
2,334,298	9/20/1999	07:13a	5.0%.1GWd.plenum.cut
2,316,986	9/20/1999	07:14a	5.0%.1GWd.top.cut
1,996,758	9/20/1999	07:27a	5.0%.1MWd.bottom.cut
2,156,046	9/20/1999	07:19a	5.0%.1MWd.fuel.cut
2,018,706	9/20/1999	07:25a	5.0%.1MWd.plenum.cut
2,016,970	9/20/1999	07:25a	5.0%.1MWd.top.cut

CD 3			
File Size (bytes)	Date of Transfer	Time of Transfer	File Name
2,549,177	9/20/1999	06:58a	5.0%.20GWd.bottom.cut
2,775,503	9/20/1999	06:03a	5.0%.20GWd.fuel.cut
2,590,733	9/20/1999	06:56a	5.0%.20GWd.plenum.cut
2,566,513	9/20/1999	06:57a	5.0%.20GWd.top.cut
2,601,534	9/20/1999	06:56a	5.0%.30GWd.bottom.cut
2,840,290	9/20/1999	06:01a	5.0%.30GWd.fuel.cut
2,646,728	9/20/1999	06:33a	5.0%.30GWd.plenum.cut
2,620,348	9/20/1999	06:54a	5.0%.30GWd.top.cut
2,633,137	9/20/1999	06:34a	5.0%.40GWd.bottom.cut
2,874,155	9/20/1999	06:00a	5.0%.40GWd.fuel.cut
2,680,041	9/20/1999	06:29a	5.0%.40GWd.plenum.cut
2,656,007	9/20/1999	06:31a	5.0%.40GWd.top.cut
2,656,948	9/20/1999	06:31a	5.0%.50GWd.bottom.cut
2,897,098	9/20/1999	05:58a	5.0%.50GWd.fuel.cut
2,706,058	9/20/1999	06:24a	5.0%.50GWd.plenum.cut
2,682,232	9/20/1999	06:28a	5.0%.50GWd.top.cut
2,683,602	9/20/1999	06:28a	5.0%.60GWd.bottom.cut
2,922,200	9/20/1999	05:57a	5.0%.60GWd.fuel.cut
2,730,282	9/20/1999	06:20a	5.0%.60GWd.plenum.cut
2,709,112	9/20/1999	06:24a	5.0%.60GWd.top.cut
2,710,938	9/20/1999	06:23a	5.0%.70GWd.bottom.cut
2,951,328	9/20/1999	05:56a	5.0%.70GWd.fuel.cut
2,759,678	9/20/1999	06:05a	5.0%.70GWd.plenum.cut
2,734,648	9/20/1999	06:08a	5.0%.70GWd.top.cut
2,725,401	9/20/1999	06:21a	5.0%.75GWd.bottom.cut
2,970,667	9/20/1999	05:55a	5.0%.75GWd.fuel.cut
2,773,635	9/20/1999	06:04a	5.0%.75GWd.plenum.cut
2,748,987	9/20/1999	06:06a	5.0%.75GWd.top.cut
2,156,746	9/20/1999	07:19a	5.5%.100MWd.bottom.cut
2,339,028	9/20/1999	07:12a	5.5%.100MWd.fuel.cut
2,189,196	9/20/1999	07:17a	5.5%.100MWd.plenum.cut
2,174,642	9/20/1999	07:18a	5.5%.100MWd.top.cut
2,474,808	9/20/1999	07:03a	5.5%.10GWd.bottom.cut
2,692,176	9/20/1999	06:27a	5.5%.10GWd.fuel.cut
2,512,442	9/20/1999	07:00a	5.5%.10GWd.plenum.cut
2,493,558	9/20/1999	07:01a	5.5%.10GWd.top.cut
2,056,632	9/20/1999	07:24a	5.5%.10MWd.bottom.cut
2,230,744	9/20/1999	07:16a	5.5%.10MWd.fuel.cut
2,086,944	9/20/1999	07:22a	5.5%.10MWd.plenum.cut
2,073,700	9/20/1999	07:23a	5.5%.10MWd.top.cut
2,296,678	9/20/1999	07:15a	5.5%.1GWd.bottom.cut
2,478,686	9/20/1999	07:03a	5.5%.1GWd.fuel.cut
2,332,070	9/20/1999	07:13a	5.5%.1GWd.plenum.cut
2,314,892	9/20/1999	07:14a	5.5%.1GWd.top.cut
1,997,253	9/20/1999	07:26a	5.5%.1MWd.bottom.cut
2,156,417	9/20/1999	07:19a	5.5%.1MWd.fuel.cut
2,019,077	9/20/1999	07:25a	5.5%.1MWd.plenum.cut
2,017,217	9/20/1999	07:25a	5.5%.1MWd.top.cut
2,547,276	9/20/1999	06:58a	5.5%.20GWd.bottom.cut

File Size (bytes)	Date of Transfer	Time of Transfer	File Name
2,772,972	9/20/1999	06:04a	5.5%.20GWd.fuel.cut
2,588,966	9/20/1999	06:56a	5.5%.20GWd.plenum.cut
2,564,156	9/20/1999	06:58a	5.5%.20GWd.top.cut
2,596,407	9/20/1999	06:56a	5.5%.30GWd.bottom.cut
2,834,791	9/20/1999	06:01a	5.5%.30GWd.fuel.cut
2,641,601	9/20/1999	06:33a	5.5%.30GWd.plenum.cut
2,614,983	9/20/1999	06:55a	5.5%.30GWd.top.cut
2,625,357	9/20/1999	06:54a	5.5%.40GWd.bottom.cut
2,868,587	9/20/1999	06:00a	5.5%.40GWd.fuel.cut
2,674,969	9/20/1999	06:29a	5.5%.40GWd.plenum.cut
2,651,049	9/20/1999	06:32a	5.5%.40GWd.top.cut
2,655,511	9/20/1999	06:31a	5.5%.50GWd.bottom.cut
2,893,037	9/20/1999	05:59a	5.5%.50GWd.fuel.cut
2,706,997	9/20/1999	06:24a	5.5%.50GWd.plenum.cut
2,679,655	9/20/1999	06:29a	5.5%.50GWd.top.cut
2,677,253	9/20/1999	06:29a	5.5%.60GWd.bottom.cut
2,918,777	9/20/1999	05:58a	5.5%.60GWd.fuel.cut
2,728,605	9/20/1999	06:20a	5.5%.60GWd.plenum.cut
2,702,973	9/20/1999	06:25a	5.5%.60GWd.top.cut
2,706,837	9/20/1999	06:24a	5.5%.70GWd.bottom.cut
2,944,727	9/20/1999	05:57a	5.5%.70GWd.fuel.cut
2,752,819	9/20/1999	06:06a	5.5%.70GWd.plenum.cut
2,730,423	9/20/1999	06:09a	5.5%.70GWd.top.cut
2,722,189	9/20/1999	06:21a	5.5%.75GWd.bottom.cut
2,963,591	9/20/1999	05:56a	5.5%.75GWd.fuel.cut
2,770,805	9/20/1999	06:04a	5.5%.75GWd.plenum.cut
2,746,033	9/20/1999	06:07a	5.5%.75GWd.top.cut
2,691,472	9/20/1999	06:27a	BWRSS.3.5%.10GWd.fuel.cut
2,516,636	9/20/1999	07:00a	BWRSS.3.5%.10GWd.plenum.cut
2,486,567	9/20/1999	07:02a	BWRSS.3.5%.1GWd.fuel.cut
2,331,041	9/20/1999	07:13a	BWRSS.3.5%.1GWd.plenum.cut
2,781,612	9/20/1999	06:02a	BWRSS.3.5%.20GWd.fuel.cut
2,587,790	9/20/1999	06:57a	BWRSS.3.5%.20GWd.plenum.cut
2,842,881	9/20/1999	06:01a	BWRSS.3.5%.30GWd.fuel.cut
2,651,605	9/20/1999	06:32a	BWRSS.3.5%.30GWd.plenum.cut
2,878,403	10/8/1999	04:05a	BWRSS.3.5%.40GWd.fuel.cut
2,689,415	10/8/1999	04:01a	BWRSS.3.5%.40GWd.plenum.cut
2,689,973	10/8/1999	04:02a	BWRSS.4.0%.10GWd.fuel.cut
2,515,375	10/8/1999	04:02a	BWRSS.4.0%.10GWd.plenum.cut
2,483,104	10/8/1999	04:02a	BWRSS.4.0%.1GWd.fuel.cut
2,328,394	10/8/1999	04:02a	BWRSS.4.0%.1GWd.plenum.cut
2,779,992	10/8/1999	04:02a	BWRSS.4.0%.20GWd.fuel.cut
2,586,280	10/8/1999	04:02a	BWRSS.4.0%.20GWd.plenum.cut
2,841,630	10/8/1999	04:03a	BWRSS.4.0%.30GWd.fuel.cut
2,649,362	10/8/1999	04:03a	BWRSS.4.0%.30GWd.plenum.cut
2,872,267	10/8/1999	04:03a	BWRSS.4.0%.40GWd.fuel.cut
2,682,999	10/8/1999	04:03a	BWRSS.4.0%.40GWd.plenum.cut

