OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT
CALCULATION COVER SHEET

1. QA: QA

Page: 1 Of: 13

2. Calculation Title
Source Terms for Average DOE SNF Canisters

3. Document Identifier (including Revision Number)
CAL-MGR-NU-000004 REV 00

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9. Remarks

Revision History

10. Revision No.	11. Description of Revision
00	Initial Issue

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TABLES

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1. PURPOSE

The objective of this calculation is to generate source terms for each type of Department of Energy (DOE) spent nuclear fuel (SNF) canister that may be disposed of at the potential repository at Yucca Mountain. The scope of this calculation is limited to generating source terms for *average* DOE SNF canisters, and is not intended to be used for subsequent calculations requiring bounding source terms. This calculation is to be used in future Performance Assessment calculations, or other shielding or thermal calculations requiring average source terms. This calculation is performed according to AP-3.12Q, *Calculations*. The development plan (Civilian Radioactive Waste Management System [CRWMS] Management and Operating Contractor [M&O] 2000) provides the guidance for this calculation.

2. METHOD

The ORIGEN-S module of SCALE 4.3 (CRWMS M&O 1997) is used to calculate the radionuclide inventories and neutron, gamma, and thermal source terms as a function of time for all the DOE SNF canisters. The ORIGEN-S module performs a decay calculation using input radionuclide activities and specified decay times. These source terms are determined from average initial radionuclide inventories of the four DOE SNF canister types. The method for controlling the final product of this work is detailed in AP-6.1Q, *Controlled Documents*, which provides for electronic source file verification. This is in accordance with the development plan for this calculation, CRWMS M&O (2000). The development plan specifies this calculation will be performed according to AP-3.12Q, which in turn specifies AP-6.1Q as the procedure governing the final controlled document.

3. ASSUMPTIONS

There are no assumptions made in this calculation.

4. USE OF COMPUTER SOFTWARE AND MODELS

4.1 SOFTWARE

4.1.1 SCALE

- Software name: SCALE
- Software version/revision number: Version 4.3
- Computer Software Configuration Item (CSCI): 30011 V4.3 (CRWMS M&O 1997)
- Computer type: Hewlett Packard (HP) 9000 Series workstation "Bloom" (CRWMS M&O Tag number 700887).

This software was previously obtained from Software Configuration Management in accordance with the appropriate procedures. The ORIGEN-S module of the SCALE code system is used to calculate the decay of the radionuclide inventories of the DOE SNF canisters. This software is appropriate for this application and is used within the range of its validation.

4.2 SOFTWARE ROUTINES

4.2.1 Excel

The commercially available Excel spreadsheet program (version/revision: Microsoft Excel 97) is used to sum the radionuclide inventories for all the DOE fuel types to be placed in each DOE SNF canister and then determine an average inventory for each canister type. It is also used to organize the source term information taken from the ORIGEN-S output files by the script files documented in Section 4.2.2 and Attachment II. Only standard functions of EXCEL are used, and no software routines or marcos (as defined in AP-SI.1Q) are developed in EXCEL. The calculations are documented in sufficient detail in Section 5 to allow for independent repetition of the computations.

4.2.2. Script Files

- Script file names: *curies, gammas, neutrons, watts, make.file*
- Version/revision number for script files: Version 0
- Computer type: Hewlett Packard (HP) 9000 Series workstation "Bloom" (CRWMS M&O Tag number 700887).

The UNIX script files *curies*, *gammas*, *neutrons*, *watts*, and *make.tables* are used to extract information from the ORIGEN-S output files. These script files use the ORIGEN-S output files listed in Table 3 as inputs. These script files are used for editorial purposes only, and their outputs have been used to create the *.xls files in Attachment I (with the exception of *Inventories.xls*). Verification that these script files provide correct results for the specified range of inputs is done by visual inspection, by comparing the *.xls files and the ORIGEN-S output files in Attachment I. The script files and sample outputs from each are provided in Attachment II.

4.3 MODELS

No models are used in this calculation.

5. CALCULATION

As stated in Section 1, the purpose of this calculation is to generate average source terms for each type of DOE SNF canister. The inputs required for this calculation are the radionuclide inventories for all DOE SNF fuel types. This inventory information is available through the Technical Data Management System (TDMS), and is identified by the data tracking number (DTN) *MO0001SPADBE00.001*. The information is also available in Idaho National Engineering and Environmental Laboratory (INEEL) (1999).

MO0001SPADBE00.001 contains the Excel spreadsheet *dbefeb99.xls*. This spreadsheet provides DOE SNF radionuclide inventories for the calendar year 2010 in the worksheet *DBE2010*. Each

record, or line of information, lists the radionuclide inventories in curies for that record and indicates which type of DOE SNF canister the fuel will be placed in. For this calculation, the records are grouped by the DOE SNF canisters the fuels will be placed in (columns X through AC, under the heading *Number of Containers*). INEEL 1999 lists several types of DOE SNF canisters: *SDC* (standard disposal canister) *17X10, SDC 17X15, SDC 24X10, SDC 24X15, HIC* (high integrity canister), and the *MCO* (multi-canister overpack). Wheatley (2000) indicates that the columns that refer to the 17-inch diameter canisters (SDC 17X10 and SDC 17X15) directly correspond to what are now commonly referred to as the 18-inch diameter canisters (SDC 18X10 and SDC 18X15). There are zero SDC 24X10 and SDC 24X15 canisters, and so they are not included in this calculation. Wheatley (2000) states that fuels for which canisters are not specified are expected to be placed in WPs designed for commercial SNF. These fuels are identified by a 'TRUE' in the *Bare Fuel Transferred* column (column AD). The Dresden fuel (SNF Identification (SNFID) 49) shows a 'TRUE' in the *Bare Fuel Transferred* column but will in fact be placed in two SDC 18X10 canisters. The Shippingport fuels (SNFIDs 191 and 192) will be placed into 13 SDC 18X15 canisters. The Tower Shielding Reactor (SNFID 270) is included in the canister inventory as one SDC 18X10 as suggested by Wheatley (2000). Because no radionuclide values are provided for SNFID 776, it is not used in this calculation.

