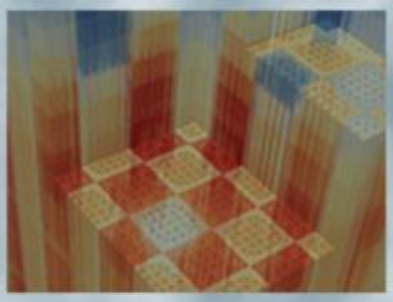
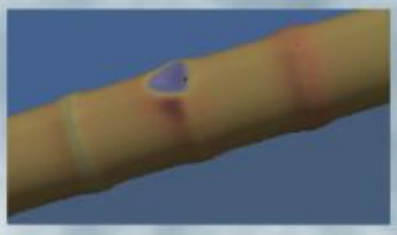
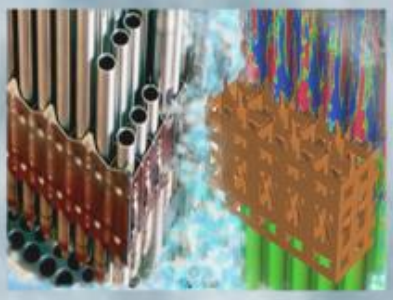
CASL-U-2016-1177-000 Rev. 0
ORNL/TM-2016/555

Generation of the V4.2m5 AMPX and MPACT 51 and 252-Group Libraries with ENDF/B-VII.0 and VII.1

Revision 0

Kang Seog Kim

December 12, 2016

-

REVISION LOG

Revision	Date	Affected Pages	Revision Description
0	12/12/2016	All	Initial version

Document pages that are:

Export Controlled None

IP/Proprietary/NDA Controlled None

Sensitive Controlled None

Unlimited - All

Requested Distribution:

To: N/A

Copy: N/A

Reviewed By:

Date:

Reviewer: Mark L. Williams, Cihangir Celik

EXECUTIVE SUMMARY

The evaluated nuclear data file (ENDF)/B-7.0 v4.1m3 MPACT 47-group library has been used as a main library for the Consortium for Advanced Simulation of Light Water Reactors (CASL) neutronics simulator in simulating pressurized water reactor (PWR) problems. Recent analysis for the high void boiling water reactor (BWR) fuels and burnt fuels indicates that the 47-group library introduces relatively large reactivity bias. Since the 47-group structure does not match with the SCALE 6.2 252-group boundaries, the CASL Virtual Environment for Reactor Applications Core Simulator (VERA-CS) MPACT library must be maintained independently, which causes quality assurance concerns. In order to address this issue, a new 51-group structure has been proposed based on the MPACT 47-g and SCALE 252-g structures. In addition, the new CASL library will include a 19-group structure for gamma production and interaction cross section data based on the SCALE 19-group structure.

New AMPX and MPACT 51-group libraries have been developed with the ENDF/B-7.0 and 7.1 evaluated nuclear data. The 19-group gamma data also have been generated for future use, but they are only available on the AMPX 51-g library. In addition, ENDF/B-7.0 and 7.1 MPACT 252-g libraries have been generated for verification purposes. Various benchmark calculations have been performed to verify and validate the newly developed libraries.

TABLE OF CONTENTS

REVISION LOG ii
EXECUTIVE SUMMARY iii
TABLE OF CONTENTS iv
ACRONYMS vii
1. INTRODUCTION 1
2. PROGRAMS AND DATA 2
2.1 Programs, data and computer to generate the AMPX MG library 2
2.2 Programs and computer to generate the MPACT MG library 3
3. GENERATION OF THE 51(n)/252(n)/19(γ)-GROUP AMPX LIBRARY 4
3.1 Procedure 4
3.2 The 51(n)/252(n)/19(γ)-group AMPX master library 7
3.2.1 Generation of 51-g and 252-g cross sections and Bondarenko data 7
3.2.2 Generation of the first AMPX 51-g and 252-g libraries 9
3.2.3 Generation of IR parameters and homogeneous F-factors 10
3.2.4 Generation of the second AMPX 51-g and 252-g library 11
3.2.5 Generation of heterogeneous F-factors 12
3.2.6 Generation of the third AMPX 51-g and 252-g library 13
4. GENERATION OF THE MPACT 51-G AND 252-G LIBRARY 14
4.1 Subgroup data generation 14
4.2 Generation of transport correction factors for ^{1}H 16
4.3 Generation of ^{238}U resonance data with and without epithermal upscattering 18
4.4 Subgroup data generation with the ^{238}U SPH factors 20
4.5 Generation of the 51-group MPACT libraries 22
5. BENCHMARK CALCULATION 24
5.1 The MPACT 51-g library results 24
5.2 The MPACT 252-g library results 30
6. DISCUSSION AND CONCLUSION 31
REFERENCE 32

APPENDIX A.1 Input files to generate MG XSs, Bondarenko data and Gamma XSs for ^{235}U 33
APPENDIX A.2 Input file to generate the first AMPX MG library 39
APPENDIX A.3 Input files to generate IR parameters and homogeneous F-factors for ^{235}U 48
APPENDIX A.4 Input file to generate the second AMPX MG library 49
APPENDIX A.5 Input files to generate heterogeneous F-factors for ^{235}U 58
APPENDIX A.6 Input file to generate the third AMPX 51-g library 64
APPENDIX B.1 The FF2RI and SUBGR input file and standard subgroup level file 68
APPENDIX B.2 The CE-KENO and MERIT input files and editing program 70
APPENDIX B.3 The DECLIB input file to generate the ENDF/B-7.0 MPACT 51-g library 74
APPENDIX B.4 The DECLIB input file to generate the ENDF/B-7.1 MPACT 51-g library 82
APPENDIX C.1 Benchmark problems for the given atomic number densities at various burnup points 90

FIGURES

Figure 3.1 The procedure to generate the AMPX MG library 4
Figure 3.2 The procedure to generate intermediate resonance data 5
Figure 3.3 Template to generate the AMPX input files to generate MG neutron XS, Bondarenko data and combined data (ENDF/B-VII.0) 8
Figure 4.1 Procedure to generate resonance data by using KENO-CE+ESSM 18
Figure 4.2 Procedure to generate the SPH factors 20
Figure 5.1 Sensitivity of the Kappa values between HELIOS and SERPENT 28
Figure 5.2 Comparison of k_{eff}'s between the ENDF/B-7.0 47-g v4.1m3 and 51-g 4.2m5 MPACT libraries with the SERPENT Kappas 28
Figure 5.3 Comparison of k_{eff}'s between the SERPENT and MPACT Kappas 29
Figure 5.4 Comparison of k_{eff}'s between the ENDF/B-7.0 and 7.1 MPACT 51-g libraries 29

TABLES

Table 2.1 Programs to generate the AMPX MG library 2
Table 2.2 Data files used in generating the AMPX MG library 3
Table 3.1 Neutron 51-group and gamma 19-group structures 6
Table 3.2 Input and output files to generate MG cross sections and Bondarenko data 7
Table 3.3 Input and output files to generate the first AMPX 51-g and 252-g libraries 9
Table 3.4 Input and output files to generate IR parameters and homogeneous F-factors 10
Table 3.5 Input and output files to generate the second AMPX 51-g and 252-g library 11
Table 3.6 Input and output files to generate heterogeneous F-factors 12
Table 3.7 Input and output files to generate the third AMPX 51-g and 252-g libraries 13
Table 4.1 Nuclides with subgroup data 14
Table 4.2 Input and output files to generate subgroup data 15
Table 4.3 Input and output files to generate the ^{1}H transport correction factors 16
Table 4.4 Transport correction factors for ^{1}H 17
Table 4.5 Input and output files to generate resonance data with/without epithermal upscattering 19
Table 4.6 The ^{238}U absorption SPH factors 21
Table 4.7 Input and output files to generate subgroup data with the ^{238}U SPH factors 21
Table 4.8 Input and output files to generate the 51-g and 252-g MPACT libraries 22
Table 4.9 Comparison of Kappa values 23
Table 5.1 Benchmark results for the VERA progression problems 1 and 2 (51-g) 24
Table 5.2 Benchmark results for the given atomic number densities (ENDF/B-7.0 51-g) 25
Table 5.3 Benchmark results for the given atomic number densities (ENDF/B-7.1 51-g) 25
Table 5.4 Representative cases for reaction rate analysis 26
Table 5.5 Results for reaction rate analysis 27
Table 5.6 Benchmark results for the VERA progression problems 1 and 2 (252-g) 29
Table 5.7 Benchmark results for the given atomic number densities (ENDF/B-7.0 252-g) 30
Table 5.8 Benchmark results for the given atomic number densities (ENDF/B-7.1 252-g) 30

ACRONYMS

1D	one-dimensional
2D	two-dimensional
BWR	boiling water reactor
CASL	Consortium for Advanced Simulation of Light Water Reactors
CE	continuous energy (as in cross sections)
DBRC	Doppler-broadening rejection correction
ENDF	evaluated nuclear data file
ESSM	Embedded Self-Shielding Method
FP	fission product
IR	intermediate resonance
MG	multi-group (as in cross sections)
MOC	Method Of Characteristics
MWD	megawatt day
MPACT	Michigan Parallel Characteristics Transport Code
NLC	neutron leakage conservation
NR	narrow resonance
ORNL	Oak Ridge National Laboratory
PW	pointwise
PWR	pressurized water reactor
SCALE	Standardized Computer Analyses for Licensing Evaluations
SG	subgroup
SPH	super homogenization
VERA-CS	Virtual Environment for Reactor Applications Core Simulator
XS	cross section

1. INTRODUCTION

The v4.1m3 MPACT 47-group library based on the evaluated nuclear data file (ENDF)/B-7.0 has been used as a main library for the Consortium for Advanced Simulation of Light Water Reactors (CASL) neutronics simulator. This library was generated by the AMPX/SCALE code package [Wia16, Rea16]. The current AMPX/SCALE procedure to generate the AMPX MG library includes the following three steps.

1. Generate the initial AMPX MG library based on a conventional AMPX procedure in which Bondarenko F-factors are generated by using narrow resonance (NR) approximation.
2. Generate a second, revised AMPX MG library in which intermediate resonance (IR) parameters are added and narrow resonance based F-factors on the initial library are replaced with homogeneous F-factors for most of nuclides.
3. Generate the third and final AMPX MG library in which homogeneous F-factors are replaced with heterogeneous F-factors for very important resonance nuclides.

The MPACT library format requires some additional data such as subgroup data, transient data, transport cross sections, and resonance data with epithermal upscattering, not normally generated during AMPX library processing. The current procedure to generate the MPACT MG library is as follows:

1. Generate subgroup data for the specified nuclides using cross sections and Bondarenko data from the AMPX MG library.
2. Generate transient data for the specified nuclides in the AMPX MG library.
3. Generate resonance self-shielding data considering epithermal upscattering by performing CE Monte Carlo with Doppler Broadening Rejection Calculation (DBRC).
4. Generate transport-cross section correction factors for ^{1}H by the neutron leakage conservation method.
5. Generate the final MPACT MG library for which the user should determine the number of nuclides to be involved, the number of resonance energy groups, background cross sections for non-resonance energy groups and nuclides, and cross section types for each nuclide.

Reference [Kim15] describes the detailed procedure to generate the AMPX and MPACT MG libraries.

Currently the MPACT code is being improved to directly use the AMPX MG master library, which will include the data presented above. An interim library data format called the *simplified AMPX MG library* has been devised to directly convert the AMPX MG format into this format, which is useful for resonance self-shielding and transport calculations.

This document includes a detailed procedure and information to generate the AMPX and MPACT 51-group libraries with ENDF/B-7.0 and 7.1.

2. PROGRAMS AND DATA

2.1. PROGRAMS, DATA AND COMPUTER TO GENERATE THE AMPX MG LIBRARY

The required programs to generate the AMPX MG library, for which detailed information is provided in Table 2.1, are (1) SCALE 6.3.beta1 + AMPX 6.3.beta1 integrated code package and (2) EXSITE.

Table 2.1 Programs to Generate the AMPX MG Library

Program	Location, date and checksum
[jupiter.ornl.gov]	
AMPX6.3.beta1	/home/ykk/scale_dev3/build/first/INSTALL/bin/ampxrte
	Date: Jul 26 16:13 md5sum: f215d7efc57aceada5f5771b19cff683
SCALE6.3.beta1	/home/ykk/scale_dev3/build/first/INSTALL/bin/scalerte
	Date: Jul 26 16:03 md5sum: 3c92a90d161c093cf1ce4f933d7d3536
EXSITE	/scale/release/6.2b5/Ampx/exsite/bin/exsite &
	Date: Oct 2 2015 md5sum: c85f2a76b6eb2c12461169d055780f9e

The computer used to generate the AMPX MG library is a Linux cluster, jupiter.ornl.gov. The required data to generate the AMPX MG library, for which detailed information is provided in Table 2.2, are as follows:

- ENDF/B-VII.0 neutron and gamma cross section data,
- the xml listing: 'endf7.*.xml' and 'endf7.*.xml config' (*: release number),
- Doppler broadened data,
- probability table,
- pointwise cross section data and description file for CENTRM, and
- scheduler data for parallel computing.

Table 2.2 Data Files Used in Generating the AMPX MG Library

Data version	File	Location
ENDF.B-VII.0	VII.0 Neutron XS	/home/dw8/libraries/endf/ENDF-B-VII.0/neutron
	VII.0 Thermal scattering	/home/dw8/libraries/endf/ENDF-B-VII.0/thermal
	VII.0 Photon XS	/home/dw8/libraries/endf/ENDF-B-VII.0/photo
	VII.0 xml file	/home/ykk/libraries/endf7.0/endf7.0_new.xml
	VII.0 xml_config file	/home/ykk/libraries/endf7.0/endf7.0_new.xml_config
	VII.0 Doppler broaden data	/home/c31/exsite/result/broaden_*
	VII.0 Probability table	/home/c31/exsite/result/ptable_*
	VII.0 Pointwise XS	/scale/scale_dev_data/cekenolib_7.0
	VII.0 description file	/scale/scale_dev_data/ce_v7.0_endf
ENDF.B-VII.1	VII.1 Neutron XS	/home/dw8/libraries/endf/ENDF-B-VII.1/neutrons
	VII.1 Thermal scattering	/home/dw8/libraries/endf/ENDF-B-VII.1/thermal_scatt
	VII.1 Photon XS	/home/dw8/libraries/endf/ENDF-B-VII.1/photoat
	VII.1 xml file	/home/ykk/libraries/endf7.0/endf7.0_new.xml
	VII.1 xml_config file	/home/ykk/libraries/endf7.0/endf7.0_new.xml_config
	VII.1 Doppler broaden data	/home/dw8/libraries/endf/ENDF-B-VII.1/point/point/broaden_*
	VII.1 Probability table	/home/dw8/libraries/endf7.1/ce/ptables/ptable_up2_*
	VII.1 Pointwise XS	/scale/scale_dev_data/cekenolib_7.1/
	VII.1 description file	/scale/scale_dev_data/ce_v7.1_endf
-	Weighting function	/home/ykk/libraries/wgtftn/200kev/casl_51g_50b00v_flux

2.2. PROGRAMS AND COMPUTER TO GENERATE THE MPACT MG LIBRARY

The required programs to generate the MPACT library are as follows:

- HTransportXS to obtain transport correction factors,
- FF2RI to convert self-shielded F-factors into resonance integral table,
- KENO-CE to generate resonance data with epithermal upscattering,
- MERIT to complete the resonance integral table by generating background cross sections,
- SUBGR to generate subgroup data, and
- DECLIB to generate the MPACT MG library.

The required data to generate the MPACT library are as follows:

- the AMPX MG library,
- subgroup data,
- transport correction factors,
- resonance data with epithermal upscattering,
- background cross sections, and
- ENDF/B-VII.0 neutron, decay, and fission product (FP) yield libraries.

The computers used in the generation of the MPACT library is a Linux cluster, jupiter.ornl.gov.

3. GENERATION OF THE 51(N)//252(N)/19(γ)-GROUP AMPX LIBRARY

3.1. PROCEDURE

The detailed procedure to generate the first AMPX MG library, including neutron/gamma data, is provided in [Wia16] , and the overall procedure is shown in Figures 3.1 and 3.2.

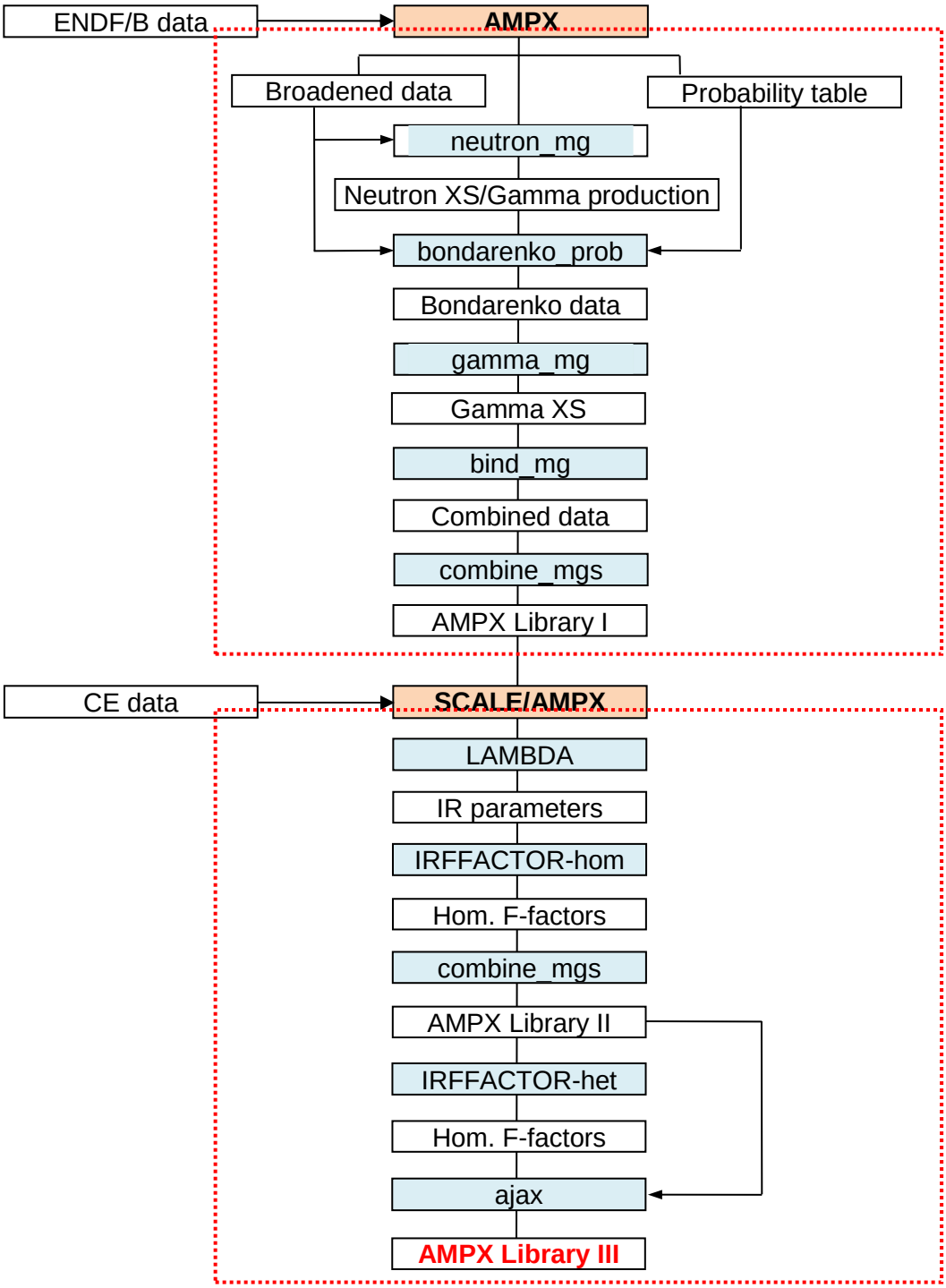


Figure 3.1 The Procedure to Generate the AMPX MG Library.

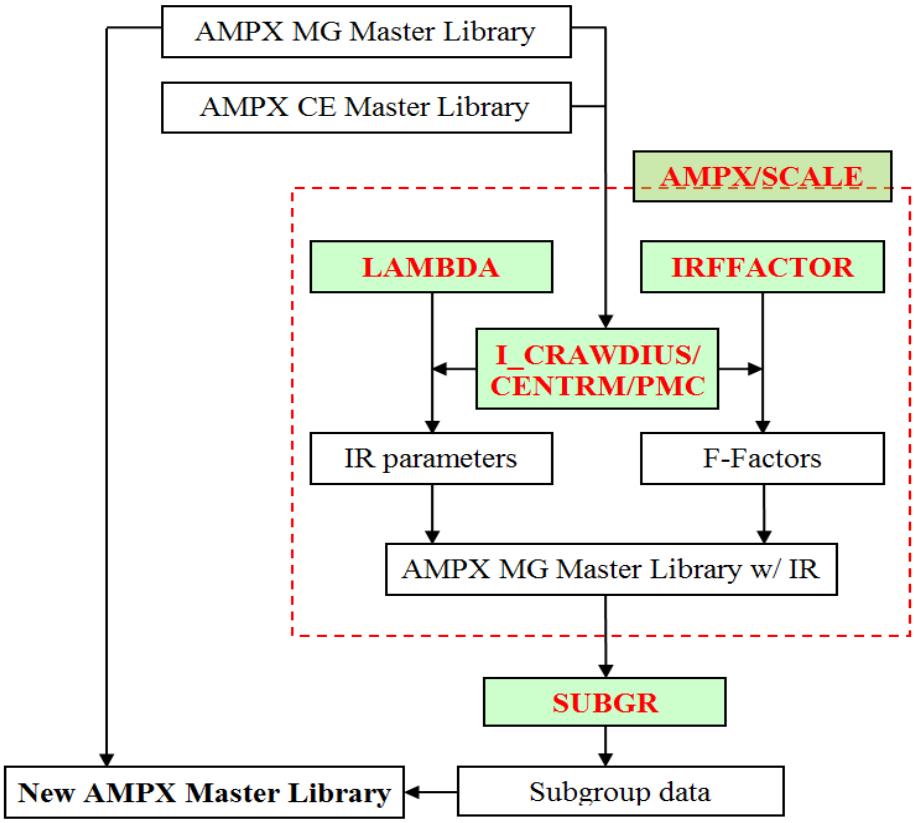


Figure 3.2 The Procedure to Generate Intermediate Resonance Data.

The following items are common data used in processing the 51(n)/19(γ)-group AMPX library.

- energy group structure: neutron 51-group structure and gamma 19-group structure (see Table 3.1);
- groups for explicit IR parameters and homogeneous F-factors:11~50;
- temperature (K): 293.0, 600.0, 900.0, 1200.0, and 2400.0;
- weighting function: typical PWR pointwise neutron spectrum at 293.0, 600.0, 900.0, 1200.0, 2400.0 K with atomic densities at 50 MWD/kgU obtained by CENTRM and renormalization program;
- thermal cutoff (eV): 5.0; and
- background cross section on NR approximation (barn): 1.0E8, 1000000.0, 100000.0, 10000.0, 5000.0, 2000.0, 1000.0, 640.0, 320.0, 160.0, 120.0, 80.0, 40.0, 20.0, 10.0, 4.0, 1.0, 1.0E-6 .

Table 3.1 Neutron 51-Group and Gamma 19-Group Structures

Neutron 47-g		Neutron 51-g		Gamma 19-g	
Group	Upper bound	Group	Upper bound	Group	Upper bound
1	2.000000E+07	1	2.000000E+07	1	2.000000E+07
2	6.065300E+06	2	6.434000E+06	2	1.000000E+07
3	3.678800E+06	3	4.304000E+06	3	8.000000E+06
4	2.231299E+06	4	2.354000E+06	4	6.500000E+06
5	1.353400E+06	5	1.356000E+06	5	5.000000E+06
6	8.208500E+05	6	8.200000E+05	6	4.000000E+06
7	4.978702E+05	7	4.920000E+05	7	3.000000E+06
8	1.831601E+05	8	2.000000E+05	8	2.500000E+06
9	6.737900E+04	9	7.300000E+04	9	2.000000E+06
10	9.118801E+03	10	5.000000E+04	10	1.660000E+06
11	2.034700E+03	11	2.000000E+04	11	1.330000E+06
12	1.300704E+02	12	9.500000E+03	12	1.000000E+06
13	7.889325E+01	13	2.250000E+03	13	8.000000E+05
14	4.785117E+01	14	9.500000E+02	14	6.000000E+05
15	2.902291E+01	15	3.050000E+02	15	4.000000E+05
16	1.371000E+01	16	1.430000E+02	16	3.000000E+05
17	1.209903E+01	17	7.600000E+01	17	2.000000E+05
18	8.315287E+00	18	4.830000E+01	18	1.000000E+05
19	7.338215E+00	19	3.000000E+01	19	4.500000E+04
20	6.476017E+00	20	1.440000E+01		1.000000E+04
21	5.715008E+00	21	1.190000E+01		
22	5.043477E+00	22	8.100000E+00		
23	4.450897E+00	23	7.150000E+00		
24	3.927903E+00	24	6.250000E+00		
25	2.382393E+00	25	5.400000E+00		
26	1.855391E+00	26	5.000000E+00		
27	1.457402E+00	27	4.700000E+00		
28	1.235105E+00	28	3.730000E+00		
29	1.166404E+00	29	2.470000E+00		
30	1.125397E+00	30	1.860000E+00		
31	1.072203E+00	31	1.450000E+00		
32	1.013699E+00	32	1.250000E+00		
33	9.710043E-01	33	1.175000E+00		
34	9.099967E-01	34	1.130000E+00		
35	7.820830E-01	35	1.080000E+00		
36	6.250621E-01	36	1.010000E+00		
37	5.032318E-01	37	9.750000E-01		
38	3.576701E-01	38	9.250000E-01		
39	2.705213E-01	39	7.500000E-01		
40	1.844302E-01	40	6.250000E-01		
41	1.457206E-01	41	5.000000E-01		
42	1.115699E-01	42	3.500000E-01		
43	8.196816E-02	43	2.750000E-01		
44	5.692194E-02	44	2.000000E-01		
45	4.275520E-02	45	1.500000E-01		
46	3.061288E-02	46	1.000000E-01		
47	1.239596E-02	47	8.000000E-02		
48	1.000000E-06	48	6.000000E-02		
49		49	4.000000E-02		
50		50	3.000000E-02		
51		51	1.000000E-02		

*Groups 10-27 include subgroup data in the 47-g MPACT library.
*Groups 10-31 include subgroup data in the 51-g MPACT library.

3.2. THE 51(N)/252(N)/19(γ)-GROUP AND 252-GROUP AMPX MASTER LIBRARY

3.2.1. GENERATION OF 51-G AND 252-G CROSS SECTIONS AND BONDARENKO DATA

Figure 3.3 provides an EXSITE template (=neutron_mg, bondarenko_prob, gamma_mg, and bind_mg) to generate the AMPX input files which will in turn generate 51-g neutron cross sections, 51-g→19-g gamma production data, Bondarenko data, 19-g gamma cross sections, intermediate resonance parameters, and homogeneous Bondarenko data. The tempate combines the files together. When expanding the EXSITE template, three input files for each nuclide are generated at the directory ./input which are for neutron_mg, bondarenko_prob, gamma_mg and bind_mg. Input files for ^{235}U are shown in Appendix A.1. The directories ./input and ./result should be established before performing the AMPX calculation,.

Table 3.2 provides detailed information for the AMPX input and output files which are located in the following directory.

```
jupiter.ornl.gov:
/home/ykk/libraries/endf7.0/mg/51g19g_07m2/0_ampx (ENDF/B-7.0)
/home/ykk/libraries/endf7.1/mg/51g19g_07m2/0_ampx (ENDF/B-7.1)
/home/ykk/libraries/endf7.0/mg/252g19g_07/0_ampx (ENDF/B-7.0)
/home/ykk/libraries/endf7.1/mg/252g19g_07/0_ampx (ENDF/B-7.1)
```

Table 3.2 Input and output files to generate MG cross sections and Bondarenko data

Description	Directory	File name
EXSITE template	.	ampx_51g.tem
AMPX input for MG neutron XS	./input	neut_***.inp
AMPX input for Bondarenko data	./input	bond_***.inp
AMPX input for gamma XS	./input	gamm_**.inp
AMPX input for combining	./input	bind_***.inp
AMPX output for MG neutron XS	./input	neut_***.out
AMPX output for Bondarenko data	./input	bond_***.out
AMPX output for gamma XS	./input	gamm_**.out
AMPX output for combining	./input	bind_***.out
AMPX message for MG neutron XS	./input	neut_***.msg
AMPX message for Bondarenko data	./input	bond_***.msg
AMPX message for gamma XS	./input	gamm_**.msg
AMPX message for combining	./input	bind_***.msg
MG XS	./result	neut_neutron_***
Free gas scattering matrix	./result	Neut_freegas_***
Gamma production data	./result	neut_yield_***
Bondarenko data	./result	Bond_***
Combined MG XS	./result	neut_***
Gamma XS data	./result	gamm_***
Integrated data	./result	master_***

*** Nuclide ID (For example: u235)

```
=neutron_mg
master=result/neut_
temperature=293
broaden=/home/c31/exsite/result/broaden_
neutgroups=51
thermalgroups=26 neutuserdef=yes
neutbounds=<1.0E-5 0.01 0.03 0.04 0.06 0.08 0.1 0.15 0.2 0.275 0.35 0.5 0.625 0.75 0.925 0.975 1.01 1.08 1.13
1.175 1.25 1.45 1.86 2.47 3.73 4.7 5.0 5.4 6.25 7.15 8.1 11.9 14.4 30.0 48.3 76.0 143.0 305.0 950.0 2250.0 9500.0
20000.0 50000.0 73000.0 200000.0 492000.0 820000.0 1356000.0 2354000.0 4304000.0 6434000.0 2.0E7>
gamgroups=19 gamuserdef=yes
gambounds=<10000.0 45000.0 100000.0 200000.0 300000.0 400000.0 600000.0 800000.0 1000000.0 1330000.0 1660000.0
2000000.0 2500000.0 3000000.0 4000000.0 5000000.0 6500000.0 8000000.0 1.0E7 2.0E7>
weightuser=yes
weighttab1=/home/ykk/libraries/wgtftn/200kev/casl_51g_50b00v_flux_new
makeyield=yes
thermcut=5.05 thermsplice=5 thinthermal=yes
makethermal=yes
thermaltemp=<293.0 600.0 900.0 1200.0 2400.0>
input=input/neut_
evals=/home/ykk/libraries/endf7.0/endf7.0_new.xml
end

=bondarenko_prob
master=result/bond_
broaden=/home/c31/exsite/result/broaden_
n1d=result/neut_ temperature=293
prob=/home/c31/exsite/result/ptable_
weightuser=yes
weighttab1=/home/ykk/libraries/wgtftn/200kev/casl_51g_50b00v_flux_new
sig0=<1.0E8 1000000.0 100000.0 10000.0 5000.0 2000.0 1000.0 640.0 320.0 160.0 120.0 80.0 40.0 20.0 10.0 4.0 1.0
1.0E-6>
temps=<293.0 600.0 900.0 1200.0 2400.0>
input=input/bond_
evals=/home/ykk/libraries/endf7.0/endf7.0_new.xml
end

=gamma_mg
gamma=result/gamm_ gamgroups=19 gamuserdef=yes
gambounds=<10000.0 45000.0 100000.0 200000.0 300000.0 400000.0 600000.0 800000.0 1000000.0 1330000.0 1660000.0
2000000.0 2500000.0 3000000.0 4000000.0 5000000.0 6500000.0 8000000.0 1.0E7 2.0E7>
gamweightuser=no
input=input/gamm_
evals=/home/ykk/libraries/endf7.0/endf7.0_new.xml
end

=bind_mg
master=result/master_
neutron=result/neut_ gamma=result/gamm_
addfree=yes addyield=yes addgamma=yes
addbond=yes
bond=result/bond_
input=input/bind_
evals=/home/ykk/libraries/endf7.0/endf7.0_new.xml
end

=combine_mgs
master=ampx51g_70_4.2m2_00.bin
indmaster=result/master_ title1=the endf/b7.0 ampx 51g 4.2m2 library 00
input=combine_51g_00.inp
evals=/home/ykk/libraries/endf7.0/endf7.0_new.xml
end

=ffactors
master=/home/ykk/libraries/endf7.0/mg/51g19g_07m2/0_ampx/ampx51g_70_4.2m2_00.bin
cedesc=/scale/scale_dev_data/ce_v7.0_endf.xml
cedatadir=ln -fs /scale/scale_dev_data/cekenolib_7.0
low=11 high=50
out=irflib/irf
input=irfinput/in_
evals=/home/ykk/libraries/endf7.0/endf7.0_new.xml
end

=combine_mgs
master=ampx51g_70_4.2m2_01.bin
indmaster=irflib/irf_irf_ title1=the endf/b7.0 ampx 51g 4.2m2 library 01
input=combine_51g_01.inp
evals=/home/ykk/libraries/endf7.0/endf7.0_new.xml
end
```

Figure 3.3 Template to Generate the AMPX Input Files To Generate MG Neutron XS, Bondarenko Data And Combined Data (ENDF/B-VII.0).

3.2.2. GENERATION OF THE FIRST AMPX 51-G AND 252-G LIBRARIES

Figure 3.3 provides an EXSITE template ('=combine_mgs') to generate the first AMPX 51-g libraries. When expanding the EXSITE template, one input file is generated at the working directory. The input file to generate the first AMPX 51-g library is shown in Appendix A.2.

Table 3.3 provides detailed information for the AMPX input and output files, which are located in the following directory.

```
jupiter.ornl.gov :
/home/ykk/libraries/endf7.0/mg/51g19g_07m2/0_ampx (ENDF/B-7.0)
/home/ykk/libraries/endf7.1/mg/51g19g_07m2/0_ampx (ENDF/B-7.1)
/home/ykk/libraries/endf7.0/mg/252g19g_07/0_ampx (ENDF/B-7.0)
/home/ykk/libraries/endf7.1/mg/252g19g_07/0_ampx (ENDF/B-7.1)
```

Table 3.3 Input and Output Files To Generate the First AMPX 51-g and 252-g Libraries

	Description	File name
ENDF/B-7.0	AMPX input for the 1st AMPX MG library	combine_51g_00.inp combine_252g_00.inp
	AMPX output	combine_51g_00.out combine_252g_00.out
	AMPX message	combine_51g_00.msg combine_252g_00.msg
	The 1st AMPX 51(n)/19(γ)-G library	ampx51g_70_4.2m2_00.bin
		Oct 8 08:38
		b1132404e8c154e33918fbfd3ad5da45
	The 1st AMPX 252(n)/19(γ)-G library	ampx252g_70_4.2m1_00.bin
		Aug 7 08:37
		03890fa9118800edb232375034060dfd
ENDF/B-7.1	The 1st AMPX 51(n)/19(γ)-G library	ampx51g_71_4.2m2_00.bin
		Oct 8 11:45
		2c3c80ad726703fd23e05aef14c1de44
	The 1st AMPX 252(n)/19(γ)-G library	ampx252g_71_4.2m1_00.bin
		Aug 7 08:47
		605d93d0ecf6770d79d77c0482303419

3.2.3. GENERATION OF IR PARAMETERS AND HOMOGENEOUS F-FACTORS

Figure 3.3 provides an EXSITE template (=ffactors) to generate intermediate resonance parameters and Bondarenko F-factors by using homogeneous models. When expanding the EXSITE template, one input file for each nuclide is generated in the directory ./input. The input file required for ^{235}U to generate intermediate resonance parameters and Bondarenko F-factors is shown in Appendix A.3. Before performing the AMPX/SCALE-LAMBDA/IRFFACTOR calculation, the directories ./irfinput and ./irflib should be established.

Table 3.4 provides detailed information for the LAMBDA/IRFFACTOR input file and output files, which are located at the following directory.

```
jupiter.ornl.gov :
/home/ykk/libraries/endf7.0/mg/51g19g_07m2/0_ampx (ENDF/B-7.0)
/home/ykk/libraries/endf7.1/mg/51g19g_07m2/0_ampx (ENDF/B-7.1)
/home/ykk/libraries/endf7.0/mg/252g19g_07/0_ampx (ENDF/B-7.0)
/home/ykk/libraries/endf7.1/mg/252g19g_07/0_ampx (ENDF/B-7.1)
```

Table 3.4 Input and Output Files to Generate IR Parameters and Homogeneous F-Factors

Description	Directory	File name
Input for IR parameter & F-factor	./irfinput	in_***.inp
Output for IR parameter & F-factor	./irfinput	in_***.out
Message for IR parameter & F-factor	./irfinput	in_***.msg
XS data + IR parameter	./irflib	irf_lambda_***
XS data + IR parameter + Hom. F-factor	./irflib	irf_irf_***

*** Nuclide ID. (For example: u235)

3.2.4. GENERATION OF THE SECOND AMPX 51-G AND 252-G LIBRARIES

Figure 3.3 provides an EXSITE template (=combine_mgs) to generate the second AMPX 51-g libraries. The AMPX/AJAX input file can be prepared by expanding the template. However, since homogeneous F-factors could not be generated for some of nuclides such as V and Zn, the AMPX/AJAX input required manual modification. The input file to generate the second AMPX MG library is shown in Appendix A.4. When preparing for the second AMPX MG library, the following rules are applied:

- All nuclides include intermediate resonance parameters.
- Nuclides for which a homogeneous slowing down calculation does not work include original F-factors based on NR approximation are available.

Table 3.5 provides detailed information for the AMPX input and output files which are located in the following directory.

```
jupiter.ornl.gov :
/home/ykk/libraries/endf7.0/mg/51g19g_07m2/0_ampx (ENDF/B-7.0)
/home/ykk/libraries/endf7.1/mg/51g19g_07m2/0_ampx (ENDF/B-7.1)
/home/ykk/libraries/endf7.0/mg/252g19g_07/0_ampx (ENDF/B-7.0)
/home/ykk/libraries/endf7.1/mg/252g19g_07/0_ampx (ENDF/B-7.1)
```

It is noted that the output files from AMPX/LAMBDA include all XS data and IR parameters, and the output files from the homogeneous IRFFACTOR are the same as the LAMDBA output files in that only NR based F-factors are replaced with new homogeneous F-factors obtained from IRFFACTOR.

Table 3.5 Input and Output Files to Generate the Second AMPX 51-g and 252-g Libraries

Data	Description	File name
ENDF/B-7.0	AJAX input for the 2nd AMPX MG lib.	combine_51g_01.inp combine_51g_01.inp
	AJAX output	combine_51g_01out combine_51g_01out
	AJAX message	combine_51g_01.msg combine_51g_01.msg
	The 2nd AMPX 51/19-group library	ampx51g_70_4.2m2_00.bin
		Oct 8 15:53
		40f035d457586a5e3de0fe91dfcc5e36
	The 2nd AMPX 252/19-group library	Ampx252g_70_4.2m1_00.bin
		Aug 8 00:48
		9869c6a49029db2893c2bb4c57e2c790
ENDF/B-7.1	The 2nd AMPX 51/19-group library	ampx51g_71_4.2m2_00.bin
		Oct 8 15:54
		373bbd1d4fa6dd9afe1430a05973e4f6
	The 2nd AMPX 252/19-group library	Ampx252g_71_4.2m1_00.bin
		Aug 8 00:21
		544e3fabcbfbe8cd6a6fe23d2e2b5dab

3.2.5. GENERATION OF HETEROGENEOUS F-FACTORS

Heterogeneous F-factors are included only for a few very important resonance nuclides that most significantly impact the neutronics results. The following 20 nuclides have heterogeneous F-factor data. This option of level-dependent background cross sections for subgroup data has been used for all nuclides except for Ag, In and Cd nuclides.

- Multiple absorber (19 nuclides):
  ^{109}Ag, ^{113}Cd, ^{113}In, ^{115}In, ^{155}Gd, ^{156}Gd, ^{157}Gd, ^{158}Gd, ^{232}Th, ^{233}U, ^{235}U, ^{236}U, ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{241}Pu, ^{242}Pu, ^{241}Am, ^{167}Er
- Single absorber (1 nuclide):
  ^{238}U

Example input files to generate heterogeneous F-factors for ^{235}U are shown in Appendix A.5. Since the typical Bondarenko approach is not able to accommodate the resonance interference effect explicitly, heterogeneous F-factors can be generated in two different ways: with or without considering explicit resonance interference. The term *single* indicates without resonance interference, and *multiple* indicates with resonance interference.

Table 3.6 provides detailed information for the heterogeneous IRFFACTOR input and output files which are located in the following directory.

```
jupiter.ornl.gov :
/home/ykk/libraries/endf7.0/mg/51g19g_07/1_ffactor_het(ENDF/B-7.0)
/home/ykk/libraries/endf7.1/mg/51g19g_07/1_ffactor_het(ENDF/B-7.1)
/home/ykk/libraries/endf7.0/mg/51g19g_07m4/1_ffactor_het_er167(ENDF/B-7.0 167Er)
/home/ykk/libraries/endf7.1/mg/51g19g_07m4/1_ffactor_het_er167 (ENDF/B-7.1 167Er)
/home/ykk/libraries/endf7.0/mg/252g19g_07/1_ffactor_het(ENDF/B-7.0)
/home/ykk/libraries/endf7.1/mg/252g19g_07/1_ffactor_het(ENDF/B-7.1)
```

Table 3.6 Input and Output Files to Generate Heterogeneous F-factors

Description	Directory	File name
Cell models for heterogeneous F-factor	./cases	*.inp
Input for heterogeneous F-factor : multiple	./multiple	*_m.inp
Output for heterogeneous F-factor : multiple	./multiple	*_m.out
Message for heterogeneous F-factor : multiple	./multiple	*_m.msg
Heterogeneous F-factor : multiple	./multiple	*_ffactors_m
Level dependent data : multiple	./multiple	subgrpdata_*_lev_m
Input for heterogeneous F-factor : single	./single	*_s.inp
Output for heterogeneous F-factor : single	./single	*_s.out
Message for heterogeneous F-factor : single	./single	*_s.msg
Heterogeneous F-factor : single	./single	*_ffactors_s
Level dependent data : single	./single	subgrpdata_*_lev_s

3.2.6. GENERATION OF THE THIRD AMPX 51-G AND 252-G LIBRARIES

This section describes the final step required to generate the AMPX 51-g and 252-g libraries by replacing homogeneous or NR based F-factors with heterogeneous F-factors. The AMPX/AJAX input file is provided in Appendix A.6. Table 3.7 provides detailed information for the AMPX/AJAX input and output files, which are located in the following directory.

```
jupiter.ornl.gov :
/home/ykk/libraries/endf7.0/mg/51g19g_07m2/1_ffactor_het (ENDF/B-7.0)
/home/ykk/libraries/endf7.1/mg/51g19g_07m2/1_ffactor_het (ENDF/B-7.1)
/home/ykk/libraries/endf7.0/mg/51g19g_07m4/1_ffactor_het_er167 (ENDF/B-7.0)
/home/ykk/libraries/endf7.1/mg/51g19g_07m4/1_ffactor_het_er167 (ENDF/B-7.1)
/home/ykk/libraries/endf7.0/mg/252g19g_07/1_ffactor_het (ENDF/B-7.0)
/home/ykk/libraries/endf7.1/mg/252g19g_07/1_ffactor_het (ENDF/B-7.1)
```

Table 3.7 Input and Output Files to Generate the Third AMPX 51-g and 252-g Libraries

Data	Directory	File name
ENDF/B-7.0	The 3rd AMPX 51-g library	ampx51g_70_4.2m2_02.bin
		Oct 16 17:05
		60c570c5c1af157c345bf0778a6063c8
	The 4th AMPX 51-g library with new ^{167}Er	ampx51g_70_4.2m5_03.bin
		Dec 5 15:18
		74056d3ad3cadab85de8d321b0eb4649
	The 3rd AMPX 252-g library	ampx252g_70_4.2m1_02.bin
		Sep 7 22:26
		fc4dc5d6a69258ded1b0aae11e94f522
ENDF/B-7.1	The 3rd AMPX 51-g library	ampx51g2_71_4.2m2_02.bin
		Oct 16 17:09
		e44afa195b7f348694df249d73d1682f
	The 4th AMPX 51-g library with new ^{167}Er	ampx51g_71_4.2m5_03.bin
		Dec 5 16:11
		ab23189f82be660e9e8490c1451dcb30
	The 3rd AMPX 252-g library	ampx252g_71_4.2m1_02.bin
		Sep 7 22:28
		64db8a3b933b75dbcc29695920800abe

4. GENERATION OF THE MPACT 51-G AND 252-G LIBRARY

4.1. SUBGROUP DATA GENERATION

At first, Bondarenko F-factors in the AMPX MG library should be converted by FF2RI into resonance integral tables to be used in the subgroup data generation. Then, subgroup data are generated by using SUBGR. Subgroup data, including weights and levels, have been generated for the 49 resonance nuclides shown in Table 4.1 and for all energy groups. Appendix B.1 provides the FF2RI and SUBGR input files and the standard subgroup level file.

Table 4.1 Nuclides with subgroup data

No	Nuclide	No	Nuclide	No	Nuclide	No	Nuclide	No	Nuclide
1	^{91}Zr	11	^{131}Xe	21	^{157}Gd	31	^{177}Hf	41	^{235}U
2	^{96}Zr	12	^{133}Cs	22	^{158}Gd	32	^{178}Hf	42	^{236}U
3	^{95}Mo	13	^{152}Sm	23	^{160}Dy	33	^{179}Hf	43	^{238}U
4	^{99}Tc	14	^{151}Eu	24	^{161}Dy	34	^{180}Hf	44	^{238}Pu
5	^{103}Rh	15	^{152}Eu	25	^{162}Dy	35	^{182}W	45	^{239}Pu
6	^{108}Pd	16	^{153}Eu	26	^{163}Dy	36	^{183}W	46	^{240}Pu
7	^{107}Ag	17	^{154}Eu	27	^{164}Dy	37	^{184}W	47	^{241}Pu
8	^{109}Ag	18	^{155}Eu	28	^{166}Er	38	^{186}W	48	^{242}Pu
9	^{113}In	19	^{155}Gd	29	^{167}Er	39	^{232}Th	49	^{241}Am
10	^{115}In	20	^{156}Gd	30	^{176}Hf	40	^{233}U		

Table 4.2 provides detailed information for the FF2RI and SUBGR input/output files, which are located in the following directory.

```
jupiter.ornl.gov :
/home/ykk/libraries/endf7.0/mg/51g19g_07m2/2_ff2ri (ENDF/B-7.0)
/home/ykk/libraries/endf7.0/mg/51g19g_07m2/3_subgr (ENDF/B-7.0)
/home/ykk/libraries/endf7.1/mg/51g19g_07m2/2_ff2ri (ENDF/B-7.1)
/home/ykk/libraries/endf7.1/mg/51g19g_07m2/3_subgr (ENDF/B-7.1)
/home/ykk/libraries/endf7.0/mg/51g19g_07m4/2_ff2ri (ENDF/B-7.0 167Er)
/home/ykk/libraries/endf7.0/mg/51g19g_07m4/3_subgr (ENDF/B-7.0 167Er)
/home/ykk/libraries/endf7.1/mg/51g19g_07m4/2_ff2ri (ENDF/B-7.1 167Er)
/home/ykk/libraries/endf7.1/mg/51g19g_07m4/3_subgr (ENDF/B-7.1 167Er)
/home/ykk/libraries/endf7.0/mg/252g19g_07/2_ff2ri (ENDF/B-7.0)
/home/ykk/libraries/endf7.0/mg/252g19g_07/3_subgr (ENDF/B-7.0)
/home/ykk/libraries/endf7.1/mg/252g19g_07/2_ff2ri (ENDF/B-7.1)
/home/ykk/libraries/endf7.1/mg/252g19g_07/3_subgr (ENDF/B-7.1)
```

Table 4.2 Input and Output Files to Generate Subgroup Data

Data	Description	Directory	File name
ENDF/B-7.0	FF2RI input file	./2_ff2ri/	FF2RI_51g_70.in FF2RI_51g_70_m5.in(^{167}Er) FF2RI_252g_70.in
	Resonance XS file	./2_ff2ri/	ssxs_51g_70_08082016.dat ssxs_51g_70_m5_12052016.dat(^{167}Er) ssxs_252g_70_09072016.dat
	SUBGR input file	./3_subgr/	subgr_51g_70.in subgr_51g_70_m5.in(^{167}Er) subgr_252g_70.in
	SUBGR output file	./3_subgr/	subgr_51g_70_08102016.out subgr_51g_70_m5_12052016.out(^{167}Er) subgr_252g_70_09072016.out
	SUBGR subgroup data file	./3_subgr/	subgr_51g_70_08102016.sub subgr_51g_70_m5_12052016.sub(^{167}Er) subgr_252g_70_09072016.sub
	SUBGR standard level file	./3_subgr/	SUBGR_51G_70.LEV SUBGR_51G_70_M5.LEV(^{167}Er) SUBGR_252G_70.LEV
ENDF/B-7.1	FF2RI input file	./2_ff2ri/	FF2RI_51g_71.in FF2RI_51g_71_m5.in(^{167}Er) FF2RI_252g_71.in
	Resonance XS file	./2_ff2ri/	ssxs_51g_71_08082016.dat ssxs_51g_71_m5_12052016.dat(^{167}Er) ssxs_252g_71_09072016.dat
	SUBGR input file	./3_subgr/	subgr_51g_71.in subgr_51g_71_m5.in(^{167}Er) subgr_252g_71.in
	SUBGR output file	./3_subgr/	subgr_51g_71_08102016.out subgr_51g_71_m5_12052016.out(^{167}Er) subgr_252g_71_09072016.out
	SUBGR subgroup data file	./3_subgr/	subgr_51g_71_08102016.sub subgr_51g_71_m5_12052016.sub(^{167}Er) subgr_252g_71_09072016.sub
	SUBGR standard level file	./3_subgr/	SUBGR_51G_71.LEV SUBGR_51G_71_M5.LEV(^{167}Er) SUBGR_252G_71.LEV

4.2. GENERATION OF TRANSPORT CORRECTION FACTORS FOR ^{1}H

The computational model from Reference [Her13, Kim16] is as follows:

- 1D slab 100 cm w/ vacuum boundary, 0.005 cm mesh size
- All ^{1}H with 4.780E+23 atom/cm^{3}
- 9 temperatures : 293.0, 350.0, 400.0, 450.0, 500.0, 550.0, 600.0, 650.0, 800.0 K
- Source : ^{235}U fission spectrum with buckled cosine spatial distribution

MOC1D was used for the MPACT 51-g libraries. Recently the HTransportXS procedure based on SCALE/XSDRN has been developed to automatically generate the ^{1}H transport correction factors and incorporate them into the AMPX MG library. This procedure has been used to generate transport correction factors for the MPACT 51 and 252-g libraries.

```
jupiter.ornl.gov :
/home/ykk/libraries/endf7.0/mg/51g19g_07m2/2_h1trpt (ENDF/B-7.0)
/home/ykk/libraries/endf7.1/mg/51g19g_07m2/2_h1trpt (ENDF/B-7.1)
/home/ykk/libraries/endf7.0/mg/252g19g_07/4_h1trpt (ENDF/B-7.0)
/home/ykk/libraries/endf7.1/mg/252g19g_07/4_h1trpt (ENDF/B-7.1)
```

Table 4.3 provides detailed information for the input/output files to generate transport correction factors.

Table 4.3 Input and Output Files to Generate the 1H Transport Correction Factors

Data	Description	Directory	File name
ENDF/B-7.0	HTransportXS input	.	htransportxs_01.inp
	HTransportXS output	.	htransportxs_01.out
ENDF/B-7.1	HTransportXS input	.	htransportxs_01.inp
	HTransportXS output	.	htransportxs_01.out

Table 4.4 provides the 51-g transport correction factors for ^{1}H which were obtained by HTransportXS with ENDF/B-7.0.