Averages from Ref. 7.24, Table 5; Maximums from Ref. 7.24, Attachment III bin.dat files

For all cases, the information on the following pages represents the data set closest to those defined on this page

Case A , B, and C Averages for the extended baseline (84k MTU)

BWR:	**Nominal data points:**	**3.5%, 40 GWd/MTU, 25 years old, 200 kg loading (actual burnup is 39.3 GWd/t)**			
	3.02	33592.24016	0.18	*Case A Average Age*	25.32
	Enrich	Burnup (MWd/MTU)	MTU	*Case B Average Age*	25.31
				Case C Average Age	25.43

Averages are calculated by multiplying the enrichment, burnup or age by the number of assemblies with that given burnup, enrichment, or age, summing, and then dividing by the total number in the waste stream

Case A , B, and C Maximums

BWR Maximums								
Case A			Case B			Case C		
Enrichment	Burnup (MWd/MTU)	Age (yrs)	Enrichment	Burnup (MWd/MTU)	Age (yrs)	Enrichment	Burnup (MWd/MTU)	Age (yrs)
4.28	65550	5	4.28	65550	5	4.28	65550	5
Nominal data points:	**5.0%, 75 GWd/MTU, 5 years old, 200 kg loading (actual burnup is 73.8 GWd/t)**							

For the maximums:

These are a combination of all the maximum parameters:
the maximum burnup, the max enrichment, and minimum age (all independent of each other).

All source term calculations use dimensions for the representative assembly

The cases refer to the arrival scenarios

Average BWR for shorter decay times										
Age:	25.0 yr	125.0 yr	225.0 yr	325.0 yr	425.0 yr	525.0 yr	1025.0 yr	2025.0 yr	5025.0 yr	10025.0 yr
Year:	2033	2133	2233	2333	2433	2533	3033	4033	7033	12033
ag108	3.335E-04	1.934E-04	1.119E-04	6.480E-05	3.761E-05	2.175E-05	1.416E-06	6.060E-09	4.680E-16	6.590E-28
ag108m	3.830E-03	2.216E-03	1.286E-03	7.460E-04	4.320E-04	2.497E-04	1.629E-05	6.960E-08	5.390E-15	7.580E-27
am241	5.580E+02	6.720E+02	5.740E+02	4.890E+02	4.170E+02	3.550E+02	1.590E+02	3.210E+01	2.900E-01	1.800E-02
am242	2.160E+00	1.320E+00	8.070E-01	4.940E-01	3.020E-01	1.850E-01	1.580E-02	1.160E-04	4.560E-11	9.640E-22
am242m	2.170E+00	1.330E+00	8.100E-01	4.960E-01	3.030E-01	1.850E-01	1.590E-02	1.160E-04	4.580E-11	9.690E-22
am243	5.340E+00	5.290E+00	5.240E+00	5.190E+00	5.140E+00	5.090E+00	4.860E+00	4.420E+00	3.340E+00	2.080E+00
ar 39	1.610E-05	1.240E-05	9.590E-06	7.410E-06	5.730E-06	4.430E-06	1.220E-06	9.280E-08	4.070E-11	1.030E-16
ba137m	1.310E+04	1.300E+03	1.290E+02	1.280E+01	1.270E+00	1.260E-01	1.210E-06	1.110E-16	0.000E+00	0.000E+00
bi212	4.700E-03	1.770E-03	6.550E-04	2.430E-04	9.010E-05	3.350E-05	3.980E-07	1.690E-07	1.770E-07	1.920E-07
c 14	1.760E-01	1.730E-01	1.710E-01	1.690E-01	1.670E-01	1.650E-01	1.560E-01	1.380E-01	9.592E-02	5.241E-02
ca 41	3.730E-05	3.730E-05	3.720E-05	3.720E-05	3.720E-05	3.720E-05	3.700E-05	3.680E-05	3.600E-05	3.490E-05
cd113m	2.262E+00	1.657E-02	1.220E-04	8.910E-07	6.530E-09	4.788E-11	1.012E-21	0.000E+00	0.000E+00	0.000E+00
ce144	2.880E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
cl 36	2.930E-03	2.930E-03	2.930E-03	2.930E-03	2.930E-03	2.930E-03	2.920E-03	2.920E-03	2.900E-03	2.860E-03
cm242	1.780E+00	1.090E+00	6.670E-01	4.080E-01	2.500E-01	1.530E-01	1.310E-02	9.580E-05	3.780E-11	8.000E-22
cm243	2.470E+00	2.170E-01	1.910E-02	1.680E-03	1.470E-04	1.290E-05	6.760E-11	1.850E-21	0.000E+00	0.000E+00
cm244	2.550E+02	5.540E+00	1.200E-01	2.610E-03	5.670E-05	1.230E-06	5.940E-15	1.370E-31	0.000E+00	0.000E+00
cm245	4.030E-02	4.000E-02	3.970E-02	3.930E-02	3.900E-02	3.870E-02	3.710E-02	3.420E-02	2.680E-02	1.780E-02
cm246	1.450E-02	1.430E-02	1.410E-02	1.390E-02	1.370E-02	1.350E-02	1.250E-02	1.080E-02	6.970E-03	3.350E-03
co 60	4.390E+01	8.510E-05	1.650E-10	3.190E-16	6.180E-22	1.200E-27	0.000E+00	0.000E+00	0.000E+00	0.000E+00
cs134	6.320E+00	1.590E-14	3.980E-29	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
cs135	1.390E-01	1.390E-01	1.390E-01	1.390E-01	1.390E-01	1.390E-01	1.390E-01	1.390E-01	1.390E-01	1.380E-01
cs137	1.390E+04	1.370E+03	1.360E+02	1.350E+01	1.340E+00	1.330E-01	1.280E-06	1.180E-16	0.000E+00	0.000E+00
eu152	5.290E-01	2.920E-03	1.610E-05	8.861E-08	4.880E-10	2.690E-12	1.370E-23	0.000E+00	0.000E+00	0.000E+00
eu154	1.746E+02	5.451E-02	1.706E-05	5.340E-09	1.676E-12	5.229E-16	0.000E+00	0.000E+00	0.000E+00	0.000E+00
eu155	1.603E+01	5.909E-06	2.188E-12	8.067E-19	2.985E-25	1.140E-31	0.000E+00	0.000E+00	0.000E+00	0.000E+00
fe 55	1.090E+00	1.020E-11	9.560E-23	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
h 3	3.950E+01	1.428E-01	5.170E-04	1.867E-06	6.750E-09	2.449E-11	1.513E-23	0.000E+00	0.000E+00	0.000E+00
ho166m	1.176E-03	1.110E-03	1.051E-03	9.927E-04	9.372E-04	8.840E-04	6.622E-04	3.716E-04	6.577E-05	3.660E-06
i129	7.420E-03	7.420E-03	7.420E-03	7.420E-03	7.420E-03	7.420E-03	7.420E-03	7.420E-03	7.420E-03	7.420E-03
kr 85	3.810E+02	5.930E-01	9.210E-04	1.430E-06	2.230E-09	3.460E-12	3.150E-26	0.000E+00	0.000E+00	0.000E+00
mo 93	2.220E-04	2.170E-04	2.130E-04	2.090E-04	2.050E-04	2.010E-04	1.820E-04	1.490E-04	8.240E-05	3.060E-05
nb 93m	4.730E-01	3.407E-01	3.388E-01	3.387E-01	3.387E-01	3.387E-01	3.387E-01	3.376E-01	3.375E-01	3.363E-01
nb 94	1.872E-02	1.862E-02	1.862E-02	1.852E-02	1.842E-02	1.842E-02	1.812E-02	1.752E-02	1.582E-02	1.331E-02
ni 59	5.020E-01	5.020E-01	5.010E-01	5.010E-01	5.000E-01	5.000E-01	4.970E-01	4.930E-01	4.790E-01	4.580E-01
ni 63	5.860E+01	2.930E+01	1.470E+01	7.340E+00	3.670E+00	1.840E+00	5.760E-02	5.660E-05	5.380E-14	4.940E-29
np237	6.880E-02	9.090E-02	1.110E-01	1.280E-01	1.430E-01	1.550E-01	1.950E-01	2.210E-01	2.270E-01	2.260E-01
np238	9.750E-03	5.960E-03	3.650E-03	2.230E-03	1.360E-03	8.350E-04	7.150E-05	5.240E-07	2.060E-13	4.360E-24
np239	5.340E+00	5.290E+00	5.240E+00	5.190E+00	5.140E+00	5.090E+00	4.860E+00	4.420E+00	3.340E+00	2.080E+00
pa231	1.390E-05	1.950E-05	2.500E-05	3.050E-05	3.600E-05	4.150E-05	6.910E-05	1.240E-04	2.890E-04	5.590E-04
pa233	6.880E-02	9.090E-02	1.110E-01	1.280E-01	1.430E-01	1.550E-01	1.950E-01	2.210E-01	2.270E-01	2.260E-01
pa234	8.210E-05	8.210E-05	8.210E-05	8.210E-05	8.210E-05	8.210E-05	8.210E-05	8.210E-05	8.210E-05	8.210E-05
pa234m	6.320E-02	6.320E-02	6.320E-02	6.320E-02	6.320E-02	6.320E-02	6.320E-02	6.320E-02	6.320E-02	6.320E-02