The worksheet *DBE2010* of *dbefeb99.xls* is used to create the Excel spreadsheet *Inventories.xls*. The worksheet *commercial* of *Inventories.xls* indicates those records that are not included in this calculation since they will be disposed of in WPs for commercial SNF. While SNFIDs 191, 192, and 270 are included in the *commercial* worksheet, they are included in the calculations for the reasons previously stated. The records for each canister type are grouped onto separate worksheets in *Inventories.xls*, with HICs and MCOs on the same worksheet. All columns except those indicating the SNFID, the number of canisters, and the columns for the radionuclide inventories are removed. The row of each worksheet labeled *TOTALS* and highlighted in yellow indicates the total number of canisters of that type, and the total inventory of each radionuclide that will be disposed of in that type of canister. Below this, under the heading *AVERAGE INVENTORIES PER CANISTER* and highlighted in pink, are the total inventories for each radionuclide divided by the total number of that type of canister. The average inventories for each canister type are summarized in the worksheet *Table 1* and the radionuclide values are entered in ORIGEN-S for decay calculations. Table 1 below reflects these radionuclide values.

Table 1. Inventories at 2010 for Average DOE SNF Canisters

Nuclide	SDC 18X10	SDC 18X15	HIC	MCO
Ac227	1.606E-04	2.135E-02	7.786E-05	4.776E-05
Am241	6.079E+01	3.985E+02	3.515E+01	1.298E+03
Am242m	9.679E-02	6.923E-01	6.805E-02	3.686E-02
Am243	2.450E-01	5.102E-01	9.136E-02	1.899E-01
C14	8.327E-02	1.065E-01	6.763E-02	1.681E+00
Cd113m	1.444E+00	5.358E-01	1.082E+00	0.000E+00
Cl36	4.541E-04	1.591E-03	9.109E-04	0.000E+00
Cm242	8.098E-02	1.077E-01	6.058E-02	0.000E+00
Cm243	1.373E-01	1.462E-01	5.407E-02	0.000E+00
Cm244	8.015E+00	3.132E+01	3.302E+00	1.128E+01
Cm245	1.840E-03	6.172E-03	6.682E-04	2.372E-03

Table 1. Inventories at 2010 for Average DOE SNF Canisters (Continued)

Nuclide	SDC 18X10	SDC 18X15	HIC	MCO
Cm246	3.664E-04	1.116E-03	1.309E-04	3.143E-04
Cm247	9.611E-10	1.081E-09	3.251E-10	0.000E+00
Co60	4.415E+01	4.646E+01	3.580E+02	2.197E+00
Cs134	1.094E+02	9.581E+01	4.556E+02	7.553E-01
Cs135	1.497E-01	3.285E-02	7.000E-02	1.851E-01
Cs137	9.269E+03	1.072E+04	5.363E+03	2.473E+04
Eu154	6.120E+01	5.708E+01	8.576E+01	0.000E+00
Eu155	1.945E+01	1.442E+01	4.158E+01	0.000E+00
Fe55	2.458E+01	1.722E+01	2.246E+02	0.000E+00
H3	1.716E+01	2.126E+01	1.615E+01	4.776E+01
I129	5.000E-03	3.137E-03	2.456E-03	1.521E-02
Kr85	4.848E+02	4.402E+02	3.495E+02	7.074E+02
Nb93m	2.018E-01	1.119E-01	9.379E-02	2.101E+00
Nb94	2.244E-02	1.288E-03	1.244E-02	3.106E-07
Ni59	1.965E-01	2.354E-02	2.292E-01	9.414E-02
Ni63	5.873E+00	5.666E+01	1.985E+01	1.021E+01
Np237	2.373E-02	2.396E-02	1.518E-02	1.792E-01
Pa231	3.730E-04	3.991E-02	1.852E-04	6.383E-05
Pb210	1.448E-08	2.783E-06	6.756E-09	3.478E-10
Pd107	5.991E-03	4.674E-03	2.907E-03	3.452E-02
Pm147	1.387E+03	1.004E+03	2.369E+03	0.000E+00
Pu238	4.719E+01	1.697E+02	4.144E+01	2.947E+02
Pu239	8.515E+00	2.319E+02	1.448E+01	5.691E+02
Pu240	9.658E+00	2.045E+02	1.149E+01	3.324E+02
Pu241	6.732E+02	5.989E+03	4.464E+02	9.521E+03
Pu242	2.298E-02	5.575E-02	6.801E-03	1.601E-01
Ra226	4.730E-08	3.577E-06	2.659E-08	5.319E-06
Ra228	6.593E-08	4.992E-03	2.545E-06	4.750E-09
Ru106	1.594E+01	1.528E+01	1.788E+02	1.463E-03
Sb125	1.582E+01	7.296E+00	7.318E+01	0.000E+00
Se79	9.104E-02	5.756E-02	3.864E-02	2.074E-01
Sm147	1.483E-06	1.770E-03	2.310E-06	0.000E+00
Sm151	1.975E+02	2.425E+02	1.005E+02	3.957E+02
Sn126	1.231E-01	4.667E-02	6.363E-02	3.622E-01
Sr90	8.443E+03	7.500E+03	4.789E+03	1.867E+04
Tc99	2.264E+00	1.345E+00	1.119E+00	6.968E+00
Th229	4.940E-08	1.491E-02	4.233E-06	4.308E-08
Th230	1.933E-06	5.673E-04	1.294E-05	4.723E-06
Th232	9.462E-09	4.321E-03	1.411E-06	5.585E-10
U232	3.716E-04	8.472E+00	9.565E-04	0.000E+00
U233	1.888E-05	5.423E+00	1.854E-03	2.643E-05
U234	1.421E-02	3.751E-01	2.591E-01	2.245E+00
U235	1.891E-02	9.395E-03	7.694E-03	8.563E-02
U236	3.454E-02	3.533E-02	2.561E-02	3.250E-01
U238	8.114E-03	2.790E-02	2.121E-03	1.766E+00
Zr93	2.958E-01	4.618E-01	1.691E-01	9.733E-01