Table 4.4 The 51-g Transport Correction Factors for ^{1}H (ENDF/B-7.0)

Group	293.0	350.0	400.0	450.0	500.0	550.0	600.0	650.0	800.0
1	8.574378E-01	8.574357E-01	8.574422E-01	8.574417E-01	8.574374E-01	8.574404E-01	8.574384E-01	8.574388E-01	8.574347E-01
2	7.882631E-01	7.882645E-01	7.882582E-01	7.882631E-01	7.882595E-01	7.882595E-01	7.882618E-01	7.882608E-01	7.882645E-01
3	6.948830E-01	6.948742E-01	6.948817E-01	6.948813E-01	6.948823E-01	6.948782E-01	6.948782E-01	6.948813E-01	6.948834E-01
4	5.611714E-01	5.611808E-01	5.611696E-01	5.611714E-01	5.611724E-01	5.611688E-01	5.611702E-01	5.611680E-01	5.611666E-01
5	4.502859E-01	4.502923E-01	4.502839E-01	4.502853E-01	4.502847E-01	4.502855E-01	4.502836E-01	4.502860E-01	4.502827E-01
6	3.659956E-01	3.659997E-01	3.659941E-01	3.659966E-01	3.659970E-01	3.659956E-01	3.659940E-01	3.659940E-01	3.659925E-01
7	2.891241E-01	2.891268E-01	2.891242E-01	2.891189E-01	2.891240E-01	2.891204E-01	2.891193E-01	2.891204E-01	2.891196E-01
8	2.331837E-01	2.331820E-01	2.331814E-01	2.331809E-01	2.331809E-01	2.331837E-01	2.331803E-01	2.331803E-01	2.331768E-01
9	2.121840E-01	2.121867E-01	2.121839E-01	2.121845E-01	2.121859E-01	2.121851E-01	2.121857E-01	2.121835E-01	2.121856E-01
10	2.159931E-01	2.159878E-01	2.159920E-01	2.159924E-01	2.159924E-01	2.159890E-01	2.159915E-01	2.159895E-01	2.159834E-01
11	2.271858E-01	2.271905E-01	2.271866E-01	2.271894E-01	2.271887E-01	2.271896E-01	2.271908E-01	2.271900E-01	2.271927E-01
12	2.541113E-01	2.541153E-01	2.541138E-01	2.541156E-01	2.541153E-01	2.541160E-01	2.541176E-01	2.541178E-01	2.541172E-01
13	2.763563E-01	2.763619E-01	2.763569E-01	2.763539E-01	2.763553E-01	2.763533E-01	2.763545E-01	2.763538E-01	2.763559E-01
14	2.945766E-01	2.945629E-01	2.945497E-01	2.945393E-01	2.945236E-01	2.945133E-01	2.944986E-01	2.944821E-01	2.944826E-01
15	3.064087E-01	3.063871E-01	3.063666E-01	3.063430E-01	3.063214E-01	3.062999E-01	3.062753E-01	3.062537E-01	3.062226E-01
16	3.130209E-01	3.130013E-01	3.129814E-01	3.129610E-01	3.129395E-01	3.129206E-01	3.128970E-01	3.128775E-01	3.128131E-01
17	3.174734E-01	3.174542E-01	3.174379E-01	3.174210E-01	3.174019E-01	3.173839E-01	3.173675E-01	3.173456E-01	3.172794E-01
18	3.201122E-01	3.200959E-01	3.200825E-01	3.200668E-01	3.200512E-01	3.200359E-01	3.200191E-01	3.200032E-01	3.199418E-01
19	3.227034E-01	3.226904E-01	3.226782E-01	3.226676E-01	3.226563E-01	3.226438E-01	3.226281E-01	3.226165E-01	3.225641E-01
20	3.253155E-01	3.252177E-01	3.252036E-01	3.251921E-01	3.251773E-01	3.251634E-01	3.251488E-01	3.251341E-01	3.250793E-01
21	3.265107E-01	3.258417E-01	3.258070E-01	3.257732E-01	3.257373E-01	3.257033E-01	3.256660E-01	3.256307E-01	3.255159E-01
22	3.277346E-01	3.266490E-01	3.266023E-01	3.265527E-01	3.265036E-01	3.264522E-01	3.264012E-01	3.263501E-01	3.261930E-01
23	3.279389E-01	3.267298E-01	3.266776E-01	3.266254E-01	3.265719E-01	3.265172E-01	3.264608E-01	3.264032E-01	3.262368E-01
24	3.282802E-01	3.269671E-01	3.269126E-01	3.268564E-01	3.267984E-01	3.267408E-01	3.266810E-01	3.266194E-01	3.264451E-01
25	3.290333E-01	3.276476E-01	3.275890E-01	3.275309E-01	3.274700E-01	3.274104E-01	3.273486E-01	3.272846E-01	3.271019E-01
26	3.291249E-01	3.293722E-01	3.292359E-01	3.291031E-01	3.289847E-01	3.288598E-01	3.287535E-01	3.286423E-01	3.283173E-01
27	3.284502E-01	3.286866E-01	3.285194E-01	3.283861E-01	3.282577E-01	3.281217E-01	3.279960E-01	3.278731E-01	3.274857E-01
28	3.253442E-01	3.256864E-01	3.256762E-01	3.256511E-01	3.256309E-01	3.255934E-01	3.255593E-01	3.255307E-01	3.253721E-01
29	3.272895E-01	3.276092E-01	3.276284E-01	3.276384E-01	3.276541E-01	3.276809E-01	3.276918E-01	3.277115E-01	3.277500E-01
30	3.292741E-01	3.295910E-01	3.296423E-01	3.296959E-01	3.297678E-01	3.298290E-01	3.299015E-01	3.299821E-01	3.302530E-01
31	3.312128E-01	3.315304E-01	3.316210E-01	3.317139E-01	3.318342E-01	3.319561E-01	3.321155E-01	3.322619E-01	3.328124E-01
32	3.325309E-01	3.327657E-01	3.328785E-01	3.330816E-01	3.332312E-01	3.333967E-01	3.336123E-01	3.338161E-01	3.345736E-01
33	3.330993E-01	3.333372E-01	3.334778E-01	3.336916E-01	3.338706E-01	3.340748E-01	3.343146E-01	3.345603E-01	3.354605E-01
34	3.337090E-01	3.340239E-01	3.341955E-01	3.343766E-01	3.345832E-01	3.348237E-01	3.350916E-01	3.353746E-01	3.364180E-01
35	3.346225E-01	3.350771E-01	3.352613E-01	3.353954E-01	3.356450E-01	3.359403E-01	3.362463E-01	3.365863E-01	3.379072E-01
36	3.355277E-01	3.358365E-01	3.360428E-01	3.363696E-01	3.366575E-01	3.369885E-01	3.373464E-01	3.377410E-01	3.394087E-01
37	3.362325E-01	3.366346E-01	3.368715E-01	3.371951E-01	3.375141E-01	3.378308E-01	3.382645E-01	3.386986E-01	3.408965E-01
38	3.389627E-01	3.395303E-01	3.398448E-01	3.401827E-01	3.406089E-01	3.409513E-01	3.416973E-01	3.425133E-01	3.495342E-01
39	3.443176E-01	3.447164E-01	3.451765E-01	3.458240E-01	3.466001E-01	3.478170E-01	3.497124E-01	3.533374E-01	3.850773E-01
40	3.510112E-01	3.516246E-01	3.525368E-01	3.541213E-01	3.571186E-01	3.631060E-01	3.735791E-01	3.902157E-01	4.519089E-01
41	3.639881E-01	3.671245E-01	3.742715E-01	3.893917E-01	4.140623E-01	4.419494E-01	4.672661E-01	4.877112E-01	5.244033E-01
42	3.905411E-01	4.116602E-01	4.461790E-01	4.817993E-01	5.088222E-01	5.279199E-01	5.412965E-01	5.508044E-01	5.675005E-01
43	4.666337E-01	5.121873E-01	5.404457E-01	5.584917E-01	5.701773E-01	5.779929E-01	5.835120E-01	5.875027E-01	5.955043E-01
44	5.638678E-01	5.856896E-01	5.967535E-01	6.038925E-01	6.086687E-01	6.120779E-01	6.146063E-01	6.166116E-01	6.212266E-01
45	6.320679E-01	6.374458E-01	6.404347E-01	6.424817E-01	6.439398E-01	6.450757E-01	6.460184E-01	6.467827E-01	6.490473E-01
46	6.697666E-01	6.712862E-01	6.721386E-01	6.727275E-01	6.730735E-01	6.733437E-01	6.735918E-01	6.737322E-01	6.746808E-01
47	6.954302E-01	6.958473E-01	6.963305E-01	6.965922E-01	6.967551E-01	6.968182E-01	6.968516E-01	6.967739E-01	6.968216E-01
48	7.339922E-01	7.322909E-01	7.311436E-01	7.301954E-01	7.292652E-01	7.283413E-01	7.274435E-01	7.264428E-01	7.240078E-01
49	7.836989E-01	7.793945E-01	7.761947E-01	7.733561E-01	7.705897E-01	7.679242E-01	7.653404E-01	7.625898E-01	7.558503E-01
50	8.631289E-01	8.555450E-01	8.499097E-01	8.446313E-01	8.391767E-01	8.336012E-01	8.280616E-01	8.219907E-01	8.067941E-01
51	9.855855E-01	9.838925E-01	9.812306E-01	9.770322E-01	9.707407E-01	9.626647E-01	9.532767E-01	9.417045E-01	9.102860E-01

4.3. GENERATION OF ^{238}U RESONANCE DATA WITH AND WITHOUT EPITHERMAL UPSCATTERING

Figure 4.1 illustrates the process to generate 51-group self-shielded resonance data by performing continuous energy KENO and the Embedded Self-Shielding Method (ESSM) [Wil12] calculations. To consider epithermal upscattering, the Doppler-broadening rejection correction (DBRC) option must be included in the CE-KENO calculation. Variations are similar to those used in the heterogeneous IRFFACTOR models. The detailed procedure can be found in the [Kim14]. For consistency, the same CE-KENO calculations without DBRC are performed to obtain resonance data without epithermal upscattering. Appendix B.2 provides samples of the CE-KENO and MERIT input files. A utility program EDITKENO is used to edit the CE-KENO to prepare the MERIT input data and its input file.

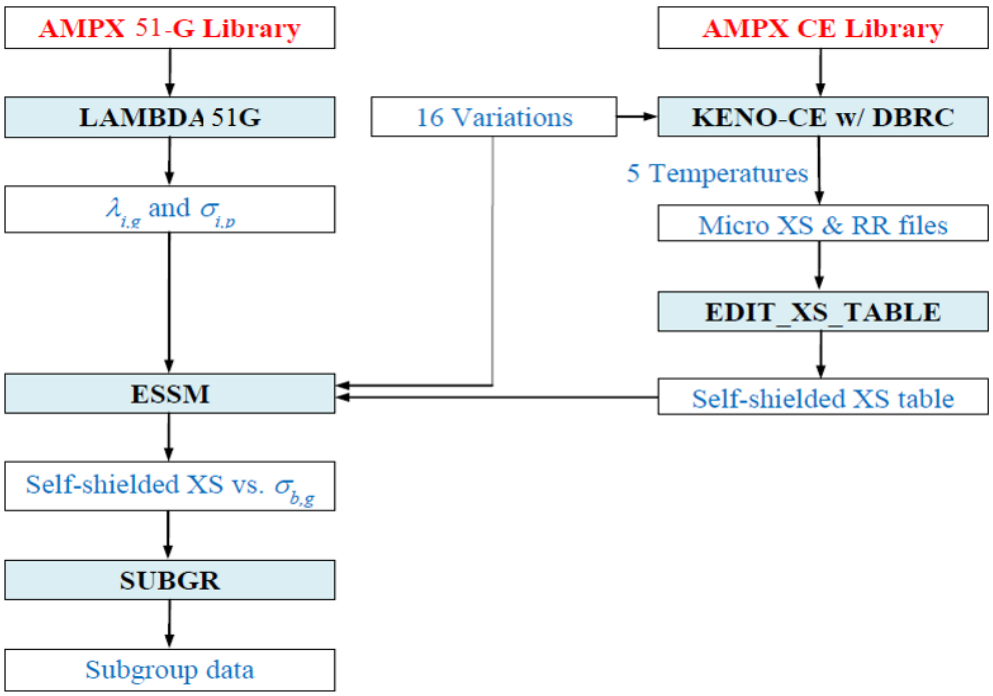


Figure 4.1 Procedure to Generate Resonance Data by Using KENO-CE+ESSM.

The ESSM calculations to obtain the corresponding background cross sections are performed by the MERIT code for which the IR parameters are edited from the third AMPX MG library. Table 4.5 provides detailed information of the input and output files for the KENO-CE, MERIT, and SUBGR calculations without DBRC.

```
jupiter.ornl.gov : /home/ykk/libraries
/endf7.0/mg/51g19g2final/8_imsl_subgr/2_u238_upscatt/ (ENDF/B-7.0)
/endf7.1/mg/51g19g2final/8_imsl_subgr/2_u238_upscatt/ (ENDF/B-7.1)
/endf7.0/mg/51g19g_07m3/4_SPH_final/ (ENDF/B-7.0)
/endf7.1/mg/51g19g_07m3/4_SPH_final/ (ENDF/B-7.1)
```

Table 4.5 Input and Output Files to Generate Resonance Data with/without Epithermal Upscattering

Data	Description	Directory	File name
ENDF/B-7.0	CE-KENO input files	./1_keno/single/	keno?k??.in
	CE-KENO output files	./1_keno/single/	keno?k??.out
	EDITKENO input file	./1_keno/	editkeno.in
	EDITKENO output XS table	./1_keno/	edtxstbl51g2_70_u238_nodbrc_16_2.dat edtxstbl51g2_70_u238_dbrc_16_2.dat
	MERIT input file	./1_merit_epi/	merit_51g_70_u238_nodbrc_16_2.in merit_51g_70_u238_dbrc_16_2.in
	MERIT output XS file	./1_merit_epi/	SCALE_92238_51g_70_nodbrc_16_2.XS2 SCALE_92238_51g_70_dbrc_16_2.XS2
	SUBGR input file	./2_subgr/	subgr_u238_51g_70_m2_nodbrc.in subgr_u238_51g_70_m2_dbrc.in
	SUBGR output file	./2_subgr/	subgr_u238_51g_70_m2_nodbrc.out subgr_u238_51g_70_m2_dbrc.out
	Subgroup data file	./2_subgr/	subgr_u238_51g_70_m2_nodbrc.sub subgr_u238_51g_70_m2_dbrc.sub
ENDF/B-7.1	CE-KENO input files	./1_keno/single/	keno?k??.in
	CE-KENO output files	./1_keno/single/	keno?k??.out
	EDITKENO input file	./1_keno/	editkeno.in
	EDITKENO output XS table	./1_keno/	edtxstbl51g2_71_u238_nodbrc_16_2.dat edtxstbl51g2_71_u238_dbrc_16_2.dat
	MERIT input file	./1_merit_epi/	merit_51g_71_u238_nodbrc_16_2.in merit_51g_71_u238_dbrc_16_2.in
	MERIT output XS file	./1_merit_epi/	SCALE_92238_51g_71_nodbrc_16_2.XS2 SCALE_92238_51g_71_dbrc_16_2.XS2
	SUBGR input file	./2_subgr/	subgr_u238_51g_71_m2_nodbrc.in subgr_u238_51g_71_m2_dbrc.in
	SUBGR output file	./2_subgr/	subgr_u238_51g_71_m2_nodbrc.out subgr_u238_51g_71_m2_dbrc.out
	Subgroup data file	./2_subgr/	subgr_u238_51g_71_m2_nodbrc.sub subgr_u238_51g_71_m2_dbrc.sub

4.4. SUBGROUP DATA GENERATION WITH THE ^{238}U SUPER HOMOGENIZATION (SPH) FACTORS

Figure 4.2 provides a procedure to obtain the super homogenization (SPH) factor for ^{238}U to conserve reaction rates between the CE-KENO reference solutions and the MPACT subgroup results for which the CE-KENO models include the same variation cases as the heterogeneous IRFFACTOR cases.

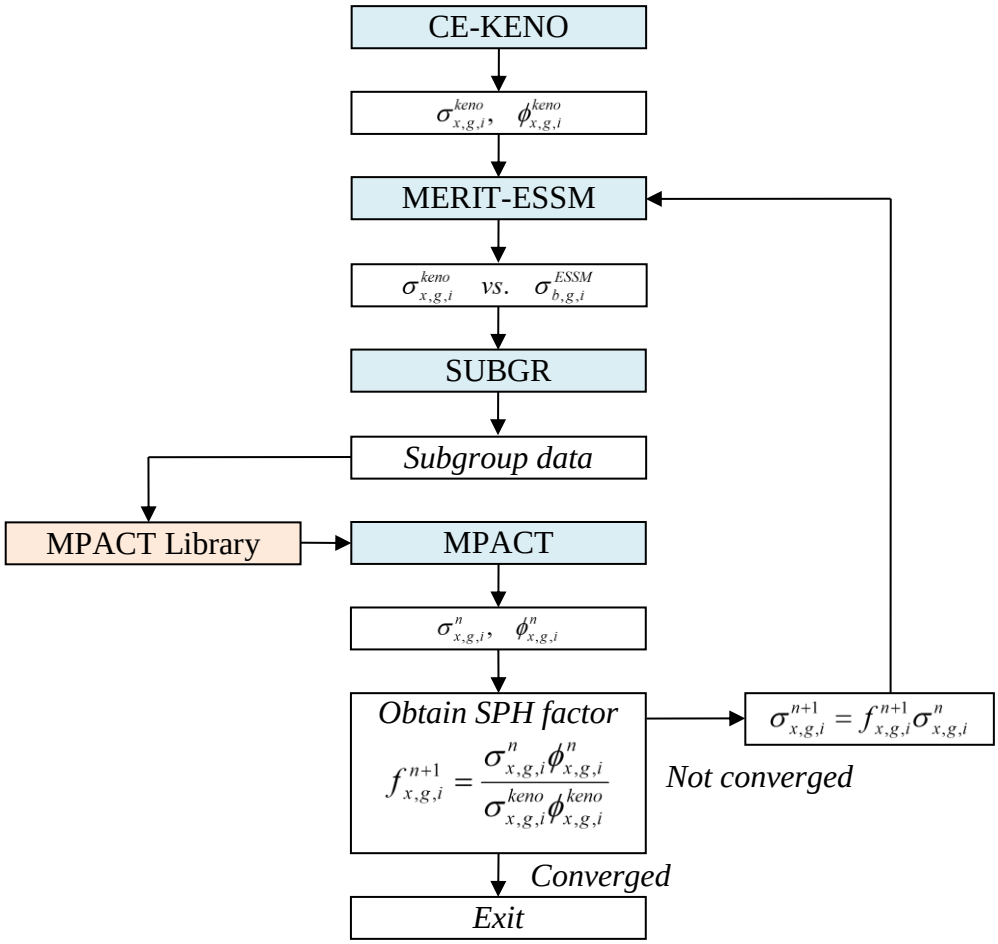


Figure 4.2 Procedure to Generate the SPH Factors.

The SPH factors have been applied to only 4 important resonance groups: 11, 12, 13, 19 and 23. The SPH factors for groups 11, 12 and 13 are to improve reaction rates for very high void BWR cases, and the SPH factors for groups 19 and 23 are to improve reaction rates for the large ^{238}U resonances. Table 4.6 provides the ^{238}U absorption SPH factors.

Table 4.7 provides detailed information of the input and output files for the KENO-CE+ESSM-based resonance data, which are located in the following directory.

```
jupiter.ornl.gov : /home/ykk/libraries
/home/ykk/libraries/endf7.0/mg/51g19g_7/8_SPH/ (ENDF/B-7.0)
/home/ykk/libraries/endf7.1/mg/51g19g_7/8_SPH/ (ENDF/B-7.1)
/home/ykk/libraries/endf7.0/mg/51g19g_7m3/4_SPH_final/ (ENDF/B-7.0)
/home/ykk/libraries/endf7.1/mg/51g19g_7m3/4_SPH_final/ (ENDF/B-7.1)
```

This procedure has not been applied to the generation of the MPACT 252-g libraries.

Table 4.6 The ^{238}U Absorption SPH Factors (ENDF/B-7.0)

Case	Group-11					Group-12				
	293 K	600 K	900 K	1200 K	2400 K	293 K	600 K	900 K	1200 K	2400 K
1	1.0465E+00	1.0474E+00	1.0467E+00	1.0471E+00	1.0470E+00	1.0515E+00	1.0544E+00	1.0555E+00	1.0567E+00	1.0590E+00
2	1.0206E+00	1.0205E+00	1.0201E+00	1.0206E+00	1.0200E+00	1.0250E+00	1.0274E+00	1.0277E+00	1.0281E+00	1.0292E+00
3	1.0047E+00	1.0046E+00	1.0040E+00	1.0034E+00	1.0024E+00	1.0083E+00	1.0081E+00	1.0083E+00	1.0078E+00	1.0082E+00
4	1.0017E+00	1.0007E+00	1.0010E+00	9.9961E-01	9.9908E-01	1.0042E+00	1.0041E+00	1.0040E+00	1.0035E+00	1.0031E+00
5	9.9998E-01	9.9898E-01	9.9868E-01	9.9781E-01	9.9826E-01	1.0031E+00	1.0019E+00	1.0026E+00	1.0017E+00	1.0009E+00
6	9.9760E-01	9.9723E-01	9.9636E-01	9.9643E-01	9.9601E-01	1.0008E+00	9.9918E-01	9.9860E-01	9.9778E-01	9.9745E-01
7	9.9546E-01	9.9518E-01	9.9543E-01	9.9514E-01	9.9405E-01	9.9727E-01	9.9608E-01	9.9647E-01	9.9515E-01	9.9420E-01
8	9.9619E-01	9.9606E-01	9.9641E-01	9.9664E-01	9.9661E-01	9.9736E-01	9.9610E-01	9.9609E-01	9.9480E-01	9.9425E-01
9	9.9549E-01	9.9558E-01	9.9560E-01	9.9486E-01	9.9582E-01	9.9577E-01	9.9487E-01	9.9271E-01	9.9307E-01	9.9353E-01
10	9.9632E-01	9.9491E-01	9.9570E-01	9.9505E-01	9.9641E-01	9.9206E-01	9.9323E-01	9.9294E-01	9.9167E-01	9.9309E-01
11	9.9451E-01	9.9536E-01	9.9478E-01	9.9505E-01	9.9581E-01	9.8903E-01	9.9237E-01	9.9112E-01	9.8988E-01	9.9124E-01
12	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00
13	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00
14	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00
15	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00
16	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00
Case	Group-13					Group-23				
	293 K	600 K	900 K	1200 K	2400 K	293 K	600 K	900 K	1200 K	2400 K
1	9.8823E-01	9.8341E-01	9.8205E-01	9.8243E-01	9.7264E-01	9.7400E-01	9.6404E-01	9.5292E-01	9.4442E-01	9.2953E-01
2	9.9032E-01	9.8712E-01	9.8378E-01	9.8429E-01	9.7816E-01	9.7876E-01	9.6971E-01	9.6138E-01	9.5676E-01	9.4652E-01
3	9.8947E-01	9.8901E-01	9.8585E-01	9.8451E-01	9.7831E-01	9.7584E-01	9.6654E-01	9.5870E-01	9.5647E-01	9.5220E-01
4	9.9237E-01	9.9059E-01	9.8734E-01	9.8697E-01	9.7888E-01	9.6986E-01	9.6095E-01	9.5311E-01	9.4983E-01	9.4879E-01
5	9.9108E-01	9.8939E-01	9.8532E-01	9.8504E-01	9.7669E-01	9.6632E-01	9.5706E-01	9.4714E-01	9.4425E-01	9.4586E-01
6	9.8819E-01	9.8489E-01	9.8161E-01	9.7953E-01	9.7203E-01	9.5573E-01	9.4392E-01	9.3773E-01	9.3302E-01	9.3628E-01
7	9.7999E-01	9.7842E-01	9.7424E-01	9.7029E-01	9.6047E-01	9.4692E-01	9.3388E-01	9.2570E-01	9.2214E-01	9.2650E-01
8	9.8059E-01	9.7532E-01	9.7498E-01	9.7279E-01	9.6427E-01	9.4484E-01	9.2848E-01	9.1964E-01	9.1952E-01	9.2120E-01
9	9.7909E-01	9.7719E-01	9.8214E-01	9.7354E-01	9.7157E-01	9.5048E-01	9.3307E-01	9.2758E-01	9.2728E-01	9.2762E-01
10	9.7917E-01	9.8086E-01	9.7459E-01	9.7525E-01	9.7208E-01	9.6387E-01	9.5031E-01	9.4148E-01	9.4566E-01	9.4713E-01
11	9.7809E-01	9.7568E-01	9.7472E-01	9.8218E-01	9.7329E-01	9.7848E-01	9.7077E-01	9.6170E-01	9.6938E-01	9.7863E-01
12	9.8356E-01	9.8185E-01	9.8130E-01	9.8646E-01	9.7445E-01	9.8862E-01	9.8248E-01	9.7449E-01	9.7889E-01	9.9521E-01
13	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00
14	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00
15	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00
16	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00	1.0000E+00

Table 4.7 Input and Output Files to Generate Subgroup Data with the ^{238}U SPH Factors

	Description	Directory	File name
ENDF/B-7.0	CE-KENO reference inputs	./0_keno_SPH	keno*k??.in
	CE-KENO reference reaction rates	./0_keno_SPH	keno*k??.keno_micro_xs_rr.0
	SPH adjusted XS table w/o DBRC	./1_merit_/	edtxstbl51g2_70_u238_nodbrc_16_2_sph.dat
	SPH adjusted XS table w/ DBRC	./1_merit_/	edtxstbl51g2_70_u238_dbrc_16_2_sph.dat
	MERIT input file for no DBRC	./1_merit/	merit_51g_70_u238_nodbrc_16_2_sph.in
	MERIT XS table for no DBRC	./1_merit/	SCALE_92238_51g_70_nodbrc_16_2_sph.XS2
	MERIT input file for DBRC	./1_merit/	merit_51g_70_u238_dbrc_16_2_sph.in
	MERIT XS table for DBRC	./1_merit/	SCALE_92238_51g_70_dbrc_16_2_sph.XS2
	SUBGR input for no DBRC	./3_subgr	subgr_u238_51g_70_m3_nodbrc_sph.in
	SUBGR output for no DBRC	./3_subgr	subgr_u238_51g_70_m3_nodbrc_sph.out
	SUBGR subgroup data for no DBRC	./3_subgr	subgr_u238_51g_70_m3_nodbrc_sph.sub
	SUBGR input for DBRC	./3_subgr	subgr_u238_51g_70_m3_dbrc_sph.in
	SUBGR output for DBRC	./3_subgr	subgr_u238_51g_70_m3_dbrc_sph.out
	SUBGR subgroup data for DBRC	./3_subgr	subgr_u238_51g_70_m3_dbrc_sph.sub
ENDF/B-7.1	SPH adjusted XS table w/o DBRC	./1_keno/	edtxstbl51g2_71_u238_nodbrc_16_2_sph.dat
	SPH adjusted XS table w/ DBRC	./1_keno/	edtxstbl51g2_71_u238_dbrc_16_2_sph.dat
	MERIT input file for no DBRC	./2_merit/	merit_51g_71_u238_nodbrc_16_2_sph.in
	MERIT XS table for no DBRC	./2_merit/	SCALE_92238_51g_71_nodbrc_16_2_sph.XS2
	MERIT input file for DBRC	./2_merit/	merit_51g_71_u238_dbrc_16_2_sph.in
	MERIT XS table for DBRC	./2_merit/	SCALE_92238_51g_71_dbrc_16_2_sph.XS2
	SUBGR input for no DBRC	./3_subgr	subgr_u238_51g_71_m3_nodbrc_sph.in
	SUBGR output for no DBRC	./3_subgr	subgr_u238_51g_71_m3_nodbrc_sph.out
	SUBGR subgroup data for no DBRC	./3_subgr	subgr_u238_51g_71_m3_nodbrc_sph.sub
	SUBGR input for DBRC	./3_subgr	subgr_u238_51g_71_m3_dbrc_sph.in
	SUBGR output for DBRC	./3_subgr	subgr_u238_51g_71_m3_dbrc_sph.out
	SUBGR subgroup data for DBRC	./3_subgr	subgr_u238_51g_71_m3_dbrc_sph.sub

4.5. GENERATION OF THE MPACT 51-G AND 252-G LIBRARIES

Appendices B.3 and B.4 provide the DECLIB input files to generate the ENDF/B-7.0 and 7.1 MPACT 51-group libraries, for which resonance energy groups are defined as 10-31 groups. The ENDF/B-7.0 based atomic masses have been used in generating the v4.2m5 MPACT 51-g libraries.

Table 4.8 provides detailed information for the DECLIB input and output files and the final MPACT 51-g and 252-g libraries, which are located in the following directory.

```
jupiter.ornl.gov :
/home/ykk/libraries/endf7.0/mg/51g19g_7m4/6_declib (ENDF/B-7.0)
/home/ykk/libraries/endf7.1/mg/51g19g_7m4/6_declib (ENDF/B-7.1)
/home/ykk/libraries/endf7.0/mg/252g19g_7/6_declib (ENDF/B-7.0)
/home/ykk/libraries/endf7.1/mg/252g19g_7/6_declib (ENDF/B-7.1)
```

Table 4.8 Input and Output Files to Generate the 51-g and 252-g MPACT Libraries

Data	Description	File name
ENDF/B-7.0	DECLIB input	declib51g_70_07_m5_sph.in declib252g_70_07m1.in
	DECLIB output	declib51g_70_m5_sph.out declib252g_70_4.2m1.out
	Final ENDF/B-7.0 MPACT 51-g library with the ^{238}U SPH	**mpact51g_70_v4.2m5_12062016_sph.fmt** **Dec 6 11:11** **df001bd3888cff606fdb07a82f442412**
	Final ENDF/B-7.0 MPACT 252-g library	mpact252g_70_v4.2m1_09072016_imsl.fmt Sep 8 00:24 594541a81e3b48cc27ff576c97f32e89
ENDF/B-7.1	DECLIB inputs	declib51g_71_07_m5_sph.in declib252g_71_07m1.in
	DECLIB outputs	declib51g_71_m5_sph.out declib252g_71_4.2m1.out
	Final ENDF/B-7.1 MPACT 51-g library with the ^{238}U SPH	**mpact51g_71_v4.2m5_12062016_sph.fmt** **Dec 6 11:12** **6a7ae1450530d64abb88a072d4a32d36**
	Final ENDF/B-7.1 MPACT 252-g library	mpact252g_71_v4.2m1_09072016_imsl.fmt Sep 8 00:28 ce5ed00bc3ad164964a43b814df52596

The ENDF/B-7.0 and 7.1 MPACT 51-g and 252-g libraries have been generated while considering the ^{238}U SPH factors to have better groupwise reaction rates for both PWR and BWR fuels. Since SERPENT is often used in depletion benchmark for code-to-code comparison, an ENDF/B-7.0 MPACT 51-g library with the SERPENT kappa values also has been generated for fair comparison. Table 4.9 provides a comparison of kappa values between MPACT and SERPENT.

Table 4.9 Comparison of Kappa Values

Nuclide	Recoverable energy (w-s)			Recoverable energy (MeV)		
	ENDF/B-7.0	ENDF/B-7.1	SERPENT-7.0	ENDF/B-7.0	ENDF/B-7.1	SERPENT-7.0
90230	3.24352E-11	3.08011E-11	3.188496E-11	202.44	192.24	199.01
90232	3.22079E-11	3.22079E-11	3.152922E-11	201.02	201.02	196.79
91231	3.22345E-11	3.13618E-11	3.345809E-11	201.19	195.74	208.83
91233	3.27020E-11	3.18390E-11	3.345809E-11	204.11	198.72	208.83
92232	3.22345E-11	3.12001E-11	3.161771E-11	201.19	194.73	197.34
92233	3.20712E-11	3.20712E-11	3.195916E-11	200.17	200.17	199.47
92234	3.26107E-11	3.26107E-11	3.209299E-11	203.54	203.54	200.31
92235	3.24142E-11	3.24017E-11	3.236792E-11	202.31	202.23	202.02
92236	3.29604E-11	3.29604E-11	3.253631E-11	205.72	205.72	203.07
92237	3.30896E-11	3.17375E-11	3.011228E-11	206.53	198.09	187.94
92238	3.39762E-11	3.39368E-11	3.312885E-11	212.06	211.82	206.77
92240	3.33592E-11	3.33592E-11	3.312350E-11	208.21	208.21	206.74
93237	3.36975E-11	3.36975E-11	3.285082E-11	210.32	210.32	205.04
93238	3.34842E-11	3.35984E-11	3.345791E-11	208.99	209.70	208.83
93239	3.40989E-11	3.26536E-11	3.178517E-11	212.83	203.81	198.39
94236	3.26352E-11	3.34433E-11	3.262163E-11	203.69	208.73	203.61
94237	3.30131E-11	3.38885E-11	3.277219E-11	206.05	211.51	204.55
94238	3.36489E-11	3.41258E-11	3.301977E-11	210.02	212.99	206.09
94239	3.36876E-11	3.36970E-11	3.326465E-11	210.26	210.32	207.62
94240	3.42944E-11	3.42944E-11	3.336942E-11	214.05	214.05	208.27
94241	3.42699E-11	3.42699E-11	3.378934E-11	213.89	213.89	210.89
94242	3.47382E-11	3.49302E-11	3.372240E-11	216.82	218.02	210.48
94244	3.41266E-11	3.35567E-11	3.393486E-11	213.00	209.44	211.80
95241	3.48153E-11	3.48153E-11	3.378599E-11	217.30	217.30	210.87
95242	3.45085E-11	3.51714E-11	3.345809E-11	215.38	219.52	208.83
95243	3.56147E-11	3.56147E-11	3.406366E-11	222.29	222.29	212.61
95342	3.56147E-11	3.56147E-11	3.345809E-11	222.29	222.29	208.83
96241	3.40465E-11	3.51880E-11	3.385121E-11	212.50	219.62	211.28
96242	3.42433E-11	3.43892E-11	3.388467E-11	213.73	214.64	211.49
96243	3.41026E-11	3.43147E-11	3.345809E-11	212.85	214.17	208.83
96244	3.42189E-11	3.51043E-11	3.345809E-11	213.58	219.10	208.83
96245	3.43622E-11	3.45060E-11	3.345809E-11	214.47	215.37	208.83
96246	3.47142E-11	3.54721E-11	3.345809E-11	216.67	221.40	208.83
96247	3.48348E-11	3.51698E-11	3.345809E-11	217.42	219.51	208.83
96248	3.50703E-11	3.55936E-11	3.492020E-11	218.89	222.16	217.95
97249	3.50703E-11	3.60559E-11				
98249	3.50703E-11	3.55494E-11				
98250	3.50703E-11	3.68134E-11				
98251	3.50703E-11	3.58147E-11				
98252	3.50703E-11	3.68984E-11				

5. BENCHMARK CALCULATION

5.1. THE MPACT 51-G LIBRARY RESULTS

Table 5.1 provides benchmark results for the VERA progression problems 1 and 2 and extended problems including various ^{235}U enrichments and void fractions by using the ENDF/B-7.0 and 7.1 v4.2m5 MPACT 51-g libraries.

Table 5.1 Benchmark Results for the VERA Progression Problems 1 and 2 (51-g)

Data		ENDF/B-7.0						ENDF/B-7.1			
Code		KENO [1]		MPACT P2 [2]		MPACT TCP0 [3]		MPACT P2 [4]		MPACT TCP0 [5]	
Case		k_{eff}	S.D.	k_{eff}	[1-2]	k_{eff}	[1-3]	k_{eff}	[2-4]	k_{eff}	[3-5]
VERA pin	a	1.18704	0.00005	1.18754	-50	1.18792	-88	1.18751	3	1.18790	2
	b	1.18215	0.00007	1.18264	-49	1.18324	-109	1.18258	6	1.18319	4
	c	1.17172	0.00007	1.17217	-45	1.17285	-113	1.17156	62	1.17225	60
	d	1.16260	0.00007	1.16256	4	1.16332	-72	1.16225	31	1.16302	30
VERA assembly	a	1.18218	0.00002	1.18265	-48	1.18240	-23	1.18256	9	1.18232	9
	b	1.18336	0.00002	1.18356	-20	1.18353	-17	1.18343	12	1.18342	11
	c	1.17375	0.00002	1.17401	-26	1.17404	-29	1.17336	65	1.17340	64
	d	1.16559	0.00002	1.16522	37	1.16531	28	1.16484	37	1.16495	36
	e	1.06963	0.00002	1.07000	-38	1.07051	-88	1.06992	8	1.07044	7
	f	0.97602	0.00003	0.97637	-35	0.97717	-115	0.97635	1	0.97717	1
	g	0.84770	0.00003	0.85051	-282	0.85286	-516	0.84990	61	0.85226	60
	h	0.78822	0.00003	0.78870	-48	0.79221	-398	0.78882	-11	0.79232	-12
	i	1.17992	0.00002	1.18045	-54	1.18023	-31	1.18029	16	1.18008	15
	j	0.97519	0.00003	0.97561	-42	0.97642	-122	0.97560	1	0.97641	0
	k	1.02006	0.00003	1.02063	-57	1.02138	-132	1.02062	1	1.02138	1
	l	1.01892	0.00002	1.01910	-18	1.01887	5	1.01905	4	1.01883	4
	m	0.93880	0.00003	0.93909	-30	0.93879	0	0.93910	-1	0.93881	-2
	n	0.86962	0.00003	0.86967	-5	0.87003	-41	0.86974	-8	0.87011	-8
	o	1.04773	0.00002	1.04699	74	1.04793	-20	1.04676	23	1.04771	22
	p	0.92741	0.00002	0.92585	156	0.92752	-11	0.92558	28	0.92726	27
Pin ^{235}U w/o	2.1	1.07034		1.07062	-28	1.07102	-68	1.07054	8	1.07094	7
	2.6	1.13569		1.13582	-13	1.13626	-57	1.13575	7	1.13620	6
	3.1	1.18217		1.18264	-47	1.18312	-95	1.18258	6	1.18308	4
	3.6	1.22118		1.22159	-41	1.22211	-93	1.22156	3	1.22209	2
	4.1	1.25271		1.25314	-43	1.25369	-98	1.25314	0	1.25370	-1
	4.6	1.27879		1.27928	-49	1.27986	-107	1.27932	-3	1.27990	-4
1D ^{235}U w/o	2.1	0.76266		0.76265	1			0.76259	6		
	3.1	0.85535		0.85448	87			0.85443	5		
	4.1	0.91583		0.91450	133			0.91448	2		
BWR Void %	0	1.49115		1.49022	93	1.48953	162	1.49083	-60	1.49013	-60
	70	1.28537		1.28122	415	1.28237	300	1.28246	-124	1.28360	-123
	90	1.02243		1.02118	125	1.02168	75	1.02255	-137	1.02304	-136
	95	0.91152		0.91208	-56	0.91220	-68	0.91367	-160	0.91379	-159

Appendix C.1 provides a new benchmark suite to see if the MPACT libraries would work reasonably at various burnup points. Atomic number densities are edited from 0, 10, 20, 40 and 60 MWD/kgU. Tables 5.2 and 5.3 show the benchmark results by using the MPACT 47-g and 51-g libraries.

Table 5.2 Benchmark Results for the Given Atomic Number Densities (ENDF/B-7.0 51-g)

No.	Case	KENO			MPACT			KENO-MPACT	
		CE [1]	MG [2]	[1-2]	47-g [3]	51-g [4]	[3-4]	[1-3]	[1-4]
A1	3-ring, full	1.18147	1.17876	271	1.18122	1.18187	-65	25	-40
A2	3-ring, full	1.04355	1.04080	275	1.04627	1.04378	249	-272	-23
A3	3-ring, full	0.96819	0.96558	261	0.97138	0.96776	362	-319	43
A4	3-ring, full	0.86140	0.85959	181	0.86575	0.86085	490	-435	55
A5	3-ring, full	0.79563	0.79379	184	0.80057	0.79497	560	-494	66
B1	1-ring, full	1.18147	-	-	1.18122	1.18187	-65	25	-40
B2	1-ring, full	1.04346	1.04196	150	1.04624	1.04376	248	-278	-30
B3	1-ring, full	0.96801	0.96673	128	0.97141	0.96777	364	-340	24
B4	1-ring, full	0.86082	0.86004	78	0.86546	0.86058	488	-464	24
B5	1-ring, full	0.79492	0.79408	84	0.80010	0.79452	558	-518	40
C1	1-ring, heavy	1.18147	-	-	1.18122	1.18187	-65	25	-40
C2	1-ring, heavy	1.12339	1.12201	138	1.12492	1.12347	145	-153	-8
C3	1-ring, heavy	1.07363	1.07255	108	1.07512	1.07274	238	-149	89
C4	1-ring, heavy	1.00389	1.00285	104	1.00553	1.00203	350	-164	186
C5	1-ring, heavy	0.96342	0.96227	115	0.96488	0.96062	426	-146	280

Table 5.3 Benchmark Results for the Given Atomic Number Densities (ENDF/B-7.1 51-g)

No.	Case	KENO			MPACT	K-M	ENDF7.0 – 7.1		
		CE [1]	MG [2]	[1-2]	51-g [3]	[1-3]	KENO	MPACT	K-M
A1	3-ring, full	1.18131	1.17822	309	1.18119	12	16	68	-52
A2	3-ring, full	1.04312	1.04045	267	1.04327	-15	43	50	-7
A3	3-ring, full	0.96857	0.96605	252	0.96792	65	-38	-15	-23
A4	3-ring, full	0.86304	0.86066	238	0.86211	93	-164	-126	-38
A5	3-ring, full	0.79745	0.79513	232	0.79705	40	-182	-207	25
B1	1-ring, full	1.18131	-	-	1.18119	12	16	68	-52
B2	1-ring, full	1.04315	1.04161	154	1.04325	-10	31	51	-20
B3	1-ring, full	0.96836	0.96719	117	0.96792	44	-35	-15	-20
B4	1-ring, full	0.86235	0.86137	98	0.86183	52	-153	-125	-28
B5	1-ring, full	0.79684	0.79599	85	0.79658	26	-192	-206	14
C1	1-ring, heavy	1.18131	-	-	1.18119	12	16	68	-52
C2	1-ring, heavy	1.12250	1.12089	161	1.12216	34	89	131	-42
C3	1-ring, heavy	1.07307	1.07089	218	1.07163	144	56	111	-55
C4	1-ring, heavy	1.00412	1.00263	149	1.00166	246	-23	37	-60
C5	1-ring, heavy	0.96370	0.96259	111	0.96108	262	-28	-46	18

Table 5.4 provides representative cases for single pin reaction rate analysis for both PWR and BWR fuels [Liu16]. Reaction rate analysis results are shown in Table 5.5 when using the v4.2m5 MPACT 51-g library.

Table 5.4 Representative Cases for Reaction Rate Analysis

Fuel	No	^{235}U w/o	Burnup	PPM	Temperature (K)			Void %	BP
					Fuel	Clad	Moderator		
PWR	1	3.1	0	0	900	600	600	0	-
	2	2.1	0	0	600	600	600	0	-
	3	4.1	0	0	900	600	600	0	-
	4	3.1	0	0	293.6	293.6	293.6	0	-
	5	3.1	0	0	600	600	600	0	-
	6	3.1	0	0	1200	600	600	0	-
	7	3.1	0	600	900	600	600	0	-
	8	3.1	0	1300	900	600	600	0	-
BWR	9	3.5	0	0	600	600	600	0	-
	10	3.5	0	0	900	600	600	50	-
	11	3.5	0	0	1200	600	600	70	-
	12	3.5	0	0	900	600	600	90	-
PWR	13	3.1	0	0	900	600	600	0	-
	14	3.1	0.1	0	900	600	600	0	-
	15	3.1	20	0	900	600	600	0	-
	16	3.1	40	0	900	600	600	0	-
	17	3.1	60	0	900	600	600	0	-
	18	3.1	0	0	900	600	600	0	1% Er_2O_3

Table 5.5 Results for Reaction Rate Analysis (ENDF/B-7.0 51-g)

Case	ID	CE-KENO [1]	MPACT 51-g [2]	Δk, pcm [1-2]	RR Δk, pcm [1-2]
1	rr_1_3.1%	1.298750	1.299511	76.1	85.6
2	rr_2_2.1%	1.212840	1.213343	50.3	63.9
3	rr_3_4.1%	1.348660	1.349623	96.3	107.2
4	rr_4_293.6K	1.396330	1.395426	-90.4	-85.0
5	rr_5_600K	1.310510	1.311343	83.3	96.9
6	rr_6_1200K	1.289040	1.288701	-33.9	-33.3
7	rr_7_B600	1.237180	1.238330	115.0	114.1
8	rr_8_B1300	1.173650	1.174937	128.7	129.3
9	rr_9_bwr_0	1.373990	1.372736	-125.4	-137.3
10	rr_10_bwr_50	1.226090	1.226213	12.3	23.3
11	rr_11_bwr_70	1.100880	1.102474	159.4	144.0
12	rr_12_bwr_90	0.887870	0.890875	300.5	290.1
13	rr_13_burn_0	1.247330	1.248385	105.5	113.8
14	rr_14_burn_001	1.204270	1.205379	110.9	104.3
15	rr_15_burn_20	1.001760	1.003709	194.9	199.7
16	rr_16_burn_40	0.880610	0.882478	186.8	181.3
17	rr_17_burn_60	0.806220	0.807706	148.6	167.6
18	rr_18_erbium	1.012200	1.012736	53.6	57.2

Figures 5.1–5.4 show sensitivity of kappa values, a comparison of the MPACT 47-g library with the 51-g one and a comparison of ENDF/B-7.0 with 7.1.

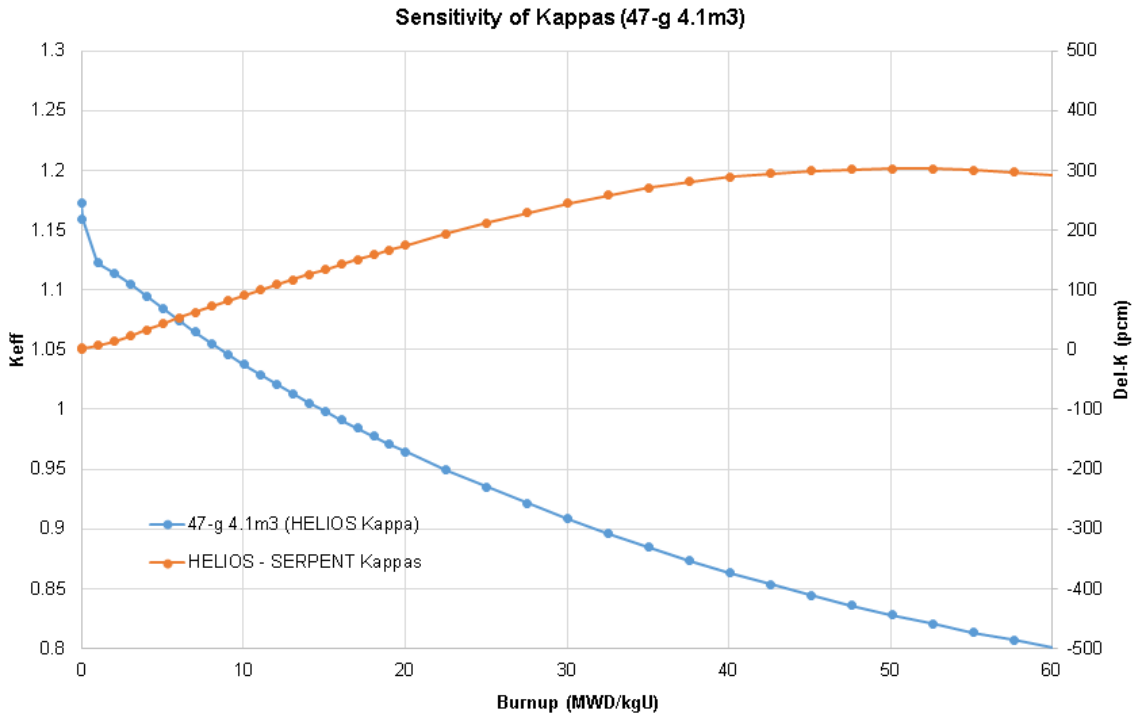


Figure 5.1 Sensitivity of the Kappa Values between HELIOS and SERPENT.

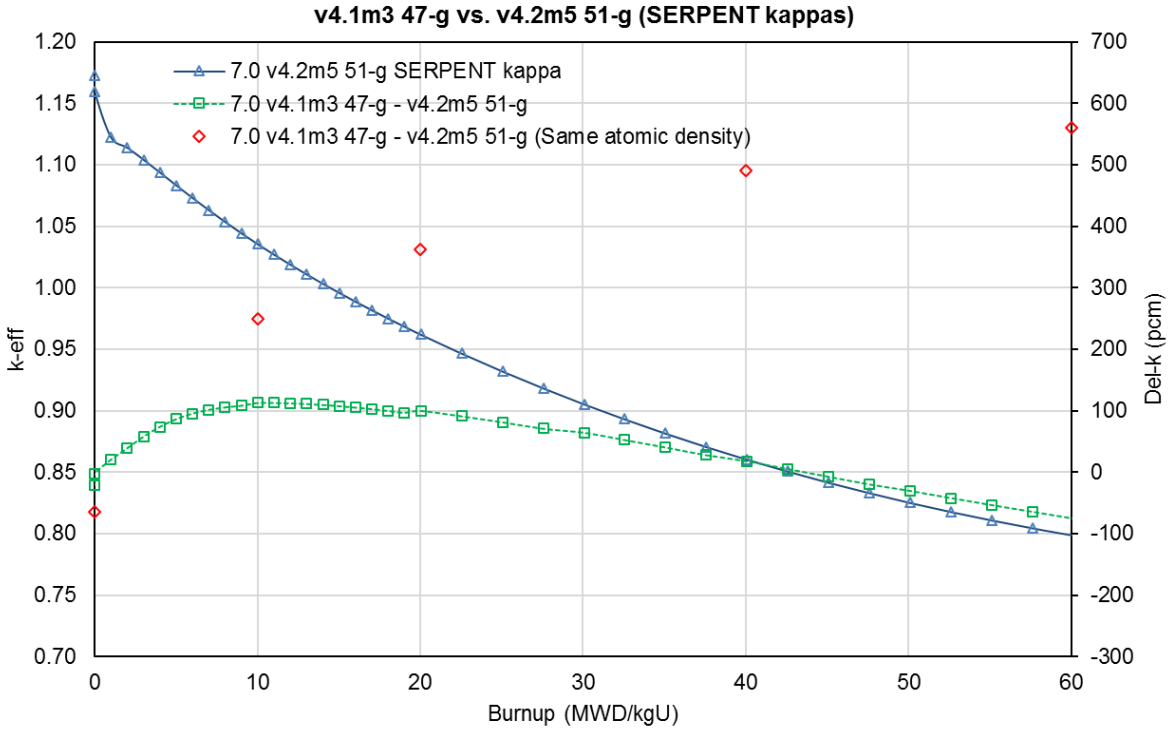


Figure 5.2 Comparison of k_{eff}s between the ENDF/B-7.0 47-g v4.1m3 and 51-g 4.2m1 MPACT Libraries with the SERPENT Kappas.