Average BWR for shorter decay times										
Age:	25.0 yr	125.0 yr	225.0 yr	325.0 yr	425.0 yr	525.0 yr	1025.0 yr	2025.0 yr	5025.0 yr	10025.0 yr
Year:	2033	2133	2233	2333	2433	2533	3033	4033	7033	12033
pb212	4.700E-03	1.770E-03	6.550E-04	2.430E-04	9.010E-05	3.350E-05	3.980E-07	1.690E-07	1.770E-07	1.920E-07
pd107	2.650E-02	2.650E-02	2.650E-02	2.650E-02	2.650E-02	2.650E-02	2.650E-02	2.650E-02	2.650E-02	2.650E-02
pm145	2.610E-04	5.200E-06	1.030E-07	2.060E-09	4.100E-11	8.180E-13	2.560E-21	0.000E+00	0.000E+00	0.000E+00
pm146	2.490E-02	8.950E-08	3.220E-13	1.160E-18	4.160E-24	1.490E-29	0.000E+00	0.000E+00	0.000E+00	0.000E+00
pm147	3.980E+01	1.330E-10	4.450E-22	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
po212	3.010E-03	1.130E-03	4.200E-04	1.560E-04	5.770E-05	2.140E-05	2.550E-07	1.080E-07	1.130E-07	1.230E-07
po216	4.700E-03	1.770E-03	6.550E-04	2.430E-04	9.010E-05	3.350E-05	3.980E-07	1.690E-07	1.770E-07	1.920E-07
pr144	2.880E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
pu236	1.670E-04	1.640E-07	1.640E-07	1.640E-07	1.640E-07	1.640E-07	1.630E-07	1.620E-07	1.590E-07	1.550E-07
pu238	5.850E+02	2.660E+02	1.210E+02	5.530E+01	2.520E+01	1.160E+01	2.490E-01	1.880E-04	1.010E-10	2.130E-21
pu239	5.350E+01	5.330E+01	5.320E+01	5.310E+01	5.290E+01	5.280E+01	5.210E+01	5.080E+01	4.690E+01	4.100E+01
pu240	1.140E+02	1.130E+02	1.120E+02	1.110E+02	1.100E+02	1.090E+02	1.030E+02	9.280E+01	6.760E+01	3.980E+01
pu241	6.780E+03	5.410E+01	4.710E-01	4.280E-02	3.910E-02	3.880E-02	3.720E-02	3.430E-02	2.690E-02	1.790E-02
pu242	5.080E-01	5.080E-01	5.080E-01	5.080E-01	5.080E-01	5.080E-01	5.070E-01	5.060E-01	5.040E-01	4.990E-01
ra224	4.700E-03	1.770E-03	6.550E-04	2.430E-04	9.010E-05	3.350E-05	3.980E-07	1.690E-07	1.770E-07	1.920E-07
rh102	6.530E-04	2.720E-14	1.130E-24	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
rh106	3.000E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
rn220	4.700E-03	1.770E-03	6.550E-04	2.430E-04	9.010E-05	3.350E-05	3.980E-07	1.690E-07	1.770E-07	1.920E-07
ru106	3.000E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
sb125	2.891E+00	2.709E-11	2.539E-22	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
sb126	1.770E-02	1.770E-02	1.770E-02	1.770E-02	1.770E-02	1.770E-02	1.760E-02	1.750E-02	1.710E-02	1.660E-02
sb126m	1.270E-01	1.270E-01	1.270E-01	1.260E-01	1.260E-01	1.260E-01	1.260E-01	1.250E-01	1.220E-01	1.180E-01
se 79	1.590E-02	1.590E-02	1.590E-02	1.590E-02	1.590E-02	1.590E-02	1.590E-02	1.580E-02	1.570E-02	1.560E-02
sm151	5.390E+01	2.500E+01	1.160E+01	5.350E+00	2.480E+00	1.150E+00	2.430E-02	1.100E-05	1.010E-15	2.280E-32
sn121	4.640E-01	1.316E-01	3.740E-02	1.059E-02	3.000E-03	8.520E-04	1.563E-06	5.270E-12	2.014E-28	0.000E+00
sn121m	5.980E-01	1.701E-01	4.810E-02	1.365E-02	3.870E-03	1.097E-03	2.016E-06	6.780E-12	2.593E-28	0.000E+00
sn126	1.270E-01	1.270E-01	1.270E-01	1.260E-01	1.260E-01	1.260E-01	1.260E-01	1.250E-01	1.220E-01	1.180E-01
sr 90	9.540E+03	8.130E+02	6.920E+01	5.900E+00	5.030E-01	4.280E-02	1.920E-07	3.880E-18	0.000E+00	0.000E+00
tc 99	3.200E+00	3.200E+00	3.200E+00	3.200E+00	3.200E+00	3.200E+00	3.190E+00	3.180E+00	3.150E+00	3.100E+00
te125m	7.060E-01	6.610E-12	6.210E-23	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
th228	4.700E-03	1.770E-03	6.550E-04	2.430E-04	9.010E-05	3.350E-05	3.980E-07	1.690E-07	1.770E-07	1.920E-07
th230	6.090E-05	3.490E-04	7.100E-04	1.100E-03	1.510E-03	1.930E-03	4.020E-03	8.170E-03	2.030E-02	3.970E-02
th231	2.620E-03	2.630E-03	2.630E-03	2.640E-03	2.640E-03	2.650E-03	2.680E-03	2.730E-03	2.870E-03	3.090E-03
th234	6.320E-02	6.320E-02	6.320E-02	6.320E-02	6.320E-02	6.320E-02	6.320E-02	6.320E-02	6.320E-02	6.320E-02
tl208	1.690E-03	6.350E-04	2.350E-04	8.730E-05	3.240E-05	1.200E-05	1.430E-07	6.060E-08	6.340E-08	6.880E-08
u232	4.630E-03	1.720E-03	6.370E-04	2.360E-04	8.760E-05	3.250E-05	3.880E-07	1.620E-07	1.590E-07	1.550E-07
u233	1.060E-05	4.530E-05	8.940E-05	1.420E-04	2.010E-04	2.660E-04	6.510E-04	1.570E-03	4.470E-03	9.260E-03
u234	2.500E-01	3.640E-01	4.160E-01	4.390E-01	4.500E-01	4.550E-01	4.580E-01	4.570E-01	4.540E-01	4.480E-01
u235	2.620E-03	2.630E-03	2.630E-03	2.640E-03	2.640E-03	2.650E-03	2.680E-03	2.730E-03	2.870E-03	3.090E-03
u236	6.260E-02	6.300E-02	6.330E-02	6.360E-02	6.390E-02	6.430E-02	6.580E-02	6.870E-02	7.580E-02	8.350E-02
u237	1.620E-01	1.300E-03	1.130E-05	1.020E-06	9.350E-07	9.260E-07	8.890E-07	8.200E-07	6.420E-07	4.270E-07
u238	6.320E-02	6.320E-02	6.320E-02	6.320E-02	6.320E-02	6.320E-02	6.320E-02	6.320E-02	6.320E-02	6.320E-02
y 90	9.540E+03	8.130E+02	6.920E+01	5.900E+00	5.030E-01	4.280E-02	1.920E-07	3.880E-18	0.000E+00	0.000E+00
zr 93	3.386E-01	3.386E-01	3.386E-01	3.386E-01	3.386E-01	3.385E-01	3.385E-01	3.375E-01	3.374E-01	3.363E-01