Two sets of ORIGEN-S calculations are done. The first set (noted by *early* in the file name in Table 3) determines source terms at 0.02, 0.04, 0.06, 0.08, 0.1, 0.2, 0.3, 0.6, 0.7, and 1.0 years after 2010. This is done to demonstrate the buildup of certain short-lived radionuclides such as

Y90 that are not specified in the initial inventory. The second set determines the source terms for the time steps shown in Table 2.

Table 2. Time steps for Decay Calculations

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	1.0E+04	1.5E+04	2.0E+04	2.5E+04	3.0E+04	3.5E+04	4.0E+04
4.5E+04	5.0E+04	5.5E+04	6.0E+04	6.5E+04	7.0E+04	7.5E+04	8.0E+04	8.5E+04	9.0E+04
9.5E+04	1.0E+05	1.5E+05	2.0E+05	2.5E+05	3.0E+05	3.5E+05	4.0E+05	4.5E+05	5.0E+05
5.5E+05	6.0E+05	6.5E+05	7.0E+05	7.5E+05	8.0E+05	8.5E+05	9.0E+05	9.50+05	1.0E+06

The tables in the ORIGEN-S output of the neutron and gamma source terms, the thermal output, and the radionuclide inventories, are extracted from the output files using the script files described in Section 4.2.2 and then organized in Excel spreadsheets for easy use. The file *Watts.xls* contains the thermal output in watts for each average canister in terms of the light elements, actinides, and fission products. These are taken directly from the ORIGEN-S output and summed in the spreadsheet to obtain a total for each time step. The worksheet *Summary* (in the file *Watts.xls*) lists the total heat output in watts for each canister over time. *Nuclide.xls* contains the radionuclide inventories for each canister in curies. The gamma source terms in photons per second and MeV per second in standard 18-group format are provided in *Gammas.xls*. The neutron source terms are in the file *Neutron.xls* and are in neutrons per second in standard 27-group format.

6. RESULTS

This document may be affected by technical product input information that requires confirmation. Any changes to the document that may occur as a result of completing the confirmation activities will be reflected in subsequent revisions. The status of the input information quality may be confirmed by review of the Document Input Reference System (DIRS) database.

Attachment I contains the results of this calculation. A summary of the thermal sources for 10 years after 2010 for each canister type is plotted in Figure 1. A summary of the thermal sources for 1000 years and 1 million years after 2010 for each canister type is plotted in Figures 2 and 3, respectively.