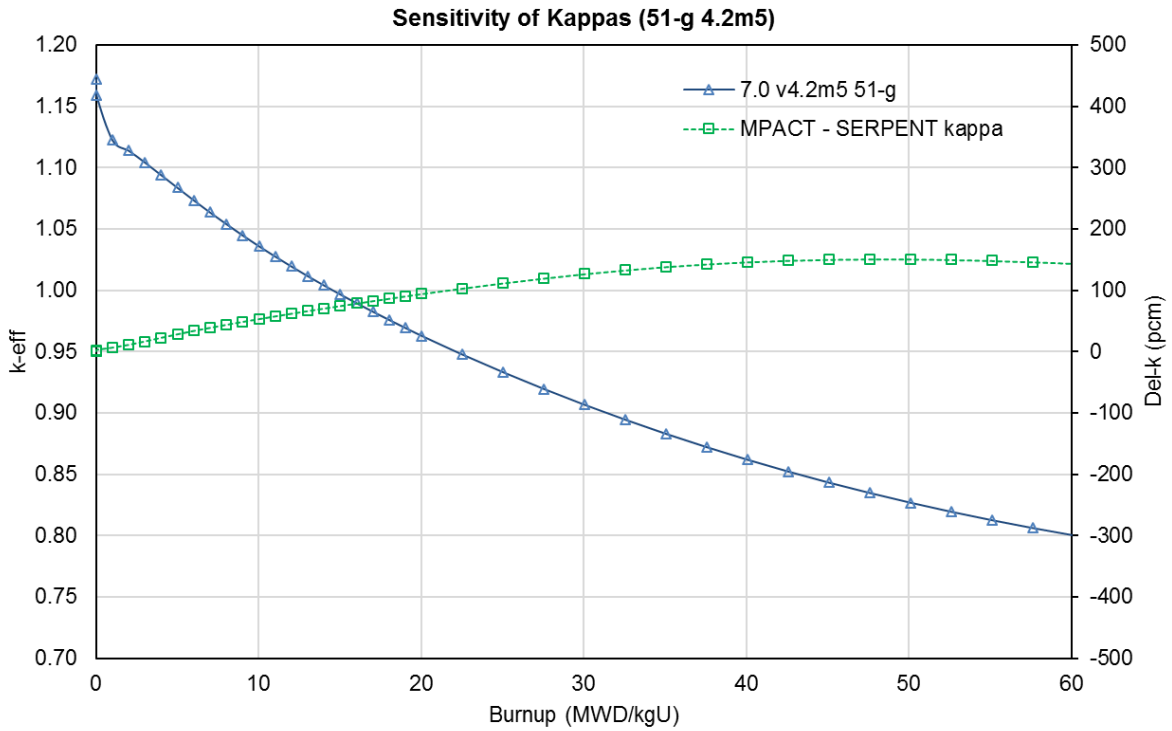


Figure 5.3 Comparison of k_{eff}s between the SERPENT and MPACT Kappas.

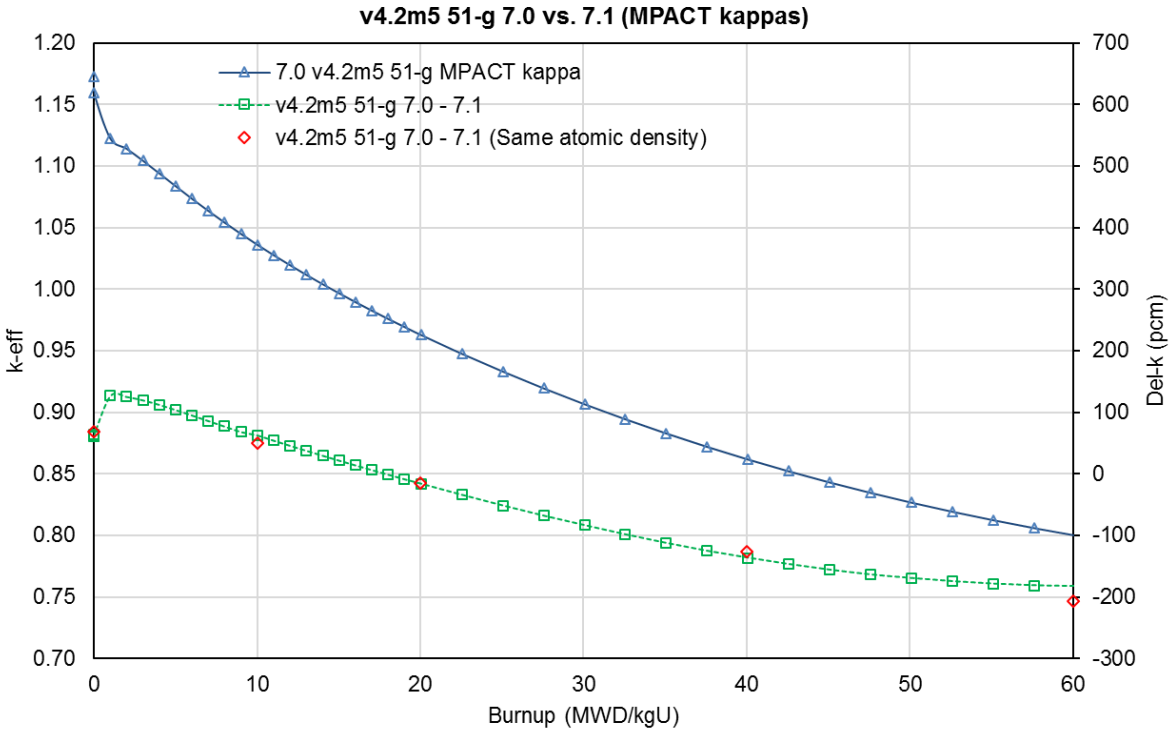


Figure 5.4 Comparison of k_{eff}s between the ENDF/B-7.0 and 7.1 MPACT 51-g Libraries.

5.2. THE MPACT 252-G LIBRARY RESULTS

Table 5.6 provides benchmark results for VERA progression problems 1 and 2 by using the ENDF/B-7.0 and 7.1 MPACT 252-g libraries.

Table 5.6 Benchmark Results for the VERA Progression Problems 1 and 2 (252-g)

Data		ENDF/B-7.0						ENDF/B-7.1			
Code		KENO [1]		MPACT P2 [2]		MPACT TCP0 [3]		MPACT P2 [4]		MPACT TCP0 [5]	
Case		k_{eff}	S.D.	k_{eff}	[1-2]	k_{eff}	[1-3]	k_{eff}	[2-4]	k_{eff}	[3-5]
VERA pin	a	1.18704	0.00005	1.18509	195	1.18683	20	1.18532	-23	1.18706	-23
	b	1.18215	0.00007	1.17995	220	1.18204	11	1.18022	-27	1.18231	-27
	c	1.17172	0.00007	1.16933	239	1.17160	13	1.16960	-27	1.17187	-27
	d	1.16260	0.00007	1.16018	242	1.16261	0	1.16046	-28	1.16288	-27
VERA assembly	a	1.18218	0.00002	1.18042	176	1.18111	106	1.18061	-19	1.18130	-19
	b	1.18336	0.00002	1.18111	225	1.18215	121	1.18134	-23	1.18238	-23
	c	1.17375	0.00002	1.17144	231	1.17261	114	1.17167	-23	1.17284	-23
	d	1.16559	0.00002	1.16307	253	1.16436	124	1.16330	-24	1.16459	-23
	e	1.06963	0.00002	1.06768	195	1.06909	53	1.06792	-24	1.06934	-24
	f	0.97602	0.00003	0.97397	205	0.97565	37	0.97426	-29	0.97593	-29
	g	0.84770	0.00003	0.84624	145	0.84918	-149	0.84628	-4	0.84922	-4
	h	0.78822	0.00003	0.78658	164	0.79075	-253	0.78694	-36	0.79111	-36
	i	1.17992	0.00002	1.17819	173	1.17892	99	1.17838	-19	1.17912	-19
	j	0.97519	0.00003	0.97321	198	0.97489	31	0.97350	-29	0.97518	-29
	k	1.02006	0.00003	1.01812	195	1.01977	29	1.01841	-29	1.02006	-29
	l	1.01892	0.00002	1.01685	207	1.01743	148	1.01710	-25	1.01768	-25
	m	0.93880	0.00003	0.93686	193	0.93730	150	0.93715	-28	0.93758	-28
	n	0.86962	0.00003	0.86740	221	0.86848	113	0.86775	-34	0.86882	-34
	o	1.04773	0.00002	1.04537	236	1.04712	61	1.04562	-25	1.04736	-24
	p	0.92741	0.00002	0.92478	263	0.92713	28	0.92507	-29	0.92742	-29
Pin ^{235}U w/o	2.1	1.07034		1.06820	214	1.06998	36	1.06848	-28	1.07025	-28
	2.6	1.13569		1.13324	245	1.13513	56	1.13351	-27	1.13540	-27
	3.1	1.18217		1.17995	222	1.18192	25	1.18022	-27	1.18219	-27
	3.6	1.22118		1.21882	236	1.22087	31	1.21909	-27	1.22113	-27
	4.1	1.25271		1.25031	240	1.25241	30	1.25058	-27	1.25268	-27
	4.6	1.27879		1.27641	238	1.27854	25	1.27668	-27	1.27881	-27
1D ^{235}U w/o	2.1	0.76266		0.76131	135			0.76132	-1		
	3.1	0.85535		0.85283	252			0.85286	-3		
	4.1	0.91583		0.91273	310			0.91277	-4		
BWR Void %	0	1.49115		1.49010	105	1.48948	167	1.49003	7	1.48941	7
	70	1.28537		1.28092	445	1.28369	168	1.28099	-7	1.28375	-7
	90	1.02243		1.01880	363	1.02017	226	1.01941	-60	1.02078	-60
	95	0.91152		0.90949	203	0.90987	165	0.91067	-118	0.91105	-118

Table 5.7 and 5.8 show the benchmark results for the problems in Appendix C.1 by using the ENDF/B-7.0 and 7.1 MPACT 252-g libraries, respectively.

Table 5.7 Benchmark Results for the Given Atomic Number Densities (ENDF/B-7.0 252-g)

No.	Case	KENO	MPACT		Δk difference, pcm	
		CE [1]	51-g [2]	252-g [3]	[1-2]	[1-3]
A1	3-ring, full	1.18147	1.18109	1.17961	38	186
A2	3-ring, full	1.04355	1.04549	1.04280	-194	75
A3	3-ring, full	0.96819	0.96959	0.96824	-140	-5
A4	3-ring, full	0.86140	0.86235	0.86298	-95	-158
A5	3-ring, full	0.79563	0.79628	0.79804	-65	-241
B1	1-ring, full	1.18147	1.18109	1.17961	38	186
B2	1-ring, full	1.04346	1.04545	1.04273	-199	73
B3	1-ring, full	0.96801	0.96957	0.96814	-156	-13
B4	1-ring, full	0.86082	0.86205	0.86255	-123	-173
B5	1-ring, full	0.79492	0.79579	0.79740	-87	-248
C1	1-ring, heavy	1.18147	1.18109	1.17961	38	186
C2	1-ring, heavy	1.12339	1.12436	1.12180	-97	159
C3	1-ring, heavy	1.07363	1.07398	1.07218	-35	145
C4	1-ring, heavy	1.00389	1.00328	1.00293	61	96
C5	1-ring, heavy	0.96342	0.96191	0.96259	151	83

Table 5.8 Benchmark Results for the Given Atomic Number Densities (ENDF/B-7.1 252-g)

No.	Case	KENO	MPACT		Δk difference, pcm	
		CE [1]	51-g [2]	252-g [3]	[1-2]	[1-3]
A1	3-ring, full	1.18131	1.18095	1.17961	36	170
A2	3-ring, full	1.04312	1.04546	1.04223	-234	89
A3	3-ring, full	0.96857	0.97020	0.96770	-163	87
A4	3-ring, full	0.86304	0.86406	0.86249	-102	55
A5	3-ring, full	0.79745	0.79880	0.79759	-135	-14
B1	1-ring, full	1.18131	1.18095	1.17961	36	170
B2	1-ring, full	1.04315	1.04542	1.04215	-227	100
B3	1-ring, full	0.96836	0.97018	0.96760	-182	76
B4	1-ring, full	0.86235	0.86376	0.86206	-141	29
B5	1-ring, full	0.79684	0.79830	0.79696	-146	-12
C1	1-ring, heavy	1.18131	1.18095	1.17961	36	170
C2	1-ring, heavy	1.12250	1.12358	1.12113	-108	137
C3	1-ring, heavy	1.07307	1.07341	1.07152	-34	155
C4	1-ring, heavy	1.00412	1.00348	1.00225	64	187
C5	1-ring, heavy	0.96370	0.96296	0.96191	74	179

6. DISCUSSION AND CONCLUSION

The AMPX master libraries with 51- and 252-group neutron and 19-group gamma structures were generated with ENDF/B-7.0 and 7.1. Then the v4.2m5 MPACT 51-g and v4.2m1 MPACT 252-g libraries were generated, including subgroup data, ^{1}H transport cross sections based on the Neutron Leakage Conservation method, transient data, and resonance data with epithermal upsattering.

The cross section library of the CASL neutronics simulator MPACT had been developed previously in a 47-group structure that is independent of the SCALE cross section library structures. However, the new 51-group structure has been developed to be a subset of the SCALE 252-group structure, and the MG AMPX master library is being improved to include new data such as subgroup data and transient data required for the CASL neutronics simulator MPACT. Therefore, both the SCALE code package and the CASL VERA-CS can use a common AMPX MG library.

REFERENCES

[Her13] Herman, Brian R., Benoit Forget, Kord Smith, “Improved Diffusion Coefficients Generated From Monte Carlo Codes,” M&C 2013, Sun Valley, Idaho, May 5–9, 2013.

[Kim14] Kim, Kang Seog, “Generation of ^{238}U Resonance Data with Epithermal Upscattering for the 47-group MPACT Libraries,” CASL-S-2015-PHI.VCS.P11.02-002, Rev. 0 (10/8/2014).

[Kim15] Kim, Kang Seog, “Procedure to Generate the MPACT Multigroup Library,” CASL-U-2015-1013-000, Rev. 0 (12/17/2015).

[Kim16] Kim, Kang Seog, Mark L. Williams, Dorothea Wiarda“Investigation of Neutron Leakage Conservation Method to Generate H-1 Transport Correction Factors,” CASL-U-2016-1163-000, Rev. 0, ORNL/TM-2016/266 (06/30/2016).

[Liu16] Yuxuan Liu, “Reaction Rate Analysis for MPACT Cross Section Library Verification,” CASL-U-2016-1255-000 (2016).

[Rea16] Rearden, B. T. and M. A. Jessee, “SCALE Code System,” ORNL/TM-2005/39, Version 6.2 (2016).

[Wia16] Wiarda, D. et al., “AMPX-6: A Modular Code System for Processing ENDF/B Evaluations,” ORNL/TM-2016/43 (2016).

[Wil12] Mark L. Williams and Kang-Seog Kim, “The Embedded Self-Shielding Method,” PHYSOR 2012, Knoxville, Tennessee, USA (2012).

APPENDIX A.1. INPUT FILES TO GENERATE MG XSS, BONDARENKO DATA AND GAMMA XSS FOR ^{235}U

[Input to generate 51-group neutron XSs for ^{235}U]

```
=shell
ln -sf /home/dw8/libraries/endf/ENDF-B-VII.0/neutron/n-092_U_235.endf ft11f001
ln -sf /home/c31/exsite/result/broaden_u235  ft34f001
end
=pickeze
-1$$ 3000000
0$$ 34 35
1$$ 1 1s 4 1  e t
2$$ 9228
4$$ -1001 -1002 -1018 -1102
5** 293 t
end

=shell
ln -fs /home/ykk/libraries/wgtftn/200kev/casl_51g_50b00v_flux ft30f001
end

=y12
eps=1e-3 ndf=11 kin=32 mat=9228 id=9228
zap=1 awp=1.0  for=leg nl=5
end

=prell
0$$ 77 49 e 1$$ 0 1 t
3$$ 51  0 0 t
7** 1.0E-5
0.01
0.03
0.04
0.06
0.08
0.1
0.15
0.2
0.275
0.35
0.5
0.625
0.75
0.925
0.975
1.01
1.08
1.13
1.175
1.25
1.45
1.86
2.47
3.73
4.7
5.0
5.4
6.25
7.15
8.1
11.9
14.4
30.0
48.3
76.0
143.0
305.0
950.0
2250.0
9500.0
20000.0
50000.0
```

```
73000.0
200000.0
492000.0
820000.0
1356000.0
2354000.0
4304000.0
6434000.0
2.0E7 t
end
=shell
cp ft49f001 ft77f001
end

=prell
0$$ 77 49 e 1$$ 0 1 t
3$$ 19  1 0 t
7** 10000.0
45000.0
100000.0
200000.0
300000.0
400000.0
600000.0
800000.0
1000000.0
1330000.0
1660000.0
2000000.0
2500000.0
3000000.0
4000000.0
5000000.0
6500000.0
8000000.0
1.0E7
2.0E7 t
end
=shell
cp ft49f001 ft77f001
end
=x10
type=neutron igm=51 ipm=19
iftg=26 id=9228
master=21 logwt=30 matwt=99 mtwt=2099 nl=5
kin=32 tab1=35 pot=1.15860E+01
title=u235 9228 endf REL0 REV7 MOD7
end
=shell
cp ft21f001 ${RTNDIR}/../result/neut__neutron_u235
end
=shell
cp ft21f001 ft10f001
end
=y12
mat=92235 kin=42 point=45 id=92235 free
awr=233.0248  pot=1.15860E+01
nl=5 emax=5.05 temp=293.0 600.0 900.0 1200.0 2400.0
for=cos
end

=pickeze
0$$  34  41  e
1$$  1 1s  1  5 e t
2$$ 9228 4$$ 2
5** 293.0
600.0
900.0
1200.0
2400.0 t
end
=zest
0$$  46  e
1$$  1  e t
2$$  41  1  e t
```

```
3$$  9228  e
4$$  2  e
6$$  92235  e
7$$  1007  e t
end

=x10
type=neutron
tab1=46 logwt=30 mtwt=2099 matwt=99 master=41 kin=42
iftg=26 igm=51 id=92235
nl=5
upscatter
end
=shell
cp ft41f001 ${RTNDIR}/../result/neut__freegas_u235
end

=filter
in=41 out=44 1dn mt=1007 1008
end
=simonize
Identifier=9228 master=21
title=u235 9228 endf REL0 REV7 MOD7
fastid=9228 thermid=0 gamid=0 yieldid=0
neutron=10 id19=9228
2dn=41 id19=92235
1dn=44 id19=92235
end

=shell
cp ft21f001 ft10f001
end
=y12
eps=1e-3 ndf=11 kin=45 mat=9228 id=9228
zap=0 awp=0.0    for=leg nl=5
end
=x10
type=yield igm=51 ipm=19
iftg=26 id=9228
master=41 logwt=30 matwt=99 mtwt=2099 nl=5
kin=45 tab1=35 pot=1.15860E+01
title=u235 9228 endf REL0 REV7 MOD7
end
=shell
cp ft41f001 ${RTNDIR}/../result/neut__yield_u235
end
=simonize
Identifier=9228 master=21
title=u235 9228 endf/7 REL0 REV7 MOD7
fastid=9228 thermid=0 gamid=0  yieldid=9228
neutron=10 id19=9228
 yield=41 id19=9228
end
=rade
1$$ 21 e t
end
=shell
cp ft21f001 ${RTNDIR}/../result/neut_u235
end
```

[Input to combine multigroup XS and Bondarenko data for ^{235}U]

```
=shell
ln -sf ${RTNDIR}/../result/neut_u235 ft19f001
ln -sf /home/dw8/libraries/endf/ENDF-B-VII.0/neutron/n-092_U_235.endf ft11f001
ln -sf  /home/c31/exsite/result/broaden_u235 ft31f001
end

=shell
ln -fs /home/ykk/libraries/wgtftn/200kev/casl_51g_50b00v_flux ft30f001
end
=shell
cp /home/c31/exsite/result/ptable_u235 ft35f001
end
```

```
=tomato
0$$  35  36  e
1$$  1  e t
2$$  92235  e
3$$  9228  e t
end
=tgel
input=31 output=32 total
end
=shell
cp ft32f001 ft33f001
end
=zest
0$$  34  e
1$$  2  e t
2$$  33  1  e t
4$$  2  e
7$$  1007  e t
2$$  32  e t
end
=y12
eps=1e-3 ndf=11 kin=41 mat=9228 id=92235
zap=1 awp=1.0   for=leg
end

=fabulous_urr
in=19 out=2
kin=41
idlib=9228 idpoint=9228
resol=34 urrprob=36
flux=30 matwt=99 mtwt=2099
sig0=[1.0E8
1000000.0
100000.0
10000.0
5000.0
2000.0
1000.0
640.0
320.0
160.0
120.0
80.0
40.0
20.0
10.0
4.0
1.0
1.0E-6]
temps=[293.0
600.0
900.0
1200.0
2400.0 ]
end

=shell
cp ft02f001 ${RTNDIR}/../result/bond_u235
end
```

[Input to generate gamma data for U]

```
=shell
ln -sf /home/dw8/libraries/endf/ENDF-B-VII.0/photo/photoat-092_U_000.endf ft11f001
end

=jergens
-1$$ a11 3000000 e
0$$ 0 30 18 1$$ 1 e
2** 1000.0 3.0E7 e t
3$$ 1599 0 11 e
4** 300.0 4.8356 1273000.0 820800.0 e
t
end
```

```
=y12
ndf=11 kin=32  point=31 mat=9200  for=leg
awp=0.0 zap=0 nl=5
end

=prell
0$$ 77 49 e 1$$ 0 1 t
3$$ 19  1 0 t
7** 1.00000E+4
4.50000E+4
1.00000E+5
2.00000E+5
3.00000E+5
4.00000E+5
6.00000E+5
8.00000E+5
1.00000E+6
1.33000E+6
1.66000E+6
2.00000E+6
2.50000E+6
3.00000E+6
4.00000E+6
5.00000E+6
6.50000E+6
8.00000E+6
1.00000E+7
2.00000E+7 t
end
=shell
cp ft49f001 ft77f001
end
=x10
type=gamma
ipm=19 nl=5
master=1   logwt=30 matwt=99 mtwt=1599  id=9200
tab1=31 kin=32
title=u 9200 endf REL0 REV7 MOD1
end
=shell
cp ft01f001 ${RTNDIR}/../result/gamm_u
end
=rade
1$$ 1 e t
end
```

[Input to bind all data for ^{235}U]

```
=shell
ln -sf  ${RTNDIR}/../result/neut__neutron_u235 ft01f001
ln -sf  ${RTNDIR}/../result/neut__yield_u235 ft09f001
ln -sf  ${RTNDIR}/../result/neut__freegas_u235 ft04f001
ln -sf  ${RTNDIR}/../result/gamm_u ft55f001
ln -sf ${RTNDIR}/../result/bond_u235 ft03f001
cp ft03f001 ft33f001
end
=filter
in=4 out=44 1dn mt=1007 1008
end
=simonize
Identifier=92235 master=20
title= u235 9228 endf-7 REL0 REV7 MOD7
fastid=7009228  za=922350 source=0 gamid=7009200 yieldid=7009228
neutron=1 id19=9228

2dn=4 id19=92235
1dn=44 id19=92235
yield=9 id19=9228
 BONDARENKO=3 id19=9228
1dn=33 id19=9228
gamma=55 id19=9200
end
```

```
=ajax
0$$ 21 e 1$$ 1 t
2$$ 20 0 e t
u235 9228 endf-7 REL0 REV7 MOD7
end
=rade
1$$ 21 e t
end
=shell
cp ft21f001 ${RTNDIR}/../result/master_u235
end
```

APPENDIX A.2 INPUT FILE TO GENERATE THE FIRST AMPX MG LIBRARY

```
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -fs ${RTNDIR}/result/master_h1  ft30f001
ln -fs ${RTNDIR}/result/master_h2  ft31f001
ln -fs ${RTNDIR}/result/master_h3  ft32f001
ln -fs ${RTNDIR}/result/master_he3  ft33f001
ln -fs ${RTNDIR}/result/master_he4  ft34f001
ln -fs ${RTNDIR}/result/master_li6  ft35f001
ln -fs ${RTNDIR}/result/master_li7  ft36f001
ln -fs ${RTNDIR}/result/master_be7  ft37f001
ln -fs ${RTNDIR}/result/master_be9  ft38f001
ln -fs ${RTNDIR}/result/master_b10  ft39f001
ln -fs ${RTNDIR}/result/master_b11  ft40f001
ln -fs ${RTNDIR}/result/master_c  ft41f001
ln -fs ${RTNDIR}/result/master_n14  ft42f001
ln -fs ${RTNDIR}/result/master_n15  ft43f001
ln -fs ${RTNDIR}/result/master_o16  ft44f001
ln -fs ${RTNDIR}/result/master_o17  ft45f001
ln -fs ${RTNDIR}/result/master_f19  ft46f001
ln -fs ${RTNDIR}/result/master_na22  ft47f001
ln -fs ${RTNDIR}/result/master_na23  ft48f001
ln -fs ${RTNDIR}/result/master_mg24  ft49f001
ln -fs ${RTNDIR}/result/master_mg25  ft50f001
ln -fs ${RTNDIR}/result/master_mg26  ft51f001
ln -fs ${RTNDIR}/result/master_al27  ft52f001
ln -fs ${RTNDIR}/result/master_si28  ft53f001
ln -fs ${RTNDIR}/result/master_si29  ft54f001
ln -fs ${RTNDIR}/result/master_si30  ft55f001
ln -fs ${RTNDIR}/result/master_p31  ft56f001
ln -fs ${RTNDIR}/result/master_s32  ft57f001
ln -fs ${RTNDIR}/result/master_s33  ft58f001
ln -fs ${RTNDIR}/result/master_s34  ft59f001
ln -fs ${RTNDIR}/result/master_s36  ft60f001
ln -fs ${RTNDIR}/result/master_cl35  ft61f001
ln -fs ${RTNDIR}/result/master_cl37  ft62f001
ln -fs ${RTNDIR}/result/master_ar36  ft63f001
ln -fs ${RTNDIR}/result/master_ar38  ft64f001
ln -fs ${RTNDIR}/result/master_ar40  ft65f001
ln -fs ${RTNDIR}/result/master_k39  ft66f001
ln -fs ${RTNDIR}/result/master_k40  ft67f001
ln -fs ${RTNDIR}/result/master_k41  ft68f001
ln -fs ${RTNDIR}/result/master_ca40  ft69f001
end
=ajax
-1$$ 9000000
0$$ 81 e
1$$ 40 t
2$$  30  0 t
2$$  31  0 t
2$$  32  0 t
2$$  33  0 t
2$$  34  0 t
2$$  35  0 t
2$$  36  0 t
2$$  37  0 t
2$$  38  0 t
2$$  39  0 t
2$$  40  0 t
2$$  41  0 t
2$$  42  0 t
2$$  43  0 t
2$$  44  0 t
2$$  45  0 t
2$$  46  0 t
2$$  47  0 t
2$$  48  0 t
2$$  49  0 t
2$$  50  0 t
2$$  51  0 t
2$$  52  0 t
2$$  53  0 t
2$$  54  0 t
2$$  55  0 t
2$$  56  0 t
2$$  57  0 t
2$$  58  0 t
2$$  59  0 t
2$$  60  0 t
2$$  61  0 t
2$$  62  0 t
2$$  63  0 t
2$$  64  0 t
2$$  65  0 t
2$$  66  0 t
2$$  67  0 t
2$$  68  0 t
2$$  69  0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
```

```
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -fs ${RTNDIR}/result/master_ca42  ft30f001
ln -fs ${RTNDIR}/result/master_ca43  ft31f001
ln -fs ${RTNDIR}/result/master_ca44  ft32f001
ln -fs ${RTNDIR}/result/master_ca46  ft33f001
ln -fs ${RTNDIR}/result/master_ca48  ft34f001
ln -fs ${RTNDIR}/result/master_sc45  ft35f001
ln -fs ${RTNDIR}/result/master_ti46  ft36f001
ln -fs ${RTNDIR}/result/master_ti47  ft37f001
ln -fs ${RTNDIR}/result/master_ti48  ft38f001
ln -fs ${RTNDIR}/result/master_ti49  ft39f001
ln -fs ${RTNDIR}/result/master_ti50  ft40f001
ln -fs ${RTNDIR}/result/master_v  ft41f001
ln -fs ${RTNDIR}/result/master_cr50  ft42f001
ln -fs ${RTNDIR}/result/master_cr52  ft43f001
ln -fs ${RTNDIR}/result/master_cr53  ft44f001
ln -fs ${RTNDIR}/result/master_cr54  ft45f001
ln -fs ${RTNDIR}/result/master_mn55  ft46f001
ln -fs ${RTNDIR}/result/master_fe54  ft47f001
ln -fs ${RTNDIR}/result/master_fe56  ft48f001
ln -fs ${RTNDIR}/result/master_fe57  ft49f001
ln -fs ${RTNDIR}/result/master_fe58  ft50f001
ln -fs ${RTNDIR}/result/master_co58  ft51f001
ln -fs ${RTNDIR}/result/master_co58m1  ft52f001
ln -fs ${RTNDIR}/result/master_co59  ft53f001
ln -fs ${RTNDIR}/result/master_ni58  ft54f001
ln -fs ${RTNDIR}/result/master_ni59  ft55f001
ln -fs ${RTNDIR}/result/master_ni60  ft56f001
ln -fs ${RTNDIR}/result/master_ni61  ft57f001
ln -fs ${RTNDIR}/result/master_ni62  ft58f001
ln -fs ${RTNDIR}/result/master_ni64  ft59f001
ln -fs ${RTNDIR}/result/master_cu63  ft60f001
ln -fs ${RTNDIR}/result/master_cu65  ft61f001
ln -fs ${RTNDIR}/result/master_zn  ft62f001
ln -fs ${RTNDIR}/result/master_ga69  ft63f001
ln -fs ${RTNDIR}/result/master_ga71  ft64f001
ln -fs ${RTNDIR}/result/master_ge70  ft65f001
ln -fs ${RTNDIR}/result/master_ge72  ft66f001
ln -fs ${RTNDIR}/result/master_ge73  ft67f001
ln -fs ${RTNDIR}/result/master_ge74  ft68f001
ln -fs ${RTNDIR}/result/master_ge76  ft69f001
end
=ajax
-1$$ 9000000
0$$ 81 e
1$$ 41 t
2$$ 80 0 t
2$$  30  0 t
2$$  31  0 t
2$$  32  0 t
2$$  33  0 t
2$$  34  0 t
2$$  35  0 t
2$$  36  0 t
2$$  37  0 t
2$$  38  0 t
2$$  39  0 t
2$$  40  0 t
2$$  41  0 t
2$$  42  0 t
2$$  43  0 t
2$$  44  0 t
2$$  45  0 t
2$$  46  0 t
2$$  47  0 t
2$$  48  0 t
2$$  49  0 t
2$$  50  0 t
2$$  51  0 t
2$$  52  0 t
2$$  53  0 t
2$$  54  0 t
2$$  55  0 t
2$$  56  0 t
2$$  57  0 t
2$$  58  0 t
2$$  59  0 t
2$$  60  0 t
2$$  61  0 t
2$$  62  0 t
2$$  63  0 t
2$$  64  0 t
2$$  65  0 t
2$$  66  0 t
2$$  67  0 t
2$$  68  0 t
2$$  69  0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
```

```
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -fs ${RTNDIR}/result/master_as74  ft30f001
ln -fs ${RTNDIR}/result/master_as75  ft31f001
ln -fs ${RTNDIR}/result/master_se74  ft32f001
ln -fs ${RTNDIR}/result/master_se76  ft33f001
ln -fs ${RTNDIR}/result/master_se77  ft34f001
ln -fs ${RTNDIR}/result/master_se78  ft35f001
ln -fs ${RTNDIR}/result/master_se79  ft36f001
ln -fs ${RTNDIR}/result/master_se80  ft37f001
ln -fs ${RTNDIR}/result/master_se82  ft38f001
ln -fs ${RTNDIR}/result/master_br79  ft39f001
ln -fs ${RTNDIR}/result/master_br81  ft40f001
ln -fs ${RTNDIR}/result/master_kr78  ft41f001
ln -fs ${RTNDIR}/result/master_kr80  ft42f001
ln -fs ${RTNDIR}/result/master_kr82  ft43f001
ln -fs ${RTNDIR}/result/master_kr83  ft44f001
ln -fs ${RTNDIR}/result/master_kr84  ft45f001
ln -fs ${RTNDIR}/result/master_kr85  ft46f001
ln -fs ${RTNDIR}/result/master_kr86  ft47f001
ln -fs ${RTNDIR}/result/master_rb85  ft48f001
ln -fs ${RTNDIR}/result/master_rb86  ft49f001
ln -fs ${RTNDIR}/result/master_rb87  ft50f001
ln -fs ${RTNDIR}/result/master_sr84  ft51f001
ln -fs ${RTNDIR}/result/master_sr86  ft52f001
ln -fs ${RTNDIR}/result/master_sr87  ft53f001
ln -fs ${RTNDIR}/result/master_sr88  ft54f001
ln -fs ${RTNDIR}/result/master_sr89  ft55f001
ln -fs ${RTNDIR}/result/master_sr90  ft56f001
ln -fs ${RTNDIR}/result/master_y89  ft57f001
ln -fs ${RTNDIR}/result/master_y90  ft58f001
ln -fs ${RTNDIR}/result/master_y91  ft59f001
ln -fs ${RTNDIR}/result/master_zr90  ft60f001
ln -fs ${RTNDIR}/result/master_zr91  ft61f001
ln -fs ${RTNDIR}/result/master_zr92  ft62f001
ln -fs ${RTNDIR}/result/master_zr93  ft63f001
ln -fs ${RTNDIR}/result/master_zr94  ft64f001
ln -fs ${RTNDIR}/result/master_zr95  ft65f001
ln -fs ${RTNDIR}/result/master_zr96  ft66f001
ln -fs ${RTNDIR}/result/master_nb93  ft67f001
ln -fs ${RTNDIR}/result/master_nb94  ft68f001
ln -fs ${RTNDIR}/result/master_nb95  ft69f001
end
=ajax
-1$$ 9000000
0$$ 81 e
1$$ 41 t
2$$ 80 0 t
2$$  30  0 t
2$$  31  0 t
2$$  32  0 t
2$$  33  0 t
2$$  34  0 t
2$$  35  0 t
2$$  36  0 t
2$$  37  0 t
2$$  38  0 t
2$$  39  0 t
2$$  40  0 t
2$$  41  0 t
2$$  42  0 t
2$$  43  0 t
2$$  44  0 t
2$$  45  0 t
2$$  46  0 t
2$$  47  0 t
2$$  48  0 t
2$$  49  0 t
2$$  50  0 t
2$$  51  0 t
2$$  52  0 t
2$$  53  0 t
2$$  54  0 t
2$$  55  0 t
2$$  56  0 t
2$$  57  0 t
2$$  58  0 t
2$$  59  0 t
2$$  60  0 t
2$$  61  0 t
2$$  62  0 t
2$$  63  0 t
2$$  64  0 t
2$$  65  0 t
2$$  66  0 t
2$$  67  0 t
2$$  68  0 t
2$$  69  0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -fs ${RTNDIR}/result/master_mo92  ft30f001
ln -fs ${RTNDIR}/result/master_mo94  ft31f001
ln -fs ${RTNDIR}/result/master_mo95  ft32f001
ln -fs ${RTNDIR}/result/master_mo96  ft33f001
ln -fs ${RTNDIR}/result/master_mo97  ft34f001
ln -fs ${RTNDIR}/result/master_mo98  ft35f001
ln -fs ${RTNDIR}/result/master_mo99  ft36f001
ln -fs ${RTNDIR}/result/master_mo100  ft37f001
ln -fs ${RTNDIR}/result/master_tc99  ft38f001
ln -fs ${RTNDIR}/result/master_ru96  ft39f001
ln -fs ${RTNDIR}/result/master_ru98  ft40f001
ln -fs ${RTNDIR}/result/master_ru99  ft41f001
ln -fs ${RTNDIR}/result/master_ru100  ft42f001
ln -fs ${RTNDIR}/result/master_ru101  ft43f001
ln -fs ${RTNDIR}/result/master_ru102  ft44f001
ln -fs ${RTNDIR}/result/master_ru103  ft45f001
ln -fs ${RTNDIR}/result/master_ru104  ft46f001
ln -fs ${RTNDIR}/result/master_ru105  ft47f001
ln -fs ${RTNDIR}/result/master_ru106  ft48f001
ln -fs ${RTNDIR}/result/master_rh103  ft49f001
ln -fs ${RTNDIR}/result/master_rh105  ft50f001
ln -fs ${RTNDIR}/result/master_pd102  ft51f001
ln -fs ${RTNDIR}/result/master_pd104  ft52f001
ln -fs ${RTNDIR}/result/master_pd105  ft53f001
ln -fs ${RTNDIR}/result/master_pd106  ft54f001
ln -fs ${RTNDIR}/result/master_pd107  ft55f001
ln -fs ${RTNDIR}/result/master_pd108  ft56f001
ln -fs ${RTNDIR}/result/master_pd110  ft57f001
ln -fs ${RTNDIR}/result/master_ag107  ft58f001
ln -fs ${RTNDIR}/result/master_ag109  ft59f001
ln -fs ${RTNDIR}/result/master_ag110m1  ft60f001
ln -fs ${RTNDIR}/result/master_ag111  ft61f001
ln -fs ${RTNDIR}/result/master_cd106  ft62f001
ln -fs ${RTNDIR}/result/master_cd108  ft63f001
ln -fs ${RTNDIR}/result/master_cd110  ft64f001
ln -fs ${RTNDIR}/result/master_cd111  ft65f001
ln -fs ${RTNDIR}/result/master_cd112  ft66f001
ln -fs ${RTNDIR}/result/master_cd113  ft67f001
ln -fs ${RTNDIR}/result/master_cd114  ft68f001
ln -fs ${RTNDIR}/result/master_cd115m1  ft69f001
end
=ajax
-1$$ 9000000
0$$ 81 e
1$$ 41 t
2$$ 80 0 t
2$$  30  0 t
2$$  31  0 t
2$$  32  0 t
2$$  33  0 t
2$$  34  0 t
2$$  35  0 t
2$$  36  0 t
2$$  37  0 t
2$$  38  0 t
2$$  39  0 t
2$$  40  0 t
2$$  41  0 t
2$$  42  0 t
2$$  43  0 t
2$$  44  0 t
2$$  45  0 t
2$$  46  0 t
2$$  47  0 t
2$$  48  0 t
2$$  49  0 t
2$$  50  0 t
2$$  51  0 t
2$$  52  0 t
2$$  53  0 t
2$$  54  0 t
2$$  55  0 t
2$$  56  0 t
2$$  57  0 t
2$$  58  0 t
2$$  59  0 t
2$$  60  0 t
2$$  61  0 t
2$$  62  0 t
2$$  63  0 t
2$$  64  0 t
2$$  65  0 t
2$$  66  0 t
2$$  67  0 t
2$$  68  0 t
2$$  69  0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -fs ${RTNDIR}/result/master_cd116  ft30f001
ln -fs ${RTNDIR}/result/master_in113  ft31f001
ln -fs ${RTNDIR}/result/master_in115  ft32f001
ln -fs ${RTNDIR}/result/master_sn112  ft33f001
ln -fs ${RTNDIR}/result/master_sn113  ft34f001
ln -fs ${RTNDIR}/result/master_sn114  ft35f001
ln -fs ${RTNDIR}/result/master_sn115  ft36f001
ln -fs ${RTNDIR}/result/master_sn116  ft37f001
ln -fs ${RTNDIR}/result/master_sn117  ft38f001
ln -fs ${RTNDIR}/result/master_sn118  ft39f001
ln -fs ${RTNDIR}/result/master_sn119  ft40f001
ln -fs ${RTNDIR}/result/master_sn120  ft41f001
```

```
ln -fs ${RTNDIR}/result/master_sn122  ft42f001
ln -fs ${RTNDIR}/result/master_sn123  ft43f001
ln -fs ${RTNDIR}/result/master_sn124  ft44f001
ln -fs ${RTNDIR}/result/master_sn125  ft45f001
ln -fs ${RTNDIR}/result/master_sn126  ft46f001
ln -fs ${RTNDIR}/result/master_sb121  ft47f001
ln -fs ${RTNDIR}/result/master_sb123  ft48f001
ln -fs ${RTNDIR}/result/master_sb124  ft49f001
ln -fs ${RTNDIR}/result/master_sb125  ft50f001
ln -fs ${RTNDIR}/result/master_sb126  ft51f001
ln -fs ${RTNDIR}/result/master_te120  ft52f001
ln -fs ${RTNDIR}/result/master_te122  ft53f001
ln -fs ${RTNDIR}/result/master_te123  ft54f001
ln -fs ${RTNDIR}/result/master_te124  ft55f001
ln -fs ${RTNDIR}/result/master_te125  ft56f001
ln -fs ${RTNDIR}/result/master_te126  ft57f001
ln -fs ${RTNDIR}/result/master_te127m1  ft58f001
ln -fs ${RTNDIR}/result/master_te128  ft59f001
ln -fs ${RTNDIR}/result/master_te129m1  ft60f001
ln -fs ${RTNDIR}/result/master_te130  ft61f001
ln -fs ${RTNDIR}/result/master_te132  ft62f001
ln -fs ${RTNDIR}/result/master_i127  ft63f001
ln -fs ${RTNDIR}/result/master_i129  ft64f001
ln -fs ${RTNDIR}/result/master_i130  ft65f001
ln -fs ${RTNDIR}/result/master_i131  ft66f001
ln -fs ${RTNDIR}/result/master_i135  ft67f001
ln -fs ${RTNDIR}/result/master_xe123  ft68f001
ln -fs ${RTNDIR}/result/master_xe124  ft69f001
end
=ajax
-1$$ 9000000
0$$ 81 e
1$$ 41 t
2$$ 80 0 t
2$$  30  0 t
2$$  31  0 t
2$$  32  0 t
2$$  33  0 t
2$$  34  0 t
2$$  35  0 t
2$$  36  0 t
2$$  37  0 t
2$$  38  0 t
2$$  39  0 t
2$$  40  0 t
2$$  41  0 t
2$$  42  0 t
2$$  43  0 t
2$$  44  0 t
2$$  45  0 t
2$$  46  0 t
2$$  47  0 t
2$$  48  0 t
2$$  49  0 t
2$$  50  0 t
2$$  51  0 t
2$$  52  0 t
2$$  53  0 t
2$$  54  0 t
2$$  55  0 t
2$$  56  0 t
2$$  57  0 t
2$$  58  0 t
2$$  59  0 t
2$$  60  0 t
2$$  61  0 t
2$$  62  0 t
2$$  63  0 t
2$$  64  0 t
2$$  65  0 t
2$$  66  0 t
2$$  67  0 t
2$$  68  0 t
2$$  69  0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -fs ${RTNDIR}/result/master_xe126  ft30f001
ln -fs ${RTNDIR}/result/master_xe128  ft31f001
ln -fs ${RTNDIR}/result/master_xe129  ft32f001
ln -fs ${RTNDIR}/result/master_xe130  ft33f001
ln -fs ${RTNDIR}/result/master_xe131  ft34f001
ln -fs ${RTNDIR}/result/master_xe132  ft35f001
ln -fs ${RTNDIR}/result/master_xe133  ft36f001
ln -fs ${RTNDIR}/result/master_xe134  ft37f001
ln -fs ${RTNDIR}/result/master_xe135  ft38f001
ln -fs ${RTNDIR}/result/master_xe136  ft39f001
ln -fs ${RTNDIR}/result/master_cs133  ft40f001
ln -fs ${RTNDIR}/result/master_cs134  ft41f001
ln -fs ${RTNDIR}/result/master_cs135  ft42f001
ln -fs ${RTNDIR}/result/master_cs136  ft43f001
ln -fs ${RTNDIR}/result/master_cs137  ft44f001
ln -fs ${RTNDIR}/result/master_ba130  ft45f001
ln -fs ${RTNDIR}/result/master_ba132  ft46f001
ln -fs ${RTNDIR}/result/master_ba133  ft47f001
ln -fs ${RTNDIR}/result/master_ba134  ft48f001
ln -fs ${RTNDIR}/result/master_ba135  ft49f001
ln -fs ${RTNDIR}/result/master_ba136  ft50f001
ln -fs ${RTNDIR}/result/master_ba137  ft51f001
ln -fs ${RTNDIR}/result/master_ba138  ft52f001
ln -fs ${RTNDIR}/result/master_ba140  ft53f001
ln -fs ${RTNDIR}/result/master_la138  ft54f001
ln -fs ${RTNDIR}/result/master_la139  ft55f001
ln -fs ${RTNDIR}/result/master_la140  ft56f001
ln -fs ${RTNDIR}/result/master_ce136  ft57f001
ln -fs ${RTNDIR}/result/master_ce138  ft58f001
ln -fs ${RTNDIR}/result/master_ce139  ft59f001
ln -fs ${RTNDIR}/result/master_ce140  ft60f001
ln -fs ${RTNDIR}/result/master_ce141  ft61f001
ln -fs ${RTNDIR}/result/master_ce142  ft62f001
ln -fs ${RTNDIR}/result/master_ce143  ft63f001
ln -fs ${RTNDIR}/result/master_ce144  ft64f001
ln -fs ${RTNDIR}/result/master_pr141  ft65f001
ln -fs ${RTNDIR}/result/master_pr142  ft66f001
ln -fs ${RTNDIR}/result/master_pr143  ft67f001
ln -fs ${RTNDIR}/result/master_nd142  ft68f001
ln -fs ${RTNDIR}/result/master_nd143  ft69f001
end
=ajax
-1$$ 9000000
0$$ 81 e
1$$ 41 t
2$$ 80 0 t
2$$  30  0 t
2$$  31  0 t
2$$  32  0 t
2$$  33  0 t
2$$  34  0 t
2$$  35  0 t
2$$  36  0 t
2$$  37  0 t
2$$  38  0 t
2$$  39  0 t
2$$  40  0 t
2$$  41  0 t
2$$  42  0 t
2$$  43  0 t
2$$  44  0 t
2$$  45  0 t
2$$  46  0 t
2$$  47  0 t
2$$  48  0 t
2$$  49  0 t
2$$  50  0 t
2$$  51  0 t
2$$  52  0 t
2$$  53  0 t
2$$  54  0 t
2$$  55  0 t
2$$  56  0 t
2$$  57  0 t
2$$  58  0 t
2$$  59  0 t
2$$  60  0 t
2$$  61  0 t
2$$  62  0 t
2$$  63  0 t
2$$  64  0 t
2$$  65  0 t
2$$  66  0 t
2$$  67  0 t
2$$  68  0 t
2$$  69  0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -fs ${RTNDIR}/result/master_nd144  ft30f001
ln -fs ${RTNDIR}/result/master_nd145  ft31f001
ln -fs ${RTNDIR}/result/master_nd146  ft32f001
ln -fs ${RTNDIR}/result/master_nd147  ft33f001
ln -fs ${RTNDIR}/result/master_nd148  ft34f001
ln -fs ${RTNDIR}/result/master_nd150  ft35f001
ln -fs ${RTNDIR}/result/master_pm147  ft36f001
ln -fs ${RTNDIR}/result/master_pm148  ft37f001
ln -fs ${RTNDIR}/result/master_pm148m1  ft38f001
ln -fs ${RTNDIR}/result/master_pm149  ft39f001
ln -fs ${RTNDIR}/result/master_pm151  ft40f001
ln -fs ${RTNDIR}/result/master_sm144  ft41f001
ln -fs ${RTNDIR}/result/master_sm147  ft42f001
ln -fs ${RTNDIR}/result/master_sm148  ft43f001
ln -fs ${RTNDIR}/result/master_sm149  ft44f001
ln -fs ${RTNDIR}/result/master_sm150  ft45f001
ln -fs ${RTNDIR}/result/master_sm151  ft46f001
ln -fs ${RTNDIR}/result/master_sm152  ft47f001
ln -fs ${RTNDIR}/result/master_sm153  ft48f001
ln -fs ${RTNDIR}/result/master_sm154  ft49f001
ln -fs ${RTNDIR}/result/master_eu151  ft50f001
ln -fs ${RTNDIR}/result/master_eu152  ft51f001
ln -fs ${RTNDIR}/result/master_eu153  ft52f001
ln -fs ${RTNDIR}/result/master_eu154  ft53f001
ln -fs ${RTNDIR}/result/master_eu155  ft54f001
ln -fs ${RTNDIR}/result/master_eu156  ft55f001
```

```
ln -fs ${RTNDIR}/result/master_eu157  ft56f001
ln -fs ${RTNDIR}/result/master_gd152  ft57f001
ln -fs ${RTNDIR}/result/master_gd153  ft58f001
ln -fs ${RTNDIR}/result/master_gd154  ft59f001
ln -fs ${RTNDIR}/result/master_gd155  ft60f001
ln -fs ${RTNDIR}/result/master_gd156  ft61f001
ln -fs ${RTNDIR}/result/master_gd157  ft62f001
ln -fs ${RTNDIR}/result/master_gd158  ft63f001
ln -fs ${RTNDIR}/result/master_gd160  ft64f001
ln -fs ${RTNDIR}/result/master_tb159  ft65f001
ln -fs ${RTNDIR}/result/master_tb160  ft66f001
ln -fs ${RTNDIR}/result/master_dy156  ft67f001
ln -fs ${RTNDIR}/result/master_dy158  ft68f001
ln -fs ${RTNDIR}/result/master_dy160  ft69f001
end
=ajax
-1$$ 9000000
0$$ 81 e
1$$ 41 t
2$$ 80 0 t
2$$  30  0 t
2$$  31  0 t
2$$  32  0 t
2$$  33  0 t
2$$  34  0 t
2$$  35  0 t
2$$  36  0 t
2$$  37  0 t
2$$  38  0 t
2$$  39  0 t
2$$  40  0 t
2$$  41  0 t
2$$  42  0 t
2$$  43  0 t
2$$  44  0 t
2$$  45  0 t
2$$  46  0 t
2$$  47  0 t
2$$  48  0 t
2$$  49  0 t
2$$  50  0 t
2$$  51  0 t
2$$  52  0 t
2$$  53  0 t
2$$  54  0 t
2$$  55  0 t
2$$  56  0 t
2$$  57  0 t
2$$  58  0 t
2$$  59  0 t
2$$  60  0 t
2$$  61  0 t
2$$  62  0 t
2$$  63  0 t
2$$  64  0 t
2$$  65  0 t
2$$  66  0 t
2$$  67  0 t
2$$  68  0 t
2$$  69  0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -fs ${RTNDIR}/result/master_dy161  ft30f001
ln -fs ${RTNDIR}/result/master_dy162  ft31f001
ln -fs ${RTNDIR}/result/master_dy163  ft32f001
ln -fs ${RTNDIR}/result/master_dy164  ft33f001
ln -fs ${RTNDIR}/result/master_ho165  ft34f001
ln -fs ${RTNDIR}/result/master_ho166m1  ft35f001
ln -fs ${RTNDIR}/result/master_er162  ft36f001
ln -fs ${RTNDIR}/result/master_er164  ft37f001
ln -fs ${RTNDIR}/result/master_er166  ft38f001
ln -fs ${RTNDIR}/result/master_er167  ft39f001
ln -fs ${RTNDIR}/result/master_er168  ft40f001
ln -fs ${RTNDIR}/result/master_er170  ft41f001
ln -fs ${RTNDIR}/result/master_lu175  ft42f001
ln -fs ${RTNDIR}/result/master_lu176  ft43f001
ln -fs ${RTNDIR}/result/master_hf174  ft44f001
ln -fs ${RTNDIR}/result/master_hf176  ft45f001
ln -fs ${RTNDIR}/result/master_hf177  ft46f001
ln -fs ${RTNDIR}/result/master_hf178  ft47f001
ln -fs ${RTNDIR}/result/master_hf179  ft48f001
ln -fs ${RTNDIR}/result/master_hf180  ft49f001
ln -fs ${RTNDIR}/result/master_ta181  ft50f001
ln -fs ${RTNDIR}/result/master_ta182  ft51f001
ln -fs ${RTNDIR}/result/master_w182  ft52f001
ln -fs ${RTNDIR}/result/master_w183  ft53f001
ln -fs ${RTNDIR}/result/master_w184  ft54f001
ln -fs ${RTNDIR}/result/master_w186  ft55f001
ln -fs ${RTNDIR}/result/master_re185  ft56f001
ln -fs ${RTNDIR}/result/master_re187  ft57f001
ln -fs ${RTNDIR}/result/master_ir191  ft58f001
ln -fs ${RTNDIR}/result/master_ir193  ft59f001
ln -fs ${RTNDIR}/result/master_au197  ft60f001
ln -fs ${RTNDIR}/result/master_hg196  ft61f001
ln -fs ${RTNDIR}/result/master_hg198  ft62f001
ln -fs ${RTNDIR}/result/master_hg199  ft63f001
ln -fs ${RTNDIR}/result/master_hg200  ft64f001
ln -fs ${RTNDIR}/result/master_hg201  ft65f001
ln -fs ${RTNDIR}/result/master_hg202  ft66f001
ln -fs ${RTNDIR}/result/master_hg204  ft67f001
ln -fs ${RTNDIR}/result/master_pb204  ft68f001
ln -fs ${RTNDIR}/result/master_pb206  ft69f001
end
=ajax
-1$$ 9000000
0$$ 81 e
1$$ 41 t
2$$ 80 0 t
2$$  30  0 t
2$$  31  0 t
2$$  32  0 t
2$$  33  0 t
2$$  34  0 t
2$$  35  0 t
2$$  36  0 t
2$$  37  0 t
2$$  38  0 t
2$$  39  0 t
2$$  40  0 t
2$$  41  0 t
2$$  42  0 t
2$$  43  0 t
2$$  44  0 t
2$$  45  0 t
2$$  46  0 t
2$$  47  0 t
2$$  48  0 t
2$$  49  0 t
2$$  50  0 t
2$$  51  0 t
2$$  52  0 t
2$$  53  0 t
2$$  54  0 t
2$$  55  0 t
2$$  56  0 t
2$$  57  0 t
2$$  58  0 t
2$$  59  0 t
2$$  60  0 t
2$$  61  0 t
2$$  62  0 t
2$$  63  0 t
2$$  64  0 t
2$$  65  0 t
2$$  66  0 t
2$$  67  0 t
2$$  68  0 t
2$$  69  0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -fs ${RTNDIR}/result/master_pb207  ft30f001
ln -fs ${RTNDIR}/result/master_pb208  ft31f001
ln -fs ${RTNDIR}/result/master_bi209  ft32f001
ln -fs ${RTNDIR}/result/master_ra223  ft33f001
ln -fs ${RTNDIR}/result/master_ra224  ft34f001
ln -fs ${RTNDIR}/result/master_ra225  ft35f001
ln -fs ${RTNDIR}/result/master_ra226  ft36f001
ln -fs ${RTNDIR}/result/master_ac225  ft37f001
ln -fs ${RTNDIR}/result/master_ac226  ft38f001
ln -fs ${RTNDIR}/result/master_ac227  ft39f001
ln -fs ${RTNDIR}/result/master_th227  ft40f001
ln -fs ${RTNDIR}/result/master_th228  ft41f001
ln -fs ${RTNDIR}/result/master_th229  ft42f001
ln -fs ${RTNDIR}/result/master_th230  ft43f001
ln -fs ${RTNDIR}/result/master_th232  ft44f001
ln -fs ${RTNDIR}/result/master_th233  ft45f001
ln -fs ${RTNDIR}/result/master_th234  ft46f001
ln -fs ${RTNDIR}/result/master_pa231  ft47f001
ln -fs ${RTNDIR}/result/master_pa232  ft48f001
ln -fs ${RTNDIR}/result/master_pa233  ft49f001
ln -fs ${RTNDIR}/result/master_u232  ft50f001
ln -fs ${RTNDIR}/result/master_u233  ft51f001
ln -fs ${RTNDIR}/result/master_u234  ft52f001
ln -fs ${RTNDIR}/result/master_u235  ft53f001
ln -fs ${RTNDIR}/result/master_u236  ft54f001
ln -fs ${RTNDIR}/result/master_u237  ft55f001
ln -fs ${RTNDIR}/result/master_u238  ft56f001
ln -fs ${RTNDIR}/result/master_u239  ft57f001
ln -fs ${RTNDIR}/result/master_u240  ft58f001
ln -fs ${RTNDIR}/result/master_u241  ft59f001
ln -fs ${RTNDIR}/result/master_np235  ft60f001
ln -fs ${RTNDIR}/result/master_np236  ft61f001
ln -fs ${RTNDIR}/result/master_np237  ft62f001
ln -fs ${RTNDIR}/result/master_np238  ft63f001
ln -fs ${RTNDIR}/result/master_np239  ft64f001
ln -fs ${RTNDIR}/result/master_pu236  ft65f001
ln -fs ${RTNDIR}/result/master_pu237  ft66f001
ln -fs ${RTNDIR}/result/master_pu238  ft67f001
ln -fs ${RTNDIR}/result/master_pu239  ft68f001
ln -fs ${RTNDIR}/result/master_pu240  ft69f001
```

```
end
=ajax
-1$$ 9000000
0$$ 81 e
1$$ 41 t
2$$ 80 0 t
2$$  30  0 t
2$$  31  0 t
2$$  32  0 t
2$$  33  0 t
2$$  34  0 t
2$$  35  0 t
2$$  36  0 t
2$$  37  0 t
2$$  38  0 t
2$$  39  0 t
2$$  40  0 t
2$$  41  0 t
2$$  42  0 t
2$$  43  0 t
2$$  44  0 t
2$$  45  0 t
2$$  46  0 t
2$$  47  0 t
2$$  48  0 t
2$$  49  0 t
2$$  50  0 t
2$$  51  0 t
2$$  52  0 t
2$$  53  0 t
2$$  54  0 t
2$$  55  0 t
2$$  56  0 t
2$$  57  0 t
2$$  58  0 t
2$$  59  0 t
2$$  60  0 t
2$$  61  0 t
2$$  62  0 t
2$$  63  0 t
2$$  64  0 t
2$$  65  0 t
2$$  66  0 t
2$$  67  0 t
2$$  68  0 t
2$$  69  0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -fs ${RTNDIR}/result/master_pu241  ft30f001
ln -fs ${RTNDIR}/result/master_pu242  ft31f001
ln -fs ${RTNDIR}/result/master_pu243  ft32f001
ln -fs ${RTNDIR}/result/master_pu244  ft33f001
ln -fs ${RTNDIR}/result/master_pu246  ft34f001
ln -fs ${RTNDIR}/result/master_am241  ft35f001
ln -fs ${RTNDIR}/result/master_am242  ft36f001
ln -fs ${RTNDIR}/result/master_am242m1  ft37f001
ln -fs ${RTNDIR}/result/master_am243  ft38f001
ln -fs ${RTNDIR}/result/master_am244  ft39f001
ln -fs ${RTNDIR}/result/master_am244m1  ft40f001
ln -fs ${RTNDIR}/result/master_cm241  ft41f001
ln -fs ${RTNDIR}/result/master_cm242  ft42f001
ln -fs ${RTNDIR}/result/master_cm243  ft43f001
ln -fs ${RTNDIR}/result/master_cm244  ft44f001
ln -fs ${RTNDIR}/result/master_cm245  ft45f001
ln -fs ${RTNDIR}/result/master_cm246  ft46f001
ln -fs ${RTNDIR}/result/master_cm247  ft47f001
ln -fs ${RTNDIR}/result/master_cm248  ft48f001
ln -fs ${RTNDIR}/result/master_cm249  ft49f001
ln -fs ${RTNDIR}/result/master_cm250  ft50f001
ln -fs ${RTNDIR}/result/master_bk249  ft51f001
ln -fs ${RTNDIR}/result/master_bk250  ft52f001
ln -fs ${RTNDIR}/result/master_cf249  ft53f001
ln -fs ${RTNDIR}/result/master_cf250  ft54f001
ln -fs ${RTNDIR}/result/master_cf251  ft55f001
ln -fs ${RTNDIR}/result/master_cf252  ft56f001
ln -fs ${RTNDIR}/result/master_cf253  ft57f001
ln -fs ${RTNDIR}/result/master_cf254  ft58f001
ln -fs ${RTNDIR}/result/master_es253  ft59f001
ln -fs ${RTNDIR}/result/master_es254  ft60f001
ln -fs ${RTNDIR}/result/master_es255  ft61f001
ln -fs ${RTNDIR}/result/master_fm255  ft62f001
end
=ajax
-1$$ 9000000
0$$ 81 e
1$$ 34 t
2$$ 80 0 t
2$$  30  0 t
2$$  31  0 t
2$$  32  0 t
2$$  33  0 t
2$$  34  0 t
2$$  35  0 t
2$$  36  0 t
2$$  37  0 t
2$$  38  0 t
2$$  39  0 t
2$$  40  0 t
2$$  41  0 t
2$$  42  0 t
2$$  43  0 t
2$$  44  0 t
2$$  45  0 t
2$$  46  0 t
2$$  47  0 t
2$$  48  0 t
2$$  49  0 t
2$$  50  0 t
2$$  51  0 t
2$$  52  0 t
2$$  53  0 t
2$$  54  0 t
2$$  55  0 t
2$$  56  0 t
2$$  57  0 t
2$$  58  0 t
2$$  59  0 t
2$$  60  0 t
2$$  61  0 t
2$$  62  0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/result/master_al27_al27 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/result/master_fe56_fe54 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/result/master_fe56_fe56 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/result/master_fe56_fe57 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/result/master_fe56_fe58 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
```

```
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/result/master_be_metal_be9 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/result/master_be_beo_be9 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/result/master_be_beo_o16 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/result/master_d_d2o_h2 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/result/master_h_ch2_h1 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/result/master_h_h2o_h1 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/result/master_h_zrh_h1 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/result/master_o_beo_be9 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/result/master_o_beo_c ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/result/master_o_uo2_o16 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/result/master_o_uo2_u232 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/result/master_o_uo2_u233 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/result/master_o_uo2_u234 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
```

```
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/result/master_o_uo2_u235 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/result/master_o_uo2_u236 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/result/master_o_uo2_u237 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/result/master_o_uo2_u238 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/result/master_o_uo2_u239 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/result/master_o_uo2_u240 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/result/master_o_uo2_u241 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/result/master_u_uo2_c ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/result/master_u_uo2_u232 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/result/master_u_uo2_u233 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/result/master_u_uo2_u234 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/result/master_u_uo2_u235 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/result/master_u_uo2_u236 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/result/master_u_uo2_u237 ft30f001
end
=ajax
```

```
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/result/master_u_uo2_u238 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/result/master_u_uo2_u239 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/result/master_u_uo2_u240 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/result/master_u_uo2_u241 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/result/master_zr_zrh_zr90 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/result/master_zr_zrh_zr91 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/result/master_zr_zrh_zr92 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/result/master_zr_zrh_zr93 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/result/master_zr_zrh_zr94 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/result/master_zr_zrh_zr95 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/result/master_zr_zrh_zr96 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/result/master_benzine_h1 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/result/master_benzine_c ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
```

```
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/result/master_graphite_c ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/result/master_l_ch4_h1 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/result/master_ortho_d_h2 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/result/master_ortho_h_h1 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/result/master_para_d_h2 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/result/master_para_h_h1 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/result/master_s_ch4_h1 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
ln -sf ajaxTemp ft80f001
end
=ajax
-1$$ 5000000
0$$ 91 e
1$$ 1  t
2$$ 80 0 t
the endf/b7.0 ampx 51g 4.2m2 library 00
Generated with AMPX code system
end
=shell
cp ft91f001 ${RTNDIR}/ampx51g_70_4.2m2_00.bin
end
```