Average BWR for longer decay times								
Decay Time	10025. yr	20025. yr	30025. yr	100025. yr	300025. yr	1000025 yr		
Year:	12033	22033	32033	102033	302033	1002033		
ac225	3.27E-03	1.01E-02	1.82E-02	7.15E-02	1.58E-01	1.75E-01		
ac227	5.59E-04	1.08E-03	1.56E-03	3.63E-03	4.49E-03	4.51E-03		
am241	1.79E-02	7.90E-03	3.49E-03	1.16E-05	1.00E-12	0.00E+00		
am243	2.08E+00	8.14E-01	3.18E-01	4.40E-04	6.84E-08	6.64E-08		
at217	3.27E-03	1.01E-02	1.82E-02	7.15E-02	1.58E-01	1.75E-01		
bi210	3.12E-02	6.74E-02	9.97E-02	2.42E-01	2.69E-01	9.71E-02		
bi211	5.59E-04	1.08E-03	1.56E-03	3.63E-03	4.49E-03	4.51E-03		
bi213	3.27E-03	1.01E-02	1.82E-02	7.15E-02	1.58E-01	1.75E-01		
bi214	3.12E-02	6.74E-02	9.97E-02	2.42E-01	2.69E-01	9.72E-02		
c 14	5.24E-02	1.56E-02	4.66E-03	9.77E-07	3.02E-17	0.00E+00		
ca 41	3.49E-05	3.26E-05	3.05E-05	1.90E-05	4.95E-06	4.45E-08		
cl 36	2.86E-03	2.80E-03	2.73E-03	2.33E-03	1.47E-03	2.93E-04		
cm245	1.78E-02	7.89E-03	3.49E-03	1.16E-05	9.51E-13	0.00E+00		
cm246	3.35E-03	7.74E-04	1.79E-04	6.28E-09	1.11E-19	9.13E-32		
cs135	1.38E-01	1.38E-01	1.38E-01	1.35E-01	1.27E-01	1.03E-01		
fr221	3.27E-03	1.01E-02	1.82E-02	7.15E-02	1.58E-01	1.75E-01		
i129	7.42E-03	7.42E-03	7.41E-03	7.39E-03	7.33E-03	7.10E-03		
mo 93	3.06E-05	4.22E-06	5.81E-07	5.50E-13	3.38E-30	0.00E+00		
nb 93m	3.36E-01	3.35E-01	3.34E-01	3.23E-01	2.96E-01	2.15E-01		
nb 94	1.33E-02	9.46E-03	6.72E-03	6.16E-04	6.66E-07	2.76E-17		
ni 59	4.58E-01	4.17E-01	3.80E-01	1.99E-01	3.14E-02	4.86E-05		
np237	2.26E-01	2.26E-01	2.25E-01	2.20E-01	2.06E-01	1.64E-01		
np239	2.08E+00	8.14E-01	3.18E-01	4.40E-04	6.84E-08	6.64E-08		
pa231	5.59E-04	1.08E-03	1.56E-03	3.63E-03	4.49E-03	4.51E-03		
pa233	2.26E-01	2.26E-01	2.25E-01	2.20E-01	2.06E-01	1.64E-01		
pa234	8.21E-05	8.21E-05	8.21E-05	8.21E-05	8.22E-05	8.22E-05		
pa234m	6.32E-02	6.32E-02	6.32E-02	6.32E-02	6.32E-02	6.32E-02		
pb209	3.27E-03	1.01E-02	1.82E-02	7.15E-02	1.58E-01	1.75E-01		
pb210	3.12E-02	6.74E-02	9.97E-02	2.42E-01	2.69E-01	9.71E-02		
pb211	5.59E-04	1.08E-03	1.56E-03	3.63E-03	4.49E-03	4.51E-03		
pb214	3.12E-02	6.74E-02	9.97E-02	2.42E-01	2.69E-01	9.72E-02		
pd107	2.65E-02	2.64E-02	2.64E-02	2.62E-02	2.56E-02	2.38E-02		
po210	3.12E-02	6.74E-02	9.97E-02	2.42E-01	2.69E-01	9.71E-02		
po213	3.20E-03	9.92E-03	1.79E-02	7.00E-02	1.55E-01	1.71E-01		