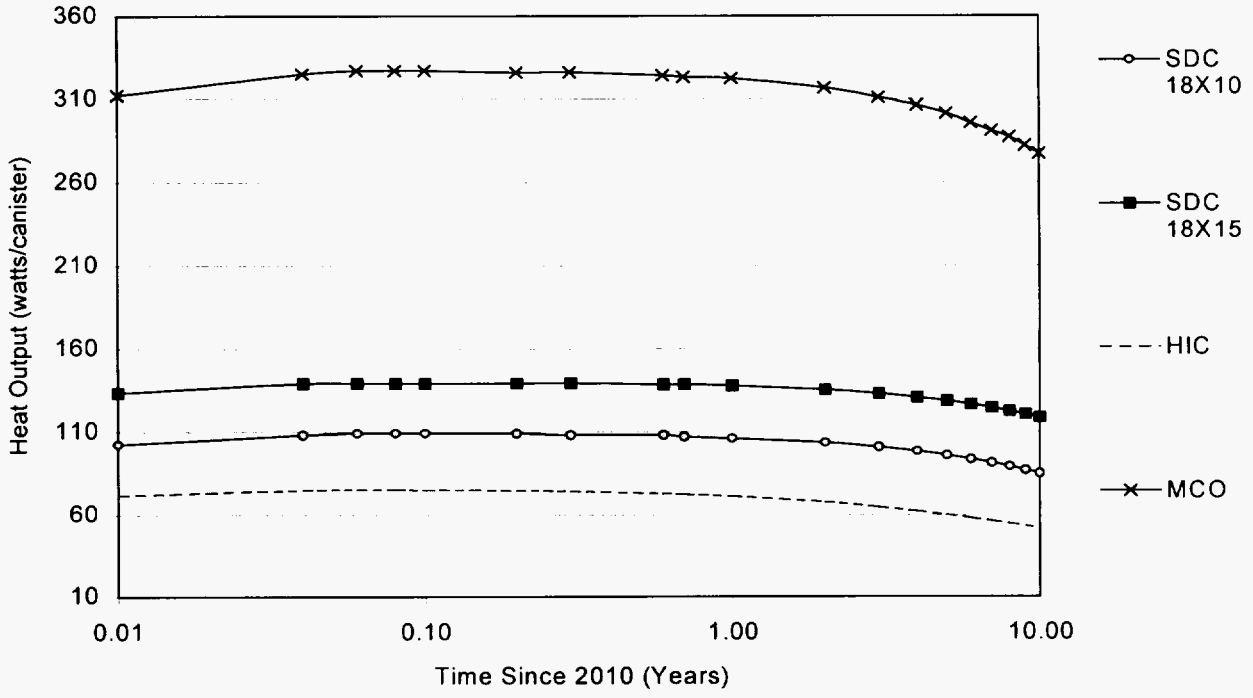

Figure 1. Time-Dependent Thermal Sources (watts/canister) for all DOE SNF Canisters to 10 Years

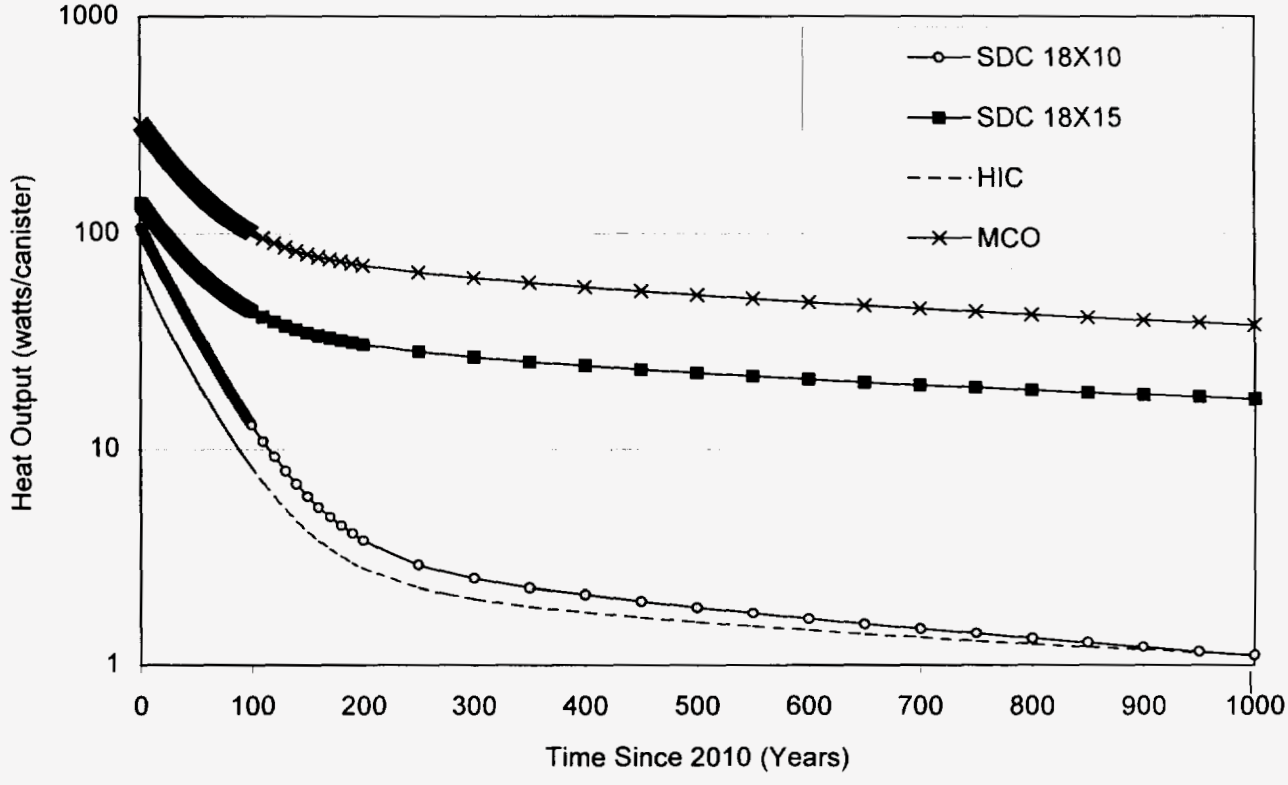

Figure 2. Time-Dependent Thermal Sources (watts/canister) for all DOE SNF Canisters to 1000 Years