APPENDIX A.3. INPUT FILES TO GENERATE IR PARAMETERS AND HOMOGENEOUS F-FACTORS FOR ^{235}U

```
=shell
ln -fs ${RTNDIR}/../ampx51g_70_4.2m1_00.bin ft77f001
cp /scale/scale_dev_data/ce_v7.0_endf.xml ce_v7.0_endf.xml
ln -fs /scale/scale_dev_data/cekenolib_7.0
end
=ajax
0$$  20  e
1$$  1  e t
2$$  77  4  e t
3$$ 92238 1001 92235 92235 e t
end
=lambda
in=20  out=44 bnuc=1001  fnuc=92238
iddens=0.0238333 bdens=0.0357499 dens=0.00743805
low=11 high=50
temp=600.0
end
=ajax
0$$ 46 e 1$$ 1 e t
2$$ 44 1 e t
3$$ 92235    e t
end
=shell
cp ft46f001 ${RTNDIR}/../irflib/irf_lambda_u235
end
=irffachomo
in=44 out=45 fnuc=92235 bnuc=1001
dens=1.0 ehres=2.25000E+03
low=11 high=50
end
=ajax
0$$ 48 e 1$$ 1 e t
2$$ 45 1 e t
3$$ 92235   e t
end
=shell
cp ft48f001 ${RTNDIR}/../irflib/irf_irf_u235
end
```

APPENDIX A.4. INPUT FILE TO GENERATE THE SECOND AMPX MG LIBRARY

```
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -fs ${RTNDIR}/irflib/irf_irf_h1  ft30f001
ln -fs ${RTNDIR}/irflib/irf_irf_h2  ft31f001
ln -fs ${RTNDIR}/irflib/irf_irf_h3  ft32f001
ln -fs ${RTNDIR}/irflib/irf_irf_he3  ft33f001
ln -fs ${RTNDIR}/irflib/irf_irf_he4  ft34f001
ln -fs ${RTNDIR}/irflib/irf_irf_li6  ft35f001
ln -fs ${RTNDIR}/irflib/irf_irf_li7  ft36f001
ln -fs ${RTNDIR}/irflib/irf_irf_be7  ft37f001
ln -fs ${RTNDIR}/irflib/irf_irf_be9  ft38f001
ln -fs ${RTNDIR}/irflib/irf_irf_b10  ft39f001
ln -fs ${RTNDIR}/irflib/irf_irf_b11  ft40f001
ln -fs ${RTNDIR}/irflib/irf_irf_c  ft41f001
ln -fs ${RTNDIR}/irflib/irf_irf_n14  ft42f001
ln -fs ${RTNDIR}/irflib/irf_irf_n15  ft43f001
ln -fs ${RTNDIR}/irflib/irf_irf_o16  ft44f001
ln -fs ${RTNDIR}/irflib/irf_irf_o17  ft45f001
ln -fs ${RTNDIR}/irflib/irf_irf_f19  ft46f001
ln -fs ${RTNDIR}/irflib/irf_irf_na22  ft47f001
ln -fs ${RTNDIR}/irflib/irf_irf_na23  ft48f001
ln -fs ${RTNDIR}/irflib/irf_irf_mg24  ft49f001
ln -fs ${RTNDIR}/irflib/irf_irf_mg25  ft50f001
ln -fs ${RTNDIR}/irflib/irf_irf_mg26  ft51f001
ln -fs ${RTNDIR}/irflib/irf_irf_al27  ft52f001
ln -fs ${RTNDIR}/irflib/irf_irf_si28  ft53f001
ln -fs ${RTNDIR}/irflib/irf_irf_si29  ft54f001
ln -fs ${RTNDIR}/irflib/irf_irf_si30  ft55f001
ln -fs ${RTNDIR}/irflib/irf_irf_p31  ft56f001
ln -fs ${RTNDIR}/irflib/irf_irf_s32  ft57f001
ln -fs ${RTNDIR}/irflib/irf_irf_s33  ft58f001
ln -fs ${RTNDIR}/irflib/irf_irf_s34  ft59f001
ln -fs ${RTNDIR}/irflib/irf_irf_s36  ft60f001
ln -fs ${RTNDIR}/irflib/irf_irf_cl35  ft61f001
ln -fs ${RTNDIR}/irflib/irf_irf_cl37  ft62f001
ln -fs ${RTNDIR}/irflib/irf_irf_ar36  ft63f001
ln -fs ${RTNDIR}/irflib/irf_irf_ar38  ft64f001
ln -fs ${RTNDIR}/irflib/irf_irf_ar40  ft65f001
ln -fs ${RTNDIR}/irflib/irf_irf_k39  ft66f001
ln -fs ${RTNDIR}/irflib/irf_irf_k40  ft67f001
ln -fs ${RTNDIR}/irflib/irf_irf_k41  ft68f001
ln -fs ${RTNDIR}/irflib/irf_irf_ca40  ft69f001
end
=ajax
-1$$ 9000000
0$$ 81 e
1$$ 40 t
2$$  30  0 t
2$$  31  0 t
2$$  32  0 t
2$$  33  0 t
2$$  34  0 t
2$$  35  0 t
2$$  36  0 t
2$$  37  0 t
2$$  38  0 t
2$$  39  0 t
2$$  40  0 t
2$$  41  0 t
2$$  42  0 t
2$$  43  0 t
2$$  44  0 t
2$$  45  0 t
2$$  46  0 t
2$$  47  0 t
2$$  48  0 t
2$$  49  0 t
2$$  50  0 t
2$$  51  0 t
2$$  52  0 t
2$$  53  0 t
2$$  54  0 t
2$$  55  0 t
2$$  56  0 t
2$$  57  0 t
2$$  58  0 t
2$$  59  0 t
2$$  60  0 t
2$$  61  0 t
2$$  62  0 t
2$$  63  0 t
2$$  64  0 t
2$$  65  0 t
2$$  66  0 t
2$$  67  0 t
2$$  68  0 t
2$$  69  0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
```

```
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -fs ${RTNDIR}/irflib/irf_irf_ca42  ft30f001
ln -fs ${RTNDIR}/irflib/irf_irf_ca43  ft31f001
ln -fs ${RTNDIR}/irflib/irf_irf_ca44  ft32f001
ln -fs ${RTNDIR}/irflib/irf_irf_ca46  ft33f001
ln -fs ${RTNDIR}/irflib/irf_irf_ca48  ft34f001
ln -fs ${RTNDIR}/irflib/irf_irf_sc45  ft35f001
ln -fs ${RTNDIR}/irflib/irf_irf_ti46  ft36f001
ln -fs ${RTNDIR}/irflib/irf_irf_ti47  ft37f001
ln -fs ${RTNDIR}/irflib/irf_irf_ti48  ft38f001
ln -fs ${RTNDIR}/irflib/irf_irf_ti49  ft39f001
ln -fs ${RTNDIR}/irflib/irf_irf_ti50  ft40f001
ln -fs ${RTNDIR}/irflib/irf_lambda_v  ft41f001
ln -fs ${RTNDIR}/irflib/irf_irf_cr50  ft42f001
ln -fs ${RTNDIR}/irflib/irf_irf_cr52  ft43f001
ln -fs ${RTNDIR}/irflib/irf_irf_cr53  ft44f001
ln -fs ${RTNDIR}/irflib/irf_irf_cr54  ft45f001
ln -fs ${RTNDIR}/irflib/irf_irf_mn55  ft46f001
ln -fs ${RTNDIR}/irflib/irf_irf_fe54  ft47f001
ln -fs ${RTNDIR}/irflib/irf_irf_fe56  ft48f001
ln -fs ${RTNDIR}/irflib/irf_irf_fe57  ft49f001
ln -fs ${RTNDIR}/irflib/irf_irf_fe58  ft50f001
ln -fs ${RTNDIR}/irflib/irf_irf_co58  ft51f001
ln -fs ${RTNDIR}/irflib/irf_irf_co58m1  ft52f001
ln -fs ${RTNDIR}/irflib/irf_irf_co59  ft53f001
ln -fs ${RTNDIR}/irflib/irf_irf_ni58  ft54f001
ln -fs ${RTNDIR}/irflib/irf_irf_ni59  ft55f001
ln -fs ${RTNDIR}/irflib/irf_irf_ni60  ft56f001
ln -fs ${RTNDIR}/irflib/irf_irf_ni61  ft57f001
ln -fs ${RTNDIR}/irflib/irf_irf_ni62  ft58f001
ln -fs ${RTNDIR}/irflib/irf_irf_ni64  ft59f001
ln -fs ${RTNDIR}/irflib/irf_irf_cu63  ft60f001
ln -fs ${RTNDIR}/irflib/irf_irf_cu65  ft61f001
ln -fs ${RTNDIR}/irflib/irf_lambda_zn  ft62f001
ln -fs ${RTNDIR}/irflib/irf_irf_ga69  ft63f001
ln -fs ${RTNDIR}/irflib/irf_irf_ga71  ft64f001
ln -fs ${RTNDIR}/irflib/irf_irf_ge70  ft65f001
ln -fs ${RTNDIR}/irflib/irf_irf_ge72  ft66f001
ln -fs ${RTNDIR}/irflib/irf_irf_ge73  ft67f001
ln -fs ${RTNDIR}/irflib/irf_irf_ge74  ft68f001
ln -fs ${RTNDIR}/irflib/irf_irf_ge76  ft69f001
end
=ajax
-1$$ 9000000
0$$ 81 e
1$$ 41 t
2$$ 80 0 t
2$$  30  0 t
2$$  31  0 t
2$$  32  0 t
2$$  33  0 t
2$$  34  0 t
2$$  35  0 t
2$$  36  0 t
2$$  37  0 t
2$$  38  0 t
2$$  39  0 t
2$$  40  0 t
2$$  41  0 t
2$$  42  0 t
2$$  43  0 t
2$$  44  0 t
2$$  45  0 t
2$$  46  0 t
2$$  47  0 t
2$$  48  0 t
2$$  49  0 t
2$$  50  0 t
2$$  51  0 t
2$$  52  0 t
2$$  53  0 t
2$$  54  0 t
2$$  55  0 t
2$$  56  0 t
2$$  57  0 t
2$$  58  0 t
2$$  59  0 t
2$$  60  0 t
2$$  61  0 t
2$$  62  0 t
2$$  63  0 t
2$$  64  0 t
2$$  65  0 t
2$$  66  0 t
2$$  67  0 t
2$$  68  0 t
2$$  69  0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
```

```
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -fs ${RTNDIR}/irflib/irf_irf_as74  ft30f001
ln -fs ${RTNDIR}/irflib/irf_irf_as75  ft31f001
ln -fs ${RTNDIR}/irflib/irf_irf_se74  ft32f001
ln -fs ${RTNDIR}/irflib/irf_irf_se76  ft33f001
ln -fs ${RTNDIR}/irflib/irf_irf_se77  ft34f001
ln -fs ${RTNDIR}/irflib/irf_irf_se78  ft35f001
ln -fs ${RTNDIR}/irflib/irf_irf_se79  ft36f001
ln -fs ${RTNDIR}/irflib/irf_irf_se80  ft37f001
ln -fs ${RTNDIR}/irflib/irf_irf_se82  ft38f001
ln -fs ${RTNDIR}/irflib/irf_irf_br79  ft39f001
ln -fs ${RTNDIR}/irflib/irf_irf_br81  ft40f001
ln -fs ${RTNDIR}/irflib/irf_irf_kr78  ft41f001
ln -fs ${RTNDIR}/irflib/irf_irf_kr80  ft42f001
ln -fs ${RTNDIR}/irflib/irf_irf_kr82  ft43f001
ln -fs ${RTNDIR}/irflib/irf_irf_kr83  ft44f001
ln -fs ${RTNDIR}/irflib/irf_irf_kr84  ft45f001
ln -fs ${RTNDIR}/irflib/irf_irf_kr85  ft46f001
ln -fs ${RTNDIR}/irflib/irf_irf_kr86  ft47f001
ln -fs ${RTNDIR}/irflib/irf_irf_rb85  ft48f001
ln -fs ${RTNDIR}/irflib/irf_irf_rb86  ft49f001
ln -fs ${RTNDIR}/irflib/irf_irf_rb87  ft50f001
ln -fs ${RTNDIR}/irflib/irf_irf_sr84  ft51f001
ln -fs ${RTNDIR}/irflib/irf_irf_sr86  ft52f001
ln -fs ${RTNDIR}/irflib/irf_irf_sr87  ft53f001
ln -fs ${RTNDIR}/irflib/irf_irf_sr88  ft54f001
ln -fs ${RTNDIR}/irflib/irf_irf_sr89  ft55f001
ln -fs ${RTNDIR}/irflib/irf_irf_sr90  ft56f001
ln -fs ${RTNDIR}/irflib/irf_irf_y89  ft57f001
ln -fs ${RTNDIR}/irflib/irf_irf_y90  ft58f001
ln -fs ${RTNDIR}/irflib/irf_irf_y91  ft59f001
ln -fs ${RTNDIR}/irflib/irf_irf_zr90  ft60f001
ln -fs ${RTNDIR}/irflib/irf_irf_zr91  ft61f001
ln -fs ${RTNDIR}/irflib/irf_irf_zr92  ft62f001
ln -fs ${RTNDIR}/irflib/irf_irf_zr93  ft63f001
ln -fs ${RTNDIR}/irflib/irf_irf_zr94  ft64f001
ln -fs ${RTNDIR}/irflib/irf_irf_zr95  ft65f001
ln -fs ${RTNDIR}/irflib/irf_irf_zr96  ft66f001
ln -fs ${RTNDIR}/irflib/irf_irf_nb93  ft67f001
ln -fs ${RTNDIR}/irflib/irf_irf_nb94  ft68f001
ln -fs ${RTNDIR}/irflib/irf_irf_nb95  ft69f001
end
=ajax
-1$$ 9000000
0$$ 81 e
1$$ 41 t
2$$ 80 0 t
2$$  30  0 t
2$$  31  0 t
2$$  32  0 t
2$$  33  0 t
2$$  34  0 t
2$$  35  0 t
2$$  36  0 t
2$$  37  0 t
2$$  38  0 t
2$$  39  0 t
2$$  40  0 t
2$$  41  0 t
2$$  42  0 t
2$$  43  0 t
2$$  44  0 t
2$$  45  0 t
2$$  46  0 t
2$$  47  0 t
2$$  48  0 t
2$$  49  0 t
2$$  50  0 t
2$$  51  0 t
2$$  52  0 t
2$$  53  0 t
2$$  54  0 t
2$$  55  0 t
2$$  56  0 t
2$$  57  0 t
2$$  58  0 t
2$$  59  0 t
2$$  60  0 t
2$$  61  0 t
2$$  62  0 t
2$$  63  0 t
2$$  64  0 t
2$$  65  0 t
2$$  66  0 t
2$$  67  0 t
2$$  68  0 t
2$$  69  0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -fs ${RTNDIR}/irflib/irf_irf_mo92  ft30f001
ln -fs ${RTNDIR}/irflib/irf_irf_mo94  ft31f001
ln -fs ${RTNDIR}/irflib/irf_irf_mo95  ft32f001
ln -fs ${RTNDIR}/irflib/irf_irf_mo96  ft33f001
ln -fs ${RTNDIR}/irflib/irf_irf_mo97  ft34f001
ln -fs ${RTNDIR}/irflib/irf_irf_mo98  ft35f001
ln -fs ${RTNDIR}/irflib/irf_irf_mo99  ft36f001
ln -fs ${RTNDIR}/irflib/irf_irf_mo100  ft37f001
ln -fs ${RTNDIR}/irflib/irf_irf_tc99  ft38f001
ln -fs ${RTNDIR}/irflib/irf_irf_ru96  ft39f001
ln -fs ${RTNDIR}/irflib/irf_irf_ru98  ft40f001
ln -fs ${RTNDIR}/irflib/irf_irf_ru99  ft41f001
ln -fs ${RTNDIR}/irflib/irf_irf_ru100  ft42f001
ln -fs ${RTNDIR}/irflib/irf_irf_ru101  ft43f001
ln -fs ${RTNDIR}/irflib/irf_irf_ru102  ft44f001
ln -fs ${RTNDIR}/irflib/irf_irf_ru103  ft45f001
ln -fs ${RTNDIR}/irflib/irf_irf_ru104  ft46f001
ln -fs ${RTNDIR}/irflib/irf_irf_ru105  ft47f001
ln -fs ${RTNDIR}/irflib/irf_irf_ru106  ft48f001
ln -fs ${RTNDIR}/irflib/irf_irf_rh103  ft49f001
ln -fs ${RTNDIR}/irflib/irf_irf_rh105  ft50f001
ln -fs ${RTNDIR}/irflib/irf_irf_pd102  ft51f001
ln -fs ${RTNDIR}/irflib/irf_irf_pd104  ft52f001
ln -fs ${RTNDIR}/irflib/irf_irf_pd105  ft53f001
ln -fs ${RTNDIR}/irflib/irf_irf_pd106  ft54f001
ln -fs ${RTNDIR}/irflib/irf_irf_pd107  ft55f001
ln -fs ${RTNDIR}/irflib/irf_irf_pd108  ft56f001
ln -fs ${RTNDIR}/irflib/irf_irf_pd110  ft57f001
ln -fs ${RTNDIR}/irflib/irf_irf_ag107  ft58f001
ln -fs ${RTNDIR}/irflib/irf_irf_ag109  ft59f001
ln -fs ${RTNDIR}/irflib/irf_irf_ag110m1  ft60f001
ln -fs ${RTNDIR}/irflib/irf_irf_ag111  ft61f001
ln -fs ${RTNDIR}/irflib/irf_irf_cd106  ft62f001
ln -fs ${RTNDIR}/irflib/irf_irf_cd108  ft63f001
ln -fs ${RTNDIR}/irflib/irf_irf_cd110  ft64f001
ln -fs ${RTNDIR}/irflib/irf_irf_cd111  ft65f001
ln -fs ${RTNDIR}/irflib/irf_irf_cd112  ft66f001
ln -fs ${RTNDIR}/irflib/irf_irf_cd113  ft67f001
ln -fs ${RTNDIR}/irflib/irf_irf_cd114  ft68f001
ln -fs ${RTNDIR}/irflib/irf_irf_cd115m1  ft69f001
end
=ajax
-1$$ 9000000
0$$ 81 e
1$$ 41 t
2$$ 80 0 t
2$$  30  0 t
2$$  31  0 t
2$$  32  0 t
2$$  33  0 t
2$$  34  0 t
2$$  35  0 t
2$$  36  0 t
2$$  37  0 t
2$$  38  0 t
2$$  39  0 t
2$$  40  0 t
2$$  41  0 t
2$$  42  0 t
2$$  43  0 t
2$$  44  0 t
2$$  45  0 t
2$$  46  0 t
2$$  47  0 t
2$$  48  0 t
2$$  49  0 t
2$$  50  0 t
2$$  51  0 t
2$$  52  0 t
2$$  53  0 t
2$$  54  0 t
2$$  55  0 t
2$$  56  0 t
2$$  57  0 t
2$$  58  0 t
2$$  59  0 t
2$$  60  0 t
2$$  61  0 t
2$$  62  0 t
2$$  63  0 t
2$$  64  0 t
2$$  65  0 t
2$$  66  0 t
2$$  67  0 t
2$$  68  0 t
2$$  69  0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -fs ${RTNDIR}/irflib/irf_irf_cd116  ft30f001
ln -fs ${RTNDIR}/irflib/irf_irf_in113  ft31f001
ln -fs ${RTNDIR}/irflib/irf_irf_in115  ft32f001
ln -fs ${RTNDIR}/irflib/irf_irf_sn112  ft33f001
ln -fs ${RTNDIR}/irflib/irf_irf_sn113  ft34f001
ln -fs ${RTNDIR}/irflib/irf_irf_sn114  ft35f001
ln -fs ${RTNDIR}/irflib/irf_irf_sn115  ft36f001
ln -fs ${RTNDIR}/irflib/irf_irf_sn116  ft37f001
ln -fs ${RTNDIR}/irflib/irf_irf_sn117  ft38f001
ln -fs ${RTNDIR}/irflib/irf_irf_sn118  ft39f001
ln -fs ${RTNDIR}/irflib/irf_irf_sn119  ft40f001
ln -fs ${RTNDIR}/irflib/irf_irf_sn120  ft41f001
```

```
ln -fs ${RTNDIR}/irflib/irf_irf_sn122  ft42f001
ln -fs ${RTNDIR}/irflib/irf_irf_sn123  ft43f001
ln -fs ${RTNDIR}/irflib/irf_irf_sn124  ft44f001
ln -fs ${RTNDIR}/irflib/irf_irf_sn125  ft45f001
ln -fs ${RTNDIR}/irflib/irf_irf_sn126  ft46f001
ln -fs ${RTNDIR}/irflib/irf_irf_sb121  ft47f001
ln -fs ${RTNDIR}/irflib/irf_irf_sb123  ft48f001
ln -fs ${RTNDIR}/irflib/irf_irf_sb124  ft49f001
ln -fs ${RTNDIR}/irflib/irf_irf_sb125  ft50f001
ln -fs ${RTNDIR}/irflib/irf_irf_sb126  ft51f001
ln -fs ${RTNDIR}/irflib/irf_irf_te120  ft52f001
ln -fs ${RTNDIR}/irflib/irf_irf_te122  ft53f001
ln -fs ${RTNDIR}/irflib/irf_irf_te123  ft54f001
ln -fs ${RTNDIR}/irflib/irf_irf_te124  ft55f001
ln -fs ${RTNDIR}/irflib/irf_irf_te125  ft56f001
ln -fs ${RTNDIR}/irflib/irf_irf_te126  ft57f001
ln -fs ${RTNDIR}/irflib/irf_irf_te127m1  ft58f001
ln -fs ${RTNDIR}/irflib/irf_irf_te128  ft59f001
ln -fs ${RTNDIR}/irflib/irf_irf_te129m1  ft60f001
ln -fs ${RTNDIR}/irflib/irf_irf_te130  ft61f001
ln -fs ${RTNDIR}/irflib/irf_irf_te132  ft62f001
ln -fs ${RTNDIR}/irflib/irf_irf_i127  ft63f001
ln -fs ${RTNDIR}/irflib/irf_irf_i129  ft64f001
ln -fs ${RTNDIR}/irflib/irf_irf_i130  ft65f001
ln -fs ${RTNDIR}/irflib/irf_irf_i131  ft66f001
ln -fs ${RTNDIR}/irflib/irf_irf_i135  ft67f001
ln -fs ${RTNDIR}/irflib/irf_irf_xe123  ft68f001
ln -fs ${RTNDIR}/irflib/irf_irf_xe124  ft69f001
end
=ajax
-1$$ 9000000
0$$ 81 e
1$$ 41 t
2$$ 80 0 t
2$$  30  0 t
2$$  31  0 t
2$$  32  0 t
2$$  33  0 t
2$$  34  0 t
2$$  35  0 t
2$$  36  0 t
2$$  37  0 t
2$$  38  0 t
2$$  39  0 t
2$$  40  0 t
2$$  41  0 t
2$$  42  0 t
2$$  43  0 t
2$$  44  0 t
2$$  45  0 t
2$$  46  0 t
2$$  47  0 t
2$$  48  0 t
2$$  49  0 t
2$$  50  0 t
2$$  51  0 t
2$$  52  0 t
2$$  53  0 t
2$$  54  0 t
2$$  55  0 t
2$$  56  0 t
2$$  57  0 t
2$$  58  0 t
2$$  59  0 t
2$$  60  0 t
2$$  61  0 t
2$$  62  0 t
2$$  63  0 t
2$$  64  0 t
2$$  65  0 t
2$$  66  0 t
2$$  67  0 t
2$$  68  0 t
2$$  69  0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -fs ${RTNDIR}/irflib/irf_irf_xe126  ft30f001
ln -fs ${RTNDIR}/irflib/irf_irf_xe128  ft31f001
ln -fs ${RTNDIR}/irflib/irf_irf_xe129  ft32f001
ln -fs ${RTNDIR}/irflib/irf_irf_xe130  ft33f001
ln -fs ${RTNDIR}/irflib/irf_irf_xe131  ft34f001
ln -fs ${RTNDIR}/irflib/irf_irf_xe132  ft35f001
ln -fs ${RTNDIR}/irflib/irf_irf_xe133  ft36f001
ln -fs ${RTNDIR}/irflib/irf_irf_xe134  ft37f001
ln -fs ${RTNDIR}/irflib/irf_irf_xe135  ft38f001
ln -fs ${RTNDIR}/irflib/irf_irf_xe136  ft39f001
ln -fs ${RTNDIR}/irflib/irf_irf_cs133  ft40f001
ln -fs ${RTNDIR}/irflib/irf_irf_cs134  ft41f001
ln -fs ${RTNDIR}/irflib/irf_irf_cs135  ft42f001
ln -fs ${RTNDIR}/irflib/irf_irf_cs136  ft43f001
ln -fs ${RTNDIR}/irflib/irf_irf_cs137  ft44f001
ln -fs ${RTNDIR}/irflib/irf_irf_ba130  ft45f001
ln -fs ${RTNDIR}/irflib/irf_irf_ba132  ft46f001
ln -fs ${RTNDIR}/irflib/irf_irf_ba133  ft47f001
ln -fs ${RTNDIR}/irflib/irf_irf_ba134  ft48f001
ln -fs ${RTNDIR}/irflib/irf_irf_ba135  ft49f001
ln -fs ${RTNDIR}/irflib/irf_irf_ba136  ft50f001
ln -fs ${RTNDIR}/irflib/irf_irf_ba137  ft51f001
ln -fs ${RTNDIR}/irflib/irf_irf_ba138  ft52f001
ln -fs ${RTNDIR}/irflib/irf_irf_ba140  ft53f001
ln -fs ${RTNDIR}/irflib/irf_irf_la138  ft54f001
ln -fs ${RTNDIR}/irflib/irf_irf_la139  ft55f001
ln -fs ${RTNDIR}/irflib/irf_irf_la140  ft56f001
ln -fs ${RTNDIR}/irflib/irf_irf_ce136  ft57f001
ln -fs ${RTNDIR}/irflib/irf_irf_ce138  ft58f001
ln -fs ${RTNDIR}/irflib/irf_irf_ce139  ft59f001
ln -fs ${RTNDIR}/irflib/irf_irf_ce140  ft60f001
ln -fs ${RTNDIR}/irflib/irf_irf_ce141  ft61f001
ln -fs ${RTNDIR}/irflib/irf_irf_ce142  ft62f001
ln -fs ${RTNDIR}/irflib/irf_irf_ce143  ft63f001
ln -fs ${RTNDIR}/irflib/irf_irf_ce144  ft64f001
ln -fs ${RTNDIR}/irflib/irf_irf_pr141  ft65f001
ln -fs ${RTNDIR}/irflib/irf_irf_pr142  ft66f001
ln -fs ${RTNDIR}/irflib/irf_irf_pr143  ft67f001
ln -fs ${RTNDIR}/irflib/irf_irf_nd142  ft68f001
ln -fs ${RTNDIR}/irflib/irf_irf_nd143  ft69f001
end
=ajax
-1$$ 9000000
0$$ 81 e
1$$ 41 t
2$$ 80 0 t
2$$  30  0 t
2$$  31  0 t
2$$  32  0 t
2$$  33  0 t
2$$  34  0 t
2$$  35  0 t
2$$  36  0 t
2$$  37  0 t
2$$  38  0 t
2$$  39  0 t
2$$  40  0 t
2$$  41  0 t
2$$  42  0 t
2$$  43  0 t
2$$  44  0 t
2$$  45  0 t
2$$  46  0 t
2$$  47  0 t
2$$  48  0 t
2$$  49  0 t
2$$  50  0 t
2$$  51  0 t
2$$  52  0 t
2$$  53  0 t
2$$  54  0 t
2$$  55  0 t
2$$  56  0 t
2$$  57  0 t
2$$  58  0 t
2$$  59  0 t
2$$  60  0 t
2$$  61  0 t
2$$  62  0 t
2$$  63  0 t
2$$  64  0 t
2$$  65  0 t
2$$  66  0 t
2$$  67  0 t
2$$  68  0 t
2$$  69  0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -fs ${RTNDIR}/irflib/irf_irf_nd144  ft30f001
ln -fs ${RTNDIR}/irflib/irf_irf_nd145  ft31f001
ln -fs ${RTNDIR}/irflib/irf_irf_nd146  ft32f001
ln -fs ${RTNDIR}/irflib/irf_irf_nd147  ft33f001
ln -fs ${RTNDIR}/irflib/irf_irf_nd148  ft34f001
ln -fs ${RTNDIR}/irflib/irf_irf_nd150  ft35f001
ln -fs ${RTNDIR}/irflib/irf_irf_pm147  ft36f001
ln -fs ${RTNDIR}/irflib/irf_irf_pm148  ft37f001
ln -fs ${RTNDIR}/irflib/irf_irf_pm148m1  ft38f001
ln -fs ${RTNDIR}/irflib/irf_irf_pm149  ft39f001
ln -fs ${RTNDIR}/irflib/irf_irf_pm151  ft40f001
ln -fs ${RTNDIR}/irflib/irf_irf_sm144  ft41f001
ln -fs ${RTNDIR}/irflib/irf_irf_sm147  ft42f001
ln -fs ${RTNDIR}/irflib/irf_irf_sm148  ft43f001
ln -fs ${RTNDIR}/irflib/irf_irf_sm149  ft44f001
ln -fs ${RTNDIR}/irflib/irf_irf_sm150  ft45f001
ln -fs ${RTNDIR}/irflib/irf_irf_sm151  ft46f001
ln -fs ${RTNDIR}/irflib/irf_irf_sm152  ft47f001
ln -fs ${RTNDIR}/irflib/irf_irf_sm153  ft48f001
ln -fs ${RTNDIR}/irflib/irf_irf_sm154  ft49f001
ln -fs ${RTNDIR}/irflib/irf_irf_eu151  ft50f001
ln -fs ${RTNDIR}/irflib/irf_irf_eu152  ft51f001
ln -fs ${RTNDIR}/irflib/irf_irf_eu153  ft52f001
ln -fs ${RTNDIR}/irflib/irf_irf_eu154  ft53f001
ln -fs ${RTNDIR}/irflib/irf_irf_eu155  ft54f001
ln -fs ${RTNDIR}/irflib/irf_irf_eu156  ft55f001
```

```
ln -fs ${RTNDIR}/irflib/irf_irf_eu157  ft56f001
ln -fs ${RTNDIR}/irflib/irf_irf_gd152  ft57f001
ln -fs ${RTNDIR}/irflib/irf_irf_gd153  ft58f001
ln -fs ${RTNDIR}/irflib/irf_irf_gd154  ft59f001
ln -fs ${RTNDIR}/irflib/irf_irf_gd155  ft60f001
ln -fs ${RTNDIR}/irflib/irf_irf_gd156  ft61f001
ln -fs ${RTNDIR}/irflib/irf_irf_gd157  ft62f001
ln -fs ${RTNDIR}/irflib/irf_irf_gd158  ft63f001
ln -fs ${RTNDIR}/irflib/irf_irf_gd160  ft64f001
ln -fs ${RTNDIR}/irflib/irf_irf_tb159  ft65f001
ln -fs ${RTNDIR}/irflib/irf_irf_tb160  ft66f001
ln -fs ${RTNDIR}/irflib/irf_irf_dy156  ft67f001
ln -fs ${RTNDIR}/irflib/irf_irf_dy158  ft68f001
ln -fs ${RTNDIR}/irflib/irf_irf_dy160  ft69f001
end
=ajax
-1$$ 9000000
0$$ 81 e
1$$ 41 t
2$$ 80 0 t
2$$  30  0 t
2$$  31  0 t
2$$  32  0 t
2$$  33  0 t
2$$  34  0 t
2$$  35  0 t
2$$  36  0 t
2$$  37  0 t
2$$  38  0 t
2$$  39  0 t
2$$  40  0 t
2$$  41  0 t
2$$  42  0 t
2$$  43  0 t
2$$  44  0 t
2$$  45  0 t
2$$  46  0 t
2$$  47  0 t
2$$  48  0 t
2$$  49  0 t
2$$  50  0 t
2$$  51  0 t
2$$  52  0 t
2$$  53  0 t
2$$  54  0 t
2$$  55  0 t
2$$  56  0 t
2$$  57  0 t
2$$  58  0 t
2$$  59  0 t
2$$  60  0 t
2$$  61  0 t
2$$  62  0 t
2$$  63  0 t
2$$  64  0 t
2$$  65  0 t
2$$  66  0 t
2$$  67  0 t
2$$  68  0 t
2$$  69  0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -fs ${RTNDIR}/irflib/irf_irf_dy161  ft30f001
ln -fs ${RTNDIR}/irflib/irf_irf_dy162  ft31f001
ln -fs ${RTNDIR}/irflib/irf_irf_dy163  ft32f001
ln -fs ${RTNDIR}/irflib/irf_irf_dy164  ft33f001
ln -fs ${RTNDIR}/irflib/irf_irf_ho165  ft34f001
ln -fs ${RTNDIR}/irflib/irf_irf_ho166m1  ft35f001
ln -fs ${RTNDIR}/irflib/irf_irf_er162  ft36f001
ln -fs ${RTNDIR}/irflib/irf_irf_er164  ft37f001
ln -fs ${RTNDIR}/irflib/irf_irf_er166  ft38f001
ln -fs ${RTNDIR}/irflib/irf_irf_er167  ft39f001
ln -fs ${RTNDIR}/irflib/irf_irf_er168  ft40f001
ln -fs ${RTNDIR}/irflib/irf_irf_er170  ft41f001
ln -fs ${RTNDIR}/irflib/irf_irf_lu175  ft42f001
ln -fs ${RTNDIR}/irflib/irf_irf_lu176  ft43f001
ln -fs ${RTNDIR}/irflib/irf_irf_hf174  ft44f001
ln -fs ${RTNDIR}/irflib/irf_irf_hf176  ft45f001
ln -fs ${RTNDIR}/irflib/irf_irf_hf177  ft46f001
ln -fs ${RTNDIR}/irflib/irf_irf_hf178  ft47f001
ln -fs ${RTNDIR}/irflib/irf_irf_hf179  ft48f001
ln -fs ${RTNDIR}/irflib/irf_irf_hf180  ft49f001
ln -fs ${RTNDIR}/irflib/irf_irf_ta181  ft50f001
ln -fs ${RTNDIR}/irflib/irf_irf_ta182  ft51f001
ln -fs ${RTNDIR}/irflib/irf_irf_w182  ft52f001
ln -fs ${RTNDIR}/irflib/irf_irf_w183  ft53f001
ln -fs ${RTNDIR}/irflib/irf_irf_w184  ft54f001
ln -fs ${RTNDIR}/irflib/irf_irf_w186  ft55f001
ln -fs ${RTNDIR}/irflib/irf_irf_re185  ft56f001
ln -fs ${RTNDIR}/irflib/irf_irf_re187  ft57f001
ln -fs ${RTNDIR}/irflib/irf_irf_ir191  ft58f001
ln -fs ${RTNDIR}/irflib/irf_irf_ir193  ft59f001
ln -fs ${RTNDIR}/irflib/irf_irf_au197  ft60f001
ln -fs ${RTNDIR}/irflib/irf_irf_hg196  ft61f001
ln -fs ${RTNDIR}/irflib/irf_irf_hg198  ft62f001
ln -fs ${RTNDIR}/irflib/irf_irf_hg199  ft63f001
ln -fs ${RTNDIR}/irflib/irf_irf_hg200  ft64f001
ln -fs ${RTNDIR}/irflib/irf_irf_hg201  ft65f001
ln -fs ${RTNDIR}/irflib/irf_irf_hg202  ft66f001
ln -fs ${RTNDIR}/irflib/irf_irf_hg204  ft67f001
ln -fs ${RTNDIR}/irflib/irf_irf_pb204  ft68f001
ln -fs ${RTNDIR}/irflib/irf_irf_pb206  ft69f001
end
=ajax
-1$$ 9000000
0$$ 81 e
1$$ 41 t
2$$ 80 0 t
2$$  30  0 t
2$$  31  0 t
2$$  32  0 t
2$$  33  0 t
2$$  34  0 t
2$$  35  0 t
2$$  36  0 t
2$$  37  0 t
2$$  38  0 t
2$$  39  0 t
2$$  40  0 t
2$$  41  0 t
2$$  42  0 t
2$$  43  0 t
2$$  44  0 t
2$$  45  0 t
2$$  46  0 t
2$$  47  0 t
2$$  48  0 t
2$$  49  0 t
2$$  50  0 t
2$$  51  0 t
2$$  52  0 t
2$$  53  0 t
2$$  54  0 t
2$$  55  0 t
2$$  56  0 t
2$$  57  0 t
2$$  58  0 t
2$$  59  0 t
2$$  60  0 t
2$$  61  0 t
2$$  62  0 t
2$$  63  0 t
2$$  64  0 t
2$$  65  0 t
2$$  66  0 t
2$$  67  0 t
2$$  68  0 t
2$$  69  0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -fs ${RTNDIR}/irflib/irf_irf_pb207  ft30f001
ln -fs ${RTNDIR}/irflib/irf_irf_pb208  ft31f001
ln -fs ${RTNDIR}/irflib/irf_irf_bi209  ft32f001
ln -fs ${RTNDIR}/irflib/irf_irf_ra223  ft33f001
ln -fs ${RTNDIR}/irflib/irf_irf_ra224  ft34f001
ln -fs ${RTNDIR}/irflib/irf_irf_ra225  ft35f001
ln -fs ${RTNDIR}/irflib/irf_irf_ra226  ft36f001
ln -fs ${RTNDIR}/irflib/irf_irf_ac225  ft37f001
ln -fs ${RTNDIR}/irflib/irf_irf_ac226  ft38f001
ln -fs ${RTNDIR}/irflib/irf_irf_ac227  ft39f001
ln -fs ${RTNDIR}/irflib/irf_irf_th227  ft40f001
ln -fs ${RTNDIR}/irflib/irf_irf_th228  ft41f001
ln -fs ${RTNDIR}/irflib/irf_irf_th229  ft42f001
ln -fs ${RTNDIR}/irflib/irf_irf_th230  ft43f001
ln -fs ${RTNDIR}/irflib/irf_irf_th232  ft44f001
ln -fs ${RTNDIR}/irflib/irf_irf_th233  ft45f001
ln -fs ${RTNDIR}/irflib/irf_irf_th234  ft46f001
ln -fs ${RTNDIR}/irflib/irf_irf_pa231  ft47f001
ln -fs ${RTNDIR}/irflib/irf_irf_pa232  ft48f001
ln -fs ${RTNDIR}/irflib/irf_irf_pa233  ft49f001
ln -fs ${RTNDIR}/irflib/irf_irf_u232  ft50f001
ln -fs ${RTNDIR}/irflib/irf_irf_u233  ft51f001
ln -fs ${RTNDIR}/irflib/irf_irf_u234  ft52f001
ln -fs ${RTNDIR}/irflib/irf_irf_u235  ft53f001
ln -fs ${RTNDIR}/irflib/irf_irf_u236  ft54f001
ln -fs ${RTNDIR}/irflib/irf_irf_u237  ft55f001
ln -fs ${RTNDIR}/irflib/irf_irf_u238  ft56f001
ln -fs ${RTNDIR}/irflib/irf_irf_u239  ft57f001
ln -fs ${RTNDIR}/irflib/irf_irf_u240  ft58f001
ln -fs ${RTNDIR}/irflib/irf_irf_u241  ft59f001
ln -fs ${RTNDIR}/irflib/irf_irf_np235  ft60f001
ln -fs ${RTNDIR}/irflib/irf_irf_np236  ft61f001
ln -fs ${RTNDIR}/irflib/irf_irf_np237  ft62f001
ln -fs ${RTNDIR}/irflib/irf_irf_np238  ft63f001
ln -fs ${RTNDIR}/irflib/irf_irf_np239  ft64f001
ln -fs ${RTNDIR}/irflib/irf_irf_pu236  ft65f001
ln -fs ${RTNDIR}/irflib/irf_irf_pu237  ft66f001
ln -fs ${RTNDIR}/irflib/irf_irf_pu238  ft67f001
ln -fs ${RTNDIR}/irflib/irf_irf_pu239  ft68f001
ln -fs ${RTNDIR}/irflib/irf_irf_pu240  ft69f001
```

```
end
=ajax
-1$$ 9000000
0$$ 81 e
1$$ 41 t
2$$ 80 0 t
2$$  30  0 t
2$$  31  0 t
2$$  32  0 t
2$$  33  0 t
2$$  34  0 t
2$$  35  0 t
2$$  36  0 t
2$$  37  0 t
2$$  38  0 t
2$$  39  0 t
2$$  40  0 t
2$$  41  0 t
2$$  42  0 t
2$$  43  0 t
2$$  44  0 t
2$$  45  0 t
2$$  46  0 t
2$$  47  0 t
2$$  48  0 t
2$$  49  0 t
2$$  50  0 t
2$$  51  0 t
2$$  52  0 t
2$$  53  0 t
2$$  54  0 t
2$$  55  0 t
2$$  56  0 t
2$$  57  0 t
2$$  58  0 t
2$$  59  0 t
2$$  60  0 t
2$$  61  0 t
2$$  62  0 t
2$$  63  0 t
2$$  64  0 t
2$$  65  0 t
2$$  66  0 t
2$$  67  0 t
2$$  68  0 t
2$$  69  0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -fs ${RTNDIR}/irflib/irf_irf_pu241  ft30f001
ln -fs ${RTNDIR}/irflib/irf_irf_pu242  ft31f001
ln -fs ${RTNDIR}/irflib/irf_irf_pu243  ft32f001
ln -fs ${RTNDIR}/irflib/irf_irf_pu244  ft33f001
ln -fs ${RTNDIR}/irflib/irf_irf_pu246  ft34f001
ln -fs ${RTNDIR}/irflib/irf_irf_am241  ft35f001
ln -fs ${RTNDIR}/irflib/irf_irf_am242  ft36f001
ln -fs ${RTNDIR}/irflib/irf_irf_am242m1  ft37f001
ln -fs ${RTNDIR}/irflib/irf_irf_am243  ft38f001
ln -fs ${RTNDIR}/irflib/irf_irf_am244  ft39f001
ln -fs ${RTNDIR}/irflib/irf_irf_am244m1  ft40f001
ln -fs ${RTNDIR}/irflib/irf_irf_cm241  ft41f001
ln -fs ${RTNDIR}/irflib/irf_irf_cm242  ft42f001
ln -fs ${RTNDIR}/irflib/irf_irf_cm243  ft43f001
ln -fs ${RTNDIR}/irflib/irf_irf_cm244  ft44f001
ln -fs ${RTNDIR}/irflib/irf_irf_cm245  ft45f001
ln -fs ${RTNDIR}/irflib/irf_irf_cm246  ft46f001
ln -fs ${RTNDIR}/irflib/irf_irf_cm247  ft47f001
ln -fs ${RTNDIR}/irflib/irf_irf_cm248  ft48f001
ln -fs ${RTNDIR}/irflib/irf_irf_cm249  ft49f001
ln -fs ${RTNDIR}/irflib/irf_irf_cm250  ft50f001
ln -fs ${RTNDIR}/irflib/irf_irf_bk249  ft51f001
ln -fs ${RTNDIR}/irflib/irf_irf_bk250  ft52f001
ln -fs ${RTNDIR}/irflib/irf_irf_cf249  ft53f001
ln -fs ${RTNDIR}/irflib/irf_irf_cf250  ft54f001
ln -fs ${RTNDIR}/irflib/irf_irf_cf251  ft55f001
ln -fs ${RTNDIR}/irflib/irf_irf_cf252  ft56f001
ln -fs ${RTNDIR}/irflib/irf_irf_cf253  ft57f001
ln -fs ${RTNDIR}/irflib/irf_irf_cf254  ft58f001
ln -fs ${RTNDIR}/irflib/irf_irf_es253  ft59f001
ln -fs ${RTNDIR}/irflib/irf_irf_es254  ft60f001
ln -fs ${RTNDIR}/irflib/irf_irf_es255  ft61f001
ln -fs ${RTNDIR}/irflib/irf_irf_fm255  ft62f001
end
=ajax
-1$$ 9000000
0$$ 81 e
1$$ 34 t
2$$ 80 0 t
2$$  30  0 t
2$$  31  0 t
2$$  32  0 t
2$$  33  0 t
2$$  34  0 t
2$$  35  0 t
2$$  36  0 t
2$$  37  0 t
2$$  38  0 t
2$$  39  0 t
2$$  40  0 t
2$$  41  0 t
2$$  42  0 t
2$$  43  0 t
2$$  44  0 t
2$$  45  0 t
2$$  46  0 t
2$$  47  0 t
2$$  48  0 t
2$$  49  0 t
2$$  50  0 t
2$$  51  0 t
2$$  52  0 t
2$$  53  0 t
2$$  54  0 t
2$$  55  0 t
2$$  56  0 t
2$$  57  0 t
2$$  58  0 t
2$$  59  0 t
2$$  60  0 t
2$$  61  0 t
2$$  62  0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/irflib/irf_irf_al27_al27 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/irflib/irf_irf_fe56_fe54 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/irflib/irf_irf_fe56_fe56 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/irflib/irf_irf_fe56_fe57 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/irflib/irf_irf_fe56_fe58 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
```

```
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/irflib/irf_irf_be_metal_be9 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/irflib/irf_irf_be_beo_be9 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/irflib/irf_irf_be_beo_o16 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/irflib/irf_irf_d_d2o_h2 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/irflib/irf_irf_h_ch2_h1 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/irflib/irf_irf_h_h2o_h1 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/irflib/irf_irf_h_zrh_h1 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/irflib/irf_irf_o_beo_be9 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/irflib/irf_irf_o_beo_c ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/irflib/irf_irf_o_uo2_o16 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/irflib/irf_irf_o_uo2_u232 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/irflib/irf_irf_o_uo2_u233 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/irflib/irf_irf_o_uo2_u234 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
```

```
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/irflib/irf_irf_o_uo2_u235 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/irflib/irf_irf_o_uo2_u236 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/irflib/irf_irf_o_uo2_u237 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/irflib/irf_irf_o_uo2_u238 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/irflib/irf_irf_o_uo2_u239 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/irflib/irf_irf_o_uo2_u240 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/irflib/irf_irf_o_uo2_u241 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/irflib/irf_irf_u_uo2_c ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/irflib/irf_irf_u_uo2_u232 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/irflib/irf_irf_u_uo2_u233 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/irflib/irf_irf_u_uo2_u234 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/irflib/irf_irf_u_uo2_u235 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/irflib/irf_irf_u_uo2_u236 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/irflib/irf_irf_u_uo2_u237 ft30f001
end
=ajax
```

```
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/irflib/irf_irf_u_uo2_u238 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/irflib/irf_irf_u_uo2_u239 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/irflib/irf_irf_u_uo2_u240 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/irflib/irf_irf_u_uo2_u241 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/irflib/irf_irf_zr_zrh_zr90 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/irflib/irf_irf_zr_zrh_zr91 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/irflib/irf_irf_zr_zrh_zr92 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/irflib/irf_irf_zr_zrh_zr93 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/irflib/irf_irf_zr_zrh_zr94 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/irflib/irf_irf_zr_zrh_zr95 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/irflib/irf_irf_zr_zrh_zr96 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/irflib/irf_irf_benzine_h1 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/irflib/irf_irf_benzine_c ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
```

```
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/irflib/irf_irf_graphite_c ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/irflib/irf_irf_l_ch4_h1 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/irflib/irf_irf_ortho_d_h2 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/irflib/irf_irf_ortho_h_h1 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/irflib/irf_irf_para_d_h2 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/irflib/irf_irf_para_h_h1 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
rm -f ft*
ln -sf ajaxTemp ft80f001
ln -sf  ${RTNDIR}/irflib/irf_irf_s_ch4_h1 ft30f001
end
=ajax
-1$$ 5000000
0$$ 81 e
1$$ 2  t
2$$ 80 0 t
2$$ 30 0 t
end
=shell
mv ft81f001 ajaxTemp
end
=shell
ln -sf ajaxTemp ft80f001
end
=ajax
-1$$ 5000000
0$$ 91 e
1$$ 1  t
2$$ 80 0 t
the endf/b7.0 ampx 51g 4.2m1 library 01
Generated with AMPX code system
end
=shell
cp ft91f001 ${RTNDIR}/ampx51g_70_4.2m1_01.bin
end
```