Average BWR for longer decay times								
Decay Time	**10025. yr**	**20025. yr**	**30025. yr**	**100025. yr**	**300025. yr**	**1000025 yr**		
Year:	**12033**	**22033**	**32033**	**102033**	**302033**	**1002033**		
po214	3.12E-02	6.74E-02	9.97E-02	2.42E-01	2.69E-01	9.71E-02		
po215	5.59E-04	1.08E-03	1.56E-03	3.63E-03	4.49E-03	4.51E-03		
po218	3.12E-02	6.75E-02	9.97E-02	2.42E-01	2.69E-01	9.72E-02		
pu239	4.10E+01	3.11E+01	2.34E+01	3.15E+00	1.00E-02	6.64E-08		
pu240	3.98E+01	1.39E+01	4.82E+00	2.96E-03	5.34E-10	1.01E-09		
pu241	1.79E-02	7.90E-03	3.49E-03	1.16E-05	9.53E-13	0.00E+00		
pu242	4.99E-01	4.90E-01	4.81E-01	4.22E-01	2.91E-01	7.95E-02		
ra223	5.59E-04	1.08E-03	1.56E-03	3.63E-03	4.49E-03	4.51E-03		
ra225	3.27E-03	1.01E-02	1.82E-02	7.15E-02	1.58E-01	1.75E-01		
ra226	3.12E-02	6.75E-02	9.97E-02	2.42E-01	2.69E-01	9.72E-02		
rn219	5.59E-04	1.08E-03	1.56E-03	3.63E-03	4.49E-03	4.51E-03		
rn222	3.12E-02	6.75E-02	9.97E-02	2.42E-01	2.69E-01	9.72E-02		
sb126	1.66E-02	1.54E-02	1.44E-02	8.87E-03	2.22E-03	1.73E-05		
sb126m	1.18E-01	1.10E-01	1.03E-01	6.34E-02	1.58E-02	1.24E-04		
se 79	1.56E-02	1.53E-02	1.49E-02	1.29E-02	8.47E-03	1.95E-03		
sn126	1.18E-01	1.10E-01	1.03E-01	6.34E-02	1.58E-02	1.24E-04		
tc 99	3.10E+00	3.00E+00	2.90E+00	2.31E+00	1.20E+00	1.20E-01		
th227	5.52E-04	1.06E-03	1.53E-03	3.58E-03	4.43E-03	4.45E-03		
th229	3.27E-03	1.01E-02	1.82E-02	7.15E-02	1.58E-01	1.75E-01		
th230	4.00E-02	7.54E-02	1.07E-01	2.41E-01	2.68E-01	9.72E-02		
th231	3.09E-03	3.44E-03	3.71E-03	4.40E-03	4.51E-03	4.51E-03		
th234	6.32E-02	6.32E-02	6.32E-02	6.32E-02	6.32E-02	6.32E-02		
tl207	5.58E-04	1.07E-03	1.55E-03	3.62E-03	4.48E-03	4.50E-03		
tl209	6.87E-05	2.13E-04	3.83E-04	1.50E-03	3.32E-03	3.67E-03		
u233	9.69E-03	1.89E-02	2.77E-02	7.89E-02	1.56E-01	1.74E-01		
u234	4.48E-01	4.38E-01	4.27E-01	3.62E-01	2.33E-01	8.68E-02		
u235	3.09E-03	3.44E-03	3.71E-03	4.40E-03	4.51E-03	4.51E-03		
u236	8.35E-02	9.08E-02	9.33E-02	9.45E-02	9.39E-02	9.20E-02		
u238	6.32E-02	6.32E-02	6.32E-02	6.32E-02	6.32E-02	6.32E-02		
zr 93	3.36E-01	3.35E-01	3.34E-01	3.23E-01	2.96E-01	2.15E-01		

Max BWR for shorter decay times										
Age:	5.0 yr	105.0 yr	205.0 yr	305.0 yr	405.0 yr	505.0 yr	1005.0 yr	2005.0 yr	5005.0 yr	10005.0 yr
Year:	2033	2133	2233	2333	2433	2533	3033	4033	7033	12033
ag108	8.490E-04	4.920E-04	2.840E-04	1.651E-04	9.560E-05	5.540E-05	3.610E-06	1.542E-08	1.194E-15	1.678E-27
ag108m	9.760E-03	5.650E-03	3.270E-03	1.895E-03	1.099E-03	6.370E-04	4.160E-05	1.772E-07	1.372E-14	1.929E-26
ag109m	9.401E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ag110	1.090E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ag110m	8.021E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
am241	2.660E+02	8.790E+02	7.540E+02	6.430E+02	5.480E+02	4.660E+02	2.100E+02	4.240E+01	5.900E-01	1.570E-01
am242	3.390E+00	2.070E+00	1.270E+00	7.760E-01	4.750E-01	2.900E-01	2.490E-02	1.820E-04	7.170E-11	1.520E-21
am242m	3.410E+00	2.080E+00	1.270E+00	7.800E-01	4.770E-01	2.920E-01	2.500E-02	1.830E-04	7.200E-11	1.520E-21
am243	1.930E+01	1.910E+01	1.890E+01	1.880E+01	1.860E+01	1.840E+01	1.760E+01	1.600E+01	1.210E+01	7.530E+00
ar 39	2.930E-05	2.270E-05	1.750E-05	1.350E-05	1.050E-05	8.090E-06	2.230E-06	1.690E-07	7.440E-11	1.890E-16
ba137m	3.650E+04	3.620E+03	3.590E+02	3.560E+01	3.540E+00	3.510E-01	3.370E-06	3.100E-16	0.000E+00	0.000E+00
bi212	1.690E-02	8.780E-03	3.250E-03	1.210E-03	4.470E-04	1.660E-04	1.920E-06	7.730E-07	7.750E-07	7.830E-07
bk249	2.900E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
c 14	3.161E-01	3.121E-01	3.081E-01	3.041E-01	3.010E-01	2.970E-01	2.800E-01	2.480E-01	1.720E-01	9.412E-02
ca 41	6.720E-05	6.710E-05	6.710E-05	6.700E-05	6.700E-05	6.690E-05	6.670E-05	6.630E-05	6.490E-05	6.280E-05
ca 45	3.610E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
cd109	9.401E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
cd113m	1.393E+01	1.023E-01	7.493E-04	5.491E-06	4.028E-08	2.947E-10	6.238E-21	0.000E+00	0.000E+00	0.000E+00
ce142	1.190E-05	1.190E-05	1.190E-05	1.190E-05	1.190E-05	1.190E-05	1.190E-05	1.190E-05	1.190E-05	1.190E-05
ce144	1.370E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
cf249	4.710E-04	3.920E-04	3.220E-04	2.640E-04	2.170E-04	1.780E-04	6.610E-05	9.150E-06	2.420E-08	1.230E-12
cf250	1.940E-03	9.690E-06	4.840E-08	2.430E-10	2.090E-12	8.800E-13	8.560E-13	8.230E-13	7.300E-13	5.980E-13
cf251	2.280E-05	2.110E-05	1.960E-05	1.810E-05	1.680E-05	1.550E-05	1.050E-05	4.870E-06	4.810E-07	1.010E-08
cf252	3.250E-03	1.350E-14	5.600E-26	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
cl 36	4.990E-03	4.990E-03	4.990E-03	4.990E-03	4.980E-03	4.980E-03	4.980E-03	4.970E-03	4.930E-03	4.880E-03
cm242	1.130E+01	1.720E+00	1.050E+00	6.420E-01	3.930E-01	2.400E-01	2.060E-02	1.510E-04	5.950E-11	1.260E-21
cm243	1.120E+01	9.850E-01	8.650E-02	7.600E-03	6.670E-04	5.860E-05	3.070E-10	8.380E-21	0.000E+00	0.000E+00
cm244	3.940E+03	8.550E+01	1.860E+00	4.030E-02	8.750E-04	1.900E-05	9.180E-14	2.140E-30	0.000E+00	0.000E+00
cm245	3.530E-01	3.510E-01	3.480E-01	3.450E-01	3.420E-01	3.390E-01	3.260E-01	3.000E-01	2.350E-01	1.560E-01
cm246	2.960E-01	2.920E-01	2.880E-01	2.840E-01	2.800E-01	2.750E-01	2.560E-01	2.210E-01	1.420E-01	6.850E-02
cm248	2.370E-05	2.370E-05	2.370E-05	2.370E-05	2.370E-05	2.370E-05	2.360E-05	2.360E-05	2.340E-05	2.320E-05
co 58	1.170E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
co 60	8.530E+02	1.650E-03	3.200E-09	6.200E-15	1.200E-20	2.330E-26	0.000E+00	0.000E+00	0.000E+00	0.000E+00
cs134	1.150E+04	2.900E-11	7.260E-26	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
cs135	2.820E-01	2.820E-01	2.820E-01	2.820E-01	2.820E-01	2.820E-01	2.820E-01	2.820E-01	2.820E-01	2.810E-01
cs137	3.870E+04	3.840E+03	3.810E+02	3.770E+01	3.740E+00	3.710E-01	3.570E-06	3.290E-16	0.000E+00	0.000E+00
eu150	2.520E-05	3.630E-06	5.240E-07	7.570E-08	1.090E-08	1.580E-09	9.850E-14	3.860E-22	0.000E+00	0.000E+00
eu152	1.690E+00	9.321E-03	5.130E-05	2.830E-07	1.560E-09	8.591E-12	4.370E-23	0.000E+00	0.000E+00	0.000E+00
eu154	1.799E+03	5.618E-01	1.759E-04	5.507E-08	1.729E-11	5.397E-15	2.280E-32	0.000E+00	0.000E+00	0.000E+00
eu155	6.280E+02	2.321E-04	8.570E-11	3.165E-17	1.175E-23	4.333E-30	0.000E+00	0.000E+00	0.000E+00	0.000E+00
fe 55	2.340E+02	2.190E-09	2.060E-20	1.830E-31	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
gd153	1.532E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
h 3	1.764E+02	6.390E-01	2.307E-03	8.370E-06	3.024E-08	1.094E-10	6.770E-23	0.000E+00	0.000E+00	0.000E+00
ho166m	2.198E-02	2.072E-02	1.957E-02	1.842E-02	1.748E-02	1.643E-02	1.235E-02	6.918E-03	1.224E-03	6.803E-05