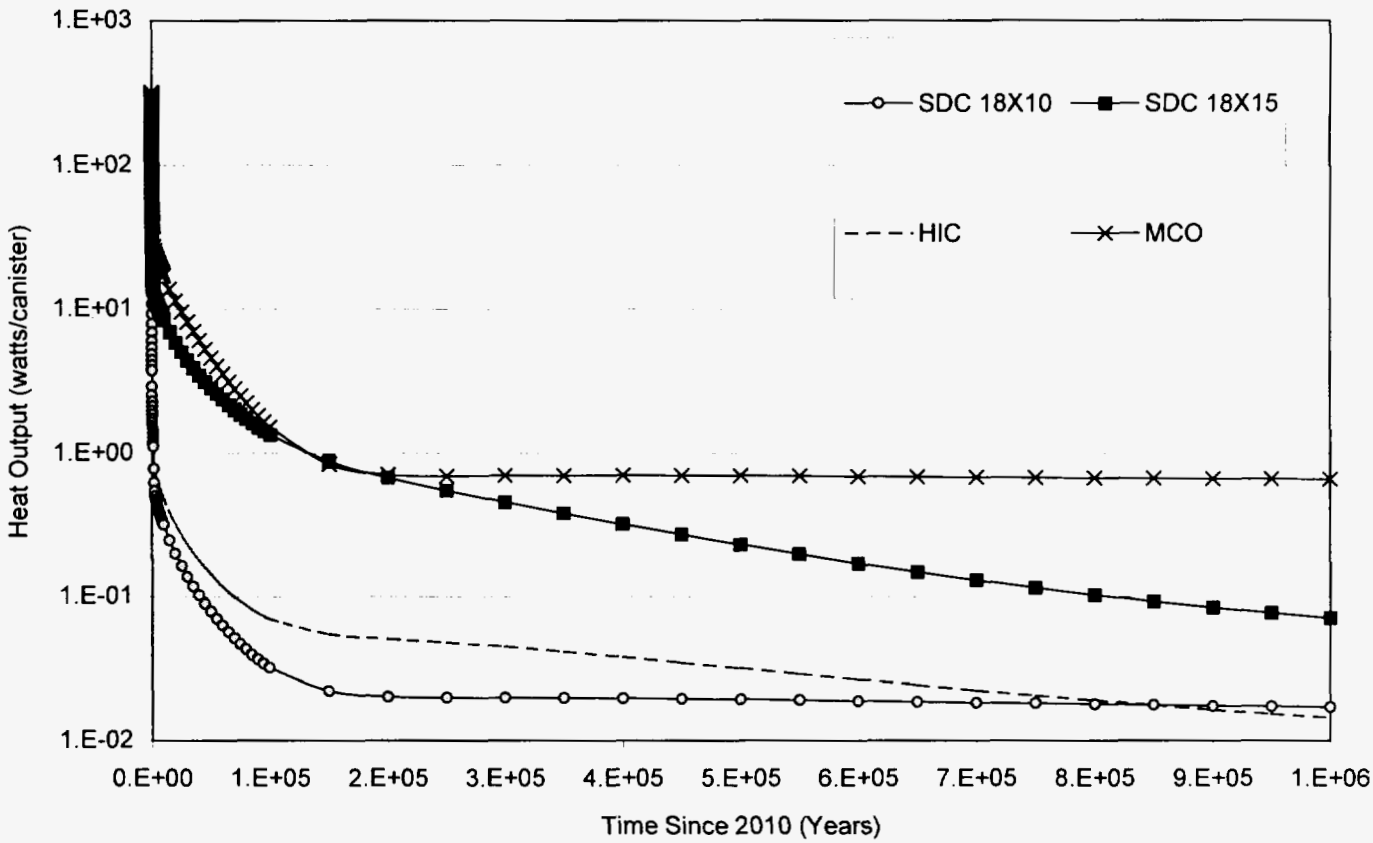

Figure 3. Time-Dependent Thermal Sources (watts/canister) for all DOE SNF Canisters to 1 Million Years

7. REFERENCES

CRWMS M&O 1997. *Software Qualification Report for the SCALE Modular Code System Version 4.3.* CSCI: 30011 V4.3. DI: 30011-2002, Rev. 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19970731.0884.

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INEEL (Idaho National Engineering and Environmental Laboratory) 1999. *CD-Design Basis Event Data (DBE), Revision 1, National Spent Nuclear Fuel Program.* Idaho Falls, Idaho: Idaho National Engineering and Environmental Laboratory. ACC: MOL.19990225.0479.

NRC (U.S. Nuclear Regulatory Commission) 1995. *SCALE 4.3, RSIC Computer Code Collection (CCC-545).* NUREG/CR-0200, Rev. 5. Washington, D.C.: U.S. Nuclear Regulatory Commission. TIC: 235920.

MO0001SPADBE00.001. DOE Spent Nuclear Fuel Data Contained in DBEFEB99.XLS Workbook. Submittal date: 01/04/2000.

Wheatley, P. 2000. "Phil Wheatley Letter to John Clouet, NSNFP Data Support for DBE Analysis - PDW-02-99, February 2, 1999." Letter from P.D. Wheatley (INEEL) to J. Clouet (CRWMS M&O), March 1, 2000, CCN 00-005155. ACC: MOL.20000307.0388.

Procedures:

AP-3.12Q, Rev. 0, ICN 1. *Calculations.* Washington, D.C.: U.S. Department of Energy, Office of Civilian Radioactive Waste Management. ACC: MOL.20000512.0065.

AP-6.1Q, Rev. 5, ICN 0. *Controlled Documents.* Washington, D.C.: U.S. Department of Energy, Office of Civilian Radioactive Waste Management. ACC: MOL.20000608.0009.