APPENDIX A.5. INPUT FILES TO GENERATE HETEROGENEOUS F-FACTORS FOR ^{235}U

[IRFFACTOR input]

```
' ------------------------------------------------------------------------------
' Heterogeneous irffactor for U-235 :: multiple absorber ENDF/B-VII.0
' ------------------------------------------------------------------------------
=shell
ln -sf $RTNDIR/../cases/U235-HetCases.inp het_input
ln -sf /home/ykk/libraries/endf7.0/mg/51g19g_07/0_ampx/ampx51g_70_4.2m1_01.bin  ft88f001
end

=irffactor
 in=88 out=92 fnuc=92235 medit=3 essm=yes nterp=1
 absopt=0  mopt=3 removal=yes  iter=no
 cellfil="het_input"
 ehres=2.25000E+03
 subgrxs= 1.0 5.0 10.0 50.0 100.0 500.0 1000.0 5000.0 10000.0 20000.0  end
end

=shell
mv  ft92f001 $RTNDIR/U235_ffactors_lev_m
mv  subgrpdata $RTNDIR/subgrpdata_U235_lev_m
end
```

[CENTRM cell models]

```
=csas1x  parm=centrm
hetrocells to compute f-factors of U-235;
 ft88f001
read composition

'
' ***CELL-1 Composition
'
u-235 1  0  9.39467E-02  293  end
u-238 1  0  2.22624E-02  293  end
o-16  1  0  4.64223E-02  293  end
al-27 2  0  6.02611E-02  293  end
h-1   3  0  1.17827E-04  293  end
o-16  3  0  5.89135E-05  293  end

'
' ***CELL-2 Composition
'
u-235 4  0  2.81840E-02  293  end
u-238 4  0  2.22624E-02  293  end
o-16  4  0  4.64223E-02  293  end
al-27 5  0  6.02611E-02  293  end
h-1   6  0  1.17827E-04  293  end
o-16  6  0  5.89135E-05  293  end

'
' ***CELL-3 Composition
'
u-235 7  0  9.39467E-03  293  end
u-238 7  0  2.22624E-02  293  end
o-16  7  0  4.64223E-02  293  end
al-27 8  0  6.02611E-02  293  end
h-1   9  0  1.17827E-04  293  end
o-16  9  0  5.89135E-05  293  end

'
' ***CELL-4 Composition
'
u-235 10  0  2.81840E-03  293  end
u-238 10  0  2.22624E-02  293  end
```

```
o-16  10  0  4.64223E-02  293  end
al-27 11  0  6.02611E-02  293  end
h-1   12  0  1.17827E-04  293  end
o-16  12  0  5.89135E-05  293  end

'
' ***CELL-5 Composition
'
u-235 13  0  9.39467E-04  293  end
u-238 13  0  2.22624E-02  293  end
o-16  13  0  4.64223E-02  293  end
al-27 14  0  6.02611E-02  293  end
h-1   15  0  1.17827E-04  293  end
o-16  15  0  5.89135E-05  293  end

'
' ***CELL-6 Composition
'
u-235 16  0  9.39467E-04  293  end
u-238 16  0  2.22624E-02  293  end
o-16  16  0  4.64223E-02  293  end
al-27 17  0  6.02611E-02  293  end
h-1   18  0  9.42618E-03  293  end
o-16  18  0  4.71308E-03  293  end

'
' ***CELL-7 Composition
'
u-235 19  0  9.39467E-04  293  end
u-238 19  0  2.22624E-02  293  end
o-16  19  0  4.64223E-02  293  end
al-27 20  0  6.02611E-02  293  end
h-1   21  0  2.35655E-02  293  end
o-16  21  0  1.17827E-02  293  end

'
' ***CELL-8 Composition
'
u-235 22  0  9.39467E-04   293  end
u-238 22  0  2.22624E-02   293  end
o-16  22  0  4.64223E-02   293  end
al-27 23  0  6.02611E-02   293  end
h-1   24  0  3.53482E-02   293  end
o-16  24  0  1.76741E-02   293  end

'
' ***CELL-9 Composition
'
u-235 25  0  9.39467E-04   293  end
u-238 25  0  2.22624E-02   293  end
o-16  25  0  4.64223E-02   293  end
al-27 26  0  6.02611E-02   293  end
h-1   27  0  4.71309E-02   293  end
o-16  27  0  2.35654E-02   293  end

'
' ***CELL-10 Composition
'
u-235 28  0  9.39467E-04   293  end
u-238 28  0  2.22624E-02   293  end
o-16  28  0  4.64223E-02   293  end
al-27 29  0  6.02611E-02   293  end
h-1   30  0  4.71309E-02   293  end
o-16  30  0  2.35654E-02   293  end

'
' ***CELL-11 Composition
'
u-235 31  0  9.39467E-04   293  end
u-238 31  0  2.22624E-02   293  end
o-16  31  0  4.64223E-02   293  end
al-27 32  0  6.02611E-02   293  end
h-1   33  0  4.71309E-02   293  end
o-16  33  0  2.35654E-02   293  end
```

```
'
' ***CELL-12 Composition
'
u-235 34  0  4.69734E-04   293  end
u-238 34  0  1.11312E-02   293  end
o-16  34  0  2.32112E-02   293  end
al-27 35  0  6.02611E-02   293  end
h-1   36  0  4.71309E-02   293  end
o-16  36  0  2.35654E-02   293  end

'
' ***CELL-13 Composition
'
u-235 37  0  2.34867E-04   293  end
u-238 37  0  5.56560E-03   293  end
o-16  37  0  1.16056E-02   293  end
al-27 38  0  6.02611E-02   293  end
h-1   39  0  4.71309E-02   293  end
o-16  39  0  2.35654E-02   293  end

'
' ***CELL-14 Composition
'
u-235 40  0  1.17433E-04   293  end
u-238 40  0  2.78280E-03   293  end
o-16  40  0  5.80279E-03   293  end
al-27 41  0  6.02611E-02   293  end
h-1   42  0  4.71309E-02   293  end
o-16  42  0  2.35654E-02   293  end

'
' ***CELL-15 Composition
'
u-235 43  0  5.87167E-05   293  end
u-238 43  0  1.39140E-03   293  end
o-16  43  0  2.90139E-03   293  end
al-27 44  0  6.02611E-02   293  end
h-1   45  0  4.71309E-02   293  end
o-16  45  0  2.35654E-02   293  end

'
' ***CELL-16 Composition
'
u-235 46  0  2.93583E-05   293  end
u-238 46  0  6.95700E-04   293  end
o-16  46  0  1.45070E-03   293  end
al-27 47  0  6.02611E-02   293  end
h-1   48  0  4.71309E-02   293  end
o-16  48  0  2.35654E-02   293  end

'
' ***CELL-17 Composition
'
u-235 49  0  9.39467E-06   293  end
u-238 49  0  2.22624E-04   293  end
o-16  49  0  4.64223E-04   293  end
al-27 50  0  6.02611E-02   293  end
h-1   51  0  4.71309E-02   293  end
o-16  51  0  2.35654E-02   293  end

'
' ***CELL-18 Composition
'
u-235 52  0  9.39467E-07   293  end
u-238 52  0  2.22624E-04   293  end
o-16  52  0  4.64223E-04   293  end
al-27 53  0  6.02611E-02   293  end
h-1   54  0  4.71309E-02   293  end
o-16  54  0  2.35654E-02   293  end

'
' ***CELL-19 Composition
'
u-235 55  0  9.39467E-09   293  end
u-238 55  0  2.22624E-04   293  end
```

```
o-16  55  0  4.64223E-04   293  end
al-27 56  0  6.02611E-02   293  end
h-1   57  0  4.71309E-02   293  end
o-16  57  0  2.35654E-02   293  end

'
' ***CELL-20 Composition
'
u-235 58  0  9.39467E-11   293  end
u-238 58  0  2.22624E-04   293  end
o-16  58  0  4.64223E-04   293  end
al-27 59  0  6.02611E-02   293  end
h-1   60  0  4.71309E-02   293  end
o-16  60  0  2.35654E-02   293  end

'
' ***CELL-21 Composition (infinitely dilute; Homo mixture)
'
u-235 70 0  1.0e-12    293  end
u-238 70 0  0.022262   293  end
o-16  70 0  0.046422   293  end
al-27 70 0  0.060262   293  end
h-1   70 0  4.4183E-02 293  end
o-16  70 0  2.2095E-02 293  end
'-------------------------------------------------------

end composition

read celldata

'
' ***CELL-1 Geometry
 latticecell  squarepitch  pitch=1.2620 3 fuelr=0.4025 1
              cladr=0.4759 2   end
 centrmdata   demin=.0001  demax=9.E3 iup=15 npxs=6 end centrmdata

'
' ***CELL-2 Geometry
 latticecell  squarepitch  pitch=1.2620 6 fuelr=0.4025 4
              cladr=0.4759 5   end
 centrmdata   demin=.0001  demax=9.E3 iup=15 npxs=6 end centrmdata

'
' ***CELL-3 Geometry
 latticecell  squarepitch  pitch=1.2620 9 fuelr=0.4025 7
              cladr=0.4759 8   end
 centrmdata   demin=.0001  demax=9.E3 iup=15 npxs=6 end centrmdata

'
' ***CELL-4 Geometry
 latticecell  squarepitch  pitch=1.2620 12 fuelr=0.4025 10
              cladr=0.4759 11   end
 centrmdata   demin=.0001  demax=9.E3 iup=15 npxs=6 end centrmdata

'
' ***CELL-5 Geometry
 latticecell  squarepitch  pitch=1.2620 15 fuelr=0.4025 13
              cladr=0.4759 14   end
 centrmdata   demin=.0001  demax=9.E3 iup=15 npxs=6 end centrmdata

'
' ***CELL-6 Geometry
 latticecell  squarepitch  pitch=1.2620 18  fuelr=0.4025 16
              cladr=0.4759 17   end
 centrmdata   demin=.0001  demax=9.E3 iup=15 npxs=6 end centrmdata

'
' ***CELL-7 Geometry
 latticecell  squarepitch  pitch=1.2620 21  fuelr=0.4025 19
              cladr=0.4759 20   end
 centrmdata   demin=.0001  demax=9.E3 iup=15 npxs=6 end centrmdata

'
' ***CELL-8 Geometry
 latticecell  squarepitch  pitch=1.2620 24  fuelr=0.4025 22
```

```
             cladr=0.4759 23   end
 centrmdata  demin=.0001  demax=9.E3 iup=15 npxs=6 end centrmdata

'
' ***CELL-9 Geometry
 latticecell  squarepitch  pitch=1.2620 27  fuelr=0.4025 25
             cladr=0.4759 26   end
 centrmdata  demin=.0001  demax=9.E3 iup=15 npxs=6 end centrmdata

'
' ***CELL-10 Geometry
 latticecell  squarepitch  pitch=1.5728 30  fuelr=0.4025 28
             cladr=0.4759 29   end
 centrmdata  demin=.0001  demax=9.E3 iup=15 npxs=6 end centrmdata

'
' ***CELL-11 Geometry
 latticecell  squarepitch  pitch=2.2621 33  fuelr=0.4025 31
             cladr=0.4759 32   end
 centrmdata  demin=.0001  demax=9.E3 iup=15 npxs=6 end centrmdata

'
' ***CELL-12 Geometry
 latticecell  squarepitch  pitch=2.2621 36 fuelr=0.4025 34
             cladr=0.4759 35   end
 centrmdata  demin=.0001  demax=9.E3 iup=15 npxs=6 end centrmdata

'
' ***CELL-13 Geometry
 latticecell  squarepitch  pitch=2.2621 39  fuelr=0.4025 37
             cladr=0.4759 38   end
 centrmdata  demin=.0001  demax=9.E3 iup=15 npxs=6 end centrmdata

'
' ***CELL-14 Geometry
 latticecell  squarepitch  pitch=2.2621 42  fuelr=0.4025 40
             cladr=0.4759 41   end
 centrmdata  demin=.0001  demax=9.E3 iup=15 npxs=6 end centrmdata

'
' ***CELL-15 Geometry
 latticecell  squarepitch  pitch=2.2621 45  fuelr=0.4025 43
             cladr=0.4759 44   end
 centrmdata  demin=.0001  demax=9.E3 iup=15 npxs=6 end centrmdata

'
' ***CELL-16 Geometry
 latticecell  squarepitch  pitch=2.2621 48  fuelr=0.4025 46
             cladr=0.4759 47   end
 centrmdata  demin=.0001  demax=9.E3 iup=15 npxs=6 end centrmdata

'
' ***CELL-17 Geometry
 latticecell  squarepitch  pitch=2.2621 51  fuelr=0.4025 49
             cladr=0.4759 50   end
 centrmdata  demin=.0001  demax=9.E3 iup=15 npxs=6 end centrmdata

'
' ***CELL-18 Geometry
 latticecell  squarepitch  pitch=2.2621 54 fuelr=0.4025 52
             cladr=0.4759 53   end
 centrmdata  demin=.0001  demax=9.E3 iup=15 npxs=6 end centrmdata

'
' ***CELL-19 Geometry
 latticecell  squarepitch  pitch=2.2621 57  fuelr=0.4025 55
             cladr=0.4759 56   end
 centrmdata  demin=.0001  demax=9.E3 iup=15 npxs=6 end centrmdata

'
' ***CELL-20 Geometry
 latticecell  squarepitch  pitch=2.2621 60  fuelr=0.4025 58
             cladr=0.4759 59   end
 centrmdata  demin=.0001  demax=9.E3 iup=15 npxs=6 end centrmdata
```

```
'
' ***CELL-21 Geometry (infinitely dilute; Homo mixture)
infhommedium  70   end
 centrmdata  demin=.0001  demax=9.E3 iup=15 end centrmdata

'-------------------------------------------------------
end celldata

end
```

APPENDIX A.6. INPUT FILE TO GENERATE THE THIRD AMPX 51-G LIBRARY

```
=shell
ln -sf /home/ykk/libraries/endf7.0/mg/51g19g_07m2/0_ampx/ampx51g_70_4.2m2_01.bin  ft82f001
ln -sf /home/ykk/libraries/endf7.0/mg/51g19g_07/1_ffactor_het/single/Ag107_ffactors_s         ft61f001
ln -sf /home/ykk/libraries/endf7.0/mg/51g19g_07/1_ffactor_het/multiple/Ag109_ffactors_s       ft62f001
ln -sf /home/ykk/libraries/endf7.0/mg/51g19g_07/1_ffactor_het/multiple/Cd113_ffactors_s       ft63f001
ln -sf /home/ykk/libraries/endf7.0/mg/51g19g_07/1_ffactor_het/multiple/In113_ffactors_s       ft64f001
ln -sf /home/ykk/libraries/endf7.0/mg/51g19g_07/1_ffactor_het/multiple/In115_ffactors_s       ft65f001
ln -sf /home/ykk/libraries/endf7.0/mg/51g19g_07/1_ffactor_het/multiple/Gd155_ffactors_lev_m   ft66f001
ln -sf /home/ykk/libraries/endf7.0/mg/51g19g_07/1_ffactor_het/multiple/Gd156_ffactors_lev_m   ft67f001
ln -sf /home/ykk/libraries/endf7.0/mg/51g19g_07/1_ffactor_het/multiple/Gd157_ffactors_lev_m   ft68f001
ln -sf /home/ykk/libraries/endf7.0/mg/51g19g_07/1_ffactor_het/multiple/Gd158_ffactors_lev_m   ft69f001
ln -sf /home/ykk/libraries/endf7.0/mg/51g19g_07/1_ffactor_het/multiple/Th232_ffactors_lev_m   ft70f001
ln -sf /home/ykk/libraries/endf7.0/mg/51g19g_07/1_ffactor_het/multiple/U233_ffactors_lev_m    ft71f001
ln -sf /home/ykk/libraries/endf7.0/mg/51g19g_07/1_ffactor_het/multiple/U235_ffactors_lev_m    ft72f001
ln -sf /home/ykk/libraries/endf7.0/mg/51g19g_07/1_ffactor_het/multiple/U236_ffactors_lev_m    ft73f001
ln -sf /home/ykk/libraries/endf7.0/mg/51g19g_07/1_ffactor_het/single/U238_ffactors_lev_s      ft74f001
ln -sf /home/ykk/libraries/endf7.0/mg/51g19g_07/1_ffactor_het/multiple/Pu238_ffactors_lev_m_r1   ft75f001
ln -sf /home/ykk/libraries/endf7.0/mg/51g19g_07/1_ffactor_het/multiple/Pu239_ffactors_lev_m   ft76f001
ln -sf /home/ykk/libraries/endf7.0/mg/51g19g_07/1_ffactor_het/multiple/Pu240_ffactors_lev_m   ft77f001
ln -sf /home/ykk/libraries/endf7.0/mg/51g19g_07/1_ffactor_het/multiple/Pu241_ffactors_lev_m   ft78f001
ln -sf /home/ykk/libraries/endf7.0/mg/51g19g_07/1_ffactor_het/multiple/Pu242_ffactors_lev_m   ft79f001
ln -sf /home/ykk/libraries/endf7.0/mg/51g19g_07/1_ffactor_het/multiple/Am241_ffactors_lev_m   ft80f001
end

=ajax
-1$$ 9000000
0$$  88 0 e
1$$  21 t

' copy everything but  Ag107,Ag109,Cd113,In113,In115,
'                      Gd155,Gd156,Gd157,Gd158,Th232,
'                      U233, U235, U236, U238, Pu238,
'                      Pu239,Pu240,Pu241,Pu242,Am241,

2$$  82 -20 t
3$$  47107  47109  48113  49113  49115
     64155  64156  64157  64158  90232
     92233  92235  92236  92238  94238
     94239  94240  94241  94242  95241  t

' add  Ag107 with het f-ractors
2$$   61  1   t
3$$   47107   t

' add  Ag109 with het f-ractors
2$$   62  1   t
3$$   47109   t

' add  Cd113 with het f-ractors
2$$   63  1   t
3$$   48113   t

' add  In113 with het f-ractors
2$$   64  1   t
3$$   49113   t

' add  In115 with het f-ractors
2$$   65  1   t
3$$   49115   t

' add  Gd155 with het f-ractors
2$$   66  1   t
3$$   64155   t

' add  Gd156 with het f-ractors
2$$   67  1   t
3$$   64156   t

' add  Gd157 with het f-ractors
2$$   68  1   t
3$$   64157   t

' add  Gd158 with het f-ractors
2$$   69  1   t
3$$   64158   t

' add  Th232 with het f-ractors
 2$$   70  1   t
 3$$   90232   t
```

```
' add  U233  with het f-ractors
2$$   71  1   t
3$$   92233   t

' add  U235  with het f-ractors
2$$   72  1   t
3$$   92235   t

' add  U236  with het f-ractors
2$$   73  1   t
3$$   92236   t

' add  U238  with het f-ractors
2$$   74  1   t
3$$   92238   t

' add  Pu238 with het f-ractors
2$$   75  1   t
3$$   94238   t

' add  Pu239 with het f-ractors
2$$   76  1   t
3$$   94239   t

' add  Pu240 with het f-ractors
2$$   77  1   t
3$$   94240   t

' add  Pu241 with het f-ractors
2$$   78  1   t
3$$   94241   t

' add  Pu242 with het f-ractors
2$$   79  1   t
3$$   94242   t

' add  Am241 with het f-ractors
2$$   80  1   t
3$$   95241   t

end
=shell
mv ft88f001  $RTNDIR/ampx51g_70_4.2m2_02.bin
end


=shell
ln -sf /home/ykk/libraries/endf7.0/mg/51g19g_07m2/1_ffactor_het/ampx51g_70_4.2m2_02.bin  ft82f001
ln -sf /home/ykk/libraries/endf7.0/mg/51g19g_07m4/1_ffactor_het_er167/multiple/Er167_ffactors_lev_m  ft61f001
end

=ajax
-1$$ 9000000
0$$  88 0 e
1$$  2 t

' copy everything but  Er167

2$$   82 -1   t
3$$   68167   t

' add  Er167 with het f-ractors
2$$   61  1   t
3$$   68167   t

end
=shell
mv ft88f001  $RTNDIR/ampx51g_70_4.2m5_03.bin
end
```

APPENDIX B.1. THE FF2RI AND SUBGR INPUT FILE AND STANDARD SUBGROUP LEVEL FILE

[FF2RI input file]

```
$F2R
  OPT  F      !BIG ENDIAN
  AMP  ampx51g_70_4.2m2_02_OLD.bin
  PRT  ALL
  NUC  1  64155   '../1_ffactor_het/multiple/subgrpdata_Gd155_lev_m'
  NUC  2  64156   '../1_ffactor_het/multiple/subgrpdata_Gd156_lev_m'
  NUC  3  64157   '../1_ffactor_het/multiple/subgrpdata_Gd157_lev_m'
  NUC  4  64158   '../1_ffactor_het/multiple/subgrpdata_Gd158_lev_m'
  NUC  5  90232   '../1_ffactor_het/multiple/subgrpdata_Th232_lev_m'
  NUC  6  92233   '../1_ffactor_het/multiple/subgrpdata_U233_lev_m'
  NUC  7  92235   '../1_ffactor_het/multiple/subgrpdata_U235_lev_m'
  NUC  8  92236   '../1_ffactor_het/multiple/subgrpdata_U236_lev_m'
  NUC  9  92238   '../1_ffactor_het/single/subgrpdata_U238_lev_s'
  NUC 10  94238   '../1_ffactor_het/multiple/subgrpdata_Pu238_lev_m'
  NUC 11  94239   '../1_ffactor_het/multiple/subgrpdata_Pu239_lev_m'
  NUC 12  94240   '../1_ffactor_het/multiple/subgrpdata_Pu240_lev_m'
  NUC 13  94241   '../1_ffactor_het/multiple/subgrpdata_Pu241_lev_m'
  NUC 14  94242   '../1_ffactor_het/multiple/subgrpdata_Pu242_lev_m'
  NUC 15  95241   '../1_ffactor_het/multiple/subgrpdata_Am241_lev_m'
$END
```

[SUBGR input file]

```
%TITL
  SUBGROUP DATA GENERATION
%IOPT
  iop  0         !0/1/2: constant/variable(RI)/variable(sig)
  con  0.01 0.001 0.001
  grp   1  51
%FILE
  sub  SUBGR_51G_70.LEV
  rit  SSXS_51G_70_08082016.DAT
%RESO
    nuc     1    40091   0   1  !
    nuc     2    40096   0   1  !
    nuc     3    42095   0   1  !
    nuc     4    43099   0   1  !
    nuc     5    45103   0   1  !
    nuc     6    46108   0   1  !
    nuc     7    47107   0   1  !
    nuc     8    47109   0   1  !
    nuc     9    49113   0   1  !
    nuc    10    49115   0   1  !
    nuc    11    54131   0   1  !
    nuc    12    55133   0   1  !
    nuc    13    62152   0   1  !
    nuc    14    63151   0   1  !
    nuc    15    63152   0   1  !
    nuc    16    63153   0   1  !
    nuc    17    63154   0   1  !
    nuc    18    63155   0   1  !
    nuc    19    64155   2   1  !
    nuc    20    64156   2   1  !
    nuc    21    64157   2   1  !
    nuc    22    64158   2   1  !
    nuc    23    66160   0   1  !
    nuc    24    66161   0   1  !
    nuc    25    66162   0   1  !
    nuc    26    66163   0   1  !
    nuc    27    66164   0   1  !
    nuc    28    68166   0   1  !
    nuc    29    68167   0   1  !
    nuc    30    72176   0   1  !
    nuc    31    72177   0   1  !
    nuc    32    72178   0   1  !
```

```
    nuc    33    72179   0   1  !
    nuc    34    72180   0   1  !
    nuc    35    74182   0   1  !
    nuc    36    74183   0   1  !
    nuc    37    74184   0   1  !
    nuc    38    74186   0   1  !
    nuc    39    90232   0   1  !
    nuc    40    92233   2   2  !
    nuc    41    92235   2   2  !
    nuc    42    92236   2   2  !
    nuc    43    92238   2   1  !
    nuc    44    94238   2   2  !
    nuc    45    94239   2   2  !
    nuc    46    94240   2   2  !
    nuc    47    94241   2   2  !
    nuc    48    94242   2   2  !
    nuc    49    95241   2   2  !
%FINE
```

[Standard subgroup level file]

```
$TIT:
  AMPX 51-G LIBRARY
$DIM:
      54      7      4
$NUC:    0
  00000
  L7A    0  -2.0  2.0  4.800000E+00  4.000000E+01  2.500000E+02  7.500000E+02  2.000000E+03  7.000000E+03  2.000000E+04
  L4A    0  -5.0  5.0  1.000000E+01  5.000000E+02  2.000000E+03  1.000000E+04
$NUC:    1
  40090
  L7A    0  -2.0  2.0  4.800000E+00  4.000000E+01  2.500000E+02  7.500000E+02  2.000000E+03  7.000000E+03  2.000000E+04
  L4A    0  -5.0  5.0  1.000000E+01  5.000000E+02  2.000000E+03  1.000000E+04
$NUC:    2
  40091
  L7A    0  -2.0  2.0  4.800000E+00  4.000000E+01  2.500000E+02  7.500000E+02  2.000000E+03  7.000000E+03  2.000000E+04
  L4A    0  -5.0  5.0  1.000000E+01  5.000000E+02  2.000000E+03  1.000000E+04
$NUC:    3
  40092
  L7A    0  -2.0  2.0  4.800000E+00  4.000000E+01  2.500000E+02  7.500000E+02  2.000000E+03  7.000000E+03  2.000000E+04
  L4A    0  -5.0  5.0  1.000000E+01  5.000000E+02  2.000000E+03  1.000000E+04
$NUC:    4
  40094
  L7A    0  -2.0  2.0  4.800000E+00  4.000000E+01  2.500000E+02  7.500000E+02  2.000000E+03  7.000000E+03  2.000000E+04
  L4A    0  -5.0  5.0  1.000000E+01  5.000000E+02  2.000000E+03  1.000000E+04
$NUC:    5
  40096
  L7A    0  -2.0  2.0  4.800000E+00  4.000000E+01  2.500000E+02  7.500000E+02  2.000000E+03  7.000000E+03  2.000000E+04
  L4A    0  -5.0  5.0  1.000000E+01  5.000000E+02  2.000000E+03  1.000000E+04
$NUC:    6
  42095
  L7A    0  -2.0  2.0  4.800000E+00  4.000000E+01  2.500000E+02  7.500000E+02  2.000000E+03  7.000000E+03  2.000000E+04
  L4A    0  -5.0  5.0  1.000000E+01  5.000000E+02  2.000000E+03  1.000000E+04
$NUC:    7
  43099
  L7A    0  -2.0  2.0  4.800000E+00  4.000000E+01  2.500000E+02  7.500000E+02  2.000000E+03  7.000000E+03  2.000000E+04
  L4A    0  -5.0  5.0  1.000000E+01  5.000000E+02  2.000000E+03  1.000000E+04
$NUC:    8
  45103
  L7A    0  -2.0  2.0  4.800000E+00  4.000000E+01  2.500000E+02  7.500000E+02  2.000000E+03  7.000000E+03  2.000000E+04
  L4A    0  -5.0  5.0  1.000000E+01  5.000000E+02  2.000000E+03  1.000000E+04
$NUC:    9
  46108
  L7A    0  -2.0  2.0  4.800000E+00  4.000000E+01  2.500000E+02  7.500000E+02  2.000000E+03  7.000000E+03  2.000000E+04
  L4A    0  -5.0  5.0  1.000000E+01  5.000000E+02  2.000000E+03  1.000000E+04
$NUC:   10
  47107
  L7A    0  -2.0  2.0  4.800000E+00  4.000000E+01  2.500000E+02  7.500000E+02  2.000000E+03  7.000000E+03  2.000000E+04
  L4A    0  -5.0  5.0  1.000000E+01  5.000000E+02  2.000000E+03  1.000000E+04
$NUC:   11
  47109
  L7A    0  -2.0  2.0  4.800000E+00  4.000000E+01  2.500000E+02  7.500000E+02  2.000000E+03  7.000000E+03  2.000000E+04
  L4A    0  -5.0  5.0  1.000000E+01  5.000000E+02  2.000000E+03  1.000000E+04
$NUC:   12
  49113
  L7A    0  -2.0  2.0  4.800000E+00  4.000000E+01  2.500000E+02  7.500000E+02  2.000000E+03  7.000000E+03  2.000000E+04
  L4A    0  -5.0  5.0  1.000000E+01  5.000000E+02  2.000000E+03  1.000000E+04
$NUC:   13
  49115
  L7A    0  -2.0  2.0  4.800000E+00  4.000000E+01  2.500000E+02  7.500000E+02  2.000000E+03  7.000000E+03  2.000000E+04
  L4A    0  -5.0  5.0  1.000000E+01  5.000000E+02  2.000000E+03  1.000000E+04
$NUC:   14
  54131
  L7A    0  -2.0  2.0  4.800000E+00  4.000000E+01  2.500000E+02  7.500000E+02  2.000000E+03  7.000000E+03  2.000000E+04
  L4A    0  -5.0  5.0  1.000000E+01  5.000000E+02  2.000000E+03  1.000000E+04
$NUC:   15
  55133
  L7A    0  -2.0  2.0  4.800000E+00  4.000000E+01  2.500000E+02  7.500000E+02  2.000000E+03  7.000000E+03  2.000000E+04
  L4A    0  -5.0  5.0  1.000000E+01  5.000000E+02  2.000000E+03  1.000000E+04
$NUC:   16
  62152
  L7A    0  -2.0  2.0  4.800000E+00  4.000000E+01  2.500000E+02  7.500000E+02  2.000000E+03  7.000000E+03  2.000000E+04
  L4A    0  -5.0  5.0  1.000000E+01  5.000000E+02  2.000000E+03  1.000000E+04
```

```
$NUC:   17
  63151
  L7A    0  -2.0  2.0  4.800000E+00  4.000000E+01  2.500000E+02  7.500000E+02  2.000000E+03  7.000000E+03  2.000000E+04
  L4A    0  -5.0  5.0  1.000000E+01  5.000000E+02  2.000000E+03  1.000000E+04
$NUC:   18
  63152
  L7A    0  -2.0  2.0  4.800000E+00  4.000000E+01  2.500000E+02  7.500000E+02  2.000000E+03  7.000000E+03  2.000000E+04
  L4A    0  -5.0  5.0  1.000000E+01  5.000000E+02  2.000000E+03  1.000000E+04
$NUC:   19
  63153
  L7A    0  -2.0  2.0  4.800000E+00  4.000000E+01  2.500000E+02  7.500000E+02  2.000000E+03  7.000000E+03  2.000000E+04
  L4A    0  -5.0  5.0  1.000000E+01  5.000000E+02  2.000000E+03  1.000000E+04
$NUC:   20
  63154
  L7A    0  -2.0  2.0  4.800000E+00  4.000000E+01  2.500000E+02  7.500000E+02  2.000000E+03  7.000000E+03  2.000000E+04
  L4A    0  -5.0  5.0  1.000000E+01  5.000000E+02  2.000000E+03  1.000000E+04
$NUC:   21
  63155
  L7A    0  -2.0  2.0  4.800000E+00  4.000000E+01  2.500000E+02  7.500000E+02  2.000000E+03  7.000000E+03  2.000000E+04
  L4A    0  -5.0  5.0  1.000000E+01  5.000000E+02  2.000000E+03  1.000000E+04
  L7A   35  -2.0  2.0  4.800000E+00  5.000000E+01  3.500000E+02  7.500000E+02  2.000000E+03  7.000000E+03  2.000000E+04
$NUC:   22
  64155
  L7A    0  -2.0  2.0  4.800000E+00  4.000000E+01  2.500000E+02  7.500000E+02  2.000000E+03  7.000000E+03  2.000000E+04
  L4A    0  -5.0  5.0  1.000000E+01  5.000000E+02  2.000000E+03  1.000000E+04
  L7A   44  -2.0  2.0  4.800000E+00  5.000000E+01  3.500000E+02  7.500000E+02  2.000000E+03  7.000000E+03  2.000000E+04
$NUC:   23
  64156
  L7A    0  -2.0  2.0  4.800000E+00  4.000000E+01  2.500000E+02  7.500000E+02  2.000000E+03  7.000000E+03  2.000000E+04
  L4A    0  -5.0  5.0  1.000000E+01  5.000000E+02  2.000000E+03  1.000000E+04
$NUC:   24
  64157
  L7A    0  -2.0  2.0  4.800000E+00  4.000000E+01  2.500000E+02  7.500000E+02  2.000000E+03  7.000000E+03  2.000000E+04
  L4A    0  -5.0  5.0  1.000000E+01  5.000000E+02  2.000000E+03  1.000000E+04
$NUC:   25
  64158
  L7A    0  -2.0  2.0  4.800000E+00  4.000000E+01  2.500000E+02  7.500000E+02  2.000000E+03  7.000000E+03  2.000000E+04
  L4A    0  -5.0  5.0  1.000000E+01  5.000000E+02  2.000000E+03  1.000000E+04
$NUC:   26
  66160
  L7A    0  -2.0  2.0  4.800000E+00  4.000000E+01  2.500000E+02  7.500000E+02  2.000000E+03  7.000000E+03  2.000000E+04
  L4A    0  -5.0  5.0  1.000000E+01  5.000000E+02  2.000000E+03  1.000000E+04
$NUC:   27
  66161
  L7A    0  -2.0  2.0  4.800000E+00  4.000000E+01  2.500000E+02  7.500000E+02  2.000000E+03  7.000000E+03  2.000000E+04
  L4A    0  -5.0  5.0  1.000000E+01  5.000000E+02  2.000000E+03  1.000000E+04
$NUC:   28
  66162
  L7A    0  -2.0  2.0  4.800000E+00  4.000000E+01  2.500000E+02  7.500000E+02  2.000000E+03  7.000000E+03  2.000000E+04
  L4A    0  -5.0  5.0  1.000000E+01  5.000000E+02  2.000000E+03  1.000000E+04
$NUC:   29
  66163
  L7A    0  -2.0  2.0  4.800000E+00  4.000000E+01  2.500000E+02  7.500000E+02  2.000000E+03  7.000000E+03  2.000000E+04
  L4A    0  -5.0  5.0  1.000000E+01  5.000000E+02  2.000000E+03  1.000000E+04
$NUC:   30
  66164
  L7A    0  -2.0  2.0  4.800000E+00  4.000000E+01  2.500000E+02  7.500000E+02  2.000000E+03  7.000000E+03  2.000000E+04
  L4A    0  -5.0  5.0  1.000000E+01  5.000000E+02  2.000000E+03  1.000000E+04
$NUC:   31
  68166
  L7A    0  -2.0  2.0  4.800000E+00  4.000000E+01  2.500000E+02  7.500000E+02  2.000000E+03  7.000000E+03  2.000000E+04
  L4A    0  -5.0  5.0  1.000000E+01  5.000000E+02  2.000000E+03  1.000000E+04
$NUC:   32
  68167
  L7A    0  -2.0  2.0  4.800000E+00  4.000000E+01  2.500000E+02  7.500000E+02  2.000000E+03  7.000000E+03  2.000000E+04
  L4A    0  -5.0  5.0  1.000000E+01  5.000000E+02  2.000000E+03  1.000000E+04
$NUC:   33
  72176
  L7A    0  -2.0  2.0  4.800000E+00  4.000000E+01  2.500000E+02  7.500000E+02  2.000000E+03  7.000000E+03  2.000000E+04
  L4A    0  -5.0  5.0  1.000000E+01  5.000000E+02  2.000000E+03  1.000000E+04
$NUC:   34
  72177
  L7A    0  -2.0  2.0  4.800000E+00  4.000000E+01  2.500000E+02  7.500000E+02  2.000000E+03  7.000000E+03  2.000000E+04
  L4A    0  -5.0  5.0  1.000000E+01  5.000000E+02  2.000000E+03  1.000000E+04
$NUC:   35
  72178
  L7A    0  -2.0  2.0  4.800000E+00  4.000000E+01  2.500000E+02  7.500000E+02  2.000000E+03  7.000000E+03  2.000000E+04
  L4A    0  -5.0  5.0  1.000000E+01  5.000000E+02  2.000000E+03  1.000000E+04
$NUC:   36
  72179
  L7A    0  -2.0  2.0  4.800000E+00  4.000000E+01  2.500000E+02  7.500000E+02  2.000000E+03  7.000000E+03  2.000000E+04
  L4A    0  -5.0  5.0  1.000000E+01  5.000000E+02  2.000000E+03  1.000000E+04
$NUC:   37
  72180
  L7A    0  -2.0  2.0  4.800000E+00  4.000000E+01  2.500000E+02  7.500000E+02  2.000000E+03  7.000000E+03  2.000000E+04
  L4A    0  -5.0  5.0  1.000000E+01  5.000000E+02  2.000000E+03  1.000000E+04
$NUC:   38
  90232
  L7A    0  -2.0  2.0  4.800000E+00  4.000000E+01  2.500000E+02  7.500000E+02  2.000000E+03  7.000000E+03  2.000000E+04
  L4A    0  -5.0  5.0  1.000000E+01  5.000000E+02  2.000000E+03  1.000000E+04
$NUC:   39
  92233
  L7A    0  -2.0  2.0  4.800000E+00  4.000000E+01  2.500000E+02  7.500000E+02  2.000000E+03  7.000000E+03  2.000000E+04
  L4A    0  -5.0  5.0  1.000000E+01  5.000000E+02  2.000000E+03  1.000000E+04
$NUC:   40
  92235
  L7A    0  -2.0  2.0  4.800000E+00  4.000000E+01  2.500000E+02  7.500000E+02  2.000000E+03  7.000000E+03  2.000000E+04
  L4A    0  -5.0  5.0  1.000000E+01  5.000000E+02  2.000000E+03  1.000000E+04
$NUC:   41
  92236
```

```
  L7A    0  -2.0  2.0  4.800000E+00  4.000000E+01  2.500000E+02  7.500000E+02  2.000000E+03  7.000000E+03  2.000000E+04
  L4A    0  -5.0  5.0  1.000000E+01  5.000000E+02  2.000000E+03  1.000000E+04
$NUC:   42
  92238
  L7A    0  -2.0  2.0  4.800000E+00  4.000000E+01  2.500000E+02  7.500000E+02  2.000000E+03  7.000000E+03  2.000000E+04
  L4A    0  -5.0  5.0  1.000000E+01  5.000000E+02  2.000000E+03  1.000000E+04
$NUC:   43
  94238
  L7A    0  -2.0  2.0  4.800000E+00  4.000000E+01  2.500000E+02  7.500000E+02  2.000000E+03  7.000000E+03  2.000000E+04
  L4A    0  -5.0  5.0  1.000000E+01  5.000000E+02  2.000000E+03  1.000000E+04
$NUC:   44
  94239
  L7A    0  -2.0  2.0  4.800000E+00  4.000000E+01  2.500000E+02  7.500000E+02  2.000000E+03  7.000000E+03  2.000000E+04
  L4A    0  -5.0  5.0  1.000000E+01  5.000000E+02  2.000000E+03  1.000000E+04
$NUC:   45
  94240
  L7A    0  -2.0  2.0  4.800000E+00  4.000000E+01  2.500000E+02  7.500000E+02  2.000000E+03  7.000000E+03  2.000000E+04
  L4A    0  -5.0  5.0  1.000000E+01  5.000000E+02  2.000000E+03  1.000000E+04
$NUC:   46
  94241
  L7A    0  -2.0  2.0  4.800000E+00  4.000000E+01  2.500000E+02  7.500000E+02  2.000000E+03  7.000000E+03  2.000000E+04
  L4A    0  -5.0  5.0  1.000000E+01  5.000000E+02  2.000000E+03  1.000000E+04
$NUC:   47
  94242
  L7A    0  -2.0  2.0  4.800000E+00  4.000000E+01  2.500000E+02  7.500000E+02  2.000000E+03  7.000000E+03  2.000000E+04
  L4A    0  -5.0  5.0  1.000000E+01  5.000000E+02  2.000000E+03  1.000000E+04
$NUC:   48
  95241
  L7A    0  -2.0  2.0  4.800000E+00  4.000000E+01  2.500000E+02  7.500000E+02  2.000000E+03  7.000000E+03  2.000000E+04
  L4A    0  -5.0  5.0  1.000000E+01  5.000000E+02  2.000000E+03  1.000000E+04
$NUC:   49
  10040091
  L7A    0  -2.0  2.0  4.800000E+00  4.000000E+01  2.500000E+02  7.500000E+02  2.000000E+03  7.000000E+03  2.000000E+04
  L4A    0  -5.0  5.0  1.000000E+01  5.000000E+02  2.000000E+03  1.000000E+04
$NUC:   50
  10040096
  L7A    0  -2.0  2.0  4.800000E+00  4.000000E+01  2.500000E+02  7.500000E+02  2.000000E+03  7.000000E+03  2.000000E+04
  L4A    0  -5.0  5.0  1.000000E+01  5.000000E+02  2.000000E+03  1.000000E+04
$NUC:   51
  74182
  L7A    0  -2.0  2.0  4.800000E+00  4.000000E+01  2.500000E+02  7.500000E+02  2.000000E+03  7.000000E+03  2.000000E+04
  L4A    0  -5.0  5.0  1.000000E+01  5.000000E+02  2.000000E+03  1.000000E+04
$NUC:   52
  74183
  L7A    0  -2.0  2.0  4.800000E+00  4.000000E+01  2.500000E+02  7.500000E+02  2.000000E+03  7.000000E+03  2.000000E+04
  L4A    0  -5.0  5.0  1.000000E+01  5.000000E+02  2.000000E+03  1.000000E+04
$NUC:   53
  74184
  L7A    0  -2.0  2.0  4.800000E+00  4.000000E+01  2.500000E+02  7.500000E+02  2.000000E+03  7.000000E+03  2.000000E+04
  L4A    0  -5.0  5.0  1.000000E+01  5.000000E+02  2.000000E+03  1.000000E+04
$NUC:   54
  74186
  L7A    0  -2.0  2.0  4.800000E+00  4.000000E+01  2.500000E+02  7.500000E+02  2.000000E+03  7.000000E+03  2.000000E+04
  L4A    0  -5.0  5.0  1.000000E+01  5.000000E+02  2.000000E+03  1.000000E+04
$END:
```

APPENDIX B.2. THE CE-KENO AND MERIT INPUT FILES AND EDITING PROGRAM

[CE-KENO input file]

```
=csas6
centrm verification pincell c01 293.0 K
ce_v7.0_endf
read comp
' Fuel
h-1   1 0  9.39467E-04 293.0  end
u-238 1 0  1.11312E+00 293.0  end
o-16  1 0  4.64223E-02 293.0  end
' Clad
al-27 2 0  6.02611E-02 600.0  end
' h2o
h-1   3 0  1.17827E-04 600.0  end
o-16  3 0  5.89135E-05 600.0  end
end comp

read parm
  gen=100 npg=200000 nsk=50 scx=no dbr=1
end parm

read geom
global unit 10
cylinder 11 0.4025 chord +x=0.0 chord +y=0.0
cylinder 12 0.4759 chord +x=0.0 chord +y=0.0
cuboid   13 0.6310 0.0 0.6310 0.0 5.0 -5.0
media 1 1 11
media 2 1 12 -11
media 3 1 13 -12
boundary 13
end geom

read bounds
all=refl
end bounds

read reactions
   xs=yes rx=yes unit=3
   mix=1
   nuclist 92238 end
   mtlist 102 18 2 end
end reactions

read energy
 2.000000E+07 6.434000E+06 4.304000E+06 2.354000E+06 1.356000E+06
 8.200000E+05 4.920000E+05 2.000000E+05 7.300000E+04 5.000000E+04
 2.000000E+04 9.500000E+03 2.250000E+03 9.500000E+02 3.050000E+02
 1.430000E+02 7.600000E+01 4.830000E+01 3.000000E+01 1.440000E+01
 1.190000E+01 8.100000E+00 7.150000E+00 6.250000E+00 5.400000E+00
 5.000000E+00 4.700000E+00 3.730000E+00 2.470000E+00 1.860000E+00
 1.450000E+00 1.250000E+00 1.175000E+00 1.130000E+00 1.080000E+00
 1.010000E+00 9.750000E-01 9.250000E-01 7.500000E-01 6.250000E-01
 5.000000E-01 3.500000E-01 2.750000E-01 2.000000E-01 1.500000E-01
 1.000000E-01 8.000000E-02 6.000000E-02 4.000000E-02 3.000000E-02
 1.000000E-02 1.000000E-05
end energy

end data
```