Max BWR for shorter decay times										
Age:	5.0 yr	105.0 yr	205.0 yr	305.0 yr	405.0 yr	505.0 yr	1005.0 yr	2005.0 yr	5005.0 yr	10005.0 yr
Year:	2033	2133	2233	2333	2433	2533	3033	4033	7033	12033
i129	1.350E-02	1.350E-02	1.350E-02	1.350E-02	1.350E-02	1.350E-02	1.350E-02	1.350E-02	1.350E-02	1.350E-02
in113m	6.480E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
kr 85	2.030E+03	3.160E+00	4.910E-03	7.640E-06	1.190E-08	1.850E-11	1.680E-25	0.000E+00	0.000E+00	0.000E+00
mn 54	1.610E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
mo 93	4.280E-04	4.200E-04	4.120E-04	4.040E-04	3.960E-04	3.880E-04	3.510E-04	2.880E-04	1.590E-04	5.900E-05
nb 93m	1.221E+00	6.120E-01	6.030E-01	6.030E-01	6.030E-01	6.030E-01	6.030E-01	6.020E-01	6.020E-01	6.000E-01
nb 94	3.380E-02	3.370E-02	3.350E-02	3.340E-02	3.330E-02	3.320E-02	3.260E-02	3.150E-02	2.850E-02	2.400E-02
nb 95	8.248E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
ni 59	7.780E-01	7.780E-01	7.770E-01	7.760E-01	7.760E-01	7.750E-01	7.710E-01	7.640E-01	7.430E-01	7.100E-01
ni 63	1.160E+02	5.790E+01	2.900E+01	1.450E+01	7.250E+00	3.630E+00	1.140E-01	1.120E-04	1.060E-13	9.750E-29
np235	3.170E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
np237	1.330E-01	1.590E-01	1.850E-01	2.080E-01	2.270E-01	2.430E-01	2.950E-01	3.290E-01	3.370E-01	3.370E-01
np238	1.530E-02	9.380E-03	5.740E-03	3.510E-03	2.150E-03	1.310E-03	1.120E-04	8.230E-07	3.240E-13	6.860E-24
np239	1.930E+01	1.910E+01	1.890E+01	1.880E+01	1.860E+01	1.840E+01	1.760E+01	1.600E+01	1.210E+01	7.530E+00
pa231	2.940E-05	3.140E-05	3.330E-05	3.520E-05	3.720E-05	3.920E-05	4.910E-05	6.940E-05	1.340E-04	2.520E-04
pa233	1.330E-01	1.590E-01	1.850E-01	2.080E-01	2.270E-01	2.430E-01	2.950E-01	3.290E-01	3.370E-01	3.370E-01
pa234	7.890E-05	7.890E-05	7.890E-05	7.890E-05	7.890E-05	7.890E-05	7.890E-05	7.890E-05	7.890E-05	7.890E-05
pa234m	6.070E-02	6.070E-02	6.070E-02	6.070E-02	6.070E-02	6.070E-02	6.070E-02	6.070E-02	6.070E-02	6.070E-02
pb212	1.690E-02	8.780E-03	3.250E-03	1.210E-03	4.470E-04	1.660E-04	1.920E-06	7.730E-07	7.750E-07	7.830E-07
pd107	5.690E-02	5.690E-02	5.690E-02	5.690E-02	5.690E-02	5.690E-02	5.690E-02	5.690E-02	5.690E-02	5.690E-02
pm145	1.520E-03	3.030E-05	6.030E-07	1.200E-08	2.390E-10	4.770E-12	1.490E-20	0.000E+00	0.000E+00	0.000E+00
pm146	5.830E-01	2.090E-06	7.520E-12	2.700E-17	9.720E-23	3.490E-28	0.000E+00	0.000E+00	0.000E+00	0.000E+00
pm147	7.460E+03	2.500E-08	8.350E-20	2.740E-31	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
po212	1.080E-02	5.620E-03	2.080E-03	7.720E-04	2.860E-04	1.060E-04	1.230E-06	4.950E-07	4.970E-07	5.010E-07
po216	1.690E-02	8.780E-03	3.250E-03	1.210E-03	4.470E-04	1.660E-04	1.920E-06	7.730E-07	7.750E-07	7.830E-07
pr144	1.370E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
pr144m	1.920E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
pt193	1.610E-05	4.020E-06	1.000E-06	2.510E-07	6.280E-08	1.570E-08	1.530E-11	1.460E-17	0.000E+00	0.000E+00
pu236	6.950E-02	7.720E-07	7.710E-07	7.710E-07	7.700E-07	7.700E-07	7.670E-07	7.630E-07	7.490E-07	7.270E-07
pu238	2.110E+03	9.570E+02	4.350E+02	1.980E+02	9.000E+01	4.100E+01	8.300E-01	4.580E-04	1.580E-10	3.350E-21
pu239	5.360E+01	5.350E+01	5.340E+01	5.330E+01	5.320E+01	5.310E+01	5.260E+01	5.160E+01	4.850E+01	4.330E+01
pu240	1.480E+02	1.570E+02	1.560E+02	1.540E+02	1.530E+02	1.510E+02	1.430E+02	1.290E+02	9.380E+01	5.530E+01
pu241	2.250E+04	1.800E+02	1.780E+00	3.570E-01	3.430E-01	3.400E-01	3.260E-01	3.010E-01	2.350E-01	1.570E-01
pu242	1.260E+00	1.260E+00	1.260E+00	1.260E+00	1.260E+00	1.260E+00	1.260E+00	1.260E+00	1.250E+00	1.240E+00
ra224	1.690E-02	8.780E-03	3.250E-03	1.210E-03	4.470E-04	1.660E-04	1.920E-06	7.730E-07	7.750E-07	7.830E-07
rh102	1.930E-01	8.010E-12	3.330E-22	2.280E-32	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
rh106	3.290E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
rn220	1.690E-02	8.780E-03	3.250E-03	1.210E-03	4.470E-04	1.660E-04	1.920E-06	7.730E-07	7.750E-07	7.830E-07
ru106	3.290E+03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
sb125	6.210E+02	5.820E-09	5.454E-20	5.023E-31	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
sb126	3.520E-02	3.520E-02	3.520E-02	3.520E-02	3.510E-02	3.510E-02	3.500E-02	3.480E-02	3.400E-02	3.290E-02
sb126m	2.520E-01	2.520E-01	2.510E-01	2.510E-01	2.510E-01	2.510E-01	2.500E-01	2.480E-01	2.430E-01	2.350E-01
se 79	2.880E-02	2.880E-02	2.880E-02	2.880E-02	2.880E-02	2.880E-02	2.880E-02	2.870E-02	2.850E-02	2.820E-02
sm145	6.780E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Max BWR for shorter decay times										
Age:	5.0 yr	105.0 yr	205.0 yr	305.0 yr	405.0 yr	505.0 yr	1005.0 yr	2005.0 yr	5005.0 yr	10005.0 yr
Year:	2033	2133	2233	2333	2433	2533	3033	4033	7033	12033
sm151	8.220E+01	3.810E+01	1.760E+01	8.150E+00	3.770E+00	1.750E+00	3.710E-02	1.680E-05	1.540E-15	2.280E-32
sn113	6.480E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
sn119m	3.719E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
sn121	1.146E+00	3.250E-01	9.210E-02	2.617E-02	7.410E-03	2.098E-03	3.850E-06	1.299E-11	4.960E-28	0.000E+00
sn121m	1.476E+00	4.190E-01	1.188E-01	3.370E-02	9.550E-03	2.711E-03	4.970E-06	1.677E-11	6.390E-28	0.000E+00
sn123	8.210E-03	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
sn126	2.520E-01	2.520E-01	2.510E-01	2.510E-01	2.510E-01	2.510E-01	2.500E-01	2.480E-01	2.430E-01	2.350E-01
sr 90	2.520E+04	2.140E+03	1.830E+02	1.560E+01	1.330E+00	1.130E-01	5.080E-07	1.020E-17	0.000E+00	0.000E+00
tb160	1.500E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
tc 99	5.350E+00	5.350E+00	5.350E+00	5.340E+00	5.340E+00	5.340E+00	5.330E+00	5.320E+00	5.260E+00	5.180E+00
te123m	2.190E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
te125m	1.511E+02	1.424E-09	1.328E-20	1.141E-31	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
te127	1.510E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
te127m	1.550E-02	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
th228	1.690E-02	8.780E-03	3.250E-03	1.210E-03	4.470E-04	1.660E-04	1.920E-06	7.730E-07	7.750E-07	7.830E-07
th230	2.050E-05	4.420E-04	1.120E-03	1.920E-03	2.780E-03	3.650E-03	8.100E-03	1.700E-02	4.290E-02	8.410E-02
th231	9.430E-04	9.480E-04	9.530E-04	9.580E-04	9.640E-04	9.690E-04	9.950E-04	1.050E-03	1.190E-03	1.420E-03
th234	6.070E-02	6.070E-02	6.070E-02	6.070E-02	6.070E-02	6.070E-02	6.070E-02	6.070E-02	6.070E-02	6.070E-02
tl208	6.080E-03	3.160E-03	1.170E-03	4.330E-04	1.610E-04	5.970E-05	6.900E-07	2.780E-07	2.790E-07	2.810E-07
tm171	4.670E-04	9.790E-20	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
u232	2.000E-02	8.540E-03	3.160E-03	1.170E-03	4.350E-04	1.620E-04	1.880E-06	7.630E-07	7.490E-07	7.270E-07
u234	2.260E-01	6.370E-01	8.230E-01	9.080E-01	9.460E-01	9.640E-01	9.770E-01	9.750E-01	9.670E-01	9.540E-01
u235	9.430E-04	9.480E-04	9.530E-04	9.580E-04	9.640E-04	9.690E-04	9.950E-04	1.050E-03	1.190E-03	1.420E-03
u236	9.550E-02	9.600E-02	9.640E-02	9.690E-02	9.730E-02	9.780E-02	1.000E-01	1.040E-01	1.140E-01	1.250E-01
u237	5.390E-01	4.310E-03	4.270E-05	8.530E-06	8.190E-06	8.120E-06	7.800E-06	7.190E-06	5.630E-06	3.740E-06
u238	6.070E-02	6.070E-02	6.070E-02	6.070E-02	6.070E-02	6.070E-02	6.070E-02	6.070E-02	6.070E-02	6.070E-02
y 90	2.520E+04	2.140E+03	1.830E+02	1.560E+01	1.330E+00	1.130E-01	5.080E-07	1.020E-17	0.000E+00	0.000E+00
y 91	3.330E-05	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
zn 65	1.350E-01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
zr 93	6.030E-01	6.030E-01	6.030E-01	6.030E-01	6.030E-01	6.030E-01	6.030E-01	6.020E-01	6.010E-01	5.990E-01
zr 95	3.744E-04	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Max BWR for longer decay times						
Decay Time	10005. yr	20005. yr	30005. yr	100005. yr	300005. yr	1000005 yr
Year:	12033	22033	32033	102033	302033	1002033
ac225	4.85E-03	1.51E-02	2.71E-02	1.07E-01	2.36E-01	2.61E-01
ac227	2.52E-04	5.14E-04	7.89E-04	2.25E-03	2.97E-03	2.98E-03
am241	1.57E-01	6.93E-02	3.06E-02	1.02E-04	8.81E-12	0.00E+00
am243	7.53E+00	2.94E+00	1.15E+00	1.59E-03	2.46E-06	2.38E-06
at217	4.85E-03	1.51E-02	2.71E-02	1.07E-01	2.36E-01	2.61E-01
bi210	6.62E-02	1.43E-01	2.12E-01	5.10E-01	5.43E-01	1.39E-01
bi211	2.52E-04	5.14E-04	7.89E-04	2.25E-03	2.97E-03	2.98E-03
bi213	4.85E-03	1.51E-02	2.71E-02	1.07E-01	2.36E-01	2.61E-01
bi214	6.63E-02	1.43E-01	2.12E-01	5.10E-01	5.43E-01	1.39E-01
c 14	9.41E-02	2.81E-02	8.37E-03	1.76E-06	5.43E-17	0.00E+00
ca 41	6.28E-05	5.87E-05	5.49E-05	3.43E-05	8.92E-06	8.01E-08
ce142	1.19E-05	1.19E-05	1.19E-05	1.19E-05	1.19E-05	1.19E-05
cl 36	4.88E-03	4.76E-03	4.66E-03	3.96E-03	2.50E-03	4.99E-04
cm245	1.56E-01	6.92E-02	3.06E-02	1.01E-04	8.34E-12	0.00E+00
cm246	6.85E-02	1.58E-02	3.66E-03	1.28E-07	2.20E-17	1.70E-29
cm248	2.32E-05	2.27E-05	2.23E-05	1.93E-05	1.28E-05	3.08E-06
cs135	2.81E-01	2.81E-01	2.80E-01	2.74E-01	2.58E-01	2.09E-01
fr221	4.85E-03	1.51E-02	2.71E-02	1.07E-01	2.36E-01	2.61E-01
ho166m	6.50E-05	2.02E-07	6.25E-10	1.72E-27	0.00E+00	0.00E+00
i129	1.35E-02	1.35E-02	1.35E-02	1.35E-02	1.34E-02	1.30E-02
mo 93	5.90E-05	8.14E-06	1.12E-06	1.06E-12	6.53E-30	0.00E+00
nb 93m	6.00E-01	5.97E-01	5.94E-01	5.76E-01	5.26E-01	3.83E-01
nb 94	2.40E-02	1.71E-02	1.21E-02	1.11E-03	1.20E-06	5.00E-17
ni 59	7.10E-01	6.47E-01	5.90E-01	3.09E-01	4.87E-02	7.54E-05
np237	3.37E-01	3.36E-01	3.36E-01	3.28E-01	3.08E-01	2.45E-01
np239	7.53E+00	2.94E+00	1.15E+00	1.59E-03	2.46E-06	2.38E-06
pa231	2.52E-04	5.14E-04	7.88E-04	2.25E-03	2.97E-03	2.98E-03
pa233	3.37E-01	3.36E-01	3.36E-01	3.28E-01	3.08E-01	2.45E-01
pa234	7.89E-05	7.89E-05	7.89E-05	7.89E-05	7.89E-05	7.90E-05
pa234m	6.07E-02	6.07E-02	6.07E-02	6.07E-02	6.07E-02	6.07E-02
pb209	4.85E-03	1.51E-02	2.71E-02	1.07E-01	2.36E-01	2.61E-01
pb210	6.62E-02	1.43E-01	2.12E-01	5.10E-01	5.43E-01	1.39E-01