AP-SI.1Q, Rev. 2, ICN 4. *Software Management.* Washington, D.C.: U.S. Department of Energy, Office of Civilian Radioactive Waste Management. ACC: MOL.20000223.0508.

OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT
SPECIAL INSTRUCTION SHEET

1. QA: QA

Complete Only Applicable Items

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2. Record Date 06/09/2000	3. Accession Number ATT-TO MOL.20000627.0213
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12. Traceability Designator DC 24749	

13. Comments

THIS IS A CD ROM AS PART OF AN ATTACHMENT WHICH CAN BE LOCATED THRU THE RECORDS PROCESSING CENTER.

8. ATTACHMENTS

Due to the size and nature of the Excel spreadsheets that contain the initial radionuclide inventory calculations and the results of this calculation, the files listed in Table 3 are provided electronically on compact disc (CD) as Attachment I. The electronic ORIGEN-S output files are also provided in Attachment I, and are described in Table 3. The column describing the date and time the file was transferred or created indicates the time the ORIGEN-S output files were transferred from the HP to the personal computer (PC) in order to copy it onto CD or the time the file was created on the PC. Attachment II contains the descriptions and code listings of the script files documented in Section 4.2.2. and is four pages long.

Table 3. Electronic Files Contained on Attachment I

File Name	Description	File Size (bytes)	Date Transferred or Created	Time Transferred or Created
18X10early.output	ORIGEN-S output file for the first set of calculations (see p. 7) for the SDC 18X10 canister	152,756	02-25-00	2:31p
18X15early.output	ORIGEN-S output file for the first set of calculations (see p. 7) for the SDC 18X15 canister	154,232	02-25-00	2:31p
Gammas.xls	Gamma source terms in photons/second and MeV/second	697,344	06-09-00	9:32a
HIC.output	ORIGEN-S output file for the second set of calculations (see p. 7 and Table 2) for the HIC canister	2,288,435	02-28-00	12:10p
HICearly.output	ORIGEN-S output file for the first set of calculations (see p. 7) for the HIC canister	153,612	02-28-00	12:10p
Inventories.xls	Initial radionuclide inventory calculations	1,300,992	05-01-00	11:44a
MCO.output	ORIGEN-S output file for the second set of calculations (see p. 7 and Table 2) for the MCO canister	2,122,459	02-14-00	12:04p
MCOearly.output	ORIGEN-S output file for the first set of calculations (see p. 7) for the MCO canister	149,310	02-25-00	2:31p
Neutron.xls	Neutron source terms in neutrons/second	313,856	05-02-00	8:42a
Nuclide.xls	Radionuclide inventories in curies/canister	1,552,896	05-02-00	8:47a
SDC18X10.output	ORIGEN-S output file for the second set of calculations (see p. 7 and Table 2) for the SDC 18X10 canister	2,281,430	02-25-00	10:27a
SDC18X15.output	ORIGEN-S output file for the second set of calculations (see p. 7 and Table 2) for the SDC 18X15 canister	2,294,842	02-25-00	10:26a
Watts.xls	Thermal source terms in watts/canister	192,000	02-28-00	5:06p

The script files documented in this attachment are used to extract information from the lengthy ORIGEN-S output. The output from each of these script files is then opened as an EXCEL file and used to create the *.xls files listed in Table 3. For this reason, the intermediate output files from these scripts are not included in this attachment, only a sample is included for demonstration purposes.

These script files *watts*, *curies*, *neutrons*, and *gammas* can be run stand-alone on a HP 9000 series workstation using the command:

```
Awk -f script.file.name input.file.name > output.file.name
```

For this calculation however, the script file *make.file* is used to combine the script files *watts*, *curies*, *neutrons*, and *gammas* along with other editing commands into one routine. This attachment presents the shorter script files first, and then *make.file*, along with a sample of the results produced by *make.file*.

1. curies

This script file extracts the tables of radionuclide inventories from the ORIGEN-S output.

```
BEGIN {intable=0 && insas=0 }
/0when/ {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}
```

2. gammas

This script file extracts the tables of gamma source terms from the ORIGEN-S output.

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

3. neutrons

This script file extracts the neutron source terms from the ORIGEN-S output.

```
BEGIN {intable=0 && insas=0 }
/0when/ {insas=1}
/alpha-n plus spon. fission/{if (insas) print $0; intable=1}
/boundaries/ {if (insas && intable) print $0}
```

```
/E/ {if (insas && intable) print $0}
/ 27 1.00E-11 - 1.00E-08/ {intable=0}
```

4. watts

This script file extracts the total thermal sources from the light elements, actinides, and fission products from the ORIGEN-S output.

```
BEGIN {intable=0 && insas=0 }
/0when/ {insas=1}
/nuclide thermal power, /{if (insas) print $0;intable=1}
/initial/ {if (insas && intable) print $0}
/total/  {if (insas && intable) print $0}
/total/ {intable=0}
```