[Program ‘editkeno’ to edit CE-KENO XS]

```
      program editkeno
!
      integer :: nog,nsig,ntemp,idtarget
      character(200) :: ssw
      character(200),allocatable :: filename(:,:)
      double precision,allocatable :: siga(:,:,:),sigc(:,:,:),sigf(:,:,:),temp(:)
      logical :: lfisxs
!
      open(1,file='editkeno.in',status='old')
      read(1,*) idtarget
      read(1,*) ntemp,nsig,nog
      allocate(filename(nsig,ntemp),temp(ntemp))
      temp(:)=0.0
      allocate(siga(nog,nsig,ntemp),sigc(nog,nsig,ntemp),sigf(nog,nsig,ntemp))
      siga(:,:,:)=0.0; sigc(:,:,:)=0.0; sigf(:,:,:)=0.0
      read(1,*) (temp(i),i=1,ntemp)
      do i=1,ntemp
        do j=1,nsig
          read(1,*) filename(j,i)
        enddo
      enddo
!
!     [Read files]
      ix=100
      lfisxs=.false.
      do i=1,ntemp
        do j=1,nsig
```

```
          ix=ix+1
          open(ix,file=filename(j,i),status='old')
          do ixx=1,10000
            read(ix,'(a200)',end=10) ssw
            !Read fission XS
            if (ssw(13:29).eq.'92238    18     1') then
              lfisxs=.true.
              backspace(ix)
              do ig=1,nog
                read(ix,*) ix1,ix2,ix3,ix4,xx1,sigf(ig,j,i)
              enddo
            endif
            !Read capture XS
            if (ssw(13:29).eq.'92238   102     1') then
              backspace(ix)
              do ig=1,nog
                read(ix,*) ix1,ix2,ix3,ix4,xx1,sigc(ig,j,i)
              enddo
            endif
          enddo
   10     close(ix)
        enddo
      enddo
      indfis=1
      if (lfisxs) indfis=2
      izero=0
      ione=1; itwo=2
!
!     [Write the XS table]
      siga(:,:,:)=sigc(:,:,:)+sigf(:,:,:)
      open(2,file='edtxstbl.dat',status='unknown')
      write(2,'("%DIM")')
      write(2,'(1x,5i5)') nog,ntemp,nsig,indfis,izero
      write(2,'("%NUC")')
      write(2,'(i6)') idtarget
      write(2,'("%TEM")')
      write(2,'(30f8.2)') (temp(i),i=1,ntemp)
      write(2,'("%RIT")')
      write(2,'(i5)') ione
      do ig=1,nog
        do i=1,ntemp
          write(2,'(2i5,1x,1p30e13.5)') ig,i,(siga(ig,j,i),j=1,nsig)
        enddo
      enddo
      write(2,'(i5)') itwo
      do ig=1,nog
        do i=1,ntemp
          write(2,'(2i5,1x,1p30e13.5)') ig,i,(sigf(ig,j,i),j=1,nsig)
        enddo
      enddo
      write(2,'("%END")')
!
      stop
      end
```

[Input file for ‘editkeno’]

```
92238
  5   16  51
  293.6  600.0  900.0  1200.0  2400.0
keno3k03x.keno_micro_xs_rr.0
keno3k04.keno_micro_xs_rr.0
keno3k05.keno_micro_xs_rr.0
keno3k06.keno_micro_xs_rr.0
keno3k07.keno_micro_xs_rr.0
keno3k08.keno_micro_xs_rr.0
keno3k09.keno_micro_xs_rr.0
keno3k10.keno_micro_xs_rr.0
keno3k11.keno_micro_xs_rr.0
keno3k12.keno_micro_xs_rr.0
keno3k13.keno_micro_xs_rr.0
keno3k14.keno_micro_xs_rr.0
keno3k15.keno_micro_xs_rr.0
keno3k17.keno_micro_xs_rr.0
keno3k19.keno_micro_xs_rr.0
keno3k21.keno_micro_xs_rr.0
keno6k03x.keno_micro_xs_rr.0
keno6k04.keno_micro_xs_rr.0
keno6k05.keno_micro_xs_rr.0
keno6k06.keno_micro_xs_rr.0
keno6k07.keno_micro_xs_rr.0
keno6k08.keno_micro_xs_rr.0
keno6k09.keno_micro_xs_rr.0
keno6k10.keno_micro_xs_rr.0
keno6k11.keno_micro_xs_rr.0
keno6k12.keno_micro_xs_rr.0
keno6k13.keno_micro_xs_rr.0
keno6k14.keno_micro_xs_rr.0
keno6k15.keno_micro_xs_rr.0
keno6k17.keno_micro_xs_rr.0
keno6k19.keno_micro_xs_rr.0
keno6k21.keno_micro_xs_rr.0
keno9k03x.keno_micro_xs_rr.0
keno9k04.keno_micro_xs_rr.0
keno9k05.keno_micro_xs_rr.0
keno9k06.keno_micro_xs_rr.0
keno9k07.keno_micro_xs_rr.0
```

```
keno9k08.keno_micro_xs_rr.0
keno9k09.keno_micro_xs_rr.0
keno9k10.keno_micro_xs_rr.0
keno9k11.keno_micro_xs_rr.0
keno9k12.keno_micro_xs_rr.0
keno9k13.keno_micro_xs_rr.0
keno9k14.keno_micro_xs_rr.0
keno9k15.keno_micro_xs_rr.0
keno9k17.keno_micro_xs_rr.0
keno9k19.keno_micro_xs_rr.0
keno9k21.keno_micro_xs_rr.0
keno12k03x.keno_micro_xs_rr.0
keno12k04.keno_micro_xs_rr.0
keno12k05.keno_micro_xs_rr.0
keno12k06.keno_micro_xs_rr.0
keno12k07.keno_micro_xs_rr.0
keno12k08.keno_micro_xs_rr.0
keno12k09.keno_micro_xs_rr.0
keno12k10.keno_micro_xs_rr.0
keno12k11.keno_micro_xs_rr.0
keno12k12.keno_micro_xs_rr.0
keno12k13.keno_micro_xs_rr.0
keno12k14.keno_micro_xs_rr.0
keno12k15.keno_micro_xs_rr.0
keno12k17.keno_micro_xs_rr.0
keno12k19.keno_micro_xs_rr.0
keno12k21.keno_micro_xs_rr.0
keno24k03x.keno_micro_xs_rr.0
keno24k04.keno_micro_xs_rr.0
keno24k05.keno_micro_xs_rr.0
keno24k06.keno_micro_xs_rr.0
keno24k07.keno_micro_xs_rr.0
keno24k08.keno_micro_xs_rr.0
keno24k09.keno_micro_xs_rr.0
keno24k10.keno_micro_xs_rr.0
keno24k11.keno_micro_xs_rr.0
keno24k12.keno_micro_xs_rr.0
keno24k13.keno_micro_xs_rr.0
keno24k14.keno_micro_xs_rr.0
keno24k15.keno_micro_xs_rr.0
keno24k17.keno_micro_xs_rr.0
keno24k19.keno_micro_xs_rr.0
keno24k21.keno_micro_xs_rr.0
```

[MERIT input file]

```
%TITL
  TIT Generation of RI Tables
%IOPT
  IOP  EXT
%FILE
  LAM  ff2ri_51g2_70_5n.lam
  T23  92238  ALL  edtxstbl51g2_70_u238_dbrc_16.dat
%COMP
  MAT 1 UO2  10.4     /  1001 9.39467E+20 92238 2.22624E+22  8016 4.64223E+22
  MAT 2 CLD  2.70     / 13027 6.02611E+22
  MAT 3 MOD  0.6608   /  1001 4.71309E+22  8016 2.35654E+22
%GEOM
  PIN  0.4025 0.4759 0.7120 / UO2 CLD MOD / 1 1 1
  RAY  3  8  0.02
%SLOW
  NFI  300000
  GRP  2.000000E+07 6.434000E+06 4.304000E+06 2.354000E+06 1.356000E+06
       8.200000E+05 4.920000E+05 2.000000E+05 7.300000E+04 5.000000E+04
       2.000000E+04 9.500000E+03 2.250000E+03 9.500000E+02 3.050000E+02
       1.430000E+02 7.600000E+01 4.830000E+01 3.000000E+01 1.440000E+01
       1.190000E+01 8.100000E+00 7.150000E+00 6.250000E+00 5.400000E+00
       5.000000E+00 4.700000E+00 3.730000E+00 2.470000E+00 1.860000E+00
       1.450000E+00 1.250000E+00 1.175000E+00 1.130000E+00 1.080000E+00
       1.010000E+00 9.750000E-01 9.250000E-01 7.500000E-01 6.250000E-01
       5.000000E-01 3.500000E-01 2.750000E-01 2.000000E-01 1.500000E-01
       1.000000E-01 8.000000E-02 6.000000E-02 4.000000E-02 3.000000E-02
       1.000000E-02 1.000000E-05
  MTD ICM
%RESO
  BXS  MOC
  NUC  92238
  LEV  1.  5.  10.  50.  100.  500.  1000.  5000.  10000.  20000.
  SEG  2.510000E+01 2.700000E+01 3.160000E+01 4.060000E+01 5.790000E+01
       9.250000E+01 1.660000E+02 3.359999E+02 7.610001E+02 1.900000E+03
       5.349999E+03 1.660000E+04 5.719999E+04 2.160000E+05 9.070000E+05
       1.000000E+15
%CASE  !3
  FRP  1.0  1.0  1.0
  FRM  1 UO2  1.0  1.0  1.0
  FRM  2 CLD  1.0
  FRM  3 MOD  0.0025 0.0025
%CASE  !4
  FRP  1.0  1.0  1.0
  FRM  1 UO2  1.0  1.0  1.0
  FRM  2 CLD  1.0
  FRM  3 MOD  0.200 0.200
%CASE  !5
  FRP  1.0  1.0  1.0
  FRM  1 UO2  1.0  1.0  1.0
  FRM  2 CLD  1.0
```

```
  FRM  3 MOD  0.500 0.500
%CASE  !6
  FRP  1.0  1.0  1.0
  FRM  1 UO2  1.0  1.0  1.0
  FRM  2 CLD  1.0
  FRM  3 MOD  0.750 0.750
%CASE  !7
  FRP  1.0  1.0  1.0
  FRM  1 UO2  1.0  1.0  1.0
  FRM  2 CLD  1.0
  FRM  3 MOD  1.0  1.0
%CASE  !8
  FRP  1.0  1.0  2.0
  FRM  1 UO2  1.0  1.0  1.0
  FRM  2 CLD  1.0
  FRM  3 MOD  1.0  1.0
%CASE  !9
  FRP  1.0  1.0  5.0
  FRM  1 UO2  1.0  1.0  1.0
  FRM  2 CLD  1.0
  FRM  3 MOD  1.0  1.0
%CASE  !10
  FRP  1.0  1.0  5.0
  FRM  1 UO2  0.5  0.5  0.5
  FRM  2 CLD  1.0
  FRM  3 MOD  1.0  1.0
%CASE  !11
  FRP  1.0  1.0  5.0
  FRM  1 UO2  0.25  0.25  0.25
  FRM  2 CLD  1.0
  FRM  3 MOD  1.0  1.0
%CASE  !12
  FRP  1.0  1.0  5.0
  FRM  1 UO2  0.125  0.125  0.125
  FRM  2 CLD  1.0
  FRM  3 MOD  1.0  1.0
%CASE  !13
  FRP  1.0  1.0  5.0
  FRM  1 UO2  0.0625  0.0625  0.0625
  FRM  2 CLD  1.0
  FRM  3 MOD  1.0  1.0
%CASE  !14
  FRP  1.0  1.0  5.0
  FRM  1 UO2  0.03125  0.03125  0.03125
  FRM  2 CLD  1.0
  FRM  3 MOD  1.0  1.0
%CASE  !15
  FRP  1.0  1.0  5.0
  FRM  1 UO2  0.01  0.01  0.01
  FRM  2 CLD  1.0
  FRM  3 MOD  1.0  1.0
%CASE  !17
  FRP  1.0  1.0  5.0
  FRM  1 UO2  0.01  0.001  0.01
  FRM  2 CLD  1.0
  FRM  3 MOD  1.0  1.0
%CASE  !19
  FRP  1.0  1.0  5.0
  FRM  1 UO2  0.01  0.00001  0.01
  FRM  2 CLD  1.0
  FRM  3 MOD  1.0  1.0
%CASE  !21
  FRP  1.0  1.0  5.0
  FRM  1 UO2  0.01  0.00000001  0.01
  FRM  2 CLD  1.0
  FRM  3 MOD  1.0  1.0
%FINE
```

APPENDIX B.3. THE DECLIB INPUT FILE TO GENERATE THE ENDF/B-7.0 MPACT 51-G LIBRARY

[DECLIB input]

```
%TITL
  DATE::DECEMBER 06, 2016; GROUP::51; MASTER::ENDF/B-VII R0; SUBGROUP::YES; TRC::YES
%IOPT
! LIBRARY VERSION
  VER  4.2
! 0: Unformatted master library -> Formatted master library
! 1: Formatted master library -> Unformatted master library
! 2: Unformatted master library -> DeCART library
! 3: Formatted master library -> DeCART library
  LIB   2
! 0: lambda*sig-p is not included in sig-b
! 1: lambda*sig-p is included in sig-b
  BXS   0
! 0: No transport corrected total XS
! 1: Transport corrected total XS
! 2: Transport correction is applied to p1 scattering matrix only for testing.
  XST   1
%FILE
  AMP  ampx51g_70_4.2m5_03_OLD.bin   ampx51g_70_4.2m5_03_OLD.fmt
  DEC  mpact51g_70_v4.2m5_12062016_sph.fmt   mpact51g_70_v4.2m5_12062016_sph.bin
  END  n-endfb7.0
  DCY  dec-endfb7.0
  FPY  fpy-endfb7.0
  SUB  subgr_51g_70_m5_12052016_sph.sub               !Subgroup data
  TRC  tcorr_51g_70_10102016_1n.dat                   !Transport correction
  XSB  backxs_51g_final_Er_12052016_m5.dat            !Background XS
  DLY  totbeta_e70_10062014.dat                       !Transient data
  DBR  subgr_u238_51g_70_m3_dbrc_sph.sub              !Epithermal upscattering
%COLL
  FLX  fluxcur_51g2.dat
  SUB  subgr.sub_moc49g_mod
  LAM  rilamb.irp_e705_49g
%RESO  !# of fast / end of reso.
  GRP    9   31
%NUCL
! NRES  NELR   NELT  NYLD
  49    194    298   121
!
! ------------------------------------------------------------------------------------------
! NID    NUCLIDE ID  1000*Z+500*A+100*B+A
!        A=0: ACTIVATION & HEAVY NUCLIDES / A=1: F.P. NUCLIDES
!        B=0: STABLE / B=1: METASTABLE
! AMASS  ATOMIC MASS
! AID    ALPHANUMERIC NUCLIDE ID.
! NO0    1/2/3  COLLAPSING SPECTRA (MODERATOR/FUEL/STRUCTURE)
! NO1    0  NON DEPLETABLE
!       >0  DEPLETABLE (W/ DECAY CONSTANT)
!        1
!        2 RI-A ONLY (FISSIONABLE W/ KAPPA, BETA, FPY)
!        3 RI-A & RI-NF (FISSIONABLE W/ KAPPA, BETA, FPY)
! NO2    NFPY  (ORDERING NO. OF FPY) (+/- : CUMULATIVE/DIRECT YIELD)
! NO3    NPI   (WITH P1/P2/P3)
! NO4    NCHIX (WITH FISSION SPECTRA)
! NO5    N2N   (WITH N2N)
! NO6    N3N   (WITH N3N)
! NO7    EPU   (WITH EPITHERMAL UPSCATTERING RESONANCE DATA)
! NO8    TRC   (TRANSPORT CORRECTION) (0/1/2 : OUTSCATT/NLC/INSCATT)
! AMPX   # OF AMPX NUCLIDES TO BE MERGED
! #T     # OF TEMPERATURES
! ------------------------------------------------------------------------------------------
! NO     NID      AMASS       AID    NO0 NO1 NO2 NO3 NO4 NO5 NO6 NO7 NO8 AMPX  #T  TEMPERATURE(K)
! ------------------------------------------------------------------------------------------
   1   40091    90.90563   'Zr-91  '    3   1   0   0   0   0   0   0   0    1   3  293  900 2000
           1   40091  100.0
   2   40096    95.90830   'Zr-96  '    3   1   0   0   0   0   0   0   0    1   3  293  900 2000
           1   40096  100.0
   3   42595    94.90589   'Mo-95  '    2   1  17   0   0   0   0   0   0    1   3  293  900 2000
           1   42095  100.0
   4   43599    98.90767   'Tc-99  '    2   1  23   0   0   2   0   0   0    1   3  293  900 2000
           1   43099  100.0
   5   45103   102.90501   'Rh-103 '    3   1   0   0   0   0   0   0   0    1   3  293  900 2000
           1   45103  100.0
   6   46608   107.90385   'Pd-108 '    2   1  37   0   0   0   0   0   0    1   3  293  900 2000
           1   46108  100.0
   7   47107   106.90537   'Ag-107 '    3   0   0   0   0   3   1   0   0    1   3  293  900 2000
           1   47107  100.0
   8   47109   108.90455   'Ag-109 '    3   0   0   0   0   4   2   0   0    1   3  293  900 2000
           1   47109  100.0
   9   49113   112.90390   'In-113 '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
           1   49113  100.0
  10   49115   114.90409   'In-115 '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
           1   49115  100.0
  11   54631   130.90555   'Xe-131 '    2   1  57   0   0   5   3   0   0    1   3  293  900 2000
           1   54131  100.0
  12   55633   132.90573   'Cs-133 '    2   1  63   0   0   6   0   0   0    1   3  293  900 2000
           1   55133  100.0
  13   62152   151.92007   'Sm-152 '    3   0   0   0   0   7   4   0   0    1   5  293  600  900 1200 2400
           1   62152  100.0
  14   63151   150.91645   'Eu-151 '    3   0   0   0   0   8   5   0   0    1   5  293  600  900 1200 2400
           1   63151  100.0
```

```
  15   63152   151.92209   'Eu-152 '    3   1   0   0   0   9   6   0   0    1   5  293  600  900 1200 2400
          1   63152  100.0
  16   63153   152.92168   'Eu-153 '    3   0   0   0   0  10   7   0   0    1   5  293  600  900 1200 2400
          1   63153  100.0
  17   63154   153.92227   'Eu-154 '    3   1   0   0   0  11   8   0   0    1   5  293  600  900 1200 2400
          1   63154  100.0
  18   63155   154.92085   'Eu-155 '    3   1   0   0   0  12   9   0   0    1   5  293  600  900 1200 2400
          1   63155  100.0
  19   64155   154.92287   'Gd-155 '    2   0   0   0   0  13   0   0   0    1   5  293  600  900 1200 2400
          1   64155  100.0
  20   64156   155.92246   'Gd-156 '    2   0   0   0   0  14   0   0   0    1   5  293  600  900 1200 2400
          1   64156  100.0
  21   64157   156.92406   'Gd-157 '    2   0   0   0   0  15   0   0   0    1   5  293  600  900 1200 2400
          1   64157  100.0
  22   64158   157.92365   'Gd-158 '    2   0   0   0   0  16   0   0   0    1   5  293  600  900 1200 2400
          1   64158  100.0
  23   66160   159.92484   'Dy-160 '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   66160  100.0
  24   66161   160.92644   'Dy-161 '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   66161  100.0
  25   66162   161.92704   'Dy-162 '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   66162  100.0
  26   66163   162.92864   'Dy-163 '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   66163  100.0
  27   66164   163.92924   'Dy-164 '    3   0   0   0   0  17  10   0   0    1   3  293  900 2000
          1   66164  100.0
  28   68166   165.93043   'Er-166 '    2   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   68166  100.0
  29   68167   166.93203   'Er-167 '    2   0   0   0   0   0   0   0   0    1   5  293  600  900 1200 2400
          1   68167  100.0
  30   72176   175.94143   'Hf-176 '    3   0   0   0   0  18   0   0   0    1   3  293  900 2000
          1   72176  100.0
  31   72177   176.94303   'Hf-177 '    3   0   0   0   0  19   0   0   0    1   3  293  900 2000
          1   72177  100.0
  32   72178   177.94363   'Hf-178 '    3   0   0   0   0  20   0   0   0    1   3  293  900 2000
          1   72178  100.0
  33   72179   178.94624   'Hf-179 '    3   0   0   0   0  21   0   0   0    1   3  293  900 2000
          1   72179  100.0
  34   72180   179.94684   'Hf-180 '    3   0   0   0   0  22   0   0   0    1   3  293  900 2000
          1   72180  100.0
! ------------------------------------------------------------------------------------------------- Newly added on 05/22/2013(b)
  35   74182   181.95307   'W-182  '    3   0   0   0   0  23   0   0   0    1   3  293  900 2000
          1   74182  100.0
  36   74183   182.95165   'W-183  '    3   0   0   0   0  24   0   0   0    1   3  293  900 2000
          1   74183  100.0
  37   74184   183.95023   'W-184  '    3   0   0   0   0  25   0   0   0    1   3  293  900 2000
          1   74184  100.0
  38   74186   185.95747   'W-186  '    3   0   0   0   0  26   0   0   0    1   3  293  900 2000
          1   74186  100.0
! ------------------------------------------------------------------------------------------------- Newly added on 05/22/2013(e)
  39   90232   232.03833   'Th-232 '    2   2   0  18   1  27  11   0   0    1   5  293  600  900 1200 2400
          1   90232  100.0
  40   92233   233.03963   'U-233  '    2   3   0  19   2  28  12   0   0    1   5  293  600  900 1200 2400
          1   92233  100.0
  41   92235   235.04395   'U-235  '    2   3   0  21   3  29  13   0   0    1   5  293  600  900 1200 2400
          1   92235  100.0
  42   92236   236.04556   'U-236  '    2   3   0  22   4  30  14   0   0    1   3  293  900 2000
          1   92236  100.0
  43   92238   238.05078   'U-238  '    2   2   0  23   5  31  15   1   0    1   5  293  600  900 1200 2400
          1   92238  100.0
  44   94238   238.04947   'Pu-238 '    2   3   0   0   6  32  16   0   0    1   3  293  900 2000
          1   94238  100.0
  45   94239   239.05218   'Pu-239 '    2   3   0  24   7  33  17   0   0    1   5  293  600  900 1200 2400
          1   94239  100.0
  46   94240   240.05419   'Pu-240 '    2   3   0  25   8  34  18   0   0    1   5  293  600  900 1200 2400
          1   94240  100.0
  47   94241   241.04874   'Pu-241 '    2   3   0  26   9  35  19   0   0    1   5  293  600  900 1200 2400
          1   94241  100.0
  48   94242   242.05841   'Pu-242 '    2   3   0  27  10  36  20   0   0    1   3  293  900 2000
          1   94242  100.0
  49   95241   241.05681   'Am-241 '    2   3   0   0   0  37  21   0   0    1   3  293  900 2000
          1   95241  100.0
! ------------------------------------------------------------------------------------------------------------------------
  50    1001     1.00783   'H-1    '    1   0   0   1   0   0   0   0   1    1   9  293.6  350  400  450  500  550  600  650  800
          1    1001  100.0
  51    1002     2.01410   'H-2    '    1   0   0   2   0  38   0   0   0    1   5  293  600  900 1200 2400
          1    1002  100.0
  52    1006     1.00783   'H-1ch2 '    1   0   0   3   0   0   0   0   0    1   3  293  900 2000
          1    1901  100.0
  53    1040     1.00783   'H-1zrh '    1   0   0   4   0   0   0   0   0    1   3  296  400  500  600  700  800 1000 1200
          1    1701  100.0
 54     2004     4.00260   'He-4   '    1   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1    2004  100.0
 55     3006     6.01507   'Li-6   '    1   0   0   7   0   0   0   0   0    1   5  293  600  900 1200 2400
          1    3006  100.0
 56     3007     7.01600   'Li-7   '    1   0   0   8   0  39   0   0   0    1   3  293  900 2000
          1    3007  100.0
 57     4009     9.01220   'Be-9   '    1   0   0   0   0  40   0   0   0    1   3  293  900 2000
          1    4009  100.0
 58     5000    10.81101   'B-nat  '    1   0   0  28   0   0   0   0   0    2   5  293  600  900 1200 2400
          1    5010   19.90
          2    5011   80.10
 59     5010    10.01294   'B-10   '    1   1   0  29   0   0   0   0   0    1   5  293  600  900 1200 2400
          1    5010  100.0
 60     5011    11.00928   'B-11   '    1   1   0  30   0   0   0   0   0    1   5  293  600  900 1200 2400
          1    5011  100.0
 61     6000    12.00110   'C-nat  '    1   0   0   9   0   0   0   0   0    1   5  293  600  900 1200 2400
          1    6000  100.0
 62     6001    12.00110   'C-graph'    1   0   0   0   0   0   0   0   0    1  10  296  400  500  600  700  800 1000 1200 1600 2000
          1    6312  100.0
```

```
63     7014    14.00307   'N-14   '    1   0   0   0   0  41   0   0   0    1   3  293  900 2000
          1    7014  100.0
64     8001    15.99730   'O-uo2  '    2   0   0  11   0   0   0   0   0    2   5  293  600  900 1200 2400
          1    8016   99.762
          2    8017    0.238
65     8016    15.99491   'O-16   '    1   0   0  12   0   0   0   0   0    1   5  293  600  900 1200 2400
          1    8016  100.0
66     9019    18.99820   'F-19   '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1    9019  100.0
67    11023    22.98949   'Na-23  '    3   0   0   0   0   0   0   0   0    1   5  293  600  900 1200 2400
          1   11023  100.0
68    12000    24.30505   'Mg-nat '    3   0   0   0   0   0   0   0   0    3   3  293  900 2000
          1   12024   78.99
          2   12025   10.0
          3   12026   11.01
69    13027    26.98154   'Al-27  '    3   0   0  13   0   0   0   0   0    1   5  293  600  900 1200 2400
          1   13027  100.0
70    14000    28.08590   'Si-nat '    3   0   0   0   0   0   0   0   0    3   3  293  900 2000
          1   14028   92.23
          2   14029    4.67
          3   14030    3.10
71    15031    30.97408   'P-31   '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   15031  100.0
72    16000    32.06429   'S-nat  '    3   0   0   0   0   0   0   0   0    4   3  293  900 2000
          1   16032   95.02
          2   16033    0.75
          3   16034    4.21
          4   16036    0.02
73    17000    35.45273   'Cl-nat '    3   0   0   0   0   0   0   0   0    2   3  293  900 2000
          1   17035   75.77
          2   17037   24.23
74    19000    39.09858   'K-nat  '    3   0   0   0   0   0   0   0   0    3   3  293  900 2000
          1   19039   93.26
          2   19040    0.01
          3   19041    6.73
75    20000    40.07803   'Ca-nat '    3   0   0   0   0   0   0   0   0    6   3  293  900 2000
          1   20040  96.941
          2   20042   0.647
          3   20043   0.135
          4   20044   2.086
          5   20046   0.004
          6   20048   0.187
76    22000    47.89328   'Ti-nat '    3   0   0   0   0   0   0   0   0    5   3  293  900 2000
          1   22046   8.0
          2   22047   7.3
          3   22048  73.8
          4   22049   5.5
          5   22050   5.4
77    23000    50.94162   'V-nat  '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   23000  100.00
78    24000    51.99589   'Cr-nat '    3   0   0   0   0  42   0   0   0    4   3  293  900 2000
          1   24050    4.345
          2   24052   83.789
          3   24053    9.501
          4   24054    2.365
79    24050    49.94606   'Cr-50  '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   24050  100.0
80    24052    51.94019   'Cr-52  '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   24052  100.0
81    24053    52.94079   'Cr-53  '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   24053  100.0
82    24054    53.93937   'Cr-54  '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   24054  100.0
83    25055    54.93805   'Mn-55  '    3   0   0   0   0  43   0   0   0    1   3  293  900 2000
          1   25055  100.0
84    26000    55.84473   'Fe-nat '    3   0   0   0   0  44   0   0   0    4   3  293  900 2000
          1   26054    5.845
          2   26056   91.754
          3   26057    2.119
          4   26058    0.282
85    26054    53.93937   'Fe-54  '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   26054  100.0
86    26056    55.93451   'Fe-56  '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   26056  100.0
87    26057    56.93510   'Fe-57  '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   26057  100.0
88    26058    57.93368   'Fe-58  '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   26058  100.0
89    27059    58.93317   'Co-59  '    3   0   0   0   0  45   0   0   0    1   3  293  900 2000
          1   27059  100.0
90    28000    58.69361   'Ni-nat '    3   0   0   0   0  46   0   0   0    5   3  293  900 2000
          1   28058   68.077
          2   28060   26.223
          3   28061    1.140
          4   28062    3.634
          5   28064    0.926
91    28058    57.93570   'Ni-58  '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   28058  100.0
92    28060    59.93084   'Ni-60  '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   28060  100.0
93    28061    60.93143   'Ni-61  '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   28061  100.0
94    28062    61.92799   'Ni-62  '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   28062  100.0
95    28064    63.92818   'Ni-64  '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   28064  100.0
96    29063    62.92960   'Cu-63  '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   29063  100.0
97    29065    64.92776   'Cu-65  '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   29065  100.0
```

```
 98    40000    91.22365   'Zr-nat '    3   0   0  14   0  47   0   0   0    5   3  293  900 2000
          1   40090  51.45
          2   40091  11.22
          3   40092  17.15
          4   40094  17.38
          5   40096   2.80
 99    40001    91.22365   'Zr-zrh2'    3   0   0  15   0  48   0   0   0    5   8  296  400  500  600  700  800 1000 1200
          1   40790  51.45
          2   40791  11.22
          3   40792  17.15
          4   40794  17.38
          5   40796   2.80
100    40090    89.90473   'Zr-90  '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   40090  100.0
101    40092    91.90501   'Zr-92  '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   40092  100.0
102    40094    93.90630   'Zr-94  '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   40094  100.0
103    41093    92.90319   'Nb-93  '    3   0   0   0   0   0   0   0   0    1   5  293  600  900 1200 2400
          1   41093  100.0
104    42000    95.93756   'Mo-nat '    3   0   0   0   0  49  22   0   0    7   3  293  900 2000
          1   42092  14.77
          2   42094   9.23
          3   42095  15.90
          4   42096  16.68
          5   42097   9.56
          6   42098  24.19
          7   42100   9.67
105    44601   100.90583   'Ru-101 '    2   1  25   0   0   0   0   0   0    1   3  293  900 2000
          1   44101  100.0
106    45603   102.90400   'Rh-103 '    2   1  31   0   0  50   0   0   0    1   3  293  900 2000
          1   45103  100.0
107    45605   104.91124   'Rh-105 '    2   1  32   0   0   0   0   0   0    1   3  293  900 2000
          1   45105  100.0
108    46605   104.90519   'Pd-105 '    2   1  34   0   0   0   0   0   0    1   3  293  900 2000
          1   46105  100.0
109    46607   106.90537   'Pd-107 '    2   1  36   0   0   0   0   0   0    1   3  293  900 2000
          1   46107  100.0
110    47609   108.90455   'Ag-109 '    2   1  38   0   0  51  23   0   0    1   3  293  900 2000
          1   47109  100.0
111    48000   112.41112   'Cd-nat '    3   0   0   0   0   0   0   0   0    8   3  293  900 2000
          1   48106   1.25
          2   48108   0.89
          3   48110  12.49
          4   48111  12.80
          5   48112  24.13
          6   48113  12.22
          7   48114  28.73
          8   48116   7.49
112    48110   109.90313   'Cd-110 '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   48110  100.0
113    48111   110.90372   'Cd-111 '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   48111  100.0
114    48112   111.90331   'Cd-112 '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   48112  100.0
115    48113   112.89987   'Cd-113 '    3   0   0   0   0  52   0   0   0    1   3  293  900 2000
          1   48113  100.0
116    48114   113.90349   'Cd-114 '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   48114  100.0
117    49000   114.81848   'In-nat '    3   0   0   0   0   0   0   0   0    2   3  293  900 2000
          1   49113   4.28
          2   49115  95.72
118    49615   114.90409   'In-115 '    2   1  44   0   0   0   0   0   0    1   3  293  900 2000
          1   49115  100.000
119    50000   118.71012   'Sn-nat '    3   0   0   0   0   0   0   0   0   10   3  293  900 2000
          1   50112    0.970
          2   50114    0.660
          3   50115    0.340
          4   50116   14.540
          5   50117    7.680
          6   50118   24.220
          7   50119    8.590
          8   50120   32.580
          9   50122    4.630
         10   50124    5.790
120    50112   111.90432   'Sn-112 '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   50112  100.0
121    50114   113.90248   'Sn-114 '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   50114  100.0
122    50115   114.90308   'Sn-115 '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   50115  100.0
123    50116   115.90166   'Sn-116 '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   50116  100.0
124    50117   116.90326   'Sn-117 '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   50117  100.0
125    50118   117.90184   'Sn-118 '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   50118  100.0
126    50119   118.90344   'Sn-119 '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   50119  100.0
127    50120   119.90202   'Sn-120 '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   50120  100.0
128    50122   121.90321   'Sn-122 '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   50122  100.0
129    50124   123.90541   'Sn-124 '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   50124  100.0
130    51000   121.76325   'Sb-nat '    3   0   0   0   0   0   0   0   0    2   3  293  900 2000
          1   51121  57.210
          2   51123  42.790
131    51121   120.90867   'Sb-121 '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   51121  100.0
```

```
 132   51123   122.90583   'Sb-123 '    3   0   0   0   0   0   0   0   0    1   3  293   900 2000
          1   51123  100.0
 133   54634   133.91036   'Xe-134 '    2   1  60   0   0  53  24   0   0    1   3  293   900 2000
          1   54134  100.0
 134   60643   142.90967   'Nd-143 '    2   1  81   0   0  54  25   0   0    1   3  293   900 2000
          1   60143  100.0
 135   60645   144.91288   'Nd-145 '    2   1  83   0   0  55  26   0   0    1   3  293   900 2000
          1   60145  100.0
 136   61647   146.91508   'Pm-147 '    2   1  88   0   0  56  27   0   0    1   3  293   900 2000
          1   61147  100.0
 137   61748   147.92072   'Pm-148m'    2   1  92   0   0   0   0   0   0    1   3  293   900 2000
          1   61601  100.0
 138   62153   152.92168   'Sm-153 '    3   1   0   0   0   0   0   0   0    1   3  293   900 2000
          1   62153  100.0
 139   62647   146.91508   'Sm-147 '    2   1  93   0   0  57  28   0   0    1   3  293   900 2000
          1   62147  100.0
 140   62649   148.91728   'Sm-149 '    2   1  95   0   0  58  29   0   0    1   3  293   900 2000
          1   62149  100.0
 141   62650   149.91687   'Sm-150 '    2   1  96   0   0  59   0   0   0    1   3  293   900 2000
          1   62150  100.0
 142   62651   150.91948   'Sm-151 '    2   1  97   0   0  60  30   0   0    1   3  293   900 2000
          1   62151  100.0
 143   62652   151.92007   'Sm-152 '    2   1  98   0   0  61  31   0   0    1   3  293   900 2000
          1   62152  100.0
 144   63156   155.92548   'Eu-156 '    3   1   0   0   0   0   0   0   0    1   3  293   900 2000
          1   63156  100.0
 145   63157   156.92507   'Eu-157 '    3   1   0   0   0   0   0   0   0    1   3  293   900 2000
          1   63157  100.0
 146   63653   152.92168   'Eu-153 '    2   1 102   0   0  62  32   0   0    1   3  293   900 2000
          1   63153  100.0
 147   63654   153.92227   'Eu-154 '    2   1 103   0   0  63  33   0   0    1   3  293   900 2000
          1   63154  100.0
 148   63655   154.92085   'Eu-155 '    2   1 104   0   0  64  34   0   0    1   3  293   900 2000
          1   63155  100.0
 149   64152   151.92007   'Gd-152 '    3   0   0   0   0  65   0   0   0    1   3  293   900 2000
          1   64152  100.0
 150   64154   153.92127   'Gd-154 '    3   0   0   0   0  66   0   0   0    1   3  293   900 2000
          1   64154  100.0
 151   64160   159.92686   'Gd-160 '    3   0   0   0   0  67   0   0   0    1   3  293   900 2000
          1   64160  100.0
 152   64655   154.92287   'Gd-155 '    2   1 108   0   0  68   0   0   0    1   3  293   900 2000
          1   64155  100.0
 153   64656   155.92246   'Gd-156 '    2   1 109   0   0  69   0   0   0    1   3  293   900 2000
          1   64156  100.0
 154   64657   156.92406   'Gd-157 '    2   1 110   0   0  70   0   0   0    1   3  293   900 2000
          1   64157  100.0
 155   64658   157.92365   'Gd-158 '    2   1 111   0   0  71   0   0   0    1   3  293   900 2000
          1   64158  100.0
! ------------------------------------------------------------------------------------------------- Newly added on 11/15/2016(b)
 156   68162   161.92906   'Er-162 '    3   0   0   0   0   0   0   0   0    1   3  293   900 2000
          1   68162  100.0
 157   68164   163.92924   'Er-164 '    3   0   0   0   0   0   0   0   0    1   3  293   900 2000
          1   68164  100.0
! ------------------------------------------------------------------------------------------------- Newly added on 11/15/2016(e)
 158   68168   167.92960   'Er-168 '    3   0   0   0   0   0   0   0   0    1   3  293   900 2000
          1   68168  100.0
! ------------------------------------------------------------------------------------------------- Newly added on 11/15/2016(b)
 159   68170   169.93584   'Er-170 '    3   0   0   0   0   0   0   0   0    1   3  293   900 2000
          1   68170  100.0
! ------------------------------------------------------------------------------------------------- Newly added on 11/15/2016(e)
 160   71176   175.94143   'Lu-176 '    3   0   0   0   0   0   0   0   0    1   3  293   900 2000
          1   71176  100.0
 161   72174   173.94024   'Hf-174 '    3   0   0   0   0  72   0   0   0    1   3  293   900 2000
          1   72174  100.0
 162   73181   180.95449   'Ta-181 '    3   0   0   0   0  73  35   0   0    1   3  293   900 2000
          1   73181  100.0
 163   73182   181.95005   'Ta-182 '    3   0   0   0   0  74  36   0   0    1   3  293   900 2000
          1   73182  100.0
 164   74000   183.84635   'W-nat  '    3   0   0   0   0  75  37   0   0    4   3  293   900 2000
          1   74182  26.62
          2   74183  14.31
          3   74184  30.64
          4   74186  28.43
 165   79197   196.96604   'Au-197 '    3   0   0   0   0   0   0   0   0    1   3  293   900 2000
          1   79197  100.0
 166   82206   205.97443   'Pb-206 '    3   0   0   0   0   0   0   0   0    1   3  293   900 2000
          1   82206  100.0
 167   82207   206.97593   'Pb-207 '    3   0   0   0   0   0   0   0   0    1   3  293   900 2000
          1   82207  100.0
 168   82208   207.97663   'Pb-208 '    3   0   0   0   0   0   0   0   0    1   3  293   900 2000
          1   82208  100.0
 169   83209   208.98025   'Bi-209 '    3   0   0   0   0  76  38   0   0    1   3  293   900 2000
          1   83209  100.0
 170   90230   230.03613   'Th-230 '    2   3   0   0   0  77  39   0   0    1   3  293   900 2000
          1   90230  100.0
 171   91231   231.03572   'Pa-231 '    2   3   0   0   0  78  40   0   0    1   3  293   900 2000
          1   91231  100.0
 172   91233   233.03994   'Pa-233 '    2   3   0   0   0  79  41   0   0    1   5  293   600  900 1200 2400
          1   91233  100.0
 173   92232   232.03712   'U-232  '    2   3   0   0   0  80  42   0   0    1   3  293   900 2000
          1   92232  100.0
 174   92234   234.04094   'U-234  '    2   3   0  20  11  81  43   0   0    1   3  293   900 2000
          1   92234  100.0
 175   92237   237.04877   'U-237  '    2   3   0   0   0  82  44   0   0    1   3  293   900 2000
          1   92237  100.0
 176   93237   237.04817   'Np-237 '    2   3   0   0  12  83  45   0   0    1   3  293   900 2000
          1   93237  100.0
 177   93238   238.05098   'Np-238 '    2   3   0   0   0   0   0   0   0    1   3  293   900 2000
          1   93238  100.0
 178   93239   239.05259   'Np-239 '    2   3   0   0  13  84  46   0   0    1   3  293   900 2000
```

```
          1   93239  100.0
 179   94236   236.04576   'Pu-236 '    2   3   0   0  14  85  47   0   0    1   3  293  900 2000
          1   94236  100.0
 180   95242   242.05942   'Am-242 '    2   3   0   0   0   0   0   0   0    1   3  293  900 2000
          1   95242  100.0
 181   95342   242.05942   'Am-242m'    2   3   0   0   0  86  48   0   0    1   3  293  900 2000
          1   95601  100.0
 182   95243   243.06143   'Am-243 '    2   3   0   0   0  87  49   0   0    1   3  293  900 2000
          1   95243  100.0
 183   96242   242.05841   'Cm-242 '    2   3   0   0   0  88  50   0   0    1   3  293  900 2000
          1   96242  100.0
 184   96243   243.06102   'Cm-243 '    2   3   0   0   0  89  51   0   0    1   3  293  900 2000
          1   96243  100.0
 185   96244   244.06263   'Cm-244 '    2   3   0   0   0  90  52   0   0    1   3  293  900 2000
          1   96244  100.0
 186   96245   245.06524   'Cm-245 '    2   3   0   0   0  91  53   0   0    1   3  293  900 2000
          1   96245  100.0
 187   96246   246.06684   'Cm-246 '    2   3   0   0   0  92  54   0   0    1   3  293  900 2000
          1   96246  100.0
 188   96247   247.07047   'Cm-247 '    2   3   0   0   0  93  55   0   0    1   3  293  900 2000
          1   96247  100.0
 189   96248   248.07207   'Cm-248 '    2   3   0   0   0  94  56   0   0    1   3  293  900 2000
          1   96248  100.0
 190   97249   249.07973   'Bk-249 '    2   3   0   0   0  95  57   0   0    1   3  293  900 2000
          1   97249  100.0
 191   98249   249.07973   'Cf-249 '    2   3   0   0   0  96  58   0   0    1   3  293  900 2000
          1   98249  100.0
 192   98250   250.07629   'Cf-250 '    2   3   0   0   0  97  59   0   0    1   3  293  900 2000
          1   98250  100.0
 193   98251   251.07991   'Cf-251 '    2   3   0   0   0  98  60   0   0    1   3  293  900 2000
          1   98251  100.0
 194   98252   252.08151   'Cf-252 '    2   3   0   0   0  99  61   0   0    1   3  293  900 2000
          1   98252  100.0
!   ---------------------------------------------------------------------------------------------
 195   1003     3.01550   'T-3    '    1   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1    1003  100.0
 196   2003     3.01493   'He-3   '    1   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1    2003  100.0
 197   35581    80.91631   'Br-81  '    2   1   1   0   0   0   0   0   0    1   1 1100
          1   35081  100.0
 198   36582    81.91348   'Kr-82  '    2   1   2   0   0 100   0   0   0    1   1 1100
          1   36082  100.0
 199   36583    82.91428   'Kr-83  '    2   1   3   0   0 101  62   0   0    1   1 1100
          1   36083  100.0
 200   36584    83.91154   'Kr-84  '    2   1   4   0   0 102   0   0   0    1   1 1100
          1   36084  100.0
 201   36585    84.91254   'Kr-85  '    2   1   5   0   0   0   0   0   0    1   1 1100
          1   36085  100.0
 202   36586    85.91062   'Kr-86  '    2   1   6   0   0 103  63   0   0    1   1 1100
          1   36086  100.0
 203   38589    88.90776   'Sr-89  '    2   1   7   0   0   0   0   0   0    1   1 1100
          1   38089  100.0
 204   38590    89.90776   'Sr-90  '    2   1   8   0   0   0   0   0   0    1   1 1100
          1   38090  100.0
 205   39589    88.90585   'Y-89   '    2   1   9   0   0 104   0   0   0    1   1 1100
          1   39089  100.0
 206   39590    89.90715   'Y-90   '    2   1  10   0   0   0   0   0   0    1   1 1100
          1   39090  100.0
 207   39591    90.90734   'Y-91   '    2   1  11   0   0   0   0   0   0    1   1 1100
          1   39091  100.0
 208   40591    90.90563   'Zr-91  '    2   1  12   0   0 105   0   0   0    1   1 1100
          1   40091  100.0
 209   40593    92.90642   'Zr-93  '    2   1  13   0   0   0   0   0   0    1   1 1100
          1   40093  100.0
 210   40595    94.90801   'Zr-95  '    2   1  14   0   0   0   0   0   0    1   1 1100
          1   40095  100.0
 211   40596    95.90830   'Zr-96  '    2   1  15   0   0 106   0   0   0    1   1 1100
          1   40096  100.0
 212   41595    94.90680   'Nb-95  '    2   1  16   0   0   0   0   0   0    1   1 1100
          1   41095  100.0
 213   42095    94.90589   'Mo-95  '    3   0   0   0   0   0   0   0   0    1   1 1100
          1   42095  100.0
 214   42596    95.90467   'Mo-96  '    2   1  18   0   0   0   0   0   0    1   3  293  900 2000
          1   42096  100.0
 215   42597    96.90597   'Mo-97  '    2   1  19   0   0   0   0   0   0    1   1 1100
          1   42097  100.0
 216   42598    97.90536   'Mo-98  '    2   1  20   0   0   0   0   0   0    1   1 1100
          1   42098  100.0
 217   42599    98.90767   'Mo-99  '    2   1  21   0   0   0   0   0   0    1   1 1100
          1   42099  100.0
 218   42600    99.90726   'Mo-100 '    2   1  22   0   0   0   0   0   0    1   1 1100
          1   42100  100.0
 219   44600    99.90413   'Ru-100 '    2   1  24   0   0   0   0   0   0    1   1 1100
          1   44100  100.0
 220   44602   101.90542   'Ru-102 '    2   1  26   0   0   0   0   0   0    1   1 1100
          1   44102  100.0
 221   44603   102.90400   'Ru-103 '    2   1  27   0   0   0   0   0   0    1   1 1100
          1   44103  100.0
 222   44604   103.90258   'Ru-104 '    2   1  28   0   0   0   0   0   0    1   1 1100
          1   44104  100.0
 223   44605   104.91124   'Ru-105 '    2   1  29   0   0   0   0   0   0    1   1 1100
          1   44105  100.0
 224   44606   105.90680   'Ru-106 '    2   1  30   0   0   0   0   0   0    1   1 1100
          1   44106  100.0
 225   46604   103.90399   'Pd-104 '    2   1  33   0   0   0   0   0   0    1   1 1100
          1   46104  100.0
 226   46606   105.90347   'Pd-106 '    2   1  35   0   0   0   0   0   0    1   1 1100
          1   46106  100.0
 227   47710   109.90615   'Ag-110m'    2   1  39   0   0   0   0   0   0    1   1 1100
          1   47601  100.0
```

```
228   47611   110.90574   'Ag-111 '    2   1  40   0   0   0   0   0   0    1   1 1100
          1   47111  100.0
229   48610   109.90313   'Cd-110 '    2   1  41   0   0   0   0   0   0    1   1 1100
          1   48110  100.0
230   48611   110.90372   'Cd-111 '    2   1  42   0   0   0   0   0   0    1   1 1100
          1   48111  100.0
231   48613   112.89987   'Cd-113 '    2   1  43   0   0 107   0   0   0    1   1 1100
          1   48113  100.0
232   50125   124.90803   'Sn-125 '    3   0   0   0   0   0   0   0   0    1   1 1100
          1   50125  100.0
233   51621   120.90867   'Sb-121 '    2   1  45   0   0   0   0   0   0    1   1 1100
          1   51121  100.0
234   51625   124.90500   'Sb-125 '    2   1  46   0   0   0   0   0   0    1   1 1100
          1   51125  100.0
235   51627   126.90690   'Sb-127 '    2   1  47   0   0   0   0   0   0    0   1 1100
236   52727   126.90518   'Te-127m'    2   1  48   0   0   0   0   0   0    1   1 1100
          1   52601  100.0
237   52729   128.90738   'Te-129m'    2   1  49   0   0   0   0   0   0    1   1 1100
          1   52611  100.0
238   52632   131.90816   'Te-132 '    2   1  50   0   0   0   0   0   0    1   1 1100
          1   52132  100.0
239   53627   126.90448   'I-127  '    2   1  51   0   0 108  64   0   0    1   1 1100
          1   53127  100.0
240   53629   128.90537   'I-129  '    2   1  52   0   0   0   0   0   0    1   1 1100
          1   53129  100.0
241   53631   130.90555   'I-131  '    2   1  53   0   0   0   0   0   0    1   1 1100
          1   53131  100.0
242   53635   134.90894   'I-135  '    2   1  54   0   0   0   0   0   0    1   1 1100
          1   53135  100.0
243   54628   127.90275   'Xe-128 '    2   1  55   0   0 109  65   0   0    1   1 1100
          1   54128  100.0
244   54630   129.90394   'Xe-130 '    2   1  56   0   0 110  66   0   0    1   1 1100
          1   54130  100.0
245   54632   131.90312   'Xe-132 '    2   1  58   0   0 111  67   0   0    1   1 1100
          1   54132  100.0
246   54633   132.90573   'Xe-133 '    2   1  59   0   0   0   0   0   0    1   1 1100
          1   54133  100.0
247   54635   134.90692   'Xe-135 '    2   1  61   0   0   0   0   0   0    1   1 1100
          1   54135  100.0
248   54636   135.90752   'Xe-136 '    2   1  62   0   0 112  68   0   0    1   1 1100
          1   54136  100.0
249   55634   133.90733   'Cs-134 '    2   1  64   0   0   0   0   0   0    1   1 1100
          1   55134  100.0
250   55635   134.90591   'Cs-135 '    2   1  65   0   0   0   0   0   0    1   1 1100
          1   55135  100.0
251   55636   135.90651   'Cs-136 '    2   1  66   0   0   0   0   0   0    1   1 1100
          1   55136  100.0
252   55637   136.90710   'Cs-137 '    2   1  67   0   0   0   0   0   0    1   1 1100
          1   55137  100.0
253   56634   133.90431   'Ba-134 '    2   1  68   0   0   0   0   0   0    1   1 1100
          1   56134  100.0
254   56637   136.90610   'Ba-137 '    2   1  69   0   0   0   0   0   0    1   1 1100
          1   56137  100.0
255   56640   139.90990   'Ba-140 '    2   1  70   0   0   0   0   0   0    1   1 1100
          1   56140  100.0
256   57639   138.90325   'La-139 '    2   1  71   0   0   0   0   0   0    1   1 1100
          1   57139  100.0
257   57640   139.90990   'La-140 '    2   1  72   0   0   0   0   0   0    1   1 1100
          1   57140  100.0
258   58640   139.90486   'Ce-140 '    2   1  73   0   0   0   0   0   0    1   1 1100
          1   58140  100.0
259   58641   140.91050   'Ce-141 '    2   1  74   0   0   0   0   0   0    1   1 1100
          1   58141  100.0
260   58642   141.90907   'Ce-142 '    2   1  75   0   0   0   0   0   0    1   1 1100
          1   58142  100.0
261   58643   142.91270   'Ce-143 '    2   1  76   0   0   0   0   0   0    1   1 1100
          1   58143  100.0
262   58644   143.91430   'Ce-144 '    2   1  77   0   0   0   0   0   0    1   1 1100
          1   58144  100.0
263   59641   140.90747   'Pr-141 '    2   1  78   0   0 113  69   0   0    1   1 1100
          1   59141  100.0
264   59643   142.91068   'Pr-143 '    2   1  79   0   0   0   0   0   0    1   1 1100
          1   59143  100.0
265   60642   141.90807   'Nd-142 '    2   1  80   0   0   0   0   0   0    1   1 1100
          1   60142  100.0
266   60644   143.91027   'Nd-144 '    2   1  82   0   0   0   0   0   0    1   1 1100
          1   60144  100.0
267   60646   145.91347   'Nd-146 '    2   1  84   0   0 114  70   0   0    1   1 1100
          1   60146  100.0
268   60647   146.91609   'Nd-147 '    2   1  85   0   0   0   0   0   0    1   1 1100
          1   60147  100.0
269   60648   147.91668   'Nd-148 '    2   1  86   0   0 115  71   0   0    1   1 1100
          1   60148  100.0
270   60650   149.92090   'Nd-150 '    2   1  87   0   0 116  72   0   0    1   1 1100
          1   60150  100.0
271   61648   147.91668   'Pm-148 '    2   1  89   0   0   0   0   0   0    1   1 1100
          1   61148  100.0
272   61649   148.91829   'Pm-149 '    2   1  90   0   0   0   0   0   0    1   1 1100
          1   61149  100.0
273   61651   150.92150   'Pm-151 '    2   1  91   0   0   0   0   0   0    1   1 1100
          1   61151  100.0
274   62648   147.91467   'Sm-148 '    2   1  94   0   0   0   0   0   0    1   1 1100
          1   62148  100.0
275   62653   152.92168   'Sm-153 '    2   1  99   0   0   0   0   0   0    1   1 1100
          1   62153  100.0
276   62654   153.92227   'Sm-154 '    2   1 100   0   0   0   0   0   0    1   1 1100
          1   62154  100.0
277   63651   150.91645   'Eu-151 '    2   1 101   0   0 117  73   0   0    1   1 1100
          1   63151  100.0
278   63656   155.92548   'Eu-156 '    2   1 105   0   0   0   0   0   0    1   1 1100
```

```
          1   63156  100.0
 279   63657   156.92507   'Eu-157 '    2   1 106   0   0   0   0   0   0    1   1 1100
          1   63157  100.0
 280   64654   153.92127   'Gd-154 '    2   1 107   0   0 118   0   0   0    1   1 1100
          1   64154  100.0
 281   64660   159.92686   'Gd-160 '    2   1 112   0   0 119   0   0   0    1   1 1100
          1   64160  100.0
 282   65159   158.92525   'Tb-159 '    3   0   0   0   0   0   0   0   0    1   1 1100
          1   65159  100.0
 283   65160   159.92686   'Tb-160 '    3   1   0   0   0   0   0   0   0    1   1 1100
          1   65160  100.0
 284   65161   160.92760   'Tb-161 '    3   1   0   0   0   0   0   0   0    0   1 1100
 285   65659   158.92525   'Tb-159 '    2   1 113   0   0   0   0   0   0    1   1 1100
          1   65159  100.0
 286   65660   159.92686   'Tb-160 '    2   1 114   0   0   0   0   0   0    1   1 1100
          1   65160  100.0
 287   65661   160.92760   'Tb-161 '    2   1 115   0   0   0   0   0   0    0   1 1100
 288   66660   159.92484   'Dy-160 '    2   1 116   0   0   0   0   0   0    1   1 1100
          1   66160  100.0
 289   66661   160.92644   'Dy-161 '    2   1 117   0   0   0   0   0   0    1   1 1100
          1   66161  100.0
 290   66662   161.92704   'Dy-162 '    2   1 118   0   0   0   0   0   0    1   1 1100
          1   66162  100.0
 291   66663   162.92864   'Dy-163 '    2   1 119   0   0   0   0   0   0    1   1 1100
          1   66163  100.0
 292   66664   163.92924   'Dy-164 '    2   1 120   0   0 120  74   0   0    1   1 1100
          1   66164  100.0
 293   67165   164.92983   'Ho-165 '    3   0   0   0   0 121  75   0   0    1   1 1100
          1   67165  100.0
 294   67665   164.92983   'Ho-165 '    2   1 121   0   0 122  76   0   0    1   1 1100
          1   67165  100.0
 295   77191   190.96045   'Ir-191 '    3   0   0   0   0   0   0   0   0    1   1 1100
          1   77191  100.0
 296   77193   192.96265   'Ir-193 '    3   0   0   0   0   0   0   0   0    1   1 1100
          1   77193  100.0
 297   91232   232.03833   'Pa-232 '    2   1   0   0   0   0   0   0   0    1   1 1100
          1   91232  100.0
 298   91234   234.04330   'Pa-234 '    2   1   0   0   0   0   0   0   0    0   1 1100
%FINE
```