Max BWR for longer decay times						
Decay Time	10005. yr	20005. yr	30005. yr	100005. yr	300005. yr	1000005 yr
Year:	12033	22033	32033	102033	302033	1002033
pb211	2.52E-04	5.14E-04	7.89E-04	2.25E-03	2.97E-03	2.98E-03
pb214	6.63E-02	1.43E-01	2.12E-01	5.10E-01	5.43E-01	1.39E-01
pd107	5.69E-02	5.68E-02	5.68E-02	5.63E-02	5.51E-02	5.12E-02
po210	6.62E-02	1.43E-01	2.12E-01	5.10E-01	5.43E-01	1.39E-01
po213	4.75E-03	1.47E-02	2.66E-02	1.04E-01	2.31E-01	2.55E-01
po214	6.62E-02	1.43E-01	2.12E-01	5.10E-01	5.43E-01	1.39E-01
po215	2.52E-04	5.14E-04	7.89E-04	2.25E-03	2.97E-03	2.98E-03
po218	6.63E-02	1.43E-01	2.12E-01	5.10E-01	5.43E-01	1.40E-01
pu239	4.33E+01	3.37E+01	2.57E+01	3.50E+00	1.11E-02	2.38E-06
pu240	5.53E+01	1.92E+01	6.69E+00	4.11E-03	4.21E-08	7.98E-08
pu241	1.57E-01	6.93E-02	3.06E-02	1.02E-04	8.36E-12	0.00E+00
pu242	1.24E+00	1.22E+00	1.20E+00	1.05E+00	7.26E-01	1.98E-01
ra223	2.52E-04	5.14E-04	7.89E-04	2.25E-03	2.97E-03	2.98E-03
ra225	4.85E-03	1.51E-02	2.71E-02	1.07E-01	2.36E-01	2.61E-01
ra226	6.63E-02	1.43E-01	2.12E-01	5.10E-01	5.43E-01	1.40E-01
rn219	2.52E-04	5.14E-04	7.89E-04	2.25E-03	2.97E-03	2.98E-03
rn222	6.63E-02	1.43E-01	2.12E-01	5.10E-01	5.43E-01	1.40E-01
sb126	3.29E-02	3.07E-02	2.86E-02	1.76E-02	4.41E-03	3.44E-05
sb126m	2.35E-01	2.19E-01	2.04E-01	1.26E-01	3.15E-02	2.46E-04
se 79	2.82E-02	2.77E-02	2.71E-02	2.34E-02	1.54E-02	3.53E-03
sn126	2.35E-01	2.19E-01	2.04E-01	1.26E-01	3.15E-02	2.46E-04
tc 99	5.18E+00	5.01E+00	4.85E+00	3.85E+00	2.00E+00	2.01E-01
th227	2.49E-04	5.07E-04	7.78E-04	2.22E-03	2.93E-03	2.94E-03
th229	4.85E-03	1.51E-02	2.71E-02	1.07E-01	2.36E-01	2.61E-01
th230	8.50E-02	1.60E-01	2.27E-01	5.08E-01	5.41E-01	1.40E-01
th231	1.42E-03	1.80E-03	2.09E-03	2.86E-03	2.98E-03	2.98E-03
th234	6.07E-02	6.07E-02	6.07E-02	6.07E-02	6.07E-02	6.07E-02
tl207	2.52E-04	5.12E-04	7.87E-04	2.24E-03	2.96E-03	2.97E-03
tl209	1.02E-04	3.16E-04	5.70E-04	2.24E-03	4.95E-03	5.48E-03
u233	1.44E-02	2.81E-02	4.13E-02	1.18E-01	2.33E-01	2.60E-01
u234	9.54E-01	9.29E-01	9.05E-01	7.54E-01	4.55E-01	1.15E-01
u235	1.42E-03	1.80E-03	2.09E-03	2.86E-03	2.98E-03	2.98E-03
u236	1.25E-01	1.35E-01	1.38E-01	1.40E-01	1.39E-01	1.36E-01
u238	6.07E-02	6.07E-02	6.07E-02	6.07E-02	6.07E-02	6.07E-02
zr 93	0.599	0.597	0.594	0.5762	0.5258	0.3826