5. make.file

The following script file makes use of the script files *curies, neutrons, gammas* and *watts*. In the listing given below, the files *HIC.output* and *HICearly.output* are the inputs. *Make.file* extracts the information makes tables that can be easily opened in EXCEL. If different input files are used, the first line is changed to "for k in *filename1 filename2 ....*" It creates four output files for each file specified as input: **.curies, *.watts, *.gammas,* and **.neutrons*.

```
for k in  HIC HICearly
do
awk -f curies ${k}.output > ${k}.curies
cut -c-1-11 ${k}.curies >tmp1
cut -c-12-21  ${k}.curies >tmp2
cut -c-22-31  ${k}.curies >tmp3
cut -c-32-41  ${k}.curies >tmp4
cut -c-42-51  ${k}.curies >tmp5
cut -c-52-61  ${k}.curies >tmp6
cut -c-62-71  ${k}.curies >tmp7
cut -c-72-81  ${k}.curies >tmp8
cut -c-82-91  ${k}.curies >tmp9
cut -c-92-101 ${k}.curies >tmp10
cut -c-102-111 ${k}.curies >tmp11
cut -c-112-121 ${k}.curies >tmp12
paste -d',' tmp1 tmp2 tmp3 tmp4 tmp5 tmp6 tmp7 tmp8 tmp9 \
tmp10 tmp11 tmp12 > ${k}.curies
#
awk -f watts ${k}.output > ${k}.watts
grep total ${k}.watts >tmp1
split -3 tmp1
rm tmp1
for y in \
 a b c d\
 e f g h\
 i j k l\
 m n o p\
 q r
        do
```

```
                cat xa${y} blankline > a${y}
                cat tmp1 a${y} > tmp2
                cp tmp2 tmp1
              done
        mv tmp1 ${k}.watts
        awk -f gammas ${k}.output > ${k}.gammas
        awk -f neutrons ${k}.output > ${k}.neutrons
        rm tmp*
        rm x*
        rm a*
        done
```

A sample of the output from this script file is shown below (taken from HICearly.curies):

```
0         ,         ,         ,         ,      nucl,ide radioa,ctivity, c,uries      ,         ,    ,,
,         ,         ,         ,      basi,s =SCALE c,ase for HI,C   Canist,er: .01 to, .1,,
,   initial,  2E-02 yr,  4E-02 yr,  6E-02 yr,  8E-02 yr,      .1 yr,      .2 yr,      .3 yr,      .6 yr,      .7 yr,     1.0 yr
,   initial,  2E-02 yr,  4E-02 yr,  6E-02 yr,  8E-02 yr,      .1 yr,      .2 yr,      .3 yr,      .6 yr,      .7 yr,     1.0 yr
cl 36 ,  9.11E-04,  9.11E-04,  9.11E-04,  9.11E-04,  9.11E-04,  9.11E-04,  9.11E-04,  9.11E-04,  9.11E-04,  9.11E-04,  9.11E-04
fe 55 ,  2.25E+02,  2.23E+02,  2.22E+02,  2.21E+02,  2.20E+02,  2.19E+02,  2.13E+02,  2.08E+02,  1.93E+02,  1.88E+02,  1.74E+02
co 60 ,  3.58E+02,  3.57E+02,  3.56E+02,  3.55E+02,  3.54E+02,  3.53E+02,  3.49E+02,  3.44E+02,  3.31E+02,  3.27E+02,  3.14E+02
ni 59 ,  2.29E-01,  2.29E-01,  2.29E-01,  2.29E-01,  2.29E-01,  2.29E-01,  2.29E-01,  2.29E-01,  2.29E-01,  2.29E-01,  2.29E-01
ni 63 ,  1.99E+01,  1.98E+01,  1.98E+01,  1.98E+01,  1.98E+01,  1.98E+01,  1.98E+01,  1.98E+01,  1.98E+01,  1.98E+01,  1.97E+01
total   ,  6.03E+02,  6.01E+02,  5.99E+02,  5.96E+02,  5.94E+02,  5.92E+02,  5.82E+02,  5.72E+02,  5.44E+02,  5.35E+02,  5.08E+02
0         ,         ,         ,         ,      nucl,ide radioa,ctivity, c,uries      ,         ,    ,,
,         ,         ,         ,      basi,s =SCALE c,ase for HI,C   Canist,er: .01 to, .1,,
,   initial,  2E-02 yr,  4E-02 yr,  6E-02 yr,  8E-02 yr,      .1 yr,      .2 yr,      .3 yr,      .6 yr,      .7 yr,     1.0 yr
,   initial,  2E-02 yr,  4E-02 yr,  6E-02 yr,  8E-02 yr,      .1 yr,      .2 yr,      .3 yr,      .6 yr,      .7 yr,     1.0 yr
tl206 ,   .00E+00,  5.67E-15,  7.74E-15,  8.51E-15,  8.80E-15,  8.91E-15,  9.05E-15,  9.14E-15,  9.43E-15,  9.50E-15,  9.83E-15
tl207 ,   .00E+00,  4.02E-06,  1.22E-05,  2.18E-05,  3.13E-05,  3.99E-05,  6.62E-05,  7.50E-05,  7.92E-05,  7.96E-05,  8.06E-05
tl208 ,   .00E+00,  1.14E-06,  3.28E-06,  5.66E-06,  8.09E-06,  1.05E-05,  2.24E-05,  3.38E-05,  6.73E-05,  7.55E-05,  1.05E-04
```