APPENDIX B.4. THE DECLIB INPUT FILE TO GENERATE THE ENDF/B-7.1 MPACT 51-G LIBRARY

[DECLIB input]

```
%TITL
  DATE::DECEMBER 06, 2016; GROUP::51; MASTER::ENDF/B-VII R1; SUBGROUP::YES; TRC::YES
%IOPT
! LIBRARY VERSION
  VER  4.2
! 0: Unformatted master library -> Formatted master library
! 1: Formatted master library -> Unformatted master library
! 2: Unformatted master library -> DeCART library
! 3: Formatted master library -> DeCART library
  LIB   2
! 0: lambda*sig-p is not included in sig-b
! 1: lambda*sig-p is included in sig-b
  BXS   0
! 0: No transport corrected total XS
! 1: Transport corrected total XS
! 2: Transport correction is applied to p1 scattering matrix only for testing.
  XST   1
%FILE
  AMP  ampx51g_71_4.2m5_03_OLD.bin   ampx51g_71_4.2m5_03_OLD.fmt
  DEC  mpact51g_71_v4.2m5_12062016_sph.fmt   mpact51g_71_v4.2m5_12062016_sph.bin
  END  n-endfb7.1
  DCY  dec-endfb7.0
  FPY  fpy-endfb7.0
  SUB  subgr_51g_71_m5_12052016_sph.sub               !Subgroup data
  TRC  tcorr_51g_71_10102016_1n.dat                   !Transport correction
  XSB  backxs_51g_final_Er_12052016_m5.dat            !Background XS
  DLY  totbeta_e71_10062014.dat                       !Transient data
  DBR  subgr_u238_51g_71_m3_dbrc_sph.sub              !Epithermal upscattering
%COLL
  FLX  fluxcur_51g2.dat
  SUB  subgr.sub_moc49g_mod
  LAM  rilamb.irp_e705_49g
%RESO  !# of fast / end of reso.
  GRP    9   31
%NUCL
! NRES  NELR   NELT  NYLD
  49    194    298   121
!
! ------------------------------------------------------------------------------------------
! NID    NUCLIDE ID  1000*Z+500*A+100*B+A
!        A=0: ACTIVATION & HEAVY NUCLIDES / A=1: F.P. NUCLIDES
!        B=0: STABLE / B=1: METASTABLE
! AMASS  ATOMIC MASS
! AID    ALPHANUMERIC NUCLIDE ID.
! NO0    1/2/3  COLLAPSING SPECTRA (MODERATOR/FUEL/STRUCTURE)
! NO1    0  NON DEPLETABLE
!       >0  DEPLETABLE (W/ DECAY CONSTANT)
!        1
!        2 RI-A ONLY (FISSIONABLE W/ KAPPA, BETA, FPY)
!        3 RI-A & RI-NF (FISSIONABLE W/ KAPPA, BETA, FPY)
! NO2    NFPY  (ORDERING NO. OF FPY) (+/- : CUMULATIVE/DIRECT YIELD)
! NO3    NPI   (WITH P1/P2/P3)
! NO4    NCHIX (WITH FISSION SPECTRA)
! NO5    N2N   (WITH N2N)
! NO6    N3N   (WITH N3N)
! NO7    EPU   (WITH EPITHERMAL UPSCATTERING RESONANCE DATA)
! NO8    TRC   (TRANSPORT CORRECTION) (0/1/2 : OUTSCATT/NLC/INSCATT)
! AMPX   # OF AMPX NUCLIDES TO BE MERGED
! #T     # OF TEMPERATURES
! ------------------------------------------------------------------------------------------
! NO     NID      AMASS       AID    NO0 NO1 NO2 NO3 NO4 NO5 NO6 NO7 NO8 AMPX  #T  TEMPERATURE(K)
! ------------------------------------------------------------------------------------------
   1   40091    90.90563   'Zr-91  '    3   1   0   0   0   0   0   0   0    1   3  293  900 2000
           1   40091  100.0
   2   40096    95.90830   'Zr-96  '    3   1   0   0   0   0   0   0   0    1   3  293  900 2000
           1   40096  100.0
   3   42595    94.90589   'Mo-95  '    2   1  17   0   0   0   0   0   0    1   3  293  900 2000
           1   42095  100.0
   4   43599    98.90767   'Tc-99  '    2   1  23   0   0   2   0   0   0    1   3  293  900 2000
           1   43099  100.0
   5   45103   102.90501   'Rh-103 '    3   1   0   0   0   0   0   0   0    1   3  293  900 2000
           1   45103  100.0
   6   46608   107.90385   'Pd-108 '    2   1  37   0   0   0   0   0   0    1   3  293  900 2000
           1   46108  100.0
   7   47107   106.90537   'Ag-107 '    3   0   0   0   0   3   1   0   0    1   3  293  900 2000
           1   47107  100.0
   8   47109   108.90455   'Ag-109 '    3   0   0   0   0   4   2   0   0    1   3  293  900 2000
           1   47109  100.0
   9   49113   112.90390   'In-113 '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
           1   49113  100.0
  10   49115   114.90409   'In-115 '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
           1   49115  100.0
  11   54631   130.90555   'Xe-131 '    2   1  57   0   0   5   3   0   0    1   3  293  900 2000
           1   54131  100.0
  12   55633   132.90573   'Cs-133 '    2   1  63   0   0   6   0   0   0    1   3  293  900 2000
           1   55133  100.0
  13   62152   151.92007   'Sm-152 '    3   0   0   0   0   7   4   0   0    1   5  293  600  900 1200 2400
           1   62152  100.0
  14   63151   150.91645   'Eu-151 '    3   0   0   0   0   8   5   0   0    1   5  293  600  900 1200 2400
           1   63151  100.0
```

```
  15   63152   151.92209   'Eu-152 '    3   1   0   0   0   9   6   0   0    1   5  293  600  900 1200 2400
          1   63152  100.0
  16   63153   152.92168   'Eu-153 '    3   0   0   0   0  10   7   0   0    1   5  293  600  900 1200 2400
          1   63153  100.0
  17   63154   153.92227   'Eu-154 '    3   1   0   0   0  11   8   0   0    1   5  293  600  900 1200 2400
          1   63154  100.0
  18   63155   154.92085   'Eu-155 '    3   1   0   0   0  12   9   0   0    1   5  293  600  900 1200 2400
          1   63155  100.0
  19   64155   154.92287   'Gd-155 '    2   0   0   0   0  13   0   0   0    1   5  293  600  900 1200 2400
          1   64155  100.0
  20   64156   155.92246   'Gd-156 '    2   0   0   0   0  14   0   0   0    1   5  293  600  900 1200 2400
          1   64156  100.0
  21   64157   156.92406   'Gd-157 '    2   0   0   0   0  15   0   0   0    1   5  293  600  900 1200 2400
          1   64157  100.0
  22   64158   157.92365   'Gd-158 '    2   0   0   0   0  16   0   0   0    1   5  293  600  900 1200 2400
          1   64158  100.0
  23   66160   159.92484   'Dy-160 '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   66160  100.0
  24   66161   160.92644   'Dy-161 '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   66161  100.0
  25   66162   161.92704   'Dy-162 '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   66162  100.0
  26   66163   162.92864   'Dy-163 '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   66163  100.0
  27   66164   163.92924   'Dy-164 '    3   0   0   0   0  17  10   0   0    1   3  293  900 2000
          1   66164  100.0
  28   68166   165.93043   'Er-166 '    2   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   68166  100.0
  29   68167   166.93203   'Er-167 '    2   0   0   0   0   0   0   0   0    1   5  293  600  900 1200 2400
          1   68167  100.0
  30   72176   175.94143   'Hf-176 '    3   0   0   0   0  18   0   0   0    1   3  293  900 2000
          1   72176  100.0
  31   72177   176.94303   'Hf-177 '    3   0   0   0   0  19   0   0   0    1   3  293  900 2000
          1   72177  100.0
  32   72178   177.94363   'Hf-178 '    3   0   0   0   0  20   0   0   0    1   3  293  900 2000
          1   72178  100.0
  33   72179   178.94624   'Hf-179 '    3   0   0   0   0  21   0   0   0    1   3  293  900 2000
          1   72179  100.0
  34   72180   179.94684   'Hf-180 '    3   0   0   0   0  22   0   0   0    1   3  293  900 2000
          1   72180  100.0
! ------------------------------------------------------------------------------------------------------- Newly added on 05/22/2013(b)
  35   74182   181.95307   'W-182  '    3   0   0   0   0  23   0   0   0    1   3  293  900 2000
          1   74182  100.0
  36   74183   182.95165   'W-183  '    3   0   0   0   0  24   0   0   0    1   3  293  900 2000
          1   74183  100.0
  37   74184   183.95023   'W-184  '    3   0   0   0   0  25   0   0   0    1   3  293  900 2000
          1   74184  100.0
  38   74186   185.95747   'W-186  '    3   0   0   0   0  26   0   0   0    1   3  293  900 2000
          1   74186  100.0
! ------------------------------------------------------------------------------------------------------- Newly added on 05/22/2013(e)
  39   90232   232.03833   'Th-232 '    2   2   0  18   1  27  11   0   0    1   5  293  600  900 1200 2400
          1   90232  100.0
  40   92233   233.03963   'U-233  '    2   3   0  19   2  28  12   0   0    1   5  293  600  900 1200 2400
          1   92233  100.0
  41   92235   235.04395   'U-235  '    2   3   0  21   3  29  13   0   0    1   5  293  600  900 1200 2400
          1   92235  100.0
  42   92236   236.04556   'U-236  '    2   3   0  22   4  30  14   0   0    1   3  293  900 2000
          1   92236  100.0
  43   92238   238.05078   'U-238  '    2   2   0  23   5  31  15   1   0    1   5  293  600  900 1200 2400
          1   92238  100.0
  44   94238   238.04947   'Pu-238 '    2   3   0   0   6  32  16   0   0    1   3  293  900 2000
          1   94238  100.0
  45   94239   239.05218   'Pu-239 '    2   3   0  24   7  33  17   0   0    1   5  293  600  900 1200 2400
          1   94239  100.0
  46   94240   240.05419   'Pu-240 '    2   3   0  25   8  34  18   0   0    1   5  293  600  900 1200 2400
          1   94240  100.0
  47   94241   241.04874   'Pu-241 '    2   3   0  26   9  35  19   0   0    1   5  293  600  900 1200 2400
          1   94241  100.0
  48   94242   242.05841   'Pu-242 '    2   3   0  27  10  36  20   0   0    1   3  293  900 2000
          1   94242  100.0
  49   95241   241.05681   'Am-241 '    2   3   0   0   0  37  21   0   0    1   3  293  900 2000
          1   95241  100.0
! ------------------------------------------------------------------------------------------------------------------------------
  50    1001     1.00783   'H-1    '    1   0   0   1   0   0   0   0   1    1   9  293.6  350  400  450  500  550  600  650  800
          1    1001  100.0
  51    1002     2.01410   'H-2    '    1   0   0   2   0  38   0   0   0    1   5  293  600  900 1200 2400
          1    1002  100.0
  52    1006     1.00783   'H-1ch2 '    1   0   0   3   0   0   0   0   0    1   3  293  900 2000
          1    1901  100.0
  53    1040     1.00783   'H-1zrh '    1   0   0   4   0   0   0   0   0    1   3  296  400  500  600  700  800 1000 1200
          1    1701  100.0
 54     2004     4.00260   'He-4   '    1   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1    2004  100.0
 55     3006     6.01507   'Li-6   '    1   0   0   7   0   0   0   0   0    1   5  293  600  900 1200 2400
          1    3006  100.0
 56     3007     7.01600   'Li-7   '    1   0   0   8   0  39   0   0   0    1   3  293  900 2000
          1    3007  100.0
 57     4009     9.01220   'Be-9   '    1   0   0   0   0  40   0   0   0    1   3  293  900 2000
          1    4009  100.0
 58     5000    10.81101   'B-nat  '    1   0   0  28   0   0   0   0   0    2   5  293  600  900 1200 2400
          1    5010   19.90
          2    5011   80.10
 59     5010    10.01294   'B-10   '    1   1   0  29   0   0   0   0   0    1   5  293  600  900 1200 2400
          1    5010  100.0
 60     5011    11.00928   'B-11   '    1   1   0  30   0   0   0   0   0    1   5  293  600  900 1200 2400
          1    5011  100.0
 61     6000    12.00110   'C-nat  '    1   0   0   9   0   0   0   0   0    1   5  293  600  900 1200 2400
          1    6000  100.0
 62     6001    12.00110   'C-graph'    1   0   0   0   0   0   0   0   0    1  10  296  400  500  600  700  800 1000 1200 1600 2000
          1    6312  100.0
```

```
63     7014    14.00307   'N-14   '    1   0   0   0   0 41   0   0   0    1   3  293  900 2000
          1    7014  100.0
64     8001    15.99730   'O-uo2  '    2   0   0 11   0   0   0   0   0    2   5  293  600  900 1200 2400
          1    8016   99.762
          2    8017    0.238
65     8016    15.99491   'O-16   '    1   0   0 12   0   0   0   0   0    1   5  293  600  900 1200 2400
          1    8016  100.0
66     9019    18.99820   'F-19   '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1    9019  100.0
67    11023    22.98949   'Na-23  '    3   0   0   0   0   0   0   0   0    1   5  293  600  900 1200 2400
          1   11023  100.0
68    12000    24.30505   'Mg-nat '    3   0   0   0   0   0   0   0   0    3   3  293  900 2000
          1   12024   78.99
          2   12025   10.0
          3   12026   11.01
69    13027    26.98154   'Al-27  '    3   0   0 13   0   0   0   0   0    1   5  293  600  900 1200 2400
          1   13027  100.0
70    14000    28.08590   'Si-nat '    3   0   0   0   0   0   0   0   0    3   3  293  900 2000
          1   14028   92.23
          2   14029    4.67
          3   14030    3.10
71    15031    30.97408   'P-31   '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   15031  100.0
72    16000    32.06429   'S-nat  '    3   0   0   0   0   0   0   0   0    4   3  293  900 2000
          1   16032   95.02
          2   16033    0.75
          3   16034    4.21
          4   16036    0.02
73    17000    35.45273   'Cl-nat '    3   0   0   0   0   0   0   0   0    2   3  293  900 2000
          1   17035   75.77
          2   17037   24.23
74    19000    39.09858   'K-nat  '    3   0   0   0   0   0   0   0   0    3   3  293  900 2000
          1   19039   93.26
          2   19040    0.01
          3   19041    6.73
75    20000    40.07803   'Ca-nat '    3   0   0   0   0   0   0   0   0    6   3  293  900 2000
          1   20040  96.941
          2   20042   0.647
          3   20043   0.135
          4   20044   2.086
          5   20046   0.004
          6   20048   0.187
76    22000    47.89328   'Ti-nat '    3   0   0   0   0   0   0   0   0    5   3  293  900 2000
          1   22046   8.0
          2   22047   7.3
          3   22048  73.8
          4   22049   5.5
          5   22050   5.4
77    23000    50.9416   'V-nat  '    3   0   0   0   0   0   0   0   0    2   3  293  900 2000
          1   23050    0.25
          2   23051   99.75
78    24000    51.99589   'Cr-nat '    3   0   0   0   0 42   0   0   0    4   3  293  900 2000
          1   24050    4.345
          2   24052   83.789
          3   24053    9.501
          4   24054    2.365
79    24050    49.94606   'Cr-50  '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   24050  100.0
80    24052    51.94019   'Cr-52  '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   24052  100.0
81    24053    52.94079   'Cr-53  '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   24053  100.0
82    24054    53.93937   'Cr-54  '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   24054  100.0
83    25055    54.93805   'Mn-55  '    3   0   0   0   0 43   0   0   0    1   3  293  900 2000
          1   25055  100.0
84    26000    55.84473   'Fe-nat '    3   0   0   0   0 44   0   0   0    4   3  293  900 2000
          1   26054    5.845
          2   26056   91.754
          3   26057    2.119
          4   26058    0.282
85    26054    53.93937   'Fe-54  '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   26054  100.0
86    26056    55.93451   'Fe-56  '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   26056  100.0
87    26057    56.93510   'Fe-57  '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   26057  100.0
88    26058    57.93368   'Fe-58  '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   26058  100.0
89    27059    58.93317   'Co-59  '    3   0   0   0   0 45   0   0   0    1   3  293  900 2000
          1   27059  100.0
90    28000    58.69361   'Ni-nat '    3   0   0   0   0 46   0   0   0    5   3  293  900 2000
          1   28058   68.077
          2   28060   26.223
          3   28061    1.140
          4   28062    3.634
          5   28064    0.926
91    28058    57.93570   'Ni-58  '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   28058  100.0
92    28060    59.93084   'Ni-60  '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   28060  100.0
93    28061    60.93143   'Ni-61  '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   28061  100.0
94    28062    61.92799   'Ni-62  '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   28062  100.0
95    28064    63.92818   'Ni-64  '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   28064  100.0
96    29063    62.92960   'Cu-63  '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   29063  100.0
97    29065    64.92776   'Cu-65  '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
```

```
          1   29065  100.0
 98   40000   91.22365   'Zr-nat '    3   0   0  14   0  47   0   0   0    5   3  293  900 2000
          1   40090  51.45
          2   40091  11.22
          3   40092  17.15
          4   40094  17.38
          5   40096   2.80
 99   40001   91.22365   'Zr-zrh2'    3   0   0  15   0  48   0   0   0    5   8  296  400  500  600  700  800 1000 1200
          1   40790  51.45
          2   40791  11.22
          3   40792  17.15
          4   40794  17.38
          5   40796   2.80
100   40090   89.90473   'Zr-90  '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   40090  100.0
101   40092   91.90501   'Zr-92  '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   40092  100.0
102   40094   93.90630   'Zr-94  '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   40094  100.0
103   41093   92.90319   'Nb-93  '    3   0   0   0   0   0   0   0   0    1   5  293  600  900 1200 2400
          1   41093  100.0
104   42000   95.93756   'Mo-nat '    3   0   0   0   0  49  22   0   0    7   3  293  900 2000
          1   42092  14.77
          2   42094   9.23
          3   42095  15.90
          4   42096  16.68
          5   42097   9.56
          6   42098  24.19
          7   42100   9.67
105   44601   100.90583   'Ru-101 '    2   1  25   0   0   0   0   0   0    1   3  293  900 2000
          1   44101  100.0
106   45603   102.90400   'Rh-103 '    2   1  31   0   0  50   0   0   0    1   3  293  900 2000
          1   45103  100.0
107   45605   104.91124   'Rh-105 '    2   1  32   0   0   0   0   0   0    1   3  293  900 2000
          1   45105  100.0
108   46605   104.90519   'Pd-105 '    2   1  34   0   0   0   0   0   0    1   3  293  900 2000
          1   46105  100.0
109   46607   106.90537   'Pd-107 '    2   1  36   0   0   0   0   0   0    1   3  293  900 2000
          1   46107  100.0
110   47609   108.90455   'Ag-109 '    2   1  38   0   0  51  23   0   0    1   3  293  900 2000
          1   47109  100.0
111   48000   112.41112   'Cd-nat '    3   0   0   0   0   0   0   0   0    8   3  293  900 2000
          1   48106   1.25
          2   48108   0.89
          3   48110  12.49
          4   48111  12.80
          5   48112  24.13
          6   48113  12.22
          7   48114  28.73
          8   48116   7.49
112   48110   109.90313   'Cd-110 '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   48110  100.0
113   48111   110.90372   'Cd-111 '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   48111  100.0
114   48112   111.90331   'Cd-112 '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   48112  100.0
115   48113   112.89987   'Cd-113 '    3   0   0   0   0  52   0   0   0    1   3  293  900 2000
          1   48113  100.0
116   48114   113.90349   'Cd-114 '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   48114  100.0
117   49000   114.81848   'In-nat '    3   0   0   0   0   0   0   0   0    2   3  293  900 2000
          1   49113   4.28
          2   49115  95.72
118   49615   114.90409   'In-115 '    2   1  44   0   0   0   0   0   0    1   3  293  900 2000
          1   49115  100.000
119   50000   118.71012   'Sn-nat '    3   0   0   0   0   0   0   0   0   10   3  293  900 2000
          1   50112    0.970
          2   50114    0.660
          3   50115    0.340
          4   50116   14.540
          5   50117    7.680
          6   50118   24.220
          7   50119    8.590
          8   50120   32.580
          9   50122    4.630
         10   50124    5.790
120   50112   111.90432   'Sn-112 '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   50112  100.0
121   50114   113.90248   'Sn-114 '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   50114  100.0
122   50115   114.90308   'Sn-115 '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   50115  100.0
123   50116   115.90166   'Sn-116 '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   50116  100.0
124   50117   116.90326   'Sn-117 '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   50117  100.0
125   50118   117.90184   'Sn-118 '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   50118  100.0
126   50119   118.90344   'Sn-119 '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   50119  100.0
127   50120   119.90202   'Sn-120 '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   50120  100.0
128   50122   121.90321   'Sn-122 '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   50122  100.0
129   50124   123.90541   'Sn-124 '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   50124  100.0
130   51000   121.76325   'Sb-nat '    3   0   0   0   0   0   0   0   0    2   3  293  900 2000
          1   51121  57.210
          2   51123  42.790
131   51121   120.90867   'Sb-121 '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
```

```
          1   51121  100.0
 132   51123   122.90583   'Sb-123 '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   51123  100.0
 133   54634   133.91036   'Xe-134 '    2   1  60   0   0  53  24   0   0    1   3  293  900 2000
          1   54134  100.0
 134   60643   142.90967   'Nd-143 '    2   1  81   0   0  54  25   0   0    1   3  293  900 2000
          1   60143  100.0
 135   60645   144.91288   'Nd-145 '    2   1  83   0   0  55  26   0   0    1   3  293  900 2000
          1   60145  100.0
 136   61647   146.91508   'Pm-147 '    2   1  88   0   0  56  27   0   0    1   3  293  900 2000
          1   61147  100.0
 137   61748   147.92072   'Pm-148m'    2   1  92   0   0   0   0   0   0    1   3  293  900 2000
          1   61601  100.0
 138   62153   152.92168   'Sm-153 '    3   1   0   0   0   0   0   0   0    1   3  293  900 2000
          1   62153  100.0
 139   62647   146.91508   'Sm-147 '    2   1  93   0   0  57  28   0   0    1   3  293  900 2000
          1   62147  100.0
 140   62649   148.91728   'Sm-149 '    2   1  95   0   0  58  29   0   0    1   3  293  900 2000
          1   62149  100.0
 141   62650   149.91687   'Sm-150 '    2   1  96   0   0  59   0   0   0    1   3  293  900 2000
          1   62150  100.0
 142   62651   150.91948   'Sm-151 '    2   1  97   0   0  60  30   0   0    1   3  293  900 2000
          1   62151  100.0
 143   62652   151.92007   'Sm-152 '    2   1  98   0   0  61  31   0   0    1   3  293  900 2000
          1   62152  100.0
 144   63156   155.92548   'Eu-156 '    3   1   0   0   0   0   0   0   0    1   3  293  900 2000
          1   63156  100.0
 145   63157   156.92507   'Eu-157 '    3   1   0   0   0   0   0   0   0    1   3  293  900 2000
          1   63157  100.0
 146   63653   152.92168   'Eu-153 '    2   1 102   0   0  62  32   0   0    1   3  293  900 2000
          1   63153  100.0
 147   63654   153.92227   'Eu-154 '    2   1 103   0   0  63  33   0   0    1   3  293  900 2000
          1   63154  100.0
 148   63655   154.92085   'Eu-155 '    2   1 104   0   0  64  34   0   0    1   3  293  900 2000
          1   63155  100.0
 149   64152   151.92007   'Gd-152 '    3   0   0   0   0  65   0   0   0    1   3  293  900 2000
          1   64152  100.0
 150   64154   153.92127   'Gd-154 '    3   0   0   0   0  66   0   0   0    1   3  293  900 2000
          1   64154  100.0
 151   64160   159.92686   'Gd-160 '    3   0   0   0   0  67   0   0   0    1   3  293  900 2000
          1   64160  100.0
 152   64655   154.92287   'Gd-155 '    2   1 108   0   0  68   0   0   0    1   3  293  900 2000
          1   64155  100.0
 153   64656   155.92246   'Gd-156 '    2   1 109   0   0  69   0   0   0    1   3  293  900 2000
          1   64156  100.0
 154   64657   156.92406   'Gd-157 '    2   1 110   0   0  70   0   0   0    1   3  293  900 2000
          1   64157  100.0
 155   64658   157.92365   'Gd-158 '    2   1 111   0   0  71   0   0   0    1   3  293  900 2000
          1   64158  100.0
! ------------------------------------------------------------------------------------------------- Newly added on 11/15/2016(b)
 156   68162   161.92906   'Er-162 '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   68162  100.0
 157   68164   163.92924   'Er-164 '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   68164  100.0
! ------------------------------------------------------------------------------------------------- Newly added on 11/15/2016(e)
 158   68168   167.92960   'Er-168 '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   68168  100.0
! ------------------------------------------------------------------------------------------------- Newly added on 11/15/2016(b)
 159   68170   169.93584   'Er-170 '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   68170  100.0
! ------------------------------------------------------------------------------------------------- Newly added on 11/15/2016(e)
 160   71176   175.94143   'Lu-176 '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   71176  100.0
 161   72174   173.94024   'Hf-174 '    3   0   0   0   0  72   0   0   0    1   3  293  900 2000
          1   72174  100.0
 162   73181   180.95449   'Ta-181 '    3   0   0   0   0  73  35   0   0    1   3  293  900 2000
          1   73181  100.0
 163   73182   181.95005   'Ta-182 '    3   0   0   0   0  74  36   0   0    1   3  293  900 2000
          1   73182  100.0
 164   74000   183.84635   'W-nat  '    3   0   0   0   0  75  37   0   0    4   3  293  900 2000
          1   74182  26.62
          2   74183  14.31
          3   74184  30.64
          4   74186  28.43
 165   79197   196.96604   'Au-197 '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   79197  100.0
 166   82206   205.97443   'Pb-206 '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   82206  100.0
 167   82207   206.97593   'Pb-207 '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   82207  100.0
 168   82208   207.97663   'Pb-208 '    3   0   0   0   0   0   0   0   0    1   3  293  900 2000
          1   82208  100.0
 169   83209   208.98025   'Bi-209 '    3   0   0   0   0  76  38   0   0    1   3  293  900 2000
          1   83209  100.0
 170   90230   230.03613   'Th-230 '    2   3   0   0   0  77  39   0   0    1   3  293  900 2000
          1   90230  100.0
 171   91231   231.03572   'Pa-231 '    2   3   0   0   0  78  40   0   0    1   3  293  900 2000
          1   91231  100.0
 172   91233   233.03994   'Pa-233 '    2   3   0   0   0  79  41   0   0    1   5  293  600  900 1200 2400
          1   91233  100.0
 173   92232   232.03712   'U-232  '    2   3   0   0   0  80  42   0   0    1   3  293  900 2000
          1   92232  100.0
 174   92234   234.04094   'U-234  '    2   3   0  20  11  81  43   0   0    1   3  293  900 2000
          1   92234  100.0
 175   92237   237.04877   'U-237  '    2   3   0   0   0  82  44   0   0    1   3  293  900 2000
          1   92237  100.0
 176   93237   237.04817   'Np-237 '    2   3   0   0  12  83  45   0   0    1   3  293  900 2000
          1   93237  100.0
 177   93238   238.05098   'Np-238 '    2   3   0   0   0   0   0   0   0    1   3  293  900 2000
          1   93238  100.0
```

```
 178   93239   239.05259   'Np-239 '    2   3   0   0  13  84  46   0   0    1   3  293  900 2000
         1   93239  100.0
 179   94236   236.04576   'Pu-236 '    2   3   0   0  14  85  47   0   0    1   3  293  900 2000
         1   94236  100.0
 180   95242   242.05942   'Am-242 '    2   3   0   0   0   0   0   0   0    1   3  293  900 2000
         1   95242  100.0
 181   95342   242.05942   'Am-242m'    2   3   0   0   0  86  48   0   0    1   3  293  900 2000
         1   95601  100.0
 182   95243   243.06143   'Am-243 '    2   3   0   0   0  87  49   0   0    1   3  293  900 2000
         1   95243  100.0
 183   96242   242.05841   'Cm-242 '    2   3   0   0   0  88  50   0   0    1   3  293  900 2000
         1   96242  100.0
 184   96243   243.06102   'Cm-243 '    2   3   0   0   0  89  51   0   0    1   3  293  900 2000
         1   96243  100.0
 185   96244   244.06263   'Cm-244 '    2   3   0   0   0  90  52   0   0    1   3  293  900 2000
         1   96244  100.0
 186   96245   245.06524   'Cm-245 '    2   3   0   0   0  91  53   0   0    1   3  293  900 2000
         1   96245  100.0
 187   96246   246.06684   'Cm-246 '    2   3   0   0   0  92  54   0   0    1   3  293  900 2000
         1   96246  100.0
 188   96247   247.07047   'Cm-247 '    2   3   0   0   0  93  55   0   0    1   3  293  900 2000
         1   96247  100.0
 189   96248   248.07207   'Cm-248 '    2   3   0   0   0  94  56   0   0    1   3  293  900 2000
         1   96248  100.0
 190   97249   249.07973   'Bk-249 '    2   3   0   0   0  95  57   0   0    1   3  293  900 2000
         1   97249  100.0
 191   98249   249.07973   'Cf-249 '    2   3   0   0   0  96  58   0   0    1   3  293  900 2000
         1   98249  100.0
 192   98250   250.07629   'Cf-250 '    2   3   0   0   0  97  59   0   0    1   3  293  900 2000
         1   98250  100.0
 193   98251   251.07991   'Cf-251 '    2   3   0   0   0  98  60   0   0    1   3  293  900 2000
         1   98251  100.0
 194   98252   252.08151   'Cf-252 '    2   3   0   0   0  99  61   0   0    1   3  293  900 2000
         1   98252  100.0
!   ------------------------------------------------------------------------------------------
 195    1003     3.01550   'T-3    '    1   0   0   0   0   0   0   0   0    1   3  293  900 2000
         1    1003  100.0
 196    2003     3.01493   'He-3   '    1   0   0   0   0   0   0   0   0    1   3  293  900 2000
         1    2003  100.0
 197   35581    80.91631   'Br-81  '    2   1   1   0   0   0   0   0   0    1   1 1100
         1   35081  100.0
 198   36582    81.91348   'Kr-82  '    2   1   2   0   0 100   0   0   0    1   1 1100
         1   36082  100.0
 199   36583    82.91428   'Kr-83  '    2   1   3   0   0 101  62   0   0    1   1 1100
         1   36083  100.0
 200   36584    83.91154   'Kr-84  '    2   1   4   0   0 102   0   0   0    1   1 1100
         1   36084  100.0
 201   36585    84.91254   'Kr-85  '    2   1   5   0   0   0   0   0   0    1   1 1100
         1   36085  100.0
 202   36586    85.91062   'Kr-86  '    2   1   6   0   0 103  63   0   0    1   1 1100
         1   36086  100.0
 203   38589    88.90776   'Sr-89  '    2   1   7   0   0   0   0   0   0    1   1 1100
         1   38089  100.0
 204   38590    89.90776   'Sr-90  '    2   1   8   0   0   0   0   0   0    1   1 1100
         1   38090  100.0
 205   39589    88.90585   'Y-89   '    2   1   9   0   0 104   0   0   0    1   1 1100
         1   39089  100.0
 206   39590    89.90715   'Y-90   '    2   1  10   0   0   0   0   0   0    1   1 1100
         1   39090  100.0
 207   39591    90.90734   'Y-91   '    2   1  11   0   0   0   0   0   0    1   1 1100
         1   39091  100.0
 208   40591    90.90563   'Zr-91  '    2   1  12   0   0 105   0   0   0    1   1 1100
         1   40091  100.0
 209   40593    92.90642   'Zr-93  '    2   1  13   0   0   0   0   0   0    1   1 1100
         1   40093  100.0
 210   40595    94.90801   'Zr-95  '    2   1  14   0   0   0   0   0   0    1   1 1100
         1   40095  100.0
 211   40596    95.90830   'Zr-96  '    2   1  15   0   0 106   0   0   0    1   1 1100
         1   40096  100.0
 212   41595    94.90680   'Nb-95  '    2   1  16   0   0   0   0   0   0    1   1 1100
         1   41095  100.0
 213   42095    94.90589   'Mo-95  '    3   0   0   0   0   0   0   0   0    1   1 1100
         1   42095  100.0
 214   42596    95.90467   'Mo-96  '    2   1  18   0   0   0   0   0   0    1   3  293  900 2000
         1   42096  100.0
 215   42597    96.90597   'Mo-97  '    2   1  19   0   0   0   0   0   0    1   1 1100
         1   42097  100.0
 216   42598    97.90536   'Mo-98  '    2   1  20   0   0   0   0   0   0    1   1 1100
         1   42098  100.0
 217   42599    98.90767   'Mo-99  '    2   1  21   0   0   0   0   0   0    1   1 1100
         1   42099  100.0
 218   42600    99.90726   'Mo-100 '    2   1  22   0   0   0   0   0   0    1   1 1100
         1   42100  100.0
 219   44600    99.90413   'Ru-100 '    2   1  24   0   0   0   0   0   0    1   1 1100
         1   44100  100.0
 220   44602   101.90542   'Ru-102 '    2   1  26   0   0   0   0   0   0    1   1 1100
         1   44102  100.0
 221   44603   102.90400   'Ru-103 '    2   1  27   0   0   0   0   0   0    1   1 1100
         1   44103  100.0
 222   44604   103.90258   'Ru-104 '    2   1  28   0   0   0   0   0   0    1   1 1100
         1   44104  100.0
 223   44605   104.91124   'Ru-105 '    2   1  29   0   0   0   0   0   0    1   1 1100
         1   44105  100.0
 224   44606   105.90680   'Ru-106 '    2   1  30   0   0   0   0   0   0    1   1 1100
         1   44106  100.0
 225   46604   103.90399   'Pd-104 '    2   1  33   0   0   0   0   0   0    1   1 1100
         1   46104  100.0
 226   46606   105.90347   'Pd-106 '    2   1  35   0   0   0   0   0   0    1   1 1100
         1   46106  100.0
 227   47710   109.90615   'Ag-110m'    2   1  39   0   0   0   0   0   0    1   1 1100
```

```
         1   47601  100.0
228   47611   110.90574   'Ag-111 '    2   1  40   0   0   0   0   0   0    1   1 1100
         1   47111  100.0
229   48610   109.90313   'Cd-110 '    2   1  41   0   0   0   0   0   0    1   1 1100
         1   48110  100.0
230   48611   110.90372   'Cd-111 '    2   1  42   0   0   0   0   0   0    1   1 1100
         1   48111  100.0
231   48613   112.89987   'Cd-113 '    2   1  43   0   0 107   0   0   0    1   1 1100
         1   48113  100.0
232   50125   124.90803   'Sn-125 '    3   0   0   0   0   0   0   0   0    1   1 1100
         1   50125  100.0
233   51621   120.90867   'Sb-121 '    2   1  45   0   0   0   0   0   0    1   1 1100
         1   51121  100.0
234   51625   124.90500   'Sb-125 '    2   1  46   0   0   0   0   0   0    1   1 1100
         1   51125  100.0
235   51627   126.90690   'Sb-127 '    2   1  47   0   0   0   0   0   0    0   1 1100
236   52727   126.90518   'Te-127m'    2   1  48   0   0   0   0   0   0    1   1 1100
         1   52601  100.0
237   52729   128.90738   'Te-129m'    2   1  49   0   0   0   0   0   0    1   1 1100
         1   52611  100.0
238   52632   131.90816   'Te-132 '    2   1  50   0   0   0   0   0   0    1   1 1100
         1   52132  100.0
239   53627   126.90448   'I-127  '    2   1  51   0   0 108  64   0   0    1   1 1100
         1   53127  100.0
240   53629   128.90537   'I-129  '    2   1  52   0   0   0   0   0   0    1   1 1100
         1   53129  100.0
241   53631   130.90555   'I-131  '    2   1  53   0   0   0   0   0   0    1   1 1100
         1   53131  100.0
242   53635   134.90894   'I-135  '    2   1  54   0   0   0   0   0   0    1   1 1100
         1   53135  100.0
243   54628   127.90275   'Xe-128 '    2   1  55   0   0 109  65   0   0    1   1 1100
         1   54128  100.0
244   54630   129.90394   'Xe-130 '    2   1  56   0   0 110  66   0   0    1   1 1100
         1   54130  100.0
245   54632   131.90312   'Xe-132 '    2   1  58   0   0 111  67   0   0    1   1 1100
         1   54132  100.0
246   54633   132.90573   'Xe-133 '    2   1  59   0   0   0   0   0   0    1   1 1100
         1   54133  100.0
247   54635   134.90692   'Xe-135 '    2   1  61   0   0   0   0   0   0    1   1 1100
         1   54135  100.0
248   54636   135.90752   'Xe-136 '    2   1  62   0   0 112  68   0   0    1   1 1100
         1   54136  100.0
249   55634   133.90733   'Cs-134 '    2   1  64   0   0   0   0   0   0    1   1 1100
         1   55134  100.0
250   55635   134.90591   'Cs-135 '    2   1  65   0   0   0   0   0   0    1   1 1100
         1   55135  100.0
251   55636   135.90651   'Cs-136 '    2   1  66   0   0   0   0   0   0    1   1 1100
         1   55136  100.0
252   55637   136.90710   'Cs-137 '    2   1  67   0   0   0   0   0   0    1   1 1100
         1   55137  100.0
253   56634   133.90431   'Ba-134 '    2   1  68   0   0   0   0   0   0    1   1 1100
         1   56134  100.0
254   56637   136.90610   'Ba-137 '    2   1  69   0   0   0   0   0   0    1   1 1100
         1   56137  100.0
255   56640   139.90990   'Ba-140 '    2   1  70   0   0   0   0   0   0    1   1 1100
         1   56140  100.0
256   57639   138.90325   'La-139 '    2   1  71   0   0   0   0   0   0    1   1 1100
         1   57139  100.0
257   57640   139.90990   'La-140 '    2   1  72   0   0   0   0   0   0    1   1 1100
         1   57140  100.0
258   58640   139.90486   'Ce-140 '    2   1  73   0   0   0   0   0   0    1   1 1100
         1   58140  100.0
259   58641   140.91050   'Ce-141 '    2   1  74   0   0   0   0   0   0    1   1 1100
         1   58141  100.0
260   58642   141.90907   'Ce-142 '    2   1  75   0   0   0   0   0   0    1   1 1100
         1   58142  100.0
261   58643   142.91270   'Ce-143 '    2   1  76   0   0   0   0   0   0    1   1 1100
         1   58143  100.0
262   58644   143.91430   'Ce-144 '    2   1  77   0   0   0   0   0   0    1   1 1100
         1   58144  100.0
263   59641   140.90747   'Pr-141 '    2   1  78   0   0 113  69   0   0    1   1 1100
         1   59141  100.0
264   59643   142.91068   'Pr-143 '    2   1  79   0   0   0   0   0   0    1   1 1100
         1   59143  100.0
265   60642   141.90807   'Nd-142 '    2   1  80   0   0   0   0   0   0    1   1 1100
         1   60142  100.0
266   60644   143.91027   'Nd-144 '    2   1  82   0   0   0   0   0   0    1   1 1100
         1   60144  100.0
267   60646   145.91347   'Nd-146 '    2   1  84   0   0 114  70   0   0    1   1 1100
         1   60146  100.0
268   60647   146.91609   'Nd-147 '    2   1  85   0   0   0   0   0   0    1   1 1100
         1   60147  100.0
269   60648   147.91668   'Nd-148 '    2   1  86   0   0 115  71   0   0    1   1 1100
         1   60148  100.0
270   60650   149.92090   'Nd-150 '    2   1  87   0   0 116  72   0   0    1   1 1100
         1   60150  100.0
271   61648   147.91668   'Pm-148 '    2   1  89   0   0   0   0   0   0    1   1 1100
         1   61148  100.0
272   61649   148.91829   'Pm-149 '    2   1  90   0   0   0   0   0   0    1   1 1100
         1   61149  100.0
273   61651   150.92150   'Pm-151 '    2   1  91   0   0   0   0   0   0    1   1 1100
         1   61151  100.0
274   62648   147.91467   'Sm-148 '    2   1  94   0   0   0   0   0   0    1   1 1100
         1   62148  100.0
275   62653   152.92168   'Sm-153 '    2   1  99   0   0   0   0   0   0    1   1 1100
         1   62153  100.0
276   62654   153.92227   'Sm-154 '    2   1 100   0   0   0   0   0   0    1   1 1100
         1   62154  100.0
277   63651   150.91645   'Eu-151 '    2   1 101   0   0 117  73   0   0    1   1 1100
         1   63151  100.0
```

```
 278   63656   155.92548   'Eu-156 '    2   1 105   0   0   0   0   0   0    1   1 1100
          1   63156  100.0
 279   63657   156.92507   'Eu-157 '    2   1 106   0   0   0   0   0   0    1   1 1100
          1   63157  100.0
 280   64654   153.92127   'Gd-154 '    2   1 107   0   0 118   0   0   0    1   1 1100
          1   64154  100.0
 281   64660   159.92686   'Gd-160 '    2   1 112   0   0 119   0   0   0    1   1 1100
          1   64160  100.0
 282   65159   158.92525   'Tb-159 '    3   0   0   0   0   0   0   0   0    1   1 1100
          1   65159  100.0
 283   65160   159.92686   'Tb-160 '    3   1   0   0   0   0   0   0   0    1   1 1100
          1   65160  100.0
 284   65161   160.92760   'Tb-161 '    3   1   0   0   0   0   0   0   0    0   1 1100
 285   65659   158.92525   'Tb-159 '    2   1 113   0   0   0   0   0   0    1   1 1100
          1   65159  100.0
 286   65660   159.92686   'Tb-160 '    2   1 114   0   0   0   0   0   0    1   1 1100
          1   65160  100.0
 287   65661   160.92760   'Tb-161 '    2   1 115   0   0   0   0   0   0    0   1 1100
 288   66660   159.92484   'Dy-160 '    2   1 116   0   0   0   0   0   0    1   1 1100
          1   66160  100.0
 289   66661   160.92644   'Dy-161 '    2   1 117   0   0   0   0   0   0    1   1 1100
          1   66161  100.0
 290   66662   161.92704   'Dy-162 '    2   1 118   0   0   0   0   0   0    1   1 1100
          1   66162  100.0
 291   66663   162.92864   'Dy-163 '    2   1 119   0   0   0   0   0   0    1   1 1100
          1   66163  100.0
 292   66664   163.92924   'Dy-164 '    2   1 120   0   0 120  74   0   0    1   1 1100
          1   66164  100.0
 293   67165   164.92983   'Ho-165 '    3   0   0   0   0 121  75   0   0    1   1 1100
          1   67165  100.0
 294   67665   164.92983   'Ho-165 '    2   1 121   0   0 122  76   0   0    1   1 1100
          1   67165  100.0
 295   77191   190.96045   'Ir-191 '    3   0   0   0   0   0   0   0   0    1   1 1100
          1   77191  100.0
 296   77193   192.96265   'Ir-193 '    3   0   0   0   0   0   0   0   0    1   1 1100
          1   77193  100.0
 297   91232   232.03833   'Pa-232 '    2   1   0   0   0   0   0   0   0    1   1 1100
          1   91232  100.0
 298   91234   234.04330   'Pa-234 '    2   1   0   0   0   0   0   0   0    0   1 1100
%FINE
```

APPENDIX C.1. BENCHMARK PROBLEMS FOR THE GIVEN ATOMIC NUMBER DENSITIES AT VARIOUS BURNUP POINTS

Table C.1.1. Benchmark Problems

Problem	Burnup	# of composition radial rings	Isotopes
A1	0.0	3	All (#1-152)
A2	10.0	3	All (#1-152)
A3	20.0	3	All (#1-152)
A4	40.0	3	All (#1-152)
A5	60.0	3	All (#1-152)
B1	0.0	1 (3 flat source rings)	All (#1-152)
B2	10.0	1 (3 flat source rings)	All (#1-152)
B3	20.0	1 (3 flat source rings)	All (#1-152)
B4	40.0	1 (3 flat source rings)	All (#1-152)
B5	60.0	1 (3 flat source rings)	All (#1-152)
C1	0.0	1 (3 flat source rings)	Heavy nuclides (#1-32)
C2	10.0	1 (3 flat source rings)	Heavy nuclides (#1-32)
C3	20.0	1 (3 flat source rings)	Heavy nuclides (#1-32)
C4	40.0	1 (3 flat source rings)	Heavy nuclides (#1-32)
C5	60.0	1 (3 flat source rings)	Heavy nuclides (#1-32)

Table C.1.2. Geometrical Configuration

Zone	radius (cm)	Material	Temp. (K)
Pellet	0.4096	UO_2	900
Cladding	0.4750	^{27}Al	600
Pin Pitch	1.2600	H_2O+B	600

Table C.1.3. Initial Composition

Material	#	MPACT ID	ORIGEN ID	Atomic number densities			
H_2O+B Moderator	1	1001	10010	4.67505E-02			
	2	8016	80160	2.33753E-02			
	3	5010	50100	1.00874E-05			
	4	5011	50110	4.06030E-05			
^{27}Al Cladding	1	13027	130270	6.02611E-02			
UO_2 pellet				Outer	Middle	Inner	Average
	1	92235	922350	7.18132E-04	7.18132E-04	7.18132E-04	7.18132E-04
	2	92238	922380	2.21546E-02	2.21546E-02	2.21546E-02	2.21546E-02
	3	8016	80160	4.57455E-02	4.57455E-02	4.57455E-02	4.57455E-02