Comparison of Source Terms per MTU of 4 Average BWR SNF Assemblies				
Assembly Characteristics	**3.5%-40GWd-25y** (0.2 MTU)	**3.03%-33.6GWd-23.0y** (0.177 MTU)	**3.02%-33.6GWd-25.0y** (0.177 MTU)	**3.09%-34.8GWd-22.0y** (0.177 MTU)
Curies				
Activation Products	6.8200E+02	7.0580E+02	6.0790E+02	7.8770E+02
Actinides and daughters	6.7620E+04	5.9170E+04	5.4690E+04	6.4560E+04
Fission products	2.4960E+05	2.1100E+05	2.0070E+05	2.2570E+05
Total	3.1790E+05	2.7090E+05	2.5610E+05	2.9110E+05
Watts				
Activation Products	4.8150E+00	5.4880E+00	4.2350E+00	6.4490E+00
Actinides and daughters	5.0520E+02	3.3040E+02	3.2880E+02	3.6590E+02
Fission products	7.1290E+02	6.0270E+02	5.7250E+02	6.4540E+02
Total	1.2230E+03	9.4440E+02	9.1110E+02	1.0250E+03
Grams				
Activation Products	7.2580E+05	7.2580E+05	7.2580E+05	7.2580E+05
Actinides and daughters	9.5460E+05	9.6340E+05	9.6340E+05	9.6160E+05
Fission products	4.5480E+04	3.5950E+04	3.5950E+04	3.7690E+04
Total	1.7260E+06	1.7260E+06	1.7260E+06	1.7260E+06
Neutrons/s				
Activation Products				
Alpha, N Neutrons	1.4810E+07	9.5950E+06	9.5330E+06	1.0670E+07
Fission products	5.4010E+08	2.7050E+08	2.5300E+08	3.3440E+08
Total	5.5500E+08	2.8060E+08	2.6290E+08	3.4560E+08
Phtons/s				
Total intensity	6.1110E+15	5.1470E+15	4.8900E+15	5.5180E+15

Complete only applicable items.

3. Document Identifier:	4. Rev.:	5. Title:	6. ECN:
000-00C-MGR0-00200-000-00A	00A	BWR Source Term Generation and Evaluation	1

7. Reason for Change:

Per LP-3.12Q-BSC Design Calculations and Analyses Section 5.1 [2] c,

> "The decision of the DEM, PCSA Manager, Criticality Manager, or PCA Manager to issue calculations or analyses with a "committed" status will be based on an experienced assessment of the likelihood that the results of the calculation or analysis will change, and the degree of impact those changes will have on designs that support the regulatory submittals or procurement activities, based on the design's bounding conservatism."

the status designation of *BWR Source Term Generation and Evaluation* (000-00C-MGR0-00200-000-00A) can be changed to "Committed" as the results are not expected to change in such a manner that will affect support of regulatory submittals.

8. Supersedes Change Document:	☐ Yes	If, Yes, Change Doc.: _____	☒ No

9. Change Impact:

Inputs Changed:	☐ Yes	☒ No	Results Impacted:	☐ Yes	☒ No
Assumptions Changed:	☐ Yes	☒ No	Design Impacted:	☐ Yes	☒ No

10. Description of Change: (Address any "Yes" answers)

Add a "Committed" option in Block 7 on the cover sheet and change the "Document Status Designation" from Preliminary to "Committed". Block 7 on the cover sheet should read as follows:

7. Document Status Designation

☐ Preliminary ☒ Committed ☐ Final ☐ Canceled

11. Originator: (Print/Sign/Date) Dorin Musat	Dorin Musat	8/12/2005
Checker: (Print/Sign/Date) YuChien Yuan	YuChien Yuan	8/12/2005
Approved: (Print/Sign/Date) Dave Darling	DS Darling	8/12/05