A sample of the output from this script file is shown below (taken from HICearly.gammas):

```
1                    gamma source spectrum for .02 years
0                         energy interval in mev       photons / second     mev / second
                     1.0000E-02 to       5.0000E-02        1.0440E+14        3.1320E+12
                     5.0000E-02 to       1.0000E-01        2.9442E+13        2.2082E+12
                     1.0000E-01 to       2.0000E-01        2.0369E+13        3.0554E+12
                     2.0000E-01 to       3.0000E-01        6.1764E+12        1.5441E+12
                     3.0000E-01 to       4.0000E-01        4.3106E+12        1.5087E+12
                     4.0000E-01 to       6.0000E-01        2.0399E+13        1.0200E+13
                     6.0000E-01 to       8.0000E-01        1.7856E+14        1.2499E+14
                     8.0000E-01 to       1.0000E+00        8.4859E+12        7.6373E+12
                     1.0000E+00 to       1.3300E+00        2.3416E+13        2.7280E+13
                     1.3300E+00 to       1.6600E+00        6.5175E+12        9.7436E+12
                     1.6600E+00 to       2.0000E+00        2.5287E+10        4.6275E+10
                     2.0000E+00 to       2.5000E+00        1.1643E+10        2.6197E+10
                     2.5000E+00 to       3.0000E+00        1.4228E+09        3.9128E+09
                     3.0000E+00 to       4.0000E+00        1.8079E+08        6.3276E+08
                     4.0000E+00 to       5.0000E+00        1.8421E+04        8.2893E+04
                     5.0000E+00 to       6.5000E+00        7.3746E+03        4.2404E+04
                     6.5000E+00 to       8.0000E+00        1.4434E+03        1.0465E+04
                     8.0000E+00 to       1.0000E+01        3.0600E+02        2.7540E+03
0                    totals                                 4.0212E+14        1.9138E+14
1                    gamma source spectrum for .04 years
```

A sample of the output from this script file is shown below (taken from HICearly.neutrons):

total (alpha-n plus spon. fission) neutron source spectrum as a function of time
0 SCALE case for HIC Canister: Initial input for the year 2010
basis = SCALE case for HIC Canister: .01 to .1

	boundaries, mev	initial	2E-02 yr	4E-02 yr	6E-02 yr	8E-02 yr	.1 yr	.2 yr	.3 yr	.6 yr	.7 yr	1.0 yr
1	6.43E+00 - 2.00E+01	9.817E+03	9.811E+03	9.804E+03	9.798E+03	9.791E+03	9.784E+03	9.752E+03	9.719E+03	9.622E+03	9.590E+03	9.494E+03
2	3.00E+00 - 6.43E+00	1.268E+05	1.267E+05	1.267E+05	1.266E+05	1.265E+05	1.265E+05	1.261E+05	1.257E+05	1.246E+05	1.243E+05	1.232E+05
3	1.85E+00 - 3.00E+00	1.661E+05	1.661E+05	1.660E+05	1.659E+05	1.658E+05	1.657E+05	1.654E+05	1.650E+05	1.638E+05	1.634E+05	1.623E+05
4	1.40E+00 - 1.85E+00	8.102E+04	8.098E+04	8.093E+04	8.089E+04	8.084E+04	8.080E+04	8.057E+04	8.035E+04	7.968E+04	7.946E+04	7.880E+04
5	9.00E-01 - 1.40E+00	1.006E+05	1.005E+05	1.005E+05	1.004E+05	1.004E+05	1.003E+05	9.999E+04	9.968E+04	9.876E+04	9.845E+04	9.755E+04
6	4.00E-01 - 9.00E-01	1.046E+05	1.045E+05	1.045E+05	1.044E+05	1.043E+05	1.043E+05	1.039E+05	1.036E+05	1.026E+05	1.022E+05	1.012E+05
7	1.00E-01 - 4.00E-01	2.040E+04	2.039E+04	2.038E+04	2.036E+04	2.035E+04	2.034E+04	2.027E+04	2.020E+04	2.000E+04	1.994E+04	1.974E+04
8	1.70E-02 - 1.00E-01	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
9	3.00E-03 - 1.70E-02	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
10	5.50E-04 - 3.00E-03	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
11	1.00E-04 - 5.50E-04	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
12	3.00E-05 - 1.00E-04	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
13	1.00E-05 - 3.00E-05	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
14	3.05E-06 - 1.00E-05	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
15	1.77E-06 - 3.05E-06	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
16	1.30E-06 - 1.77E-06	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
17	1.13E-06 - 1.30E-06	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
18	1.00E-06 - 1.13E-06	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
19	8.00E-07 - 1.00E-06	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
20	4.00E-07 - 8.00E-07	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
21	3.25E-07 - 4.00E-07	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
22	2.25E-07 - 3.25E-07	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
23	1.00E-07 - 2.25E-07	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
24	5.00E-08 - 1.00E-07	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
25	3.00E-08 - 5.00E-08	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
26	1.00E-08 - 3.00E-08	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00
27	1.00E-11 - 1.00E-08	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00	.000E+00

A sample of the output from this script file is shown below (taken from HICearly.watts):

total	5.53E+00	5.51E+00	5.50E+00	5.49E+00	5.47E+00	5.46E+00	5.39E+00	5.32E+00	5.11E+00	5.04E+00	4.85E+00
total	3.50E+00	3.50E+00	3.50E+00	3.50E+00	3.50E+00	3.50E+00	3.50E+00	3.50E+00	3.50E+00	3.50E+00	3.51E+00
total	1.86E+01	6.27E+01	6.60E+01	6.64E+01	6.64E+01	6.63E+01	6.59E+01	6.55E+01	6.43E+01	6.39E+01	6.29E+01
TOTAL											