Table C.1.4. Fuel Composition at 10 and 20 MWD/kgU

#	MPACT	ORIGEN	10 MWD/kgU				20 MWD/kgU			
			outer	middle	inner	Average	outer	middle	inner	Average
1	8016	80160	4.57455E-02	4.57455E-02	4.57455E-02	4.57455E-02	4.57455E-02	4.57455E-02	4.57455E-02	4.57455E-02
2	90230	902300	1.77618E-14	1.79846E-14	1.81662E-14	1.79709E-14	6.32198E-14	6.42134E-14	6.50274E-14	6.41535E-14
3	90232	902320	4.53847E-13	4.43538E-13	4.34989E-13	4.44125E-13	1.56511E-12	1.53683E-12	1.51279E-12	1.53824E-12
4	91231	912310	3.31067E-13	3.34533E-13	3.37137E-13	3.34246E-13	4.58521E-13	4.68476E-13	4.75951E-13	4.67649E-13
5	91232	912320	9.07244E-16	8.95836E-16	8.87574E-16	8.96885E-16	1.28499E-15	1.28057E-15	1.27760E-15	1.28105E-15
6	91233	912330	5.49054E-14	5.31689E-14	5.18576E-14	5.33106E-14	1.75762E-13	1.67039E-13	1.61079E-13	1.67960E-13
7	91234	912340	3.76790E-15	3.77695E-15	3.77774E-15	3.77419E-15	3.76227E-15	3.78137E-15	3.78221E-15	3.77528E-15
8	92232	922320	6.46667E-14	6.37626E-14	6.31006E-14	6.38433E-14	2.05098E-13	2.03189E-13	2.01856E-13	2.03381E-13
9	92233	922330	1.19116E-11	1.20932E-11	1.22574E-11	1.20874E-11	1.76204E-11	1.80112E-11	1.83718E-11	1.80011E-11
10	92234	922340	1.78826E-08	1.81403E-08	1.83492E-08	1.81240E-08	3.18876E-08	3.23953E-08	3.28291E-08	3.23707E-08
11	92235	922350	4.91442E-04	4.97804E-04	5.02637E-04	4.97294E-04	3.37286E-04	3.46106E-04	3.52814E-04	3.45402E-04
12	92236	922360	4.18709E-05	4.10101E-05	4.02915E-05	4.10575E-05	6.83662E-05	6.74938E-05	6.66992E-05	6.75198E-05
13	92237	922370	1.40381E-07	1.33418E-07	1.28468E-07	1.34089E-07	2.17235E-07	2.01830E-07	1.92138E-07	2.03734E-07
14	92238	922380	2.19326E-02	2.19984E-02	2.20066E-02	2.19792E-02	2.16916E-02	2.18299E-02	2.18470E-02	2.17895E-02
15	93237	932370	2.01538E-06	1.94563E-06	1.89379E-06	1.95160E-06	5.65418E-06	5.35657E-06	5.15690E-06	5.38921E-06
16	93238	932380	6.20668E-09	5.88665E-09	5.65473E-09	5.91602E-09	1.83491E-08	1.70683E-08	1.62117E-08	1.72097E-08
17	93239	932390	2.85900E-06	1.91977E-06	1.80152E-06	2.19343E-06	3.06028E-06	2.04617E-06	1.91831E-06	2.34159E-06
18	94236	942360	1.20965E-14	1.16975E-14	1.14253E-14	1.17398E-14	1.44021E-13	1.36393E-13	1.31835E-13	1.37417E-13
19	94238	942380	1.86181E-07	1.77720E-07	1.71920E-07	1.78607E-07	1.07227E-06	9.97788E-07	9.54642E-07	1.00823E-06
20	94239	942390	1.17977E-04	8.07909E-05	7.67376E-05	9.18350E-05	1.67727E-04	1.15520E-04	1.10492E-04	1.31247E-04
21	94240	942400	1.86651E-05	1.25844E-05	1.17739E-05	1.43412E-05	4.22070E-05	2.95832E-05	2.83651E-05	3.33851E-05
22	94241	942410	8.37254E-06	5.41329E-06	4.92514E-06	6.23699E-06	2.72837E-05	1.73455E-05	1.56906E-05	2.01066E-05
23	94242	942420	6.94829E-07	4.36000E-07	3.87247E-07	5.06025E-07	4.84121E-06	2.98818E-06	2.63827E-06	3.48922E-06
24	95241	952410	7.25195E-08	4.73321E-08	4.32899E-08	5.43805E-08	4.54972E-07	2.94074E-07	2.68556E-07	3.39200E-07
25	95242	952420	1.97472E-10	1.25202E-10	1.12104E-10	1.44926E-10	1.25144E-09	7.83015E-10	6.98624E-10	9.11025E-10
26	95342	952421	1.00286E-09	6.49394E-10	5.90220E-10	7.47492E-10	8.60315E-09	5.54257E-09	5.04897E-09	6.39823E-09
27	95243	952430	4.46594E-08	2.79925E-08	2.47978E-08	3.24832E-08	6.75756E-07	4.18654E-07	3.69201E-07	4.87870E-07
28	96242	962420	8.37397E-09	5.32408E-09	4.77176E-09	6.15660E-09	1.00159E-07	6.28878E-08	5.61541E-08	7.30670E-08
29	96243	962430	5.16980E-11	3.25046E-11	2.88644E-11	3.76890E-11	1.34210E-09	8.37246E-10	7.42732E-10	9.74025E-10
30	96244	962440	3.51654E-09	2.18488E-09	1.92247E-09	2.54129E-09	1.20804E-07	7.41793E-08	6.49392E-08	8.66407E-08
31	96245	962450	7.02660E-11	4.31895E-11	3.76777E-11	5.03777E-11	4.93561E-09	3.00926E-09	2.61808E-09	3.52098E-09
32	96246	962460	1.23028E-12	7.26540E-13	6.14701E-13	8.57174E-13	1.87792E-10	1.10273E-10	9.32035E-11	1.30423E-10
33	35581	350810	4.93026E-07	4.49580E-07	4.36680E-07	4.59762E-07	9.71063E-07	8.54152E-07	8.28347E-07	8.84521E-07
34	36582	360820	4.07671E-09	3.57778E-09	3.43748E-09	3.69733E-09	1.62424E-08	1.40323E-08	1.34843E-08	1.45863E-08
35	36583	360830	1.14807E-06	1.07239E-06	1.04652E-06	1.08899E-06	2.04460E-06	1.86162E-06	1.81900E-06	1.90841E-06
36	36584	360840	2.33328E-06	2.18645E-06	2.13059E-06	2.21677E-06	4.53253E-06	4.14903E-06	4.04139E-06	4.24099E-06
37	36585	360850	6.00925E-07	5.64240E-07	5.49956E-07	5.71707E-07	1.09269E-06	1.00354E-06	9.78592E-07	1.02494E-06
38	36586	360860	4.25940E-06	4.01549E-06	3.91675E-06	4.06388E-06	7.88150E-06	7.28620E-06	7.11222E-06	7.42664E-06
39	38589	380890	2.70546E-06	2.52502E-06	2.46404E-06	2.56484E-06	2.39032E-06	2.15037E-06	2.10249E-06	2.21439E-06
40	38590	380900	1.22030E-05	1.15175E-05	1.12328E-05	1.16511E-05	2.22211E-05	2.05857E-05	2.00951E-05	2.09673E-05
41	39589	390890	7.39159E-06	7.00734E-06	6.83364E-06	7.07752E-06	1.61580E-05	1.50426E-05	1.46828E-05	1.52945E-05
42	39590	390900	3.14084E-09	2.96313E-09	2.88800E-09	2.99732E-09	5.79951E-09	5.36937E-09	5.23739E-09	5.46875E-09
43	39591	390910	3.91918E-06	3.64105E-06	3.55097E-06	3.70373E-06	3.62270E-06	3.23029E-06	3.15356E-06	3.33552E-06
44	40591	400910	8.80827E-06	8.32522E-06	8.11706E-06	8.41685E-06	2.00454E-05	1.85540E-05	1.80984E-05	1.88993E-05
45	40593	400930	1.45089E-05	1.34824E-05	1.31287E-05	1.37067E-05	2.77558E-05	2.50651E-05	2.43929E-05	2.57379E-05
46	40595	400950	5.26706E-06	4.76314E-06	4.62875E-06	4.88631E-06	5.42865E-06	4.62724E-06	4.48541E-06	4.84710E-06
47	40596	400960	1.53170E-05	1.40871E-05	1.37033E-05	1.43691E-05	3.02310E-05	2.68576E-05	2.60837E-05	2.77241E-05
48	41595	410950	2.66691E-06	2.44037E-06	2.37282E-06	2.49337E-06	2.96224E-06	2.55346E-06	2.47654E-06	2.66408E-06
49	42595	420950	7.38314E-06	6.89860E-06	6.71593E-06	6.99922E-06	2.12154E-05	1.91740E-05	1.86453E-05	1.96783E-05
50	42596	420960	8.48776E-08	7.68945E-08	7.32251E-08	7.83324E-08	5.83852E-07	5.16190E-07	4.90577E-07	5.30206E-07
51	42597	420970	1.48636E-05	1.35584E-05	1.31746E-05	1.38655E-05	2.97860E-05	2.61425E-05	2.53456E-05	2.70914E-05
52	42598	420980	1.48447E-05	1.34696E-05	1.30807E-05	1.37984E-05	3.03064E-05	2.64047E-05	2.55745E-05	2.74285E-05
53	42599	420990	2.55047E-07	2.20277E-07	2.13166E-07	2.29497E-07	2.62922E-07	2.13161E-07	2.05328E-07	2.27137E-07
54	42600	421000	1.63247E-05	1.47506E-05	1.43166E-05	1.51307E-05	3.35597E-05	2.90548E-05	2.81152E-05	3.02432E-05
55	43599	430990	1.48231E-05	1.34539E-05	1.30750E-05	1.37840E-05	2.93549E-05	2.55590E-05	2.47964E-05	2.65701E-05
56	44600	441000	5.84220E-07	5.23791E-07	4.97848E-07	5.35286E-07	2.42034E-06	2.08824E-06	1.97401E-06	2.16086E-06
57	44601	441010	1.36484E-05	1.22851E-05	1.19224E-05	1.26186E-05	2.79955E-05	2.40871E-05	2.32976E-05	2.51267E-05
58	44602	441020	1.24939E-05	1.11197E-05	1.07760E-05	1.14632E-05	2.72300E-05	2.30941E-05	2.22834E-05	2.42025E-05
59	44603	441030	2.58130E-06	2.13261E-06	2.04960E-06	2.25450E-06	3.18472E-06	2.44264E-06	2.32857E-06	2.65197E-06
60	44604	441040	7.66393E-06	6.43486E-06	6.19285E-06	6.76388E-06	1.85727E-05	1.46958E-05	1.40408E-05	1.57697E-05
61	44605	441050	8.08853E-09	6.08991E-09	5.77368E-09	6.65071E-09	1.08248E-08	7.75678E-09	7.30265E-09	8.62808E-09
62	44606	441060	2.98523E-06	2.27487E-06	2.15907E-06	2.47306E-06	7.18698E-06	5.17820E-06	4.86946E-06	5.74488E-06
63	45603	451030	6.98311E-06	6.09165E-06	5.89666E-06	6.32380E-06	1.63680E-05	1.34202E-05	1.29286E-05	1.42389E-05
64	45605	451050	5.92818E-08	4.47753E-08	4.25323E-08	4.88631E-08	7.94129E-08	5.70672E-08	5.38290E-08	6.34363E-08
65	46604	461040	8.36611E-07	7.36180E-07	7.05003E-07	7.59265E-07	4.29539E-06	3.57467E-06	3.39974E-06	3.75660E-06
66	46605	461050	4.98260E-06	4.01390E-06	3.84844E-06	4.28165E-06	1.29280E-05	9.83229E-06	9.35324E-06	1.07045E-05
67	46606	461060	1.09208E-06	8.62801E-07	8.17280E-07	9.24055E-07	4.43710E-06	3.31314E-06	3.11886E-06	3.62303E-06
68	46607	461070	2.35322E-06	1.72804E-06	1.62996E-06	1.90374E-06	6.97682E-06	4.91461E-06	4.60091E-06	5.49744E-06
69	46608	461080	1.43515E-06	1.02465E-06	9.61247E-07	1.14035E-06	4.47011E-06	3.08655E-06	2.87690E-06	3.47785E-06
70	47609	471090	8.85532E-07	6.26058E-07	5.86481E-07	6.99357E-07	2.58450E-06	1.77290E-06	1.65259E-06	2.00333E-06
71	47710	471101	4.40713E-09	3.11743E-09	2.88555E-09	3.47004E-09	2.28125E-08	1.54639E-08	1.41763E-08	1.74842E-08
72	47611	471110	1.59292E-08	1.16342E-08	1.09761E-08	1.28465E-08	2.42052E-08	1.69127E-08	1.58077E-08	1.89752E-08
73	48610	481100	1.06742E-07	7.58020E-08	7.02128E-08	8.42522E-08	6.59915E-07	4.49643E-07	4.12596E-07	5.07385E-07
74	48611	481110	2.33547E-07	1.80493E-07	1.72111E-07	1.95384E-07	7.04574E-07	5.15019E-07	4.85855E-07	5.68483E-07
75	48613	481130	6.21646E-09	5.23350E-09	5.17887E-09	5.54294E-09	8.44668E-09	6.72301E-09	6.59156E-09	7.25375E-09
76	49615	491150	5.96399E-08	5.37450E-08	5.28428E-08	5.54092E-08	1.00041E-07	8.61533E-08	8.43999E-08	9.01981E-08

77	51625	511250	1.64658E-07	1.44441E-07	1.40703E-07	1.49934E-07	3.50238E-07	2.93256E-07	2.84270E-07	3.09255E-07
78	51627	511270	1.73133E-08	1.37448E-08	1.31529E-08	1.47370E-08	2.07399E-08	1.55990E-08	1.48524E-08	1.70638E-08
79	52727	521271	3.60106E-08	2.98717E-08	2.90094E-08	3.16306E-08	4.72076E-08	3.66437E-08	3.54037E-08	3.97517E-08
80	52729	521291	6.67059E-08	5.49330E-08	5.29619E-08	5.82003E-08	8.00501E-08	6.17168E-08	5.91275E-08	6.69648E-08
81	52632	521320	2.24403E-07	1.91609E-07	1.85159E-07	2.00390E-07	2.36653E-07	1.89575E-07	1.82282E-07	2.02837E-07
82	53627	531270	5.37516E-07	4.55692E-07	4.39636E-07	4.77615E-07	1.27706E-06	1.02513E-06	9.83763E-07	1.09532E-06
83	53629	531290	1.83663E-06	1.58075E-06	1.52748E-06	1.64829E-06	4.22958E-06	3.45071E-06	3.31733E-06	3.66587E-06
84	53631	531310	3.93007E-07	3.33360E-07	3.21789E-07	3.49385E-07	4.21515E-07	3.35040E-07	3.21722E-07	3.59426E-07
85	53635	531350	2.65205E-08	2.28309E-08	2.20865E-08	2.38126E-08	2.75338E-08	2.22274E-08	2.13944E-08	2.37185E-08
86	54628	541280	1.00855E-08	8.68665E-09	8.32321E-09	9.03180E-09	5.13186E-08	4.19991E-08	4.00436E-08	4.44538E-08
87	54630	541300	2.06965E-08	1.73876E-08	1.64698E-08	1.81846E-08	9.07741E-08	7.34514E-08	6.93367E-08	7.78541E-08
88	54631	541310	6.81450E-06	6.11331E-06	5.94447E-06	6.29076E-06	1.31674E-05	1.12856E-05	1.09718E-05	1.18083E-05
89	54632	541320	1.22974E-05	1.10207E-05	1.06717E-05	1.13299E-05	2.76165E-05	2.36280E-05	2.27657E-05	2.46700E-05
90	54633	541330	5.36954E-07	4.63097E-07	4.48029E-07	4.82693E-07	5.56478E-07	4.50049E-07	4.33315E-07	4.79948E-07
91	54634	541340	1.99701E-05	1.81331E-05	1.76077E-05	1.85703E-05	4.06550E-05	3.54239E-05	3.43024E-05	3.67938E-05
92	54635	541350	1.07255E-08	9.43210E-09	9.32461E-09	9.82739E-09	1.12931E-08	9.29889E-09	9.13528E-09	9.90907E-09
93	54636	541360	2.93383E-05	2.63006E-05	2.54200E-05	2.70196E-05	6.07632E-05	5.21169E-05	5.02077E-05	5.43626E-05
94	55633	551330	1.59656E-05	1.44791E-05	1.40720E-05	1.48389E-05	3.17714E-05	2.76162E-05	2.67961E-05	2.87279E-05
95	55634	551340	6.54148E-07	5.84175E-07	5.54477E-07	5.97600E-07	2.49244E-06	2.13754E-06	2.01850E-06	2.21616E-06
96	55635	551350	4.52528E-06	4.19358E-06	4.16414E-06	4.29433E-06	9.58346E-06	8.47965E-06	8.38081E-06	8.81464E-06
97	55636	551360	1.24256E-08	9.79859E-09	9.37360E-09	1.05326E-08	2.25578E-08	1.77734E-08	1.70649E-08	1.91320E-08
98	55637	551370	1.58596E-05	1.43253E-05	1.39017E-05	1.46955E-05	3.24012E-05	2.80185E-05	2.71044E-05	2.91747E-05
99	56634	561340	4.95191E-08	4.47713E-08	4.25659E-08	4.56188E-08	3.89924E-07	3.41176E-07	3.22998E-07	3.51366E-07
100	56637	561370	1.27381E-07	1.16525E-07	1.13142E-07	1.19016E-07	5.14034E-07	4.55505E-07	4.41326E-07	4.70289E-07
101	56640	561400	1.12877E-06	9.90932E-07	9.60689E-07	1.02680E-06	1.13517E-06	9.35071E-07	9.02731E-07	9.90990E-07
102	57639	571390	1.57682E-05	1.43917E-05	1.39840E-05	1.47146E-05	3.16274E-05	2.77526E-05	2.69019E-05	2.87606E-05
103	57640	571400	1.49704E-07	1.31521E-07	1.27495E-07	1.36240E-07	1.51700E-07	1.25080E-07	1.20730E-07	1.32503E-07
104	58640	581400	1.40824E-05	1.29146E-05	1.25527E-05	1.31833E-05	2.96505E-05	2.61419E-05	2.53478E-05	2.70467E-05
105	58641	581410	2.68907E-06	2.37689E-06	2.30508E-06	2.45701E-06	2.71978E-06	2.25098E-06	2.17411E-06	2.38162E-06
106	58642	581420	1.43100E-05	1.30821E-05	1.27101E-05	1.33674E-05	2.85959E-05	2.51705E-05	2.44021E-05	2.60561E-05
107	58643	581430	1.10161E-07	9.72276E-08	9.43532E-08	1.00581E-07	1.07450E-07	8.93718E-08	8.64421E-08	9.44214E-08
108	58644	581440	9.63038E-06	8.85817E-06	8.61770E-06	9.03542E-06	1.44484E-05	1.27337E-05	1.23647E-05	1.31823E-05
109	59641	591410	1.16222E-05	1.06780E-05	1.03807E-05	1.08936E-05	2.58846E-05	2.28490E-05	2.21619E-05	2.36318E-05
110	59643	591430	1.08201E-06	9.60548E-07	9.32505E-07	9.91687E-07	1.05619E-06	8.82367E-07	8.53799E-07	9.30785E-07
111	60642	601420	4.80551E-08	4.37289E-08	4.17811E-08	4.45217E-08	2.35562E-07	2.08065E-07	1.98574E-07	2.14067E-07
112	60643	601430	1.18842E-05	1.09889E-05	1.07099E-05	1.11943E-05	2.25707E-05	2.01404E-05	1.96331E-05	2.07814E-05
113	60644	601440	4.30418E-06	3.99379E-06	3.86490E-06	4.05429E-06	1.48127E-05	1.33612E-05	1.29085E-05	1.36941E-05
114	60645	601450	9.13640E-06	8.40589E-06	8.18063E-06	8.57431E-06	1.73792E-05	1.54253E-05	1.49913E-05	1.59319E-05
115	60646	601460	7.76210E-06	7.12124E-06	6.92297E-06	7.26877E-06	1.62199E-05	1.43549E-05	1.39205E-05	1.48318E-05
116	60647	601470	3.55358E-07	3.11683E-07	3.02349E-07	3.23130E-07	3.61896E-07	2.97984E-07	2.87781E-07	3.15887E-07
117	60648	601480	4.42078E-06	4.01824E-06	3.90297E-06	4.11399E-06	9.02152E-06	7.86853E-06	7.62108E-06	8.17037E-06
118	60650	601500	1.94433E-06	1.73143E-06	1.67951E-06	1.78509E-06	4.19923E-06	3.55929E-06	3.43687E-06	3.73180E-06
119	61647	611470	3.90299E-06	3.58151E-06	3.49719E-06	3.66056E-06	6.14712E-06	5.40035E-06	5.28111E-06	5.60953E-06
120	61648	611480	2.85609E-08	2.54435E-08	2.43120E-08	2.61055E-08	4.77596E-08	4.05422E-08	3.86779E-08	4.23266E-08
121	61748	611481	3.95561E-08	3.60649E-08	3.50430E-08	3.68880E-08	6.74129E-08	5.86462E-08	5.69416E-08	6.10002E-08
122	61649	611490	4.78851E-08	4.13817E-08	3.99004E-08	4.30557E-08	5.68308E-08	4.63592E-08	4.44273E-08	4.92058E-08
123	61651	611510	1.01753E-08	8.42296E-09	8.10612E-09	8.90144E-09	1.17883E-08	9.13169E-09	8.72387E-09	9.88130E-09
124	62647	621470	3.40724E-07	3.18228E-07	3.10845E-07	3.23265E-07	1.11468E-06	1.01018E-06	9.88268E-07	1.03771E-06
125	62648	621480	5.50792E-07	5.01871E-07	4.81348E-07	5.11337E-07	2.17489E-06	1.92039E-06	1.84053E-06	1.97860E-06
126	62649	621490	9.47310E-08	8.50435E-08	8.42988E-08	8.80244E-08	1.13652E-07	9.62017E-08	9.46840E-08	1.01513E-07
127	62650	621500	2.98797E-06	2.70184E-06	2.61853E-06	2.76945E-06	6.59367E-06	5.71168E-06	5.51498E-06	5.94011E-06
128	62651	621510	3.58333E-07	3.18718E-07	3.16669E-07	3.31240E-07	5.11329E-07	4.29975E-07	4.24253E-07	4.55186E-07
129	62652	621520	1.53138E-06	1.33609E-06	1.28901E-06	1.38549E-06	3.05429E-06	2.52726E-06	2.43466E-06	2.67207E-06
130	62653	621530	1.88921E-08	1.58517E-08	1.51313E-08	1.66250E-08	3.37620E-08	2.69258E-08	2.55803E-08	2.87560E-08
131	62654	621540	3.24102E-07	2.71059E-07	2.60739E-07	2.85300E-07	8.01266E-07	6.30688E-07	6.01837E-07	6.77930E-07
132	63651	631510	3.58801E-10	3.34140E-10	3.39681E-10	3.44207E-10	5.50690E-10	4.84296E-10	4.91193E-10	5.08727E-10
133	63653	631530	8.57996E-07	7.46666E-07	7.17843E-07	7.74168E-07	2.46924E-06	2.04700E-06	1.95884E-06	2.15836E-06
134	63654	631540	1.03340E-07	9.09264E-08	8.72430E-08	9.38365E-08	4.49752E-07	3.78929E-07	3.63294E-07	3.97325E-07
135	63655	631550	5.82293E-08	4.76120E-08	4.56466E-08	5.04960E-08	1.56520E-07	1.25612E-07	1.19446E-07	1.33859E-07
136	63656	631560	3.82558E-08	3.00021E-08	2.83866E-08	3.22148E-08	9.00535E-08	6.94310E-08	6.50779E-08	7.48542E-08
137	63657	631570	4.08229E-10	2.98978E-10	2.81123E-10	3.29443E-10	6.72419E-10	4.77375E-10	4.44606E-10	5.31467E-10
138	64654	641540	1.77272E-09	1.58526E-09	1.52343E-09	1.62714E-09	1.52934E-08	1.31540E-08	1.26229E-08	1.36901E-08
139	64655	641550	4.06065E-10	3.49809E-10	3.47977E-10	3.67950E-10	1.18767E-09	1.00274E-09	9.86605E-10	1.05900E-09
140	64656	641560	2.33962E-07	1.91177E-07	1.82512E-07	2.02550E-07	9.32494E-07	7.32293E-07	6.91282E-07	7.85357E-07
141	64657	641570	2.04682E-09	1.58844E-09	1.55380E-09	1.72969E-09	3.69732E-09	2.79172E-09	2.69940E-09	3.06281E-09
142	64658	641580	1.04995E-07	8.07622E-08	7.66312E-08	8.74629E-08	3.31074E-07	2.42760E-07	2.28057E-07	2.67297E-07
143	64660	641600	7.21979E-09	5.33707E-09	5.04532E-09	5.86739E-09	2.22134E-08	1.56989E-08	1.47015E-08	1.75380E-08
144	65659	651590	1.59932E-08	1.19286E-08	1.12838E-08	1.30685E-08	4.91167E-08	3.49323E-08	3.27201E-08	3.89230E-08
145	65660	651600	3.46232E-10	2.60474E-10	2.45565E-10	2.84090E-10	1.44168E-09	1.02610E-09	9.57336E-10	1.14171E-09
146	65661	651610	2.25047E-10	1.58012E-10	1.47780E-10	1.76946E-10	3.81038E-10	2.60119E-10	2.41521E-10	2.94226E-10
147	66660	661600	2.58953E-10	2.00908E-10	1.90483E-10	2.16782E-10	2.14748E-09	1.56804E-09	1.47085E-09	1.72879E-09
148	66661	661610	2.82317E-09	2.05975E-09	1.94673E-09	2.27655E-09	8.31089E-09	5.84577E-09	5.48715E-09	6.54794E-09
149	66662	661620	1.73866E-09	1.27568E-09	1.20509E-09	1.40648E-09	5.69106E-09	4.04135E-09	3.79426E-09	4.50889E-09
150	66663	661630	7.84765E-10	5.87051E-10	5.56528E-10	6.42781E-10	2.65991E-09	1.90785E-09	1.78870E-09	2.11882E-09
151	66664	661640	2.42192E-10	1.89880E-10	1.83520E-10	2.05197E-10	6.78580E-10	5.08805E-10	4.87931E-10	5.58439E-10
152	67665	671650	2.35781E-10	1.88063E-10	1.79953E-10	2.01266E-10	8.90215E-10	6.72163E-10	6.35446E-10	7.32608E-10

Table C.1.5. Fuel Composition at 40 and 60 MWD/kgU

			40 MWD/kgU				60 MWD/kgU			
			outer	middle	inner	Average	outer	middle	inner	Average
1	8016	80160	4.57455E-02	4.57455E-02	4.57455E-02	4.57455E-02	4.57455E-02	4.57455E-02	4.57455E-02	4.57455E-02
2	90230	902300	2.25584E-13	2.26845E-13	2.28937E-13	2.27122E-13	5.43136E-13	5.28967E-13	5.26802E-13	5.32968E-13
3	90232	902320	4.75531E-12	4.72220E-12	4.68442E-12	4.72064E-12	8.20880E-12	8.25712E-12	8.25526E-12	8.24040E-12
4	91231	912310	4.33824E-13	4.53215E-13	4.67924E-13	4.51654E-13	3.25144E-13	3.44159E-13	3.59294E-13	3.42866E-13
5	91232	912320	1.29929E-15	1.32174E-15	1.33884E-15	1.31996E-15	1.01492E-15	1.04510E-15	1.06984E-15	1.04329E-15
6	91233	912330	4.63563E-13	4.30667E-13	4.11679E-13	4.35303E-13	6.97479E-13	6.42346E-13	6.14117E-13	6.51314E-13
7	91234	912340	3.75967E-15	3.79758E-15	3.79716E-15	3.78480E-15	3.73948E-15	3.79837E-15	3.79781E-15	3.77855E-15
8	92232	922320	6.60444E-13	6.48097E-13	6.42912E-13	6.50484E-13	1.68372E-12	1.59306E-12	1.55993E-12	1.61223E-12
9	92233	922330	1.94087E-11	1.99357E-11	2.04833E-11	1.99426E-11	1.76379E-11	1.78461E-11	1.82693E-11	1.79178E-11
10	92234	922340	6.73438E-08	6.61628E-08	6.60702E-08	6.65256E-08	1.36354E-07	1.27426E-07	1.24585E-07	1.29455E-07
11	92235	922350	1.52954E-04	1.61190E-04	1.67526E-04	1.60557E-04	6.61282E-05	7.16145E-05	7.59103E-05	7.12177E-05
12	92236	922360	9.32048E-05	9.39051E-05	9.39921E-05	9.37006E-05	9.58208E-05	9.89707E-05	1.00396E-04	9.83957E-05
13	92237	922370	3.09105E-07	2.79282E-07	2.63671E-07	2.84019E-07	3.39717E-07	3.05730E-07	2.89464E-07	3.11637E-07
14	92238	922380	2.11610E-02	2.14593E-02	2.14964E-02	2.13722E-02	2.05830E-02	2.10548E-02	2.11141E-02	2.09173E-02
15	93237	932370	1.37846E-05	1.27506E-05	1.21646E-05	1.28999E-05	2.00171E-05	1.83304E-05	1.74810E-05	1.86095E-05
16	93238	932380	4.89597E-08	4.44241E-08	4.17928E-08	4.50588E-08	7.48154E-08	6.71356E-08	6.30952E-08	6.83488E-08
17	93239	932390	3.42363E-06	2.28439E-06	2.13882E-06	2.61561E-06	3.63042E-06	2.42742E-06	2.27011E-06	2.77598E-06
18	94236	942360	1.57406E-12	1.43780E-12	1.37514E-12	1.46233E-12	5.42774E-12	4.85098E-12	4.62626E-12	4.96833E-12
19	94238	942380	5.63181E-06	5.03227E-06	4.76426E-06	5.14278E-06	1.26931E-05	1.11148E-05	1.05036E-05	1.14371E-05
20	94239	942390	2.03991E-04	1.41610E-04	1.36306E-04	1.60635E-04	2.16562E-04	1.51234E-04	1.45734E-04	1.71177E-04
21	94240	942400	7.43905E-05	5.69295E-05	5.73342E-05	6.28847E-05	8.98640E-05	7.34820E-05	7.67127E-05	8.00196E-05
22	94241	942410	5.81475E-05	3.69727E-05	3.35245E-05	4.28816E-05	7.35804E-05	4.79997E-05	4.41078E-05	5.52293E-05
23	94242	942420	2.20007E-05	1.34736E-05	1.18837E-05	1.57860E-05	4.17001E-05	2.59943E-05	2.31451E-05	3.02798E-05
24	95241	952410	1.58771E-06	1.02922E-06	9.45644E-07	1.18752E-06	2.35734E-06	1.56736E-06	1.46164E-06	1.79545E-06
25	95242	952420	4.59432E-09	2.87195E-09	2.57268E-09	3.34632E-09	7.03838E-09	4.50189E-09	4.08762E-09	5.20929E-09
26	95342	952421	3.55959E-08	2.29824E-08	2.10759E-08	2.65514E-08	5.53816E-08	3.65999E-08	3.40370E-08	4.20062E-08
27	95243	952430	6.03791E-06	3.68348E-06	3.23775E-06	4.31971E-06	1.54708E-05	9.44622E-06	8.33738E-06	1.10848E-05
28	96242	962420	6.13492E-07	3.82823E-07	3.42294E-07	4.46203E-07	1.15849E-06	7.34618E-07	6.63790E-07	8.52298E-07
29	96243	962430	1.72825E-08	1.07508E-08	9.57656E-09	1.25366E-08	4.71338E-08	2.97528E-08	2.67995E-08	3.45620E-08
30	96244	962440	2.53141E-06	1.52804E-06	1.33018E-06	1.79655E-06	1.06200E-05	6.37065E-06	5.54566E-06	7.51212E-06
31	96245	962450	2.00236E-07	1.20652E-07	1.04725E-07	1.41871E-07	1.15611E-06	6.93056E-07	6.02384E-07	8.17185E-07
32	96246	962460	1.83100E-08	1.06613E-08	9.00802E-09	1.26598E-08	1.87766E-07	1.08754E-07	9.19946E-08	1.29505E-07
33	35581	350810	1.85990E-06	1.55790E-06	1.50757E-06	1.64179E-06	2.66962E-06	2.15977E-06	2.08445E-06	2.30461E-06
34	36582	360820	6.59914E-08	5.54843E-08	5.33226E-08	5.82661E-08	1.49924E-07	1.23164E-07	1.18287E-07	1.30458E-07
35	36583	360830	3.29151E-06	2.87457E-06	2.81387E-06	2.99332E-06	4.03485E-06	3.40129E-06	3.32962E-06	3.58858E-06
36	36584	360840	8.78159E-06	7.74629E-06	7.53575E-06	8.02121E-06	1.29769E-05	1.11130E-05	1.07875E-05	1.16258E-05
37	36585	360850	1.86936E-06	1.65370E-06	1.61254E-06	1.71187E-06	2.46977E-06	2.11427E-06	2.05791E-06	2.21398E-06
38	36586	360860	1.40225E-05	1.25405E-05	1.22453E-05	1.29361E-05	1.92966E-05	1.67697E-05	1.63530E-05	1.74731E-05
39	38589	380890	1.90160E-06	1.59432E-06	1.55760E-06	1.68451E-06	1.64206E-06	1.29543E-06	1.25597E-06	1.39782E-06
40	38590	380900	3.83297E-05	3.43765E-05	3.35793E-05	3.54285E-05	5.12067E-05	4.46065E-05	4.35196E-05	4.64443E-05
41	39589	390890	3.06707E-05	2.76628E-05	2.70266E-05	2.84534E-05	4.26693E-05	3.74125E-05	3.65213E-05	3.88677E-05
42	39590	390900	1.01021E-08	9.05362E-09	8.83632E-09	9.33069E-09	1.35581E-08	1.18011E-08	1.15037E-08	1.22876E-08
43	39591	390910	3.00846E-06	2.49008E-06	2.42592E-06	2.64149E-06	2.67618E-06	2.08863E-06	2.01910E-06	2.26130E-06
44	40591	400910	3.93714E-05	3.51609E-05	3.43054E-05	3.62792E-05	5.58566E-05	4.83788E-05	4.71386E-05	5.04580E-05
45	40593	400930	5.18266E-05	4.47734E-05	4.35009E-05	4.67003E-05	7.37852E-05	6.15904E-05	5.96801E-05	6.50186E-05
46	40595	400950	5.18438E-06	4.05362E-06	3.90330E-06	4.38043E-06	5.02771E-06	3.73236E-06	3.56421E-06	4.10809E-06
47	40596	400960	5.92418E-05	5.00340E-05	4.84403E-05	5.25720E-05	8.75188E-05	7.12875E-05	6.87757E-05	7.58607E-05
48	41595	410950	2.83598E-06	2.23377E-06	2.15274E-06	2.40750E-06	2.74553E-06	2.04645E-06	1.95589E-06	2.24929E-06
49	42595	420950	4.73604E-05	4.06229E-05	3.94349E-05	4.24727E-05	7.02319E-05	5.79591E-05	5.61448E-05	6.14453E-05
50	42596	420960	3.17714E-06	2.68441E-06	2.54128E-06	2.80094E-06	7.86630E-06	6.40688E-06	6.04393E-06	6.77237E-06
51	42597	420970	5.94258E-05	4.94025E-05	4.77106E-05	5.21796E-05	8.86287E-05	7.09817E-05	6.82851E-05	7.59652E-05
52	42598	420980	6.22147E-05	5.13022E-05	4.94769E-05	5.43313E-05	9.49896E-05	7.55241E-05	7.25488E-05	8.10209E-05
53	42599	420990	2.73612E-07	2.05414E-07	1.96138E-07	2.25054E-07	2.79701E-07	2.02363E-07	1.91851E-07	2.24638E-07
54	42600	421000	6.94017E-05	5.67402E-05	5.46434E-05	6.02618E-05	1.06200E-04	8.36458E-05	8.02142E-05	9.00200E-05
55	43599	430990	5.57335E-05	4.58737E-05	4.44231E-05	4.86767E-05	7.80665E-05	6.19765E-05	5.99525E-05	6.66652E-05
56	44600	441000	9.96416E-06	8.13209E-06	7.62932E-06	8.57519E-06	2.24613E-05	1.76246E-05	1.64520E-05	1.88459E-05
57	44601	441010	5.70256E-05	4.62051E-05	4.44549E-05	4.92285E-05	8.51613E-05	6.63987E-05	6.35986E-05	7.17195E-05
58	44602	441020	6.14983E-05	4.91640E-05	4.71456E-05	5.26026E-05	1.00727E-04	7.77795E-05	7.42459E-05	8.42507E-05
59	44603	441030	3.86301E-06	2.78020E-06	2.62760E-06	3.09027E-06	4.22475E-06	2.97681E-06	2.80103E-06	3.33420E-06
60	44604	441040	4.60449E-05	3.43670E-05	3.25771E-05	3.76630E-05	7.79162E-05	5.65740E-05	5.33976E-05	6.26293E-05
61	44605	441050	1.42056E-08	9.83517E-09	9.20642E-09	1.10824E-08	1.60367E-08	1.10418E-08	1.03211E-08	1.24665E-08
62	44606	441060	1.51800E-05	1.04697E-05	9.76823E-06	1.18060E-05	2.10371E-05	1.43189E-05	1.33244E-05	1.62268E-05
63	45603	451030	3.26054E-05	2.50327E-05	2.40356E-05	2.72246E-05	4.41762E-05	3.28899E-05	3.15782E-05	3.62148E-05
64	45605	451050	1.03813E-07	7.20789E-08	6.76050E-08	8.11657E-08	1.16878E-07	8.07092E-08	7.55977E-08	9.10615E-08
65	46604	461040	1.93216E-05	1.50376E-05	1.41851E-05	1.61814E-05	4.31220E-05	3.22874E-05	3.03143E-05	3.52413E-05
66	46605	461050	3.31836E-05	2.40502E-05	2.27226E-05	2.66521E-05	5.60214E-05	3.98221E-05	3.75121E-05	4.44519E-05
67	46606	461060	1.85935E-05	1.32333E-05	1.23777E-05	1.47348E-05	4.16576E-05	2.90491E-05	2.70858E-05	3.25975E-05
68	46607	461070	1.99789E-05	1.36624E-05	1.27185E-05	1.54532E-05	3.53844E-05	2.39834E-05	2.22892E-05	2.72190E-05
69	46608	461080	1.34437E-05	9.07396E-06	8.42097E-06	1.03129E-05	2.45815E-05	1.65189E-05	1.53267E-05	1.88090E-05
70	47609	471090	6.80167E-06	4.58063E-06	4.26240E-06	5.21490E-06	1.10009E-05	7.39993E-06	6.89762E-06	8.43282E-06
71	47710	471101	9.88973E-08	6.49763E-08	5.91327E-08	7.43355E-08	2.02459E-07	1.31720E-07	1.19641E-07	1.51274E-07
72	47611	471110	3.57470E-08	2.42831E-08	2.25329E-08	2.75210E-08	4.35136E-08	2.94450E-08	2.72662E-08	3.34082E-08
73	48610	481100	3.90137E-06	2.57887E-06	2.34955E-06	2.94326E-06	1.04356E-05	6.82268E-06	6.20122E-06	7.81983E-06
74	48611	481110	2.14729E-06	1.50167E-06	1.40252E-06	1.68382E-06	4.15294E-06	2.85117E-06	2.64878E-06	3.21763E-06
75	48613	481130	1.10925E-08	8.45145E-09	8.20791E-09	9.25063E-09	1.30598E-08	9.78355E-09	9.44876E-09	1.07640E-08
76	49615	491150	1.39771E-07	1.15149E-07	1.12531E-07	1.22484E-07	1.58107E-07	1.27950E-07	1.24894E-07	1.36984E-07

77	51625	511250	6.96542E-07	5.57738E-07	5.38422E-07	5.97567E-07	9.78222E-07	7.66998E-07	7.38834E-07	8.28018E-07
78	51627	511270	2.43153E-08	1.75167E-08	1.66035E-08	1.94785E-08	2.60835E-08	1.85242E-08	1.75037E-08	2.07038E-08
79	52727	521271	5.56748E-08	4.10630E-08	3.94855E-08	4.54078E-08	5.91845E-08	4.29279E-08	4.11507E-08	4.77543E-08
80	52729	521291	9.30316E-08	6.79145E-08	6.46734E-08	7.52065E-08	9.92253E-08	7.10582E-08	6.74074E-08	7.92303E-08
81	52632	521320	2.50973E-07	1.86904E-07	1.78204E-07	2.05360E-07	2.58010E-07	1.85836E-07	1.76030E-07	2.06625E-07
82	53627	531270	2.92027E-06	2.22589E-06	2.12630E-06	2.42415E-06	4.55963E-06	3.38848E-06	3.22876E-06	3.72562E-06
83	53629	531290	9.64867E-06	7.45291E-06	7.12801E-06	8.07653E-06	1.53678E-05	1.15403E-05	1.10030E-05	1.26370E-05
84	53631	531310	4.52979E-07	3.35334E-07	3.19381E-07	3.69232E-07	4.68148E-07	3.35749E-07	3.17787E-07	3.73895E-07
85	53635	531350	2.89144E-08	2.16029E-08	2.06004E-08	2.37059E-08	2.96269E-08	2.13471E-08	2.02123E-08	2.37288E-08
86	54628	541280	2.65683E-07	2.06219E-07	1.95699E-07	2.22534E-07	6.87199E-07	5.18340E-07	4.90616E-07	5.65385E-07
87	54630	541300	4.19460E-07	3.24415E-07	3.05190E-07	3.49688E-07	1.04106E-06	7.83417E-07	7.35362E-07	8.53280E-07
88	54631	541310	2.25767E-05	1.83138E-05	1.78392E-05	1.95766E-05	2.81510E-05	2.21284E-05	2.15968E-05	2.39587E-05
89	54632	541320	6.44857E-05	5.20059E-05	4.97678E-05	5.54198E-05	1.07248E-04	8.33618E-05	7.94044E-05	9.00048E-05
90	54633	541330	5.81888E-07	4.35594E-07	4.15667E-07	4.77716E-07	5.96152E-07	4.30090E-07	4.07472E-07	4.77905E-07
91	54634	541340	8.32958E-05	6.85444E-05	6.60606E-05	7.26336E-05	1.26942E-04	1.00549E-04	9.64839E-05	1.07991E-04
92	54635	541350	1.15369E-08	8.79963E-09	8.55436E-09	9.63029E-09	1.16341E-08	8.57090E-09	8.27162E-09	9.49221E-09
93	54636	541360	1.27483E-04	1.03132E-04	9.88569E-05	1.09824E-04	1.97370E-04	1.53812E-04	1.46807E-04	1.65997E-04
94	55633	551330	6.00482E-05	4.93068E-05	4.77700E-05	5.23750E-05	8.33985E-05	6.60424E-05	6.39408E-05	7.11273E-05
95	55634	551340	8.56643E-06	6.91482E-06	6.48349E-06	7.32158E-06	1.62002E-05	1.25108E-05	1.16761E-05	1.34623E-05
96	55635	551350	2.04680E-05	1.70476E-05	1.67080E-05	1.80745E-05	3.23661E-05	2.59198E-05	2.52029E-05	2.78296E-05
97	55636	551360	4.37887E-08	3.40816E-08	3.27331E-08	3.68678E-08	6.73970E-08	5.15316E-08	4.92782E-08	5.60689E-08
98	55637	551370	6.62926E-05	5.40291E-05	5.19973E-05	5.74397E-05	1.00376E-04	7.86891E-05	7.53836E-05	8.48161E-05
99	56634	561340	2.81207E-06	2.34144E-06	2.20349E-06	2.45233E-06	8.37662E-06	6.71796E-06	6.29602E-06	7.13020E-06
100	56637	561370	2.08177E-06	1.76136E-06	1.70062E-06	1.84791E-06	4.71443E-06	3.85726E-06	3.71255E-06	4.09474E-06
101	56640	561400	1.14872E-06	8.71060E-07	8.33293E-07	9.51024E-07	1.15546E-06	8.39462E-07	7.96600E-07	9.30506E-07
102	57639	571390	6.34685E-05	5.26313E-05	5.07941E-05	5.56313E-05	9.52127E-05	7.59410E-05	7.29781E-05	8.13773E-05
103	57640	571400	1.56027E-07	1.18572E-07	1.13399E-07	1.29333E-07	1.59606E-07	1.16337E-07	1.10367E-07	1.28770E-07
104	58640	581400	6.14436E-05	5.12130E-05	4.94391E-05	5.40319E-05	9.40539E-05	7.54165E-05	7.24892E-05	8.06532E-05
105	58641	581410	2.73838E-06	2.08451E-06	1.99634E-06	2.27308E-06	2.74549E-06	1.99957E-06	1.89962E-06	2.21489E-06
106	58642	581420	5.70482E-05	4.75467E-05	4.59129E-05	5.01692E-05	8.53943E-05	6.84993E-05	6.58772E-05	7.32570E-05
107	58643	581430	1.04904E-07	8.03101E-08	7.70109E-08	8.74082E-08	1.03712E-07	7.58115E-08	7.20739E-08	8.38657E-08
108	58644	581440	1.79837E-05	1.46691E-05	1.41658E-05	1.56062E-05	1.87057E-05	1.43464E-05	1.37481E-05	1.56001E-05
109	59641	591410	5.41419E-05	4.51591E-05	4.36300E-05	4.76437E-05	8.18260E-05	6.56308E-05	6.31604E-05	7.02057E-05
110	59643	591430	1.03008E-06	7.90777E-07	7.58670E-07	8.59843E-07	1.01679E-06	7.44307E-07	7.07890E-07	8.22996E-07
111	60642	601420	1.09211E-06	9.22651E-07	8.79024E-07	9.64594E-07	2.64179E-06	2.15902E-06	2.05282E-06	2.28454E-06
112	60643	601430	3.82355E-05	3.22571E-05	3.14374E-05	3.39767E-05	4.82201E-05	3.89459E-05	3.78950E-05	4.16870E-05
113	60644	601440	4.60053E-05	3.96145E-05	3.81657E-05	4.12618E-05	8.44090E-05	7.00109E-05	6.72524E-05	7.38908E-05
114	60645	601450	3.15620E-05	2.65155E-05	2.56934E-05	2.79236E-05	4.30576E-05	3.47335E-05	3.35402E-05	3.71104E-05
115	60646	601460	3.53468E-05	2.97270E-05	2.86993E-05	3.12577E-05	5.72708E-05	4.65083E-05	4.47151E-05	4.94981E-05
116	60647	601470	3.73532E-07	2.83980E-07	2.71761E-07	3.09758E-07	3.81548E-07	2.78913E-07	2.64900E-07	3.08454E-07
117	60648	601480	1.85542E-05	1.52784E-05	1.47248E-05	1.61858E-05	2.83124E-05	2.24429E-05	2.15335E-05	2.40963E-05
118	60650	601500	9.27027E-06	7.39164E-06	7.09034E-06	7.91742E-06	1.47703E-05	1.13647E-05	1.08492E-05	1.23281E-05
119	61647	611470	7.77718E-06	6.36326E-06	6.22853E-06	6.78966E-06	8.04677E-06	6.26054E-06	6.11077E-06	6.80603E-06
120	61648	611480	6.60178E-08	5.18605E-08	4.93295E-08	5.57359E-08	7.18718E-08	5.34696E-08	5.06034E-08	5.86483E-08
121	61748	611481	9.08444E-08	7.31834E-08	7.08694E-08	7.82991E-08	9.70834E-08	7.40962E-08	7.14113E-08	8.08636E-08
122	61649	611490	6.72378E-08	5.10346E-08	4.85171E-08	5.55965E-08	7.22491E-08	5.27658E-08	4.98666E-08	5.82938E-08
123	61651	611510	1.40026E-08	1.01781E-08	9.63249E-09	1.12711E-08	1.53593E-08	1.09224E-08	1.02879E-08	1.21899E-08
124	62647	621470	2.74567E-06	2.36737E-06	2.32303E-06	2.47869E-06	3.83671E-06	3.17331E-06	3.11831E-06	3.37611E-06
125	62648	621480	7.45383E-06	6.27679E-06	6.01489E-06	6.58184E-06	1.41847E-05	1.15294E-05	1.10434E-05	1.22525E-05
126	62649	621490	1.30074E-07	1.02361E-07	9.97716E-08	1.10736E-07	1.38461E-07	1.04959E-07	1.01669E-07	1.15029E-07
127	62650	621500	1.39910E-05	1.14289E-05	1.09833E-05	1.21344E-05	2.05847E-05	1.61630E-05	1.54817E-05	1.74098E-05
128	62651	621510	7.71671E-07	6.16342E-07	6.02391E-07	6.63468E-07	9.97497E-07	7.76931E-07	7.55956E-07	8.43461E-07
129	62652	621520	5.30248E-06	4.12936E-06	3.96132E-06	4.46439E-06	6.84530E-06	5.17779E-06	4.95189E-06	5.65833E-06
130	62653	621530	5.96585E-08	4.49727E-08	4.24739E-08	4.90350E-08	7.92502E-08	5.81575E-08	5.47160E-08	6.40412E-08
131	62654	621540	2.03698E-06	1.51114E-06	1.42935E-06	1.65916E-06	3.49073E-06	2.51970E-06	2.37221E-06	2.79421E-06
132	63651	631510	8.16379E-10	6.79243E-10	6.82379E-10	7.26000E-10	1.03311E-09	8.37375E-10	8.37309E-10	9.02597E-10
133	63653	631530	6.39211E-06	4.99953E-06	4.76648E-06	5.38604E-06	9.83521E-06	7.44141E-06	7.07826E-06	8.11829E-06
134	63654	631540	1.61292E-06	1.28686E-06	1.23527E-06	1.37835E-06	2.82625E-06	2.18020E-06	2.09296E-06	2.36647E-06
135	63655	631550	4.79277E-07	3.73077E-07	3.54836E-07	4.02397E-07	8.20663E-07	6.22044E-07	5.92171E-07	6.78293E-07
136	63656	631560	2.65178E-07	2.00389E-07	1.87578E-07	2.17715E-07	4.58984E-07	3.38890E-07	3.17312E-07	3.71729E-07
137	63657	631570	1.27179E-09	8.94498E-10	8.27837E-10	9.98042E-10	1.85799E-09	1.30070E-09	1.20219E-09	1.45363E-09
138	64654	641540	1.14414E-07	9.38026E-08	9.01277E-08	9.94479E-08	3.14849E-07	2.50291E-07	2.40794E-07	2.68645E-07
139	64655	641550	4.07027E-09	3.33290E-09	3.26990E-09	3.55769E-09	7.84872E-09	6.26444E-09	6.14520E-09	6.75279E-09
140	64656	641560	4.74909E-06	3.64510E-06	3.41892E-06	3.93770E-06	1.25789E-05	9.48581E-06	8.89194E-06	1.03189E-05
141	64657	641570	8.58032E-09	6.47733E-09	6.20778E-09	7.08847E-09	1.61922E-08	1.22241E-08	1.17007E-08	1.33723E-08
142	64658	641580	1.20906E-06	8.66093E-07	8.06509E-07	9.60553E-07	2.89767E-06	2.07438E-06	1.92658E-06	2.29954E-06
143	64660	641600	6.80282E-08	4.64949E-08	4.31966E-08	5.25732E-08	1.28580E-07	8.68599E-08	8.04276E-08	9.86224E-08
144	65659	651590	1.54906E-07	1.06713E-07	9.91074E-08	1.20242E-07	3.14357E-07	2.15813E-07	1.99792E-07	2.43321E-07
145	65660	651600	5.76879E-09	3.95807E-09	3.66134E-09	4.46273E-09	1.30361E-08	8.89727E-09	8.20432E-09	1.00459E-08
146	65661	651610	6.96914E-10	4.66439E-10	4.29629E-10	5.30994E-10	1.08546E-09	7.22735E-10	6.61705E-10	8.23299E-10
147	66660	661600	1.64109E-08	1.14534E-08	1.06477E-08	1.28373E-08	5.18920E-08	3.57117E-08	3.30764E-08	4.02267E-08
148	66661	661610	2.34394E-08	1.60882E-08	1.50139E-08	1.81805E-08	4.47750E-08	3.04981E-08	2.83388E-08	3.45373E-08
149	66662	661620	1.89792E-08	1.31684E-08	1.23194E-08	1.48223E-08	3.97030E-08	2.72365E-08	2.53961E-08	3.07785E-08
150	66663	661630	1.01459E-08	7.01330E-09	6.49915E-09	7.88611E-09	2.40911E-08	1.62818E-08	1.49591E-08	1.84440E-08
151	66664	661640	2.30487E-09	1.65250E-09	1.56378E-09	1.84038E-09	5.56413E-09	3.86657E-09	3.61382E-09	4.34817E-09
152	67665	671650	4.11315E-09	2.94796E-09	2.75068E-09	3.27059E-09	1.19340E-08	8.25000E-09	7.60492E-09	9.26297E-09